Appendix A: Summary of lighting recommendations

CHINA - GB 50034-2004 Standard for lighting design of buildings			
NEEDS & EXPECTATIONS Human, societal, environmental	**PARAMETERS**	**REQUIREMENTS**	
A. INDIVIDUAL NEEDS		Level1	Level 2
VISUAL PERFORMANCE	Illuminance (horizontal) Task area	500 lx	300 lx
	Drawing	500 lx	
	Illuminance (horizontal), computer		
	Meeting room	300 lx	
	Reception	300 lx	
	Corridors	100 lx	50 lx
	Archives	200 lx	
	Illuminances of immediate surroundings	300 lx	200 lx
	Illuminance (vert) on screens		
VISUAL COMFORT	Luminance ratio on task area	1:3 near work place	
	Ceiling luminance	Minimum shielding angle: 10°→ 1-20 kcd/ m^2 15°→ 20-50 kcd/ m^2 20°→ 50-500 kcd/ m^2 30°→ $\geq$ 500 kcd/ m^2	
	Maximum luminances from luminaries overhead	Maximum required luminances 1000 cd/ m^2	
	Wall luminances	Less than 10:3:1	
	Maximum luminance from window		
	Surface reflectance	$\rho_{ceiling}$ 0.6-0.9 , ρ_{walls} 0.3-0.8 $\rho_{working\ planes}$ 0.2-0.6, ρ_{floor} 0.1-0.5	
	Flicker-Free		
	Uniformity task	>0.7	
	Contrast rendering factor	>0.5	
	Uniformity surroundings	>0.5	
	Discomfort glare	UGR $\leq$ 19	
	Reflected glare Veiling reflections	To prevent and reduce glare and veiling reflections: Do not install luminaries in areas which can appear interferences. Don't use material which increase glare. Set maximum value for the illuminance.	
COLOUR APPEARANCE	Colour rendering of light (CRI)	>80	
	Colour temperature of light CCT	3300 K < CCT < 5300 K	
	Use of saturated colours		
	Colour Variations		
WELL-BEING	Contact to the outside	Use daylight as much as possible	
	Light modelling		
	Daylight consideration	Use of daylight allows dimming and switching on/off lamps. Considerations about daylight system.	
	Lighting design	Choose the CCT of lamps according to the characteristics of the place.	
	Aesthetics of space		
	Aesthetics of lighting equipment		
NON VISUAL EFFECTS	Spectral distribution		
	Daily doses		
	Frequency		

	UV amount	
	IR amount	
B. SOCIETY NEEDS		
	Cost, budget	
	Productivity Reduction of complaints More individual control	If it is possible, use automatic lighting control system based on availibility of daylight.
	Maintenance	All the repairs and safety checks should be performed by professionals. A system should be set up for cleaning the luminaries and the lamps according to the standard requirements. All the cleaning work should follow this system. The used luminaries should be changed by new ones when they meet their expected lifetime. When replacing the old luminaries with new ones, make sure that they have similar light output as the original design. Periodic checkup and tests should be performed for the luminaries.
	Lamp type	Fluorescent lamp Should not use incandescent lamps except for reasons described in this standard e.g. dimming, immediate open, often turn on/off, emergency lamps. In this case, the power should be less than 100 W. Considerations according to the environmental particularity (humidity, high temperature…)
	Security	It is better to use battery for emergency sign. The battery should be located beside the place for repair.
	Feeling of safety	The illuminance of emergency lighting should not be lower than 5% of normal lighting. The illuminance of escape lighting > 0.5 lx
	Lighting Management	Occupancy sensors In some buildings according to the requirement, light should automatically control itself, e.g. elevator corridors should dim light automatically during evening.
C. ENVIRONMENTAL NEEDS		
	Use of daylight	Use daylight as much as possible. Refer to the standard GB/T50033 about daylighting.
	Efficiency for peak load	Efficient luminaries should be chosen. Efficiency for fluorescent ceiling luminaries: 60%
	Lighting control	If possible, automatic lighting control system based on availibility of daylight. Paragraph about lighting control in public buildings, gymnasium, cinema, hotel and residential areas. Lighting for corridors, stairs and halls should be controlled in one place and automatically. Controls in groups according to daylight and the usage of buildings. Others considerations.
	Mercury / Harmonics	Do not use mercury vapor lamps in normal indoor areas.
	Lamp extinction	Use of fluorescent lamp, daylight, electronics ballasts. Assessment for energy savings
	Electrical Power density	Level 1:18 W/ m^2

		Level 2: 11 W/ m^2 Current value & target value for different offices (Normal office : 11W/ m^2 and 9 W/ m^2)
	Energy Consumption	When the amount of used electricity is being evaluated, "per user" should be used as the unit. e.g. 45 kW / user.

Some points in the Chinese lighting codes:

1. The requirements of electrical power density for office lighting, commercial lighting, hotel lighting, hospital lighting, school lighting and industry lighting are mandatory, while other items are recommended.
2. In the requirements of electrical power density, there are two values for each place, one is the mandatory value at this moment, and the other value is the target value in the future. For example, the mandatory value for office light level 1(500lx) is 18 W/m^2, and the target value is 15 W/m^2. The mandatory value for office light level 2(300lx) is 11 W/m^2, and the target value is 9 W/m^2.
3. In office lighting with VDTs, the luminance on the surface of luminaire at angles of > 65° to perpendicular bisector is limited. For screen with good quality (class I, II), the value should be lower than 1000 cd/m^2. For screen with bad quality (class III), the value should be lower than 200 cd/m^2.
4. The lighting codes have following proposed items for daylighting:
   - The automatic lighting control system based on the change of outdoor's lighting condition, if possible.
   - Daylighting should be used in indoor lighting by some light tube or reflected installation, if possible.
   - The solar energy should be used, if possible.

JAPAN - The Japanese code JIES-008(1999)		
NEEDS & EXPECTATIONS (Human, societal, environmental)	**PARAMETERS**	**REQUIREMENTS**
A. INDIVIDUAL NEEDS		
VISUAL PERFORMANCE	Illuminance (horizontal) Task area	750 lx < x< 1500 lx
	Illuminance vertical on task area	> 150 lx
	Illuminance (horizontal), computer	500 lx
	drawing	>750 lx
	Illuminances of immediate surroundings	200 lx
	Illuminance (vertical) on screens	
VISUAL COMFORT	Luminance ratio on task area	1:5
	Ceiling luminance	
	Maximum luminances from luminaries overhead	
	Maximum wall luminnances	
	Maximum luminance from window	
	Surface reflectance	
	Flicker-free	
	Uniformity task	> 0.6
	Uniformity surroundings	
	Discomfort glare	range of quality class of discomfort glare D2, D3
	discomfort glare for VDT	D1, D2
	Reflected glare Veiling reflections	luminance limitation of V glare classification luminaire V2 < 200 cd/m^2 V3 < 2000cd/m^2
	Luminaires	G2, V2 (block horizontal line of sight to the lamp) limit glare
COLOUR APPEARANCE	Colour rendering of light CRI	80 < CRI < 90
	Colour temperature of light CCT	CCT > 3300 K
	Use of saturated colours	
	Colour variations	
WELL-BEING	Contact to the outside	
	Light modelling	
	Directional lighting	
	Biophilia hypothesis	
	Aesthetics of space	
	Aesthetics of lighting equipment	
	Daylight control	blinds
NON VISUAL EFFECTS	Spectral distribution	
	Daylight factor	1.5% < x < 2%
	Daily doses	
	Frequency	
	UV amount	
	IR amount	
B. SOCIETY NEEDS		
	Cost, budget	
	Productivity, Reduction of complaints More individual control	
	Maintenance	
	Security	
	Feeling of safety	

C. ENVIRONMENTAL NEEDS		
	Efficiency for peak load	
	Luminous efficacy	
	Mercury / Harmonics	
	Reduction of resources	
	Lamp extinction	
	Electrical Power density	
	Energy Consumption	

European code EN 12464-1; offices		
NEEDS & EXPECTATIONS (Human, societal, environmental)	**PARAMETERS**	**REQUIREMENTS**
A. INDIVIDUAL NEEDS		
VISUAL PERFORMANCE	Illuminance (horizontal) task area	> 500 lx
	Drawing	> 750 lx
	Illuminance (horizontal), computer	> 500 lx
	Illuminances of immediate surroundings	Ambient lighting > 300 lx
	Archives	200 lx
	Illuminance (vertical) on screens	< 200 lx
VISUAL COMFORT	Luminance ratio on task area	1:3 near work place 1:10 for other surfaces
	Shielding	there are minimum shielding angles according to the light level
	Ceiling luminance	
	Maximum luminances from luminaries overhead	Luminances of room surfaces, 40:1. Angles from luminaries and “high value”
	Wall luminnances	Less than 10:3:1
	Maximum luminance from window	
	Surface reflectance	$\rho_{ceiling}$: 0.6-0.9 ρ_{walls}: 0.3-0.8 $\rho_{working\ planes}$: 0.2-0.6 ρ_{floor}: 0.1-0.5
	Flicker-free	avoid flicker & stroboscopic effects by lighting system
	Uniformity task	> 0.7
	Uniformity surroundings	> 0.5
	Discomfort glare	UGR ≤ 19
	Reflected glare Veiling reflections	must be prevented or reduced
COLOUR APPEARANCE	Colour rendering of light CRI	> 80
	Colour temperature of light CCT	3000 K < CCT < 5000 K
	Use of saturated colours	
	Colour variations	
WELL-BEING	Contact to the outside	Window next to work place, with good shading
	Daylight factor	
	Daylight consideration	use of available daylight
	Light modelling	not too directional, not too diffuse
	Directional lighting	on visual task
	Biophilia hypothesis	
	Aesthetics of space	
	Aesthetics of lighting equipment	
NON VISUAL EFFECTS	Spectral distribution	
	Daily doses	
	Frequency	
	UV amount / IR amount	
B. SOCIETY NEEDS		
	Cost, budget	
	Productivity / Reduction of complaints	More individual control
	Maintenance	Maintenance factor must be calculated, a maintenance scheduled must be prepared
	Security	Safety level (min 1 lx emergency lighting), EN 1834
	Feeling of safety	
	Lighting management	

C. ENVIRONMENTAL NEEDS		
	Lighting control	automatic or manual switching and/or dimming
	Efficiency for peak load	
	Luminous efficacy	
	Mercury / Harmonics	
	Reduction of resources / Lamp extinction	
	Electrical power density	
	Energy Consumption	no waste of energy, reduce energy to the max with appropriate lighting technology

1) in the definitions it is said that lighting is to ensure:

- -visual comfort
- -visual performance
- -safety

2) In office lighting with VDTs, the luminance on the surface of luminaire at the angle of > 65° to perpendicular bisector is limited. For screen with good quality (class I, II), the value should be lower than 1000 cd/m^2. For screen with low quality (class III), the value should be lower than 200 cd/m^2.

BRAZIL - CIE S 008/E-2001		
NEEDS & EXPECTATIONS (Human, societal, environmental)	**PARAMETERS**	**REQUIREMENTS**
A. INDIVIDUAL NEEDS		
VISUAL PERFORMANCE	Illuminance (horizontal) Task area, conference room	500 lx
	Illuminance (horizontal), computer	
	Illuminances of immediate surroundings	300 lx
	Drawing	750 lx
	Archives	200 lx
	Illuminance (vertical) on screens	
VISUAL COMFORT	Luminance ratio on task area	
	Ceiling luminance	
	Maximum luminances from luminaries overhead	< 1000 cd/m^2
	Maximum wall luminnances	
	Maximum luminance from window	
	Surface reflectance	$\rho_{ceiling}$: 0.6-0.9 ρ_{walls}: 0.3-0.8 $\rho_{working\ planes}$: 0.3-0.6 ρ_{floor}: 0.1-0.5
	Flicker-free	use DC electrical supply or operating lamps at high frequency (30 kHz)
	Uniformity task	0.7
	Uniformity surroundings	0.5
	Discomfort glare	UGR < 19
	Reflected glare / Veiling reflections	must be prevented or reduced
COLOUR APPEARANCE	Colour rendering of light CRI	>80
	Colour temperature of light CCT	
	Use of saturated colours	
	Colour variations	
	Daylight factor	> 1% within 3m from the window
WELL-BEING	Contact to the outside	window is required to provide part or all lighting
	Light modelling	not too directional not too diffuse
	Directional lighting	
	Biophilia hypothesis	
	Aesthetics of space	
	Aesthetics of lighting equipment	
NON VISUAL EFFECTS	Spectral distribution	
	Daily doses	
	Frequency	
	UV amount	
	IR amount	
B. SOCIETY NEEDS		
	Cost, budget	
	Productivity, Reduction of complaints More individual control	
	Maintenance factor	< 0.7
	Security	
	Feeling of safety	
	Lighting Management	
C. ENVIRONMENTAL NEEDS		

	Efficiency for peak load	
	Luminous efficacy	
	Mercury / Harmonics	
	Reduction of resources	
	Lamp extinction	
	Electrical power density	
	Energy consumption	

1) In the definitions it is said that lighting is to ensure:

- -visual comfort
- -visual performance
- -safety

2) In the office lighting with VDT, the luminance on the surface of luminaire at the angle of > 65° to perpendicular bisector is limited. For screen with good quality (class I, II), the value should be lower than 1000 cd/m^2. For screen with low quality (class III), the value should be lower than 200 cd/m^2.

RUSSIA - SNiP 23-05-95 Daylight and Artificial Lighting		
NEEDS & EXPECTATIONS (Human, societal, environmental)	**PARAMETERS**	**REQUIREMENTS**
A. INDIVIDUAL NEEDS		
VISUAL PERFORMANCE	Illuminance (horizontal) task area	With general lighting 300 lx With supplemented lighting: supplementary 400lx & general 200lx
	Drawing	With general lighting 500 lx With supplemented lighting: supplementary 600lx & general 400 lx
	Illuminance (horizontal), computer	With general lighting 400 lx With supplemented lighting: supplementary 500lx & general 300 lx
	Conference room	300 lx
	Reception, lounge, lobbies	150 lx
	Archives	With supplemented lighting 75 lx
	Corridors	main corridors 75 lx other corridors 50lx
	Illuminance (vertical) on screens	200 lx
VISUAL COMFORT	Maximum luminances from luminaries overhead	Maximum permissible luminance of the work plane are given according to area of work surface: $\leq$ 500 cd/ m^2 for area $\geq$ 0,1 m^2
	Wall luminances	
	Luminaire distribution	
	Maximum luminance from window	
	Optimum size range for task detail	
	Surface reflectance	$\rho_{ceiling}$: 0.7-0.8 ρ_{walls} :0.4-0.5 $\rho_{working\ planes}$: 0.25-0.4 $\rho_{furniture}$: 0.25-0.4 ρ_{floor} : 0.25-0.4
	Flicker-free	In rooms where a stroboscopic effect can occur, adjacent lamps must be connected to three phases of the supply voltage or supplied with electronic ballasts.
	Uniformity task	Uniformity ratio (maximum illuminance to minimum) Fluorescent lamp $\leq$ 1,3 Other light sources $\leq$ 1,5 Over task area $\leq$ 1,5 or 2
	Contrast rendering factor	
	Discomfort glare	
	Reflected glare Veiling reflections	Supplementary lighting: luminaires with opaque reflectors, luminous element not in the field of vision of workers.
COLOUR APPEARANCE	Color rendering of light CRI	CRI = 55 (offices, work rooms, designing and drafting rooms) CRI = 85 (artistic offices, service offices)
	Color temperature of light CCT	3500 K-5000 K
	Use of saturated colors	
	Color variations	
WELL-BEING	Contact to the outside	Rooms without daylight are permitted only in specific ones (example: located in basement floors of buildings).
	Psychological effects	

	Light modeling	Supplementary lighting is permitted to achieve the optimum spatial planning arrangements.
	Daylight consideration	Daylight is divided into side, top and combination (side & top) lighting. Consideration about the calculation of the daylight factor according to the visual task categories and the type of room.
	Daylight factor	Daylighting with side lighting: DF(office)= 1% DF(Design office)= 1.5% DF(conference hall)=0.7% DF(computer room)=1.2% Combined daylight-artificial lighting with side lighting: DF(office)= 0.6% DF(Design office)= 0.9% DF(conference hall)=0.4% DF(computer room)=0.7%
NON VISUAL EFFECTS	Spectral distribution	
	Daily doses	
	Frequency	
	UV amount	
	IR amount	
B. SOCIETY NEEDS		
	Cost, Budget	
	Productivity Reduction of complaints More individual control	Increase the recommended illuminance in rooms where more than 50% of workers are older than 40 years.
	Maintenance	
	Lamp type	Fluorescent lamp, white color, Metal halide lamp Discharge lamps & Incandescent lamps
	Security	Emergency lighting consists of safety and evacuation lighting, Evacuation lighting shall provide illumination on the floor of main passages and on stair steps. Luminaires for safety lighting may be used for evacuation lighting. Lighting device for emergency lighting may be used with the normal lighting system or normally off (switched on automatically)
emergency lighting	Feeling of safety	Minimum illuminance for evacuation lighting : rooms 0.5 lx / Outdoors: 0.2 lx Uniformity of evacuation lighting ≤ 40:1 (ratio of maximum to minimum illuminance on the centerline of evacuation passages) Minimum illuminance for safety lighting : 0.5 lx At a level of 0.5m from the ground.
	Lighting Management	
C. ENVIRONMENTAL NEEDS		
	Use of daylight	Use of daylight: with top lighting, with side lighting, with combined top-side lighting. Use of combination of daylight-artificial lighting.
	Efficiency for peak load	Use of efficient discharge lamps.

	Lighting control	Supplementary lighting shall be equipped with dimming.
	Luminous efficacy	Luminance efficacy ≥ 55 lm/W Fluorescent lamp: Ra≥ 80 → >65 lm/W Ra ≥ 60 → > 75 lm/W Metal halide lamp: Ra ≥ 80 → >75 lm/W Ra ≥ 60 → > 90 lm/W
	Mercury / Harmonics	
	Reduction of resources	
	Lamp extinction	
	Electrical power density	Maximum allowed power density (W/m^2) according to the illuminance on work surface and room index (Kr)
	Energy consumption	

AUSTRALIA – AS 1680.1-2006, AS 1680.2.2-1994, AS 1680.2.0-1990		
NEEDS & EXPECTATIONS (Human, societal, environmental)	**PARAMETERS**	**REQUIREMENTS**
A. INDIVIDUAL NEEDS		
VISUAL PERFORMANCE	Illuminance (horizontal) task area	320 lx
	Drawing	600 lx
	Illuminance (horizontal), computer	320 lx
	Conference room	240 lx
	Reception, lounge, lobbies	160 lx
	Visual task near threshold	
	Illuminances of immediate surroundings	Not less than the maintained illuminance recommended for the task. Not less than 240 lx for combined system (local&general lighting) or task illuminances>600 lx
	Corridors	40 lx
	Illuminance (vertical) on screens	Good, simple: 240 lx Average detail: 320 lx Poor, fine detail: 600 lx
VISUAL COMFORT	Luminance ratio on task area	2:1 between task and background $<3:1$
	Visual comfort probability	
	Ceiling luminance	With luminous ceiling, average < 0.5 kcd/ m^2 For indirect lighting systems: Average luminance < 0.5 kcd/m^2 Max luminance <1.5 kcd/m^2
	Maximum luminances from luminaries overhead	Upward light-output ratio at least 0, 3. 55°→ 6 kcd/ m^2 65°→ 3 kcd/ m^2 75°→ 2 kcd/ m^2 85°→ 2 kcd/ m^2
	Wall luminances	Illuminance for the background/environment: office & computer room: 160lx drafting office: 240 lx
	Luminaire distribution	Maximum 3:1
	Maximum luminance from window	
	Surface reflectance	$\rho_{ceiling} > 0.8$ ρ_{walls} 0.3-0.7 $\rho_{working\ planes}$ 0.2-0.5 $\rho_{furniture}$ 0.2-0.5 $\rho_{floor} <0.4$
	Flicker-free	To avoid flicker and stroboscopic effects by lighting system. For incandescent lamps, oscillations are small; for discharge lamps, oscillations can be more marked. Depend on sensitivity, amplitude
	Uniformity task	≥ 07 (over the task area)
	contrast rendering factor	Definition. Further details in CIE 19.21.
	Discomfort glare	UGR ≤ 19
	Reflected glare Veiling reflections	Luminaires adjustable in position and orientation Fixed or adjustable task lighting Medium-height partition screens (1.5 m to 1.8 m above floor)
COLOUR APPEARANCE	Color rendering of light CRI	80≤ CRI < 90

	Color temperature of light CCT	Warm <3300 K Intermediate 3300 K ≤ 5300 K
	Use of saturated colors	For decorative effect
	Color variations	Uniform color appearance Compatible with the light sources
WELL-BEING	Contact to the outside	People prefer to work with daylight
	Ergonomics (modify work environment to correspond to human capabilities and limitations)	Rearranging of the workstations in order to reduce discomfort glare.
	Psychological effects	Diffuse reflection from the screen, conspicuous reflections in dark, high-gloss desk tops can give rise to distraction and annoyance. Indirect lighting can result in an unstimulating environment for work.
	Light modeling	A combination of diffuse and directional light
	Daylight consideration	Use available daylight. CIE models for lighting design of daylighting systems.
	Daylight factor	
	Directional lighting	Highly directional lighting provides uneven general illumination, sharp deep shadows and harsh modeling. Luminous ceilings should not be installed in interiors where screens-based task is used unless space has a room index of 2 or less.
	Biophilia hypothesis	
	Lighting design	Lighting design procedure: flowchart, description of lighting design stages. Establish design objectives (safety, identifying visual tasks, creating appearance and atmosphere) and design constraints (costs, environmental consideration,…) to have a safe and healthy environment., choice of surface finishes, use of dayligt.
	Aesthetics of space	The sense of space and of form can be influenced by appropriate lighting design. No real considerations about aesthetics.
	Aesthetics of lighting equipment	Unity in lighting equipment: using of luminaires having a related shape or by harmony of layout. Special interior design considerations to integrate the lighting equipment.
NON VISUAL EFFECTS	Spectral distribution	
	Daily doses	
	Frequency	
	UV amount	
	IR amount	
B. SOCIETY NEEDS		
	Budget, cost	Economic analysis includes costs, depreciation, taxation, inflation, operating costs, and capital.
	Productivity Reduction of complaints More individual control	Local lighting for individual control. Flexibility is the prime requirement.
	Maintenance	Maintenance of electric and lighting system (to save costs and energy and prolong life of the system).
	Lamp type	
Emergency lighting	Security	Safety lighting system can be incorporated into any other lighting system. Emergency evacuation lighting system is useful if the normal lighting system is failing. Color for identification and safety. Colored patch

		on the wall have to be at least 2m above the floor.
Emergency lighting	Feeling of safety	To facilitate the recognition of hazards in general and in relation to specific physical tasks. Illuminating safety warning sign and safe pathways within space.
	Lighting management	Manual methods, automatic control, computer-based control.
C. ENVIRONMENTAL		
	Use of daylight	The electric lighting serves to supplement daylight. Combined electric lighting and daylighting systems.
	Efficiency for peak load	Energy savings from reduction in electrical load: choice of lamps, control gear, luminaires, arrangement of luminaires, high reflectance finishes.
	Lighting control	Automatic or manual switching and/or dimming may be used. (Manual switch, remote switches, time switches, PIR motion sensor and photocells). Dimmers can be controlled manually or automatically. Electronic control gear will give superior performance with discharge lamps.
	Luminous efficacy	
	Mercury	
	Reduction of resources	Use of daylight, energy conservation, control of internal and external heat gains or losses
	Harmonics	
	Lamp extinction	
	Electrical power density	
	Energy Consumption	Windows and rooflights have a significant impact on the net annual energy consumption. Design and effective management of windows, increasing window areas (find the optimum window area), control of solar gain, new and more efficient fenestration systems can reduce the energy consumption.

Nepal - J.B. Gupta, Electrical installation estimation and costing, New Delhi, 1995, 7th edition		
NEEDS & EXPECTATIONS (Human, societal, environmental)	**PARAMETERS**	**REQUIREMENTS**
A. INDIVIDUAL NEEDS		
VISUAL PERFORMANCE	Illuminance (horizontal) task area	General lighting oriented towards the working surface
	Drawing	Shadowless light
	Illuminance (horizontal), computer	
	Conference room	
	Reception, lounge, lobbies	100 lx
	Visual task near threshold	
	Illuminances of immediate surroundings	300 lx
	Corridors	
	Archives	
	Illuminance (vert) on screens	
VISUAL COMFORT	Luminance ratio on task area	< 3:1
	Luminance reflected in the screen (for elevation angles of 65° or more)	
	Visual comfort probability	
	Ceiling luminance	
	Maximum luminances from luminaries overhead	Large floor area: luminaries mounted close to the ceiling (direct light)
	Wall luminnances	
	Luminaire distribution	
	Maximum luminance from window	
	Optimum size range for task detail	
	Surface reflectance	

USA - ANSI/IESNA RP-1-04, American National Standard Practice for Office Lighting		
NEEDS & EXPECTATIONS (Human, societal, environmental)	**PARAMETERS**	**REQUIREMENTS**
A. INDIVIDUAL NEEDS		
VISUAL PERFORMANCE	Illuminance (horizontal) task area	High contrast and simple task 100 lx High contrast and large visual target size 300 lx Low contrast and large visual target size or high contrast and small visual target size 500 lx Low contrast and small target size 1000 lx
	Drawing	Horizontal 1000 lx Vertical 500 lx
	Illuminance (horizontal), computer	300 lx vertical 50 lx
	Conference room	Meeting: horizontal 300lx, vertical 50 lx Video: horizontal 500 lx, vertical 300 lx
	Reception, lounge, lobbies	Horizontal 100 lx Vertical 30 lx
	Visual task near threshold	3000 - 10000 lx
	Illuminances of immediate surroundings	
	Corridors	50 lx
	Archives	
	Illuminance (vert) on screens	
VISUAL COMFORT	Luminance ratio on task area	Between task and immediate surrounding 3:1 Between task and remote 1:10
	Luminance reflected in the screen (for elevation angles of 65º or more)	
	Visual comfort probability	VCP > 70 % Open plan office VCP > 80
	Ceiling luminance	Without VDT screen: $L_{ceiling\ (maximum)} < 10 \times L_{task}$ With VDT screen: $L_{ceiling\ (maximum)} < 850\ cd/m^2$
	Maximum luminances from luminaries overhead	Respect angles and intensity limits to prevent from glare 55º: 300 cd, 65º: 220 cd, 75º: 135 cd, 85º: 45 cd
	Wall luminances	
	Luminaire distribution	Ceiling luminance ratio: maximum=8:1, Best= 2:1, good=4:1
	Maximum luminance from window	
	Optimum size range for task detail	Reading at desk: 10-12 point
	Surface reflectance	$\rho_{ceiling}$ 0.8 ρ_{walls} 0.5-0.7 ρ_{floor} 0.2-0.4 $\rho_{furniture}$ 0.25-0.45 $\rho_{partitions}$ 0.4-0.7 surface specularity must be considered

Appendix B: Questionnaire of lighting system control

This questionnaire has been established by the AIE annex 45 in order:

- To identify the needs of the Building user
- To identify the parameters of the lighting control schemes and systems.

This will help the manufacturer or designer to predict the strategies of lighting control.

Identification

Building coordinates

Building name			
Address (street)		Number	
City		ZIP	
Country		State	

Building type

Offices ☐
Hospitals ☐
Educational buildings ☐
Manufacturing factory ☐
Hotels, bars and restaurants ☐
Wholesale and retail service ☐
Sporting areas ☐
Other ☐

Contact person

Coordinates:

Name			
Address (street)		Number	
City		ZIP	
Country		State	
Telephone		Fax	
E-mail			

Function :

Building energy manager ☐
Building designer (architect, engineering team…) ☐
Building user ☐
Maintenance team ☐
Other ☐

Lighting design control

The most important barrier to using lighting control systems is:

- There are no barriers ☐
- Uncertain functioning ☐
- Too expensive ☐
- No (or not enough) energy saved ☐
- Not economically justifiable ☐
- Other (please specify) ☐

…………………………………………………………………………………………
…………………………………………………………………………………………

Lighting control is a way to:
(scale 1 to 5, 1 not important, 5 very important)

- Save energy ☐
- Perform maintenance on luminaires ☐
- Adapt the lighting conditions to the task ☐
- Be informed on the status of the luminaires ☐
- Improve the image of the building ☐
- Improve the productivity of employees ☐
- Improve the well-being of the building users ☐
- Install (expensive) useless systems ☐
- Render the building and its environment dynamic ☐
- Other (please specify) ☐

…………………………………………………………………………………………
…………………………………………………………………………………………

Lighting control has to be designed by :
(scale 1 to 5, 1 not important, 5 very important)

- The architect ☐
- The building manager ☐
- The building owner/user ☐
- The engineering team ☐
- The lighting manufacturer ☐
- Other (please describe) ☐

…………………………………………………………………………………………
…………………………………………………………………………………………

Lighting control is expensive:

- Yes ☐
- Yes, but with a justifiable payback time ☐
- No ☐
- No idea ☐
- It depends on the system ☐

Lighting control has to be function of:
(scale 1 to 5, 1 not important, 5 very important)

Absence ☐
Presence ☐
Clock control ☐
Colour control ☐
Daylight ☐
Occupant's demand ☐
Other (please describe) ☐
…………………………………………………………………………………………
…………………………………………………………………………………………

Lighting control is best a control
(scale 1 to 5, 1 not important, 5 very important)

For the whole building ☐
By building wing/building orientation ☐
By floor ☐
By room ☐
By work zone ☐
By work place ☐
Other (please describe) ☐
…………………………………………………………………………………………
…………………………………………………………………………………………

Lighting control shouldn't be only on/off, it should happen in a gradational way (i.e. continuous dimming or dimming in one or more discrete steps)

Yes ☐
No ☐
No idea ☐

Lighting control has to be flexible and modular :

Yes ☐
No ☐
No idea ☐

It is important to maintain the lighting system, in order to attain at every moment the desired lighting level

Yes, maintenance should be performed at a regular basis (following a fixed scheme) ☐
Yes, maintenance is important but punctual interventions (lamp changing, …) will do ☐
No, maintenance is not important ☐
No idea ☐

Background of the lighting control design questionnaire

Aims

The aim of this document is to describe the technical background of the questionnaire. Answers in the questionnaire may be very useful to help the lighting control designer to understand the needs of the building user.

Explanations

The identification of the uses helps the designer to understand the way he has to design the installation : in a basic school, an On/Off system coupled with daylight dimming may satisfy but in certain offices, it could be necessary to go one step further by integrating more advanced techniques.

The identification of the person who answered the questionnaire may be very useful to understand its needs. The building energy manager will be more interested by the energy consumption and the energy savings.

Asking the perception of the people on the barriers of lighting control may give information about the type and quality of lighting control system that can be applied (basic On/Off switching system, advanced daylight dimming system,…).

Identifying the best person for the designing of the lighting control system delivers information on the perception of the building control system.

Choosing an architect as lighting designer may indicate that the correspondent wants to generate an added value to the building as e.g. a dynamic object. Or that he wants the building to have different possible aspects during day time and night time.

Asking about the type of control gives information on the techniques that will be used for the installation of the sensors. i.e. the cabling of a central clock control will not be the same as the one of a local daylight dimming system.

Asking for the size of the zone controlled by a sensor or input device is very important.

Daylight dimming may be very interesting in case of local zoning but it may not be acceptable in case of control by floor or by building wing. A clock control is best used in case of floor control (including, of course, possibility of derogation).

Identifying the way that the flux can be varied, gives information on the way the control by the sensors has to happen : Switching or dimming (step by step or continuous)

The questions may be linked and structured according to the figure below.

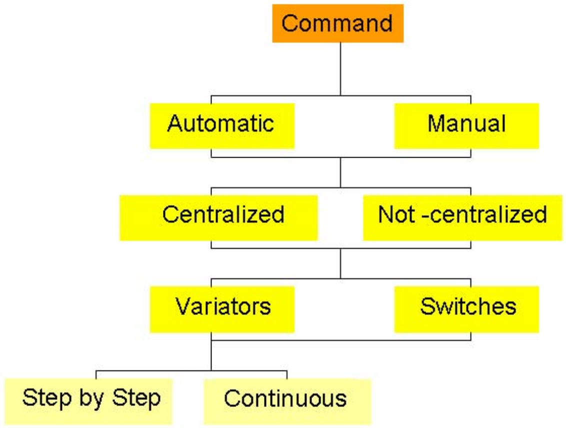

Figure B-1. *Commissioning process.*

The question on flexibility and modularity of the lighting system may be considered as information about the future affectations of the building. For some buildings (i.e. rented offices) light structure walls are displaced and spaces are reorganized regularly. A change of the lighting control system than has to be possible and has to be as easy as possible.

The question on maintenance wants to identify whether the correspondent is aware of the need of a regular maintenance scheme in order to assure a desired light level or considers punctual interventions (e.g. changing of broken lamps) to be enough. In the latter case, he should be informed on possible light comfort problems in the future.

Appendix C: Published articles

Tetri & Halonen. Guidebook on energy efficient electric lighting for buildings. 11th European Lighting Conference. Lux Europa 9-11 September 2009, Turkey. pp. 761-768.

Pohl. Energy efficient electric lighting. 11th European Lighting Conference. Lux Europa 9-11 September 2009, Turkey. pp. 785-792.

Halonen, Tetri: Needs and challenges for energy efficient lighting in developed and developing countries. Light & Engineering, Vol. 17, No. 1, pp.5-10, 2009.

Halonen, Tetri: Lighting Efficiency and LED Lighting Applications in Industrialized and Developing Countries. The 5th International Conference ILUMINAT 2009, Sustainable Lighting. Cluj-Napoca, Romania, 20 February 2009

Halonen: Efficient Lighting for the 21st Century. Balkan Light 2008. Ljubljana, October 7 - 9, 2008, p. 39-44. Invited paper.

International Workshop on Visual Quality and energy efficiency in indoor lighting: today for tomorrow, Rome, Italy, presentations by Annex participants.

- *Aizenberg:* Integral approach to design building engineering systems design: Lighting, heating, air- conditioning as an effective way to energy saving
- *Bisegna& Gori:* Generic algorithms for lighting design optimization.
- *Chen & Wang &Li:* A stand-alone solar lighting system for electrodeless fluorescent lamp
- *Dehoff:* ELI and LENI – Tools for the evaluation and presentation of human aspects and energy efficiency in lighting
- *Halonen:* Lighting Energy Usage and Lighting Efficiency in Industrialized and Developing Countries – IEA ECBCS Annex 45
- *Kaase:* Optimized illumination improving energy efficiency and quality of light
- *Pohl:* Energy efficient lighting solutions – trends and chances
- *Tetri:* Usability of LEDs for General Lighting

Tetri & Pohl: Concepts and techniques for energy efficient lighting solutions. Fifth International Conference, Improving Energy Efficiency in Commercial Buildings (IEECB'08)

J. Aizenberg, Integral approach to design building engineering systems: (lighting, heating, air-conditioning) - as an effective way to Energy Saving, Fifth International Conference, Improving Energy Efficiency in Commercial Buildings (IEECB'08)

Fontoynont M., Long-term economical assessment of lighting systems, Light and engineering, 2007.

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Tetri E. Energiatehokkaat valaistusratkaisut (Energy efficient lighting solutions). Projektiuutiset 5/2007, pp. 66-69.

Bhusal P., Tetri E., Halonen L. Quality and Efficiency of office lighting. Proceedings of the

4th European Conference on Energy Performance and Indoor Climate in Building and the 27th International Conference AIVC, Lyon, France, 20-22 November 2006, pp. 535-540.

Halonen L., Tetri E. 2006. IEA ECBCS Annex 45 - Energy efficient electric lighting for buildings. Lighting of work places: proceedings. Fifteenth International Symposium Lighting Engineering 2006, Bled, Slovenia. Lighting Engineering Society of Slovenia. pp. 5-10.
Truus Debruin. 2006. Dayligt and electric light in School buildings, Dutch Journal of Building Physics.

Matorski Z. Influence of new lighting technologies into electrical networks and installations. EURO-SINE Electrical networks and Installations in EU Legislation Acts. SEP – Association of Polish Electrical Engineers. Silesian University of Technology and Silesian Chamber of Civil Engineers. Ustron, Poland. pp. 125-134.

Mantorski Z., Sitko A. 2006. Digital dta transmission using low voltage power line. Silesian University of technology Scientfic Bulletin Elektryka, no 198, pp. 85-98.

Mantorski Z. Energy efficient ligting in buildings – Annex 45. XIV National Lighting Conference, Lighting techniques 2005. pp. 73-74.

Merzwinski S. Efficient energy consumption. Information on Silesian university of technology participation in iea programmes. z zycia Politechniki slaskiej, March 2007 No 6(170), pp. 26-29.