Implications of Indoor Environment Quality in an Office Environment

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OUTLINE

1. Ergonomics
2. What is indoor environment quality (IEQ)?
3. Major components affecting IEQ
4. New rating scheme (TAIL Criteria)
5. Discussion of the TAIL Parameters and tips to control them.

Ergonomics

What is Ergonomics?

The science of studying people at work, and designing the workplace to fit the worker.

Ergonomics is not only for making the work better but also making it more comfortable and efficient

- Ergonomic Risk factors
  - Force
  - Awkward postures
  - Repetition (Inadequate recovery)
  - Vibration

What is Indoor Environment Quality?

- Indoor environmental quality (IEQ) refers to indoor conditions in a building related to the health of those who occupy it.

Image source: shorturl.at/ouxH7

Major components to IEQ

- There are four major factors to IEQ
  - Thermal Environment
  - Acoustic Environment
  - Indoor Air Quality
  - Lighting

Acronym “ TAIL”

Other factors affecting IEQ in office building

- Ergonomics
- Water quality
- Vibration

Thermal Environment

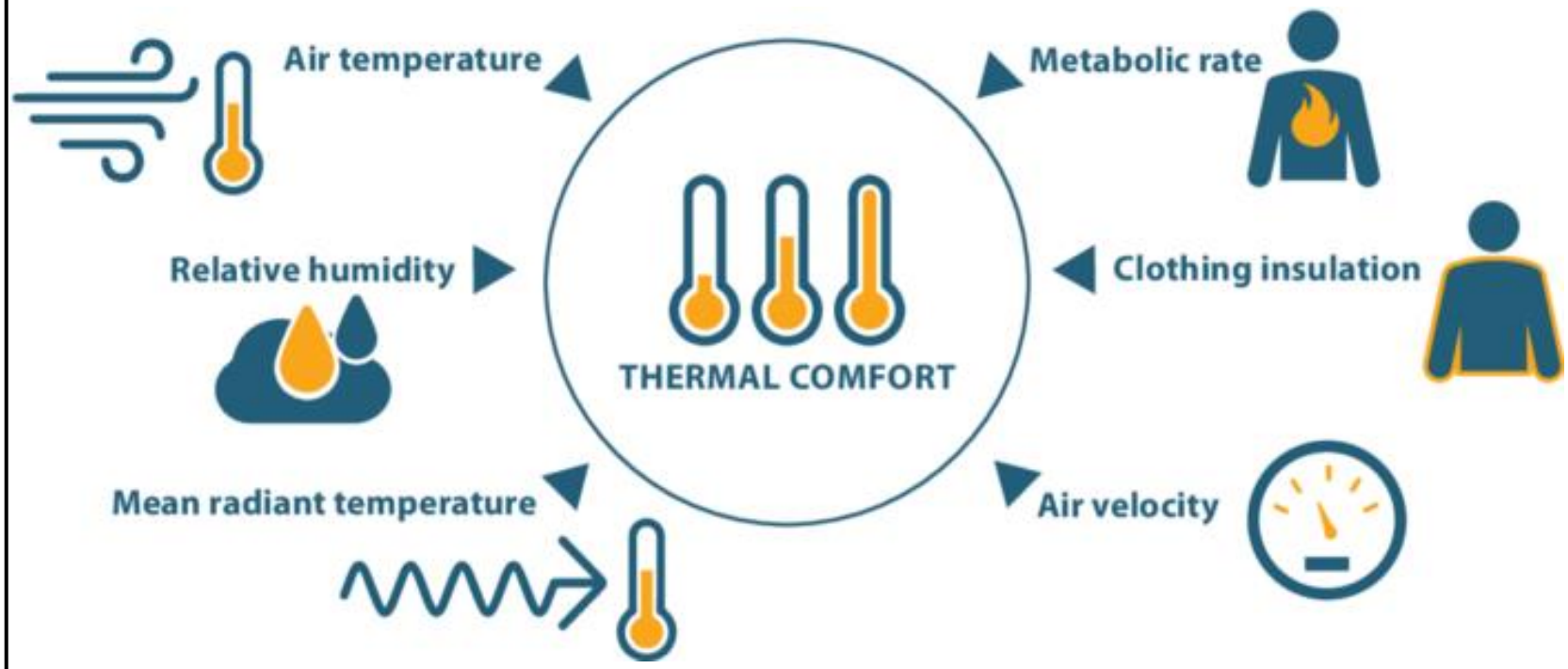


Image source: https://rb.gy/rdgkit

Acoustic Environment (Noise)

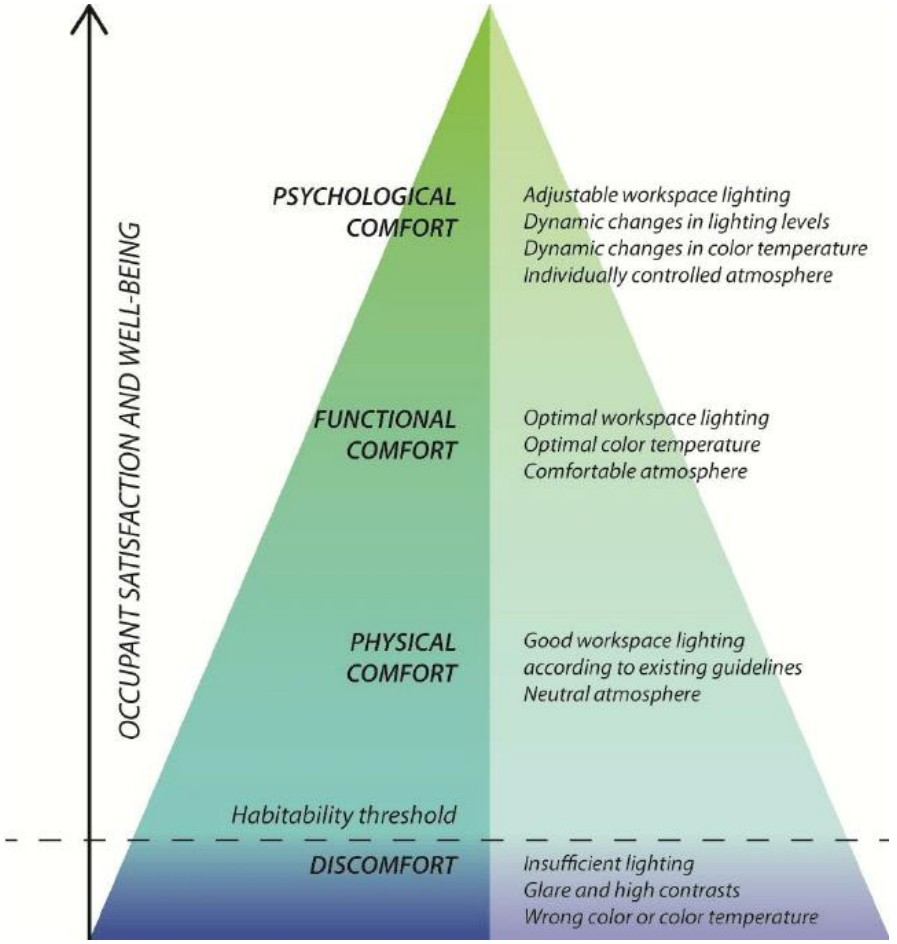
- Office equipment
  - Printer, fax, server
- Type of office space
  - cubicle, open, private
- *“Overall acoustic quality”*

Indoor Air Quality

- Indoor environments are complex. Exposures can include a variety of contaminants in the form of gases and particles such as:
  - Office machines
  - Cleaning products
  - Water-damaged building material
  - Microbial growth (fungal, mold, and bacterial)
  - Insects
  - Carpets and furnishings
  - Perfumes

Lighting Environment

- Visual Comfort
  - Type of light
  - Exposure time
- Good lighting should conside the following:
  - Sufficient lighting for the task
  - Is there unwanted dark spots or shadows?
  - Excessive glare; especially on the screen?
  - Enough contrast between task and background?



New rating scheme for IEQ

- TAIL Criteria
- Rating thermal, acoustic, IAQ, and Lighting
  - Based on 12 measurable parameters
    - Temperature heating
    - Temperature cooling
    - Noise
    - CO^2
    - Outdoor air (OA) supply
    - Relative Humidity (RH)
    - Visible Mold
    - Benzene *
    - Formaldehyde*
    - PM 2.5
    - Radon **
    - Lighting

extracted from: Wargocki et al (2021), "TAIL, a new scheme for rating indoor environmental quality in offices and hotels undergoing deep energy renovation (EU ALDREN project)", Energy & Buildings 244 (2021) 111029

* Part of VOC measurement
** only in basements

	parameter	Green	Yellow	Orange	Red
T = quality of thermal environment	temperature (heating)	21-23°C	20-24°C	19-25°C	<19 or >25°C
	temperature (cooling)	23.5-25.5°C	23-26°C	22-27°C	<22 or >27°C
	OHCOW temp*	23.3-24.3°C	22-25°C	21-26°C	<21 or >26°C
A = quality of acoustic environment	noise (small office)	≤30 dBA	≤35 dBA	≤40 dBA	>40 dBA
	noise (open office)	≤35 dBA	≤40 dBA	≤45 dBA	>45 dBA
	COPE (2003)	42-48 dBA for open plan offices (background & foreground noise)			
	ASHRAE (NC/RC dBA_{eq})	*≤35 dBA for small offices ≤45 dBA for open plan offices*			
I = quality of indoor air	CO_2 *(misprint?)*	*≤550 ppm above background*	*≤800 ppm above background*	*≤1350 ppm above background*	*>1350 ppm above background*
	MOL CO_2 (1983)**	<270 ppm above background	≤470 ppm above background	≤670 ppm above background	>670 ppm above background
	1983 background 330 ppm	<600 ppm	<800 ppm	<1000 ppm	1000+
	2022 background 420 ppm	<700 ppm	<900 ppm	<1100 ppm	1100+
	outdoor air (OA) supply	≥10 L/s/p + 2.0 L/s/m^2	≥7 L/s/p + 1.4 L/s/m^2	≥4 L/s/p + 0.8 L/s/m^2	<4 L/s/p + 0.8 L/s/m^2
		≥21 cfm/p + 0.4 cfm/ft^2	≥15 cfm/p + 0.28 cfm/ft^2	≥8.5 cfm/p + 0.16 cfm/ft^2	<8.5 cfm/p + 0.16 cfm/ft^2
	OA supply (ASHRAE) "comfort"	recommended **minimum** OA supply (with default occupancy density): offices: 2.5 L/s/p + 0.3 L/s/m^2; classrooms: 5 L/s/p + 0.6 L/s/m^2			
		recommended **minimum** OA supply (with default occupancy density): offices: 5 cfm/p + 0.06 cfm/ft^2; classrooms: 10 cfm/p + 0.12 cfm/ft^2			
	OA supply (NADR) infection control	≥14 L/s/p + 7.1 L/s/m^2	14 L/s/p + 7.1 L/s/m^2	10 L/s/p + 5.8 L/s/m^2	<10 L/s/p + 5.8 L/s/m^2
		≥30 cfm/p + 1.4 cfm/ft^2	30 cfm/p + 1.4 cfm/ft^2	21 cfm/p + 1.15 cfm/ft^2	<21 cfm/p + 1.15 cfm/ft^2
		>6 ACHeq	6 ACHeq	4 ACHeq	<4 ACHeq
	RH	30-50%	25-60%	20-70%	<20% or >70%
	Verheyen & Bourouiba#	40-60%	35-65%	30-70%	<30%* or >70% (*lower if condensation on windows)
	visible mold	no visible mould	Minor moisture damage, minor areas with visible mould (<400 cm^2)	Damaged interior structural component, larger areas with visible mould (≤2500 cm^2)	Large areas with visible mould (≥2500 cm^2)
	NIOSH Dampness & Mold Assessment Tool	no **visible mold**, water **damage or stains**, **wet or damp** building materials	**visible mold/damage or stains/wet or damp** area ≤ the size of a sheet of paper [≤600 cm^2]	**visible mold/damage or stains/wet or damp area** > than a sheet of paper to the size of a standard door [600-15,000 cm^2]	**visible mold/damage or stains/wet or damp** area > than the size of a standard door [15,000 cm^2 or 1.5 m^2]
	building material moisture detection	criteria in manual of moisture testing device			
	Health Canada*** VOCs	≤0.3 mg/m^3	≤3 mg/m^3	≤25 mg/m^3	>25 mg/m^3
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	radon	≤100 Bq/m^3	≤300 Bq/m^3		>300 Bq/m^3
L = quality of lighting	lighting (% of time between 300-500 lux)	60-100%	40-60%	10-40%	<10%
	CSA: 75-300 lux for computer work; 200-500 lux for both computer & reading (% of time)	80%	70%	60%	50%

Thermal Environment (TAIL Criteria)

- The indoor air temperature is used describe the quality of the thermal environment

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* these are based on field data collected by OHCOW (applicable to heating & cooling seasons)

Thermal Environment controls

Ideal conditions

- Balanced HVAC system providing heating and cooling to all areas of the building within the parameter listed in the TAIL Criteria

Poor conditions

- Space heaters,
- Localized air conditioners,

Acoustic Environment

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Acoustic controls

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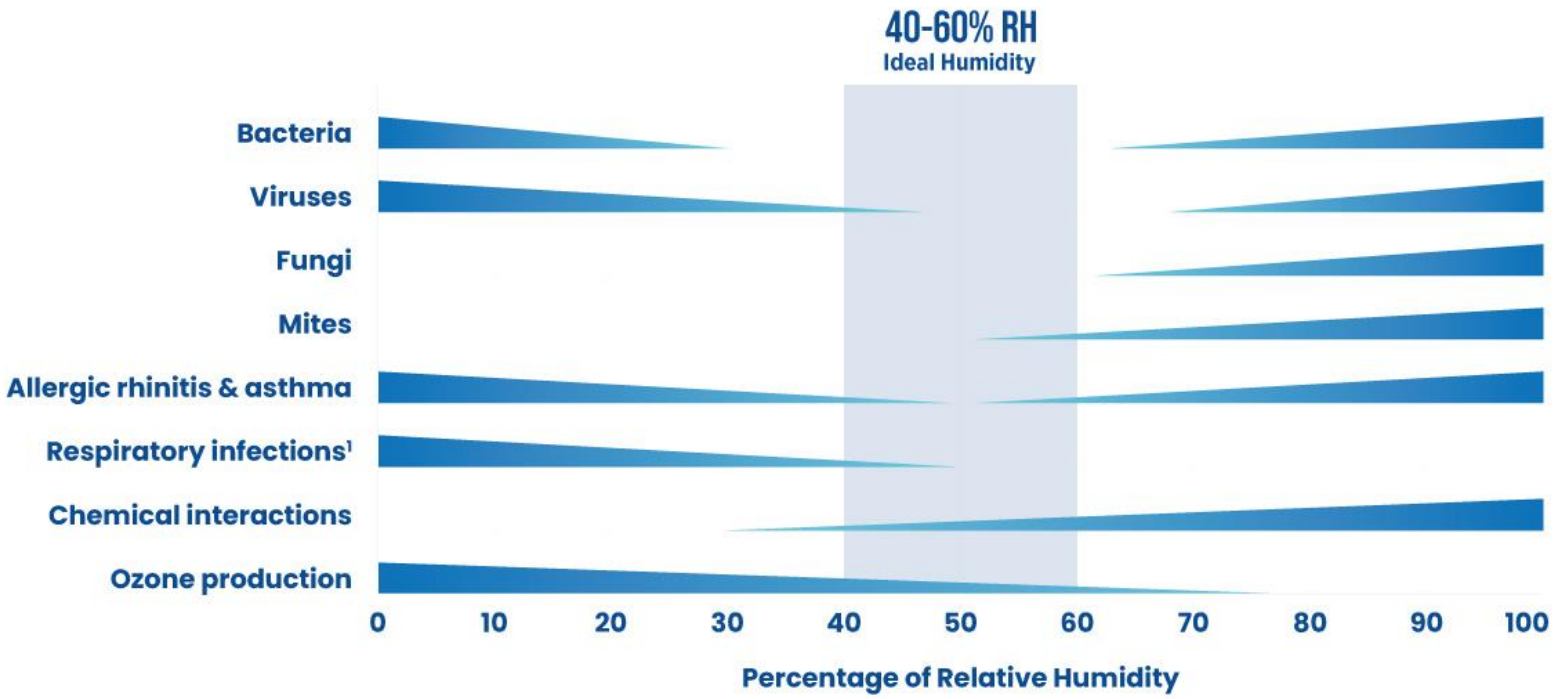
Relative humidity



Indoor Air Quality

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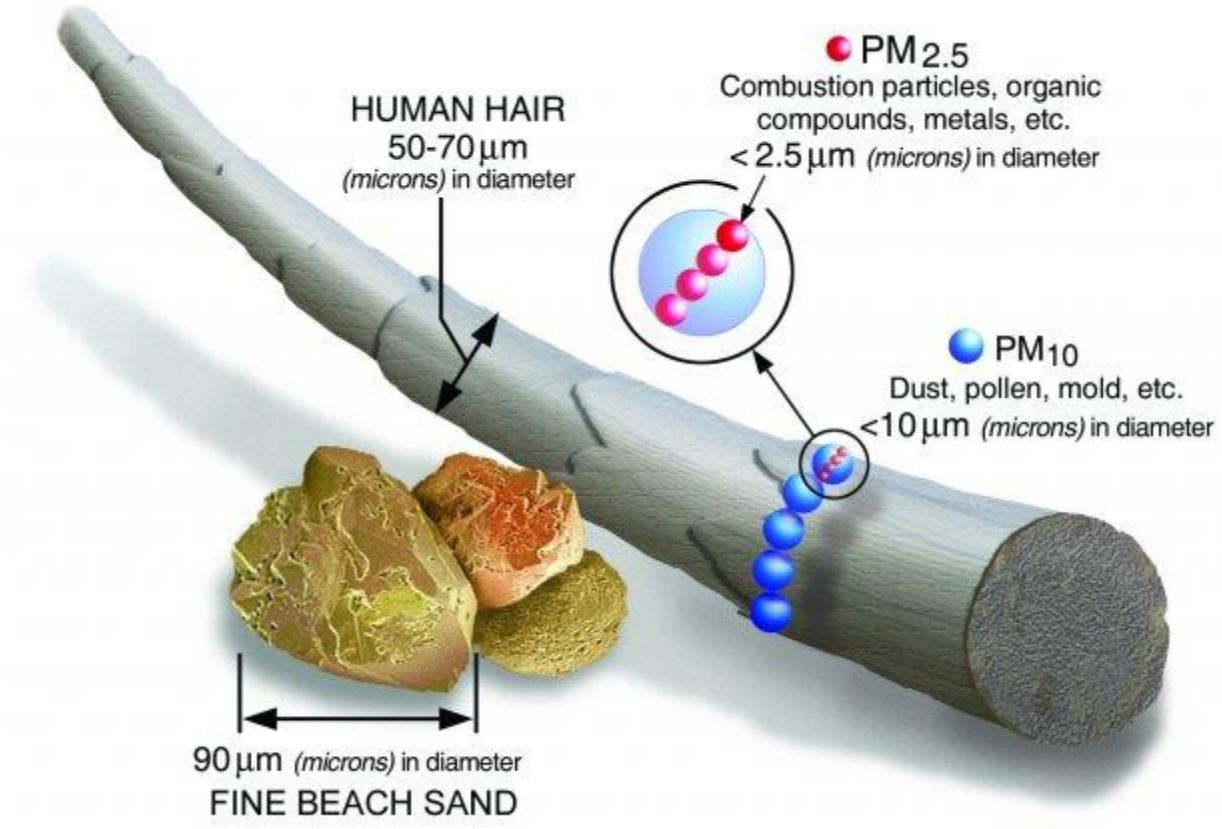
PM 2.5


HUMAN HAIR
50-70 µm
(microns) in diameter
PM2.5
Combustion particles, organic compounds, metals, etc.
< 2.5 µm (microns) in diameter
PM10
Dust, pollen, mold, etc.
<10 µm (microns) in diameter
90 µm (microns) in diameter
FINE BEACH SAND

Indoor Air Quality

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CARBON MONOXIDE LEVELS CHART

0 ppm	**Recommended Safe Level**	
6 ppm	WHO 24 Hour Average	
9 ppm	ASHRA 8 Hour Average EPA 8 hour 8 Hour Average NAAQS 8 Hour Average WHO 8 Hour Average	
25 ppm	ACGIH 8 Hour Average	
30 ppm	WHO 1 Hour Average	
35 ppm	NIOSH 8 Hour Average NAAQS 1 Hour Average	Physical symptoms after 6-8 hours.
50 ppm	OSHA 8 hour Average (PEL)	
30-69 ppm	UL 30 Day Alarm	
87 ppm	WHO 15 Minute Average	
70-149 ppm	UL 1-4 Hour Alarm	
200 ppm	NIOSH 15 minute STEL	Physical symptoms after 2-3 hours.
150-399 ppm	UL 10-50 Minute Alarm	Physical symptoms in 1-2 hours. Life threatening 3 hours.
400+ ppm	UL 4 Minute Alarm	Physical symptoms in 45 minutes. Unconscious in 2 hours. Fatal in 2-3 hours.
800 ppm		Physical symptoms in 20 minutes. Fatal within 1 hour.
1,600 ppm		Physical symptoms in 5-10 minutes. Fatal within 25-30 minutes.
3,200 ppm		Physical symptoms in 1-2 minutes. Fatal within 10-15 minutes.
6.400 ppm		
12,800 ppm		Fatal within 1-3 minutes.

Physical Symptoms
physical symptoms may include headache, fatique, dizziness and/or nausia.

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Indoor Air Quality

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Control measures for IAQ

- Increase ventilation rate and fresh air intake.
- Proper maintenance of the ventilation system
- Regular filter changes to catch PM 2.5 particles MERV 11 or higher (HEPA filters or ≥ *MERV 13 for COVID 19 control)
  *minimum efficiency rating value
- Portable air cleaners
- Ensure gas appliances are well ventilated (gas stoves should have exhaust fans to remove CO)

Lighting

- Appropriate lighting can reduce eye fatigue, headaches and prevent workplace accidents
- Important for health and well being and productivity of the employees
- Inadequate lighting causes people to adopt poor or awkward postures

Lighting

L = quality of lighting	**lighting (% of time between 300-500 lux)**	60-100%	40-60%	10-40%	<10%
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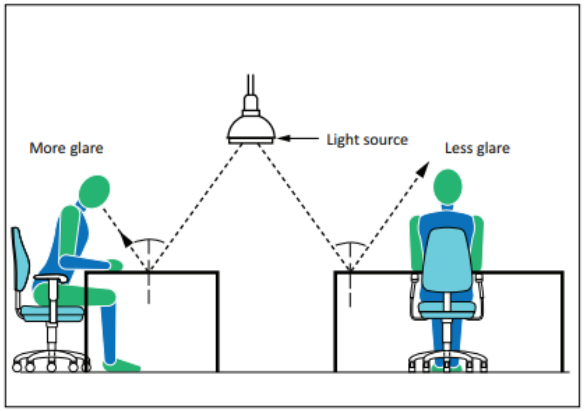
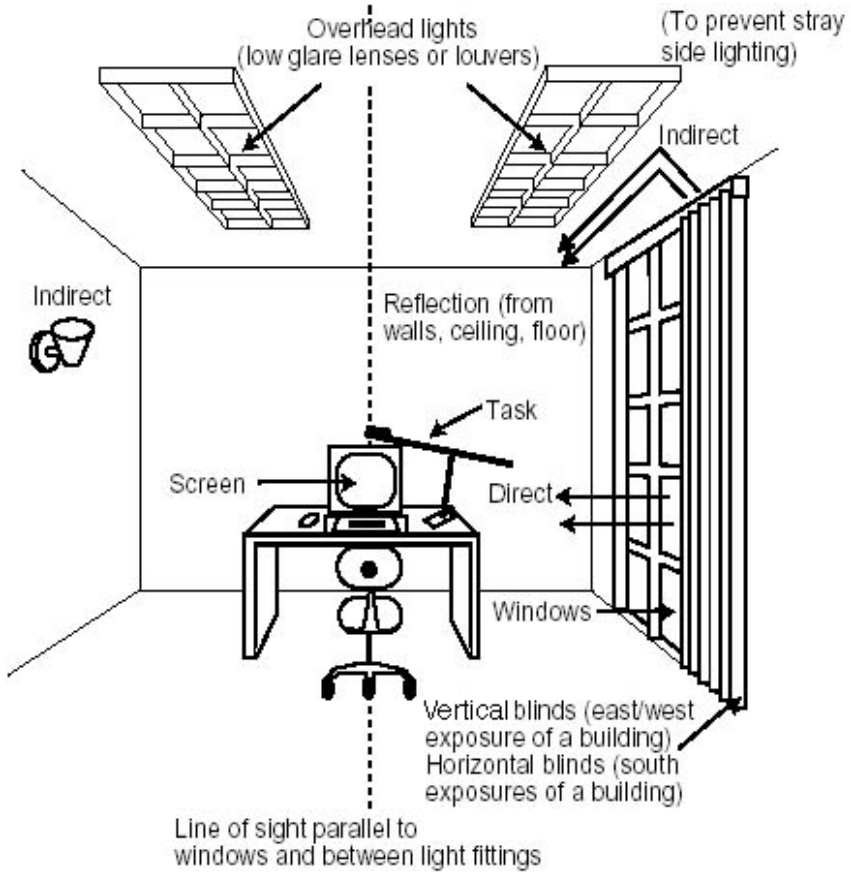


Lighting controls



Positoning a Workstation Among Various Light Sources

[Source: OSHA]

Summary

- Overall IEQ depends on 4 major factor in a building. All of which complement an ergonomic workstation.
  - Temperature
  - Acoustic environment
  - Indoor Air Quality
  - Lighting

Consider the indoor environment quality of the building when completing an office ergonomics assessment.

Thank you for your attention

If you have any questions about ergonomics or any other occupational health concern, contact OHCOW at:

Phone: **1-877-817-0336**

E-mail: ask@ohcow.on.ca

Website: http://www.ohcow.on.ca