

MSc. Facilities Management Services and Energy Performance of Buildings

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Introductions

Taking 5 minutes describe:

- *Your current job role*
- *Your previous experience(s)*
- *What you would like to get out of this module*

Module learning outcomes

1. *Systematically understand the issues involved in operationally managing building engineering services.*
2. *Critically analyse building engineering services maintenance strategies.*
3. *Critically evaluate energy procurement and management.*

Schedule of topics

- Introduction to module
- Comfort
- Thermal properties of buildings, heating system choices
- Boilers, (including biomass) and CHP
- Heat pumps, air-conditioning and ventilation systems
- Building control systems
- Hot and cold water services, above ground drainage
- Electricity, small power and lighting design
- Legislation, policies and procurement
- Energy management and auditing
- Building integrated renewables

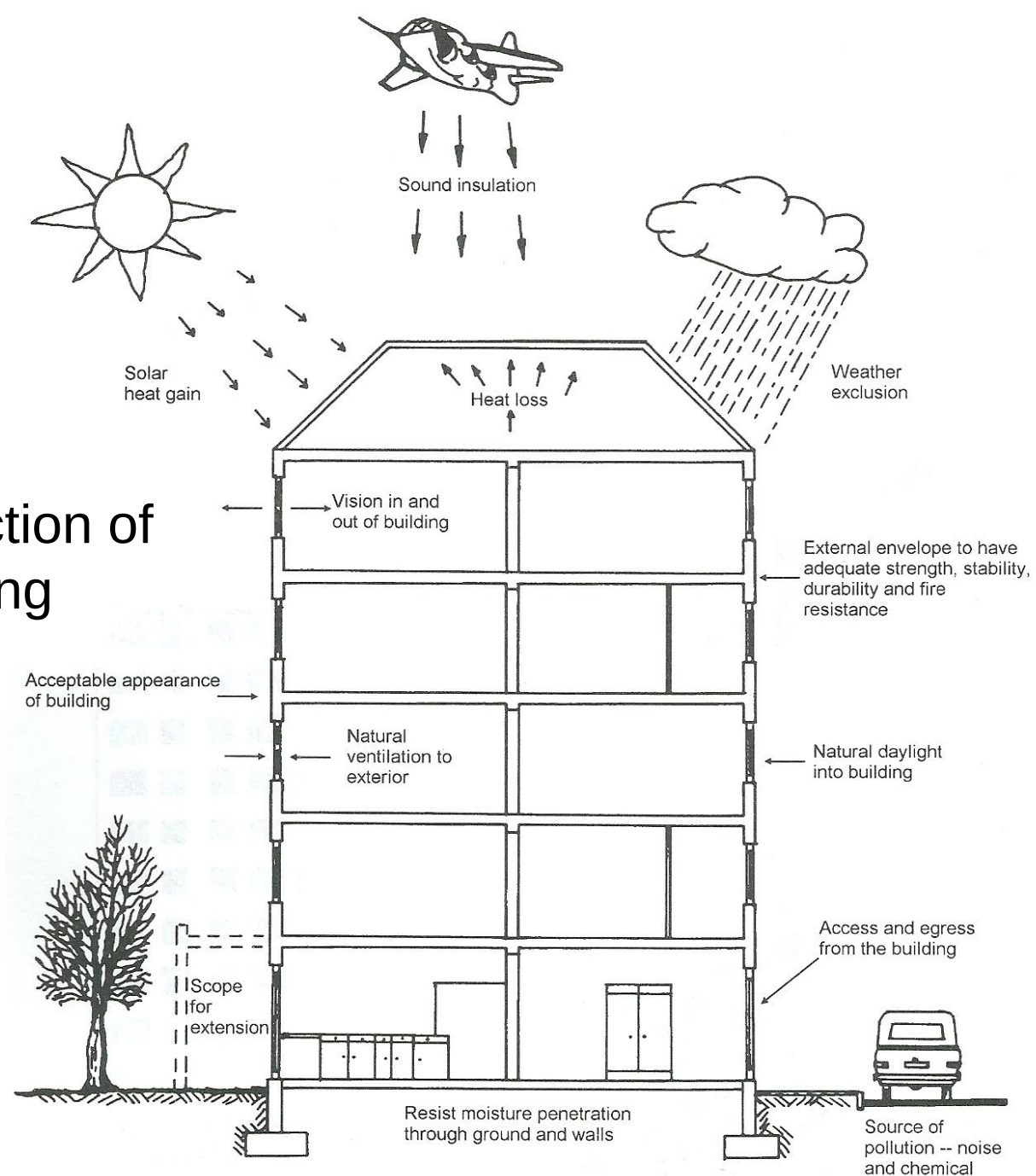
Why energy performance?

- Finite Resources
- Rising Population
- Greater Focus on Energy Efficiency
- Rising Costs
- Increasing Legislation
- Renewables?

The need for maintenance

- Give examples that relate to your organisation
- Do they fit into these groups?
 - To provide a safe and healthy environment
 - To satisfy legal requirements
 - To protect the value of the property or asset
 - To provide a service and safeguard image
 - To reduce utility consumption
- Any others?

general function of a building



Services

- Services are essential in making buildings habitable and comfortable;
- Services ensure the health and well-being of occupants are maintained;
- Cost effective (controllable cost);
- The 'People Factor'.

Comfort

- Sitting Comfortably?
- Often said, but what does it mean?
- How important is comfort to building users?

- Buildings modify the external, natural environment by moderating the climate and providing protection and shelter;
- Designers need to understand how the external climate, the building fabric and the human body interact.

- One of the primary functions of buildings and building services is to create and maintain a comfortable environment;
- Thus the design of a building (and services) must provide a good thermal, aural and visual environment i.e. fresh air and warmth or cooling, good lighting and no unwanted noise or odours.

- Design criteria exists for all of these factors;
- Problem is comfort is subjective!
- Aim is to keep most people happy most of the time.
- What are the factors which affect human comfort?

Poor 'comfort' conditions inc.

- Uncomfortable temperatures;
- Low humidity;
- Low air movements;
- Low ventilation rates;
- Unsuitable lighting & decoration;
- Low daylight;
- Uncomfortable seating;
- All the above lead to low morale, general dissatisfaction and poor productivity.

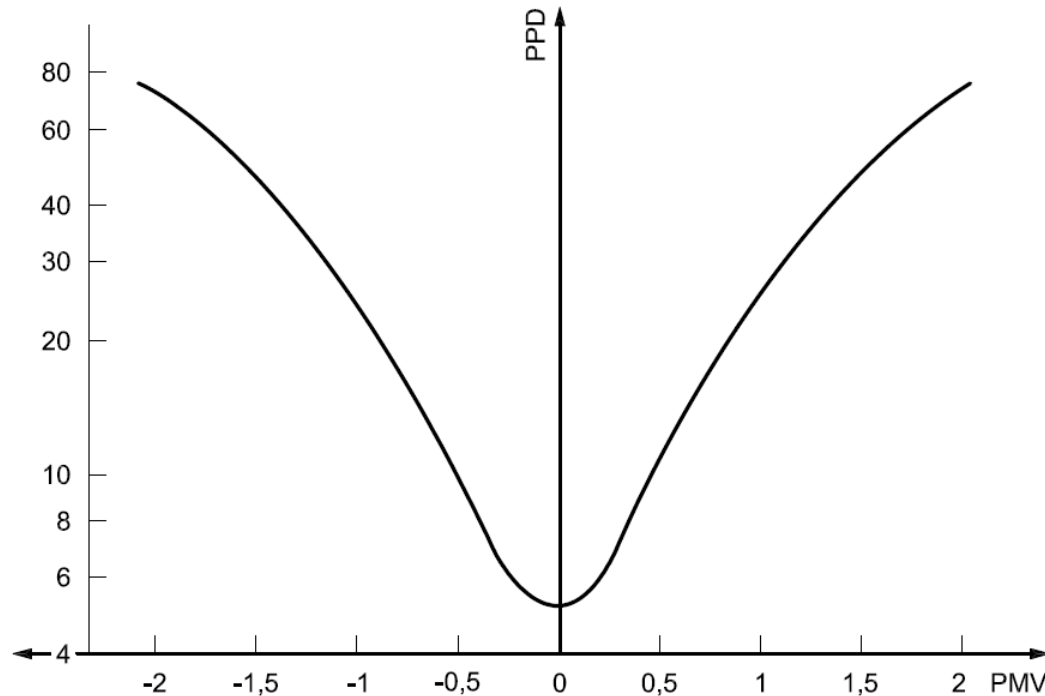
Thermal Comfort

- Defined in British Standard BS EN ISO 7730 as:
- ‘that condition of mind which expresses satisfaction with the thermal environment’;
- How does the body lose excess heat?
- How is it determined?
- How does the body produce heat?

- HSE considers 80% of occupants should be thermally comfortable;
- Therefore, thermal comfort is not measured by air temperatures, instead it is measured by the number of people complaining;
- What are the environmental factors which affect human comfort?
- What are termed the 'personal factors' and 'the variables'?

“The predicted mean vote (PMV) combines the influence of air temperature, mean radiant temperature, air movement and humidity with that of clothing and activity level into one value on a thermal sensation scale ...” source: CIBSE Guide A – chapter 1

EN ISO 7730:2005



Key

PMV predicted mean vote

PPD predicted percentage dissatisfied, %

Figure 1 — PPD as function of PMV

- Thermal comfort is psychological;
- It can affect morale;
- Productivity might fall – refusal to work in cold areas;
- Contribute to sick building syndrome (SBS);

Six basic factors

- Environmental –
 - Air temperature
 - Radiant temperature
 - Air velocity
 - Humidity
- Personal –
 - Clothing insulation
 - Metabolic heat

Sensation of warmth

Is influenced by the following main environmental parameters:

- air temperature
- radiant temperature
- air velocity
- relative humidity

And personal variables

- Age, sex, activity & clothing
- Activity – typical heat outputs of human body

Activity	Example	Heat emission
Immobile	Sleeping	70 W
Seated	Watching TV	115 W
Light work	Office	140 W
Heavy work	Lifting	440 W

Clothing

- Thermal insulator – maintain body at comfortable temperature;
- Clothing values (1Clo = 0.155k/m²/W) or 1.55 togs

Clo value	Clothing example	Comfort temp. when sitting (°C)
0 clo	Naked; swimwear	29
0.5 clo	Light trousers, shirt, light dress	25
1.0 clo	Business suit; dress jumper	22
2.0 clo	Heavy suit, overcoat, hat, gloves	14

Operative temperature

“The operative temperature (θ_c), like the dry resultant temperature combines the air temperature and the mean radiant temperature into a single value to express their joint effect.”

At indoor air speeds below 0.1 m/s the equation is:

$$\Theta_c = 1/2 \theta_{ai} + 1/2 \theta_r$$

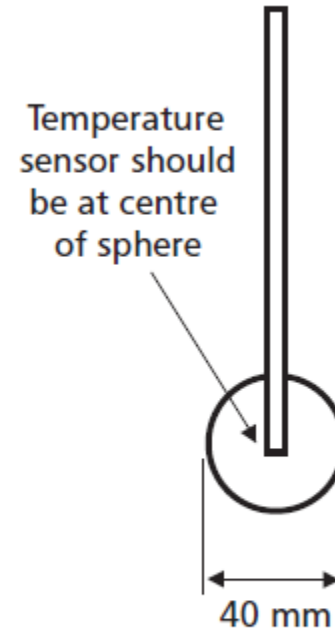


Figure 1.22 Schematic of a globe thermometer

Other comfort issues

- Thermal discomfort – too hot or cold;
- Thermal stress – heat stress or cold stress;
- Harmful medical conditions – dehydration, heat exhaustion, hypothermia or hyperthermia.

Recommended thermal comfort criteria (winter temperatures)

- Offices –
 - boardrooms 22-23°C;
 - computer rooms, corridors, drawing offices, entrance halls, toilets 19-21°C;
 - Office space (cellular/open plan) 21-23°C;
- Air supply rate 10 litres/second per person

Control of summer overheating, high external temperatures:

- Affect ability to naturally ventilate (nv) buildings;
- Cooling potential of (nv) limited by prevailing climate & occupant expectations of thermal comfort;
- Main design features:
 - Good solar control;
 - Modest internal gains;
 - Acceptance that peak space temperatures will exceed 25°C for some periods of time.

Acoustic comfort

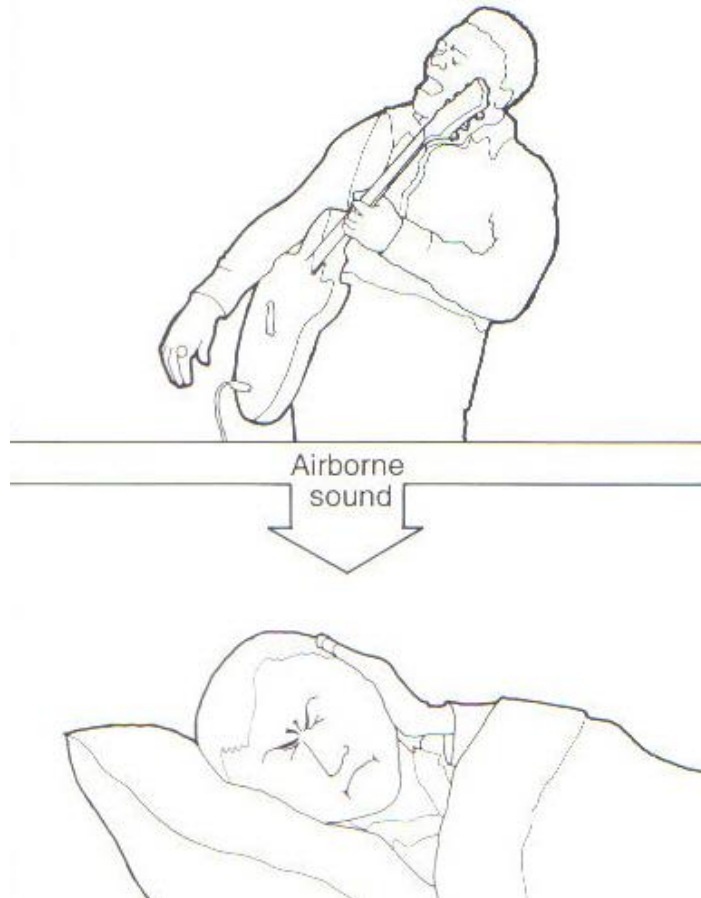
- Main requirement is quiet environment to do task without distraction;
- Noise can affect people in different ways:-
 - Annoyance
 - Masking
 - Hearing damage
- Frequency from: 20 Hz to 20 000 Hz
- Sound pressure level from: $2 \times 10^{-5} \text{ N/m}^2$ to 200 N/m^2 ;
- Measured in decibels (dBA).

Environmental factors for sound

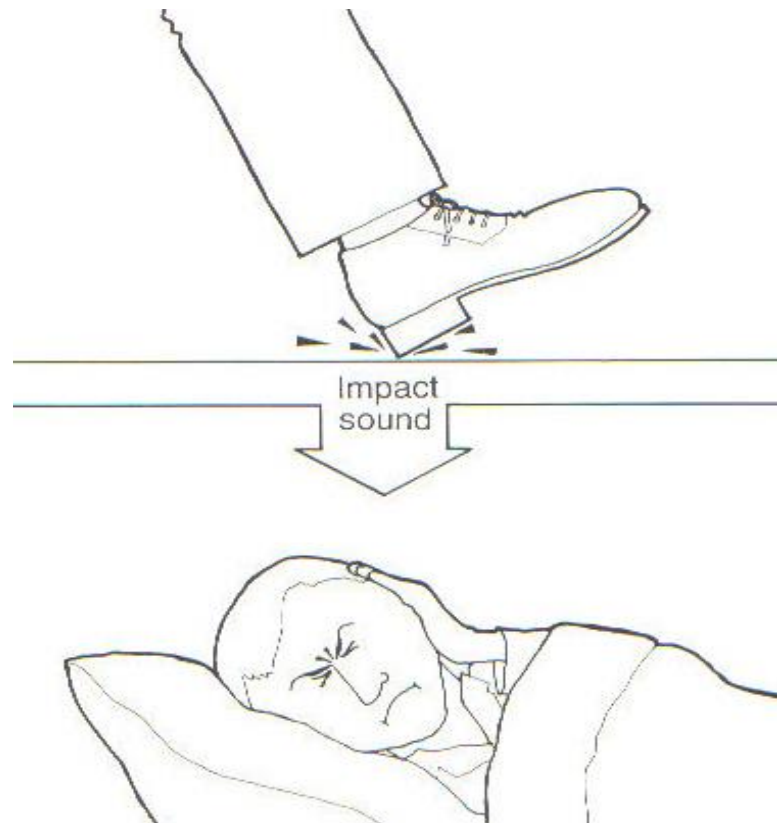
- Sound reaches us in two ways:
 - Airborne;
 - Structure-borne;
- Noise reduction (best stop noise at source);
- Sound reduction index (reduction of sound passing between rooms or buildings).

Noise Transfer

Airborne sound – including voices, radios, traffic and aircraft noise



Impact or structure-borne sound – such as footsteps, hammering, slamming doors, vibrations



Noise Reduction

- Airborne
 - Mass;
 - Completeness;
 - Absorption.
- Structure-borne
 - isolation.

Visual Comfort

- Lighting in buildings has three purposes –
 - To enable the occupants to work and move about safely;
 - To enable tasks to be performed correctly and at an appropriate pace;
 - To create a pleasing appearance.

Visual Comfort

Factors affecting visual comfort include:

- Quantity
- Distribution
- Directional effects
- Discomfort glare
- Colour (temperature)

How bright is comfortable

Quantity of light or illuminance is usually expressed in lumens/m² or lux;

- Moonlight = 0.5 lux
- Sunlight = 100 000 lux
- Shop = 500 lux
- Corridors = 100 lux
- Offices 300-500 lux
- Computer rooms = 500 lux

Daylight

In new projects good daylight design starts at site layout stage;

- Try to make use of daylight, but avoid glare;
Glare can have two effects:-
- **Disability** glare – vision impaired by dazzle from bright light source;
- **Discomfort** glare – visual discomfort from very bright light e.g. sunlight or bright lights.

AVOID blinds down, lights on!!

Further Reading

- CIBSE Guide A – Chapter 1: Environmental criteria for design