Mechanical
Electrical
Energy
Water
Sustainability

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Guidelines
Sustainable Services & Thermal Comfort

Residential Buildings &
Small to Medium Size Commercial Premises

Basis of document:

- These guidelines may be freely distributed, but without alteration/deletion, and with full acknowledgement of the Author
- This information and other technical information can be found on our web-site, for the benefit of all designers and Clients. www.understandingenergy.com.au
- In a general document like this cost-effectiveness cannot be readily categorised. Your designer may be able to assist you in investigating the options. Alternatively the technical staff at Healey Engineering can assist.
- We offer no guarantee for your own assessment of your facilities, and professional help is recommended to overview your findings and to implement them effectively.

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Comfort, Energy Savings, Payback

The energy cost for a small building will range from $ 70 to $ 20 per square metre a year. This applies to residential and commercial. Energy saving schemes can only fund small capital works items, not entire (say) lighting or air conditioning systems.

"Payback period" concepts also do not formally account for environmental externalities such as pollution created, imported fuels (strategic societal issue) and depletion of non-renewable energy resources. An NPV (net present value) calculation is more realistic than payback period, but is still only a more accurate "payback" calculation. An NPV can also include a "notional" value for carbon (for example), or for direct pollution items to bias toward greater sustainability.

This report looks at comfort and liveability on the basis that staff productivity of comfortable occupants is a much greater cost factor. Conventional solutions (eg: air conditioning systems) do not automatically bring comfort. Even where theoretically "perfect" conditions are achieved (usually at ridiculous energy cost) comfort may not be achieved. Mechanical comfort systems control surrounding air temperature, not comfort.

The sustainable solutions proposed give better working conditions, and allow occupants a greater degree of personal control of comfort, as well as environmental benefits. These are the target, a better long term total investment.

In most workplaces basic comfort relates to occupant satisfaction and productivity. The salaries paid can be 50 to 200 times the energy cost in an office building. Lost productivity is far more expensive than the power bill.

The Basic Issues

Concepts

Sustainable comfort involves the careful design of the building. This is the integration of shade, sun penetration, insulation, and cross ventilation.

Affordable sustainable comfort in summer comes from the combination of good cross ventilation in mild weather, and night cooling on still nights in warm and hot weather. Air conditioning is then needed on fewer occasions, a desirable supplement.

Affordable sustainable comfort in winter involves heat gain from solar, preferably by passive gain, alternatively by active solar air collectors. Again this minimises the need for heaters or air conditioners. Then possibly this gained heat may need to be re-distributed to cooler areas of the building (lower floors, south aspect).

Heating or cooling the surrounding building structure is more important for comfort than simply controlling the air temperature. That is why a "naturally" comfortable building is more pleasant than a "heated" or "cooled" building.

Shape, Aspect, Insulation, Ventilation

The most important issue is a sound building design. This could be described as "Shape, Aspect, Insulation, and Ventilation". These need be dealt with by the Architect / Builder first so that the money will be spent on mechanical systems (if any) will be effective.

Building & Energy Codes

Buildings that meet the energy requirements of the Building & Energy Codes (the BCA in Australia) will achieve a basic level of insulation and solar control.

Beyond the Building Codes – Solar PV

Solar electric power from Grid-PV can make your building "zero-energy". But why isn't that "carbon neutral" or "sustainable". When you bought the solar PV system you sold the "Solar Credits" (RECs) to the market. This is a subsidy to encourage solar, BUT you have just sold your Carbon-Equivalent to a power station or an airline or a car fleet. And what about the overnight power you use?

Beyond the Building Codes – Mechanical Systems

Further detailed design can take a building from basic compliance to 6 stars plus.

- Passive solar gain
- Double glazing
- Air leakage
- Free cooling & night cooling systems
- Climate wizard
- Geothermal heating, cooling & dhw
- Solar-air thermal collectors
- Solar-water thermal & electric modules
- Heat transfer & de-stratification
- Controlled cross ventilation

Cross ventilation is mainly needed in warm weather; hence the air flow needs to occur at high level. Low level airflows cause drafts and blow papers off the table. The design of our windows and doors usually blocks this airflow above the 2100 lintel height, keeping the pocket of hot air that needs to be removed. Internal doors need to go to ceiling height, or more effectively, and open-able transom window/panel above the door should be provided.

Estimating & Modelling the Energy

The question to ask is "why don't some buildings actually meet their estimated design performance"? The answer lies in air leakage, and insulation that do not work, so the building doesn't operate as you thought.

Air Leakage

Massive heat loss, discomfort, and drafts can occur from even subtle leaks. Take time to experiment to detect them on a windy day. Close all doors and windows, then stand in an open doorway; you may be surprised by the draft. Sources of air leakage are:

- weather board framed construction
- suspended timber floors – gaps between boards, and gaps at the wall
- drainage holes in windows
- no weather stripping on doors
- fans without shut-off dampers
- short-glazing on lavatory windows
- gap at the wall ceiling joint
- vent holes in light fittings (down light tubs, recessed fluoro lights)

- (and more!)

Roof-Ceiling Insulation

Bulk fibre insulation (fibreglass, wool, acrylic etc) is the most effective These do not meet their Code-Rated performance claims in roof-ceiling systems. Batts are more effective (and expensive) with a paper or foil layer. Batts given better long-term results than loose material.

Foil sheet insulation (alone: usually multiple foil sheets separated by an insulating air gap) is reasonably effective in summer (controlling radiant heat) but much less so in winter compared with bulk fibre. Consider this insulation for a retrofit in difficult locations (under floor, high roof).

Suspended Floors

Floor insulation under raised floors is often neglected and not required in the codes in many climate zones. In every situation and climate zone a significant qualitative improvement can be made by insulating the under floor, and taking measures to reduce air leakage.

Double Brick

In some climate zones the recommended "building code" level of insulation does not require bulk insulation in "double brick & cavity" walls. Double brick walls do not perform anywhere near their claimed performance. This is because much of the thermal mass is ineffective, and the calculated "R values" are simplistic and do not account for real life. We advise that 25 mm rigid or semi-rigid insulation boards or batts installed (during construction) give a significant boost to qualitative comfort in that building. This occurs because the internal leaf of the brick wall acts as affective thermal mass when insulated.

Direct Solar Gain

(a) *Solar Gain – Residential*

Direct solar gain is usually desirable, but care must be taken that glare (say TV viewing) is not prominent.

(b) *Solar Gain – Office Buildings*

Heat gain from direct solar radiation is not very useful when directed into the working spaces, as it is accompanied with glare. Also in temperate Climate zones the need for heating in active office zones ceases mid-morning even on a cold day.

(c) *The Total Building*

The above indicates that the solar windows need be biased slightly to morning collection (say 15 degrees E of N), but not too far E as to give a solar gain problem in summer. Direct solar radiation can be brought in from north-facing windows (or glass blocks) into "circulation" spaces such as corridors, foyers, meeting rooms, utility areas and lunchrooms. The air con RA grilles can be best located close to these solar collection areas.

(d) *Shading & Sun Control*

All windows need control of the sun heat and glare. Buildings without sun control end up with ridiculous ineffective schemes of multiple internal blinds, reflective treatments, tinting, and are still plagued with glare and radiant heat of the hot glass. The heat calculations for the commonly used "sun control" internal blinds are (at best) optimistic. Sun control must be external, before the heat gets through the glass.

(e) *Residential*

A guide to shading is as follows: In summer if the sun falls directly on windows for more than 1 hour per day, then shading needs review. If the direct solar is unavoidable then window reflective or tinting film should be installed.

(f) *Office Buildings*

In particular in poorly-shaded offices the 2 meters near the window are only useful as circulation space and filing cabinets. If these were honestly calculated (eg: half the rental returns for that zone) then we would not see the silly "international style" all-glass office buildings. These buildings are described as "all glass buildings without windows" as the multiple blinds are always drawn closed.