Chapter Six

Healthy Dwellings

Did you know?
Allowing people to have personal control over the temperature in their indoor environment can increase their tolerance of lower temperatures and saves energy use

The World Health Organisation defines health as "a state of complete physical, mental and social wellbeing". Dwellings can provide a stimulating and relatively stress-free environment that increases our sense of wellbeing. Poorly designed dwellings, however, increase ill health through unnecessary pollution and discomfort.

This chapter offers guidance on the following key areas so that housing providers adopt a positive approach to healthy dwelling design:

- interaction of the human body with the environment
- materials and toxicity in the home
- holistic wellbeing

6.1

Interaction Of Human Body With The Environment

Some key physical processes which influence human health are:

- thermal comfort
- humidity
- ventilation
- lighting
- sound

Comfort is significantly increased and tolerance levels raised when users feel they can adjust the comfort conditions of their surrounding. It is very important that housing providers allow any environmental control system in the dwelling, such as lighting, heating or ventilation, to have the option for override by the individual occupier. The design of the dwelling itself should also be flexible enough to accommodate this.

Table 6.1 Measures to enhance human comfort inside dwellings

	thermal comfort	humidity	ventilation	lighting	sound
building fabric	ensure building is well insulated all round to avoid "cold spots" provide visible point source of heating (gas fire, woodstove etc) in living room -this has strong psychological effect of wellbeing on occupant	avoid condensation due to accumulation of moisture on cold surfaces use "breathing wall" construction to allow moisture to leave dwelling naturally avoid damp due to penetration of moisture from outside	prevent uncontrollable air leakage and draughts	avoid glare by allowing building to self-shade as required and design of fenestration allow for maximum penetration of daylight using openings in building fabric	energy efficient windows, particularly double frame ones with a larger air gap, have the additional benefit of greater sound reduction use careful detailing to prevent sound leakage through cracks and joints
air quality	radiant heat is more comfortable than convective heat mechanical air heating systems can feel very dry and uncomfortable -avoid if possible	avoid condensation due to accumulation of moisture in air use plants to provide humidity in centrally heated homes	quality of ventilation is important -avoid draughts keep above 0.5 air changes per hour to avoid damp and smells avoid mechanical ventilation if possible	Use sunlight to heat the air and give a pleasant warmth provide ventilation measures to avoid overheating	include external planting and trees in housing developments to encourage natural air-borne sounds and absorb artificial noise
material quality/ medium quality	provide materials that are warm to touch (wood, plastic, cloth) metals are cold to touch	use hygroscopic "breathing materials" to absorb moisture avoid moisture resistant materials internally	provide materials that minimise off-gassing into the indoor air to prevent air pollution.	provide daylighting which changes subtly over the day and comes from more than one angle, as this is restful and comfortable use natural shading devices such as deciduous plants and trees, to provide a gentle and changing filter for daylight in the summer while allowing more filtered daylight through in the winter	use the texture of materials and their different densities to alter sound qualities of spaces
user control	heating strategy should be easy to understand by the user	use humidistat extract fans to remove moisture at source and check settings	provide controllable ventilation that allows the user to increase ventilation as necessary	provide occupiers with dimmer switches to give control of lighting and save energy	provide means for users to ventilate house without compromising sound reduction in noisy areas

6.2

Materials And Toxicity In The Home

The strong chemical smell given off by new kitchen areas is an example of indoor pollution in dwellings due to off-gassing by artificial products and materials. This is set to increase as we reduce ventilation levels in dwellings to save energy. Often the initial strong smell wears off after a few weeks, but some products can continue to off-gas at low levels for many months.

Assessing the health effects of pollution is highly complex and findings are often disputed. In some cases, high level off-gassing by certain construction products and materials is a proven health hazard. The health effects produced by low level emissions, particularly in confined spaces, are less clear however, as are the "cocktail" effects of emissions from a variety of products placed together. Most disputed construction products and materials fall into this low level emission category. Although measured effects may be below the legal tolerance levels permitted, it is the cumulative effect over a period of time that can have adverse health effects.

Housing providers should adopt a precautionary approach where uncertainty exists and avoid materials and products that are disputed.

There is always an alternative product or material that can be specified but these may have a cost implication. Consultants should carry out a cost/benefit exercise based on suitable alternatives[1] (Table 6.2) allowing housing providers to develop an informed approach to environmental specification in their design guides (see Case Study Nos. 2,3,9 and 10).

The key pollutants that we need to minimise are:

- suspected carcinogens (cancer producing), mutagens (genetic mutation), tetragens (birth defects)
- Toxins and subtoxins (affecting bodily functions)
- Aeropathogens (including viruses and bacteria)
- Allergens (allergic reactions)

The first category is the most serious because cell alteration is often irreversible, and can pass onto the next generation. Examples of products containing carcinogenic ingredients include PVC[2] (which has restricted use in Sweden, Germany, and Austria) and certain timber remedial treatments[3]. Naturally occurring carcinogens such as radon, which is found in parts of Scotland, also need to be prevented from entering dwellings[4].

Did you know?
BRE recently identified 254 VOCs emitted from building materials in four new houses[2]

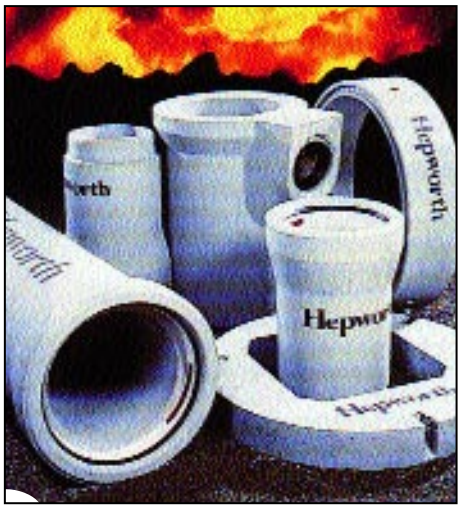

Figure 6.1 Clay and concrete drainage piping provides an environmentally benign alternative to

[1] Both ACTAC(1998) and Hall and Warm (1998) can help with sourcing and comparing alternatives
[2] Crump (1996) for a full discussion on the use of PVC see Hall and Warm (1998) section three. Also, Danish Environmental Protection Agency (1993)
[3] see London Hazard Centre (1989) for a good introduction to toxicity in timber treatment.
[4] BRE can provide advice on detailing to avoid a build up of radon in housing affected; the National Radiological Protection Boardwill test for Radon

Toxins are becoming increasingly present in the Scottish home through the use of highly processed products and materials that emit volatile organic compounds such as formaldehyde (Figure 6.2), organochlorides and phenols at some point during their life cycle. Some toxins are released during the manufacturing stage, while others are released directly into the dwelling. PVC products can give off lethal fumes when set on fire and should be avoided for this reason.

Viruses and bacteria are transmitted through organisms carried in dust and mould. These can be minimised by avoiding carpeting, keeping houses free from condensation and damp, and encouraging good waste management of organic matter.

The process of allergic reaction is still poorly understood. As well as being caused by specific pollutants and organisms, allergies can also arise once the body has reached a general "overload" point, having absorbed numerous low-level pollutants which combine to give a reaction.

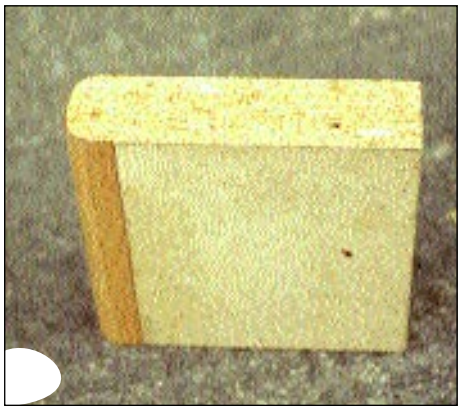

Figure 6.2 Chipboard products can contain formaldehyde - a known toxin which can be released directly into the dwelling.

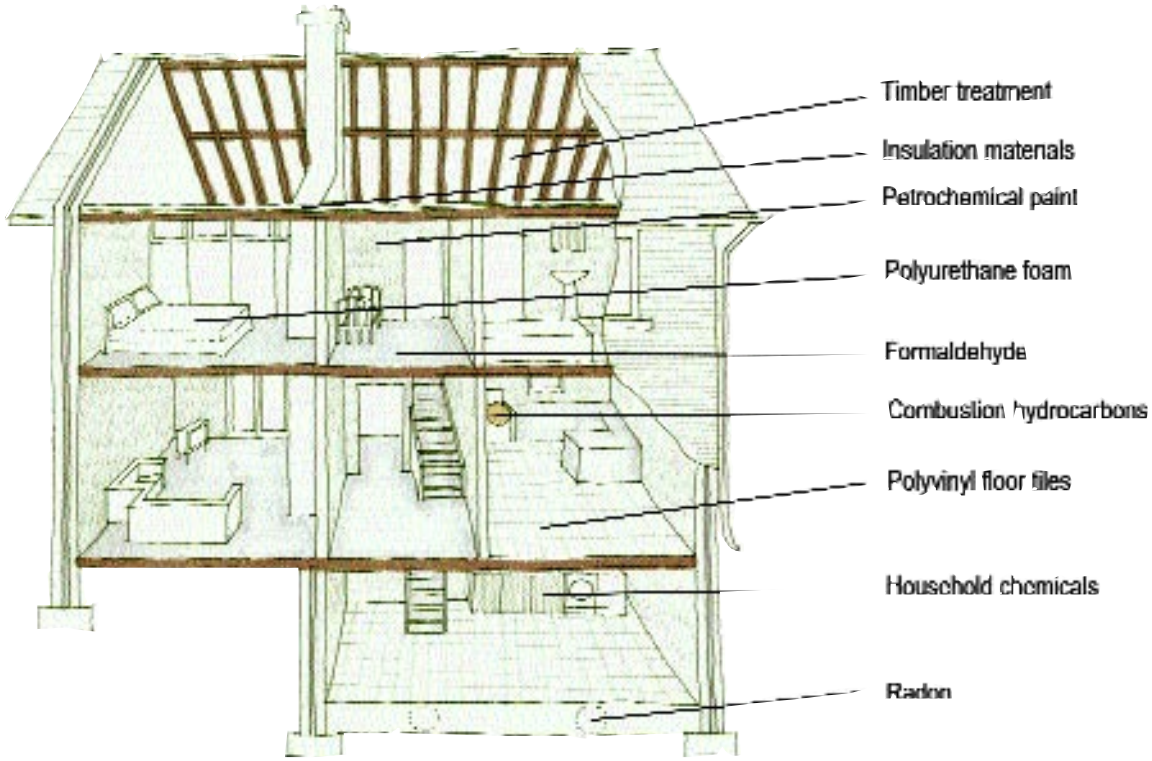

Figure 6.3 The toxic house (after Pearson 1989)

Table 6.2 Potentially toxic substances and alternatives

building element	disputed products/materials materials	toxic substance used to make product	health effects	alternatives	cost over standard specification
foundations	chemical dpc bitumenous dpc/ dpm	organic compounds	nausea nervous system headaches	low odour chemical dpc polyethylene dpc/ dpm engineering brick slate thin steel sheeting	additional cost no difference substantially more
structure	timber preservative	phenols copper –chrome - arsenic	nausea nervous system headaches	no treatment required borax impregnation	savings additional cost
secondary elements	timber preservative for windows/doors medium density fibreboard skirtings, linings urea-formaldehyde insulation	organic solvents formaldehyde formaldehyde	nervous system headaches nausea irritant to skin, eyes, respiritory system possible carcinogen	borax impregnation formaldeyde free mdf softwood non-foam based insulant	additional cost extra cost little or no difference little or no difference
fittings	chipboard kitchen units melamine worktops	formaldehyde resins (manufacture stage only)	irritant to skin, eyes, respiritory system possible carcinogen	wooden units or wooden doors only beech worktop	extra cost extra cost
services	pvc wiring pvc rainwater goods lead piping pvc underground drainage	plasticizers lead vinyl chloride (manufacture stage only)	carcinogen nervous system carcinogen	halogen free wiring HDPE (high density polyethylene) piping clay piping HDPE	extra cost little or no difference small additional cost
finishes	gloss paint varnishes emulsion paint solvents wood sealant adhesives pvc flooring fungicides	xylene toluene white spirit benzene plasticizers vinyl chloride (manufacture stage only) formaldeyde	nausea headaches nevous system reproductive effects carcinogen allergenic irritant to skin, eyes, respiritory system possible carcinogen	natural water or resin based paints and stains natural resin oil primer linoleum cork hardwood bamboo omit	emulsions -little difference resin-based -extra cost extra cost extra cost for natural paints

6.2.1 Timber treatment

Many timber preservative products contain hazardous active ingredients[5], which is why manufacturers recommend that buildings are unoccupied during application. Treatment is mostly unnecessary inside dwellings apart from fire protection. It is only essential externally where timber connects with the ground, or cannot be well ventilated to prevent rot. In some instances it is possible to carry out remedial treatment to existing timber using extra ventilation techniques (see Case Study No. 8).

Consultants should be encouraged to minimise the use of timber preservatives through careful detailing and specification of timber (Figure 6.4). Difficulties may arise, however, when attempting to get warranties from the NHBC or other bodies which require treatment certificates. In these instances, housing providers should source the least harmful treatment product. Borax impregnation is a suitable treatment in many cases.

Did you know?
Painting as a trade is carcinogenic and professional painters have a lung cancer rate 40% above the average[6].

Figure 6.4 This housing has used untreated larch timber for cladding (Gledhill Leeds).

6.2.2 Finishes

Solvent-based finishes should be avoided as much as possible. Water-based paints are preferable, particularly when they are natural based odourless paints rather than crude oil-based "low-odour paints" (Figure 6.5). Microporous and natural finishes also allow the surface of materials to breathe, increasing the ability for materials to absorb and emit moisture without deteriorating.

6.2.3 Indoor planting

Indoor planting can improve indoor air quality by removing up to 87% of the pollutants. The use of indoor planting has been proven by NASA (National Aeronautical Space Agency) to absorb artificial toxins such as formaldehyde and toluene. The most effective absorbers of toxins are the common ivy, spider plant and mother-in-law's tongue plants. Housing providers can use indoor planting beds in communal areas to improve air quality where this is appropriate (see Case Study No. 3). Planting can also be encouraged by building extra wide internal window cills for for plant pots to sit on.

Figure 6.5 Some housing at Findhorn, Scotland uses natural based stains.

[5] see London Hazard Centre (1989)
[6] Reported by the World Health Organisation International Agency on Research on Cancer, (1989)

Box 6.1 Improving indoor air quality: pointers for good practice

- carry out cost/benefit analysis on alternatives to products and materials with disputed toxicity levels
- specify relatively unprocessed natural materials as much as possible
- avoid synthetic materials that give off fumes
- avoid timber treatment as far as possible
- correct humidity levels to avoid fungal growth
- encourage use of indoor plants which absorb toxins

Did you know?
The frequency of the human body's bio-electrical system pulses with the same frequency as that of the Earth's natural frequency (7.83 beats a second).

6.3

Electromagnetic Fields (EMF's)

The Earth's natural electromagnetic pulse is essential to our health and well being. Domestic mains current operates at 50 pulses a second (50Hz) in Scotland, which is six times faster than the natural pulse, and studies show that this can result in disturbed sleep patterns, nervousness, and high blood pressure, particularly where beds are sited next to mains cabling[7].

Housing providers can encourage the building design team to minimise the amount of electrical mains cabling inside a house through efficient circuit planning. Circuit breakers allow bedrooms to be isolated from the electromagnetic effects of electric circuits at night. This is particularly important as we may spend more time lying close to cabling in our bedroom than anywhere else in the house.

Another source of electromagnetic disturbance occurs outside the house in the form of overhead transmission lines and electricity substations. Many existing housing estates in Scotland contain substations and many houses are within several hundred yards of overhead transmission lines. These fields are far more powerful than those generated by domestic mains. There is growing consensus among researchers that it is inadvisable to site houses near transmission lines, micro-wave masts, or substations. It is however, also possible to screen existing housing from the effects of these elements using thick concrete walling or equivalent material which can absorb electromagnetic radiation.

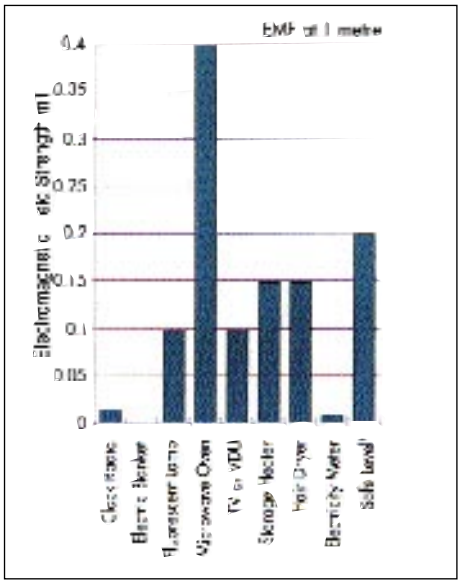

Figure 6.6 Some houshold items emit significant EMF at close distances
(After Borer and Harris, 1998).

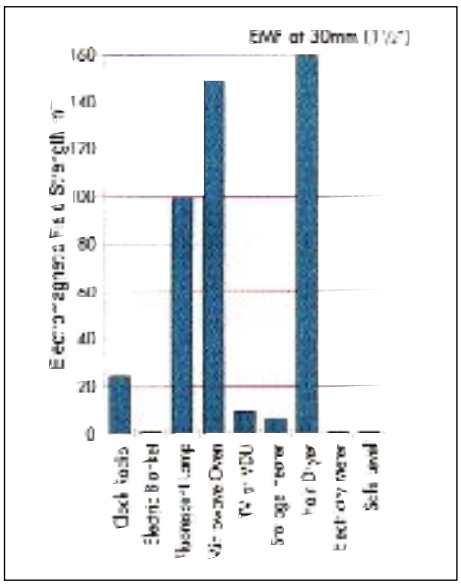

Figure 6.7 Microwave ovens can emit strong EMF's if leaking
(After Borer and Harris, 1998).

[7] see Coghill (1998), for an excellent introduction to this area

Box 6.2 Minimising effects of electromagnetic fields: pointers for good practice

- apply metal conduiting to mains cables when re-wiring to provide a shield to EMF's emitted by the cables
- minimise circuit routing - keep circuit rings on internal walls
- install demand switches to isolate mains and circuitry at night
- use circuit planning to avoid close proximity to beds
- screen walls of dwellings adjacent to electricity substations
- avoid siting housing within 100 yards of substations, microwave masts, mobile phone masts or electricity pylons

6.4

Holistic wellbeing

Our understanding of health in relation to housing is constantly changing to accommodate new knowledge. In the past, most emphasis was placed on quantitative health indicators but increasingly we recognise the subtle interplay of qualitative indicators. Table 6.3 below shows which issues are presently addressed and which still need addressing:

Table 6.3 Health indicators for design of dwellings

Current Health Quantitative Indicators	Sources	Additional Health Quality Indicators not addressed	Sources
Daylight	building regulation	colour quality of artificial lighting	manufactors building biology
Noise	building regulation and environmental health	life enhancing sounds	building biology
Warmth	building regulation	affordable warmth	poverty action groups
Dampness	building regulation	undue dryness	building biology
Air quality	building regulation and environmental health	electrostatic effects	building scientists building biology
Radiation	NRPB	Electromagnetic Fields	building biology
Material toxicity	control of hazardous substances act	low level pollutants quality of materials	building scientists building biology
Water quality	SEPA	water for emotional well being	building biology
Security	Police	User control	TPAS (tenant participation advisory service)
Basic amenities	building regulation	Contact with natural elements	London Ecology Trust Reforesting Scotland other interest groups
Community facilities	planning departments	sense of community.v. isolation	local voluntary groups community groups

Specifying appropriate physical responses to human health only partially addresses the issue. Health is a very subtle interaction between mind and body. Mental health in housing is as important as physical health and any technology introduced into housing must be closely allied to user requirements. This means giving the user control and understanding of the materials, products and processes used in their housing. This can be achieved through integrative and consultative management practice which fully engages with the user through participatory design and workshops with the consultants.

Housing providers also have the opportunity to address the qualitative aspects of healthy dwelling design and maintenance through user feedback. Incorporating health aspects into the post occupancy evaluation of new schemes can help inform future developments.

The use of sensory stimulation can contribute greatly to the quality of housing. Tactile, visual, and auditory stimulation all contribute to a sense of well being. This qualitative appreciation of the built environment and its interaction with the natural environment has been well covered in literature produced by building biologists and others[8]. Housing providers can encourage the design of developments that provide multiple stimulation through natural features such as water, trees, planting and wildlife. The gentle sound of leaves rustling in a breeze soothes while also providing a fresh smell and gentle visual stimulation through leaves swaying.

Figure 6.8 Planting can be introduced at a variety of scales to improve air quality in housing.

Figure 6.9 The provision of trees around our housing improves health in many ways.

[8] For a general introduction to qualitative health issues in and around the home see Pearson (1989), Holdsworth and Sealey (1992) and Day (1990)

Box 6.3 Holistic wellbeing: pointers for good practice

- adopt integrative and consultative management practice which informs the user
- provide clear but comprehensive user manuals, tailored to individual dwellings if necessary
- involve the user fully in the design of housing developments using tenant participation techniques[9]
- use qualitative as well as quantitative indicators in post-occupancy evaluation
- encourage design that maximises sensory stimulation

Healthy Dwellings Checklist - Key Areas

- specify non-toxic materials and finishes (see Table 6.2)
- take account of condensation and humidity levels (see Section 6.1)
- minimise timber treatment (see Section 6.2.1)
- use external and internal planting to absorb toxins and dust (see Section 3.4 and 6.2.3)
- provide adequate sound insulation while still allowing for natural sounds (see Table 6.1)
- promote holistic approach to user health using tenant participatory techniques (see Section 6.4)
- allow for maximum contact with nature in design of development
- encourage design which stimulates all the senses, not just visual sense (see Section 6.4)

[9] TPAS (see useful addresses) can advise on this.