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ABSTRACT

Responding to the need for users of schools to use their buildings in a way that creates a better internal environment for children and reduces harm to the environment, this document lists the environmental issues that need to be addressed and the corrective recommendations that designers and administrators can apply. Environmental issues cover such areas as sources of noxious fumes, water and air quality, lead-free paint, recycling and waste disposal, ventilation, lighting, energy management, and legionnaires' disease. The choices made in new school design will have a considerable effect on the environment for the life of the building. Existing school buildings will remain in use for many years to come, so it is imperative that they are as benign to the environment as possible. Fortunately, many steps exist to address both these situations. An appendix provides carbon dioxide rating calculations for new and existing schools. A list of non-governmental organizations involved in environmental health, and an environmental assessment summary sheet conclude the booklet. (GR)

Schools' Environmental Assessment Method (SEAM)

Architects & Building Branch

BUILDING BULLETIN 83

DfEE

Department for Education and Employment

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LONDON: THE STATIONERY OFFICE

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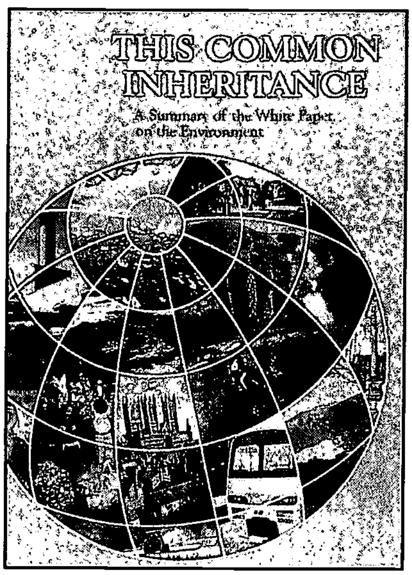
Introduction

Today there is general awareness that the environment is a concern for everyone. Designers of new schools, extensions and major refurbishments need to ensure that their designs and the materials they specify cause as little environmental damage as possible.

Users of existing schools also need to be aware that they can use their buildings in a way which not only creates a better internal environment for children, but also reduces harm to the environment at large.

The Schools' Environmental Assessment Method (SEAM) has been produced as a part of a wider effort by the Government to promote sustainable development[1,2].



Within this strategy the UK has committed itself under the United Nations Framework Convention on Climate Change to take measures aimed at returning emissions of carbon dioxide (CO_2) and other greenhouse gases to 1990 levels by the year 2000[3,4]. This target will be reviewed if necessary in the light of any new scientific evidence. For this reason a major part of the assessment is the Energy (carbon dioxide) rating.

The aims of SEAM are to:

- raise awareness of how energy use in buildings has a major impact on the atmospheric problems of global warming and acid rain;
- improve the quality of the internal environment for school users, eg, by providing better air quality, adequate ventilation and optimum use of daylight;
- encourage the use of construction materials and products which are of an environmentally friendly nature, minimising the depletion of non-renewable resources, destruction of the tropical rain forests and wasteful use of local resources; and
- make better use of school grounds and resources for ecology, teaching, recreation, and recycling.

The wider context to SEAM is that environmental issues are now included in a number of National Curriculum subjects, particularly geography and science. Many schools are also developing environmental policies and have formed environmental action teams.

Environmental issues need to be continually kept under review. Progress continues in many areas such as research into allergies, non-toxic paints, varnishes, polishes, wood preservatives and methods and materials of construction.

New schools

The choices made in a new design will have a considerable effect on the environment for the life of the building. For example, the orientation and positioning of the building, the type of engineering services and the materials of construction are all important.

Existing schools

Clearly, existing school buildings would have difficulty in meeting some of the requirements for new schools, such as orientation. However, most school buildings will remain in use for many years to come, so it is imperative that they are as benign to the environment as possible. Fortunately, there are many steps that can reasonably be taken to improve an existing school.

References

(1) *Sustainable Development, The UK Strategy*, HMSO, 1994, £22, ISBN 0 10 124262 X.

(2) *This Common Inheritance, Britain's Environmental Strategy*, HMSO, 1990, £24.50, ISBN 0 10 112002 8.

(3) *Climate Change, The UK Programme, United Kingdom's Report under the Framework Convention on Climate Change*, HMSO, 1994, £10, ISBN 0 10 124272 7.

(4) *Climate Change* Newsletter, from Department of the Environment, Publications Dispatch Centre, Blackhorse Road, London, SE99 6TT, Tel: 0181 691 9191, Fax: 0181 694 0099.

Environmental issues

SEAM identifies a list of environmental issues and makes recommendations that headteachers and governors can easily apply. This section lists the environmantal issues which need to be assessed.

How to use SEAM.

- Work through the following 23 environmental issues and allocate points for complying with the recommendations.
- Complete the environmental audit summary sheet on page 31 to produce an overall SEAM rating for the school.
- If the school has 15 points or over then it can claim the SEAM certificate of achievement, class A, B or C depending on the number of points awarded. A blank certificate is included with the bulletin for the school to fill out. The minimum rating for a new school building should be C.
- As part of a school's environmental policy carry out an environmental action plan. See page 19.
- Review the environmental performance by repeating SEAM periodically.

1 Site selection for new buildings

It is environmentally better to build on derelict land or a previously developed site (providing this is safe to build on and has not been colonised by important wildlife) than on a green field site. When in doubt about the ecological value of a site, advice should be sought from a professional ecologist. Surveys of ecology are available through the Royal Society for Nature Conservation's Wildlife Trusts Partnership[1].

It is worth consulting the local authority planning unit. They often employ a wildlife officer and have lists of sites of special scientific interest (SSSIs) and locally significant habitats. Local amenity groups might also be worth contacting.

When building on an existing or derelict site where soil contamination is a possibility, a specialist geological/environmental consultant[2] should conduct a site investigation including chemical analysis of soil samples. A full list of current titles of Government publications on all aspects of contaminated land is available from the Department of the Environment[3]. Advice on the assessment and remediation of contaminated land is contained in guidance published by the Construction Industry Research and Information Association[4].

Recommendation
Encouragement should be given for building on and revitalising a previously derelict site or other idle land if it has been made safe. Developments, particularly green field sites should respect wildlife habitats and retain positive features of the landscape where possible.

- One point is awarded for such sensitive development of the site.

2 Sources of hardwoods and softwoods

Wood is the most ecologically benign of the construction materials. Much less energy is needed to manufacture and build a wooden building than a steel or concrete one. There are, however, some hardwoods which are extracted from virgin forests in a way which destroys the forest. Similarly some softwoods such as redwood (sequioa), cedar and cypress species are being depleted. Mahogany, rosewood, sapele and afrormosia are now endangered species.

Forests are a solution to, not a cause of global warming. A growing tree absorbs carbon dioxide very efficiently. When a tree approaches maturity its production and consumption of carbon dioxide are roughly equal. Mature trees are however important to the water balance and the overall ecosystem.

A sensitively managed forest with a balance of young and mature trees is a source of income as well as a solution to

References

(1) Royal Society for Nature Conservation, The Green, Witham Park, Waterside South, Lincoln, LN5 7JR.

(2) The Department of the Environment produces a general list of environmental consultants which is available from DOE Library, 2 Marsham Street, London, SW1P 3EB.

A list of consultant organisations for investigation and assessment of contaminated land is available from the Royal Society of Chemistry, Burlington House, Piccadilly, London, W1V 0BN.

(3) CLL Division, Room A323, Department of the Environment, Romney House, 43 Marsham Street, London, SW1P 3PY.

(4) Construction Industry Research and Information Association(CIRIA), 6 Storey's Gate, Westminster, London, SW1P 3AU.

the CO_2 problem. The number of trees that need to be logged to provide an income is small. In a typical West African forest, for example, with over 600 tree species, less than 40 are used for timber.

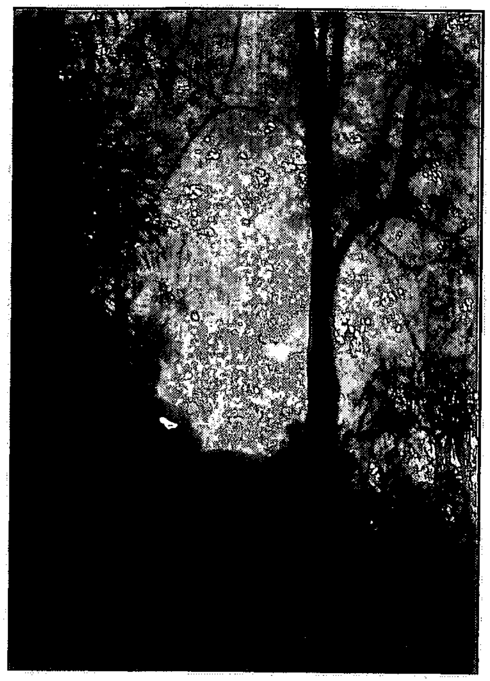
Tropical forests are being lost primarily to agricultural settlement (about 60% of the area cleared each year). This is the most serious threat to the rain forests. Yet these grow on a relatively thin layer of soil which cannot support cash crops or cattle. These activities are not sustainable and after a few years the land is left as a wasteland. New areas of virgin forest are then cleared either by irresponsible logging or worse still by deliberate burning of the forest causing a massive increase in global CO_2.

The other major pressures on forests are demand for fuel wood, accidental and natural fires, mineral exploitation and mining activity, industrial and infrastucture developments and human settlements.

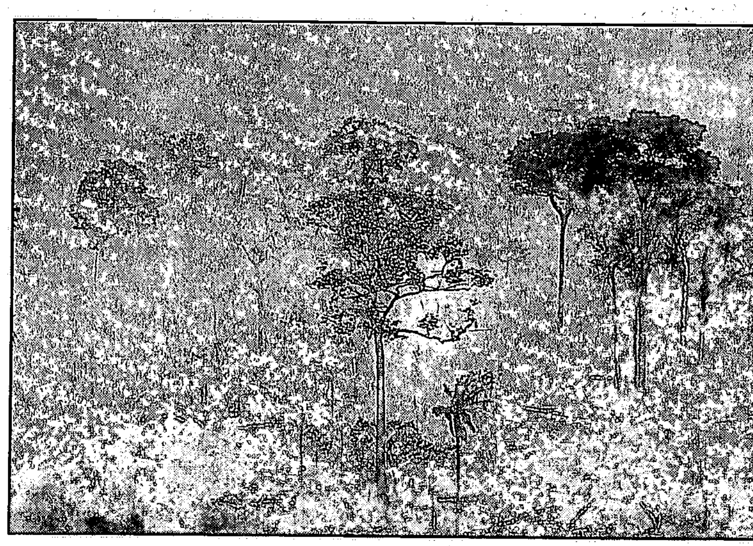
The development of a sustainable timber trade discourages the destruction of forests for planting of cash crops or to provide grassland for ranching.
All the major tropical timber producing countries are members of the International Tropical Timber Organisation (ITTO). They have collectively agreed a target for the year 2000 at the latest to achieve sustainable management of all tropical forests. This is an ambitious but realistic target.

The London Environmental Economics Centre (LEEC) examined how the tropical timber trade affects deforestation. It concluded that trade interventions such as bans, taxes and quantitative restrictions may 'reduce rather than increase the incentives for sustainable timber management and may actually increase overall tropical deforestation'.

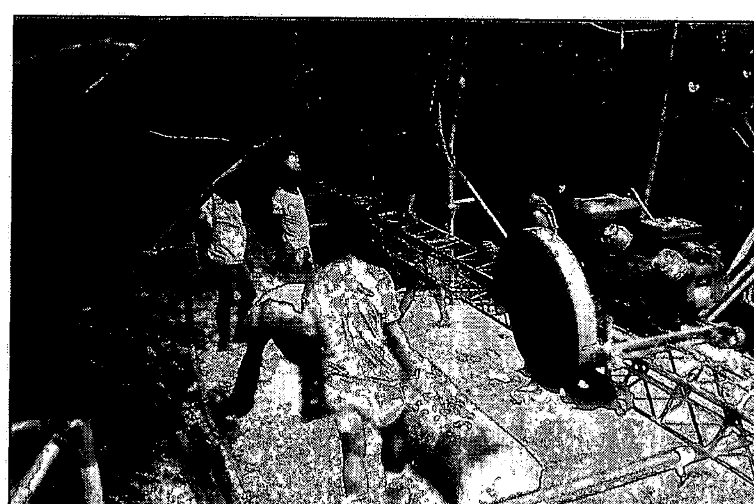
Forests Forever of the Timber Trade Federation have produced an architects' guide to specifying timber and wood products. At present they advise against



Virgin rain forest, Malawi, [David Daniels]



Below: Amazon forest fire, [Herbert Girardet/Environmental Picture Library]



Bottom: Community Forest Management Project, Papua New Guinea, [WWF UK]

Forestry organisations
Forests Forever, c/o The Timber Trade Federation, Clareville House, 20-27 Oxendon Street, London, W1M 8AD,
Tel: 0171 839 1891
provides current information on the availability of timber from well managed sources.

Forest Stewardship Council UK, c/o Hannah Scrase, National Working Group Co-ordinator, Oleuffynnon, Old Hall, Llanidloes, Powys, Wales, SY18 6PJ.
Tel/Fax: 01686 412176.

the specification 'of wood from sustainable forests' as the systems of certification are inconsistent, have not been sufficiently developed and cover only some supplies.

Instead they suggest that the best way forward is to ask that timber or wood product suppliers should present a copy of their formal environmental policy for those products. Preference can then be given to suppliers who have adopted the Environmental Policy of Forests Forever, or another comparable policy, and who can provide evidence of commitment to the policy.

The Forests Forever Environmental Policy aims to ensure that timber companies establish, as far as possible, where their timber derives from and the nature of forest management at source. It also aims to strengthen communications on environmental matters between individual UK timber companies and their suppliers, and to encourage suppliers to adopt environmental policies and standards.

The policy currently has over 150 signatories. Signatories are encouraged to use only those certificates of sustainable forest management that have been authenticated by the national forest authority of the supplying country.

Forests Forever also produces an extensive database directory of national forest policies in timber supplying countries.

The Forest Stewardship Council operates a scheme of independent forest certification designed to encourage the forest sector to adopt principles of sustainable development. The certification is based on national-level forestry standards compatible with generally accepted international principles and is, therefore, in line with the Forests Forever Environmental Policy. The certification is being used in temperate, boreal and tropical forests.

There are five independent certification schemes in operation at present and some national governments have developed their own certification schemes.

Recommendation
Timber and timber products should be obtained from suppliers with an Environmental Policy such as that of Forests Forever. Details of the policy should be readily available to customers.

Preference should be given to timber from forests that are subject to an independent certification scheme or a national certification scheme. Independent schemes should be based on national - level forestry standards. All schemes should be compatible with generally accepted international principles.

- For existing schools one point and for new schools up to two points are awarded for specifying timber from a supplier with an environmental policy.
- For existing schools a further one point and for new schools up to two points are awarded where preference is given to timber from forests subject to certification schemes compatible with internationally accepted principles of forest management.

3 Low NO_x combustion equipment

Nitrogen oxides (NO_x) are products of combustion which are a major cause of air pollution. Emissions into the atmosphere are from three main sources: power generation, internal combustion engines and combustion equipment. NO_x contributes to acid rain and to the greenhouse effect through reaction with photo-chemical oxidising agents, particularly ozone.

Electricity generation from fossil fuels produces high levels of NO_x. On average each kWh of electricity delivered results in approximately 1880mg of NO_x at the power station. For this reason no points are awarded where electricity is used for space heating.

References
A WWF Guide to Forest Certification, 1995, ISBN 1 85850 069 9.

Forest Strategy, Environment Policy Department, ODA, 94 Victoria Street, London, SW1E 5JL.

Recommendation
Specify combustion equipment fitted with low NO_x emitting burners, which emit NO_x at a rate no higher than 150 mg/kWh of delivered energy.

- One point is awarded for specifying combustion equipment which emits NO_x at a rate no higher than 150 mg/kWh of delivered energy. Where electric heating is used no points are awarded.

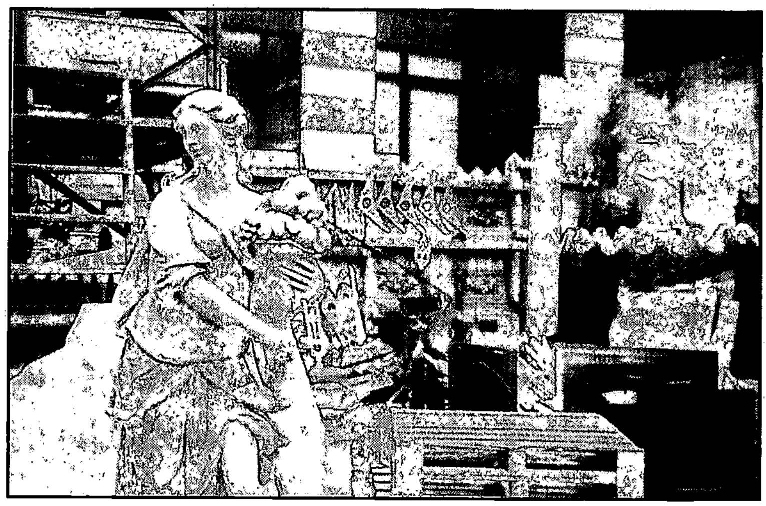
4 Use of recycled materials in new buildings

The use of waste or recycled materials saves both energy and raw materials. For example, pulverised fuel ash from power stations can be used to form blocks, concrete can be recycled as aggregate, or waste paper can be made into insulation.

Architectural salvage of timber, bricks and many other items can substantially reduce waste and provide a source of high quality building materials, particularly where existing buildings are replaced by new construction.

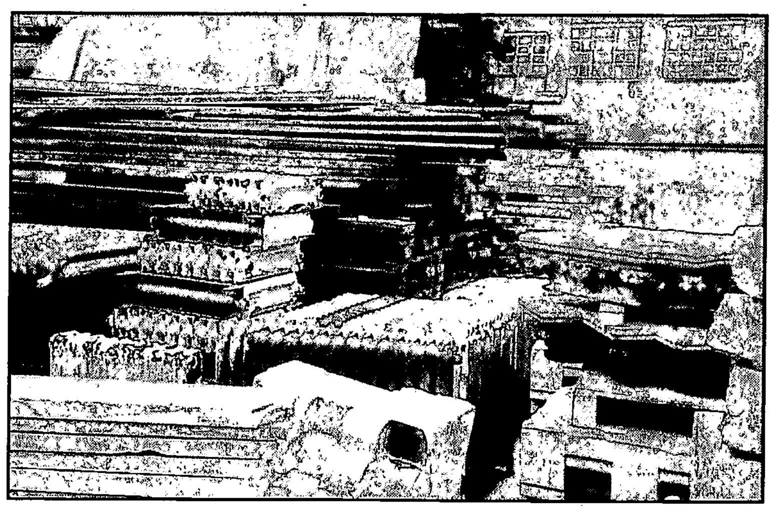
Recommendation
Encouragement should be given to re-use of building materials or use of products manufactured from recycled or waste material.

- One point is awarded for significant use of recycled materials or re-use of building materials.

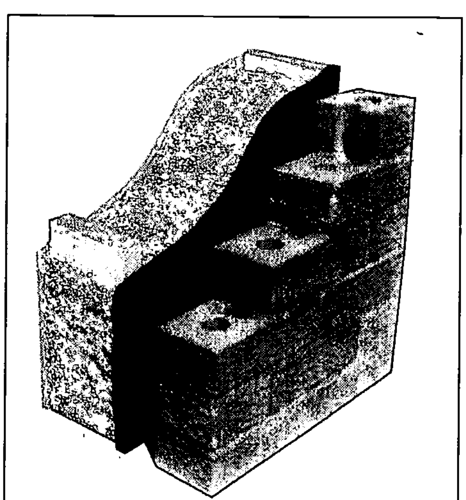


Above: Architectural salvage yard

Below: Architectural salvage: Reclaimed timber store



Below left: Cellulose fibre (waste paper) insulation [Warmcel]



Below: Brick reclamation and recycling [Trevor Perry Environmental Picture Library]

Table 1

Ozone depleting chemical (ODC)	EC regulation 3093/94	Montreal Protocol (4th meeting in Nov 92)
CFCs (chlorofluorocarbons)	85% cut by 1/1/94 Phase out by 1/1/95	75% cut by 1/1/94 Phase out by 1/1/96*
Carbon tetrachloride (tetrachloromethane) CCl_4	85% cut by 1/1/94 Phase out by 1/1/95*	85% cut by 1/1/95 Phase out by 1/1/96*
Halons	Phase out by 1/1/94*	Phase out by 1/1/94*
1,1,1 trichloroethane (methylchloroform) CH_3CCl_3	50% cut by 1/1/94 Phase out by 1/1/96*	50% cut by 1/1/94 Phase out by 1/1/96*
HBFCs (hydrobromoflurocarbons)	Phase out 1/1/96	Phase out by 1/1/96
Methylbromide	Freeze at 1991 levels from 1/1/95 25% cut by 1/1/98	Freeze at 1991 levels from 1/1/95 —
HCFCs (hydrochlorofluorocarbons)	Freeze at 2.6% of CFC consumption + total HCFC consumption in 1989 by 1/1/95 35% cut - 2004 60% cut - 2007 80% cut - 2010 95% cut - 2013 Phase out by 2015	Freeze at 3.1% of CFC consumption + total HCFC consumption in 1989 by 1/1/96 35% cut - 2004 60% cut - 2010 90% cut - 2015 99.5% cut - 2020 Phase out by 2030

* indicates provision for possible 'essential use' exemption.

Table 2

Ozone Depleting Chemical	Type	Ozone Depletion Potential	Global Warming Potential (Carbon dioxide=1)
R11	CFC	1	4000
R12	CFC	0.8	8500
R22	HCFC	0.04	1700
R32		0	580
R113	CFC	0.9	5000
R114	CFC	0.85	9300
R115	CFC	0.6	7400
R123	HCFC	0.014	93
R124	HCFC	0.03	480
R125	HFC	0	3200
R134a	HFC	0	1300
R141b	HCFC	0.1	630
R142b	HCFC	0.05	2000
R152a	HFC	0	140
R500	CFC/HFC	0.74	3333
R502	HCFC/CFC	0.33	4038
H1211	Halon	5.1	?
H1301	Halon	12	5600
H2402	Halon	6	?
CCl_4		1.2	1400
CH_3CCl_3		0.12	110

Reference

(1) *The ozone layer*, Department of the Environment, 95 EP053, August 1995.

5 Ozone depleting chemicals (ODCs)

The ozone layer is found in the stratosphere between 10km and 50km above the earth's surface. This layer filters out the harmful wavelengths of ultraviolet (UV) light from the sun. The term UVB refers to solar radiation of wavelength in the range 280-320 nanometres (nm). This is only a small proportion of the total UV radiation but is the most energetic and the main cause of sunburn[1]. Even small amounts of UVB radiation can cause harm.

The effects of an increase in UVB radiation reaching the earth's surface could include an increase in skin cancer, damage to the immune system and damage to crops and marine life. Some man-made chemicals such as chlorofluorocarbons (CFCs) and halons cause depletion of the ozone layer. International concern about the ozone layer led to the adoption of the Montreal Protocol in 1987. The European Union has subsequently introduced tighter control measures on these chemicals.

The naturally generated ozone at high altitude should not be confused with the ozone near ground level which is caused by pollution and is harmful to health.

The latest EC regulation EC/3093/94 on ozone depleting chemicals came into force on the 1 January 1995. Table 1 summarises the main EU targets compared to the revised Montreal Protocol.

In addition to causing ozone depletion these chemicals are 'greenhouse gases' causing global warming (See section 20).

The relative Ozone Depletion Potential (ODP) and Global Warming Potential (GWP) of various CFCs and hydrochlorofluorocarbons (HCFCs) and other chemicals are given in Table 2 to show the wide range of values for different chemicals. Halons have high ODP values which is why they were the first substances to be phased out under the Montreal Protocol.

The EC regulation also contains controls on HCFCs to ensure that they are used only where they or CFCs have been used previously, and where there is no acceptable alternative. From the 1st January 1996 the use of HCFCs in schools is permitted only as fixing agents for laser printers produced before that date, as refrigerants in air-conditioning units and as refrigerants in domestic refrigerators and freezers produced before 31 December 1995.

Article 14 of the EC regulation states that ODCs in commercial refrigeration equipment, in air conditioning equipment, in equipment containing solvents and in fire protection equipment shall be recovered if practicable for destruction, recycling or reclamation. This should be done during service and maintenance of equipment, as well as prior to equipment dismantling or disposal.

Article 15 states that all practicable precautionary measures must be taken to avoid leakages from commercial and industrial air conditioning and refrigeration equipment and from equipment containing solvents during manufacture, installation, operation and servicing.

Alternative refrigerants are now available and should be specified where air conditioning, refrigeration or heat recovery is employed. Although air conditioning is not normally used in schools, it may be needed in swimming pools and small areas with unavoidable high heat gains from equipment.

In schools, halons are still present in many fire extinguishers. The physical properties of these gases make them most suited for use in portable fire extinguishers of the type encountered in school laboratories and computer rooms. They are subject to visual inspection and are not tested by release of halons. They can be changed for non-halon extinguishers when due for replacement and should be returned to the manufacturer for disposal or recycling, in accordance with Article 14 of the EC regulation.

Thermal insulation materials, which are usually manufactured using CFCs or HCFCs as the gas to form the foam, include rigid foams such as polyurethane foam, extruded polystyrene and phenolic foams.

HCFCs and CFCs are used because they contribute to the thermal properties of the product, are non-flammable, stable, cost effective and have a low toxicity. However, there are now alternative types of insulation available, eg:

- cellulose fibre;
- mineral fibre;
- glass fibre;
- expanded polystyrene beadboards;
- polystyrene beads;
- cellular glass (foamglass); and
- rigid foams not manufactured using HCFCs or CFCs.

Aerosol cans with CFC propellants should not be used.

Recommendations

Specify materials which are CFC and HCFC free and do not use CFC or HCFC in their manufacture for:

- insulation of buildings, freezers, ice makers, refrigerators and cold rooms;
- flexible and rigid foams in furniture, bedding, carpet underlay, and packaging;
- refrigerants in refrigerators, freezers and air conditioning systems;
- solvents used for cleaning in electronics or dry cleaning; and
- propellants in aerosols.

Do not use 1,1,1 trichloroethane as a degreasing agent or solvent cleaner, in adhesives or in typing correction fluid.

Replace halon fire extinguishers (trade names BFC, BTM or DTE) at the end of their service life with non-halon types.

Do not use carbon tetrachloride in chemical experiments.

- Two points are awarded for complying with all the above recommendations

6 Volatile organic compounds

Many building components act as a source of volatile organic compounds (VOCs). The most widely studied are particulate boards, eg, chipboard, and urea formaldehyde foam insulation (UFFI) which emit formaldehyde and other aldehydes.

Paints, wood preservatives, varnishes, floor coverings and furniture can emit a variety of VOCs. High concentrations of VOCs create an unpleasant working environment and can cause illness. Wherever possible, designers should specify materials which have a low VOC content.

Water based paints are widely available as an alternative to solvent based paints. They avoid the dangers of VOCs produced during application and are generally considered to be safer to use. However, they contain biocides and other chemicals which may be toxic and can be as damaging to water supplies as solvent based paint, depending on the sensitivity of the waters to which they are released.

Other options are high solids paints, chemically cured paints and paints made from natural plant oils and resins, plant and bees waxes, and earth, mineral or plant colours. Natural paints are being produced on a small scale and are potentially more environmentally benign, particularly if the harvesting of plant resins provides a means of sustainable forest management. However, it should be remembered that natural paints can be as toxic in use as more conventional paints.

VOCs should be avoided in building work such as decoration, refurbishment or upgrading of thermal insulation. Maintenance work should be planned to minimise exposure of a building's occupants to VOCs. For example, this might involve work during school holidays and providing high ventilation rates after completion to remove odours before re-occupation.

Some classwork activities use VOCs in glues, solvents and propellants in aerosols which are hazardous to health and adequate ventilation is needed. Where possible sources of VOCs should be avoided in classwork.

Where the use of VOCs is unavoidable the recommended health and safety precautions must be followed. Failure to do this can result in prosecution under the *Health and Safety at Work etc Act, 1974.*

Recommendations
As a general rule designers should comply with the following guidelines:

- use varnishes with low solvent content, or leave surfaces unvarnished;
- use water based paint or paints with natural solvent bases for interior decoration;
- avoid use of particle boards and urea formaldehyde foam insulation (UFFI), or use only in accordance with British Standards;
- do not use products which could emit naphthalene;
- avoid aerosol cans that use VOCs as propellants; and
- where exposure to VOCs cannot be avoided take the recommended Health and Safety precautions.

- **New schools**
  One point is awarded for limiting the use of construction materials containing high levels of VOCs.

  A further point is awarded for limiting the use of VOCs in building work.
- **Existing schools**
  Two points are awarded for limiting the use of VOCs in classwork.

Reference
Enquiry into Volatile Organic Compounds, Report of House of Commons Environment Select Committee, April 1995.

7 Harmful substances

Avoid using harmful cleaning agents such as disinfectants containing cresol, trichlorophenol, benzalkonium chloride and formaldehyde, and detergents containing phosphates.

Some batteries contain mercury or cadmium which are both highly toxic and can easily contaminate ground water supplies if disposed of in land fill sites. Rechargeable batteries cost 2 or 3 times as much as disposable batteries but can be recharged up to 1000 times. The manufacture of batteries can consume up to 50 times the energy they produce.

Care should be taken in disposing of used electric lamps. Some local authorities treat fluorescent tubes as hazardous waste. Other bulbs should be disposed of in compliance with manufacturers' recommendations.

Schools should implement safe methods of disposal of waste materials that pose a health risk, eg, oil, metal swarf, wood and ceramic dust and chemicals. Secure storage should be provided to reduce health and arson risks.

In some areas, particularly those on granite rock such as Devon and Cornwall, there is a high background level of the radioactive gas radon. In these areas it may be necessary to take precautions to reduce radon levels in buildings(1). These measures involve sealing the foundations and ventilating the gas from below the ground floors. Guidance is available from the NRPB(2).

Recommendations

- Specify cleaning products which do not harm the environment.
- Use solar cells or rechargeable batteries instead of disposable batteries where possible.
- Only use mercury-free and cadmium-free batteries.
- Do not mix old and new batteries as the life of the new ones will be reduced.
- Buy portable equipment such as PCs which have nickel hydride battery packs in preference to nickel cadmium packs.
- Use manufacturers and suppliers who will take back batteries for recycling.
- Dispose of waste materials that pose a health risk in a safe way.
- In areas with high background levels of radon take the recommended precautions.

- One point is awarded for complying with these recommendations.

8 Lead-free paint

Lead is a poison which has been shown to cause brain damage particularly in young children. Lead from paint can be ingested by children and decorators are exposed during painting and when stripping old paint. Recent UK Legislation(3) prohibits the use of lead carbonates (white lead) and lead sulphates in paints, except in those used to restore or maintain historic finishes to listed buildings and works of art. However, there may be some residual stocks of these paints, supplied before the 28th February 1992 which can still be legally used.

Recommendation
Lead-free paint should be specified.

- One point is awarded for specifying the use of lead-free paint.

9 Lead pipework in existing schools

Lead pipework for drinking water supplies is a health hazard. This is increased in areas with plumbosolvent water, ie soft water, particularly where the water is acidic. In schools built before the early 1950s, where there is a likelihood of the presence of lead pipework, its extent should be assessed and a programme drawn up for its removal.

Recommendation
Check for the presence of lead pipework. If present, draw up a programme for its removal.

- One point is awarded for checking for the presence of lead pipework and if appropriate drawing up a programme for its removal.

References

(1) *The Ionising Radiation Regulations 1985*, London, HMSO.

(2) National Radiological Protection Board (NRPB), Chilton, Didcot, Oxon, OX11 0RQ. Tel: 01235 831600 Fax: 01235 833891.

(3) Department of the Environment, *Environmental Protection (Control of injurious substances) Regulations 1992*, Circular 3/92, HMSO, £3.80.

Top: Pond dipping [London Wildlife Trust]

Bottom: Nature trail

Further guidance

Building Bulletin 71, *The Outdoor Classroom*, HMSO, 1990, £14.50, ISBN 0 11 270730 0.

Building Bulletin, *School Grounds, a guide to good practice* (planned for 1996).

Wildlife and the school environment, RSPB and LTL, 1991 £2.50, ISBN 0 903138 51 4.

Guidance and publications on grounds related issues including education, design, management, maintenance and environmental auditing, can be obtained from Learning Through Landscapes, address on p.26.

Expert advice is also available from School Grants Scheme, English Nature, Northminster House, Peterborough, PE1 1UA, Tel: 0733 340345.

10 School grounds

Well developed school grounds provide for, and encourage, positive pupil attitudes to play, sports, and recreational activities. They help to prevent the negative attitudes which can be associated with boring, overcrowded and featureless playgrounds.

A variety of spaces can be created by varying surface treatments, imaginative planting and the provision of features such as benches and tables. This will encourage small scale and more passive outdoor activities.

Trees and shrubs can form local screening to specialist activity spaces. Larger shelter belts can improve comfort conditions by making playing fields less windswept and reducing the heat loss from buildings. Hedges planted against boundary fences can give the landscape a softer appearance. Thorny shrubs can also form a physical barrier to intruders.

Existing ecological features of a site may well be worth preserving. Trees and hedgerows provide links with the past and their retention could be a valuable asset, if appropriate to the overall landscape design. However old trees can sometimes be dangerous. A tree survey, in accordance with British Standard BS 8583: 1980 *Trees in relation to construction,* should be undertaken.

School grounds are an educational resource that can usefully support the curriculum, however they are often under used. In such instances, thought might be given to outdoor developments which can support both learning and leisure activities. Developments might include the creation of nature resources planted by pupils as part of classwork. Making bird boxes or introducing renewable forms of energy, eg, solar cells, wind generators or water turbines, are other possibilities. Sources of renewable energy would in most cases be for purposes of demonstration, although there are some locations where they might be economic.

Before making changes to the landscape and developing outdoor areas, it is important to involve the whole school rather than to rely on one or two enthusiastic individuals. A school grounds development plan, which brings together a practical balance of ideas, should be made after consulting a permanent support group, including pupils, staff and parents. Where possible the wider community could be encouraged to help.

Recommendation

Involve staff, pupils and parents in developing school grounds that are stimulating, environmentally friendly, enjoyable to work and play in, and of benefit to the school and community as a whole.

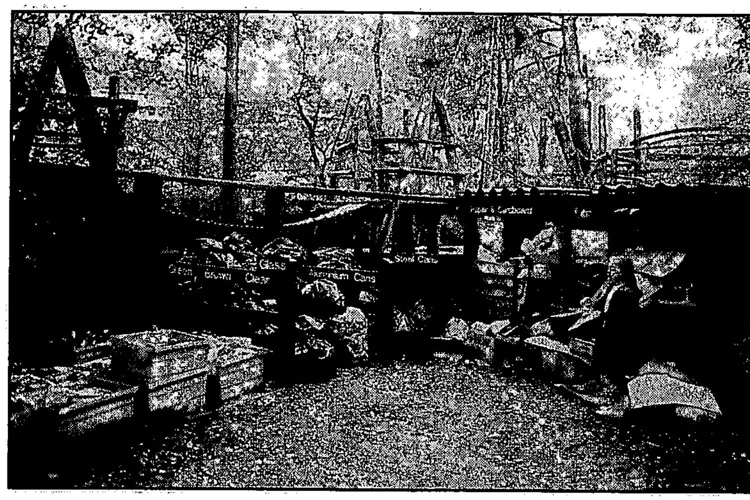
- Up to 3 points are awarded for development and maintenance of school grounds that meet the above recommendations.

11 Recycling facilities and waste disposal

Recycling of waste avoids environmental degradation due to landfill tipping and provides scrap materials, saving both raw materials and energy. Common materials which can be recycled are: paper, cardboard, aluminium (eg, cans and foil), metals from craft design and technology projects, garden refuse via composting, plastic and clothing. Advice on recycling is available from Waste Watch (see address on p.30).

Environmental purchasing

Some schools have extended their environmental policy to include a commitment to purchase more environmentally friendly products and materials. Careful choice of products can minimise waste due to packaging, use of non-biodegradable materials, built in obsolescence, etc. Green consumer guides can help to make the right choices. This is perhaps more important than the recycling of waste materials as the waste may, in many cases, be stopped altogether.



Recycling facilities at National Centre for Alternative Technology, Machynlleth, Wales

Recommendations
Provide separate bins for collection of waste and a secure store to enable successful recycling.

Introduce an environmentally friendly purchasing policy.

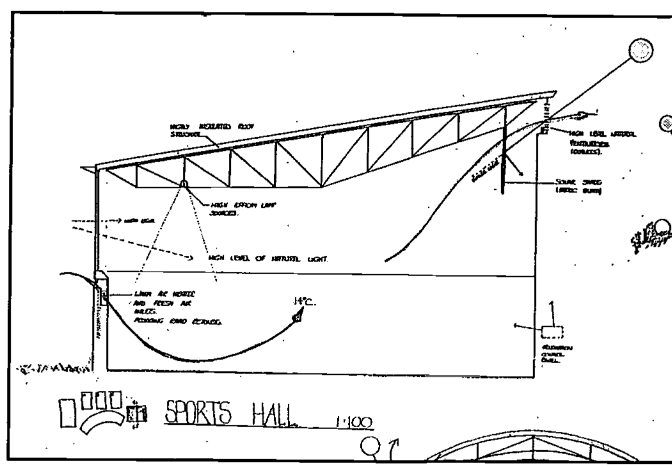
- **New and existing schools**
  Two points are awarded for provision of separate bins and a secure store for recycling waste materials.

- **Existing Schools**
  A further point is awarded to schools who have an environmentally friendly purchasing policy.

12 Ventilation

The design of a naturally ventilated building should aim to achieve a high quality of indoor air and good control over ventilation. The School Premises Regulations[1] require that, as far as possible, school buildings should be naturally ventilated. Exceptions to this are WCs, changing rooms, kitchens, laboratories, etc, which may require mechanical ventilation. Natural ventilation should be controllable, allowing users to adjust the ventilation rate as necessary. In order to achieve this control, designers should select appropriate types and sizes of window openings and trickle ventilators.

Where air contamination may result from work processes, eg, chemical experiments, wood machining, heat treatment, etc, proper local extraction in the form of fume cupboards or ventilation hoods should be provided to meet the requirements of COSHH (See Section 18).



Natural ventilation Kingshurst City Technology College

Recommendation
Building design should provide controllable natural ventilation in most areas. Mechanical ventilation and local extract ventilation should only be provided where necessary

- Up to 3 points are awarded for good ventilation.

Reference

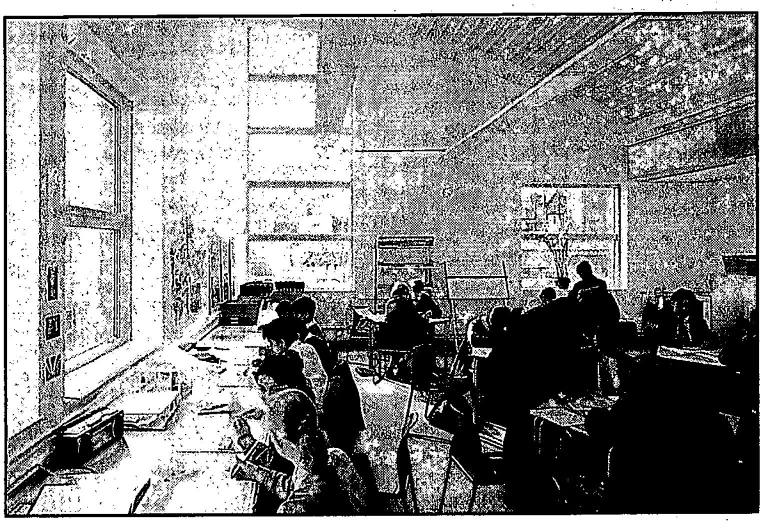
(1) *The Education (School Premises) Regulations 1996*, Statutory Instrument, SI 1996 No. 360, HMSO

13 Lighting

In new designs, daylight should be the predominant form of lighting in most working areas, and energy efficient lighting should be employed.

While little can be done to improve the quality of daylighting in existing schools, it is important that teachers are discouraged from blocking windows with display boards as it reduces the amount of daylight available. Schools can also ensure that electric lighting in teaching areas is up to the required standards, is flicker-free and does not create glare.

A well daylit classroom Swanlea Secondary School, London Borough of Tower Hamlets



Lights can be arranged to be switched in rows parallel to the windows. This allows the lights furthest from the window wall to be switched on independently from those nearer the windows. This minimises the number of lights which need to be switched on at any time.

Energy saving lamps and controls can be incorporated into the lighting system and children generally made aware that they should switch the lights off every time they leave a classroom unoccupied.

Recommendation
Maximise the use of daylight and provide energy efficient lighting to School Premises Regulation standards, of good colour quality, glare and flicker-free.

- One point for existing schools and up to 2 points for new schools are awarded for integrated design of high quality daylighting and electric lighting.
- Up to 2 further points are awarded if the electric lighting installation is energy efficient and incorporates lighting controls or switching arrangements to maximise energy efficiency.

14 Water economy

Water is a valuable natural resource which is delivered at considerable cost to consumers, via treatment plants and pumping stations. Reducing consumption and eliminating risks of contamination of water supplies will help prevent depletion of reservoirs, assist towards the maintenance of levels in rivers and other waterways. This will reduce the harmful knock-on effects on wildlife habitats due to low water levels.

Water conservation will lead to a reduction in the energy used to maintain pumping and in effluent treatment plants. It will also reduce water bills. Collection and use of rainwater and re-use of domestic waste water are possible as well.

Recommendations
New designs should incorporate features in addition to those required by the Water Byelaws to substantially reduce water usage.
Existing schools should encourage economy in the use of water and take steps to reduce usage. The Department's guide *Saving Water in Schools*' gives further advice[1]. The following measures will decrease the demand for publicly supplied water:

- install automatic urinal flush controls;
- provide low flush volume WCs;
- install a generous provision of isolating valves to prevent the need to drain down the system during servicing;
- fit timed operation taps, etc;
- check for leaks on a regular basis;
- locate water meters in easily accessible positions to help monitor for leaks; and
- monitor and target water consumption.

- One point is awarded where 4 of the above measures have been taken to reduce water usage.

References
(1) Managing School Facilities Guide *Saving Water*, DFE, 1993, HMSO, £3.95, ISBN 0 11 270851 X.

15 Water quality

Poor maintenance of cold water systems can lead to contamination of water supplies. The main areas of concern are as follows.

Cold water tanks:

- often oversized or with wrongly positioned inlet and outlets, leading to stagnation;
- displaced, loose, poorly-fitting or 'improvised' lids;
- lack of meshing on warning and overflow pipes to prevent ingress of dirt, insects, vermin etc;
- inadequate insulation;
- submerged inlet pipes (back-siphonage risk);
- significant internal corrosion;
- dirt and debris in water;
- providing supplies to kitchens and handbasins where they may be used for drinking water; and
- poor access to tank for maintenance.

Pipework:

- no records of pipework; and
- redundant pipework still connected, producing stagnant sections of water.

Non compliance with the *Water Byelaws*[1] leading to risk of back-syphonage, causing contamination of drinking water supplies:

- appliances connected to the mains without double check valves or other suitable backflow prevention devices (interposed cistern or air gap); and
- inadequate air gaps on sink taps.

Recommendations

Water storage tanks should not be oversized, should be inspected periodically and maintained in a hygienic condition. Hoses and equipment should be fitted with the correct backflow prevention devices. Water supply systems should comply with the *Water Byelaws*.

As part of a water consumption audit and water saving initiative, the pipework should be traced and a plumbing diagram prepared. Pipework should be colour coded and redundant pipework removed.

- Two points are awarded, one for each of the above recommendations.

16 *Legionellosis* (including legionnaires' disease)

Ingestion of the *Legionella* organism by inhalation can give rise to *Legionellosis*, but the risk of infection is low. Aerosols produced by hot water services, such as showers and spray taps, are potential sources of infection.

Although there have been no known outbreaks of Legionaires' disease in schools, and as a rule children are not very susceptible, this is no reason for complacency. Schools need to be aware of the dangers and their responsibility to maintain hot and cold water systems properly.

In accordance with the HSC Approved Code of Practice *The prevention or control of legionellosis*[2], risk assessments are required for certain water systems, including hot water systems exceeding a volume of 300 litres. Where a reasonable foreseeable risk is assessed, management plans should be drawn up and maintained to minimise the risk by regular inspection, maintenance, cleaning and treatment procedures.

Whilst surveys have shown *legionella* to be present in quite large numbers of water systems, such as those found in hospitals, schools and office blocks, only rarely do these appear to give rise to infection.

It is generally not possible to completely and permanently eradicate the bacteria. Therefore, in practice, the danger of infection is addressed by the application of good engineering practice to ensure the bacteria is prevented from proliferating. A considerable amount of guidance has been issued on the risks. Compliance with HSE(G)70 *The control of legionellosis*[3] and HSC Approved Code of Practice *The prevention or control of legionellosis*[2] is a minimum requirement. Good practical guidance is also available in CIBSE TM13 *Minimising the Risks of Legionnaires' Disease*[4].

Steps should be taken to minimise the opportunity for growth of *Legionella*.

References on water quality

(1) Water Research Council, *Water Supplies Byelaws Guide*, 2nd edition, 1989, £7.95, ISBN 0 90215671 3.

Water Research Council, *The Water Fittings and Materials Directory*,

BS 6700: 1987, *British Standard Specification for Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtillages*, ISBN 0 580 15769 5.

CIBSE Guide, Section B4: *Water Service Systems*, 1986, ISBN 0 9009533 30 6.

References on legionellosis

(2) Health and Safety Executive, HSC Approved code of practice, L8, *The prevention or control of Legionellosis including Legionaires' disease*, 1991.

(3) Health and Safety Executive, HSE(G)70 *The control of legionellosis including Legionaires' disease*, 1991, ISBN 0 1 882150 4.

(4) Chartered Institution of Building Services Engineers (CIBSE), Technical Memorandum 13, 1991, *Minimising the risk of Legionnaires' disease*, ISBN 0 900953 52 7.

It multiplies in warm water (approximately 26 to 46°C) and will thrive in the presence of scale or debris. Thus the temperature of cold water supplies should be kept below 20°C. Hot water should be stored at a temperature of 60°C or above and distributed at a temperature of 55°C. However for occupant safety, the temperature at point of use should not be above 43°C for all primary and nursery school supplies, for baths and showers and where occupants are severely disabled. This may be achieved by thermostatic mixing at the point of use.
It is recommended that hot water supplies to washbasins in nursery and primary schools are limited to 43°C. Systems for washbasins in secondary schools using local, point of use water heaters, with capacities of less than 300 litres, can be run at lower storage temperatures if the water at the draw off points is above 46°C.

Because the organism thrives in warm (but not hot) water, the length of piping carrying hot and cold water (eg, after a thermostatic mixer valve) must be kept to an absolute minimum, certainly less than 2 metres. Preferably each shower head should have its own mixer valve. Similarly. the length of pipes feeding washbasin hot taps should be minimised, especially with spray head taps which could generate an aerosol containing *Legionella*; point of use water heaters may be preferable to centralised hot water systems.

Past outbreaks of legionnaires' disease have only been associated with systems that have been neglected, or where the routine operation has changed. Frequent monitoring of the operation of the system and factors encouraging rapid multiplication of bacteria are therefore vital control measures.

Excessive periods of stagnation (in tanks or 'dead legs') should be avoided, and storage tanks must be maintained in a clean condition.

Particular attention should be given to the effective maintenance of systems as recommended in CIBSE TM13.

As sampling for *legionella* will often yield positive results, it is not advocated as a routine measure because it can cause unnecessary alarm and anxiety to all concerned, or at the other extreme, complacency and relaxation of standards. Sampling is expensive, and since no firm conclusions can be drawn from the results, the random sampling for *legionella* does not represent good value for money.

On the other hand, monitoring general water quality can provide a fair indication of system conditions. This, together with a package of other routine measures recommended by HSE, will draw attention to potential problems as they develop.

Recommendations
Steps should be taken to minimise the opportunity for growth of *legionella* within the water supply systems.

- One point is awarded for the above.

17 Asbestos in existing buildings

Natural fibrous silicate materials known as asbestos have been, and still are, in common use throughout the world. The use of asbestos products in building has been widespread and the majority of existing buildings contain asbestos in some form.

Airborne asbestos fibres are very hazardous to health. The main area of risk is work on existing buildings. In general, fibres are not released unless asbestos materials are disturbed or damaged. However, asbestos materials that are accessible to pupils will need special consideration, as they may be vulnerable to accidental or deliberate damage. Surveys should be made to locate asbestos in existing buildings.

Once asbestos has been identified there are three options:

- leave the material in place without sealing and introduce a management system to keep its condition under review;
- leave the material in place, seal or enclose it and introduce a management system to keep its condition under review; or
- remove and dispose of the asbestos.

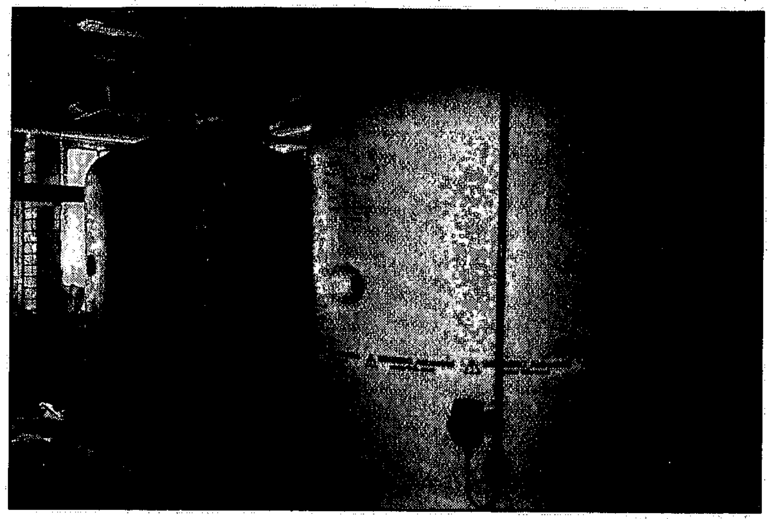
The first option is preferable when asbestos materials are sound, undamaged and not prone to damage, and not releasing fibres. Otherwise, the second option should be considered as a potentially better alternative to removal.

The management system referred to might include the registration, notification and labelling of materials and their periodic inspection.

A record system should be developed to provide data on:

- location of materials containing asbestos;
- areas where asbestos has been removed or encapsulated; and
- analysts' reports.

If it is decided to remove asbestos materials, appropriate precautions should always be taken. All work with asbestos is strictly regulated by the *Control of Asbestos at Work Regulations 1987*(1). These Regulations not only impose duties on employers to protect their employees from exposure to asbestos, but also extend this duty to include the protection of anyone else who may be affected by the work. In addition, work with asbestos insulation and coating (including its removal) is further regulated by the *Asbestos (Licensing) Regulations 1983*, and must only be carried out by specialist firms licensed by the Health and Safety Executive.



Asbestos insulated hot water storage calorifiers that have been encapsulated and labelled

Work can only be carried out if the employer has identified the type of asbestos involved, or assumed it is crocidolite or amosite, and made an adequate assessment of the exposure to asbestos involved in the work.

Further advice is available from the Department of the Environment(2) and in the Department for Education and Employment's memorandum(3). Detailed information and advice about the statutory requirements relating to asbestos can be obtained from area offices of the Health and Safety Executive.

Recommendations

1. Existing buildings should be surveyed.
2. Where asbestos has been identified a management system should include the registration, notification and labelling of materials and their periodic inspection.
3. A system should be developed to record:
   - location of materials containing asbestos;
   - areas where asbestos has been removed or encapsulated; and
   - analysts' reports.

- One point is awarded for each of the above.

References on asbestos

(1) Health and Safety Commission, *Control of Asbestos at Work Regulations 1987*, HMSO, 1988, ISBN 0 11 078115 5 and the Approved Code of Practice (COP21), ISBN 0 11 883984 5.

(2) *Asbestos Materials in Buildings*, third edition 1991, Department of the Environment, London: HMSO, £4.80, ISBN 0 11 752370 4.

(3) Administrative Memorandum 3/86 (Department of Education and Science), *The use of asbestos in educational establishments*, available from the Department for Education and Employment.

References on Health and Safety

(1) *Management of Health and Safety at Work Regulations 1992*, (SI 1992/2501), £2.30, ISBN 0 11 025051 6.

Workplace (Health Safety and Welfare) Regulations 1992, (SI 1992/3004), £3.10, ISBN 0 11 025804 5.

Provisions and Use of Work Equipment Regulations 1992 (PUWER), (SI 1992/2932), £3.10, ISBN 0 11 025849 5.

Manual Handling Operations Regulations 1992, (SI 1992/2973), £1.55, ISBN 0 11 025920 3.

Personal Protective Equipment at Work Regulations 1992, (SI 1992/2966), £2.70, ISBN 0 11 025832 0.

Health & Safety (Display Screen Equipment) Regulations 1992, (SI 1992/2792), £1.90, ISBN 0 11 025919 X.

(2) *Health and Safety at Work etc Act 1974*, HMSO, ISBN 0 10 54 3774 3.

(3) Building Services Engineers Guidance Note GN2: 1993 *Healthy Workplaces*, CIBSE, £6.99, ISBN 0 900953 586.

(4) *Workplace (Health, Safety and Welfare) Regulations 1992, Guidance for the Education Sector*, HSE Books, 1995, ISBN 0 7176 1049 7.

(5) *Contractors in schools, Information for headteachers, school governors and bursars*, IAC(L)98, HSE Books, 1996.

(6) *The Control of Substances Hazardous to Health Regulations 1988*, (SI 1988/1657), £3.30, ISBN 0 11 087657 1.

(7) *Electricity at Work Regulations 1989*, (SI 1989/635), HMSO, £2.65, ISBN 0 11 096635 X.

CIBSE Lighting Guide, *Lighting for Visual Display Units*, LG3, Revised 1996.

Guidance on maintenance

CIBSE TM17, *Maintenance management for building services*, 1990, ISBN 0 900953 44 6.

Building Bulletin 70, *Maintenance of mechanical services*, DfEE, HMSO, 1990, £10.95, ISBN 0 11 270717 3.

Building Bulletin 76, *Maintenance of electrical services*, DfEE, HMSO, 1992, £13.50, ISBN 0 11 270799 8.

18 Health and safety

Health and safety regulations affect classroom activities and building work as well as the design of the built environment.

The *Management of Health and Safety at Work Regulations 1992*[1] made under the *Health and Safety at Work etc, Act, 1974*[2] require employers to carry out risk assessments. They were introduced as a six pack of regulations[1]. CIBSE have produced a guide to these for building services engineers[3]. Guidance for the education sector to the Workplace Regulations[1] and on contractors in schools has been produced by the Health and Safety Commission[4,5].

The Regulations include the assessments demanded by previous legislation such as the *Control of Substances Hazardous to Health Regulations 1988 (COSHH)*[6] and the *Electricity at Work Act, 1989*[7] as well as those covered by more recent legislation.

Many of these regulations have implications for the school environment. For example COSHH affects the provision of ventilation as described in Section 12.

Recommendations

The following are requirements of the Management of Health and Safety at Work Regulations and should be complied with:

1. there should be a written policy statement on health and safety;
2. suitable and sufficient risk assessments should be conducted;
3. risk control systems and procedures should be introduced and followed; and
4. all staff should be given health and safety training appropriate to their duties.

- **For new designs**
  Up to 2 points are awarded for involvement of the client and user in the new design, in connection with incorporation of risk control systems and procedures to comply with Health and Safety legislation.

- **For existing schools**
  Up to 2 points are awarded for conducting risk assessments and arranging training for staff.

19 Maintenance

Designs which do not facilitate easy maintenance of building systems and plant in accordance with manufacturers' instructions may lead to health hazards for a building's users, high use of primary energy and harmful emissions to the atmosphere.

Designers should develop buildings which require little maintenance during their proper operation and facilitate ease of maintenance by virtue of location of plant and equipment.

Designers and building managers should minimise any health hazards which may result from lack of appropriate maintenance to buildings.

It is crucial to keep proper, up-to-date drawings and a full set of maintenance records.

Operator training in the use of equipment is essential.

Recommendation

New buildings should be designed for ease of maintenance and reduction of health hazards. Ensure that proper drawings and records are provided and caretakers and other operators are adequately trained in the operation of all plant and equipment for which they are responsible.

- Up to 2 points are awarded if the school has a full set of record drawings and operation and maintenance manuals.
- Up to 2 further points are awarded if full training is arranged for the caretaker and others in the use of heating and other controls.

20 Energy (carbon dioxide) rating

Since the beginning of the industrial revolution 200 years ago carbon dioxide (CO_2) levels have risen from 280 parts per million (ppm) to their present level of 358 ppm. Annual variation is due primarily to the production and withdrawal of CO_2 by vegetation. Levels of CO_2 have risen at about 0.5% per year over the last 4 years.

Increased emission of gases such as CO_2 may result in a warming of the earth's surface. This global warming may cause a rise in sea levels, flooding of coastal regions and catastrophic changes in climate. As a response to this serious ecological threat the UK has committed itself to reducing CO_2 and other greenhouse gases to 1990 levels by the year 2000.

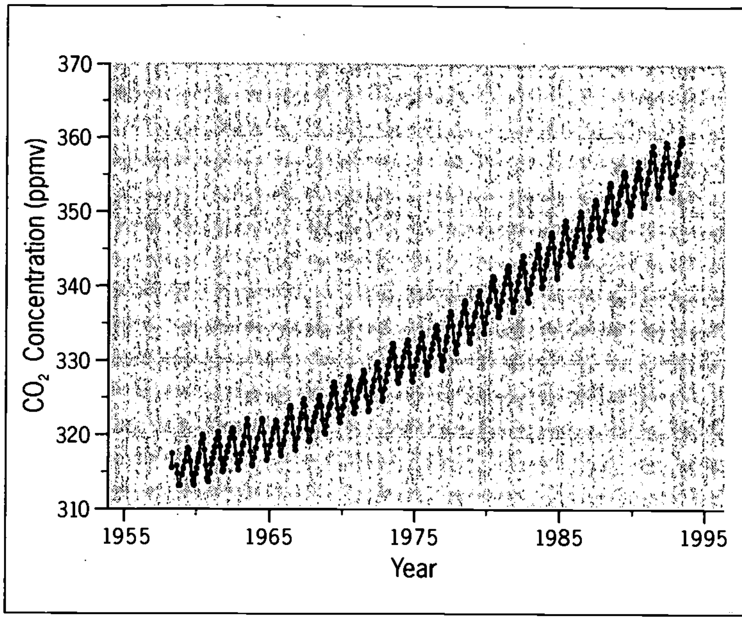
Half of the CO_2 emitted in the UK results from energy use in buildings. This is for space heating, hot water, lighting and use of appliances. It is therefore important that schools use energy as efficiently as possible. This will:

- help to protect the environment by reducing the emissions of CO_2 and oxides of nitrogen;
- conserve limited supplies of fossil fuels; and
- save money.

Clearly the performance of an existing school will depend to some extent on the buildings, but it also depends to a large extent on management and good housekeeping measures (see section 21).

A building which is particularly old and inefficient in terms of energy can be improved if reasonable steps are taken to reduce energy consumption through good housekeeping measures. Common problems in existing buildings are:

- poor insulation of the building fabric;
- lack of control of heating;
- inefficient boiler plant and heating distribution systems; and
- inefficient hot water systems.



Monthly atmospheric CO_2 concentrations at Mauna Loa increased from 315 parts per million by volume (ppmv) in 1959 to 356 ppmv in 1992[1].

The appendix starting on page 20 gives a calculation method for new and existing schools to predict the annual carbon dioxide production value. The resulting values are compared with the target bands for new and existing schools shown in figures 1 and 2 of the appendix and a corresponding number of points is awarded.

Recommendation
Minimise the production of carbon dioxide due to energy use.

- The following numbers of points are awarded for the various energy (carbon dioxide) ratings. See figures 1 and 2 on page 20 of the appendix for graphs showing the bands A to F for primary and secondary schools.

Type of construction	**New buildings**	**Existing schools**
Band	Number of points	
A	7	11
B	5	9
C	3	7
D	2	5
E	1	3
F		1

Reference
(1) Keeling, C.D., and T.P.Whorf, 1994. Atmospheric records from sites in the SIO air sampling network. pp.16 - 26. In T.A. Boden, D.P. Kaiser, R.J. Sepanski, and F.W. Stoss (eds.), Trends '93: *A compendium of Data on Global Change.* ORNL/CDIAC - 65. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A.

21 Energy management

The management of a building can enhance or nullify the design effort expended to achieve efficiency and low fuel consumption. As these Guidelines are intended to aid energy conservation in existing buildings as well as in new, a short summary of good management practice is appropriate.

Checklist of energy management measures

1. In the heating season, do not cool overheated rooms by opening windows or using extractor fans. Adjust the heating system instead and where possible set thermostats to give the recommended room temperatures. If additional ventilation is still required, open windows the minimum amount or use fans for the minimum period. Excess ventilation causes over-cooling and an increase in the heating required.

2. Economise on the use of hot water, subject of course to the need for cleanliness and hygiene. Caretaking and purchasing staff should be given information on cold water cleaning compounds. These can eliminate the need for hot water for cleaning during periods out of normal school hours.

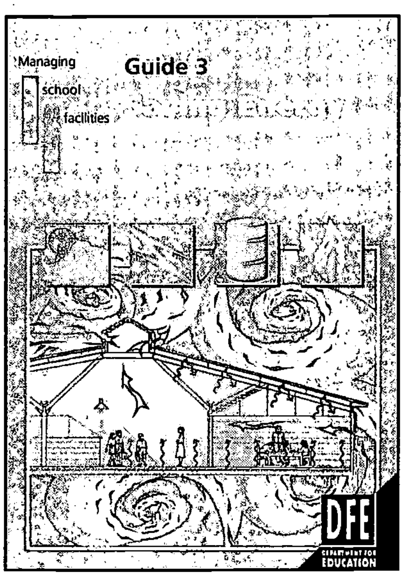
3. Encourage staff and pupils to wear clothes that are suitable for the required temperatures.

4. If separate zones of a building can be heated independently, allocate rooms for both daytime and out of school hours use so that the plant is used economically, and heat and light are not supplied to unused areas.

5. Start heating plant no earlier than is necessary to achieve normal working temperatures by the beginning of the occupied period. The plant can be turned off some time before the end of occupation. Optimum stop/start controls can achieve this. If a Building Energy Management System (BEMS) is installed a member of staff should be trained to use it and be responsible for its operation.

6. External doors should be kept closed as much as possible in cold weather and all windows closed overnight. Blinds or curtains drawn at dusk will help conserve heat overnight.

7. Equipment with high electrical power consumption should not be used at times during the winter months when the total electrical load from other sources is likely to be near the maximum demand limit. The maximum demand meter measures the amount of electricity being used at any instant. The highest reading in any month or quarter (depending on the tariff) is often used to calculate the standing charge. The increase in standing charge caused by exceeding the limit can increase the cost of the electricity for the winter quarter by as much as three times.



Recommendation
Appoint an energy manager or make a member of staff responsible for energy and conduct an energy awareness campaign.

- **Existing Schools**
One point is awarded if the school has an energy awareness campaign and has appointed an energy manager or given a member of staff responsibility for energy.

References
Department for Education and Employment, Managing school facilities, Guide 3, *Saving Energy*, HMSO, 1995,£3.95, ISBN 0 11 270880 3.

Department for Education, Building Bulletin 73, *A guide to energy efficient refurbishment*, HMSO, 1991, £8.50, ISBN 0 11 270772 6.

Introduction to Energy Efficiency in Schools, the whole school approach, BRECSU, 1996.
Reference should also be made to the Energy Efficiency Office Good Practice Guides and Energy Consumption Guides. These can be obtained free of charge from the Building Research Establishment Conservation Support Unit (BRECSU), Building Research Establishment, Garston, Watford, WD2 7JR, Tel: (01923) 664258.

22 Home to school transport policy

Transport is often the largest use of energy associated with schools. It also has the largest environmental impact causing a large amount of pollution including nitrogen oxides (NO_x).

School traffic can present a high risk to pupil safety. Pupil drop-off zones are often hazardous areas due to the large number of vehicles and the mix of cars, buses, bicycles and pedestrians.

Fifty years ago most pupils travelled to school by foot or bicycle but today most come by car. One reason is that parents no longer feel confident that young children will be safe walking or cycling alone.

Local education authorities often provide bus passes or special bus services. and schools usually provide cycle racks. This encourages pupils to use alternative methods of transport to the car. They are also providing safe drop-off points and separating bicycles and pedestrian traffic.

Recommendation
Develop a comprehensive policy on home to school transport. This should include energy use, environmental damage and the health and safety of pupils.

- Up to 2 points are awarded where schools have a comprehensive policy on home to school transport.

23 School environmental policy

SEAM gives an initial rating to schools according to the number of points obtained. The next step to improve environmental performance further is to develop an environmental policy and an action plan.

An environmental policy encourages the 'green' management of the school grounds and buildings. It provides a framework to ensure that pupils:

- learn about the environment and related important issues;
- develop positive attitudes and a commitment to environmental protection; and
- actively participate in resolving environmental problems.

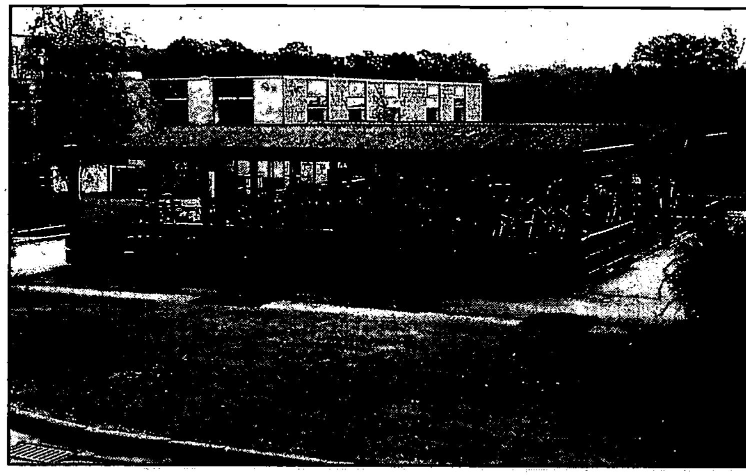
A policy will enable the whole school community to be involved in decisions about their environment.

The policy statement can be formally included in the school building and academic development plans and can be implemented by the formation of an environmental action team led by a member of staff.

The BRE are developing a 'toolkit' on computer disk which will enable schools to take their environmental management further and to decide on the best forms of action to take. This will be made available to schools on computer disc free of charge(1). The Tidy Britain Group(2) are running the Eco-Schools award scheme which encourages a whole school approach to environmental education.

Recommendation
The school should develop an environmental policy and action plan

- One point is awarded for developing an environmental policy and action plan



Secure storage of bicycles in shed overlooked by classrooms

References
(1) *The School Toolkit, A guide for reducing costs and environmental impact,* PA Consulting Group and the Building Research Establishment, 1996, from the BREEAM Office Tel: 01923 664462, Fax: 01923 664103.

(2) *Eco-Schools Handbook,* Tidy Britain Group, 1994, see address on page 30.

Further reading
BS 7750: *Environmental Management Systems.*

Positive Action, Ideas for enhancing the environmental performance of your school, Published by the National Association for Environmental Education, see address on page 30, ISBN 0 907 808 298.

Environmental Code of Practice for Buildings and their services, BSRIA Old Bracknell Lane West, Bracknell, Berkshire, RG12 7AH, 1994, ISBN 0 86022 361 1.

Appendix: Energy (carbon dioxide) rating calculations

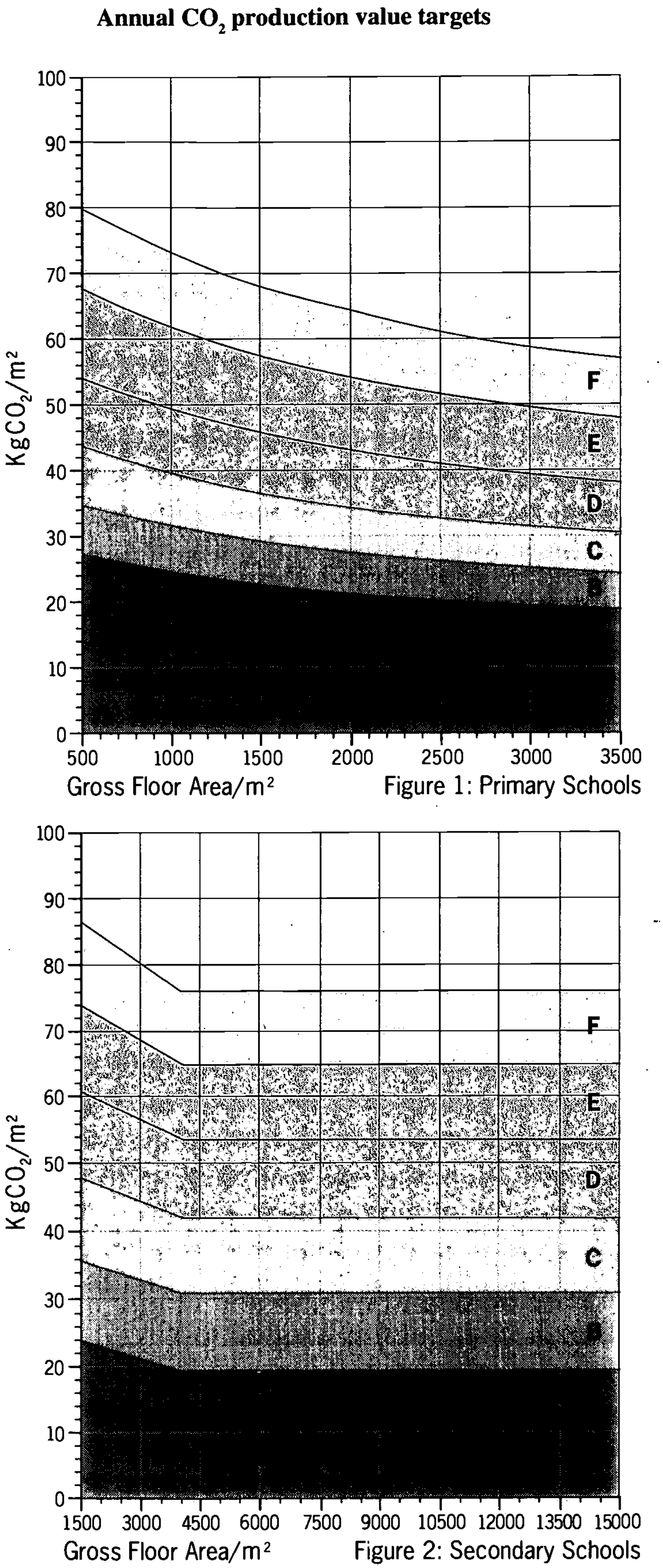


Figure 1: Primary Schools

Figure 2: Secondary Schools

Energy (carbon dioxide) rating

This appendix gives calculation methods to predict the Energy (CO_2) Rating for both new and existing buildings. The calculation for new schools is on pages 21 to 28. That for existing schools using actual energy consumption data is on page 29.

Figures 1 and 2 show the target bands for annual carbon dioxide production per square metre for new and existing primary and secondary schools. The graphs show bands A to F. Existing schools should be lower than the top of band F and new buildings should be below the top of band E. The corresponding numbers of points awarded in Section 20 of SEAM are shown below.

Annual CO_2 production value targets

Band	Comments
F	Upper line of band indicates the maximum permissible Annual CO_2 Production Value for **existing** buildings
E	Upper line of band indicates the maximum permissible Annual CO_2 Production Value for **new** buildings.
D, C, B	Varying degrees of Improvement upon the maximum permissible Annual CO_2 Production Value.
A	Very good low energy design.

- The following numbers of points are awarded for the various energy (carbon dioxide) ratings:

Type of construction Band	New build Number of points	Existing schools
A	7	11
B	5	9
C	3	7
D	2	5
E	1	3
F		1

General

There are a variety of calculation methods available to predict the annual energy consumption and amount of CO_2 produced by new buildings. The most accurate are computerised real time models which use recorded weather data to simulate the actual performance of the building. These models require the input of many parameters and are most useful at the later stages of design when the form of the building is known in some detail. At the early stage of design when assessing different options, a steady state calculation method can be more useful.

One method which allows alternative designs to be ranked in terms of their cost-effectiveness and their environmental impact in terms of CO_2 production follows.

Calculated or actual energy consumptions in kWh per square metre floor area are converted into $kgCO_2/m^2$ using the conversion factors of the various fuels. This is a measure of the overall environmental impact of the energy use.

The Total Annual CO_2 Production Value is then compared with the target bands in Figures 1 and 2 for primary and secondary schools respectively. The figures show bands of annual energy consumption in terms of $kgCO_2$ per square metre of the gross floor area (GFA) that is heated.

As the design of a building develops, alternatives (eg, in the choice of fuel, fuel efficiency or the methods of heating and lighting) may present themselves.[1,2] Realistic estimates of the options and the consequent life cycle costs for operation and maintenance of the building are required so that design decisions can be based on both cost and environmental impact.

Calculation for new buildings

The calculation procedure derives an Annual CO_2 Production Value by the summation of the heat requirement of the building and the energy used for other purposes such as lighting, small power, hot water, and the circulating pumps for the heating system. The heat requirement is calculated from the theoretical heat loss minus the heat displaced by adventitious gains such as lighting, occupancy, small power use, and solar gains. Using this basis the annual energy uses are calculated over a model year and converted to $kgCO_2/m^2$.

Kitchens and swimming pools are not included and their areas and energy consumptions must be excluded from the calculations[3]. Craftwork and home ecomomics loads are also not included.

Recommended design data

The values in the boxes that follow are recommended in the absence of more accurate information for the proposed design.

Building fabric U-values

Opaque areas	**Watts/square metre/°C**
Walls	0.4
Floor	0.4
Roof	0.3
Roof with a loft	0.25
Windows	
Single glazed (timber)	4.7
Double glazed (timber)	3.3
Rooflights	3.3

Ventilation losses

The background ventilation (infiltration) rate will depend upon the type of window system used and the air leakage characteristics of the building construction. Designers should pay careful attention to window design to avoid excessive heat loss whilst maintaining satisfactory fresh air provision and comfort conditions.

Minimum ventilation requirement
3 litres/second/person of fresh air

Typical ventilation rate
4-6 litres/second/person of fresh air

If a heat recovery system is to be used, the ventilation losses may be reduced by 50%. However there will be additional electrical energy used for fan power and a need for maintenance of filters, ductwork and grilles.

References

(1) Department for Education and Employment, Revision of Design Note 17, *Guidelines for environmental design in schools*, HMSO, Building Bulletin currently being drafted.

(2) Good Practice Guide 173, *Energy efficient design of new buildings and extensions – for schools and colleges*, BRECSU, address given on page 18.

(3) Guidance on swimming pools is available from the Energy Efficiency Office through their best practice programme.

Energy Efficiency Office Best Practice Publications: *Introduction to Energy Efficiency in Sports and Recreation Centres.*

Good Practice Guide 129, *Good housekeeping in dry sports centres.*

Good Practice Guide 130, *Good housekeeping in swimming pools - a guide for centre managers.*

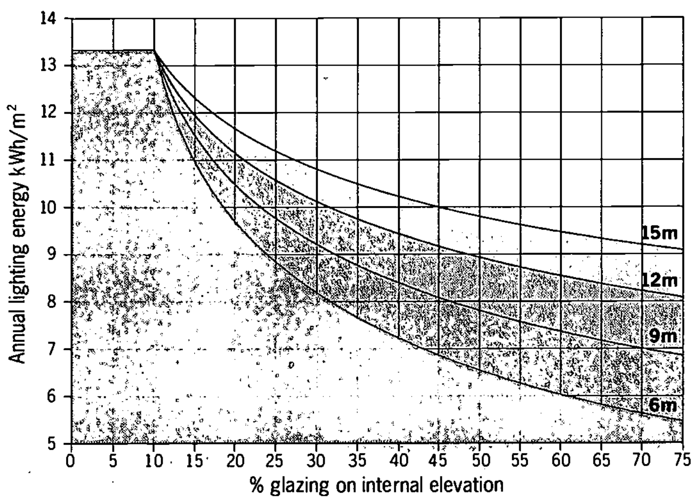
For further information contact BRECSU, address given on page 18.

Occupancy gains

For this calculation procedure a constant rate of heat production from the occupants is used. The total heat produced is estimated from the number of occupants within the building.

Typical rate of heat production
70 Watts per pupil

Figure 3. Annual lighting energy consumption in relation to vertical glazed area in external walls, for various average room depths.



The graph above is based upon the following assumptions:

- lights are switched on and off in response to daylight levels;
- electric lighting is needed for the number of hours that the daylight is below 300 Lux as given in the table below for different design daylight factors;

Daylight Factor (DF)	Number of hours when daylight is below 300 Lux
DF below 0.5	1640 hours
DF 0.5 to 1.0	1600 hours
DF 1.0 to 2.0	1280 hours
DF 2.0 to 4.0	700 hours
DF over 4.0	250 hours

- a minimum maintained illuminance for general teaching spaces of 300 Lux, which can be provided at a loading of 8 W/m^2;
- reflection factors: walls - 30% (average including pinboard areas), ceiling - 70%, floor - 15%; and
- floor-ceiling height 2.4m, window height 1.5m, cill height 0.9m.

If rooflights are used, their glazed area is multiplied by the ratio of 180 degrees minus the angle of the rooflight to the horizontal, this is then divided by 90 degrees, eg, 1m^2 horizontal rooflight is equivalent to 2m^2 of vertical window. This equivalent area is then added to the area of the vertical glazing to determine the percentage glazing of the internal face of external walls.

Hot water service

Hot water energy use varies according to the type and use of the building. However as an approximation the figure below may be used.

Typical rate 2 Watts/m^2
This value does not include hot water use for kitchens.

Heating circulators.

Fans and pumps for use in the heating system are often located outside of the building in which case they will produce an electrical load but not a heat gain.

Typical load 2 Watts/m^2

Electric lighting gains

The average room depth should be calculated. For example, a daylit building would have an average room depth of from 6m to 9m. The average room depth and percentage glazing on the internal area of the external wall are used to find the lighting energy in kWh/m^2 using Figure 3 on the left.

The prediction of annual lighting energy use obtained from Figure 3 is based on a design load of 8W/m^2 and a design minimum maintained illuminance of 300 lux at desk height. More accurate information for the proposed design may be used if available.

Typical load
8 Watts/m^2 for an illuminance of 300 Lux

Miscellaneous power gains.

Included in the figure below, are all small power teaching uses such as computers and audio-visual equipment. Individual high load equipment such as kilns and cooking appliances are not included in the calculation. The value, however, is intended to include the use of general cleaning equipment.

Teaching and cleaning equipment
5 Watts/m^2

Solar gains

Most buildings benefit from solar heat gains to some extent. If careful consideration is given to the use of solar gains at the design stage these benefits can be optimized[1].

Design and methods of using solar gains are many and varied and separate independent calculations or computer simulations can be used to assess the effects of different designs. However a simple method of accounting for the effect of direct solar gains on space heating is included in this calculation procedure.(See example calculation on page 26, paragraph f. Solar heat gains).

Solar utilisation values tabulated below are used in the same way as U-values ie, multiplied by the winter design temperature difference (eg, 19°C for classrooms, ie, 18°C internal air temperature with -1°C external design temperature) to compute the annual heat gain due to solar radiation.

Solar utilization values:
Annual average value in W/m²/°C

Window orientation	Glazing: Single	Glazing: Double
North	1.0	0.9
South	3.0	2.6
East	1.7	1.5
West	1.7	1.5
Rooflights	2.7	2.4

The solar utilisation factors are calculated from the formula:

$$\text{Solar utilisation value}^{(2)} = \frac{1000 f T_s T_g S}{0.24 D}$$

Where:
$f = 0.65$
$T_g = 0.87$ (single glazing) or 0.76 (double)
$T_s = 0.8$
$S = 1.5$ (north), 4.31 (south), 2.43 (east & west), 3.96 (horizontal)

$D = 1.3 \times 2006$ (see Table 3 on p.24)
$= 2608$ Degree-days

Seasonal system efficiencies averaged over the heating season

Type of system	Seasonal efficiency % (based on gross calorific values of fuels)
Space heating	
Electric	
Fan assisted electric off-peak heaters	90
Direct electric floor and ceiling systems	95

Gas/Oil	Boiler type: Conventional	Boiler type: High performance	Boiler type: Condensing
Automatic centrally fired radiator or convector system	63	76	87
Automatic centrally fired warm air ventilation system	60	73	84

Domestic hot water heating	
Gas and oil fired boiler/storage cylinder	56
Off-peak electric storage with cylinder & immersion heater	80
Instantaneous gas multi-point heater	62
Instantaneous electric multi-point heater	95
District heating with central calorifiers and distribution	56

The design heating requirement is divided by the seasonal efficiency of the heating system to obtain the delivered fuel equivalent, ie, the amount of gas, oil or electricity supplied to the school.

Carbon dioxide (CO_2) emissions

The delivered energy of a fuel is multiplied by the carbon dioxide conversion factor to give the carbon dioxide equivalent. The level of CO_2 produced by different fuels varies according to the initial proportion of carbon and the degree of processing required to arrive at the delivered fuel. Values for typical fuels are given in the table below. Note that each unit of electricity delivered consumes almost three times as much primary energy and emits three times as much CO_2 as a similar unit of gas due to conversion losses at the power station.

$KgCO_2$ per kWh of delivered energy	
Electricity	**0.58**[3]
Natural gas	**0.21**
Solid fuel	**0.34**
Oil	**0.29**
Sustainable wood or biomass fuel	**0.01**

In the case of systems using heat pumps, the CO_2 conversion factors for whichever fuel is used by the heat pump, should be divided by its coefficient of performance. Typically, the instantaneous factor if electrically driven is (0.58/2.5) = 0.23 and if gas driven is (0.21/1) = 0.21.

Kilogrammes of carbon dioxide can be converted to tonnes of carbon by multiplying by 0.048

References
(1) *Passive Solar Schools, A Design Guide*, Building Bulletin 79, DFE, HMSO 1994, ISBN 0 11 270876 5, £19.95.
(2) CIBSE Applications Manual *Window Design AM2: Section B5.2 Useful Heat Gains 1987*, ISBN 0 900953 33 0.
(3) Department of Trade and Industry *Digest of UK Energy Statistics*.

Table 3: Degree-days

Location	Zone	Degree-days
Thames Valley	1	1794
South Eastern	2	1979
Southern	3	1932
South Western	4	1646
Severn Valley	5	1705
Midlands	6	2183
West Pennines	7	2136
North Western	8	2228
Borders	9	2271
North Eastern	10	2160
East Pennines	11	2107
East Anglia	12	2047
Wales	16	1893
Average		2006

Degree-days are a measure of how cold the weather is during the heating season (September to May for schools). The number of degree-days equals the sum of the number of days times the number of degrees that the temperature is less than the base temperature. The table gives 20 year average degree days (for 1975 to 1995) to a base of 15.5°C for each of the recognised zones within England and Wales. Degree-days are usually quoted to a base temperature of 15.5°C. This is lower than room temperature and allows for occupancy and miscellaneous gains. However, the calculation method shown in this appendix does not apply this correction and uses a base temperature equal to the room temperature in this case 18°C for classrooms. Note that current annual and 20 year degree-day figures should be used if available.

Box 1 Corrected equivalent hours of operation

The method uses local degree-days and the design temperature to represent the space heating requirement in terms of the equivalent number of hours at full load operation.

$$E = \frac{24 \times D_d}{\Delta t_d}$$

Where:
E = Equivalent hours of operation at full load.
D_d = Seasonal total of degree-days to the base of the design internal temperature.
Δt_d = Design internal temperature minus design external temperature.

Correction for mode of operation
The calculated equivalent hours is adjusted by a series of correction factors (detailed below) appertaining to the building's mode of operation, which produces a corrected equivalent hours of operation. This value is used to determine the heating requirement of the building.

$E_c = E \times W \times DR \times R_p \times D_l$
E_c = Corrected equivalent hours of operation at full load.
W = Factor for length of working week.
DR = Ratio of school operating days to office operating days.
R_p = Factor for the response of the building and plant.
D_l = Factor for the length of the school day.

In the tables on page 25 the buildings are categorised into Light, Medium, and Heavy weight buildings. This refers to their thermal capacity which may include considerations of the buildings' contents as well as their construction.

Reference
[1] CIBSE Guide, Volume B, *Installation and equipment data, Section B18 - Owning and operating costs*, 1988.

Model year - hours of operation[1] of space heating

It is necessary to construct a model year on which to base calculations so that comparisons can be made. For this purpose a normal school day is used. Evening and holiday use is excluded as this varies from school to school. Likewise, kitchens, swimming pools and other process loads are excluded from the calculations.

Assuming a medium weight building (most school buildings are) and intermittent use of plant, and disregarding occupancy and other miscellaneous gains, the base temperature = the internal design temperature (Section C recommends 18°C for classrooms).

In order to correct the degree-days for other base temperatures, the figure for base temperature of 15.5°C should be adjusted by the relevant factor in Table B18.9 of CIBSE Guide Section B18[1]:
Base temperature = 18°C
ratio $D_d/D_{15.5}$ = 1.30
Hence, average equivalent annual operation: $E = \frac{24 \times 2006 \times 1.30}{19} = 3294$ hours
The average value of degree-days for England and Wales over the school heating season for normal working hours = 2006. (use local figure for D_d from Table 3).

The length of the heating season, 1st September - 31st May = 195 working days. The number of school days, including 9 days for cleaning and maintenance = 160.

Correction for mode of operation
(a) 5 day week (for school use)
= 0.8 x (160/195)
= 0.66(**W x DR**)
(b) intermittent use... = 0.75(**R_p**)
(c) 7.5 hour day... = 0.96(**D_l**)

Corrected E = 3294 x 0.66 x 0.75 x0.96
= 1565 hours
This equivalent hours calculation is based on CIBSE Guide[1]. Box 1 explains this calculation and the correction factors which must be applied for mode of operation.

a. Length of working week (W)

Table 4

Working week	Type of Construction		
	Light Weight	Medium Weight	Heavy Weight
7 day	1.0	1.0	1.0
5 day	0.75	0.80	0.85

Schools are most commonly medium weight buildings when a factor of 0.8 is used for a 5 day working week.

Definitions of light, medium and heavy weight buildings.

Heavy weight: buildings of curtain walling, masonry or concrete, especially multi-storey, with solid internal walls. eg, inner city, particularly Victorian, 2 and 3 storey buildings.

Medium weight: traditional brick-built, single-storey or concrete multi-storey with large windows.

Light weight: system or temporary buildings with light weight partitions and external walls.

b. Ratio of school operating days to office operating days (DR)

The values in Table 4 were designed for office buildings which have 195 working days during the defined heating season (September to May inclusive). Schools operate for fewer days than offices over the same heating season and total school operating days, including 9 days for cleaning, are generally 160 days. Therefore a further correction has to be applied to make the above factors suitable for school buildings.

The factor is obtained by a ratio of the number of operating days, so for school use, the additional factor is generally: (160/195) = 0.82.

c. Response of building and plant (R_p)

Table 5

Type of heating	Type of construction		
	Light Weight	Medium Weight	Heavy Weight
Intermittent - responsive plant	0.55	0.70	0.85
Intermittent - plant with long lag	0.70	0.85	0.95
Continuous	1.0	1.0	1.0

Most schools are intermittently heated, although the heating may be responsive or have a long time lag and consideration should be given to the type of system when using these correction factors.

d. Length of working day (D_l)

Table 6

Occupied Period (hours)	Type of construction		
	Light	Medium	Heavy
4	0.68	0.82	0.96
7.5	0.96	0.98	0.99
8	1.0	1.0	1.0
12	1.25	1.14	1.03

Educational buildings commonly have a daily occupancy of 7.5 hours.

Other gains and energy uses

The period of full-occupancy at 5(1) hours per day is taken for metabolic gains during the heating season (ie, 151 x 5 = 755 hours).

Hot water and miscellaneous power requirements are assumed for 1500 hours per annum = (7.5hrs x 200days); useful heat gains from them are provided only over the heating season for 1133 hours = (7.5hrs x 151days(2)).

Heating circulators and fans operate over the heating season only, for 1200 hours per annum = (7.5hrs x 160days).

It is assumed that 80% of the lighting is used over the heating season and that this contributes useful heat into the space.

Notes
(1) 5 hours is used in preference to 7.5 hours to allow for lunch and other breaks and for class changeover.
(2) 151 days is the fully occupied part of the heating season ie, minus the 9 cleaning days.

Example calculation for a new school

To calculate the annual CO_2 production value for a 450 place, secondary, general teaching, single storey school building with a gross floor area of 3565m^2 and a perimeter of 432m. Assume a gas-fired central boiler with radiators and hot water storage cylinder, temperature difference Δt_d = 19°C (internal 18°C, external -1°C).

Given

Local degree-days = 1873
Floor-ceiling height = 2.4m
Overall height = 3.0m
Room depth (Figure 3)= 8.0m
Overall window : wall ratio = 0.29
(internal elevation of external wall)
The overall percentage glazing is distributed as follows:

north, west and east	25%
south	45%

All glazing is assumed to be single and it is assumed that each facade has the same overall surface area.

U-values and installed loads are as recommended earlier in this section.
Ventilation is assumed to be 15m^3/person/hour.

Default values for U-values and incidental gains have been used.

Sample calculations for example school

In the calculation that follows the default values for U-values (maximum values), incidental gains, domestic hot water loads, lighting loads, miscellaneous power and heating circulator loads have been used.

In practice these values can be considerably improved on and default values should be replaced by actual calculated values where available.

Single glazing and a ventilation rate of 15 m^3/person/hour (4.2 litres/second/person) have been used.

a. Fabric losses

$$\text{Fabric losses} = \frac{\Sigma(\text{Area x U-value}) \times \Delta t_d}{\text{gross floor area}}$$

example:
wall losses = [(735 x 0.4) x 19]/3565
=1.57 W/m^2

b. Ventilation losses

Ventilation losses =[m^3/person/hour x 0.33 x Δt_d]/(density of occupation)

example:
ventilation losses
= [15 x 0.33 x 19]/(3565/450)
= 11.87 W/m^2

c. Miscellaneous power gain

Miscellaneous power =
[installed load(W/m^2)] x [hours of operation]/1000

example:
miscellaneous power = (5 x 1133/1000)
= 5.67 kWh/m^2

d. Lighting gain

The value for electric lighting is taken from Figure 3, using the overall glazing ratio and the average room depth. 80% of the lighting use is assumed to be during the heating season, the energy use for this is therefore a useful space heating gain and is used to off-set the heating requirement.

example:
lighting gain = 0.8 x 8.8 = 7.04 kWh/m^2

e. Occupancy gain

Occupancy gain
= [metabolic rate (W/m^2) x number of occupants x hours occupied]/(floor area x 1000)

example:
Occupancy gains
= [70 x 450 x755]/(3565 x 1000)
= 6.67 kWh/m^2

f. Solar heat gains

Solar gains are calculated using a solar utilization value related to the area of glazing, the orientation of the window and the type of glazing used (ie, single or double). Typical solar utilization values for the U.K. for both single and double glazed windows are given in a table on page 23. The solar utilization value works like a U-value, the total for the glazing on each facade is obtained and multiplied by the equivalent hours of operation.

Solar gain = Σ([areas x solar utilization values] x Δt_d x equivalent hours of operation)/(gross floor area x 1000)

example:
solar gains = [(65x1.0)+(104x3.0) + (65x1.7) +(65x1.7)] x 19 x (1634*2006/1873)]/(3565 x 1000)
= 5.58 kWh/m^2

The spreadsheet on page 28 shows that for the example school, the predicted annual carbon dioxide production value, is 23.62 kgCO_2/m^2 gross floor area. This has been plotted on the graph for a new secondary school (see figure 4) and the result is in band B. This is much lower than the maximum permitted target band E for a new school. However, there is still scope for improved design which would enable the design to satisfy the band A design target.

If the predicted annual CO_2 production value had been above the maximum permitted (ie, the top of band E), then the design would have been reconsidered in order to identify the factors which produced the excess energy consumption. These factors would then be altered to improve the design so that it satisfied the design target.

The calculation was repeated with double glazed timber framed windows (U-value = 2.7 W/m^2/°C), an improved roof U-value of 0.25 W/m^2/°C, a high performance boiler, a direct gas-fired hot water generator and the minimum ventilation rate of 10m^3/person/hour. The resulting CO_2 Production Value was 16.88 KgCO_2/m^2 an improvement of 28% putting the design into band A. This shows the value of the calculation during early design decisions.

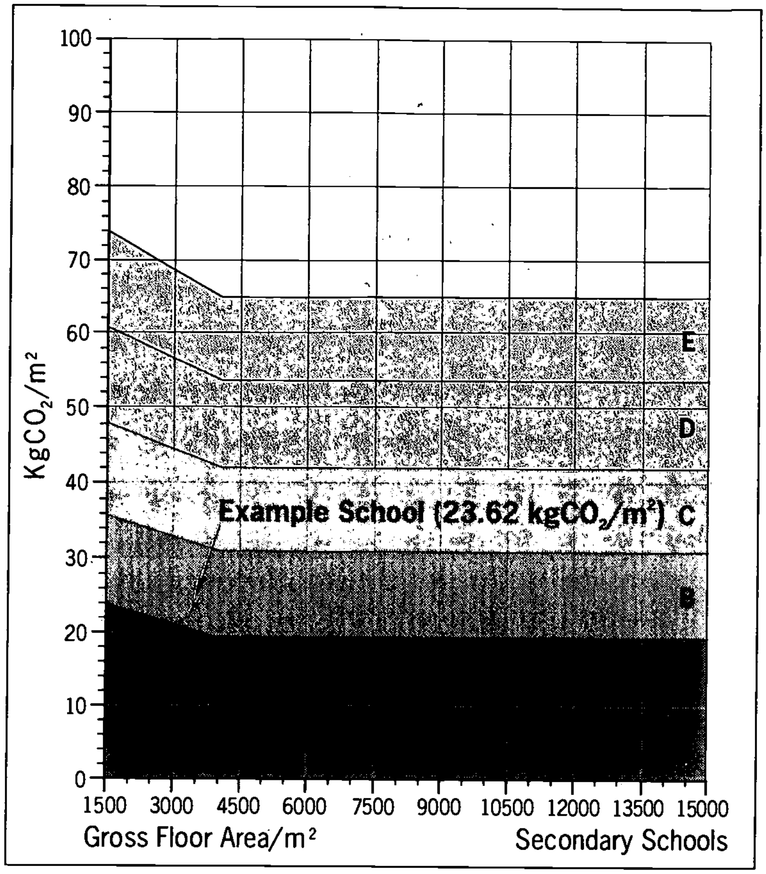


Figure 4: The predicted annual CO_2 production value, at 23.62 kgCO_2/m^2 gross floor area, is in band B within the maximum permitted design target.

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Example Calculation

Floor Area	3565	square metres excluding kitchens and swimming pools
Perimeter	432	metres
Average Room Depth	8	"
Floor – ceiling height	2·7	metres
Overall height	3	"
Window : wall ratio	0·29	(internal elevation of external wall)
Occupancy	450	persons
Density of occupancy	7·92	square metres of gross floor area per person

Design temperature	Internal	18 °C	National 20-year		
	External	–1 °C	degree day average	2006	
	Temperature difference	19 °C	Local degree days	1873	

Losses		Area	U-value	Watts/m²	
Opaque area (a)	Walls	735	0·4	1·57	
	Roof	3565	0·3	5·70	
	Floor	3565	0·4	7·60	
Windows	North	65	4·7	1·63	
	South	104	4·7	2·61	
	East	65	4·7	1·63	
	West	65	4·7	1·63	
	Rooflights				
Ventilation (b) rate	15 m³/hour/person		Ventilation loss	11·87	Watts/m²
Total Losses (Fabric + Ventilation losses)				**34·23**	Watts/m²
Convert to kWh/m²: (divide by 1000 and multiply by corrected equilvalent hours of operation 1750)				**59·90**	**kWh/m²**

Gains					
Incidental		Installed load (W/m²)	Hours of operation	kWh/m²	
Miscellaneous Power (c)		5	1133	**5·67**	
Lighting from Figure 3 (d)				**7·04**	
		Metabollic rate (w/person)	Hours of occupancy		
Occupancy (e)		70	755	**6·67**	
Solar (f)		Area	Solar utilisation values (W/m² °C)	Solar gains (kWh/m²)	
	North	65	1·0	0·61	
	South	104	3·0	2·91	
	East	65	1·7	1·03	
	West	65	1·7	1·03	
	Rooflights	0	2·4	0·00	
	Sum of solar gains			**5·58**	
Total gains				**24·95**	**kWh/m²**

Heating Requirement: Losses – Gains			**34·95**	**kWh/m²**
Delivered fuel equivalent:	(divide by heating system efficiency	0·63)	**55·47**	**kWh/m²**
Carbon dioxide equivalent:	(multiply by carbon dioxide conversion factor	0·21)	**11·65**	**$KgCO_2/m^2$ (i)**

Other Uses		Installed Load (W/m²)	Hours of operation	kWh/m²	
Domestic hot water		2	1500	**3**	
Delivered fuel equivalent:	(divide by hot water system efficiency		0·56)	**5·36**	
Carbon dioxide equivalent:	(multiply by carbon dioxide conversion factor		0·21)	**1·13**	**$KgCO_2/m^2$ (ii)**

Electrical energy		Installed Load (W/m²)	Hours of operation	kWh/m²	
Lighting (Figure 3)				8·8	
Miscellaneous power		5	1500	7·5	
Heating circulators		2	1200	2·4	
Total electric				**18·7**	**kWh/m²**
Carbon dioxide equivalent:	(multiply by carbon dioxide conversion factor		0·58)	**10·85**	**$KgCO_2/m^2$ (iii)**

Total Annual Carbon Dioxide Production Value
(heating + hot water + electrical) (i + ii + iii) 23·62 Kg Carbon Dioxide per square metre of gross floor area

Calculation for an existing school

A sample calculation method for existing schools using actual energy consumption figures is given in the following example.

Year	1989-90
Gross floor area	9000m²
Site degree-days (See table 3 on p24)	2047
20 year average degree-days for England	2006

Annual energy consumption:

electricity	257,563 kWh
gas	1,965,693 kWh

The calculation does not allow for energy use in catering or swimming pools. These parts of the energy consumption may be separately metered in which case they will be known, otherwise it will be necessary to estimate them.

Subtract the energy use by the swimming pool:

electricity (pool)	32,000kWh
gas (pool)	480,000kWh

School energy consumption excluding swimming pool:

electricity = 257,563 - 32,000
= 225,563kWh

gas = 1,965,693 - 480,000
= 1,485,693kWh

The heating fuel should be degree-day corrected to the 20 year degree day average = 2006 degree-days.

Degree-day factor = 2006/2046 = 0.98

(If the percentage of fossil fuel which is used for purposes other than heating is not known, assume it to be 30%. This excludes electricity consumption).

Assuming no electricity is used for heating:

heating gas = 1,485,693 x 0.70
= 1,039,985kWh

non-heating gas = 1,485,693kWh x 0.30
= 445,708kWh

Degree-day corrected gas consumption

= 445,708 + 0.98 x 1,039,985
= 1,464,863kWh

Convert energy consumption to production of CO_2 using the conversion ratios to $KgCO_2$ given on page 23.

Electricity = 225,563 x 0.58
=130,827 $KgCO_2$

Gas = 1,464,863 x 0.21
= 307,621$KgCO_2$

Total = 438,448 $KgCO_2$

Annual CO_2 production value

= 438,448/9000
= 48.7 $KgCO_2/m^2$

Multiply by 0.93 to allow for catering on the premises (or 0.97 for delivered meals):

Total annual carbon dioxide production value = 45.3$KgCO_2/m^2$

This is in band D therefore 3 points are awarded.

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Non-Government Environmental Organisations

Waste Watch, Hobart House, Grosvenor Place, London, SW1X 7AE, Tel: 0171 245 9998. Advice on school recycling schemes.

Council for Environmental Education, University of Reading, London Road, Reading, RG1 5AQ, Tel: 01734 756061.
National co-ordinating body for environmental education.

Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire, SG19 2DL. Information on environmental issues.

National Association for Environmental Education, Wolverhampton University, Walsall Campus, Gorway, Walsall, West Midlands, WS1 3BD.

Centre for Research in Energy and the Environment (CREATE), Kenley House, 25 Bridgeman Terrace, Wigan, WN1 1TD. Tel: 01942 322271, Fax: 01942 322273 (http://www.create.org.uk). National co-ordinating body for energy education.

Friends of the Earth, 26-28 Underwood Street, London, N1 7JQ, Tel: 0171 490 1555, Fax: 0171 490 0881, Email: info@foe.co.uk

Timber Research and Development Association (TRADA), Stocking Lane, Hughenden Valley, High Wycombe, Buckinghamshire, HP14 4ND. Tel: 01494 563091, Fax: 01494 565487.

WWF UK (World Wide Fund for Nature), Panda House, Weyside Park, Godalming, Surrey, GU7 1XR. Tel: 01483 426444, Fax: 01483 426409.

Tidy Britain Group, The Pier, Wigan, WN3 4EX, Tel: 01942 824620, Fax: 01942 824778. Runs the The Eco-Schools initiative.

Learning through Landscapes, 3rd. Floor, Southside Offices, The Law Courts, Winchester, SO23 9DL. Tel: (0962) 846258, Fax: (0962) 869099.
Advice on developing the use of school grounds.

Groundwork, Cornwall Street, Birmingham, B3 3BY. Tel: 0121 236 8586.
Specialists in development of school grounds and coordinators of the Esso Young Energy Savers scheme.

Greenpeace Ltd., Canonbury Villas, London, N1 2PN, Tel: 0171 354 5100.
Provide information on global environmental issues.

Centre for Alternative Technology, Machynlleth, Powys. SY20 9AZ. Tel: 01654 702400.
Visitors centre demonstrating sustainable technology. Runs residential courses for schools.

SEAM ENVIRONMENTAL ASSESSMENT SUMMARY SHEET

Issue number	Page number	Environmental aspect	New buildings	Maximum No. of points	Existing schools	Maximum No. of points
1	2	Site selection	☐	1		
2	2	Sources of hardwoods and softwoods	☐	4	☐	2
3	4	Low NO_x combustion equipment	☐	1	☐	1
4	5	Use of recycled materials	☐	1		
5	6	Ozone depleting chemicals	☐	2	☐	2
6	8	Volatile organic compounds	☐	2	☐	2
7	8	Harmful substances	☐	1	☐	1
8	9	Lead-free paint	☐	1	☐	1
9	9	Lead pipework in existing schools			☐	1
10	10	School grounds	☐	3	☐	3
11	11	Recycling facilities and waste disposal	☐	2	☐	2
	11	Environmental purchasing			☐	1
12	11	Ventilation	☐	3	☐	3
13	12	Lighting				
		- high quality integrated design of daylighting and electric lighting	☐	2	☐	1
		- lighting controls or switching arrangements	☐	2	☐	2
14	12	Water economy	☐	1	☐	1
15	13	Water quality	☐	2	☐	2
16	13	*Legionellosis* (including legionaires' disease)	☐	1	☐	1
17	14	Asbestos in existing buildings			☐	3
18	16	Health and safety legislation	☐	2	☐	2
19	16	Maintenance				
		- complete set of record drawings and maintenance manuals	☐	2	☐	2
		- caretaker training	☐	2	☐	2
20	17	Energy (carbon dioxide) rating	☐	7	☐	11
21	18	Energy management			☐	1
22	19	Home to school transport policy	☐	2	☐	2
23	19	School environmental policy	☐	1	☐	1
		Total number of points	☐	45	☐	50

Environmental classification based on total number of points

Class A - 35 points and over
Class B - 25 - 34 points
Class C - 15-24 points

Class ☐

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Schools' Environmental Assessment Method (SEAM)

Certificate of Achievement

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has achieved the SEAM Standard

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In recognition of its contribution towards the UK Strategy for Sustainable Development

Department for Education and Employment

This building bulletin provides a method of environmental assessment (SEAM) for both new and existing schools.

SEAM is designed so that schools can conduct their own environmental assessments. It can also form part of the curriculum, using the school grounds and buildings as a learning resource.

For new build and refurbishment schemes SEAM enables architects and building services engineers to assess the environmental impact at the design stage.

It covers global problems such as the destruction of the rain forest and the depletion of the ozone layer, local problems such as transport to school and internal problems such as air quality, legionnaires' disease and lead paint.

Energy consumption is the most important issue and is calculated in terms of the carbon dioxide produced, using the method for new buildings described in the companion publication 'Guidelines for Environmental Design in Schools'.

Schools' Environmental Assessment Method (SEAM)

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