

# E-learning environmental management

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### **Improving management and leadership skills in the furniture industry.**

The aim of this e-learning initiative is to raise awareness of environmental issues facing the industry.

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The Furniture, Furnishings and Interiors National Training Organisation (FFINTO) have been working in partnership with the trade association of British Furniture Manufacturing (BFM) and their Environmental Consultant - Alistair Bromhead to bring you this interactive e-learning website.

[www.ffinto.org](http://www.ffinto.org)

[www.bfmenvironmental.co.uk](http://www.bfmenvironmental.co.uk)

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# 1 Course Introduction

Environmental management pressures on furniture manufacturers are constantly increasing. New legislation is emerging in Europe and the UK, customers are increasingly asking questions about environmental performance and the cost of waste management continues to rise. Consequently, environmental management can no longer be sidelined. To do so could prove very costly, as highlighted by the number of prosecutions brought about by the Environment Agency and local authorities.

Avoiding the issue also places companies at a competitive disadvantage. Those that address new legislation in a proactive manner with the help of regulators will invariably comply in a more cost effective manner than those that ignore an issue until threatened by the regulator.

As a result of increasing pressures, keeping up to date with current and proposed legislation as well as technological developments, is becoming a full time occupation. However, busy managers can generally only afford to spend a limited amount of time addressing environmental management.

This course has been developed to give busy managers a working introduction to the issue of environmental management.

## 1.1 Objectives

The objectives of the course are to enable managers to:

- ◆ Understand the practical implications of environmental legislation
- ◆ Appreciate relevant areas of best practice
- ◆ Be able to provide basic training to others on relevant issues

## 1.2 How to use the manual

The manual is split into 8 sections which should be worked through in order. Sections 1-3 provide background information to enable you to understand the scope of environmental management, associated driving forces, the wider global agenda and the logic behind environmental legislation. Sections 4-7 concentrate on the key areas of waste, air, water, land, energy and transport management. A general introduction is provided to each issue along with more detailed information on legislation, best practice and sources of further information.

## 1.3 How to undertake the assessments

Each section of the manual is accompanied by a short assessment to test the level of understanding

**Further detail**

# 2 Introduction to Environmental Management

Environmental management involves a wide spectrum of issues which can affect the space in which we live and work. In the context of furniture manufacturing, these issues can include:

- ◆ Consumption of raw materials: nature of the material, source, packaging and associated wastage rate
- ◆ Process efficiency: efficient utilisation of raw materials, energy and water
- ◆ Air emissions: control of releases to air such as solvents, dust, noise and odour
- ◆ Waste management: elimination, minimisation, reuse, recycling, recovery and disposal of solid wastes with associated controls
- ◆ Wastewater: minimisation and control of liquid wastes ranging from vehicle washdown water to solvent waste
- ◆ Ground and groundwater: protection of ground to avoid land contamination
- ◆ End-of-life: consideration of the design and manufacture of an item to facilitate its reuse, recycling and recovery at the end of its useful life

## 2.1 Environmental driving forces

A number of driving forces encourage good environmental performance. It is important that both management and the work-force understand the importance of the driving forces to your company and that environmental management issues are perceived as a real business issue rather than a nicety.

The environmental driving forces can be split into:

- ◆ Legal
- ◆ Financial
- ◆ Market
- ◆ Social

### 2.1.1 Legal driving forces

Legislation is the single most important driving force. Laws will generally provide a minimum acceptable standard and companies which fall below this standard can face prosecution by the relevant regulatory authority. Good environmental performance will help to protect the future of companies and jobs, by minimising potential environmental liabilities and legislative non-compliance.

### 2.1.2 Financial forces

**a. Cost savings:** Waste minimisation and energy management are two areas with substantial savings potential in furniture manufacturing. When asked to estimate the cost of waste, it is very common for companies to purely think in terms of the disposal cost. The true cost of waste is typically 5 to 20 times the cost of disposal as it includes:

- ◆ The value of the raw materials being thrown away
- ◆ The labour and resources expended in processing the materials prior to discarding them
- ◆ Legislative compliance, e.g. cost of administrative procedures and any fines / long term liabilities associated with waste
- ◆ Opportunity costs of space, equipment and resources given over to on site waste handling and storage

By systematically identifying and managing all areas of environmental management, cost savings can be identified. Work by BFM Ltd and Envirowise suggest that most companies can save 1% of turnover through simple waste reduction measures. A cost reduction of 1% will generally have the same bottom line impact as a 10% increase in sales.

**b. Cost of financial services:** Financial institutions are increasingly concerned with the implications of current and long term environmental liabilities for their clients. It is becoming ever more expensive to insure against environmental damage resulting from site's activities. Banks and creditors are now requiring environmental reviews or audits of those companies to whom they lend money, because they realise the potential cost implications of bad environmental practices, e.g. the contamination of ground and groundwater. In similar fashion, large organisations have increasingly been conducting pre-acquisition environmental due diligence audits of companies that they are considering acquiring. There have been cases where the resultant value of companies has been reduced to zero due to the potential environmental liabilities.

### 2.1.3 Market forces

Environmental performance is becoming an issue raised by customers. This is likely to become increasingly important especially for those furniture manufacturers in the contract markets & / or supplying large companies due to the expected widespread uptake of environmental management systems (EMSs) throughout European industry. Companies who adopt EMSs will be required to evaluate the environmental performance of their suppliers, including those who supply their furniture. Hence the evolution of supply chain pressures for the improvement of environmental management performance. More horizontal pressures will subsequently arise, with firms having to implement EMSs to stay on equal terms with their competitors.

### 2.1.4 Social forces

Good environmental management will generally lead to a cleaner working environment, and hence one which is better for employees, e.g. less dust and solvent fumes. Similarly, such control will help to prevent the creation of nuisance which impacts on local residents. Social pressures also arise due to strong feelings regarding the global issues and they can be manifested in the shape of "environmental consumerism" - purchasing on the basis of environmental credentials.

## 2.2 How has your company responded?

These driving forces have impacted on different companies in various ways. Some firms have taken no notice - others have implemented full environmental management systems. The majority will fall somewhere in between.

In order to make progress, it can be useful to gain a snapshot of where the company is at present. Appendix 1 contains an “Environmental Management Matrix” which can be used to assess current areas of strength and weakness. To use the charts:

- ◆ Work down each column on the first sheet. For each area such as “policy” and “organisation” decide which statement best reflects the position in your own company.
- ◆ Mark each correct statement (one per column) on the second sheet. Join up the markings to form a line which can be compared to those on the third sheet

## 2.3 Sustainable development

The long term goal of environmental management is a movement towards “sustainable development”. This is defined as development which meets our needs without compromising the ability of future generations to do the same.

Many of our current practices are not sustainable. For example, transport based on fossil fuels is using a resource which is finite as well as taking carbon from the earth and emitting it into atmosphere where it can contribute to global warming.

If manufacturing industry is to become more sustainable, it will be necessary to develop technologies which allow more goods to be produced with fewer resources. Such practices are being encouraged by the vast majority of European and UK based environmental policy.

The practical reality of achieving sustainable development at a site level is much more complex than the theory, requiring an economy-wide shift towards more efficient patterns of resource use. The World Business Council for Sustainable Development has developed six key principles of “eco-efficiency”. The latter is defined as

“the delivery of competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing ecological impacts and resource intensity through the life cycle, to a level at least in line with the earth’s estimated carrying capacity.”

The six key principles of eco-efficiency are:

- ◆ **Increase service efficiency** - can the method by which the service is delivered be optimised. E.g. the service efficiency of this environmental management manual might be greatly increased by electronic publishing.
- ◆ **Reduce material intensity** - minimise the amount of resources needed for a given product. E.g. specify timber of correct size to minimise wastage and use residue for heating.
- ◆ **Optimise material selection** - ensure the sustainable management of renewable resources and select less environmentally sensitive resource. E.g. timber from sustainable sources.
- ◆ **Increase the useful lifetime of embodied resources** - design for long life and reuse, ie in a way that “borrows” resources from the environment and returns them to the economy as

a usable resource. E.g. produce a bed with a long working life which can be dismantled / refurbished for reuse at the end of its first life.

- ◆ **Increase energy efficiency** - increase the amount of product per unit of energy consumed
- ◆ **Reduce releases** - minimise the quantity and environmental impact of any production residues and by-products. E.g. use water based coatings on the desk rather than solvent based coatings.

## 2.4 Global issues

A number of global and local environmental effects occur as a result of emissions by man. Although we have all heard plenty about global warming, acid rain, ozone depletion and smog, much of the information in the public arena is either incorrect or confused. This section provides an overview of the global issues, which have had a major driving force for environmental legislation, economic instruments and best practice.

### 2.4.1 Global warming

The terms “global warming” and “greenhouse effect” are wrongly used interchangeably. The greenhouse effect is the mechanism which allows life to survive on earth by maintaining a suitably high average temperature. Global warming is the enhancement of the greenhouse effect due to compounds emitted by man. If this results in a significant average global temperature increase, it will be a major cause of concern.

Various bands of gases exist around the earth. The lowest of these is the **troposphere** which extends to between 9 and 20 km above the earth's surface. The next layer is the **stratosphere** between 9 and 60 km which is followed by the **ionosphere** stretching out to around 1,000 km above the surface. The outer layer is known as the **exosphere**.

Some of the gases in the lower layers produce an insulating effect. They allow energy from the sun (UV or short-wave radiation) to pass through and reach the earth. The earth then radiates back this energy in the form of infra red or long-wave radiation. Some of this is absorbed by the layer of gases and thus the temperature of the lower atmosphere and the earth is increased.

The gases that allow short-wave radiation to pass through, but absorb long-wave radiation, are known as the “**greenhouse gases**”. Without the effect that they produce, the average global temperature would be around 30°C lower - and life as we know it would not exist.

The main greenhouse gas is water vapour, but others include carbon dioxide, methane, chlorofluorocarbons (CFCs). Global warming is a real concern because the level of such gases in the atmosphere is increasing as a result of mans activities. It is therefore feared that the average global temperature will increase - leading to climate change, shifting of rain patterns and crop bands and the melting of the polar ice caps.

Around 50% of the enhancement of the greenhouse effect is due to carbon dioxide (CO<sub>2</sub>). This is released from the burning of fossil fuels such as oil, natural gas and coal. It is also released from deforestation and the burning of wood - though inversely, it is absorbed by growing trees. The industrialised nations account for around 20% of world population but 80% of CO<sub>2</sub> emissions. Hence the concern at the Earth Summit in Rio in 1992 and the Earth Summit II in the US 1997, for major reductions in CO<sub>2</sub> emissions by nations such as the US. The lat-

ter emits 22 tonnes of CO<sub>2</sub> p.a. per person compared to just 2 tonnes in China and 0.7 in India.

Much has been made of the importance of CFCs in the global warming process. Such compounds have a massive global warming potential - 1 kg of CFC 12 has the same global warming effect as 7,300 kg of CO<sub>2</sub>. As a result replacements are being formulated for their industrial uses, e.g. in foams, as propellants and refrigerants.

Huge quantities of greenhouse gases have been released since the industrial revolution. However, their total global warming effect has not yet been felt due to the natural time lag involved in the heating up of oceans and from complex feedback mechanisms. It is therefore believed that the global warming effects from the past 50 years emissions have not yet manifested themselves. When / if they do, it will be too late to take action - the damage will already have been done.

The conclusion that has generally been reached is that global warming is not proven but it is strongly suggested by many factors. If the release of greenhouse gases by man continues unchecked, there is a strong possibility of catastrophic effects in the next century. Nations are therefore entering into voluntary agreements to bring their emissions of greenhouse gases under control.

## 2.4.2 Acid rain

All rain is acidic, normally around pH 5. This acidity results from carbon dioxide dissolving in rain droplets as they fall through the atmosphere, leading to a weak solution of carbonic acid.

If the atmosphere also contains oxides of sulphur and nitrogen, they too will dissolve in falling rain, leading to increased acidity. Thus rain can have a pH as low as 4 (which is 10 times more acidic than pH 5 due to the logarithmic nature of the pH scale). In addition, acidic gases and particulate matter can be deposited on the earth. These are then washed into lakes and rivers by rainfall. These wet and dry processes are collectively known as "acid deposition" and they result in the acidification of water resources.

Sulphur dioxide and nitrogen oxides are the main gases that contribute to acid deposition. Nearly all fossil fuels release sulphur upon combustion. 70% of UK sulphur dioxide emissions are caused by coal fired power stations. The latter also contribute a significant amount of nitrogen oxides (NO<sub>x</sub>), which are formed when air is heated to more than 650°C. Road transport is the single biggest contributor of NO<sub>x</sub> in the UK.

The main European areas of production for these gases are central Europe and the British Isles. However, due to prevailing wind conditions, acid deposition tends to occur in areas in a north-easterly direction, e.g. Scandinavia. The effects of such acid deposition may be neutralised in areas with a natural buffering capacity, eg an underlying layer of chalk which neutralises the acidity. Unfortunately, much of Scandinavia is underlain by granite, which has a poor buffering capacity and the acidification of water resources is the result. This leads to a reduction in species and fragile ecosystems due to the degree of environmental stress. Acidification also affects the productivity of soils, causing stress to plant life and killing off necessary soil bacteria and earthworms.

## 2.4.3 Ozone depletion

Ozone (O<sub>3</sub>) is a naturally occurring gas. At ground level it is harmful to health (see section on summer time smog). However at stratospheric levels (9 to 60 km above the earth) ozone is beneficial as it absorbs harmful ultra-violet radiation. This stratospheric ozone is commonly known as the “ozone layer” and its depletion can lead to problems such as skin cancer, premature ageing of the skin and damage to eye tissue.

The reduction of ozone in this layer is being brought about by chemicals containing chlorine or bromine that are released by man. These substances destroy stratospheric ozone and have led to an annual springtime “hole” in the ozone layer above Antarctica.

Chlorofluorocarbons (CFCs) are particularly severe ozone depleters. Due to their chemical stability, CFCs can be transported into the stratosphere where one chlorine atom can destroy up to 100,000 ozone molecules. For this reason, hydrochlorofluorocarbons (HCFCs) have been introduced as substitutes, as their ozone depletion potential is generally 2 to 10% of that of one of the main CFCs. Hydrofluorocarbons (HFCs) are even more preferable as they lack chlorine and therefore do not deplete ozone. However, they still contribute to global warming.

Although no international legislation exists to control ozone depletion, over 100 countries have signed the Montreal Protocol which limits the production of ozone depleting substances.

## 2.4.4 Summer time smog

At ground level, ozone is an undesirable substance. Tropospheric ozone is formed by a photochemical reaction (i.e. one requiring light) between volatile organic compounds (VOCs) and nitrogen oxides (NO<sub>x</sub>). This results in a brown atmospheric haze known as summer time or photochemical smog.

Such an occurrence can lead to irritation of the eyes and nose - especially in those that are most sensitive, e.g. the elderly, young or those that are particularly active. High levels of tropospheric ozone can also damage trees and crops.

As mentioned previously, NO<sub>x</sub> is derived from combustion at high temperatures - with transport being the biggest cause in the UK.

VOCs are a class of carbon containing compounds which evaporate easily. They are released from many sources including solvents and petrol usage - as well as being given off naturally by vegetation. They are an important pollutant from a furniture manufacturing perspective as the sector is estimated to emit around 10,500 tonnes of VOC each year from wood coating operations.

## 2.4.5 Winter time smog

Air temperature normally decreases with height. However, during cold winter nights, “inversions” may form in the atmosphere - where there is a layer of cold air at ground level, above which is warmer air. For example, in a valley, cold air sinks towards the lower ground - pushing warm air above it. This leads to a lid of air which traps pollutants such as particulates and sulphur compounds at ground level. These may lead to the irritation of eyes and nose.

# 3 Environmental legislation

## 3.1 Introduction

The long term goal of environmental management is a movement towards “sustainable development”. The two main methods which are used to encourage a movement towards sustainable development are legislation and economic instruments.

Legislation sets a minimum level of performance which everyone is expected to attain. Environmental legislation generally aims to ensure that companies minimise emissions and render harmless those emissions that are unavoidable.

Economic instruments help to ensure that the polluter pays for any damage to the environment. By increasing the cost of producing pollution, the payback of pollution prevention techniques is improved. For example, the landfill tax makes the disposal of wood waste to skip more expensive, thereby encouraging companies to look at minimisation and improving the payback of initiatives such as recycling or wood combustion.

## 3.2 Background to legislation

The UK has a long history of environmental legislation dating from the 19th Century. Since joining the European Community, the UK has had to bring national controls in line with the rest of Europe.

The EU produces various kinds of legislative Acts, of which the most important are Regulations and Council Directives.

**EU Regulations** take effect directly in the national laws of the Member States without the necessity for any additional domestic legislative action. **Directives** dictate the desired end result but give Member States the discretion to determine how the new legislation is put into effect. It is Directives that are most often used in environmental matters.

## 3.3 Regulators

Regulators are necessary to ensure that the minimum levels of performance are attained by all. The two main environmental regulators for furniture manufacturers are the Environment Agency and the local authorities - though the regional sewerage undertakers also have a degree of control.

### 3.3.1 Environment Agency

Created on 1<sup>st</sup> April 1996 by the *Environment Act 1995*, the Environment Agency has taken over duties previously held by:

- ◆ National Rivers Authority
- ◆ Her Majesty's Inspectorate of Pollution
- ◆ Waste Regulation Authorities

North of the border, the Agency is known as SEPA - Scottish Environmental Protection Agency - which is also responsible for Air Pollution Control regulation.

These Agencies creates a one stop shop for water and waste regulation, as well as regulating all environmental impacts from the most polluting industrial sites in the country.

### 3.3.2 Local authorities

Local authorities are responsible for dealing with air pollution from lesser polluting industries. They are therefore responsible for Air Pollution Control authorisations, e.g. for wood coatings and wood burning boilers. Local authorities also regulate occurrences of nuisance such as dust, odour and smoke as well as having duties under the Contaminated Land Regulations 2000.

### 3.3.3 Regional sewerage undertakers

A degree of regulatory control over discharges to foul sewer is held by the regional sewerage undertakers. The latter are responsible for the issue of consents to discharge trade effluents to foul sewer. However, as a result of the appalling compliance records of the regional sewerage undertakers, there are pressures to transfer their regulatory functions to the Environment Agency.

## 3.4 Consequences of legislative breaches

Regulatory authorities in the UK generally prefer a non-combative approach to achieving compliance. Local authorities will normally be sympathetic towards manufacturers that are seen to be making progress towards compliance. Where progress is not evident, an enforcement notice may be served requiring compliance within a stipulated period. Failure to comply may result in prosecution - generally in a Magistrate's Court with a fine of up to £20,000. The more sizeable the offence and the greater the size of the offending company, the higher the chances of a case going to the Crown Court where fines can be unlimited. Examples of the maximum fines / imprisonment for breaches of environmental legislation are provided below:

Legislation	Offence	Magistrate's Court	Crown Court
Environmental Protection Act	Authorisation breach	£20,000 fine &/or 3 months in prison	Unlimited fine &/or 2 years in prison
Water Resources Act	Unconsented discharge to controlled waters	£20,000 fine &/or 3 months in prison	Unlimited fine &/or 2 years in prison
Water Industry Act	Unconsented discharge to foul sewer	£20,000 fine	Unlimited fine
Special Waste Regulations	Breach of requirements	£5,000 fine	Unlimited fine &/or 2 years in prison
Producer Responsibility for Packaging Waste	Lack of / incorrect data provision, failure to meet obligation	£5,000 fine	Unlimited fine

Regulators such as the Environment Agency can provide helpful advice to minimise potential risks, but they are under a duty to consider the prosecution of actual unconsented discharges

and pollution incidents. The table below gives an idea of potential pollution costs, though none of these incidents relate to ground / groundwater contamination which can be more expensive by several orders of magnitude.

Any of the below non-compliances could potentially occur on a furniture manufacturing site. Of particular note is the incident involving a printing company which spilled just 22 litres of toluene - a solvent used by many furniture manufacturers for thinning and cleaning purposes. The solvent entered surface water drains and then a brook where it is estimated to have killed over 4,000 fish.

Personal liability also exists for environmental damage. If an offence is committed by a company under the Environmental Protection Act or the Water Resources Act, any director or manager will also be guilty if it can be proved that the offence was committed with his consent, or was attributable to any neglect by him. This may result in imprisonment for up to two years.

Examples of environmental prosecutions		
Company	Non-compliance	Cost
Furniture manufacturer, Newark	Consignment of “empty” coating containers in wood waste skip. Two drums still contained coatings. Company fined for three offences: <ul style="list-style-type: none"> <li>◆ Breach of Special Waste Regulations - improper disposal</li> <li>◆ Duty of Care - for failing to generate transfer documents</li> <li>◆ Disposing of waste in a manner likely to cause harm to human health or pollution.</li> </ul>	£6,000
Timber company, Essex	Spillage of timber treatment chemicals was thought to have been contained in a bund - but bund was unlined and the preservative seeped into a local watercourse, poisoning fish and invertebrates	£6,000
Furniture manufacturer	Consignment of 59 x 25 litre drums containing coating residues. Several drums had no lid or were badly sealed. Company fined for: <ul style="list-style-type: none"> <li>◆ Breach of Duty of Care - no written description</li> <li>◆ Failing to pre-notify under special waste regulations</li> </ul> The coating company was the waste transporter and they were also fined the same amount	£2,050
Printing company	Solvent spillage entered surface water drains and subsequently a brook	£8,114
Animal renderer	Non compliance with air pollution control authorisation conditions	£216k
	Non compliance with air pollution control authorisation conditions - the two fines led to bankruptcy	£330k
Waste management company	Illegal deposit of wastes for which the Director received a jail sentence	18 months

# 4 Air Emissions

## 4.1 Introduction

Air pollution has been a cause of concern in the UK for many hundreds of years, with coal burning being regulated in London as early as 1273. The main air emissions of concern generated during furniture manufacture are:

- ◆ Volatile organic compounds (VOCs)
- ◆ Wood dust
- ◆ Particulate matter from spraying and combustion
- ◆ Formaldehyde from glues and board material
- ◆ Hydrogen cyanide and hydrogen chloride from combustion
- ◆ Odour
- ◆ Noise

Key legislation	
Pollution Prevention and Control Act 1999	
◆ PG1/12(04) Combustion of fuel manufactured from or comprised of solid waste in appliances between 0.4 and 3MW	Controls wood combustion plant burning more than 90 kg per hour
◆ PG6/2(04) Manufacture of timber and wood based products	Applies to sites which process >1,000 m <sup>3</sup> of timber p.a.
◆ PG6/33(04) Wood coating processes	Relevant to companies which use > 5 tonnes of solvent p.a.
Environmental Protection Act, 1990, Part III, Statutory Nuisance	Controls neighbourhood nuisance resulting from noise, odour and dust etc.
Clean Air Act, 1993	Prevents emissions of dark smoke
Climate Change Levy (Registration and Miscellaneous Provisions) Regulations 2001	Places a levy on the use of fossil fuels

## 4.2 Local Air Pollution Prevention and Control

The most significant air pollution controls for the furniture industry are those which were initially imposed at the start of the 1990's by the Environmental Protection Act 1990 (EPA). Part I of the EPA made it an offence to operate a prescribed process or use a prescribed substance without an authorisation. The EPA has since been superseded by the Pollution Prevention and Control Act 1999 and its associated regulations, though this change has had little practical impact on the sector.

Companies operating prescribed processes, above specified thresholds, must hold a permit under the Local Air Pollution Prevention and Control regime (LAPPC). Processes of particular relevance to furniture manufacturers are:

- ◆ PG1/12(04): Combustion of fuel manufactured from or comprised of solid waste in appliances between 0.4 and 3MW
- ◆ PG6/2(04): Manufacture of timber and wood based products
- ◆ PG6/33(04): Wood coating processes

Each prescribed process has a process guidance note (PG) which is updated on a periodic basis, with 2004 being the latest revision hence the (04) notation. The guidance notes are available from <http://www.defra.gov.uk/environment/airquality/lapc/pgnotes/>

The process guidance notes contain useful background information as well as the details of the Best Available Techniques (BAT) for the control of pollutants from the process. Companies which hold a permit are expected to apply BAT, which is effectively a balance between state-of-the-art technology and management techniques and what an industrial sector can generally afford.

Typical controls specified in the process guidance notes include emissions limits, monitoring, maintenance and recording. These will be incorporated into a site specific permit, unless the local regulator can be persuaded to use their discretionary powers to waive some of the requirements.

The aim of the notes is to provide a consistent level of control to specific processes across the UK, whilst allowing a degree of flexibility to local regulators with regards to the interpretation of requirements at individual sites. Requirements may vary depending upon the presence of sensitive residential areas close-by, the cost and benefit of conducting upgrades and the general degree of diligence shown previously by the company. However, the guidance notes constitute BAT in the eyes of the DEFRA (Department for Environment, Food and Rural Affairs) and local regulators must have good reasons to deviate from them. The APC system is regulated by the local authorities (in England and Wales) and by the Scottish Environmental Protection Agency (SEPA) north of the border.

### 4.2.1 PG1/12(04) Combustion of fuel manufactured from or comprised of solid waste in appliances between 0.4 and 3MW

The wood combustion guidance note was republished in September 2004, following a lengthy revision process which resulted in very little practical change. The note sets emission limits for wood burning boilers between 0.4 and 3 MW which is roughly equivalent to a feed rate of 90 to 675 kg/hour:

Total particulate matter	200 mg/m <sup>3</sup>
Organic compounds	20 mg/m <sup>3</sup>
Carbon monoxide for existing processes <sup>1</sup>	*
... for new appliances <1MWth	250 mg/m <sup>3</sup>
... for new appliances >1MWth	150 mg/m <sup>3</sup>
Formaldehyde	5 mg/m <sup>3</sup>
Hydrogen chloride	100 mg/m <sup>3</sup>
Hydrogen cyanide	5 mg/m <sup>3</sup>
<sup>1</sup> Existing processes are those which were installed in December 1995 or before	
*Emission limits for carbon monoxide for existing plant were suspended in 1995 and are currently agreed on a site specific basis.	

The limits for formaldehyde, hydrogen chloride and hydrogen cyanide are only relevant to sites burning board material, e.g.:

- ◆ Formaldehyde from chipboard, plywood, fibreboard and similar material
- ◆ Hydrogen chloride where painted or PVC coated wood is burned
- ◆ Hydrogen cyanide from melamine faced wood

### Monitoring requirements

These emission limits form the basis of the note and monitoring of various forms must be undertaken to demonstrate compliance. The guidance note contains a range of monitoring requirements which vary according to whether a site is burning purely raw timber / dust or it is burning board material and other wood based products.

Raw timber (e.g. uncoated, untreated hardwood and softwood):

- ◆ Particulate matter: continuous quantitative monitoring with a visible and audible alarm
- ◆ Carbon monoxide and organic compounds: annual test

Other wood based products (e.g. MDF, MFC and chipboard)

- ◆ Particulate matter: continuous quantitative monitoring with a visible and audible alarm
- ◆ Carbon monoxide: continuous quantitative monitoring with a visible and audible alarm. Results may be discarded when taken within 30 minutes of start-up or during periods of idling
- ◆ Oxygen or carbon dioxide: continuous indicative monitoring
- ◆ Annual testing for particulate matter, carbon monoxide, organic compounds and where appropriate for formaldehyde, hydrogen chloride and hydrogen cyanide

- ◆ Daily visual and olfactory assessments

Monitoring imposes a significant cost on wood combustion plant. Continuous monitoring equipment will generally cost £20,000 to £30,000. Furthermore, the equipment tends to be unreliable especially with regard to carbon monoxide. Re-calibration after repair will typically cost between £500 and £1,000. Annual testing incurs another £1,000 to £2,000 p.a.

### **EU Waste Incineration Directive**

EU Waste Incineration Directive (2000/76/EC) requirements have been integrated into PG1/12(04). The Directive excludes “wood waste” except that containing “halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating”. Current understanding suggests that this excludes all wood and timber based products e.g. except where they contain halogenated organic compounds - basically substances which contain chlorine, bromine or fluorine, e.g. polyvinyl chloride (PVC) - or they contain heavy metals.

Therefore, the Directive will not apply to the majority of furniture manufacturers. Plant falling within the scope of the Directive would effectively have to close down as the emission limits could not be met by plant which has not been specifically designed for this purpose.

## **4.2.2 PG6/2(04) Manufacture of timber and wood based products**

Sites *likely to use* more than 1,000m<sup>3</sup> of timber *in any 12 month period* are required to hold a local authority authorisation for processes involving the manufacture of timber and wood based products as defined in PG6/2. The threshold figure increases to 10,000m<sup>3</sup> if the wood is sawn only, i.e. not sanded or drilled etc. Sites unsure of the need for authorisation should take particular note of the italicised words.

The main aim of this legislation is to ensure the correct extraction and collection of wood dust to prevent environmental harm and the creation of neighbourhood nuisance. As with much environmental legislation, there are close links with health and safety requirements, with wood dust controls also serving to protect human health and minimise fire hazards.

The main requirement of the note is the switch from cyclones to bag filters for furniture manufacturers, though this may not be necessary for timber companies generating larger chips of material with moisture content above 20%. Operations requirements also apply such as:

- ◆ Requirement to conduct and record 3 visual observations each day to ensure that there are no emissions of particulates
- ◆ Staff training must be undertaken for those with responsibility for the extraction system
- ◆ A written maintenance programme must be provided to the regulator with respect to pollution control equipment.

## **4.2.3 PG6/33(04) Wood coating processes**

This process guidance note applies to sites likely to use more than 5 tonnes of organic solvent in any 12 month period in their coating process. The wood coating sector emits around 10,500 tonnes p.a. which is around half of one percent of the UK total (BFM, 2001).

There are a variety of options that can be used by sites above the threshold limit to ensure compliance with the requirements of the guidance note. There are two bands of solvent users: 5-15 tonnes and 15 tonnes upwards. The former have an extended deadline for compliance with their final compliance option (2007) whilst the latter had a compliance deadline of April 1999.

N.B. When talking of such dates it should be remembered that the extension applies only to small users in respect of their final compliance routes (i.e. mass balance, compliant coatings or emission limits). All other aspects of the note should have been complied with by all sites by 1<sup>st</sup> April 1999.

The compliance options available are:

- ◆ Compliant coatings: where all coatings have less than a specified level of solvent. This level has been increased from 435 g/l to 475 g/l in the 2004 note. This options ceases to be available to larger solvent users (>15 tonnes) from October 2005.
- ◆ Emission limits: typically involving abatement technology to reduce VOC emission levels below 50 mg/m<sup>3</sup> (where solvent use is above 15 tonnes) or to below 150 mg/m<sup>3</sup> (where solvent use is between 5 and 15 tonnes). It is thought that some small sites might be able to achieve 150 mg/m<sup>3</sup> without abatement, but they would still need to install expensive monitoring equipment
- ◆ Mass balance approach: compliance is achieved by reaching a “target emission” which is related to the solids content of coatings to allow flexibility in accordance with varying levels of production. The target is calculated as follows:
  - ◆ 5 to 15 tonne users can apply up to 1.6 times as much solvent as solids, i.e. 1.6:1 (and they have until 2007 to do so)
  - ◆ 15 tonne and upwards users can apply the same amount of solvent as solids, i.e. 1:1 (and they had until 1999 to do so)

Companies are required to draw up a solvent inventory which is submitted annually to the local authority. This should include a calculation of solvent usage during the year (opening stock + purchases - closing stock) from which should be subtracted the discountable solvent (solvent sent for re-use and recovery).

The starting point for any such upgrade should be the reduction of unnecessary VOC usage:

- ◆ Use of a solvent management system to understand exactly what solvent is consumed in each process and the levels of variation that occurs
- ◆ Elimination of non essential solvent use, e.g. the use of unnecessary thinners for thinning
- ◆ Better house-keeping such as ensuring lids are placed on all tins

- ◆ Staff training and education - how will lower solvent usage benefit the individual and how can it be achieved
- ◆ Careful collection and storage of special waste (waste solvent & thinners) which is then sent for reuse - and hence can be claimed as “discountable solvent”.
- ◆ Efficient spray technology with an efficiency of at least 65% is used - and all sites must have this in place by April 1999.

Once steps such as those outlined above have been taken, it will be a case of working with your coating suppliers to develop the best solution. Unfortunately, the large number of timber / process / finish variables mean that there are no generic solutions.

Further information is provided in a variety of benchmarking and best practice guides produced by BFM Ltd and Envirowise, as outlined in the final section on further reading.

### **EU Solvent Emission Directive**

The 2004 revision of PG6/33 incorporates the requirements of the EU Solvent Emissions Directive. The latter only applies to sites using >15 tonnes of solvent p.a. As a result, PG6/33 differentiates between 5-15 tonnes users (to which the directive does not apply) and >15 tonnes users to which it does.

## **4.3 Environmental Protection Act 1990, Part III, Statutory Nuisance**

The most common statutory nuisances generated by furniture manufacturers are odour, noise, litter, smoke and fumes. Complaints from neighbours which are made to the local authority may be investigated. Where the degree of nuisance warrants such action, the local authority may serve an abatement notice under the Environmental Protection Act, s.80, requiring the cessation of the nuisance. The site would have 21 days to comply - with failure to do so being an offence.

## **4.4 Clean Air Act, 1993**

This Act makes it an offence to emit “dark smoke” i.e. smoke darker than shade 2 of a Ringelmann Chart from any trade premises. Therefore, it imposes some degree of control on small wood burning boilers which fall under the local authority control threshold as well as making yard fires illegal. One defence of note is where a furnace is being lit from cold and all reasonable steps have been taken to minimise emissions. Unless the contrary is proven, an emission of dark smoke is deemed to have taken place if material is burned which is likely to give rise to the emission of dark smoke. This closes a loophole due to night time burning where dark smoke can not be seen!

## **4.5 Climate Change Levy (Registration and Miscellaneous Provisions) Regulations 2001**

This levy was introduced in 2001 to reduce the volume of carbon being emitted by the UK and aid compliance with the requirements of the Kyoto climate change agreement. The rates of the levy are 0.15 p/kWh for gas and coal and 0.43 p/kWh for electricity, applicable to all business energy use. Part of this cost will be offset by a reduction in employers' national insurance contributions from 12.2% to 11.9%.

Certain energy intensive industries subject to Pollution Prevention Control (PPC) have been able to negotiate levy discounts of up to 80%. The same is also true for some smaller processes. For example, BFM Ltd operates a Climate Change Levy rebate scheme for the furniture manufacturing sector which enables companies to claim back up to 80% of the levy paid in respect of their coating operation energy use.

# 5 Waste Management

## 5.1 Introduction

Society often views waste as a valueless substance and this can lead to a lack of effort by waste producers in their treatment and disposal of waste. However, waste has the potential to have an extremely high negative value for waste producers due to:

- ◆ Cost of production
- ◆ Legal liability

All waste has the potential to adversely affect the environment; by contaminating the air, water and soil, and causing nuisance such as odour and litter. As a result there is a Duty of Care on all waste producers to ensure that waste is correctly handled and treated on site. Waste producers also retain some degree of responsibility even after the waste has been passed into the care of others, which means that sites should check up on carriers and disposal sites.

Whilst we tend to take waste production for granted, it should be remembered that waste disposal is essentially the throwing away of raw materials. For example, sites pay for raw timber to be delivered, spend time and effort in processing, throw 40 to 80% of the timber into a skip and then pay someone else to take it away.

Therefore waste minimisation at source is desirable from an economic and an environmental perspective in line with the waste management hierarchy (as discussed later).

<h3>Key legislation</h3>	
Environmental Protection Act 1990 Part II: Duty of Care	Duty on all who produce, handle, store, transport or dispose of waste to ensure it is safely managed
Hazardous Waste (England & Wales) Regulations 2005	Specific duties regarding hazardous waste
Producer Responsibility Obligations (Packaging Waste) Regulations 1997	Obligations to finance the recycling of packaging which falls on certain companies
Packaging (Essential Requirement) Regulations 1998	Duty to minimise packaging use
Landfill Tax Regulations 1996	Regulations which impose a tax on each tonne of waste sent to landfill

## 5.2 What is waste?

Some of the residues from furniture production are classed as waste, whilst some are not. The distinction is important as waste management legislation only applies to waste.

One definition of waste is provided by the Environment Agency (2004): “any substance or object that you discard, intend to discard or are required to discard may be considered to be waste. Waste may require treatment or recycling either on your premises or elsewhere.”

The intention of the holder of the substance is an important factor in determining whether or not it is defined as waste. This issue was explored further by the Environment Agency (2003). Where the holder passes the item onto another party, it is necessary to decide whether the holder has discarded the item or intends it to be used for its original purpose. For example, a chair donated to a furniture reuse charity for resale would not be deemed waste. However, a broken chair taken by the householder to a civic amenity site would be waste. It may cease to be classed as a waste once it has been repaired and is suitable for its original use.

## 5.3 Duty of Care

A chain of individuals are involved in the life-cycle of waste. This will start with the producer, e.g. a furniture manufacturer, who will consign the waste to a carrier, who takes it to a disposal site or to someone who can treat, convert or reuse it.

The Duty of Care was introduced to prevent the incorrect storage, handling, treatment or disposal of waste throughout this life-cycle. It seeks to do this by placing a duty on sites to ensure that:

- ◆ They do not commit an offence themselves
- ◆ They do not allow others in the chain to commit an offence

**The system is designed to be essentially self-regulating, with the burden of proof being on your site to show that it has fulfilled its duty.** The duty applies to anyone who produces, imports, carries, keeps, treats or disposes of controlled waste, or as a broker has control of such waste.

A practical guide called the “Code of Practice” is available which recommends a series of steps which should normally be enough to meet the duty (HMSO, 1996). The following section provides a summary of these steps.

The duty is not really a single duty, but four interconnected duties:

- ◆ To prevent the unlawful disposal of the waste by anybody  
As a waste producer, your site must take all reasonable steps to prevent unlawful disposal of the waste by third parties (e.g. waste carriers, disposal contractors, etc.)
- ◆ To make sure that waste does not escape your control or that of any other person  
Similarly, this is an extended responsibility. It requires your site to handle and store the waste correctly on site. The duty also requires that the waste is placed in suitable containers for any transport or storage under the custody of other people.
- ◆ Only to transfer the waste to "authorised persons"  
Authorised persons for this purpose are the waste collection authority or, more commonly, a registered waste carrier.
- ◆ To give the person taking the waste a written description which will enable them to deal lawfully with the waste (i.e. meet his/her own duty of care)  
This duty involves the introduction by the generator of a standard system of waste documentation (which a prudent generator should have in place anyway!).

### 5.3.1 On-site considerations

- ◆ **Storage:** all waste holders must act to keep waste safe against:
  - Corrosion or wear of containers
  - Accidental spillage, leaking or leaching from the ingress of rainwater
  - Accident or weather breaking contained waste open and allowing it to escape
  - Waste blowing away or falling while stored or transported
  - Scavenging of waste by vandals, thieves, children, trespassers or animals.
- ◆ **Labelling:** should be used on all waste containers - including skips. Everyone must know what can and cannot be placed in a given skip / container. The disposal of unsuitable items, e.g. half full tin of old coating (often a special waste) in a general waste skip will constitute a breach of the duty as the skip will not be general waste as claimed in the transfer note (see later). This is particularly important if there are often contractors on site. Labelling is also essential if waste is to be segregated for reuse or recycling.
- ◆ **Security:** waste should be secure from vandalism, scavenging and wind-blow - covering with a tarpaulin is again a good idea and it is preferable to have a locked area for waste storage (this will also stop others putting their waste in your skip - which is costly and risks contravening the Duty due to the inclusion of unsuitable waste).

### 5.3.2 Transfer considerations

Transfer: must occur only to an "authorised person", e.g. a:

- Waste collection authority (local authority)
- Waste manager who is licensed for the activity he manages (or is exempt)
- Registered carrier.

The latter is the most common type of carrier. Registration certificates will be issued by the Environment Agency. Manufacturers are advised to obtain a numbered copy of the carrier's registration certificate provided by the Environment Agency. Photocopies are not valid and do not provide evidence of the carrier's registration. Failure to obtain a registration certificate would make it difficult to show that your site has transferred waste only to an authorised person.

When waste is passed onto another person, it must be accompanied by a transfer note and a written description with enough information to allow subsequent handlers to be able to handle the waste safely.

In reality, the transfer note and written description will normally be combined into one document, and copies must be kept for two years. In the case of repeated transfers of waste of an identical nature, e.g. skips of off-cuts, these documents may be issued on an annual basis rather than for each collection trip. Such documents must be generated for each waste stream. Thus, two separate annual transfer notes will be required on a site which has one general waste skip and one trailer for saw-dust. Similarly, a new set of documents must be generated if the details change, e.g. the size of skip increases.

It is advisable to check that the disposal site is licensed to accept the waste that you are consigning to it. Under the Waste Management Licensing Regulations 1994, disposal sites / transfer stations generally require one of the following:

- A waste management license
- Registration with the Environment Agency
- Relevant exemption

The effectiveness of individual companies to comply with their licence conditions varies widely. Checks can be made to ensure that waste is correctly treated further down the line of waste handlers by;

- ◆ Requesting a copy of the waste management license for each site that you use. This should be checked to ensure that it is current and that the site can accept your particular waste
- ◆ If you have difficulties interpreting the licence - you can address written queries to the issuing branch of the Environment Agency
- ◆ Visiting any disposal sites that are used; either for a brief walk-around and chat (to gauge the level of competence and conscientiousness of the operatives) or to conduct a brief environmental review.

Written details relating to each of the above checks should be retained on record. Licenses, registration or evidence of exemption should be checked afresh in the following cases:

- ◆ Whenever a new waste stream is involved
- ◆ Where there has been a change in the disposal site or carrier
- ◆ At least once a year if nothing has changed in a series of transfers.

In the event of an Environment Agency investigation into a waste incident in the locality, e.g. a consignment of fly tipped wood waste, your site will then be able to produce the following:

- ◆ Transfer notes (dating back at least two years) for each waste stream
- ◆ Carrier registration for each waste collector used by your site
- ◆ Waste management licence for each facility that your waste is taken to
- ◆ Correspondence with the Agency with regards to the current validity of such licenses
- ◆ Review details from visits to waste management company sites.

Your site will therefore have a strong case that it has taken all reasonable precautions and exercised all due diligence to prevent the mis-treatment of its waste.

## 5.4 Hazardous Waste (England & Wales) Regulations 2005

Hazardous waste is basically waste considered so dangerous or difficult to keep, treat or dispose of, that special provision is required for dealing with it. Typical hazardous wastes on furniture sites will include:

- ◆ Coating shop residues: e.g. waste thinners, empty solvent based coating tins and obsolete solvent based coatings
- ◆ Waste oil and oil / water interceptor residues
- ◆ Fluorescent tubes from lighting and cathode ray tube computer screens

The actual process of deciding whether or not a substance is hazardous waste can be complicated. Waste management companies should be able to provide clarification.

Between 1996 and July 2005, the Special Waste Regulations 1996 controlled special or hazardous waste. From July 2005, the Hazardous Waste (England & Wales) Regulations 2005 take effect. This has led to the following changes:

- ◆ The term “hazardous waste” has replaced “special waste”
- ◆ Producers of hazardous waste (such as furniture manufacturers) have to register with the Environment Agency on an annual basis.
- ◆ Hazardous waste cannot be mixed with non-hazardous, e.g. it is not acceptable to mix water borne and solvent borne coating wastes in the same drum
- ◆ Pre-notification of the Environment Agency is no longer required before moving a consignment of hazardous waste

## 5.5 Producer Responsibility Obligations (Packaging Waste) Regulations 1997

Producer Responsibility is the concept of making manufacturers responsible for obtaining some value from their materials, products and wastes via reuse, recovery and recycling. The first target area was that of packaging waste and other areas have followed through the controls on end-of-life vehicles and waste electrical equipment directives.

The Producer Responsibility Obligations (Packaging Waste) Regulations 1997 apply to companies that handle more than 50 tonnes of packaging p.a. **and** have a turnover of more than £2 mil p.a. Companies exceeding these thresholds will incur an obligation to recover / recycle a certain proportion of their packaging waste.

The amount of packaging handled is the tonnage of packaging or packaging material that your company supplied onto another stage in the packaging chain in the previous year in addition to the amount imported. Examples of relevant packaging include:

- ◆ Cardboard, bubble wrap and tape on goods out
- ◆ Transit packaging on imported goods in, e.g. plastic sheets, metal banding and disposable wooden crates - where your company is the first UK owner.

Complying with the regulations involves the following:

- ◆ Calculate the amount of packaging handled during the previous year. If this is greater than 50 tonnes and your company has a turnover above the £2 mil (at the last set of audited accounts) then the Regulations apply and your company will pick up an obligation.
- ◆ Decide the tonnages of packaging on which you perform each activity. There are four stages in the packaging chain, each of which incurs a specific percentage of the obligation. A furniture manufacturer may pick up one or more of these activity obligations:
  - ◆ Raw material producers           6%
  - ◆ Converters                           9%
  - ◆ Packer fillers                       37%
  - ◆ Retailers                             48%
- ◆ Decide on the appropriate UK targets: the regime is only trying to recover and recycle a proportion of the total packaging stream and this is set on an annual basis
- ◆ Calculate the resulting obligation: tonnages are multiplied by activity percentages and the UK target to calculate the resulting obligation to recover and recycle
- ◆ Decide on a compliance strategy: companies can either try to buy or earn packaging recovery notes (PRNs) to meet their obligation or they can join a compliance scheme which will obtain PRNs on their behalf

## 5.6 Packaging (Essential Requirements) Regulations 1998

These regulations implement further parts of the EU Packaging and Packaging Waste Directive to ensure that:

- ◆ Packaging volume and weight are limited to the “minimum adequate amount to maintain the necessary level” of safety, hygiene and protection
- ◆ Packaging must be designed and produced so as to permit its reuse or recovery
- ◆ Packaging must be manufactured so that noxious and other hazardous substances are minimised with heavy metal concentrations within specified limits.

The first bullet point will be of particular interest to furniture manufacturers. Trading standards officers will act as regulators for the regime and they will be able to request technical documentation from companies to demonstrate that the regulations have been complied with.

## 5.7 Waste Electrical and Electronic Equipment (Producer Responsibility) Regulations 2005

The WEEE regulations are expected to be passed in summer 2005 with the regime starting in January 2006. The regime contains implications for the product manufacturers, component manufacturers, importers, retailers and consumers of electrical equipment.

The directive may impact directly upon certain furniture manufacturers. For example, many kitchen companies sell electrical appliances along with their wood based products. Other companies have electrical elements to their furniture such as lights in cabinets or electric recliner mechanisms. Interpretation is still being sought on whether the latter elements would fall within the scope of the directive. Current discussions with DTI suggest that where the electrical equipment is integral to the product, the item would fall within the scope of the legislation.

The regulations apply to all electrical and electronic equipment placed on the market in the United Kingdom falling into one of ten product categories. A specified percentage of these items must be recycled and recovered when they reach the end of their working life.

There are a number of exemptions, two of which are of particular relevance:

- ◆ “The electrical or electronic components are not needed to fulfill the primary function.” This is of relevance to furniture which incorporates a small amount of electronic equipment, such as a display cabinet which includes a light. The main function of storage and display can be performed with or without the light, so the item should be exempt from the regulations.
- ◆ “Electrical equipment that is part of a fixed installation” – exempts items such as wood-working machinery from the regime

### **Producer definition**

Under the regime the obligations fall upon the “producer”. This term is defined as: “any person who:

- ◆ Manufactures and sells electrical and electronic equipment under his own brand,
- ◆ Resells under his own brand equipment produced by other suppliers, a reseller not being regarded as the ‘producer’ if the brand of the producer appears on the equipment, as provided for in subparagraph (i), or
- ◆ Imports or exports electrical and electronic equipment on a professional basis into a member State”

Consequently, smaller kitchen manufacturers which sell branded electrical appliances obtained from a UK source will not incur an obligation. However, if the company imports these items directly from overseas and makes payment to the overseas company rather than a UK based one, an obligation will be incurred.

### **Producers’ obligations**

- ◆ Register with the Environment Agency or a compliance scheme
- ◆ Provide annual data regarding sales of equipment on the UK market. This will enable the calculation of producers' market share in respect of each product category
- ◆ Finance the costs of collection, treatment, recovery and environmentally sound disposal of WEEE allocated to them by the NCH. This will typically be achieved through a compliance scheme
- ◆ Report evidence to show the appropriate amount of WEEE allocated to them is treated at authorised treatment facilities
- ◆ Producers supplying new equipment to business users from 13 August 2005 will be required to finance the treatment, recovery and disposal of the waste arising from these products unless they make alternative arrangements with the business users.
- ◆ Producers should ensure the appropriate marking of equipment they place onto the UK market

## 5.8 Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2005

This regime bans the placing on the EU market of new Electrical and Electronic Equipment (EEE) containing more than the set levels of lead specified substances from 1 July 2006. A maximum concentration value of up to 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, PBB and PBDE and of up to 0.01% by weight in homogeneous materials for cadmium will be permitted in the manufacture of new equipment.

Manufacturers will need to ensure that their products and the components of such products comply with the requirements of the Regulations by the relevant date in order to be placed on the Single Market. The Regulations will also have an impact on those who import EEE into the European Union on a professional basis, those who export to other Member States and those who rebrand other manufacturers' EEE as their own.

Producers must be able to demonstrate compliance by submitting technical documentation or other information to the enforcement authority on request and retain such documentation for a period of four years after the EEE is placed on the market.

## 5.9 Landfill Tax Regulations 1996

The practice of landfilling is frowned upon for a number of reasons:

- ◆ Waste is essentially raw materials that are being thrown away. There are therefore environmental and economic impacts associated with the production and transport of the raw material to the user, followed by processing, disposal and landfilling.

- ◆ Landfill gas arises from biodegradable materials. This is composed of 65% methane and 35% carbon dioxide. Both are greenhouse gases and methane is an asphyxiant and can be explosive in certain concentrations.
- ◆ Leachate is a noxious liquid produced by landfill sites. It is generated by water percolating through the bulk of the landfill and picking up contaminants. It also has an extremely high demand for oxygen. If such liquid escapes into the surrounding environment it can cause much damage.

In order to encourage a movement away from the use of landfill, October 1996 saw the introduction of the landfill tax at £7 per tonne for active waste and £2 per tonne for inactive waste. The active rate rose to £18 per tonne in April 2005 and will increase by £3 per year thereafter.

“Active” is defined as waste which decays (and therefore does give off methane) or has the potential to pollute groundwater or contaminate land. The vast majority of waste from the sector will be classified as active.

The aim of the tax is to discourage the use of landfill which has traditionally been popular because it represents a low cost waste management option. By increasing the cost of such disposal, the Government wants to encourage a switch away from the “chuck it in a skip” mentality. Increased landfill prices should encourage the use of waste management options nearer the top of the waste hierarchy, e.g. minimisation, reuse and recycling.

## 5.10 Waste minimisation

In addition to legal implications, there are economic and environmental reasons for careful waste management. Waste essentially consists of raw materials for which your company pays twice: once for the materials to be brought onto site and once for them to be taken away. Further costs are added by the fact that time, energy, machinery and labour costs must be incurred before the raw material can be thrown away.

Work in the furniture industry has shown that waste typically costs a manufacturer around 5% of turnover and around 1% of turnover can often be saved through simple measures. Wood waste alone accounts for an average of 2.0% of turnover, though this figure can be as high as 10% (BFM, 2003).

A major reason why more companies do not put time and effort into reducing waste is a failure to understand the true cost that it entails. A common mistake is to think that skip hire / emptying, i.e. disposal, is the sole cost. However, there will be a significant cost associated with raw materials which end up in the skip. Wood wastage rates of 40 to 80% are common on furniture sites, and the true cost of waste to your site should include the value of materials that are disposed of. In addition, it is necessary to expend worker time, energy and resources in processing the raw materials prior to being able to throw them away.

Further cost will accrue from on site waste handling, storage and administration. Finally, there may be opportunity costs associated with the space consumed by waste storage facilities. These costs are destined to increase over time due to the introduction of more legislation and economic instruments.

As a result, the total cost of waste is typically between 5 and 20 times the cost of disposal. In order to find the true cost of waste to your own site, it is necessary to calculate costs below:

◆ Raw materials	£
◆ Processing	£
◆ Handling	£
◆ Disposal	£
◆ Legislative	£
◆ Miscellaneous	£
TOTAL	£

These are the economic costs, but there will also be environmental costs. Examples include transport emissions from waste carriers, and emissions associated with bio-degradation once waste enters a landfill, i.e. landfill gas (carbon dioxide and methane) and leachate (noxious liquid with a high oxygen demand and containing contaminants). In addition, there are environmental impacts associated with harvesting and processing of the original raw materials.

### 5.10.1 Waste management hierarchy

The optimum method of avoiding problems with waste is to avoid producing it in the first place. This is often not feasible, and hence the other options in the Government's waste management hierarchy; in order of reducing "environmental friendliness" these are:

#### **Eliminate and minimise**

This will reduce the costs of waste storage, handling, and disposal, as well as minimising the costs of the raw materials being thrown away. Wood waste is frequently the largest waste stream of furniture sites, though the nature of the production process limits the scope for minimisation. When considering waste minimisation, it is important to consider the whole of a production process to ensure that a change to one part of the process to reduce waste does not increase the waste produced or adversely affect its "quality" in another part of the process.

#### **Recycle and reuse**

Recycling is the conversion of waste back to a useful material. Over the past decade there has been a tendency to automatically associate "recycling" with a positive environmental image. However, recycling is not automatically beneficial as there are environmental and economic costs as well as benefits.

Efficient reuse and recycling will normally rely on effective segregation of different wastes at source. A common example is the growing use of cardboard only skips. These will generally make environmental and economic sense for furniture manufacturers - as cardboard will often make up a good deal of the volume of waste disposed of to general waste skips.

#### **Treat / incinerate**

Combustion with heat recovery is frequently used to deal with wood waste. This method of waste removal has the benefit of generating a potentially useful resource in the form of heat.

Various liquid effluents generated by furniture manufacturing processes will require off-site treatment prior to disposal, e.g. water back booth effluent and veneer press washdown.

#### **Dispose**

In the UK, 70% of waste currently goes to landfill. Landfilling has always provided the cheapest “authorised” means of waste disposal. Although the disposal costs for each tonne of waste have increased, landfilling costs generally remain lower than other disposal options.

However, this equation is gradually changing with the use of economic instruments and legislation to ensure that the economic price of landfill better reflects the environmental cost.

## 5.10.2 Reducing the cost of waste

A wide variety of initiatives can be used to minimise waste costs and a good body of sector specific information is listed in the “further reading” section. Minimisation programmes will typically involve:

- ◆ Quantification of the current situation: it is essential to establish a base line to evaluate whether improvements will be economically viable. As well as measuring wastage rates, the true cost of waste should be calculated
- ◆ Evaluation of improvement options
- ◆ Implementation of initiatives
- ◆ Review of impact

A wide variety of improvement options exist, especially regarding wood and coating shop waste minimisation. Best practice and benchmarking information is provided in publications such as:

- ◆ BFM (2003) Wood waste recycling in furniture manufacturing – a good practice guide. [www.bfmenvironment.co.uk](http://www.bfmenvironment.co.uk)
- ◆ Bromhead, A (2003) Reducing wood waste in furniture manufacturing. Fauna & Flora International, Cambridge. [www.abromhead.co.uk](http://www.abromhead.co.uk)
- ◆ Envirowise (1999) GG177 “Reducing Solvent Use in the Furniture Industry” [www.envirowise.gov.uk](http://www.envirowise.gov.uk)
- ◆ Envirowise (2001) Savings from waste minimisation in furniture manufacture

## 5.10.3 Potential waste minimisation initiatives

**Wood waste** (A. Bromhead, 2003)

- ◆ Ensure that minimisation is considered at the design stage, to optimise the yield from lengths of board and solid timber
- ◆ Review the company product ranges:
  - ◆ Can colours be reduced in board materials? Increasing colours lead to decreased economies of scale, reduced chance of off-cuts being usable on other orders, increased chances of mistakes and greater storage requirements

- ◆ Can components be standardised? As with colours, the lower the number of components the better. Consider the opportunity to rationalise shelf widths, carcasses, chair blocks and fittings? For example, are pedestal carcasses colour sensitive or can they be produced from any available colour of board off-cut?
- ◆ Has the real cost of bespoke items been calculated? Short runs interfere with production, lead to greater down-time, increased chance of mistakes and worse material yields.
- ◆ Does the company give itself the best chance of optimising timber yield by looking at future orders to:
  - ◆ See whether any smaller components can be produced from the off-cuts of current production?
  - ◆ Achieve better economies of scale?
- ◆ When deciding upon the type of solid timber to buy, ensure that all variables are considered such as cost, quality, processing requirements and waste generation.
- ◆ Is wood waste generated from incoming raw material packaging, e.g. cover boards? If so, can this wood be incorporated within the product or returned to the supplier?
- ◆ Record all areas of waste, such as returns to sender, yield of material and in-process damage. The resulting information should be evaluated regularly to identify and remedy any recurring problems
- ◆ Ensure that veneer is stored in a damp / cool atmosphere with as little fluctuation as possible. Would humidifiers help to maintain veneer quality?
- ◆ Consider man-made veneer where longer runs of material are required and joins must be minimised.
- ◆ Use discoloured and non-matching veneers for backing.
- ◆ Is there an agreed quality standard so that material is accepted or rejected in a consistent manner?
- ◆ Raise awareness of the cost of waste at the end of the process, once the company has added value to the product.

#### **Solvent waste reduction** (Envirowise, 2001)

- ◆ Review the proportion of solvent use accounted for by thinners. If this exceeds 10%, further investigations should be conducted
- ◆ Work out the proportion of thinners used for cleaning and the proportion for thinning. A recording system for thinner requisitioning may be required.
- ◆ Ensure that lids are placed on all solvent containers

- ◆ Remove the need for thinning by ensuring that sprayers are properly trained on the use of their spray equipment
- ◆ Ensure that coatings are up to room temperature. If they remain sluggish, consider the use of in-line heaters to raise the temperature in the spray system pipelines
- ◆ Ensure that thinners are recaptured after use for cleaning. Consider using dirty thinners as a pre-wash followed by virgin thinners for a final rinse. The latter can subsequently become the pre-wash
- ◆ If your site generates >1,000 litres of solvent waste each year, consider the scope for an on-site recovery still. These units will purify dirty solvent, creating thinners suitable for cleaning
- ◆ Ensure that high efficiency spray systems are used
- ◆ Regularly check air and fluid pressures
- ◆ Atomisation pressures should remain <10 psi on high volume low pressure spray guns. Higher pressures will lead to a rapid reduction in transfer efficiency
- ◆ Avoid catalysing more two-pack material than is required for a given period of work. Ideally, only enough material to last for two hours' production should be mixed.
- ◆ Dilute any catalysed material left at the end of the day with un-catalysed lacquer. Add the balance of acid catalyst at the start of the next day and use as normal.

# 6 Water Management

## 6.1 Introduction

Many furniture manufacturers will produce “trade effluent”. This is defined as "any liquid, either with or without suspended particles, which is wholly or partly produced in the course of any trade or industry carried on at trade premises." Therefore, it includes liquids such as:

- ◆ Boiler blowdown: liquid from water based heating systems containing corrosion inhibitors
- ◆ Compressor condensate: oil / water mixture produced by air compressors
- ◆ Vehicle wash-down: water from washing vehicle exteriors.
- ◆ Veneer press wash down water and water back booth effluent

In fact, the only two liquid waste streams likely to escape such classification are rainwater and domestic sewage. Depending on effluent volume and concentration, the cheapest option is often to dispose of effluent under consent to drain. Most sites have two types of drain:

- ◆ Surface water drain: principally used to carry rainwater to controlled waters
- ◆ Foul sewer: carries domestic sewage & trade effluent to sewage treatment works.

The main alternative to disposal via drain is to consign effluent to a registered waste carrier for off site treatment and disposal.

<h3>Key legislation</h3>	
Water Resources Act 1991	Controls the substances which can be put into surface water drains
Water Industry Act 1991	Controls foul sewer discharges
Contaminated Land Regulations 2000	Regime to secure the clean up of contaminated land
Control of Pollution (Oil Storage) (England) Regulations 2001	Requirements regarding the containment and security of oil stores from 205 litre barrels upwards

The aqueous environment and the organisms supported therein are particularly susceptible to pollution. Spillages on site have swift pathways in the form of drains - which channel pollutants to potential receptors. In the case of surface water drains, such pollutants receive no form of treatment prior to discharge into **controlled waters**. The latter include:

- ◆ Rivers and streams
- ◆ Ditches and ponds

- ◆ Territorial waters (within 3 miles of national boundary)
- ◆ Groundwater

## 6.2 Water Resources Act 1991

Surface water drains are used to discharge rainwater from sites into controlled waters (including to groundwater via soakaway). Such drains are an important pathway for carrying spillages into controlled waters. These discharges receive no form of treatment and as a result many major pollution incidents occur from pollutants travelling down surface water drains each year.

Such pollution will normally constitute a breach of Section 85 of the Act, under which it is an offence to:

"cause or knowingly permit any poisonous, noxious or polluting matter,  
or any solid waste to enter controlled waters."

Therefore, particular care is required when storing, handling or disposing of potentially hazardous or polluting substances on site in the vicinity of controlled waters, or surface water drains.

Companies wishing to discharge trade effluent into surface water drains or soakaways, must obtain a consent from the Environment Agency. This will set limits on the amount, location and type of substances which may be discharged in order to prevent environmental damage.

**The Water Resources Act is one of the most often contravened pieces of legislation on the sites of furniture manufacturers.** Unconsented discharges to surface water drains can result in fines of up to £20,000 &/or 3 months in prison. In cases taken to the Crown Court, such fines may be unlimited.

## 6.3 Water Industry Act 1991

Under the Water Industry Act, companies wishing to discharge trade effluent to foul sewer must hold a consent from the local sewerage undertaker (normally the regional water company). Charges may be levied according to effluent nature, concentration and volume.

Again, conditions will be imposed on the consent, and monitoring to ensure compliance may either be undertaken by the sewerage undertaker or the site itself. Failure to comply with the consent conditions, or the lack of a consent altogether, would be an offence under the WIA.

The system of consents allows treatment works to budget for the type of substances that they will have to treat. Unconsented discharges may contain substances which cannot be treated effectively and which will therefore pollute the discharge of effluent into controlled waters from the treatment works. In addition, treatment works rely on bacteria to break down incoming effluent and sewage. Unusual chemicals entering the works may damage the bacteria and reduce the efficiency of the plant.

## 6.4 Contaminated Land Regulations 2000

The Environment Agency estimates that there may be around 300,000 hectares of contaminated land in the UK. However, under the regime, not all of this will be deemed "contaminated" as it may be suitable for its current or intended use.

The Contaminated Land Regulations place a duty upon local authorities to inspect their areas to identify contaminated land which is defined as:

- ◆ Land which appears to the local authority to be in such a condition, by reason of substances in, on or under it, that:
  - Significant harm is being caused or there is a significant possibility of such harm being caused; or
  - Pollution of controlled waters is being, or is likely to be, caused.

“Harm” means harm to one or more receptors: humans, buildings, other property or ecosystems. For land to be contaminated, a “pollutant linkage” must be identified. This has three components - a pollutant, pathway and receptor. If these are present and the land meets the criteria for “contaminated land” then there is a “significant pollutant linkage” and the land must be cleaned up. In some cases, contamination will be present but there will be no pathway or receptor and hence clean up will not be required.

Where clean up is deemed necessary, a remediation notice will be served upon the “appropriate person” i.e. the person who caused or knowingly permitted the pollution. Where they cannot be found, responsibility passes to the current owner or occupier. Where remediation notices are not complied with, fines will be incurred and the enforcing authority will be able to carry out the specified work itself and recover costs.

Remediation must be effective, durable and practicable. It must also be done at reasonable cost, having regard to the seriousness of the harm involved. Clean up must occur to a level that is “suitable for use” - i.e. appropriate for the desired end use of the land.

Contaminated land is potentially relevant to the furniture manufacturers where:

- ◆ The problem has been inherited from previous occupants. In the UK the principle of “caveat emptor” has traditionally applied - ie buyer beware. When buying land you may also be buying any pollution that comes with it.
- ◆ Contamination results from manufacturing activities, such as the disposal or spillage of timber treatment chemicals, oil, coatings or effluent

## 6.5 Control of Pollution (Oil Storage) (England) Regulations 2001

Oil accounts for around 30% of all water pollution incidents. In 1998, there were 4,940 oil incidents, 60% to 90% of which result from poor storage facilities. These regulations impose controls which will cost the average business around £265 to £487 per tank (2,500 to 5,000 litres). Significantly higher costs are typically associated with an oil pollution incident due to clean up, fines, bad publicity and replacement fuel. Controls are likely to lead to equivalent savings of £11,000 to £30,000 per incident.

### **What stores do the new regulations apply to?**

The requirements apply to the storage of oil of any kind such as diesel, heating oil, hydraulic oil and petrol in any container exceeding 200 litres. Exemptions include:

- ◆ Waste oil: this will be covered under revisions to the Waste Management Licensing Regulations 1994 - in addition to which, sites should be storing waste oil in a secure, contained and labelled manner in order to comply with the duty of care.
- ◆ Oil in any road tanker
- ◆ Oil in any container which is situated inside a building or wholly underground

### **What requirements apply to oil stores?**

**Containers:** Oil must be stored in a container of sufficient strength and integrity to ensure that it is unlikely to burst or leak in normal circumstances. Containers may include drums, IBCs (intermediate bulk containers) and tanks.

**Secondary containment:** Containers must be within secondary containment i.e. drip trays or bund walls. In the case of tanks, this must be able to hold at least 110% of the container contents (for tanks and IBCs). For drums, drip trays must be able to hold 25% of the contents.

- ◆ The secondary containment must be impermeable to water and oil and the base and walls must not be penetrated by any valve, pipe or other opening which is used for draining the system.
- ◆ Any fill pipe or draw off pipe which penetrates the wall must be adequately sealed to prevent oil escape.
- ◆ Any valve, filter, sight gauge, vent pipe or other equipment must be within the secondary containment system.

**Pipes:** Any fill pipe, draw off pipe or overflow pipe must be positioned so as to minimise any risk of damage by impact so far as is reasonably practicable and if above ground it must be properly supported. If the pipe is underground, it must have no mechanical joints (except at a place which is accessible for inspection by removing a hatch or cover); be laid in a duct or sleeve which protects it from physical damage; have adequate facilities for detecting any leaks and be fitted with a leakage detection device.

**Fill pipes:** automatic overflow prevention device required if the filling operation is controlled from a place where it is not reasonably practicable to observe the tank and vent pipe. A screw fitting or other fixed coupling must be used when the tank is being filled with oil.

**Pumps:** these must be fitted with a non-return valve in the feed line, positioned so as to minimise any risk of damage by impact and protected from unauthorised use.

**Discharge points:** Any permanent vent pipe, tap or valve through which oil can be discharged from the tank to the open must be located within the secondary containment system; and arranged so as to discharge vertically downwards within the system.

# 7 Energy and transport management

## 7.1 Introduction

Emissions associated with energy use and transport can have significant environmental and economic implications for furniture manufacturers. However, their management is often neglected as the issues are not as apparent as other forms of waste such as wood off-cuts. Work by BFM Ltd has shown that energy costs typically account for 1 to 3% of turnover with transport averaging around 3% of turnover.

Energy generation and use leads to environmental impacts, especially when fossil fuels are used. For example, the burning of coal to produce electricity will generate a range of air pollutants such as carbon dioxide and sulphur dioxide. Such gases contribute to environmental issues such as global warming and acid rain.

## 7.2 Energy management

Energy may be used in a variety of forms such as electricity, gas, heating oil and wood fuel. The majority will be consumed in operations such as machinery operation, compressed air generation, heating and lighting.

Energy specific advice and publications can be obtained free of charge from organisations such as the Energy Efficiency Best Practice Programme and the Carbon Trust: [www.thecarbontrust.co.uk](http://www.thecarbontrust.co.uk). A few examples of areas worthy of consideration are listed below.

### General

- ◆ Take meter readings during a period when the factory is closed to highlight unnecessary usage and leaks. For example, read the water, gas and electricity meters at 5 pm on a Friday and again before work starts on Monday morning
- ◆ Measure the amount of energy which is consumed by the site as a whole and specific processes
- ◆ Make people aware of how much they are wasting. Rather than talking in terms of kWh and other units which are hard to envisage, convert information to easily understandable figures. Examples include: by leaving this machine on overnight, you waste enough energy to power your home for one month, or the wastage is equivalent to the energy required to make 50 cups of tea etc.
- ◆ Energy management systems provide a good degree of control over key energy using processes. They allow the remote setting of timers and thermostats, thereby reducing unnecessary usage and making it more difficult for people to interfere with energy consuming systems

- ◆ Is there any benefit in working overtime before the shift rather than at the end, e.g. due to a cheaper tariff?

### **Compressed air**

- ◆ A common misconception is that compressed air is cheap. In fact it is the most expensive form of energy used on site and will typically account for 20% of the total energy bill in a manufacturer. Compressed air is generated using electricity and the inefficiency of the generation process means that each kWh of compressed air is ten times as expensive as each kWh of electricity. Consequently, compressed air can cost upwards of 50p/kWh. It is important that everyone is aware of the cost
- ◆ A site walk around during lunch time enables you to listen for leaks. An independent survey of 47 industrial sites in the UK found an average compressed air leak rate of 39% (Envirowise, 2001a).
- ◆ There are many examples of unnecessary air use on furniture sites. For instance, air lines which are left permanently open to blow dust away from a machine or air lines which are used to blow-down people and workpieces. Such practices not only waste a significant amount of money but they also lead to higher than necessary dust exposure levels for employees, thereby contravening the Control of Substances Hazardous to Health Regulations 2002.
- ◆ Check the timing of compressors. If they are switched on and off by a time switch, does this take into account weekends and clock changes? Is there scope to turn the system off before the end of the working day to allow the last half hour of production to use up the stored air?

### **Electricity**

- ◆ Motors and drives can account for two-thirds of electrical energy used by industry (Envirowise, 2001a). Motors can cost up to one hundred times as much to run over their ten-year life as the initial purchase cost, hence it is worth selecting higher efficiency motors.
- ◆ Ensure that motors and drives are switched off when not in use
- ◆ Reduce the load (e.g. drive train maintenance) and motor speeds whenever possible. Variable speed drives can save 30-40% in many situations.
- ◆ Can wood dust extraction systems be segmented so that only the required sections are operated. This is particularly useful when a limited amount of overtime is being worked
- ◆ If coating booths are in occasional use, consider the installation of an idling switch for the motor. Thus, when the spray gun is placed on its hook, the booth continues at normal speed for a short time afterwards (e.g. 2 minutes) before switching off or dropping to a lower speed. The 2 minute lag allows residual solvent to be removed and avoids the motor constantly starting and stopping.
- ◆ Consider the installation of movement sensors for lights in areas which are less frequently used

- ◆ The cleaning of windows and sky lights allows the use of natural light

### Heating

- ◆ Heating generated by electricity will cost five times as much as that provided by gas. If possible, remove electric heaters from offices. If only one or two individuals are complaining of the cold, advise them to wear warmer clothes!

## 7.3 Transport management

The cost of energy used in road transport can often exceed the energy consumed by other parts of a business. Fuel is used in a number of areas:

- ◆ Company cars used by the sales force and management team
- ◆ Deliveries to customers
- ◆ Installation teams

Furniture companies can take a number of steps to improve environmental performance with regard to transport. A few suggestions are made below and much more detailed information exists in the guides referred to in the “Further Reading” section.

- ◆ Route planning: this function is essential to ensure that as many customers as possible are served by a single vehicle
- ◆ Return loads: is there any scope to reduce empty vehicle miles. For example, could raw materials be collected on the way back or could transport be undertaken for a company the delivery are
- ◆ Conduct fuel efficiency training and monitor fuel consumption against driver performance
- ◆ Ensuring all vehicles are well maintained and run efficiently

# 8 Environmental Management Systems

## 8.1 Introduction

The term "environmental management" covers a wide range of disciplines and in the business context it can encompass information from many diverse sources. Due to the wealth of information involved, it is unlikely that any one individual could manage this on their own. Indeed it would not be beneficial for one person to take responsibility for environmental matters whilst isolated from operational and other day-to-day activities, as the environment impinges either directly or indirectly on every activity and on every member of an organisation.

Therefore, effective environmental management should involve the co-ordination and control of the activities and efforts of all members of the organisation in achieving the desired level of environmental performance. This co-ordination and control should be carried out in a structured way to ensure that significant omissions do not arise and hence the need for a documented and systematic approach: the environmental management system (EMS). This should ensure that everyone is working towards the same policy, targets and standards etc. and that relevant information is documented, retrievable and auditable.

An EMS is therefore a system to enable a company to manage its environmental performance in a structured and effective manner. The two central aims of an EMS are to:

- ◆ Ensure legislative compliance
- ◆ Improve environmental performance

However, even if a company feels that a certified EMS is not currently relevant, all businesses can benefit from the selection and implementation of key EMS elements, e.g. maintaining information on legislation and introducing environmental training.

## 8.2 EMS Standards

Having identified the need for EMSs, a natural progression on a national or international scale, is to establish a standard format. This allows systems to be compared, verified, certified and saves companies the time and expense of each re-inventing a format. Three main standards have been developed:

- ◆ BS 7750: the British Standards Institute EMS was the first to be launched in the UK in 1995 but has since been replaced by the international standard - ISO 14001.
- ◆ EMAS: the Eco Management and Audit Scheme is the EU EMS standard and is similar to BS 7750 in content, with the additional requirement of an environmental statement covering past and current environmental performance and the aims for the future. This process of revealing potentially sensitive information has made some industrial sectors nervous due to worries about the potential for civil or criminal law-suits.
- ◆ ISO 14001: the international EMS standard.

- ◆ BS 8555: Guide to the Phased Implementation of an Environmental Management System. The newest of the standards, BS 8555 is split down into 6 stages to which companies can be assessed. Therefore, recognition is gained during the process of implementation, not just when a full system has been installed. In addition, companies may not want a full EMS but may decide to remain at a halfway house, such as stage 3:
  - ◆ Phase 1: Commitment and establishment of baselines.
  - ◆ Phase 2: Identification and compliance with environmental legislation.
  - ◆ Phase 3: Development of objectives, targets and programmes.
  - ◆ Phase 4: Implementation and operation of an EMS.
  - ◆ Phase 5: Checking, auditing and review.
  - ◆ Phase 6: Environmental management system certification

## 8.3 Benefits of an EMS

If the two central aims of an EMS (ensure legislative compliance and improve environmental performance) are met, a number of benefits should accrue:

- ◆ Legislative compliance will result in significantly lower current and future liabilities. This will mean less risk of prosecution, fines, clean up costs and bad publicity etc.
- ◆ The timely identification of legislative requirements will mean that upgrade programmes to meet future requirements can be carried out in the most logical and cost effective manner - rather than being carried out in a last minute rush at the insistence of a regulatory authority. EMSs therefore promote proactive management which can result in marketing benefits.
- ◆ Improved environmental performance will involve the minimisation of raw material consumption, utility usage and waste production - all of which will have a significant beneficial effect on the bottom line.
- ◆ Better environmental management practices should also lead to a more pleasant working environment, with less dust, fumes and noise etc. This in turn should result in better productivity, the maintenance of quality and the reduction of nuisance creation for neighbouring residents.
- ◆ A competitive edge should increasingly accrue to those with certified EMSs as these act as badges of achievement - in much the same way as quality systems are badges of quality achievement. Indeed, those seeking to supply organisations with an EMS will face increasing pressure to implement one of their own. Such pressures are already being felt by companies in the contract markets.
- ◆ The presence of an EMS should lead to a greater degree of understanding from local regulators. The latter can see that your company takes the issue of environmental man-

agement seriously and invests time and effort in to related issues. A greater degree of co-operation and flexibility may therefore result.

- ◆ One benefit of an EMS that is often forgotten is the fact that it will help to reduce your company's impact on the environment.

## 8.4 Stages of action

If an EMS is being implemented with a view to certification to ISO 14001, it is vital that companies obtain a copy of the standard (as well as ISO 14004) and evaluate each part of the system to ensure that it complies with the requirements of the standard. In order to help with this process, various observations are made in the remainder of the chapter.

ISO 14001 identifies five main phases in EMS implementation. These follow the pattern of plan, act and check:

- ◆ **Commitment and policy:** it is necessary to obtain management commitment, choose an EMS champion and build a project team. The team will usually take responsibility for the conduct of a preliminary environmental review designed to establish the baseline performance. The latter must be recorded if improvement is to be demonstrated. In addition, an environmental policy statement should be formulated.
- ◆ **Planning:** the review will enable the company to identify its relevant environmental aspects, defined as elements of activities, products or services that can interact with the environment and they may result in environmental impacts. For example, one activity of furniture manufacture is wood coating, which has a number of potential aspects including the release of volatile organic compounds, odour and particulate matter. Each aspect can lead to a number of impacts, e.g. a contribution to photochemical smog and global warming in the case of VOCs.

The review identifies the aspects and it is then necessary to prioritise them using a significance evaluation technique. The most significant will then be subject to the improvement programmes, targets and objectives to contribute to the company's continual improvement.

- ◆ **Implementation:** this stage involves actually making an impact upon performance. It will typically involve training of relevant personnel to give them the skills needed to implement initiatives. Communication will be required to gain support for improvement programmes and documentation will be needed to provide appropriate procedures and work instructions.
- ◆ **Measurement and evaluation:** if progress is to be demonstrated it must be measured and evaluated against the targets and objectives. Audits will be used to ensure that the system is working properly and corrective / preventive actions will need to be taken where things have gone awry
- ◆ **Review and improvement:** the EMS will need to be reviewed occasionally to ensure its continuing suitability and relevance to the organisation.

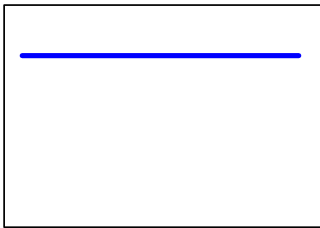
## Appendix 1: Environmental Management Matrix

Level	Environmental Policy	Organisation	Motivation & Training	Information Systems	Marketing	Investment
4	Active commitment of top management	Environmental management fully integrated into general management	All staff trained and motivated to address issues	Comprehensive system - effective data capture and management reporting	Extensive marketing on basis of environmental management performance	Positive discrimination in favour of “green schemes”
3	Formal policy - but no commitment from top	Clear delegation and accountability	Most relevant personnel are motivated / trained	Data capture and retention for most areas	Regular publicity campaigns	Same appraisal used as for any other investment
2	Unadopted policy	Some delegation but authority unclear	Motivation and training are patchy	Legally required data is retained	Some degree of in house promotion / awareness raising	Investment with short term pay back only
1	Unwritten guidelines	Informal responsibility	Some staff awareness	Patchy data retention	Informal contacts to promote environmental management	Only low cost measures taken
0	No policy	No delegation of environmental management	No awareness of need to address issues	No information kept	No marketing or promotion of environmental management	No investment in environmental management

Matrix adapted from Energy Management Matrix - Guide 167 - “Organisational aspects of energy management” EEBPP: [www.thecarbontrust.gov.uk](http://www.thecarbontrust.gov.uk)

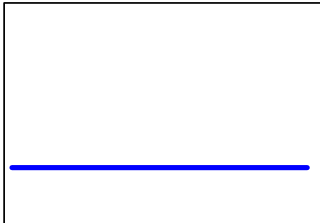
<b>Level</b>	<b>Env. Policy</b>	<b>Organisation</b>	<b>Motivation &amp; Training</b>	<b>Information Systems</b>	<b>Marketing</b>	<b>Investment</b>
<b>4</b>	x	x	x	x	x	x
<b>3</b>	x	x	x	x	x	x
<b>2</b>	x	x	x	x	x	x
<b>1</b>	x	x	x	x	x	x
<b>0</b>	x	x	x	x	x	x

Matrix adapted from Envirowise Energy Management Matrix - Guide 167 - "Organisational aspects of energy management" EEBPP:  
[www.thecarbontrust.gov.uk](http://www.thecarbontrust.gov.uk)



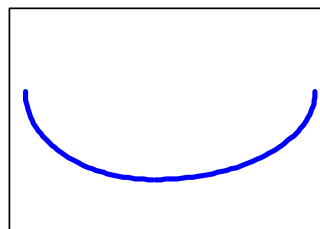
## 1 - High balanced

Excellent performance all-round - you should be presenting the course!



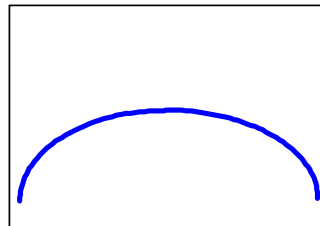
## 2 - Low balanced

Environmental management is given low priority  
At least there will be plenty of areas for you to make progress on!



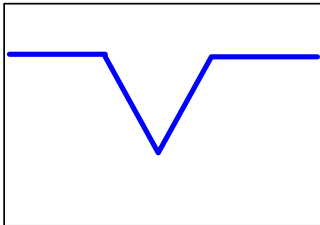
## 3 - U-Shaped

Top management have given their commitment - but there is a people problem which needs to be addressed if progress is to be made. Therefore necessary to raise motivation, awareness and reporting standards



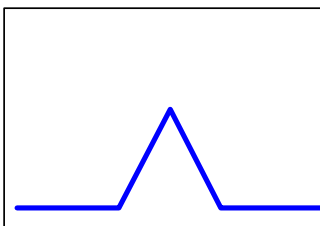
## 4 - N-Shaped

Work-force motivated but receive no top-level support.



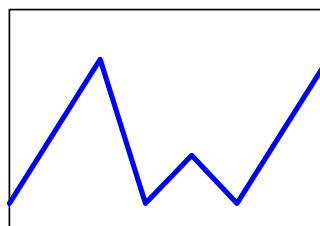
## 5 - Trough

One areas of weakness which needs to be addressed to prevent it holding back other areas of strength



## 6 - Peak

One area of strength - but benefits may not be realised unless the other areas are addressed



## 7 - Unbalanced

Increased co-ordination is needed. Poor areas will hinder general progress

# References and further reading

## General

- ◆ BFM Ltd (2002) Implications of sustainable development for UK reproduction furniture manufacturers. BFM Ltd, London. [www.bfmenvironment.co.uk](http://www.bfmenvironment.co.uk)  
*This report considers the practical implications of sustainable development in relation to reproduction furniture manufacture. It goes on to identify priority issues which need to be addressed to enable the sub-sector to operate more sustainably.*
- ◆ Environment Agency (2004) Net Regs glossary: <http://www.environment-agency.gov.uk/netregs>  
*This site provides a guide to environmental legislation including the definition of waste*
- ◆ Envirowise (2001a) Furniture Essentials: environmental information for furniture manufacturers (GG289) [www.envirowise.gov.uk](http://www.envirowise.gov.uk)  
*A very useful signposting guide which provides an overview of the main environmental issues facing the furniture sector and gives details of relevant publications for further information*

## Waste

- ◆ BFM (2003) Wood waste recycling in furniture manufacturing. WRAP, Banbury. <http://www.wrap.org.uk>  
*This publication involved the furniture sector's most detailed survey of wood waste to date. Information was gathered from 72 sites regarding wood types, volumes, wastage rates and management options. Sub-sectoral benchmarks were subsequently developed.*
- ◆ BFM (2004) Evaluation of the market development potential of the waste wood and wood products reclamation and reuse sector. WRAP, Banbury. <http://www.wrap.org.uk>  
*This publication considers the issue of end-of-life furniture wood waste arisings, with quantification, barrier identification and suggestions regarding ways in which barriers may be overcome.*
- ◆ BFM (2005) Benchmarking wood waste combustion in furniture manufacturing. BFM Ltd London. [www.bfmenvironment.co.uk](http://www.bfmenvironment.co.uk)  
*This is the most comprehensive UK project on wood waste combustion to date. It involved the gathering of data from 82 authorised wood combustion plant regarding issues such as the type and amount of wood waste consumed, energy utilisation, emissions and compliance.*
- ◆ Bromhead, A (2003) Reducing wood waste in furniture manufacturing. Fauna & Flora International, Cambridge. [www.abromhead.co.uk](http://www.abromhead.co.uk)  
*A guide which provides practical advice on the reduction of wood waste at source.*
- ◆ Envirowise (2001b) Savings from waste minimisation in furniture manufacture (GG290) [www.envirowise.gov.uk](http://www.envirowise.gov.uk)

*This guide gives advice on the methodology and practical measures which can be used in furniture manufacturing to reduce wastage of raw materials and utilities*

- ◆ Envirowise (2001) Furniture workbook: cut waste cut costs [www.envirowise.gov.uk](http://www.envirowise.gov.uk)  
*A practical guidance pack to enable furniture manufacturers to run an in-house waste minimisation programme*

## Solvent reduction

- ◆ BFM Ltd (2001) Benchmarking solvent use in the UK furniture manufacturing sector. [www.bfmenvironment.co.uk](http://www.bfmenvironment.co.uk).  
*Sponsored by Biffaward, this project undertook the largest survey of authorised wood coating operations to date in the UK. Solvent reduction benchmarks were subsequently developed on a sub-sectoral basis and the guide provides advice on best practice.*
- ◆ Envirowise (1999) Reducing Solvent Use in the Furniture Industry (GG177) [www.envirowise.gov.uk](http://www.envirowise.gov.uk)  
*A best practice guide which explains the no and low cost measures which can be undertaken to reduce unnecessary solvent use*
- ◆ Envirowise (2002) Savings through low solvent wood coatings (GG340) [www.envirowise.gov.uk](http://www.envirowise.gov.uk)  
*A guide to the practical issues of changing to low solvent coatings which highlights the potential economic and environmental savings which can accrue*

## Energy and transport

A wide range of publications are available from [www.thecarbontrust.gov.uk](http://www.thecarbontrust.gov.uk). A few examples are listed below:

- ◆ Compressing Air Costs – Generation (ECG040) [www.thecarbontrust.gov.uk](http://www.thecarbontrust.gov.uk)  
*This guide looks at ways of improving compressor efficiency to reduce the costs of generating compressed air. It is one of a set of three guides relating to compressed air: ECG041 considers the costs of leakage and ECG042 deals with post-compression treatment.*
- ◆ Economic Use of Electricity in Buildings (FEB009B) [www.thecarbontrust.gov.uk](http://www.thecarbontrust.gov.uk)  
*Guidance on the terms used and construction of electricity tariffs and how electricity is metered. The efficient operation of plant and its correct loading to manage maximum demand are explained, together with information on power factor and its correction*
- ◆ Motors and Drives Fact Sheet (GIL128) [www.thecarbontrust.gov.uk](http://www.thecarbontrust.gov.uk)  
*This fact sheet provides information on energy saving measures specific to motors and drives running in a typical commercial/industrial site.*
- ◆ Transport fact sheet (GIL132) [www.thecarbontrust.gov.uk](http://www.thecarbontrust.gov.uk)  
*Information on energy saving measures for businesses in the transport sector*

TransportEnergy is a division of the Energy Saving Trust; a non-profit company established by the Government to help the UK meet its international commitments to reduce greenhouse gas emissions. <http://www.transportenergy.org.uk/>

- ◆ Non-food retail KPI (Key Performance Indicators) final report  
<http://www.transportenergy.org.uk/downloads/NonFoodRetailKPI.pdf>  
*Benchmarking guide on key performance indicators of distribution*
- ◆ GPG273: Computerised Routing and Scheduling for Efficiency Logistics  
<http://www.transportenergy.org.uk/downloads/gpg273.pdf>  
*Describes the different types of computerised vehicle routing and scheduling available and their benefits*
- ◆ Telematics Guide <http://www.transportenergy.org.uk/downloads/gpg341.pdf>  
*Provides information on the basis ingredients of telematics systems, highlights how you use this technology and the information you get from it. Gives advice on which issues you should watch out for when buying a system.*
- ◆ GPG307: Fuel Management Guide  
<http://www.transportenergy.org.uk/downloads/GPG307.pdf>  
*A comprehensive guide, covering many aspects of fuel efficiency including data collection and analysis, vehicle specification and driver training.*

# Useful contacts

Organisation	Relevance	Contact details
Alistair Bromhead	Environmental Consultant specialising in the UK furniture manufacturing sector	Tel: 07932 674707 <a href="http://www.abromhead.co.uk">http://www.abromhead.co.uk</a>
BFM Ltd	Trade association for British Furniture manufacturers providing a variety of environmental management and health & safety services	Tel: 0207 724 0851 <a href="http://www.bfm.org.uk">http://www.bfm.org.uk</a>
BFM Environment Ltd	Subsidiary of BFM Ltd providing environmental, health and safety services to the furniture industry. A variety of sector specific publications can be downloaded from the website	<a href="http://www.bfmenvironment.co.uk">http://www.bfmenvironment.co.uk</a>
Envirowise	A government-funded programme offering free, independent advice on practical ways to minimise waste and increase profit.	Tel: 0800 585794 <a href="http://www.envirowise.gov.uk">http://www.envirowise.gov.uk</a>
Environment Agency	Regulator of waste and controlled waters in England and Wales	Tel: 0845 9333111 <a href="http://www.environment-agency.org.uk">http://www.environment-agency.org.uk</a>
FFINTO	The Furniture, Furnishings and Interiors National Training Organisation	Tel: 0151 9221200 <a href="http://www.ffinto.org">http://www.ffinto.org</a>
Furniture Reuse Network (FRN)	National co-ordinating body for 300 furniture and appliance reuse and recycling organisations in the UK that collect a wide range of household items to pass onto people in need	Tel: 0117 954 3571 <a href="http://www.frn.org.uk">http://www.frn.org.uk</a>
Wood Recyclers Association	Association to promote wood recycling	Tel: 01480 455249 <a href="http://www.woodrecyclers.sagenet.co.uk">http://www.woodrecyclers.sagenet.co.uk</a>
Wood Panel Industries Federation	Representative organisation for manufacturers of board material in the United Kingdom and Ireland	Tel: 01476 563707 <a href="http://www.wpif.org.uk/">http://www.wpif.org.uk/</a>
Waste and Resources Action Programme	Government programme established to promote sustainable waste management by tackling the barriers to waste minimisation and increased recycling	Tel: 01295 819900 <a href="http://www.wrap.org.uk">http://www.wrap.org.uk</a>

# Glossary of terms

**Acid rain:** rain of higher than normal acidity (pH less than 5) resulting from human-induced pollution effects, particularly sulphur dioxide and nitrogen oxides, in the atmosphere.

**BAT (Best Available Techniques):** a balance between state-of-the-art technology / management techniques and what an industrial sector can actually afford.

**Biodegradable:** capable of being decomposed by bacteria or other biological means.

**Board material:** particleboard such as medium density fibreboard, chipboard and melamine faced chipboard which comprises wood fibres bound with a resin matrix

**BS 7750:** former British Standard for Environmental Management. The standard encourages organisations to establish an effective environmental management system, as a foundation for sound environmental performance and participation in environmental auditing schemes.

**BS 8555:** Guide to the Phased Implementation of an Environmental Management System. The newest of the environmental management system standards, BS 8555 is split down into 6 stages to which companies can be assessed.

**Carbon tax:** a tax on different types of fossil fuels calculated according to the amount of carbon that would be emitted when the fuel is burned for energy.

**CO<sub>2</sub> (Carbon dioxide):** gas produced when organic matter decomposes or when fossil fuels are burned. Carbon dioxide is one of the principal greenhouse gases, accounting for around 50% of the effect attributed to man's actions

**CO (Carbon monoxide):** gas produced by incomplete combustion, e.g. in wood burning. Also found in vehicle exhaust fumes and cigarette smoke. CO combines with haemoglobin in the blood stream in preference to oxygen, and thus leads to a form of suffocation.

**Coated wood:** timber to which stains, sealers or lacquers have been applied. This category does not include wood which has been impregnated with preservative (treated wood)

**CFCs (Chlorofluorocarbons):** compounds whose molecules contain atoms of carbon, chlorine and fluorine bonded together in various proportions. CFCs were used as refrigerants, propellants for aerosol spray cans, foaming agents, solvents and cleaning fluids. Because they are so inert and very stable, CFCs have atmospheric lifetimes in excess of 50 years. They are broken up in the stratosphere by UV radiation, producing free chlorine atoms which can destroy ozone. CFCs are also important greenhouse gases.

**Cradle to grave:** consideration of every aspect of product design and use, from the environmental impact of the raw materials to their disposal, re-use or recycling.

**Dioxins:** produced when chlorinated organic compounds, such as PCBs and PVC, are burned at low temperature. Highly toxic to certain animals, they may cause cancer in humans, genetic damage and damage to the unborn child.

**Duty of Care:** waste legislation which requires that a company demonstrates it has taken all reasonable precautions to ensure that all waste is properly cared for on site and is disposed of in a responsible manner.

**End-of-life furniture:** furniture which has come to the end of a particular cycle in its life. For example, a table which is discarded by its first owner and passed to a charity based organisation for reuse. “End-of-cycle” furniture is a more correct term as the life of the item continues until it has been remanufactured or recycled. However, EOL is the term in most common use

**Environment Agency (EA):** environmental regulator responsible for a number of regimes including waste, certain air emissions, water and packaging

**EMAS (Eco-Management and Audit Scheme):** a voluntary European Union scheme to encourage environmental management systems in industry.

**Global warming:** atmospheric warming due to the absorption by the so called Greenhouse Gases of infra-red radiation emitted from the surface of the earth.

**GWP (Global Warming Potential):** an index of the global warming potential of a set amount of a given gas compared with the same amount of CO<sub>2</sub> over a given period e.g. the GWP over 100 years for methane is 21 (i.e. 21 times the contribution to global warming of the same amount of CO<sub>2</sub>)

**Greenhouse Effect:** mechanism by which the earth is kept warmer than it would be otherwise due to greenhouse gases absorbing long wavelength (infra-red) radiation.

**Greenhouse Gases:** gases which absorb infra-red radiation reflected from the earth's surface.

**HCFCs (Hydrochlorofluorocarbons):** halogenated hydrocarbons containing chlorine and fluorine. They are less ozone depleting than CFCs and will probably be used as a transitional substitute during the CFC phase out period. HCFCs are greenhouse gases.

**HFCs (Hydrofluorocarbons):** Halogenated hydrocarbons, similar to HCFCs. They do not contain chlorine and are not ozone depleting, but they are greenhouse gases.

**ISO 9000:** International Standards Organisation Quality Management standard.

**ISO 14000:** International Standards Organisation Environmental Management standard.

**Landfill:** excavated areas or natural depressions into which waste is deposited. Modern sites are engineered with the use of liners (clay or synthetic) to control the escape / migration of the products of bio-degradation; principally leachate and landfill gas.

**Landfill gas:** a by product of the bio-degradation of waste, this gas typically consists of 65% methane and 35% carbon dioxide, together with a variety of trace gases. The gas has to be managed, due to the properties of methane, which is an asphyxiant and can explode in air. Landfill gas may be vented to atmosphere, burnt, or used to generate power.

**Leachate:** Liquid effluent produced during the bio-degradation of waste in landfill sites, which can impact on local water resources if it is not contained and treated.

**LCA (Life Cycle Analysis):** a technique to examine the entire life of a product, from the extraction of raw materials through manufacture to final disposal.

**Medium density fibreboard (MDF):** form of particleboard in common use within furniture manufacturing

**Melamine faced chipboard (MFC):** chipboard with a plastic foil covering – a material which is used extensively on low to middle quality office desks and kitchen cabinets

**Methane (CH<sub>4</sub>):** a potent greenhouse gas generated by biodegradation, for example in landfill sites

- NO<sub>x</sub> (Nitrogen oxides):** range of compounds formed by the oxidation of atmospheric nitrogen. Some of these oxides contribute to acid rain and photochemical smog. Nitrogen dioxide is a major factor in photochemical ozone formation.
- Non-renewable energy:** finite stores of energy in fossil fuels (from ancient photosynthesis) and nuclear fuels (from older cosmic processes) which cannot be replaced once used.
- Nuisance:** nuisance is defined as an unreasonable interference with someone's enjoyment of their land. It is an offence under the Environmental Protection Act Part III, and is controlled by the local authorities. Examples of statutory nuisance may include noise, odour, smoke and dust.
- Ozone:** a form of oxygen, each molecule of which contains three atoms of oxygen bonded together. Ozone is formed in the upper atmosphere by ultraviolet light and can be generated at ground level by the reaction of VOCs and NO<sub>x</sub> in the presence of sunlight.
- Ozone hole:** massive loss of ozone from the lower stratosphere over Antarctica that occurs with the return of the sunlight each southern spring.
- Ozone layer:** region of the stratosphere lying roughly between 15 and 40 km above the Earth's surface. It contains most of the atmospheric ozone, which is constantly being created and destroyed through natural chemical cycles. The layer is critical to life on Earth because it filters out damaging ultraviolet radiation from the Sun.
- Packaging recovery note (PRN):** a certificate to prove the recovery or recycling of an amount of packaging. PRNs enable obligated companies to demonstrate compliance with the requirements of the Producer Responsibility Obligations (Packaging Waste) Regulations 1997
- Particulates:** small suspended particles, measured by filters, that can be found in smoke, mist and air. PM<sub>10</sub> are defined as those particles which are <10µm in diameter. These fine particles are released during the combustion of fuels such as diesel, and they have been linked to adverse health effects.
- pH:** measure of acidity and alkalinity. Values below pH7 are acid, values above are alkaline. The pH scale is logarithmic.
- Photochemical smog:** layer of pollutants generated in the lower atmosphere by the action of sunlight on gaseous pollutants such as VOCs and NO<sub>x</sub>. Also known as summertime smog
- Polluter Pays principle:** the principle that polluters bear the costs of dealing with the problems caused by the pollution they generate.
- PCBs (polychlorinated biphenyls):** group of organic compounds containing biphenyls and chlorine. PCB's can accumulate in food chains and are thought likely to produce harmful side effects, particularly during the reproductive cycle of some marine animals. Previously used in electrical equipment such as transformers, in the form of cooling oils.
- Polyvinyl Chloride (PVC):** substance which generates hydrogen chloride when burned. Therefore, it must be removed from furniture in wood combustion units to prevent the requirements of the Waste Incineration Directive becoming applicable
- Producer responsibility:** a term used to describe a policy approach which requires producers who place products on the market to take greater responsibility for those products when they become waste. For example, the Producer Responsibility Obligations (Packaging

Waste) Regulations 1997 require those who own packaging and supply it down the packaging chain to contribute to the cost of its recovery and recycling

**Recycling:** reprocessing of materials for reuse. For example, chipping of wood waste for use in chipboard manufacture

**Remanufacturing:** the process of disassembly and reassembly of products during which time parts are cleaned, repaired or replaced. For example, an office table which is dismantled and has the surface stripped and recoated prior to reassembly with clean fittings. The process can occur in a closed loop where the goods are returned to the original owner or an open loop where they enter the general market

**Reuse:** the continued use of an item for its original purpose. For example, a table which is discarded by the first owner and passed onto a subsequent owner for use as a table. A small amount of work may be required to make an item suitable for reuse, e.g. the cleaning of the table surface

**Stratosphere:** region of the atmosphere, between about 10 km and 50 km, where the temperature-altitude curve changes direction and temperature begins to rise with altitude. The ozone layer occurs in the stratosphere.

**SO<sub>2</sub> (Sulphur dioxide):** compound of sulphur and oxygen which is emitted into the atmosphere by the combustion of fuels containing sulphur, such as coal, diesel oil and fuel oil. It is toxic at high concentrations and contributes to the acidity in rain, resulting in acid rain.

**SO<sub>x</sub> (Sulphur oxides):** range of compounds formed by the oxidation of sulphur; includes sulphur dioxide.

**Sustainable development:** development that meets the needs of the present without compromising the validity of future generations to meet their own needs.

**Troposphere:** bottom-most layer of the atmosphere where the warmth of the Earth is the predominant source of heat; consequently air temperature drops with altitude as distance from the Earth's surface increases.

**VOCs (Volatile Organic Compounds):** compounds which evaporate readily and contribute to air pollution (photochemical smog).

**Waste management hierarchy:** a series of options in decreasing order of environmental and economic desirability ranging from elimination at source through to disposal via landfill