SEPA
Scottish Environment Protection Agency

SPECIAL WASTE REGULATIONS 1996
SPECIAL WASTE ADVISORY NOTE

WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE) Ref: SWAN/02

Background

This note covers potentially hazardous (special) WEEE (and its components) and their classification in the European Waste Catalogue (EWC). Hazardous waste has the same meaning as special waste.

There are a range of dangerous substances in WEEE in their use as plasticisers, flame retardants, colourants and insulators. Many are also used for light emission and semi-conduction. The principal substances are heavy metals (e.g. lead, mercury, cadmium), halogenated organic compounds (polychlorinated, fluorinated and/or brominated substances) and asbestos or other mineral fibres.

The potential hazards will depend on whether the dangerous substances must be assessed against the component parts or the equipment as a whole.

Summary

Many items of WEEE are assessed on the dangerous substances in their component parts (capacitors etc). If hazardous, these parts will render the whole equipment hazardous and the following EWC entry is appropriate:

16 02 13* **Discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12**

Separately collected hazardous WEEE from municipal sources - with the exception of CFC and mercury containing wastes (such as older industrial cooling equipment, medical devices and fluorescent tubes) - is classified in the EWC as:

20 01 35* **Discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components**

The classification as hazardous therefore generally depends on the presence of a **hazardous component,** regardless of its size, in the WEEE. There may be exceptions in the EWC in refrigeration and PCB or asbestos contaminated equipment, where the dangerous substances are assessed in the whole WEEE. Mercury switches, lead and NiCd batteries/accumulators, cathode ray tubes (CRTs) and other activated glass components are already identified as examples in the EWC that are absolute hazardous components.

If the components are identified and removed at the end of life, the remaining parts of the WEEE may be non-hazardous and the components classified in the EWC as:

16 02 15* **Hazardous components removed from discarded (WEEE) equipment**

Note this has a corresponding non-hazardous entry in **16 02 16**.

Waste Classification

1. Capacitors and PCB components

Capacitors store electrical energy and transmit current. In most modern appliances they simply act as small 'starting' units. The conductive medium is an electrolyte such as glycol: With a risk phrase of **R22**[2] glycol would have to account for more than 25% w/w in total of the capacitor to make the equipment hazardous (**H5** - **harmful**). Many electrolytes may not have known R phrases.

Some capacitors, transformers and fluorescent light 'ballast' may contain polychlorinated biphenyls (**PCBs**). PCBs are chemically stable, fire resistant and good electrical insulators, although they will not have been fitted in domestic appliances since 1986. Many old Trade names for PCBs exist, e.g. Asbestol and Clorinol.

The typical concentration of PCBs in a capacitor is about 50g. A worst case assumption must be made that pre-1986 capacitors contain PCBs, unless the contrary can be proven. PCBs are classified in the ASL with risk phrase **R50-53**[2] which is **H14 - eco-toxic** above 0.25% (the substances being additive). However, as PCBs are persistent in the environment and are able to move into the food chain they are more rigorously controlled. **50 mg/kg** (**0.005%**) of PCBs or PCTs (see below) is the threshold such waste should be considered against to maintain consistency with international/UK legislation and guidance.

The EWC entry depends on whether PCB-containing parts or whole equipment is being classified:

16 02 09* **Transformers and capacitors containing PCBs**
16 02 10* **Discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09**

Old oil filled equipment may be contaminated with PCBs for heat transmission, the oil then being classified as an absolute entry under Chapter 13 if removed, e.g.:

13 03 01* **Insulating or heat transmission oils containing PCBs**

Although PCBs are used in parts that are exposed to particularly high thermal loads, when subject to uncontrolled heat they can produce highly toxic substances known as furans and dioxins.

Polychlorinated terphenyls (**PCTs**) and polychlorinated naphthalenes (**PCNs**) are insulating electrolytes with similar properties to PCBs. Some sources verify them as **H4 - Irritant**, **H5** and **H6** - **Toxic**. Any WEEE with a total concentration of PCNs of 3% would be hazardous waste. The average electrolyte content of a PCN-type capacitor is 25% by weight of the capacitor with the concentration of PCN in the electrolyte being approximately 90%. The presumption is therefore that PCN-type capacitors will be hazardous waste.

2. Appliances containing ozone depleting substances (ODS)

ODSs (chlorofluorocarbons) are listed in Annex I to Council Regulation (EC) 2037/2000 on substances that deplete the ozone layer (CFC, HCFC, HFC, HC). The most common ODSs are classified in the ASL as **R59**[2] which is **H14** at a threshold of 0.1%. ODS is the refrigerant in the coolant/oil (compressor gas) or blowing agent in the insulation foam (no CFCs have been used since the early-mid 1990s). At normal ODS contents (say 150g refrigerant in a typical 35kg fridge), it will exceed the threshold for both the components (e.g. discarded compressor units) and the appliance as a whole.

HCFCs in fridges and air conditioning equipment are being replaced by HFCs or other hydrocarbons such as cyclopentane or isobutane. Pentane is classified with **R12**[2] (**H3A – Highly Flammable**), **R65**[2] (**H5** above 25%) and **R51-53**[2] (**H14** above 2.5%). It may be difficult to identify appliances on their refrigerant, but the plate at the back should be checked along with any material data sheets associated with the manufacturer/model or any other person marketing the agent. Appliances entering the waste stream thought to be older than 10 years should be presumed to contain ODS unless proved to the contrary.

EWC codes for separate municipal collections of fridge-freezers distinguish CFC-containing appliances from others as CFCs had earlier phase out dates and are deemed more damaging to the environment:

20 01 23* **Discarded equipment containing chlorofluorocarbons**

Other municipal collections could be classified under **20 01 35***. Other appliances destined for specialist recovery could be classified under Chapter 16 of the EWC:

16 02 11* **Discarded equipment containing chlorofluorocarbons, HCFC, HFC**

A degassed fridge would be non-hazardous (**16 02 14** or **20 01 36**) assuming there are no other contents or hazardous components that make it hazardous waste. Both the refrigerant and blowing agent would have to be recovered if they are ODS to make the appliance non-hazardous. Refrigerants and foam propellants themselves are classified in Chapter 14, further information is given in Appendix B39, WM2.

3. Fibrous insulating materials

Items over 20 years old such as electric coffee pots, toasters, irons and other heating appliances may contain asbestos in the thermal pads. Asbestos is classified as a category 1 **carcinogen** - **H7** where the individual chemical form is present (in free or bonded form) above 0.1% (risk phrase **R45**[2]). Asbestos is also classified as **H6** when present at 3% (with risk phrase **R48/23**[2]). WEEE containing asbestos at these levels is classified in the EWC as:

16 02 12* **Discarded equipment containing free asbestos**

Any other insulating material stripped off the WEEE could be classified under Chapter 17 06 – Insulating Materials. Since the assessment of hazardous waste relates to hazard and not to risk, the ability of the waste to release free fibres is not relevant for consideration.

Other forms of synthetic fibre may be present in modern appliances, for instance **refractory ceramic fibres** (RCF) or **mineral wool**. Further information on man made mineral fibres is in SWAN03.

Other insulating materials that may be present could include the foams from cooling appliances containing CFCs which are hazardous by **H14**.

4. Plastics and PVC

Cable insulation, casings and other plastic components (such as the laminate of circuit boards) may contain organic halogenated substances. They are collectively known as '**brominated flame retardants**' (e.g. polybrominated biphenyls). Many R phrases are not yet available but there is no evidence on their persistence, bioaccumulation or consensus on their risk to the environment, although they can liberate HCl or highly toxic dioxins and furans when burnt. Office equipment makes up the major part of BFRs, although there has been a growing trend against their use.

Some metal compounds, e.g. lead and cadmium are used as colouring pigments or stabilising additives in plastics and PVC. There is as yet no definitive finding on the hazardousness of lead stabilisers and as a precautionary measure it should be considered to be hazardous waste. Cadmium sulphide is classified as **H7 – carcinogenic** and **H6**, but also **H14** and **H5** at higher concentration (25%). Sulphides can also release hydrogen sulphide in the presence of acids and have the potential to classify waste as **H12** – '**substances which release toxic or very toxic gases in contact with water, air or acid**'.

'Phthalates' such as dibutyl phthalate perform a similar function to plastic stabilisers: This has risk phrases **R61** and **R62**[2] (**H10** - **Toxic for reproduction** at concentrations of 0.5%, and also **H14** at higher limits). If there was more than about 5% in the plastic, not only would it be hazardous but the overall concentration in the whole WEEE would likely exceed the threshold. Plastics contain on average about 18% in flame retardants and it can be assumed all discarded laser printers and photocopiers will contain BFRs.

5. Switches, printed circuit boards and other mercury based components

Many mercury containing items are found in the parts soldered onto circuit (wiring) boards, in particular the switches. Circuit boards are nearly ubiquitous in white goods and other electronic items, for instance in timers and variable speed controllers, and they also contain other metals.

Mercury is also present in thermostats, sensors, relays, medical equipment, telecoms products and mobile phone batteries. Mercury switches not going separately for specialist recovery will be classified **16 02 15*** in the EWC. Mercury containing equipment or components that are separately collected (with the exception of mercury batteries – **20 01 33***) will be classified:

20 01 21* Fluorescent tubes and other mercury-containing waste

Fluorescent tubes contain mercury which ionises to emit ultraviolet light and are covered in SWAN01.

The manufacture of printed circuit boards involves the etching of copper wires onto fabricated fibre glass surfaces with acidic or ammonia based solutions. These confer **H8 - corrosive** (or at lower concentrations **H4**) properties: Etching waste may also be contaminated by copper at hazardous (**H14**) levels. Further information is given in Appendix B21 of WM2. Lead soldering dross is classified in Chapter 10.

6. Cathode ray tubes

These are absolute hazardous wastes **16 02 15*** in the EWC. Their hazardous nature is due to the conductive phosphor powder that generates the image on the inside of the glass screen: This coating contains heavy metal oxides (e.g. lead, chromium, cobalt, nickel and arsenic). They have similar applications in light bulbs, X-ray fluorescent screens, smoke detectors, photographic exposure meters and photocopier glass plates. The likely hazards are **H5, H7**, **H10, H11 - mutagenic** and **H14**.

7. Liquid Crystals

These are organic compounds (hexane and benzene based substances) which conduct electricity and transmit/change polarised light. They are embedded within the **liquid crystal displays** (LCDs) common in mobile phones, digital clocks, microwaves, handheld devices, PC monitors and non-CRT flat screens (LCDs or plasma screens are being used more commonly in favour of CRTs). The presence of liquid crystals is unlikely to exceed the thresholds in either the LCD panels or the whole item. However, the assessment of the hazardous nature of waste containing liquid crystals should be on a case by case, including any verifiable risk phrase information.

Mercury will be contained within the switches for the back light to LCDs, however toxicity data on liquid crystals is limited and again it is unlikely to classify the LCD as hazardous waste. The backlight itself is a hazardous component. The precautionary principle should be invoked on insufficient or inconclusive data.

8. Printer and photocopier cartridges

Used cartridges would only be hazardous if the residues left over are enough to breach the thresholds relative to the weight of the cartridges. These are 25% of a **H5** or 3% of a **H6** substance.

Full or part full waste cartridges (i.e. those not fully utilised and subject to the above heading) are assessed on the hazardous nature of the contents alone regardless of the weight of packaging:

08 03 17* Waste printing toner containing dangerous substances

EC Directives ensure that dangerous substances cannot be placed on the market unless the labelling on their packaging indicates the name and origin of the substances. Users should therefore check the data sheets or look on the labels/packaging. Modern inks tend to use non-toxic pigments but may contain some harmful ingredients. Further information is given in Appendix B20 of WM2.

9. Mixed wastes containing hazardous parts or equipment

Hazardous WEEE from non-municipal sources will make the whole waste hazardous if discarded into the general municipal waste stream and not separated out. The relevant EWC code for the WEEE and the mixed municipal waste (**20 03 01**) is given.

Construction and demolition wastes containing hazardous WEEE are classified under Chapter 17 09.

10. Others

Heavy metals such as chromium (VI) have been used in the electronics industry as anti-corrosion agents e.g. sodium dichromate in the circulating water systems of fridge-freezers.

WEEE can also be contaminated from the lubricants, cutting/machining oils or degreasers used to manufacture and treat the electronic parts, for instance **chlorinated solvents** such as trichloroethylene. Further information is in Appendix B31 of WM2. Wastes arising specifically from electronics treatment and manufacture would be covered under Chapters 10 - 12 or 14.

Batteries are covered in Appendix B44, and metals recovery waste from spent rechargeables in Appendix B33 of WM2. Onboard batteries in WEEE are likely to be hazardous components and therefore render the whole waste hazardous, e.g. NiCds commonly found as battery packs to power tools. Recent studies by DEFRA indicate that nickel metal hydride and lithium ion batteries are classified as hazardous due to nickel and manganese dioxide levels. Separately collected, these will be classified in the EWC as **20 01 33*.**

Some WEEE contains radioactive material, e.g. Americium-241 in the ionisation cells of smoke detectors (photo detector alarms are not radioactive). These are regulated under the Radioactive Substances Act 1993 (RSA), but if any of the components are hazardous will also be subject to special waste regulations.

The disposal of hazardous WEEE with radioactive material is normally regulated under exemption orders to the RSA, e.g. the 'Radioactive Substances (Smoke Detectors) Exemption (Scotland) Order 1980 removes the need to register smoke detectors in most circumstances and the need to authorise their disposal as radioactive waste when they become waste. There are conditions in the Order that must be complied with in order for the radioactive material and waste to remain exempt, further advice should be sought from Radioactive Substances specialist staff in SEPA.

Notes

[1] ASL (provides simple information for the labelling of products with chemicals that could be dangerous to human health or the environment) WM2 uses the most recent version of the ASL to ensure that classification of waste reflects current understanding on dangerous substances

[2] **Risk phrases**
R12 - extremely flammable; R22 - harmful if swallowed; R23 - toxic by inhalation; R38 – irritating to the skin; R40 – limited evidence of a carcinogenic effect; R45 – may cause cancer; R48 – danger of serious damage to health by prolonged exposure; R49 – may cause cancer by inhalation; R50-53 - very toxic to aquatic organisms and may cause long term effects in the aquatic environment; R51-53 – toxic to aquatic organisms and may cause long term effects in the environment; R59 – dangerous for the ozone layer; R61- may cause harm to the unborn child; R62 – possible risk of impaired fertility

It should be noted that for some hazards (**H4**, **H5**, **H6**, **H8** and **H14**) the concentrations of components in the waste must be added together to calculate the total concentration of the substances with that hazard