GUIDELINES ON BEST AVAILABLE TECHNIQUES AND PROVISIONAL GUIDANCE ON BEST ENVIRONMENTAL PRACTICES

relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants

Smouldering of copper cables

UNEP

Stockholm Convention

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Contents

Section IV: Compilation of summaries from the source categories included in sections V and VI

Summaries of section V: source categories included in Part II of Annex C

Summaries of section VI: source categories included in Part III of Annex C

Section V: Guidance/guidelines by source categories: Source categories in Part II of Annex C

V.A Waste incinerators

(i) Municipal solid waste, hazardous waste and sewage sludge

(ii) Medical waste

V.B Cement kilns firing hazardous waste

V.C Production of pulp using elemental chlorine or chemicals generating elemental chlorine

V.D Thermal processes in the metallurgical industry

(i) Secondary copper production

(ii) Sinter plants in the iron and steel industry

(iii) Secondary aluminium production

(iv) Secondary zinc production

Section VI: Guidance/guidelines by source categories: Source categories in Part III of Annex C

VI.A Open burning of waste, including burning of landfill sites

VI.B Thermal processes in the metallurgical industry not mentioned in Annex C Part II

(i) Secondary lead production

(ii) Primary aluminium production

(iii) Magnesium production

(iv) Secondary steel production

(v) Primary base metals smelting

Section VI.L

Guidance/guidelines by source category: Source categories in Part III of Annex C

Part III Source category (l): Smouldering of copper cables

CONTENTS

Tables

■ **Summary**

Scrap copper is often recovered by open burning of plastic coatings from electrical cable and wiring. Chemicals listed in Annex C of the Stockholm Convention are probably formed from plastic and trace oils with copper as a catalyst at smouldering temperatures between 250°C and 500°C.

Best available techniques include mechanical cable chopping, stripping or high-temperature incineration >850°C. A consideration is to set premium pricing for unstripped cables and wiring and encourage sending the feed material to copper smelters using best available techniques for treatment.

Performance levels associated with best available techniques are not applicable, as the smouldering process is not a best available technique or best environmental practice and should not be practised.

1. Process description

Smouldering of copper cables involves the open burning of plastic coatings from electrical cable and wiring to recover scrap copper and other constituents of the cables. This process is labour intensive, and is performed by individuals or in small facilities without any abatement measures for air emissions. Smouldering is conducted in burn barrels or on open ground. No means of temperature control or oxygen addition are used to achieve complete combustion of plastic compounds.

The smouldering of copper cables is becoming prevalent in developing nations due to the recycling of computer scrap using manual methods. However, the process is not limited to developing countries and should be addressed on a global scale. Legislation has been implemented by many developed and developing countries to ban open burning, but the practice continues.

In the technical guidelines for identification and environmentally sound management of plastic wastes and for their disposal under the Basel Convention on the Control of the Transboundary Movements of Hazardous Wastes and Their Disposal it is stated: "Open burning is not an environmentally acceptable solution for any kind of waste" (UNEP 2002, p. 43). In addition, Decision VII/19 of the seventh meeting of the Conference of the Parties to the Basel Convention (October 2004) amended Annexes VIII and IX of the Convention to include new entries regarding the uncontrolled burning of plastic-coated cable scrap. The United Kingdom Clean Air Act states: "A person who burns insulation from a cable with a view to recovering metal from the cable shall be guilty of an offence … [and] shall be liable on summary conviction to a fine…" (Government of the United Kingdom 1993).

2. Sources of chemicals listed in Annex C of the Stockholm Convention

The formation of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) may occur with trace oils and the presence of chlorine from plastics in the feed material. As copper is the most efficient metal to catalyse PCDD/PCDF formation, the burning of copper cables may be a critical source of PCDD/PCDF emissions.

2.1 General information on emissions from smouldering of copper cables

Smouldering of copper cables releases various contaminants besides PCDD/PCDF, such as carbon monoxide (CO), sulphur dioxide (SO_2), polycyclic aromatic hydrocarbons, hydrogen chloride, heavy metals and ash. Incomplete incineration occurs because of the low burning temperature (250°C to 700°C), resulting in the generation of hydrocarbons and particulate matter. Lead stabilizers, often included into the PVC polymer matrix of the plastic cable coating, are released during smouldering. Lead-coated copper cables are also burnt, releasing additional lead. Contaminants are emitted to air, water and soil.

2.2 Emissions of PCDD/PCDF to air

The incomplete incineration of chlorinated plastics causes PCDD/PCDF generation. Plastic coatings on copper cables consist mainly of polyvinyl chloride (PVC).

> "During combustion, various ring-structure hydrocarbon species (referred to as 'precursors') are formed as intermediate reaction products. If chlorine is also present, these species can react with each other to form PCDD/PCDF. The most frequently identified precursors are chlorobenzenes, chlorophenols, and chlorinated biphenyls. PCDD/PCDF may also be formed from the reaction of complex organic molecules and chlorine. Several studies have identified strong correlations between chlorine content and PCDD/PCDF emissions during combustion tests" (EPA 1997, p. 3–8).

Destruction of PCDD/PCDF requires temperatures above 850°C in the presence of oxygen (European Commission 2001).

3. Alternative processes to smouldering of copper cables

To prevent the generation of PCDD/PCDF, smouldering of copper cables should not be conducted. Alternative treatment processes to open burning are discussed below. The insulation material, for example PVC, may also be recovered by using these processes.

3.1 Cable chopping

Cable chopping allows for the separation of plastic coatings from cables without the generation of PCDD/PCDF through thermal methods (UNEP 2001). This process is able to treat cables of mixed type and different gauges. The products recovered are granulated copper and PVC.

Cable chopping involves the following steps:

3.1.1 Presorting

Presorting according to cable type is crucial for efficient cable chopping operations, providing maximum value from recovered scrap with easier separation of plastics. Sorting criteria include metal alloys (separating copper and aluminium cables), conductor diameter, cable length and type of insulation. Long cable lengths are sheared to <1 m, while densely baled cable is broken up into loose streams. Treated cables can vary between thin gauge and 8 cm diameter. Unsuitable material such as superfine wire and grease or tar-filled cables should be removed.

> "In the past PCB was added to PVC for certain cable systems for high voltage applications to improve insulation performance and to certain low voltage cables as flame retardant. The presence of these cable systems should be determined before starting the recycling process" (UNEP 2001).

According to PCB data reported for Germany, most of the samples show contamination levels of 30 mg PCB/kg, with some reaching contamination levels of several hundred ppm and others with contamination levels <10 ppm.

3.1.2 Cable chopping

Cable chopping is used to reduce long cable sections into acceptable size for the granulator. This process is optional in smaller facilities. Less filter dust is produced in comparison to cable shredding.

3.1.3 Granulation

Granulation is conducted to free metals from plastic insulation and jacketing. Fine granulation is necessary to achieve sufficient liberation of metals from the plastic. However, small amounts of metals will remain locked in the plastic and be lost as waste.

3.1.4 Screening

Screening can be used to ensure adequate liberation of metals by particle size separation. Oversize material can be reprocessed in the granulator. Metal particles can be recovered from the screen product by removal of lighter non-metallic particles using an aspirator. Dust collection and filtering should be conducted during screening.

3.1.5 Density separation

The recovery of metals is dependent on the efficiency of the separation technique and degree of liberation of the metal from plastics. Separation of metal particles can be conducted using density separation techniques such as fluidized bed separators. Dry electrostatic separators can provide increased recovery compared to density techniques.

3.2 Cable stripping

Cable stripping is a cheaper method for copper cable recovery than chopping, but at lower throughput. PCDD/PCDF generation is not of concern in this process. This technique is preferred in developing countries due to the lower cost. Presorting of cables should also be conducted before stripping according to metal type, insulation material, conductor diameter and length (UNEP 2001, p. 44).

Despite the lower production rate, copper can be completely recovered as no residual metal remains in the plastic insulation. Careful segregation by insulator type can produce waste material consisting of only one type of polymer, allowing for easier recycling of both the metal and plastic fractions.

Cable stripping machines can process only single strands of cable at rates up to 60 m/min or 1,100 kg/min with cable diameter ranging from 1.6 mm to 150 mm.

3.3 High-temperature incineration

High-temperature incineration should only be used for treating cable that cannot be recovered by chopping or stripping. Materials such as fine wire and grease- or tar-filled cables are burnt in controlled atmosphere incinerators to ensure complete combustion of plastics. Effective flue gas cleaning systems should be utilized (UNEP 2001, p. 46).

Furnace off-gases contain contaminants such as PCDD/PCDF, carbon dioxide (CO_2), sulphur dioxide (SO_2), hydrogen chloride and fluoride, and dust. Because PCDD/PCDF adsorb on particulate matter, dust should be collected using efficient methods such as fabric filters and recycled to the furnace. Post-incinerator afterburning and quenching should be considered if incineration is ineffective in eliminating PCDD/PCDF. SO_2 and hydrogen chloride and fluoride should be removed by wet alkaline scrubbing.

Incinerated scrap metal has less value due to oxidation from thermal treatment. A high potential for PCDD/PCDF generation exists with incineration. Cable chopping and stripping are preferred to high-temperature incineration as these processes are more economical and environmentally sound. Cable types unsuitable for chopping or stripping can also be treated in primary or secondary copper smelters.

4. Summary of measures

Table 1 summarizes measures for new copper cable recovery facilities.

Table 1. Measures for new copper cable recovery facilities

Measure	Description	Considerations	Other comments
Alternative processes	Various recommended treatment processes should be considered to replace open burning	Processes to consider include: • Cable chopping • Cable stripping • High-temperature incineration for material unsuitable for chopping or stripping	Incineration is considered to be a best available technique in configuration with suitable gas collection and abatement

Smouldering of copper cables should not be conducted as this practice generates PCDD/PCDF emissions. Open burning should never be considered as an acceptable means of waste treatment. Guidelines and legislation against the smouldering of copper cables have been implemented at federal, state, provincial, territorial and municipal levels by many countries.

Examples of such guidelines and legislation include UNEP 2001; Government of the United Kingdom 1993; Government of Hong Kong 1996; Government of New Zealand 2004.

A consideration is to set premium pricing for unstripped cable and wiring to encourage sending the feed material for treatment in copper smelters using best available techniques.

Achievable performance limits are not applicable, as the smouldering process is not a best available technique or best environmental practice and should not be practised.

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