



European Metals' comments on the ongoing discussion on changes to Section K of the Basel Convention Technical Guidelines for the Environmentally Sound Management of Wastes Consisting of, Containing or Contaminated with Persistent Organic Pollutants

Introduction

Metallurgical and thermal techniques for the production of non-ferrous metals have been proven, throughout the years, to be effective methods for the destruction of Persistent Organic Pollutants (POPs), under the high temperatures achieved through these processes. In this context, the high-quality recycling of non-ferrous metals is a fundamental part of the treatment of complex metal-containing waste streams – such as e-waste and end-of-life vehicles – which may contain POPs or POPs-containing materials. While modern techniques allow for a substantial percentage of POPs-containing materials to be removed already at the pre-processing stage, certain organic materials cannot be effectively separated from the metals present in these complex fractions and consequently enter specialised metallurgical recycling processes.

These techniques are also currently explicitly recognised as effective for the purpose of destroying POPs, under Section K of the Basel Convention *General Technical Guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants* (the General Technical Guidelines). Any potential deletion of the reference to thermal and metallurgical processes as effective methods for POP destruction risks having a ripple effect on EU and national legislation that also recognise these well-established techniques and significantly undermining efforts to achieve global circular economy objectives.

Our recommendations on Section K of the technical guidelines

- Retain Section K in the General Technical Guidelines and continue recognising thermal and metallurgical techniques as effective for the destruction of POPs.
- Recognise compliance with applicable BATs as sufficient to demonstrate the effectiveness of thermal and metallurgical techniques to destroy POPs.
- Avoid a technology-based approach and rather apply an evidence- and performance-based approach for the assessment of treatment technologies, in light of existing scientific evidence, BAT requirements, and industrial performance. In this context, such an approach should not be interpreted as requiring a detailed substance-by-substance mass balance for every individual recycling facility.



Sources of POPs

POPs can have different origins. For instance, Polybrominated Diphenyl Ethers (PBDEs) can be found in, among others, plastic components of a range of electronic products and vehicles, where they are used as flame retardants.¹ These products often enter secondary smelting and recycling streams as e-waste and end-of-life vehicles components.

Conversely, polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are unintentionally produced as by-products of combustion processes in incinerators and other installations where organic material is burnt, also including smelters.²

The role of pre-processing

The treatment of POPs-containing waste already begins during the pre-processing phase. For instance, before proceeding to high-quality recycling, e-waste undergoes depollution, dismantling, and separation of parts. These processes involve the removal of specific substances, mixtures, and/or components, mechanical processing, and finally the separation into different fractions, including non-ferrous metals and plastics. These are in turn re-directed towards specialised recycling and treatment routes. Plastics separated from e-waste also undergoes further sorting to separate recyclable plastics from fractions with high levels of flame retardants. Plastics containing POPs at concentrations exceeding the applicable POPs concentration limits must be removed from the recycling stream and managed in line with relevant regulatory requirements. Similarly, complex metal-rich fractions in which individual plastics and metal constituents cannot be fully separated (e.g. printed circuit boards, fine wire, other small or complex electronic components) must undergo further pyrometallurgical processing to ensure the proper destruction of POPs.

Scientific literature on the efficiency of thermal and metallurgical techniques for the destruction of POPs

As a general principle, POPs can be destroyed through high temperatures, which can be achieved through thermal and metallurgical processes, as recognised in a 2011 [European Commission study](#).³ Indeed, thermal and metallurgical processes relevant for the destruction of POPs (e.g. Waelz rotary kiln process, bath melting processes using vertical or horizontal furnaces) in non-ferrous metals operate at temperatures of up to 1,200°C.⁴ Furthermore, these techniques also rely on rapid quenching to prevent the *de novo* formation of both PCDDs and PCDFs⁵, bypassing the critical temperature window of 200 °C–450 °C, in line with the [EU conclusions on Best Available](#)

¹ European Commission, *Impact Assessment Report on a Proposal for a Regulation of the European Parliament and of the Council amending Annexes IV and V to the EU POPs Regulation*, 2021.

² Ibid.

³ European Commission, *Study on waste related issues of newly listed POPs and candidate POPs*, prepared by the Expert Team to Support Waste Implementation (ESWI), 2011.

⁴ Ibid.

⁵ Ibid.



Techniques for the non-ferrous metals industries.⁶ As recognised by the European Commission in the study, those processes – which are labelled under the code R4 in the Basel Convention (Recycling reclamation of metals and metal compounds) – are therefore “*considered appropriate for the recovery and disposal of POPs currently listed under the Basel Convention*”.⁷ Moreover, the study also underlines that POPs are “*largely destroyed during the... processes for Recycling/reclamation of metals and metal compounds*”.⁸

Further scientific literature and industry data exist for specific non-ferrous metals, notably lead, copper, and zinc.

1. Lead

Industry data confirms that lead producers and recyclers operate through well-established metallurgical processes and have demonstrated compliance with the stringent limit values for POPs, in line with destruction efficiency (DE) requirements under the General Technical Guidelines. European Metals’ Members were able to provide non-confidential data concerning two specific examples: one from a UK-based secondary lead production facility, and the second from one of the world’s largest Canada-based fully integrated zinc and lead smelting and refining complexes.

The first case focused on how effectively Company X’s lead acid battery recycling process destroys POPs – particularly brominated flame retardants such as deca-BDE –, measured in terms of DE. During the process, batteries are broken, and casings are separated by density. The light fraction (polypropylene) is then recycled, while the dense fraction (mainly ABS, potentially containing POPs) is used as a co-fuel in a high-temperature furnace (>1,000°C). The measurement took place in October 2024 over a three-day trial that introduced varying amounts of dense polymer casings into the furnace. Samples were collected from the infeed and all output streams to perform a mass balance destruction efficiency and calculate DE⁹, with advanced analytical techniques (GC-MS, XRF, LC-MS/MS) used to detect and quantify POPs at very low concentrations (down to 0.0008 mg/kg for deca-BDE). Trial results indicate that Deca-BDE was the only BFR present in sufficient quantities in the infeed to allow meaningful DE calculations, while other BFRs, SCCPs/MCCPs, and PFAS were at or below detection limits. Overall, the smelting process achieved very high DE for deca-BDE: 99.9997% on day 1; 99.9839% on day 2; and 99.8864% on day 3. Notably, the highest DE was observed when the infeed had the highest deca-BDE concentration. Lower DEs on days 2 and 3 were due to lower input concentrations, not higher output residues. Overall, the reported value met or even exceeded the DE requirements currently envisioned in the adopted General Technical Guidelines and under the existing BAT target of 99.999% DE for POPs.

The second case covered a study in Canada, to demonstrate that processing e-waste could be done safely and avoiding adverse environmental impacts. To assess this, the company conducted a year-long monitoring program comparing periods when e-scrap was processed with baseline periods when no plastic-containing e scrap was treated. Sampling included: ambient air within the

⁶ European Commission, *Commission Implementing Decision (EU) 2016/1032 of 13 June 2016 establishing best available techniques (BAT) conclusions for the non-ferrous metals industries, under Directive 2010/75/EU, 2016*

⁷ Ibid.

⁸ Ibid.

⁹ Destruction efficiency (DE) was calculated as the percentage of POPs destroyed relative to the input amount, including partial combustion products (brominated dioxins/furans) in the calculation.



community; stack emissions from the operation; final effluent discharged to the Columbia River. The results successfully showed that processing e-waste did not result in measurable environmental impacts relative to normal operations. PBDE concentrations in ambient air, stack emissions, and effluent were generally comparable to baseline conditions, and PBDDs and PBDFs were essentially non-detected in both stack emissions and external effluent samples. The study also found no meaningful increase in PBDE loading to the Columbia River attributable to e-scrap processing. Overall, the study concluded that electronic scrap containing PBDE flame retardants could be processed without causing significant increases in PBDE or PBDDs and PBDFs releases to air or water.

2. Copper

A consistent amount of scientific literature exists on secondary copper operations, ranging from high-quality recycling, the management of off-gases, and the management and recycling of copper-bearing flue dust.

Regarding high-quality pyrometallurgical recycling, complex secondary materials are smelted in high-temperature furnaces to recover copper and approximately 20 other materials, generating a copper-rich phase known as “black copper”, with other materials distributed among the metal, slag and fume phases. Subsequent metallurgical processing enables further recovery and refining. In this context, scientific literature underlines that pyrometallurgical copper recycling is characterised by very high temperatures.¹⁰ Nicol et al. (2023) underline that e-scrap smelting using ISASMELT™ technology can take place at approximately 1,250°C, with a highly turbulent molten bath into which air and oxygen are introduced, destroying organic constituents. This is consistent with the EU BAT framework for non-ferrous metals¹¹, under which BAT 48 identifies thermal destruction of PCDD and PCDF above 850°C as a technique for reducing PCDD and PCDF emissions, alongside optimised combustion, oxygen injection and internal burner systems; the associated BAT-AEL is ≤ 0.1 ng I-TEQ/Nm³. PBDDs and PBDFs can also form during thermal treatment of brominated flame-retardant materials, but scientific literature shows that high temperatures promote their decomposition. Wan et al. (2023) report a PBDDs and PBDFs decomposition temperature above 1,100°C and show that between 800 and 1,300°C, PBDDs and PBDFs toxic equivalence decreases with increasing temperature, with organic bromine potentially converted into inorganic bromine.¹² Scientific literature confirms that high temperatures, combined with adequate oxygen input, mixing, and residence time, can favour the destruction of PCDDs and PCDFs.¹³

Following post-combustion, off-gases are rapidly quenched to prevent the re-formation of dioxins and furans during cooling. After cooling, fine dust and particulate matter are then removed and further gas cleaning is conducted through, e.g., scrubbing for the removal of hydrogen chloride (HCl) and hydrogen fluoride (HF) as well as activated-carbon treatment and fabric filtration. High

¹⁰ Nicol et al., *Extraction and Recovery of Critical Metals from Electronic Waste Using ISASMELT™ Technology*, 2023.

¹¹ European Commission, *Commission Implementing Decision (EU) 2016/1032 of 13 June 2016 establishing best available techniques (BAT) conclusions for the non-ferrous metals industries, under Directive 2010/75/EU*, 2016.

¹² Wan, J., Sun, J., Zhao, X.L. et al., *Emission of Brominated Pollutants from Waste Printed Circuit Boards during Thermal Treatment: A Review*, *Aerosol Air Qual. Res.* 23, 2023; and Weber, R., Kuch, B., *Relevance of BFRs and thermal conditions on the formation pathways of brominated and brominated-chlorinated dibenzodioxins and dibenzofurans*, *Environ. Int.* 2003.

¹³ Themba, N., Sibali, L.L. & Chokwe, *A review on the formation and remediations of polychlorinated dibenzo p-dioxins and dibenzo-furans (PCDDs and PCDFs) during thermal processes with a focus on MSW process*, *Air Qual Atmos Health* 16, 2023.



PCDDs and PCDFs DEs are reported for these systems.¹⁴ As for high-quality recycling, afterburners and quenching are explicitly mentioned in both the Stockholm Convention BAT Guidelines and EU BAT framework for non-ferrous metals.

Finally, fine solid particles from the gas stream are also separated from the gas through dust-collection systems (e.g. fabric systems). These are referred to as flue dust¹⁵, which can contain a wide range of valuable metals, including copper, lead, zinc, and cadmium. Depending on its composition, flue dust can be either recycled directly or subjected to dedicated hydrometallurgical and/or pyrometallurgical treatment.¹⁶

Further evidence on the efficiency of these processes can also be found in the [EU BAT Reference Document \(BREF\) on non-ferrous metals](#)¹⁷, which provides concrete examples of European installations relying on relevant thermal and metallurgical techniques. For instance, Aurubis Lünen uses the Kayser Recycling System (KRS), designed for thermal destruction of dioxins and prevention of their de novo synthesis through rapid cooling, with reported PCDDs and PCDFs concentrations of 0.01–0.1 ng TEQ/Nm³. Aurubis Hamburg's plant can reach temperatures above 950°C for the thermal destruction of dioxins, and rapid gas cooling is used to prevent their re-formation. The Boliden Rönnskär plant, where gases from the TBRC furnace are quenched, treated with lime and activated carbon and subsequently dedusted in a bag filter, reported low PCDDs and PCDFs concentrations below 0.05 ng I-TEQ/Nm³. Of note, these levels are in line with the atmospheric emissions levels of 0.1 ng TEQ/Nm³ identified in the General Technical Guidelines.

3. Zinc

Similarly, zinc production also goes through processes entailing extremely high temperatures, thus effectively eliminating POPs. Notably, several zinc producers rely on the Waelz Rotary Kiln process, through which a homogeneous feed of pelletized zinc-containing starting materials (e.g., steel mill dusts, filter cakes) is fed into a large rotary kiln operating at temperatures of up to 1200 °C.¹⁸ This process produces zinc oxide together with other volatile components, which are in turn recovered in the form of zinc concentrate, also known as Waelz oxide. This is then delivered to metal smelters for zinc production.

The Waelz oxide can subsequently be subject to an additional three-stage leaching process for the removal of impurities and further concentration. While the by-product slag is normally used as a landfill construction material, the off-gas generated is treated by using the best available technology, leading to PCDDs and PCDFs emissions below 0.1 I-TEQ/m³.¹⁹

¹⁴ Ibid.

¹⁵ Flue dust can include both particles entrained from the metallurgical process and material that volatilises at high temperature and subsequently condenses as the gas cools.

¹⁶ Chen J, Zhang W, Ma B, Che J, Xia L, Wen P, Wang C., *Recovering metals from flue dust produced in secondary copper smelting through a novel process combining low temperature roasting, water leaching and mechanochemical reduction*, J Hazard Mater, 2022.

¹⁷ European Commission, *Best Available Techniques (BAT) Reference Document for the Non-Ferrous Metals Industries. Industrial Emission Directive 2010/75/EU (Integrated Pollution Prevention and Control)*, 2017.

¹⁸ C. Meyer-Wulf, *Technical Background Paper on the Recycling of Non Ferrous Metal Waste contaminated with POPs*, 2006.

¹⁹ Ibid.



Conclusions and recommendations

1. Retaining Section K

Both industry data and scientific literature show that thermal and metallurgical techniques as mentioned in Section K of the General Technical Guidelines are effective methods to destroy POPs from non-ferrous metal-containing waste streams. These techniques include, but are not limited to, historically well-established processes such as the Waelz Rotary Kiln Process for zinc, the Kayser Recycling System (KRS) for copper, and Qunenau Schumann Lurgi (QSL) process for lead. All of these techniques are commonly used by the industry and, in the EU, are compliant with the low emissions standards set in the EU BREF for the non-ferrous metals sector.

The references to these techniques in Section K facilitate the treatment of complex waste streams entering these specialised treatment routes, contributing to an efficient circular economy. Removing these references from Section K risks having direct consequences on EU and national legislation reflecting the standards set by the Basel and Stockholm Conventions and potentially hamper the production of secondary metals through the affected techniques.

Furthermore, it must be considered that Article 7(2) of the EU POPs Regulation²⁰ requires Member States to dispose or recover without undue delay and in accordance with Part 1 of Annex V to that Regulation – which explicitly refers to processes listed under code R4, in line with Annex IV of the Basel Convention – waste consisting of or containing POPs, in such a way to ensure that the POP content is destroyed or irreversibly transformed so that the remaining waste and releases do not exhibit the characteristics of POPs. Additionally, under Article 14(3) of the EU Industrial Emissions Directive (IED), the EU BAT conclusions must be used by Member States as the reference for setting permit conditions, making them *de facto* binding. As explained in the chapters above, both scientific literature and industry data show that thermal and metallurgical techniques can achieve levels of DE in line with the levels set out in the EU BAT conclusions, which are, in turn, consistent with the Stockholm Convention BAT Guidelines.

Our Recommendations

- Retain Section K in the General Technical Guidelines and continue recognising thermal and metallurgical techniques as effective for the destruction of POPs.
- Ensure that complex metal-rich waste streams can access specialised recycling routes, thus supporting both the environmentally-sound management of POPs and the recovery of non-ferrous metals.

2. Comments on the proposed template to assess the performance of new technologies on the destruction and irreversible transformation of POP content in wastes.

The proposed template for the submission of data on new technologies for the destruction and irreversible transformation of POPs represents an additional administrative burden for European undertakings. These are already subject to an array of comprehensive reporting requirements under applicable EU and national laws.

²⁰ European Parliament and Council, *Regulation (EU) 2019/1021 of 20 June 2019 on persistent organic pollutants (recast)*, 2019.



In particular, specific attention must be paid to the DE/DRE section of the template, keeping in mind that the requirement for standardized DE/DRE parameters initially originated from the mono-incinerations of defined pure substances. However, thermal and metallurgical processes entail the recovery of complex, heterogeneous secondary raw material mixtures containing fluctuating trace concentrations of POPs. At trace levels in the sub-ppm range, calculating DE/DRE is mathematically and analytically distorted, as dividing near-zero concentrations can introduce significant statistical artifacts. As underlined above, existing BAT thresholds already offer an accurate picture of the effectiveness of a given thermal and metallurgical technique in destroying POPs and are reflected in EU and national law requirements. Therefore, European Metals recommends that compliance with applicable BATs is recognised as sufficient to demonstrate the effectiveness of thermal and metallurgical techniques to destroy POPs.

Furthermore, it must be underlined that relying on a purely technology-based approach for the assessment of treatment technologies risks producing results that do not appropriately quantify the effectiveness of a given process. Therefore, European Metals recommends relying on an evidence- and performance-based approach, based on existing BATs requirements. Therefore, a facility-specific DE/DRE assessment should be avoided. The latter would be extremely challenging, if not impractical, for undertakings, due to the limitations in analytical methods, sampling uncertainties, the heterogeneous nature of input materials, and the large number of substances that would need to be monitored and quantified.

Our Recommendations

- Recognise compliance with applicable BATs as sufficient evidence of the effectiveness of thermal and metallurgical techniques to destroy POPs.
- Avoid a technology-based approach and rather apply an evidence- and performance-based approach for the assessment of treatment technologies, in light of existing scientific evidence, BAT requirements, and industrial performance. In this context, such an approach should not be interpreted as requiring a detailed facility assessment.

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About European Metals

European Metals is an umbrella association representing the interests of the combined non-ferrous metals industry towards EU policy makers. We bring together the companies and associations shaping Europe's non-ferrous metals ecosystem: from upstream mining and refining to downstream use and high-quality recycling. By connecting technical expertise with policy action, we ensure that the importance of the metals sector is recognised, valued, and that our sector's future is secured. For more information, visit our website: <https://european-metals.eu>