



ZERO  
WASTE  
EUROPE



# Incineration Bottom Ash (IBA)

Recommendations for EU-level regulation

Policy brief

June 2026

[zerowasteurope.eu](https://zerowasteurope.eu)



# Contents

- 3 Why EU-level regulation of IBA is needed**
- 4 Overview of parameters to be regulated**
  - 4 Recommendation 1: Establish limit values for heavy metals and metalloids
  - 5 Recommendation 2: Establish a limit value for polycyclic aromatic hydrocarbons (PAHs)
  - 6 Recommendation 3: Set a combined limit for dioxins, dioxin-like PCBs and brominated dioxins
  - 7 Recommendation 4: Introduce a binding PFAS limit - with full method specification
  - 8 Recommendation 5: Introduce requirements for microplastics
  - 9 Recommendation 6: Require a full ecotoxicological and effect-based bioassay panel
    - 9 6.a Standard ecotoxicological tests - applied to IBA leachate
    - 9 6b. Effect-based methods (EBMs) - applied to IBA leachate
  - 10 Recommendation 7: Prohibit pH adjustment of leachate in ecotoxicity testing of IBA
  - 11 Summary: Recommended chemical limits for IBA (dry matter)

# Why EU-level regulation of IBA is needed

Incineration bottom ash (IBA) constitutes approximately 25% by mass of all municipal solid waste fed into incinerators – roughly 12 million tonnes per year across Europe<sup>1</sup> – yet its use in civil engineering and construction remains almost entirely unregulated at EU level. The result is a patchwork of national rules that differ widely in scope, testing methods, and limit values, creating significant gaps in the protection of human health and the environment.

IBA is not an inert material. It contains a complex mixture of potentially toxic elements (heavy metals, metalloids) and persistent organic pollutants (POPs), including dioxins, polychlorinated biphenyls (PCBs), brominated flame retardants, PFAS, and microplastics. These substances can leach into soil and groundwater over long timescales and across a wide range of conditions, including conditions not captured by the short-term, sterile leaching tests currently used by most Member States.

Two Zero Waste Europe reports document this regulatory gap in detail. The 2022 report 'Toxic Fallout'<sup>2</sup> demonstrates that polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polybrominated diphenyl ethers (PBDEs), PCBs, and PFAS occur in bottom ash at concentrations higher than in fly ash, and that no European country at the time of writing regulated these substances when permitting IBA use as a building aggregate. The 2026 report 'A Toxic Legacy'<sup>3</sup> documents active environmental contamination from IBA processing and use, identifies PFAS in European IBA at concentrations comparable to drinking water limits, and confirms microplastics in IBA from European plants. Both reports conclude that IBA use in civil engineering is premature without robust, harmonised, science-based standards.

The following recommendations set out the minimum requirements that any EU-level framework for IBA use must include, based on the precautionary principle and the best available scientific evidence.

---

<sup>1</sup> Zero Waste Europe (2022), [Incineration and Residues in the EU: Quantities and Fates](#).

<sup>2</sup> Zero Waste Europe (2022), [Toxic Fallout - Waste Incinerator Bottom Ash in a Circular Economy](#).

<sup>3</sup> Zero Waste Europe (2026), [A Toxic Legacy: Bottom Ash in Europe's Circular Economy](#).

# Overview of parameters to be regulated

Any EU framework governing the use of IBA in engineering and construction applications must include binding limit values for specific chemical contaminants in dry matter. Compliance with dry matter limits must be verified at a minimum of four times per year per installation; leachate limits must be verified for every 5,000 tonnes of material produced. The following parameters must be regulated as a minimum:

- **Heavy metals and metalloids** – see Recommendation 1
- **Polycyclic aromatic hydrocarbons (PAHs)** – see Recommendation 2
- **Dioxins and related compounds** – see Recommendation 3
- **PFAS** – see Recommendation 4
- **Microplastics** – see Recommendation 5
- **Total organic carbon (TOC)** – limit 30,000 mg/kg dm

## Recommendation 1: Establish limit values for heavy metals and metalloids

Heavy metals and metalloids are among the most well-documented contaminants in IBA. They originate from both the waste itself and from combustion reactions, and several, including arsenic, cadmium, lead, and mercury, are classified as priority hazardous substances under EU water and environmental legislation. Their potential to leach into soil and groundwater over time makes binding limit values in both dry matter and leachate essential.

The following elements must be regulated as a minimum, with limits applied to dry matter of matured slag:

ELEMENT	SYMBOL	UNIT	LIMIT
Arsenic	As	mg/kg dm	45
Cadmium	Cd	mg/kg dm	20
Chromium	Cr	mg/kg dm	200
Copper	Cu	mg/kg dm	7,000
Mercury	Hg	mg/kg dm	1

Nickel	Ni	mg/kg dm	500
Lead	Pb	mg/kg dm	1,000
Zinc	Zn	mg/kg dm	10,000

Leachate limits for these elements must be specified separately and verified using a standardised leaching test. The short-term EN 12457 batch test is insufficient for assessing long-term release; dynamic leaching tests should be required where technically feasible.

## Recommendation 2: Establish a limit value for polycyclic aromatic hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons are a group of persistent organic compounds formed during incomplete combustion. Several PAHs are classified as carcinogenic, mutagenic or reprotoxic (CMR substances) under EU chemical legislation, and four in particular – Benzo[a]pyrene (BaP), Benzo[b]fluoranthene (BbF), Benzo[k]fluoranthene (BkF), and Indeno(1,2,3-cd)pyrene (IP) – are established indicators of PAH contamination risk in construction materials and soils.

**The PAH limit for IBA must be set as the sum of BaP + BbF + BkF + IP ( $\Sigma$  4 PAHs) and must not exceed 1 mg/kg dry matter.**

This four-compound sum is widely used in national frameworks for secondary construction materials and is consistent with approaches adopted in several Member States. The limit applies to dry matter of matured slag and must be verified at the same frequency as other dry matter parameters.

# Recommendation 3: Set a combined limit for dioxins, dioxin-like PCBs and brominated dioxins

A limit covering only polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) is insufficient, as it omits other persistent halogenated toxic compounds that are structurally equivalent and co-occur in IBA from municipal solid waste incineration.

**The dioxin-related limit for IBA should cover the combined sum of PCDD/Fs, dioxin-like PCBs (dl-PCBs) and brominated dioxins and furans (PBDD/Fs), expressed as WHO toxic equivalents (TEQ). The assessment should include the 17 toxic PCDD/F congeners, the 12 WHO dioxin-like PCB congeners, and the 17 toxic PBDD/F congeners. The combined limit should be set at 10 ng TEQ/kg dry matter.**

Justification for including dl-PCBs and PBDD/Fs:

- **dl-PCBs** share the same AhR-mediated mechanism of toxicity as PCDD/Fs and are assigned WHO toxic equivalency factors (TEFs); they must not be excluded from regulatory limits on IBA.
- **PBDD/Fs** arise from the incineration of products containing brominated flame retardants, which are common in municipal waste. Their toxicity is equivalent to that of chlorinated analogues, and their occurrence in IBA is well documented.
- The high toxicity of dl-PCBs and PBDD/Fs is especially concerning given their persistence and potential for bioaccumulation. Regulating all three compound groups under a single combined TEQ limit is consistent with current WHO TEF methodology and closes a significant protection gap.

# Recommendation 4: Introduce a binding PFAS limit – with full method specification

PFAS are not currently regulated under EU frameworks governing IBA use, while they are common in municipal waste. Given the extreme persistence, mobility and bioaccumulative potential of these compounds, their presence in IBA placed in direct contact with soil and groundwater represents an unacceptable risk without a binding limit.

**A total PFAS limit of 1 µg/kg dry matter (= 1 ng/g dm) should be established. A tolerance of up to 2 ng/g dm may be considered based on monitoring evidence. A value above 5 ng/g dm must not be permitted under any circumstances.**

For this limit to be enforceable and produce comparable results across Member States, four elements must be specified in the regulatory text:

<b>TARGET COMPOUND LIST</b>	<p>At a minimum, the 24 priority PFAS covered by the EU PFAS restriction dossier under REACH, measured individually, plus a total PFAS sum parameter.</p> <p>Short-chain PFAS (C4–C7 PFCAs, PFBS, and analogues) must be explicitly included. Current analytical methods tend to underdetect these compounds; their absence from a target list must not be treated as absence from the material.</p>
<b>ANALYTICAL METHOD</b>	<p>EN 17637 (LC-MS/MS in solid matrices) or ISO 21675.</p> <p>SPE cleanup using graphitised carbon or HLB cartridges must be specified. Different cleanup procedures produce substantially different recoveries; leaving this unspecified means laboratories across Member States generate incomparable results.</p>
<b>LIMIT OF DETECTION (LOD)</b>	<p>≤ 0.02 ng/g dm per individual compound.</p> <p>Reporting "below detection" at a laboratory LOD above 0.02 ng/g dm must not constitute compliance with a 1 ng/g dm limit. The regulatory text must set a maximum permissible LOD, not merely a limit value.</p>

## LEACHATE LIMIT

≤ 0.1 µg/L total PFAS in eluate.

A dry matter limit alone does not address the actual exposure pathway. PFAS are highly mobile and leach readily into soil and groundwater. Leachate must be tested using a dynamic leaching test (e.g. NEN 7375) – not the short-term EN 12457 batch test, which underestimates long-term release.

Note: If monitoring data show that routine IBA samples consistently exceed these limits, the appropriate regulatory response is to suspend IBA use in civil engineering, not to raise the limit. Methodological uncertainty about short-chain PFAS detection is itself a reason for precaution, not for waiving the assessment.

# Recommendation 5: Introduce requirements for microplastics

Microplastics must be explicitly regulated in IBA due to their persistence, environmental mobility, and potential for long-term accumulation in soils, sediments, and aquatic systems. Incineration bottom ash may contain microplastic particles originating from incomplete combustion and fragmentation of plastic waste during incineration and ash handling.

Despite increasing scientific evidence confirming their presence in IBA, microplastics are not addressed in any EU-level framework governing bottom ash use in civil engineering. This is a significant regulatory gap given their persistence and their role as vectors for sorbed contaminants, including heavy metals, POPs and PFAS.

**Microplastics in incineration bottom ash must be regulated as a distinct contaminant class.**

EU legislation should:

- **Establish a precautionary limit value** expressed as: (a) particle number per kg dry matter; and (b) mass concentration (mg/kg dry matter), where technically feasible.
- **Define a harmonised analytical methodology**, including: a minimum particle size threshold (e.g. ≥ 20 µm or lower where technically feasible); polymer identification using FTIR or Raman spectroscopy; and strict quality assurance and contamination control procedures.
- **Require assessment of microplastic leaching and mobilisation** under relevant environmental conditions, including mechanical stress, abrasion, and water infiltration.
- **Ensure periodic review** of analytical methods, detection limits and regulatory thresholds in line with scientific and technical developments.

# Recommendation 6: Require a full ecotoxicological and effect-based bioassay panel

Two categories of testing are required; both are mandatory and no individual test may be waived. Standard ecotoxicological tests assess general acute toxicity. Effect-based methods (EBMs) are additionally required because POPs act via specific receptor-mediated mechanisms at concentrations too low for standard tests to detect.

## 6.a Standard ecotoxicological tests – applied to IBA leachate

Testing must use unadjusted leachate (see Recommendation 7 on pH adjustment). All four organisms are required:

ORGANISM	MATRIX	EXPOSURE	PASS CRITERION
<i>Aliivibrio fischeri</i> ( <i>Vibrio fischeri</i> )	Leachate	15 min and 30 min	Inhibition of bacterial luminescence $\leq$ 25%
<i>Daphnia magna</i>	Leachate	48 hours	Immobilisation $\leq$ 30%
<i>Desmodesmus subspicatus</i>	Leachate	72 hours	Inhibition of algal growth $\leq$ 30% vs control
<i>Lactuca sativa</i>	Leachate	120 hours	Inhibition of root growth $\leq$ 50% vs control

## 6b. Effect-based methods (EBMs) – applied to IBA leachate

Standard acute tests are largely insensitive to dioxins, PCBs, brominated flame retardants and PFAS, which act via receptor-mediated pathways at very low concentrations. The following bioassays must be run in parallel on IBA leachate:

ASSAY	TARGET PATHWAY	PURPOSE
DR-CALUX or CAFLUX	Aryl hydrocarbon receptor (AhR)	Detects combined dioxin-like bioactivity from PCDD/Fs, dl-PCBs and PBDD/Fs as a bioanalytical TEQ cross-check against the chemical limits in Recommendation 5.
ER $\alpha$ -CALUX	Oestrogen receptor $\alpha$ (ER $\alpha$ )	Detects oestrogenic activity from brominated flame retardants and their degradation products.
Nrf2-CALUX	Oxidative stress response (Nrf2)	Detects reactive species and oxidative stress activity in the leachate, capturing toxicity not reflected in receptor-based assays.

**All four standard ecotoxicological tests and all three effect-based assays are mandatory. No test may be waived.**

## Recommendation 7: Prohibit pH adjustment of leachate in ecotoxicity testing of IBA

Relevant ISO standards permit pH adjustment of leachate prior to ecotoxicity testing, but exclusively for materials that contain inorganic binders such as lime, hydraulic lime, cement, or other silicates. This exception does not apply to incineration bottom ash.

**pH adjustment of IBA leachate must be explicitly prohibited for the purposes of ecotoxicity testing. This applies specifically to the *Daphnia magna*, *Aliivibrio fischeri* and *Desmodesmus subspicatus* tests. Laboratory protocols must not apply pH correction to bottom ash samples regardless of the general permissions in the applicable ISO standard.**

Rationale:

- **IBA is not a binder material.** The ISO permission was designed for stabilised waste treated with cement or lime and is technically inapplicable to bottom ash.

- **The natural leachate pH of IBA is often strongly alkaline** – an inherent property reflecting its real environmental behaviour. Testing at adjusted pH produces results that do not represent actual environmental conditions.
- pH adjustment alters the speciation and solubility of heavy metals and organic contaminants, producing artificially favourable ecotoxicity outcomes and concealing genuine hazards.
- Explicit regulatory prohibition is necessary because, in practice, some laboratories have been applying pH adjustment to IBA leachates, undermining the protective function of ecotoxicity testing.

## Summary: Recommended chemical limits for IBA (dry matter)

All values refer to dry matter of matured slag. Green rows indicate parameters not currently regulated at EU level.

PARAMETER	UNIT	RECOMMENDED LIMIT
As (Arsenic)	mg/kg dm	45
Cd (Cadmium)	mg/kg dm	20
Cr (Chromium)	mg/kg dm	200
Cu (Copper)	mg/kg dm	7,000
Hg (Mercury)	mg/kg dm	1
Ni (Nickel)	mg/kg dm	500
Pb (Lead)	mg/kg dm	1,000
Zn (Zinc)	mg/kg dm	10,000
TOC	mg/kg dm	30,000
PAHs ( $\Sigma$ BaP, BbF, BkF, IP)	mg/kg dm	1
<b>PCDD/Fs (17 congeners) + dl-PCBs (12 congeners) + PBDD/Fs (17 congeners)</b>	<b>ng TEQ/kg dm</b>	<b>10</b>
<b>PFAS – dry matter (total, <math>\geq</math> 24 compounds per REACH list)†</b>	<b><math>\mu\text{g}/\text{kg dm}</math> (= ng/g)</b>	<b>1 (tolerance up to 2; max. 5)</b>
<b>PFAS – leachate (total)†</b>	<b><math>\mu\text{g}/\text{L}</math></b>	<b>0.1</b>

Microplastics	Particles/kg dm + mg/kg dm	To be established pending harmonised method
---------------	----------------------------	---

\* † PFAS measured by EN 17637 or ISO 21675; SPE cleanup with graphitised carbon or HLB cartridges; LOD ≤ 0.02 ng/g dm per compound for dry matter; leachate by dynamic leaching test (e.g. NEN 7375), not EN 12457 batch test. If routine monitoring shows widespread exceedance, IBA use in civil engineering must be suspended rather than the limit raised.



Zero Waste Europe (ZWE) is the European network of communities, local leaders, experts, and change agents working towards a better use of resources and the elimination of waste in our society. We advocate for sustainable systems; for the redesign of our relationship with resources; and for a global shift towards environmental justice, accelerating a just transition towards zero waste for the benefit of people and the planet. [www.zerowasteurope.eu](http://www.zerowasteurope.eu)



Zero Waste Europe gratefully acknowledges financial assistance from the European Union. The sole responsibility for the content of this material lies with Zero Waste Europe. It does not necessarily reflect the opinion of the funder mentioned above. The funder cannot be held responsible for any use that may be made of the information contained therein.



Authors: Janek Váhk

Editors: Dorota Napierska, Nanna Cornelsen

Date: June 2026

General information: [hello@zerowasteeurope.eu](mailto:hello@zerowasteeurope.eu)

Media: [news@zerowasteeurope.eu](mailto:news@zerowasteeurope.eu)

Cities-related topics: [cities@zerowasteeurope.eu](mailto:cities@zerowasteeurope.eu)

[www.zerowasteeurope.eu](http://www.zerowasteeurope.eu)

[www.zerowastecities.eu](http://www.zerowastecities.eu)

[www.missionzeroacademy.eu](http://www.missionzeroacademy.eu)

