

# Technical note on classifying and consigning used e-cigarettes

## 1 Description of the waste

E-cigarettes are an electronic device and contain several elements:

- a plastic and/or glass and/or metal casing
- a heating element
- a microprocessor plus possibly a switch and an LED
- a (rechargeable lithium-ion) battery
- e-liquid

E-liquid usually contains nicotine, a known poison and is therefore a good starting point for any assessment. Typical e-liquid (strength 18mg/litre of nicotine) was analysed for SWEEEP-Kuusakoski in November 2020<sup>1</sup>. They were found to contain the following:

- Nicotine
- Benzoic Acid
- Piperonal
- Benzyl alcohol

All these chemicals are listed by the European Chemicals Agency (ECHA)<sup>2</sup> as hazardous above specified concentrations and all are typically present in e-liquid at or above these concentrations. Therefore, e-liquid is itself hazardous and, depending on the proportion of e-liquid remaining, several of these liquid components as well as the other parts of the e-cigarette have the potential to make a waste e-cigarette hazardous.

## 2 Assessment of e-liquid and its effect on the classification of a waste e-cigarette

From the ECHA website, nicotine and benzoic acid are the most hazardous substances contained in e-cigarettes. ECHA lists all the known hazards associated with chemicals. The harmonised<sup>3</sup> classification for these two substances is given in Table 1 below.

Based on these limits and the typical weight of e-cigarettes and e-pods, RWSP concluded in November 2020 that used e-cigarettes would have to contain between 30% and 56% of the e-liquid to be classed as hazardous due to nicotine and/or benzoic acid. An empty e-cigarette contains on average less than 0.25g of e-liquid and therefore it was concluded that on average waste e-cigarettes contain **insufficient** e-liquid to render them a hazardous waste.

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<sup>1</sup> Resource and Waste Solutions, Hazard Assessment Report for E-Cigarette Pods, November 2020 (Client confidential),

<sup>2</sup> <https://echa.europa.eu>

<sup>3</sup> Accepted worldwide under the UN globally harmonised system (GHS) for classification.

**Table 1: Hazard, hazard codes and statements**

Substance	Haz code	Hazard statement	Lower limit conc.
<b>Nicotine</b>			
Acute Tox. 2 (Oral)	H300	Fatal if swallowed	≥ 0.25%
Acute Tox.2 (Inhal.)	H330	Fatal if inhaled	≥0.5%
Acute Tox.2 (Dermal)	H310	Fatal in contact with skin	≥ 2.5%
Aquatic chronic 2	H411	Toxic to aquatic life with long lasting effects	≥ 2.5%
<b>Benzoic Acid</b>			
Skin irrit. 2	H315	Causes skin irritation	≥ 20%
Eye Dam. 1	H318	Causes serious eye damage	≥ 10%
STOT RE 1	H372	Causes damage to organs through prolonged or repeated exposure	≥1% (Indiv.)

Note: hazard codes in grey are not applicable as substances are present below these threshold concentrations

The above hazards mean that appropriate safe procedures are adopted and protective clothing worn to protect the skin from splashes of e-liquid and to prevent or minimise inhalation. Due care needs to be exercised in the handling, transportation and treatment or disposal of e-cigarettes due to the potential hazards arising from e-liquids.

### 3 Assessment of other e-cigarette components

With regards to the other components, it is considered unlikely that any of them will contain materials that give rise to a hazardous property. Even if the microprocessor incorporates p.c.b.s with high levels of toxic heavy metals, such as copper antimony or zinc, these will mainly be present as metals or alloys in massive form or their overall concentration will be below the threshold for hazardous classification and can therefore be discounted in accordance with the technical guidance WM3.

However, it is not possible to rule out the presence of POPs in the form of brominated flame retardants (BFRs) in any of the plastic components or BFRs and other substances in the printed circuit board that might be present in a device.

### 4 The presence of POPs (BFRs) in e-cigarettes

Scientific studies of e-cigarettes have understandably focussed on any hazards to human health from the e-liquid and on the occasional incidence of fire and (even more rare) explosions related mainly to charging the lithium-ion batteries incorrectly.

Binnian et al found<sup>4</sup> diphenyl phosphate (DPhP), bis(1,3-dichloro-2-propyl) phosphate (BDCPP), bis(2-chloroethyl) phosphate (BCEP), and dibutyl phosphate (DBUP) were detected

<sup>4</sup> Int J Environ Res Public Health. 2018 Feb; 15(2): 201. Published online 2018 Jan 25. doi: 10.3390/ijerph15020201, Urinary Metabolite Levels of Flame Retardants in Electronic Cigarette Users: A Study Using the Data from NHANES 2013–2014, Binnian Wei, Maciej L. Goniewicz, Richard J. O'Connor, Mark J. Travers, and Andrew J. Hyland

in the urine of all e-cigarette users<sup>5</sup>. The adjusted geometric mean of BCEP, the metabolite of tris(2-chloroethyl) phosphate (TCEP), was 81% higher than nonusers ( $p = 0.0124$ ) and significantly higher than those for both cigarette and cigar users ( $p < 0.05$ ). This suggests that e-cigarette manufacturers are using organophosphate flame retardants (OPFRs), which are not classified as POPs, in preference to BFRs. However, Shan Shan et al from the Baptist University in Kowloon found moderate to elevated levels of poly-brominated diphenyl ethers (PBDEs) in the aerosols from 5 out of the 13 samples of e-cigarettes<sup>6</sup>.

We therefore consider that in 2018 at least some e-cigarettes sold containing BFRs which are POPs. We have not found any data that indicates whether the concentration of BFRs is above the threshold for consideration as POPs or whether BFRs are no longer used but given the purpose of the BFRs, we consider it is likely that some e-cigarettes will be POPs waste and should be identified accordingly.

## 5 Classification of waste e-cigarettes

Although not law, under Government guidance on the different categories of products are electrical and electronic equipment and therefore WEEE when wastes shows that e-cigarettes are categorised under leisure goods, Category 7<sup>7</sup>.

The legal requirement for waste is that they are classified using the List of Wastes (LoW) and the system for classifying different wastes is set out in WM3<sup>8</sup>. Waste e-cigarettes are discarded electronic equipment.

### 5.1 The List of Wastes

The LoW is arranged in chapters and the instructions for using the LoW states that the first step is to look at Chapters 01 to 12 and 17 to 20. These chapters refer specifically to an industry process or business activity that has produced the waste, and to municipal waste.

Chapter 20 covers municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions. As waste e-cigarettes come from households, they will fall under Chapter 20 as similar wherever they arise provided there is a suitable description in Chapter 20. Chapter 20 contains the following entries:

20 01 35*	discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components
20 01 36	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35

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<sup>5</sup> Only 14 of the total sample were e-cigarette users but the effect was universal.

<sup>6</sup> Journal of Cleaner Production, Volume 171, 10 January 2018, Pages 10-16 Harmful flame retardant found in electronic cigarette aerosol Shan-Shan Chung <sup>a</sup>, Jin-Shu Zheng <sup>a</sup>, Antonio C.S. Kwong <sup>b</sup>, Vienna W.Y. Lai <sup>b</sup>

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<sup>7</sup> <https://www.gov.uk/government/publications/electrical-and-electronic-equipment-eee-covered-by-the-weee-regulations/electrical-and-electronic-equipment-eee-covered-by-the-weee-regulations#consumer>

<sup>8</sup> Environment Agency et al, Waste classification, Guidance on the classification and assessment of waste (1<sup>st</sup> edition v1.2GB), Technical Guidance WM3, October 2021.

## 5.2 Lithium-ion batteries

Lithium-ion batteries are widely recognised as a fire hazard and additionally may contain hazardous substances, such as strong alkalis. However, the List of Waste includes only the following entries:

- 20 01 33\* batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries
- 20 01 34 batteries and accumulators other than those mentioned in 20 01 33

16 06 01\*, 16 06 02\* and 16 06 03\* cover lead batteries, Ni-Cd batteries and mercury-containing batteries respectively. All other batteries (including lithium-ion batteries) are therefore non-hazardous.

## 6 Agreement by the industry forum for approved, authorised treatment facilities (AATF) for a standardised classification approach.

The AATF Forum has interpreted published EA guidance and presented this interpretation to the Environment Agency (EA) as a standardised approach for classification of WEEE. This approach is understood to be based on the project carried out for ICER on WEEE by WRc<sup>9</sup>. WRc are a large, skilled, reputable environmental consultancy. The project reported on sampling different types of WEEE at multiple sites. However, WRc did not sample or analyse any waste e-cigarettes and WRc did not conclude that the report was representative of e-cigarettes, or of all WEEE.

## 7 Hazardous waste consignment note

Any hazardous waste consignment note must describe the waste, give its waste code(s), and list any hazardous substances and hazardous properties associated with them.

From Section 2 above all the following chemicals are typically present in e-cigarettes: nicotine, benzoic acid, piperonal and benzyl alcohol. Whilst nicotine and benzoic acid are the most dangerous, both piperonal and benzyl alcohol are also hazardous but are below the threshold concentrations. For completeness they should be listed on any consignment note.

Any hazardous waste consignment note should also highlight that the waste may also be hazardous due to the suspected concentration of brominated flame retardants which are classified as POPs.

Lithium-ion batteries can also be potentially hazardous but are not classified as hazardous waste. Again this is supported by Government guidance<sup>7</sup>. However, to fulfil its obligations under the Duty of Care, any consignment note or waste transfer note should mention their presence and potential fire risk.

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<sup>9</sup> Keeley-Lopez P, Turrell J and Vernon J, WRc, An assessment of the levels of persistent organic pollutants (POPs) in waste electronic and electrical equipment in England and Wales, March 2020.

Table A1 in Annex A shows the waste section of a hazardous waste consignment note for e-cigarettes with the appropriate description, the relevant codes, composition and the hazardous properties we consider apply to waste e-cigarettes, based on their maximum concentrations from manufacturers, legislation and analytical data and the relevant information on their hazard classification (under the GB Classification, Labelling and Packaging Regulations<sup>10</sup> and EU REACH and UK REACH<sup>11</sup>).

Table A2 in Annex A is partly based on the description, composition and hazardous properties agreed for small domestic WEEE by the forum for AATF and presented to the EA. The AATF classification applies only to the solid substances: antimony trioxide and poly-brominated diphenyl ethers (PBDEs). The List of Waste codes are identical but the hazardous components and hazardous properties differ from those we would recommend for waste e-cigarettes. We have considered the AATF classification carefully and whilst we agree with the POPs classification, we can find no evidence to support the use of other hazardous properties for waste consisting solely of e-cigarettes. The remainder of Table A2 (for e-liquid) is based on RWSP's classification in Table A1.

## 8 Conclusions

Waste e-cigarettes are discarded electronic equipment. Based on the amount of e-liquid likely to be contained in a waste e-cigarette, they are not hazardous due to the presence of e-liquid. However, we consider that some waste e-cigarettes are likely to be classified as hazardous due to the presence of POPs, as outlined in section 4 above and therefore any load of waste e-cigarettes that contains POPs should be classified as 20 01 35\* and mixed loads should additionally be classified as 20 01 36 to cover the non-hazardous element. This classification is supported by non-legally binding Government guidance<sup>12</sup> and concurs with the coding agreed between AATF and the EA for small mixed WEEE.

As a potentially hazardous waste, any movement of waste e-cigarettes should be accompanied by a properly completed hazardous waste consignment note. Table A1 in Annex A gives the coding, composition and hazardous properties for waste e-cigarettes based on the available evidence, including (from our 2020 study) a safety data sheet from a manufacturer and the chemical analysis and hazardous waste assessment of e-liquids.

Table A2 combines the AATF coding, composition and hazardous properties for small mixed WEEE with the composition and hazardous properties of e-liquids derived for Table A1. As outlined above, apart from POPs, we have not been able to find any evidence to support the use of the details given for the solid substances in Table A2 on hazardous waste consignment notes produced specifically for waste e-cigarettes, particularly with regards to the hazardous properties listed.

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<sup>10</sup> The Chemicals (Health and Safety) and Genetically Modified Organisms (Contained Use) (Amendment etc.) (EU Exit) Regulations 2019 No. 720 as amended by The Chemicals (Health and Safety) and Genetically Modified Organisms (Contained Use) (Amendment etc.) (EU Exit) Regulations 2020

<sup>11</sup> European Parliament and Council Regulation (EC) No 1907/2006 (Corrigendum 29 May 2007) and Directive 2006/121/EC (Corrigendum 29 May 2007).

<sup>12</sup> <https://www.gov.uk/how-to-classify-different-types-of-waste/electronic-and-electrical-equipment>

Ultimately however whether the details in Table A2 or the details in Table A1 are used for any consignment note is a decision for the producer of the waste.

## Resource and Waste Solutions

21 October 2022

## Annex A: Descriptions and coding for hazardous waste consignment notes

Table A1: Proposed details for hazardous waste consignment note based on evidence detailed in this technical note

Description of waste	List of wastes (EWC code)	Quantity (kg) Approx.	The chemical/biological components of the waste and their concentrations		Physical Form	Hazard property code(s)
			Component	Typical max. concentration (%)*		
e-cigarettes	20 01 35* and 20 01 36	To be added	Nicotine	2%	Liquid	HP5 and HP6
			Benzoic acid	1%		
			Piperonal	0.5%		
			Benzyl alcohol	0.5%		
			PBDE-POPs	0.1 - 23% (overall - assumed)	Solid	POPs

\* Concentrations of liquids given in e-liquid only. On average used e-cigarettes will be below the relevant hazardous waste thresholds.

Table A2: Details for hazardous waste consignment note based on a combination of the agreement for classification of small mixed WEEE by the AATF forum and the classification details of the e-liquid from Table A1 above.

Description of waste	List of wastes (EWC code)	Quantity (kg) Approx.	The chemical/biological components of the waste and their concentrations		Physical Form	Hazard property code(s)
			Component	Typical max. concentration* (%)		
e-cigarettes (WEEE category 7) dual coded 20 01 35* and 20 01 36	20 01 35* and 20 01 36	To be added	Nicotine	2%	Liquid	HP5 and HP6
			Benzoic acid	1%		
			Piperonal	0.5%		
			Benzyl alcohol	0.5%	Solid	HP5, HP6, HP7 and HP14 POPs
			Antimony trioxide	0.1 - 10%		
			PBDE-POPs	0.1-23%		

\* Concentrations of liquids given in e-liquid only. On average used e-cigarettes will be below the relevant hazardous waste thresholds.