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7 April 2025

The Hon Penny Sharpe MLC
Minister for Climate Change
Minister for Energy
Minister for the Environment and
Minister for Heritage
office@sharpe.minister.nsw.gov.au

Dear Minister Sharpe,

Re: International practice standards and controls for energy from waste facilities (DOC24/919778)

In 2019 the (then) Minister for Energy and Environment, the Hon Matt Kean MP requested the Office of Chief Scientist & Engineer (OCSE) to establish a cross-agency working group on Energy from Waste (EfW) in NSW to adopt international best practice standards and controls to protect human health and the environment. The report was published in May 2020 with additional advice published in November 2020. The independent expert review recommended reviewing best practice air emission limits within three years.

In December 2024 you requested OCSE to consider any further advice on international best practice standards and controls for EfW facilities, including:

- Technical and practical feasibility for EfW facilities to meet the air emission standards if performance is averaged over 1-hour periods
- Technical feasibility to include confidence intervals for measuring and monitoring continuous emissions from EfW facilities, and
- The best ammonia slip emission standard for energy from waste facilities to protect human health and the environment.

In summary, our analysis finds the following:

1. Emission limits in NSW remain among the most stringent, compared to other jurisdictions. Existing facilities have less stringent emissions requirements than new facilities. There are currently no updates to EU or US practice standards and controls for EfW facilities.
2. It may be appropriate to consider amending relevant regulations to accommodate flexibility in the application of averaging periods, particularly where this enables more robust or representative monitoring of emissions. Any such change would need to ensure consistency with the original intent of the emissions limits to safeguard human health and reduce negative environmental impacts. Regulatory settings on average periods should also consider technical and operational practicability and associated costs imposed on industry. Any regulatory changes should be made in consultation with EPA, NSW Health, other government agencies and industry
3. The regulator could consider adopting measurement of uncertainty for compliance assessment based on feedstock composition and instrumentation uncertainty. This should ideally be based on evaluation of emission data from facilities that apply best practice for process design and emission control



Office of the Chief Scientist & Engineer

4. It is possible to meet NSW emission standards for ammonia at least by using selective non-catalytic reactor (SNCR) with wet abatement techniques or a hybrid system of selective catalytic reactor (SCR) and SNCR. Techno-economic analysis (TEA) should be carried out to determine which technology to employ to meet the emission standards

Kind Regards

Hugh Durrant-Whyte
Chief Scientist & Engineer

Updated advice on Energy from Waste (EfW)

Background

In 2019 the (then) Minister for Energy and Environment, the Hon Matt Kean MP requested the Office of Chief Scientist & Engineer (OCSE) to establish a cross-agency working group on Energy from Waste (EfW) in NSW to adopt international best practice standards and controls to protect human health and the environment. The report was published in May 2020 with additional advice in November 2020. The independent expert review recommended reviewing best practice air emission limits within three years.

In December 2024 you requested the Office of Chief Scientist & Engineer (OCSE) to consider any further advice on international practice standards and controls for energy from waste facilities and to provide advice on the specific matters listed below:

- Technical and practical feasibility for EfW facilities to meet the air emission standards in Table 1 of the NSW Energy from Waste Policy statement if performance is averaged over 1-hour periods
- Technical feasibility to include confidence intervals for measuring and monitoring continuous emissions from EfW facilities, and
- The best ammonia slip emission standard for energy from waste facilities to protect human health and the environment.

Air emission findings from OCSE Energy from Waste Report 2020 (the Review)

To address the Terms of Reference of the 2020 Review, OCSE commissioned the Waste Transformation Research Hub (University of Sydney) to provide independent expert advice to comment on the draft best practice air emissions limits outlined in the NSW framework and comment on whether these limits are internationally the most stringent and reflect technical best practice.

The findings from the Review which led to the *NSW Energy from Waste Policy Statement 2021* emissions standards are as follows:

- *NSW Protection of the Environment Operations (Clean Air) Regulation 2010* (the Clean Air Regulation) sets out the maximum emissions permissible for an industrial source located anywhere in NSW. Any new EfW facilities would belong to 'Group 6' limits with the most stringent emissions standards in the regulation (see **Table 1**). The emissions standards are based on levels that are achievable through the application of reasonably available technology and good environmental practices, but do not consider site specific feature such as meteorology and background air quality.
- Schedule 5, Part 2 of the Clean Air Regulation sets out the required averaging period for each regulated pollutant. The majority are an averaging period of one hour.
- EPA could set point source emission limits for EfW facilities in Environment Protection Licenses (EPLs) that are more stringent than the 'Group 6' emissions to protect the health and amenity of the surrounding community.
- The independent expert review showed that the NSW draft limits for EfW facilities are the most stringent when compared to international best practice in 8 out of 10 pollutant categories. The expert review proposed limit revisions of hydrogen fluoride and heavy metals to align with the world's best practice based on the 2019 EU limits.
- As a result, the finalised *NSW Energy from Waste Policy Statement 2021* emissions standards are the most stringent compared to other jurisdictions (see **Table 1**), with the majority of regulated pollutants subject to an averaging period of one hour.

Table 1. Air emission limits in mg/m³ (unless indicated) in international jurisdictions and emission standards in the Clean Air Regulation and Energy from Waste Policy Statement 2021.

Pollutant	Averaging period	EU Directive 2010 (100% compliance)	EU-BAT AEL	China Waste Incineration Policy 2014	US Waste combustion guidelines 2006 [a]	Proposed amendments for US LMWC [a,b]	NSW Regulatory limit [c]	NSW Energy from Waste Policy Statement 2021
Total solid	0.5-1 hour	30	-	30	-	-	36	20
	24 hours	10	2-5	20	16	3.8	-	-
Gaseous organic	1 hour	-	-	-	-	-	28	20
	24 hours	-	3-10	-	-	-	-	-
Chloride and compounds	0.5-1 hour	60	-	60	-	-	71	50
	24 hours	10	2-7	50	32	9.7	-	-
Fluoride and compounds	0.5-1 hour	4	-	-	-	-	-	4
	24 hours	1	1	-	-	-	-	-
Mercury	0.5-8 hours	0.05	0.01-0.04	0.05	0.04	0.005	0.1	0.04
Heavy metals (total)	0.5-8 hours	0.5	0.3	1	0.1 (lead)	0.01(lead)	-	0.3
Cadmium and thallium	0.5-8 hours	0.05	0.02	0.1	0.01	0.0008	0.1	0.02
Sulphur dioxide	0.5-1 hour	200	-	100	-	-	-	100
	24 hours	50	40	80	66	31	-	-
Nitrogen oxide	0.5-1 hour	400	-	300	-	-	250	250
	24 hours	200	150	250	240	80	-	-
Dioxins (ng/m ³)	1-8 hours	0.1	0.01-0.1	0.1	10	-	0.1	0.1
Carbon monoxide	10 min	150	-	-	-	-	-	-
	30 min	100	-	-	-	-	-	-
	1 hour	-	-	100	-	-	89	80
	4 hours	-	-	-	49-146	16-96	-	-
	24 hours	50	50	80	98-244	-	-	-
Ammonia	24 hours	-	2-10	-	-	-	-	5

[a] Original unit is in standard condition of 293.15 K, 7% O₂. The limit has been converted into 273.15 K, 101.325 kPa (1 atm), 11% O₂ using the following formula: concentration * (20.9-11)/ (20.9-7)*293.15/273.15. Conversion factor from ppmv to mg/dscm is molecular weight/ 22.4.

[b] Limits are based on emission limits for new sources

[c] Group 6 limits defined under the NSW *Protection of the Environment Operations (Clean Air) Regulation 2010*. The original reference condition for fuel burning equipment is 273.15 K, 101.325kPa, 7% O₂. The limit has been converted to 273.15K, 101.325kPa, 11% O₂ using the following formula: concentration * (20.9-11)/(20.9-7).

Response – 2025 updated advice

1. Update in international practice standards and controls for energy from waste facilities

Emission limits in NSW remain one of the most stringent compared to other jurisdictions. Existing facilities in NSW have less stringent requirement than new sources. There are currently no updates to EU or US practice standards and controls for energy from waste facilities (**Table 2**). US EPA is proposing new emission limits for large municipal waste combustors (LMWC), as shown in **Table 1**. If approved, these would require existing sources to achieve compliance within 5 years after promulgation of emission guidelines, or 3 years after the plans are approved, whichever is earlier.

Table 1. International practice standards and controls for energy from waste facilities

Jurisdiction	Standards and controls	Update since 2020 ¹
EU	2019 EU Best Available Technique (BAT) Document for Waste Incineration	None
	2010 EU Directive on Industrial Emissions (Directive 2010/75/EU)	None
USA	40 Code of Federal Regulation – Standard of Performance for New Stationary Sources	
	Large Municipal Waste Combustors (LMWC) ² : New Source Performance Standards (NSPS)	Proposed 2023 amendments ³ include: • Revisions to all emission limits for existing sources, except for carbon monoxide limits for two subcategories of combustors, and all emission limits for new sources. • New cost-effective NOx emission controls. • Removal of exemptions and exclusions for startup, shutdown and malfunction. Hence, the proposed limits would apply at all times.
	Emission Limit for New Small Municipal Waste Combustion	None

¹ Relevant to EfW facilities

² LMWC combust > 250 tons of waste per day

³ <https://www.epa.gov/system/files/documents/2024-03/epas-propsoed-amendments-to-large-municipal-waste-combustor-rule-informational-webinar.pdf>

2. Averaging period

As noted in the Expert Paper commissioned for the original Review in 2020, periodical averaging (0.5 -1 hour) will result in a higher frequency of fluctuations, whereas daily averaging would dampen the fluctuation. The current *NSW Energy from Waste Policy Statement* uses 1-hour averaging during normal operating condition (NOC). This averaging time is appropriate for NOC only because steady-state operation results in smaller deviations or spikes in emissions. The exemptions for start-up and shutdown periods (other-than-normal operating condition, OTNOC) are allowed under Clause 54 of *Protection of the Environment Operations (Clean Air) Regulation 2022* with no specified requirements.

Other jurisdictions adopt either dual (periodical and daily) limits or periodical limits only. Technical and practical considerations for longer averaging time would require review of real data, which is currently not available as there are no operational EfW facilities in NSW.

It may be appropriate to consider amending relevant regulations to accommodate flexibility in the application of averaging periods, particularly where this enables more robust or representative monitoring of emissions. Any such change would need to ensure consistency with the original intent of the emissions limits to safeguard human health and reduce negative environmental impacts. Regulatory settings on average periods should also consider technical and operational practicability and associated costs imposed on industry. Any regulatory changes should be made in consultation with EPA, NSW Health, other government agencies and industry.

3. Confidence intervals

The use of confidence intervals for continuous emission monitoring (CEM) in some jurisdictions is related to meeting quality assurance (QA) criteria when monitoring and determining compliance. For instance, for a power plant categorised as a large combustion plant under the EU Directive 2010/75/EU⁴, the CEM system measurement uncertainty for SO₂ and NO_x shall not exceed 20% of the emission limit values at 95% confidence level. The USA also specifies QA requirements for gas continuous emission monitoring systems for compliance determination.⁵ This is achieved by introducing a reference gas of known concentrations and reading the result from CEM system to assess its accuracy.

For compliance assessment, there are different approaches in EU countries. The most common approach is to subtract the measurement uncertainty from the result and to use the resulting value for further assessment.⁶

NSW currently does not use adjusted data for comparison. The regulator could consider adopting measurement of uncertainty for compliance assessment based on feedstock composition and instrumentation uncertainty. This should ideally be based on evaluation of emission data from facilities that apply best practice for process design and emission control.

⁴ Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02010L0075-20240804>

⁵ <https://www.epa.gov/emc/procedure-1-quality-assurance-requirements-gas-continuous-emission-monitoring-systems-used>

⁶ Brinkmann, T et al., *JRC Reference Report on Monitoring of Emissions to Air and Water from IED Installations* (2018) Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control)

4. Ammonia slip

Ammonia is used to react with NO_x pollutants to form water vapour and nitrogen gas using selective non-catalytic reactor (SNCR) or selective catalytic reactor (SCR). However, the efficiency rate of the reaction is never perfect, resulting in release of unreacted ammonia into the atmosphere - known as ammonia slip.

SCR can achieve an efficiency rate of up to 95%, but it is more costly than SNCR - which can only achieve up to 70% efficiency. SNCR can be used in combination with SCR or wet scrubbers to reduce NO_x emissions while limiting emissions of other gases including ammonia.

The comparison between the EU 2019 BAT-AEL and NSW emission standards in **Table 3** shows that NSW has more stringent requirement for ammonia emission. It is possible to meet NSW emission standard for ammonia at least by using SNCR with wet abatement techniques or a hybrid system of SCR and SNCR. Techno-economic analysis (TEA) should be carried out to determine which technology to employ to meet the emission standards.

Table 2. Comparison between EU 2019 BAT-associated emission levels (AEL) and NSW emission standards

Gas	Averaging period	BAT-AEL (mg/m ³)*		NSW emission standard (mg/m ³)
		New plant	Existing plant	
Nox	24 hours	50-120 ^a	50-150 ^b	
	1 hour			250
NH ₃	24 hours	2-10 ^a	2-10 ^{a,c}	5

*The unit for BAT- AEL is mg/Nm³ which indicates standard conditions at a temperature of 273.15 K and a pressure of 101.3 kPa and normalised for a reference oxygen level of 11%. These standards also apply to NSW emission standard.

[a] The lower end of BATAEL range can be achieved when using SCR.

[b] The higher end of BAT-AEL range is 180 mg/m³ where SCR is not applicable.

[c] For existing plants fitted with SNCR without wet abatement techniques, the higher end of the BAT-AEL range is 15 mg/m³.

5. Energy from waste facilities in Australia

The list of the EfW facilities in Australia is given in **Table 4**. Three EfW facilities have been approved for construction, and two of the projects (East Rockingham and Kwinana facilities in WA), were expected to complete by the end of 2024. There are currently no published data on the emission reporting for the commissioned facilities in WA. The EfW facilities in WA and Victoria all comply with the daily emission limits based on *2010 EU Directive*, whereas the planned EfW facility in NSW would need to comply with hourly emissions limits in the *NSW Energy from Waste Policy Statement 2021*.

Table 3. Proposed and commissioned EfW facilities in Australia

State	Facility Name	Waste processing capacity (tonnes per year)	Energy generation	Companies involved	Status	Emission standard
WA	East Rockingham Resource Recovery Facility	300,000	28.9 MW (power for 36k homes)	Veolia - waste supply, operations and maintenance Hitachi Zosen Inova – operation and maintenance	Operating (?) Emission reporting here	Directive 2010/75/EU – daily averaging method
WA	Kwinana Energy Recovery	460,000	38 MW (power for 50k homes)	Acciona – owner Keppel Seghers – furnace, boiler and flue gas treatment technology provider Veolia - Waste supply and operation	Operating (?) First fire on 2 Sep 2024	Directive 2010/75/EU – daily emission limit
VIC	Maryvale Energy from Waste Facility	Stage 1: 325,000 Stage 2: 650,000 (80% municipal solid waste and 20% C&I waste)		Opal Australian Paper – Maryvale paper mill owner and EfW facility owner Veolia - Plant development, operation and maintenance Masdar Tribe Australia – plant development Cobra – technology provider Babcock & Wilcox – technology partner	In development	Directive 2010/75/EU – daily emission limit
NSW	Woodlawn Advanced Energy Recovery Centre	380,000	30 MW (power for 40k homes)	Veolia - Plant development, operation and maintenance	Planning	NSW Energy from Waste Policy Statement 2021 -hourly emission limit

Note that a Processed Engineered Fuel (PEF) facility in Wetherill Park which is co-owned by Cleanaway and ResourceCo turns waste with high biomass content into refuse-derived fuel (RDF), some of which is used by Boral to substitute coal to power their cement manufacturing in Berrima.⁷ The stack emission limits in Boral's Berrima facility are higher than that in *NSW Energy from Waste Policy Statement 2021* because the facility is considered as pre-existing and therefore not defined as an EfW facility under current regulations. Recent emissions data (2023) indicates the facility is nevertheless compliant with limits in the relevant EPL (Table 5). At the end of 2024, Boral's Berrima Cement Works upgraded its facility to increase RDF usage from 30% substitution to enable 60% increase over the next three years.⁸ It is unclear whether there are any changes to their emission limits following this upgrade.

Table 4. Stack emission results based on data collected on 18 April 2023 at Berrima Cement. This result is compliant with the EPL limits. Source: [Boral Cement Limited, Berrima Works, Non-Standard Fuels Pollutant Tracking – First Half Year Result, April 2023](#).

Parameter	Unit	Limits	18/04/2023 R014636
Mercury	mg/m3	0.05	0.0047
Type 1 and type 2 substances	mg/m3	0.5	<0.034
Solid particles	mg/m3	50	19
Nitrogen oxides	mg/m3	1250	790
Cadmium and Thallium	mg/m3	0.05	<0.0024
Chlorine	mg/m3	50	<0.06
Dioxine and Furans (I-TEQ middle bound)	ng/m3	0.1	0.0074
Hydrogen chloride (HCl)*	mg/m3	10	0.15
Hydrogen fluoride	mg/m3	1	0.074
Sulfur dioxide	mg/m3	50	6.1
Sulfuric acid mist and sulfur trioxide	mg/m3	50	5.3
Volatiles organic compounds	mg/m3	40	2.5

⁷ <https://www.cefc.com.au/media/media-release/cefc-welcomes-opening-of-new-fuel-from-waste-plant-to-transform-industrial-and-commercial-waste/>

⁸ <https://www.boral.com.au/berrima-cement-works-upgraded-carbon-reducing-technology-officially-opens>