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US EPA's Revised Air Emissions Limits for New Large Municipal Waste Combustors

Proposed Regulations, Emissions Limits in Europe, and Technology Options

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US EPA's Revised Air Emissions Limits for New Large Municipal Waste Combustors

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TABLE 3—COMPARISON OF NEW SOURCE LIMITS FOR 2006 LARGE MWC RULE AND THE PROPOSED EMISSION LIMITS FOR NEW SOURCES

Pollutant	Units of measure	2006 NSPS (current) limits	Proposed subcategory NSPS limits		
			MB/WW	MB/RC	RDF/S
Cd	ug/dscm @7 percent O_2	10	1.1		
Pb	ug/dscm @7 percent O_2	140	13		
PM	mg/dscm @7 percent O_2	20	4.9		
Hg	ug/dscm @7 percent O_2	50	6.1		
PCDD/PCDF	ng/dscm @7 percent O_2	13	1.8		
HCl	ppmdv @7 percent O_2	25	7.8		
SO_2	ppmdv @7 percent O_2	30	14		
NO_X [a]	ppmdv @7 percent O_2	150	50		
CO	ppmdv @7 percent O_2	[b] 50–150	16		100

[a] NO_X limit based on 50 ppm (24 hour) permitted limit for units currently equipped with SCR control devices.
[b] Range in limits based on combustor type. MB/WW (100); RDF/S (150); Modular starved air or modular excess air (50).

		MACT_2024-00747.pdf Table 3			Conversion to units used in IED (Industrial Emissions Directive)		Comparison with European emission limit values defined in the IED (Industrial Emissions Directive) incl. BAT conclusions 2019 → Daily average value or average from spot sampling [*1]				
COMBUSTION-RELATED POLLUTANTS											
- Carbon monoxide	CO	16.0	ppmdv @ 7% O_2	➡	14.3	mg/m^3 STP, dry, 11% O2	Daily average value for CO	10	-	50	mg/m^3 STP, dry, 11% O2
- Total organic carbon	TOC	*N.A.*					Daily average value for TOC	3	-	10	mg/m^3 STP, dry, 11% O2
NITROGEN COMPOUNDS											
- Nitrogen oxides	NOx	50.0	ppmdv @ 7% O_2	➡	49.1	mg/m^3 STP, dry, 11% O2	Daily average value for NOx [*2]	50	-	120	mg/m^3 STP, dry, 11% O2
- Ammonia	NH_3	*N.A.*					Daily average value for NH_3	2	-	10	mg/m^3 STP, dry, 11% O2
ACID GASES											
- Hydrogen fluoride	HF	*N.A.*					Daily average value for HF		<	1	mg/m^3 STP, dry, 11% O2
- Hydrogen chloride	HCl	7.8	ppmdv @ 7% O_2	➡	9.1	mg/m^3 STP, dry, 11% O2	Daily average value for HCl	2	-	6	mg/m^3 STP, dry, 11% O2
- Sulphur dioxide	SO_2	14.0	ppmdv @ 7% O_2	➡	28.6	mg/m^3 STP, dry, 11% O2	Daily average value for SO_2	5	-	30	mg/m^3 STP, dry, 11% O2
DUST AND DUST-BOUND HEAVY METALS											
- Dust / particulate matter	PM	4.9	mg/dscm @ 7% O_2	➡	3.5	mg/m^3 STP, dry, 11% O2	HMV for total dust	2	-	5	mg/m^3 STP, dry, 11% O2
- Cadmium	Cd	1.1	µg/dscm @ 7% O_2	➡	0.8	$µg/m^3$ STP, dry, 11% O2	Spot sampl. for Cd + Tl	5	-	20	$µg/m^3$ STP, dry, 11% O2
- Lead	Pb	13.0	µg/dscm @ 7% O_2	➡	9.3	$µg/m^3$ STP, dry, 11% O2	Spot sampl. for Σ Sb - V [*3]	10	-	300	$µg/m^3$ STP, dry, 11% O2
MERCURY AND DIOXINS / FURANS											
- Mercury	Hg	6.1	µg/dscm @ 7% O_2	➡	4.4	$µg/m^3$ STP, dry, 11% O2	Daily avg. or spot sampl. for Hg [*4]	5	-	20	$µg/m^3$ STP, dry, 11% O2
- Dioxins / furans	PCDD/F	1.8	ng/dscm @ 7% O_2	➡	1.3	ng/m^3 STP, dry, 11% O2	Spot sampling for PCDD/F	0.01	-	0.06	ng/m^3 STP, dry, 11% O2

Abbrevations for units:

a) ppmdv = Parts per million by dry volume

b) dscm = Standard cubic meter of dry gas, i.e. m^3 STP, dry

Notes:

*1 Sampling periods:

a) For PCDD/F and PCB's: Sampling period = 6 - 8 hours

b) For all other pollutants: Sampling period = min. 30 min. → Avg. of 3 cons. meas.

*2 Nitrogen monoxide (NO) + nitrogen dioxide (NO_2), expressed as NO_2

*3 Σ Sb - V = Sb + As + **Pb** + Cr + Co + Cu + Mn + Ni + V

*4 Can be defined as daily average value or as average over a sampling period

Reference for European Standards

Emission limit values (ELV's)

Industrial Emissions Directive IED (2010/75/EU), incl. BAT conclusions 2019 ➡ Upper range for new plants

BAT associated emission levels (BAT-AEL) for new plants (upper range values) according to the latest BAT conclusions (published 03.12.2019)

Substance	Base unit	Daily average	Half-hourly avg. *2		10 min. average	Sampling period *3
			100%	97%		
Total dust	mg/m³ STP, dry, 11% O2	5	30	10	-	-
Hydrogen chloride (HCl)	mg/m³ STP, dry, 11% O2	6	60	10	-	-
Hydrogen fluoride (HF)	mg/m³ STP, dry, 11% O2	1 *4	4	2	-	1 *4
Sulphur dioxide (SO_2)	mg/m³ STP, dry, 11% O2	30	200	50	-	-
Gaseous + vaporous organic substances, expressed as total organic carbon (TOC) *1	mg/m³ STP, dry, 11% O2	10	20	10	-	-
Carbon monoxide (CO) *1	mg/m³ STP, dry, 11% O2	50	100	-	150	-
Nitrogen monoxide (NO) + nitrogen dioxide (NO_2) expressed as NO_2 *1	mg/m³ STP, dry, 11% O2	120	400	200	-	-
Ammonia (NH_3)	mg/m³ STP, dry, 11% O2	10	-	-	-	-
Cadmium + Thallium (Cd + Tl)	µg/m³ STP, dry, 11% O2	-	-	-	-	20
Mercury (Hg) + its compounds	µg/m³ STP, dry, 11% O2	20 *4	35	-	-	20 *4
Σ heavy metals incl. comp. (Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V)	µg/m³ STP, dry, 11% O2	-	-	-	-	300
Dioxins and furans (PCDD/F)	ng/m³ STP, dry, 11% O2	-	-	-	-	0.04
PCDD/F and dioxin-like PCB's	ng/m³ STP, dry, 11% O2	-	-	-	-	0.06

*1 Emission limit values for total organic carbon (TOC) and carbon monoxide (CO) are not influenced by the specified flue gas treatment system, but only by the combustion process. The same is true for nitrogen oxides (NOx), in case a SNCR system (e.g. HZI DyNOR) is used.

*2 With the exception of mercury, no half-hourly average values are specified in the WI-BREF regulation. But since IED (2010/75/EU) is still valid, definitions of half-hourly values remain also valid and must be considered.

*3 The following sampling periods shall be applied to all substances which are only measured during a specific period:
a) For PCDD/F and PCB's: Sampling period = 6 - 8 hours
b) For all other pollutants: Sampling period = min. 30 min. → Average value of 3 consecutive measurements

*4 According to the new BREF regulation (published 03.12.2019), emission limit values for hydrogen fluoride (HF) and mercury (Hg) can be defined either as daily average values or as average values over a sampling period.

Emission limit values (ELV's)

Industrial Emissions Directive IED (2010/75/EU), incl. BAT conclusions 2019 ➡ Lower range for new plants

BAT associated emission levels (BAT-AEL) for new plants (lower range values) according to the latest BAT conclusions (published 03.12.2019)

Substance	Base unit	Daily average	Half-hourly avg. *2		10 min. average	Sampling period *3
			100%	97%		
Total dust	mg/m³ STP, dry, 11% O2	2	30	10	-	-
Hydrogen chloride (HCl)	mg/m³ STP, dry, 11% O2	2	60	10	-	-
Hydrogen fluoride (HF)	mg/m³ STP, dry, 11% O2	1 *4	4	2	-	1 *4
Sulphur dioxide (SO_2)	mg/m³ STP, dry, 11% O2	5	200	50	-	
Gaseous + vaporous organic substances, expressed as total organic carbon (TOC) *1	mg/m³ STP, dry, 11% O2	3	20	10	-	-
Carbon monoxide (CO) *1	mg/m³ STP, dry, 11% O2	10	100	-	150	-
Nitrogen monoxide (NO) + nitrogen dioxide (NO_2) expressed as NO_2 *1	mg/m³ STP, dry, 11% O2	50	400	200	-	-
Ammonia (NH_3)	mg/m³ STP, dry, 11% O2	2	-	-	-	-
Cadmium + Thallium (Cd + Tl)	µg/m³ STP, dry, 11% O2	-	-	-	-	5
Mercury (Hg) + its compounds	µg/m³ STP, dry, 11% O2	5 *4	35	-	-	5 *4
Σ heavy metals incl. comp. (Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V)	µg/m³ STP, dry, 11% O2	-	-	-	-	10
Dioxins and furans (PCDD/F)	ng/m³ STP, dry, 11% O2	-	-	-	-	0.01
PCDD/F and dioxin-like PCB's	ng/m³ STP, dry, 11% O2	-	-	-	-	0.01

*1 Emission limit values for total organic carbon (TOC) and carbon monoxide (CO) are not influenced by the specified flue gas treatment system, but only by the combustion process.

*2 With the exception of mercury, no half-hourly average values are specified in the WI-BREF regulation. But since IED (2010/75/EU) is still valid, definitions of half-hourly values remain also valid and must be considered.

*3 The following sampling periods shall be applied to all substances which are only measured during a specific period:
a) For PCDD/F and PCB's: Sampling period = 6 - 8 hours
b) For all other pollutants: Sampling period = min. 30 min. → Average value of 3 consecutive measurements

*4 According to the new BREF regulation (published 03.12.2019), emission limit values for hydrogen fluoride (HF) and mercury (Hg) can be defined either as daily average values or as average values over a sampling period.

US EPA's Revised Air Emissions Limits for New Large Municipal Waste Combustors

Limits That Can Be Met With Current Technologies

Emission	Units	Limit	Technology
Particulate Matter (PM)	mg/dscm@7%O2	4.9	Semi-dry system with Fabric Filter Baghouse
Sulfur Dioxide (SO2)	ppmdv@7%O2	14	Lime & Semi-Dry system
Hydrogen Chloride (HCl)	ppmdv@7%O2	7.8	Lime & Semi-Dry system
Nitrogen Oxides (NOx)	ppmdv@7%O2	50	Catalyst and Aqueous Ammonia (SCR)
Dioxins & Furans	ng/dscm@7%O2	1.8	Furnace residence time, PAC and SCR.
Mercury (Hg)	µg/dscm@7%O2	6.1	Powdered Activated Carbon (PAC)

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Limits That Require Additional Research

Emission	Units	Limit	Technology
Carbon Monoxide (CO)	ppmdv@7%O2	16	Can be achieved only if sampling is based on a 30-day period.
Cadmium (Cd)	µg/dscm@7%O2	1.1	TBD
Lead (Pb)	µg/dscm@7%O2	13	TBD

During combustion, metals react with oxygen, sulphur, chlorine and other elements to form non-volatile oxides (e.g. PbO, CdO), chlorides (e.g. $PbCl_2$, $ZnCl_2$), and sulfates (e.g. $PbSO_4$ and $ZnSO_4$). Remaining metal vapours will also re-condense on existing fly ash particles when the flue gas cools down. Thus, the heavy metals are deposited with fly ash, and the main techniques for removal of heavy metals are those applicable to particulate removal. It is possible that additional stages of PM removal would be effective in reduction of Cd and Pb. Additional research is required.

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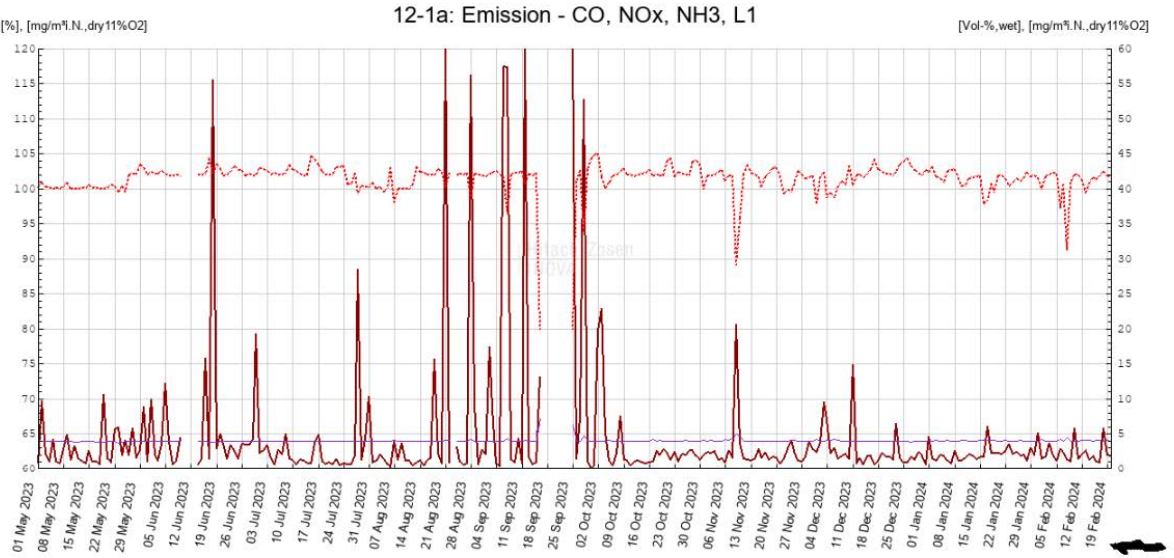
CO Emissions for Recent 1000 TPD Combustion Line



Signal		#values	mean	stdev	Min	Max
Filter: &r_fm_LveStm_L1 >= 70 %						
Conc NOx EmiMeas, 1CFB40CQ901XE01	[mg/m³i.N.,dry11%O2]	283	171.10	21.20	79.71	190.90
Live Steam Flow relative to 100% MCR&r_fm_LveStm_L1	[%]	283	101.41	2.49	79.95	105.03
Conc NH3 Comp EmiMeas, 1CFB43CQ901XE01	[mg/m³i.N.,dry11%O2]	283	0.07	0.21	0.00	1.76
Conc CO Comp EmiMeas, 1CFB50CQ901XE01	[mg/m³i.N.,dry11%O2]	283	5.72	23.60	0.19	357.60
Conc O2 OutlHd Blr QTI, 1HBK10CQ001XQ01, &cv_O2_Blr_out_L1	[Vol-%,wet]	283	4.05	0.26	3.75	7.21

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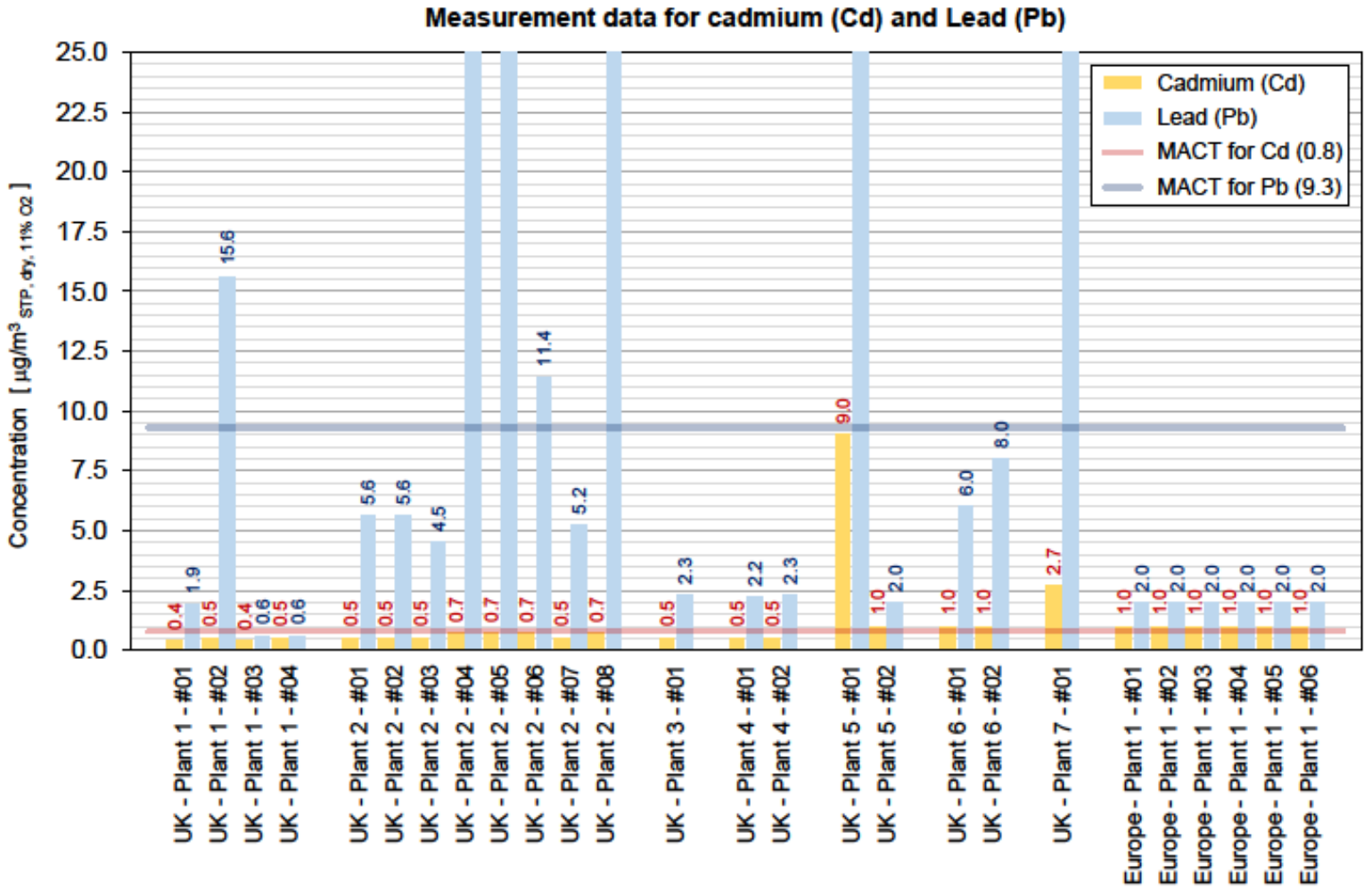

Main Components of the SemiDry Process

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❶ Circulating fluidised bed reactor (CFB reactor)

❷ Fabric filter for solid-gas separation
(filter design from Kanadevia Inova)

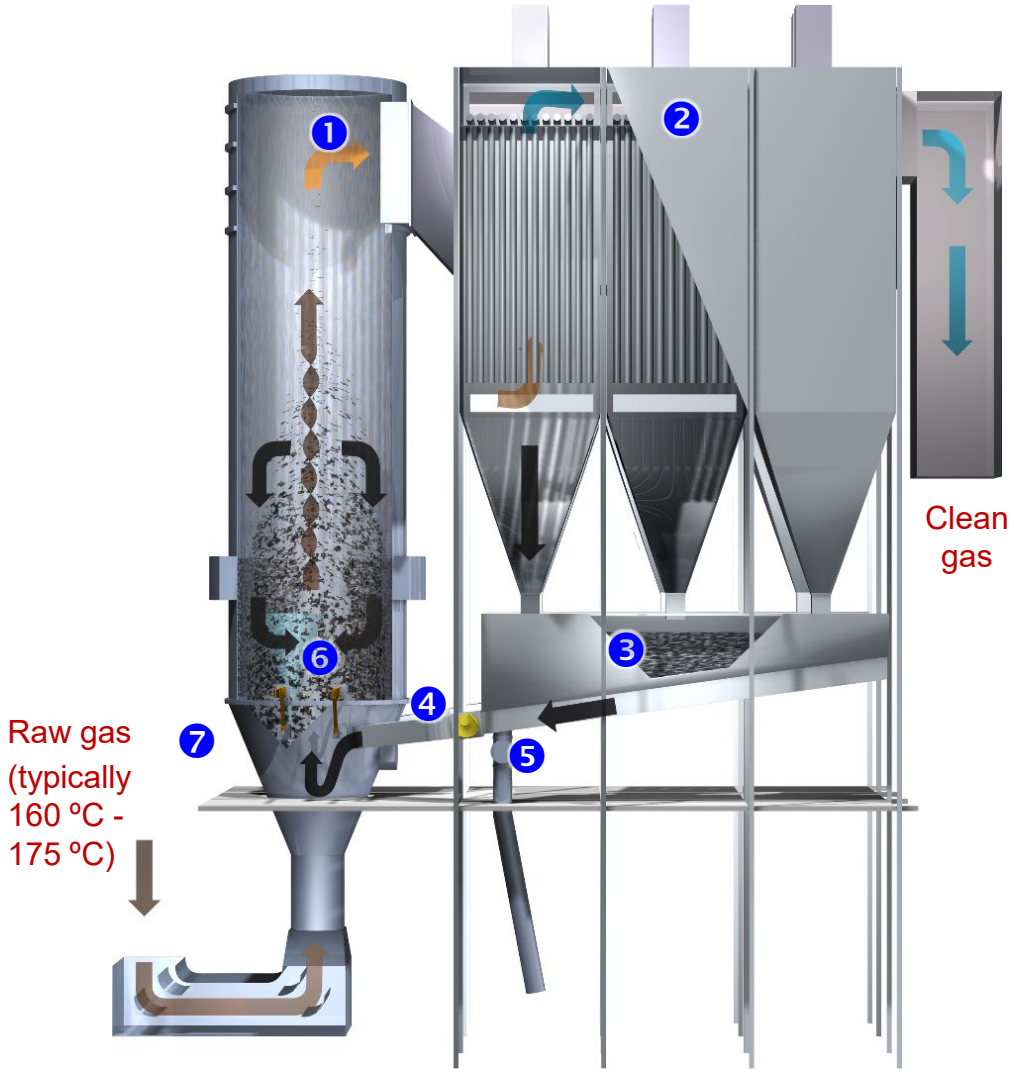
❸ Residue bunker below the fabric filter
(collection of solids separated in the fabric filter)

❹ Fluidised channels for residue recirculation:
Allows high recirculation rates, resulting in high buffering capacity against peaks and reduced additive consumption

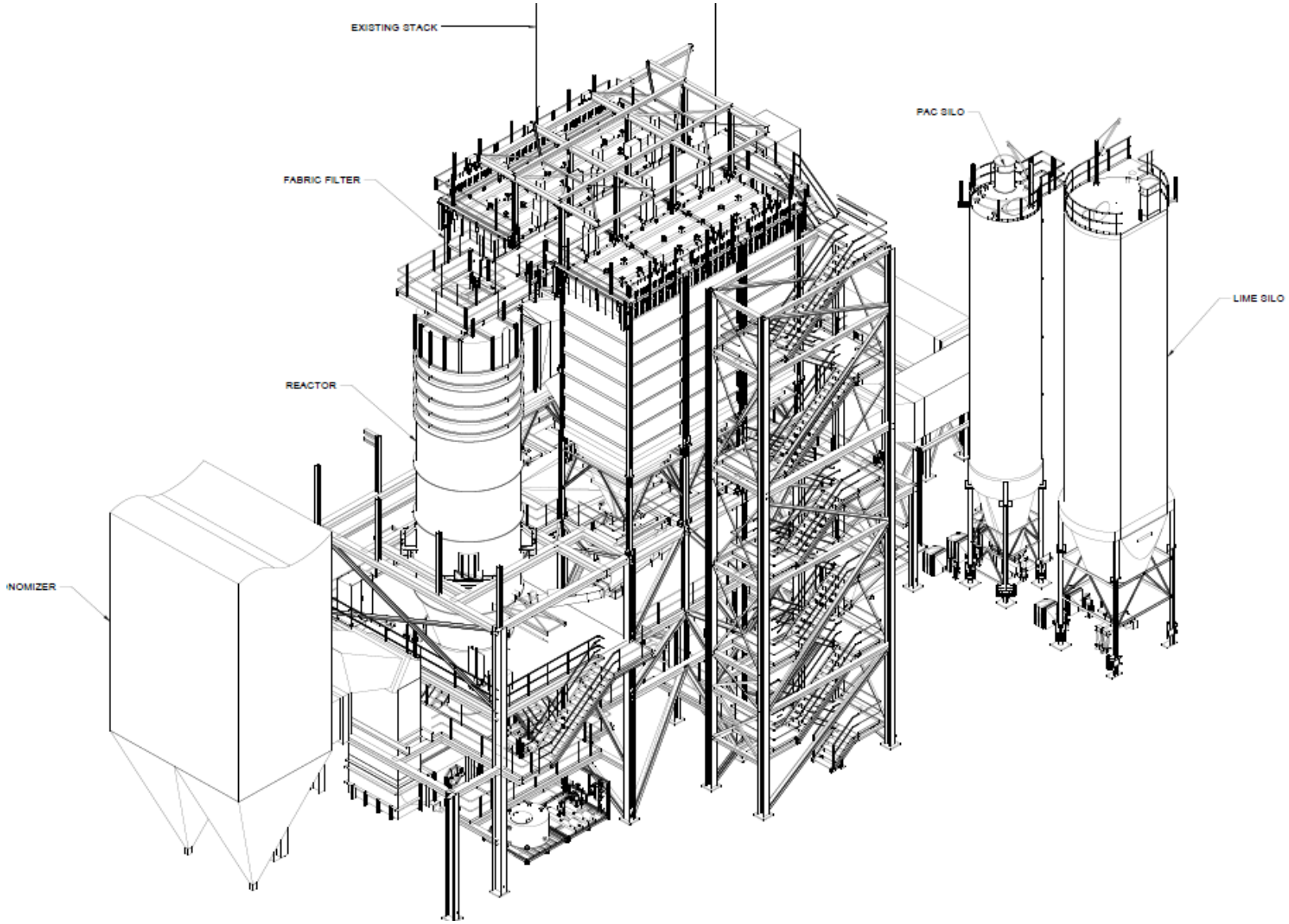
❺ Discharge of residues into the residue silo
(preferably with pneumatic conveying vessel)

❻ Water injection via injection lances

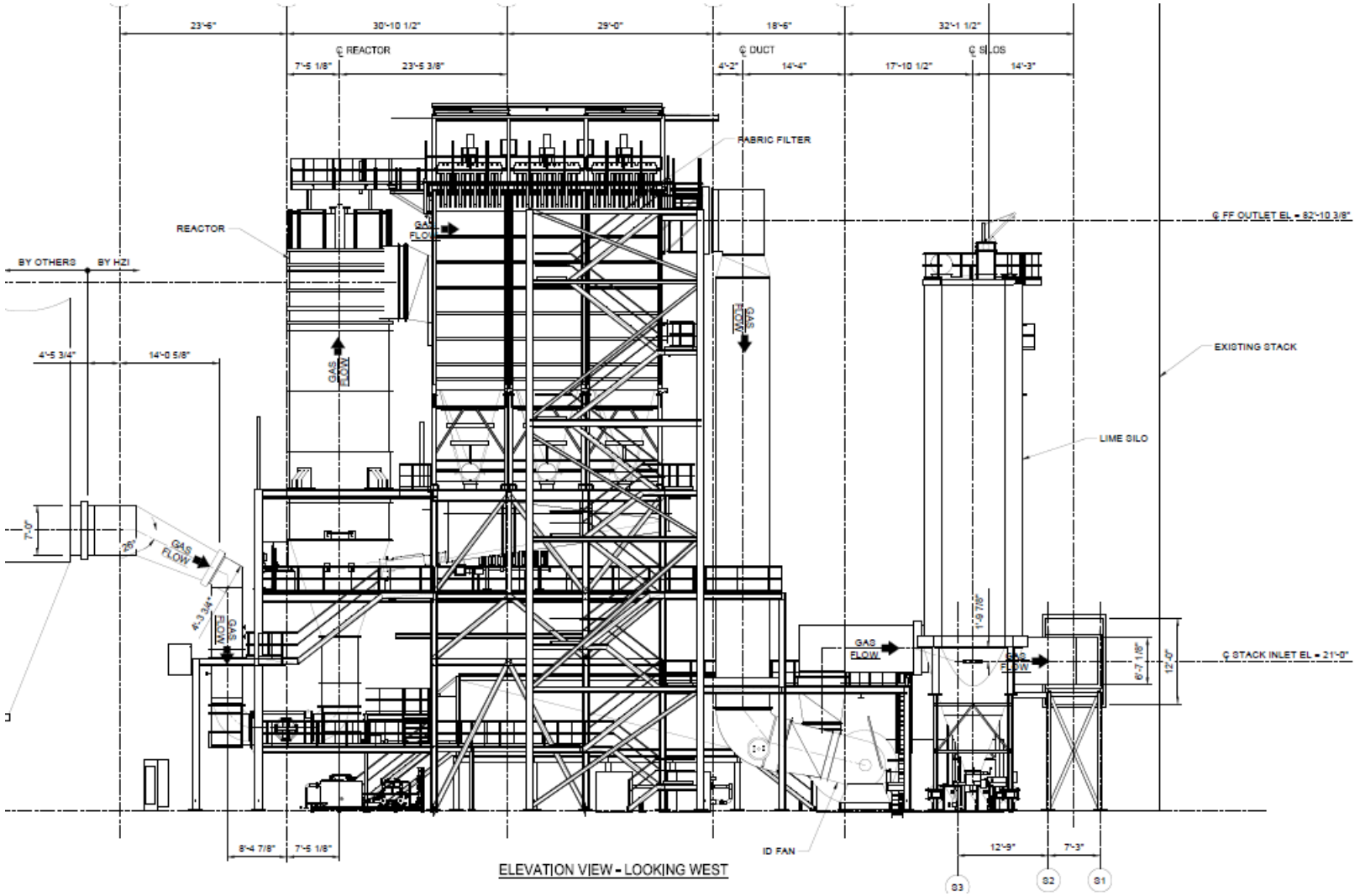
❼ Injection of additives (pneumatic conveying):
- Hydrated lime
- Activated carbon or lignite coke



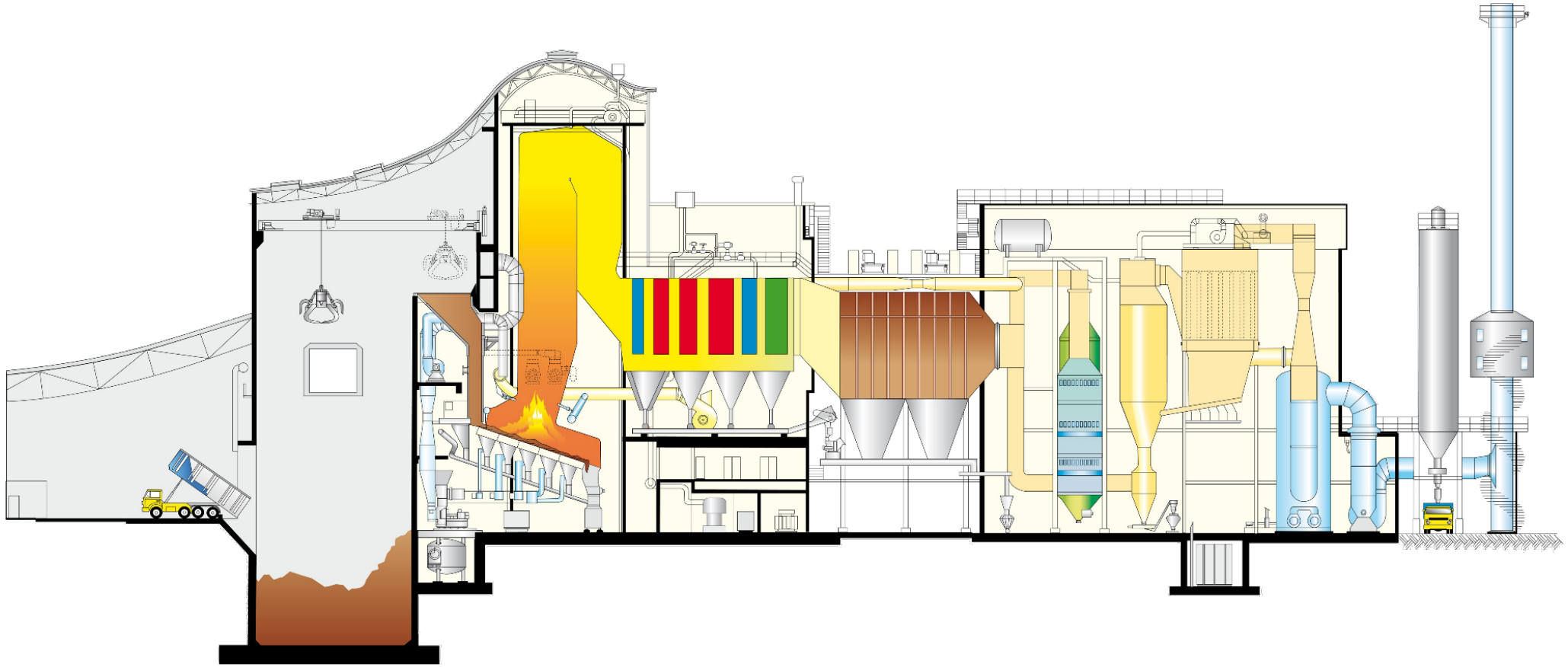
Semi Dry General Arrangement Isometric View



Semi Dry General Arrangement Elevation View



WTE Plant With ESP, SCR, Semi-Dry and Wet Scrubber



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Comments to CEMS Availability Standards

"Our experience is that CEMS are not currently capable of operating at 100% reliability. To achieve 100% reliability will require full redundancy or 2 systems for 1 line. We respectfully believe the existing CEMS availability standards should remain in effect because of the additional costs required for installation and operation of the redundant systems, with no demonstrable benefit to the environment. It is important to note that many facilities rely on CEMS feedback as part of their WTE plant control strategy, including monitoring CO for good combustion, and monitoring reagent usage for NOx and SO2 control systems. Therefore, it is in the best interests of the owners and operators to maintain CEMS operation at the highest level of availability."

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Comments to CO Catalysts for LMWCs

"On page 4255 of FR Vol. 89, No. 15, III.A.3 EPA advises that use of CO oxidation catalysts would be too expensive to retrofit on existing LMWC units for multiple reasons. However, new sources are allowed to consider the use of CO oxidation catalysts to meet the proposed new limits. Comments are requested about LMWC units that are equipped with CO oxidation catalysts and performance and operating costs of these catalysts. We are not aware of any LMWC units that are equipped with CO oxidation catalysts anywhere in the world. As noted earlier, good combustion practices are the most effective control for CO. We have contacted five prominent power industry CO catalyst manufacturers in an effort to determine the feasibility of using this technology on LMWC units. The feedback thus far has not been favourable, and most of the concerns expressed by manufacturers focus on catalyst fouling, catalyst masking and catalyst poisoning."

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Comments to Start Up Shut-Down and Malfunction

"Combustion during these transition periods can be unstable, meaning it can be difficult to control emissions to precise levels whether using fossil fuels or MSW. LMWC start up and shut down on rare occasions and will only shut down when necessary in the event of a malfunction, or for a planned maintenance outage. It is not in the operator's interests to shut down and then subsequently restart the plant, which can involve burning expensive fossil fuels when available, as well as reducing the amount of MSW they can treat along with their electric power generation and sales…Moreover, due to the unstable furnace conditions, and because emissions control begins in the furnace with stable and complete combustion, we are not able to provide emissions guarantees during the warm-up, start-up, shutdown, and malfunction periods…. HZI therefore strongly encourages EPA to withhold implementation of this adjustment to the rule. "

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*See also "*Environment Agency guidance on deriving start-up and shut-down definitions for waste incinerators and co-incinerators" under References

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Comments to Standards of Performance for Existing LMWC

"While we understand the intent of using the best performing facilities as the bar, so to speak, for establishing emissions standards for other facilities, this does not consider the differences in the respective LMWC units design, MSW fuel, and other factors that have a significant impact on performance. Our experience has shown that WTE plants can vary in performance and even individual combustion lines within a WTE plant can perform differently. In other words, just because a plant in one location can achieve a very low emission level for a pollutant does not necessarily mean the same can be achieved by plants in other locations. This is much like assuming that Michael Jordan and Lebron James set the *minimum* standard for any player to play in the NBA."

Kanadevia Inova – USEPA March 25, 2024

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