

**Technical Support Document for the
Zinc Production Sector: Proposed Rule for
Mandatory Reporting of Greenhouse Gases**

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1. Industry Description

Zinc is a metal used as corrosion-protection coating on steel (galvanized metal), as die castings, as an alloying metal with copper to make brass, and as chemical compounds in rubber, ceramics, paints, and agriculture. For this proposed rule, EPA is defining the zinc production source category to consist of zinc smelters using pyrometallurgical processes and secondary zinc recycling facilities. Zinc smelters can process zinc sulfide ore concentrates (primary zinc smelters) or zinc-bearing recycled and scrap materials (secondary zinc smelters). A secondary zinc recycling facility recovers zinc from zinc-bearing recycled and scrap materials to produce crude zinc oxide for use as a feed material to zinc smelters. Many of these secondary zinc recycling facilities have been built specifically to process dust collected from electric arc furnace (EAF) operations at steel mini-mills across the country.

There are no process emissive primary zinc smelters in the United States that use pyrometallurgical processes. The one operating U.S. pyrometallurgical zinc smelter processes secondary materials, and is therefore classified as a secondary producer (Horsehead Holding Corporation 2007).

Secondary zinc recycling facilities operating in the U.S. use either of two thermal processes to recover zinc from recycled EAF dust and other scrap materials. For the Waelz kiln process, the feed material is charged to an inclined rotary kiln together with petroleum coke, metallurgical coke, or anthracite coal. The zinc oxides in the gases from the kiln are then collected in a baghouse or electrostatic precipitator. The second recovery process used for EAF dust uses a flame reactor to form vaporized zinc that is subsequently captured in a vacuum condenser. The crude zinc oxide produced at secondary zinc recycling facilities is shipped to a zinc smelter for further processing.

In 2006, total U.S. primary and secondary production of zinc was 510,000 metric tons. Of this, primary production methods accounted for 113,000 metric tons, and secondary zinc production methods accounted for 397,000 metric tons (mt). Three companies contributed to this production with a total of 9 plants in the U.S as presented in Table 1.

Table 1. U.S. Zinc Production Facilities

Company	Facility Location	Zinc Production Process	Process Emissive
Horsehead Corp.	Monaca, PA ^A	Electrothermic furnaces	Y ^B
	Calumet, IL	Waelz kilns	Y
	Palmerton, PA	Waelz kilns	Y
	Rockwood, TN ^C	Waelz kilns	Y
	Beaumont, TX	Flame reactor	N
	Bartlesville, OK	Hydrometallurgical recovery	N
Nyrstar NV	Clarksville, TN	Electrolytic	N
Votorantim Metals	Coldwater, MI	Batch retorts	N
	Houston, TX	Pinto process	N

^A While the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2006* says that the Monaca, PA facility is shut down, our research shows that it is operational (Personal Communication 2008).

^B 2006 IPCC Guidelines for National Greenhouse Gas Inventories provides no emission factor for the Electrothermic process. Instead the Guidelines give, "Unknown". However, based on the primary role that this facility plays in producing Horsehead Holding Corporation's zinc as well as information gathered from The Zinc Handbook: *Properties, Processing, and Use in Design*, this facility is assumed to be process emissive.

^C This facility added a kiln in December 2007(Reuters 2008). This added capacity is not taken into account in the process emissions *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2006*. Therefore, these emissions are not taken into account in this analysis.

2. Total Emissions

Zinc production results in combustion and process-related GHG emissions.

Total nationwide GHG emissions from zinc production in the United States were estimated to be approximately 851,708 metric tons CO₂ equivalent (mtCO₂e) in 2006. This total GHG emissions estimate includes both process-related emissions (CO₂ and CH₄) resulting from zinc production operations at the 4 facilities identified as process emissive in Table 1, and combustion emissions (CO₂, CH₄) from all 9 facilities.¹ Process-related GHG emissions were 528,777 mtCO₂e (62 percent of the total emissions). The remaining 322,931 mtCO₂e emissions (38 percent of the total emissions) were combustion GHG emissions.

2.1 Process Emissions

The major sources of GHG emissions from a zinc production facility are the process-related emissions from the operation of electrothermic furnaces at zinc smelters and Waelz kilns at secondary zinc recycling facilities. In an electrothermic furnace, reduction of zinc oxide using carbon provided by the charging of coke to the furnace produces CO₂. In the Waelz kiln, the zinc feed materials are heated to approximately 1200°C in the presence of carbon producing zinc vapor and carbon monoxide (CO). When combined with the surplus of air in the kiln, the zinc vapors are oxidized to form crude zinc oxide, and the CO oxidized to form CO₂.

2.2 Combustion Emissions

Waelz kilns release combustion emissions (CO₂, CH₄, and N₂O) in addition to process emission as a result of burning natural gas or other fossil fuels to produce heat for the process. For other metallurgical process equipment used at zinc production facilities, the only source of carbon is the natural gas or other fuel burned in the unit to produce heat for drying, melting, or casting operations. These types of combustion emissions sources can include flame reactors, fuel-fired furnaces, calcining kilns, dryers, casting machines, boilers, and space heaters depending on the specific processes used at a given facility.

¹ As noted above, Horsehead Holding Corporation's Rockwood, TN facility added a kiln in December 2007. This added capacity is not taken into account in the process emissions *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2006*.

3. Review of Existing Programs and Methodologies

Four reporting programs and guidelines were reviewed including: the Canadian Mandatory Greenhouse Gas Reporting Program, the Australian National Greenhouse Gas Reporting Program, the U.S. Greenhouse Gas Inventory protocol, and the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. In general, the methodologies used for facility level reporting coalesce around the IPCC's guidelines.

3.1 2006 IPCC Guidelines

IPCC has 3 tiers of methods used to estimate process-related CO₂ emissions. The Tier 1 method uses a default emission factor per unit of output multiplied by national production activity data. IPCC offers two equations for calculation. The first utilizes a general default emission factor per unit output of zinc using any process. The second utilizes default emission factors specific to production processes - electrothermic distillation, Imperial Smelting Furnace, or Waelz Kiln (IPCC 2006). The 2 Tier 1 IPCC methodological equations are as follows:

$$E_{CO_2} = Zn \times EF_{\text{default}}$$

Where:

E_{CO_2} = CO₂ emissions from zinc production, metric tonne

Zn = quantity of zinc produced, metric tonne

E_{default} = default emission factor, Mt CO₂/Mt zinc produced

$$E_{CO_2} = ET \times EF_{ET} + PM \times EF_{PM} + WK \times EF_{WK}$$

Where:

E_{CO_2} = CO₂ emissions from zinc production, metric tonne

ET = Quantity of zinc produced by electrothermic distillation, metric tonne

EF_{ET} = Emission factor for electrothermic distillation, mt CO₂/mt zinc produced

PM = Quantity of zinc produced by Imperial Smelting Furnace Process

EF_{PM} = Emission factor for Imperial Smelting Furnace Process, mt CO₂/mt zinc produced

WK = Quantity of zinc produced by Waelz Kiln process, metric tonne

EF_{WK} = Emission factor for Waelz Kiln process, mt CO₂/mt zinc produced.

IPCC's Tier 2 method calculates process-related emissions using country specific emission factors based on aggregated plant statistics for the use of reducing agents, furnace types and other process materials. Default emission factors are applied to each material. This method is more accurate than Tier 1 because, instead of assuming industry-wide practices, it accounts for reducing agents, furnaces, and other process materials that affect emissions. No equation is given by the IPCC guidelines for this method.

IPCC’s Tier 3 method relies either on actual facility specific measurements of emissions, or on facility specific calculation of emission factors and collection of activity data, multiplied by plant production. No equation is given by the IPCC guidelines for this method.

3.2 Australian National Government’s Greenhouse and Energy Reporting Program

The Australian National Government’s Greenhouse and Energy Reporting Program requires reporting of CO₂ emissions from zinc producing corporations if: they control facilities that emit at least 25,000 MtCO₂e, or produce or consume at least 100 terajoules of energy; or their corporate group emits at least 125,000 MtCO₂e, or it produces or consumes at least 500 terajoules of energy (Australian DCC 2007). The method used for estimating emissions is based on the National Greenhouse Account (NGA) default method, which calculates emissions based on the following equation:

$$E_I = \sum Q_C \times EC_C \times EF_C / 1000$$

Where:

E_I = emissions of CO₂ from production of metal, metric tonne

Q_C = the quantity of each carbon reductant used in production of metal, metric tonne

EC_C = the energy content of reductant, gigajoule per metric tonne

EF_C = the emission factor of fuel used, kilogram per gigajoule

Facilities may use the default emission factor presented in Table 2, but the higher-order method would be to develop facility-specific emission factors from the carbon content of the reducing agent. This higher order method is similar in protocol to IPCC’s Tier 3 requirements.

Table 2. Australian National Greenhouse Account Default Emission Factors

Fuel Combusted	Energy Content (gross) GJ/t	Full Fuel Cycle EF Emission Factor kg CO₂e/GJ
Coke Oven Coke	27.0	125.7

Source: Australia National Greenhouse and Energy Reporting System 2007
 (<http://www.greenhouse.gov.au/reporting/publications/pubs/nger-techguidelines.pdf>)

3.3 Canadian Mandatory Greenhouse Gas Reporting Program

The Canadian Mandatory Greenhouse Gas Reporting Program requires reporting of CO₂ emissions from zinc producing facilities if their total GHG emissions exceed 100,000 MtCO₂e. The method used for estimating emissions is based on the following equation:

$$\text{Emissions}_{\text{CO}_2} = \text{EF}_{\text{RA}} \times \text{M}_{\text{RA}} + \text{M}_{\text{C in Metal Ore}} \times (44/12)$$

Where:

EF_{RA} = EF for the reducing agent, Mt CO₂/Mt reducing agent

M_{RA} = mass of reducing agent consumed, Mt

$\text{M}_{\text{C in Metal Ore}}$ = mass of carbon in the metal ore feed, Mt

44/12 = stoichiometric ratio of CO₂/C

The guidelines suggest the calculation and use of facility specific process-related emission factors for the reducing agent consumed in order to ensure better accuracy of the estimates. However, they also provide IPCC default emissions in the case that facility specific emission factors can not be calculated. (Environment Canada 2006).

3.4 U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks

While these two protocols coalesce around the same methodology used for IPCC's Tier 3 protocol, the *U.S. Inventory of Greenhouse Gas Emissions and Sinks* utilizes IPCC's Tier 2 protocol with national default process specific emission factors, as discussed previously (US EPA 2008).²

² One difference to note between methodologies of the U.S. Inventory and the Australian Inventory is that the U.S. Inventory does not consider the coke in secondary zinc production to be "combusted." Instead, the CO₂ emissions from the coke are considered to be a process emission, not a stationary combustion emission. The U.S. Inventory characterization of the coke consumption in secondary zinc production as a process emission is not consistent with the terminology of "fuel combusted" in the Australia Inventory.

4. Options for Reporting Threshold

4.1 Options Considered

Zinc smelters and secondary zinc recycling facilities in the U.S. vary in types and sizes of the metallurgical processes used and mix of zinc-containing feedstocks processed to produce zinc products. Options considered for reporting protocol include mandatory greenhouse gas reporting from all zinc production facilities, capacity based emissions reporting, or emissions based thresholds at 1,000, 10,000, 25,000, and 100,000 MTCO₂e.

4.2 Emissions and Facilities Covered Per Option

4.2.1 Process Emissions

In order to determine the process-related CO₂ emissions for all zinc production facilities in the U.S, EPA applied the IPCC Tier 2 method, which involves multiplying an emission factor based upon the amount of EAF dust consumed by individual facilities' EAF dust consumption. Due to the complexities of recovering zinc from recycled EAF dust, an emission factor based on the amount of EAF dust consumed, rather than the amount of secondary zinc produced, was developed to represent emissions from the Waelz Kiln process more accurately (U.S. EPA 2008). This emission factor is calculated using the following equation:

$$\begin{aligned} EF_{\text{EAF Dust}} &= (0.4 \text{ Mt coke/Mt EAF Dust}) \times (0.84 \text{ Mt C/Mt coke}) \times (3.67 \text{ Mt CO}_2\text{/Mt C}) \\ &= 1.23 \text{ Mt CO}_2\text{/Mt EAF Dust} \end{aligned}$$

Specifically, to obtain CO₂ emissions, the total 2006 secondary zinc production for the US was multiplied by a fraction to get the portion of zinc attributed to the Horsehead Holding Corporation's plant. This portion of secondary zinc was then multiplied by a Waelz Kiln process emission factor for EAF dust to obtain total CO₂ emissions. The default emission factor and results of the analysis are presented below in Table 3.

Table 3. Facility Emission Calculations

Facility	Total National Secondary Zinc Production (Mt)	Percent Attributed to Facility	Production Attributed to Facility (Mt zinc)	EAF Dust Consumption Attributed to Production	Emission Factor (Mt CO ₂ /Mt EAF Dust)	CO ₂ Attributed to Facility (Mt)
Horsehead Corporation	397,000	36%	142,929	425,384	1.23	528,777

In total, 14 facilities were identified that have, or will have in the future, some form of zinc production. Of these 14 facilities, five were not evaluated for process or combustion emissions, and were not included in the cost analysis. Two of the five facilities are not listed in the Directory of Metal Producers and therefore can be assumed to be producing Zinc Oxide, not zinc metal (USGS Commodity Specialist).³ The other three facilities are planned to come on line in the future.⁴

The remaining nine facilities were evaluated for process and combustion emissions. Of these nine, three facilities have process emissions, and one facility uses a process that was assumed to be emissive, totaling four process emissive facilities. These four facilities are part of Horsehead Holding Corporation's production process, wherein six facilities each play a role in refining the product and the final step is performed at the Monaca, PA plant.⁵ The *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2006* provides the aggregated emission estimate for Horsehead Holding Corporation. This estimate was split among the three plants that employ processes which are known to contribute to the process emission estimate and the Monaca, PA facility, which employs the electrothermic process. While the magnitude of emissions from the electrothermic process is uncertain, this facility was included in this analysis due to its role as the final processor of all of the Horsehead Holding Corporation's zinc (IPCC 2006). Due to the nature of the production process that Horsehead Holding Corporation employs, the exact contribution of each facility to the process emissions estimate has not been determined. Secondary zinc products are processed and refined using several different processes at 5 facilities. These materials are then reprocessed at the Monaca, PA facility into final products. Because materials are being recycled throughout this production process, dividing the estimate from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006* among the 4 facilities that employ process emissive production processes may underestimate the process emissions resulting from Horsehead Holding Corporation's overall process. Table 4 includes each of Horsehead Holding Corporation's facilities, the different products they produce, and calculated zinc processing capacities. The process emissions from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006* was apportioned to the four facilities based on the relative capacity of zinc produced.

³ The two facilities, US Zinc facilities in Millington, TN and Spokane, WA, are assumed to produce zinc oxide are not included in this cost analysis because the analysis is focused on emissions related to zinc metal production.

⁴ These three facilities include ZincOx's Big River Zinc and Ohio Projects (ZincOx Resources Plc) and Steel Dust Recycling's Greenfield site in Pickens County, AL (Steel Dust Recycling, LLC 2007).

⁵ While the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2006* says that the Monaca, PA facility is shut down, our research shows that it is operational (Personal Communication 2008, Horsehead Holding Corporation 2007).

Table 4. Horsehead Holding Corporation Facilities Products and Calculated Zinc Production Capacity

Facility Location	Product	Annual Capacity (Metric Tons)	Zinc Production Capacity (Metric Tons)
Palmerton, PA	Calcine	117,936	76,658
	Crude Zinc Oxide	247,666	136,216
	Zinc Powder	4,536 - 12,700.8	4,536 - 12,700.8
	Zinc Copper	-	-
	Base	2,722	NA ^A
Monaca, PA	Prime Western Metal	84,370	84,370
	Zinc Oxide	76,205	61,231
	SSHG Metal ^B	13,608	13,608
	Zinc Dust	5,352	5,352
Rockwood, TN	Crude Zinc Oxide	134,266	73,846
Calumet, IL	Crude Zinc Oxide	153,317	84,324
Beaumont, TX	Crude Zinc Oxide	25,402	13,971
Bartlesville, OK	Lead Carbonate	25,402	-
<p>Note 1: "Facility location", "Product", and "Annual Capacity" information is taken from Horsehead Holding Corporation's Form 10-K. Zinc production capacity is calculated. For Calcine and Crude Zinc Oxide, percentages of zinc content were multiplied by given capacities to calculate capacities of metric tons of zinc produced. Prime Western and Special Special High Grade Metal were assumed to be 100% zinc. Zinc powder and zinc dust were assumed to have 100% zinc content. Zinc powder is manufactured by the atomization of molten zinc. The only distinction drawn between zinc dust and zinc powder is that zinc powder is coarser than zinc dust (Horsehead Holding Corporation 2007).</p> <p>Note 2: Totaling zinc production capacity for each plant to arrive at a total zinc production capacity for all Horsehead facilities is potentially misleading as the same zinc may be processed at several different plants before being sold.</p> <p>Note 3: In this table, "Annual Capacity" is the amount of each zinc product, as listed in the "Product" column, that each facility is potentially able to produce. "Zinc Production Capacity" is the amount of zinc content potentially able to be produced. These numbers were reached through the calculations described in Note 1 above.</p> <p>^A Information on zinc content could not be found to estimate production capacity.</p> <p>^B SSHG Metal stands for Special Special High Grade Metal</p>			

The remaining five facilities included in the analysis used processes either confirmed or assumed not to be process emissive. Horsehead Holding Corporation's Bartlesville, OK facility is not process emissive (Sjardin 2003), and Nyrstar NV's Clarksville, TN, Votorantim Metals' Coldwater, MI, and Houston, TX facilities, and Horsehead Holding Corporation's Beaumont, TX facility were assumed to not be process emissive. These facilities were assumed not to be process emissive due to a lack of information regarding the specific nature of the processes employed at each facility.

4.2.2 Combustion Emissions

Stationary combustion-related GHG emissions from on site fossil fuel combustion were estimated for zinc production for nine facilities based on data collected on operations at the Horsehead Holding Corporation's facility in Palmerton, PA and Nyrstar NV's Clarksville, TN facility. The Horsehead Holding Corporation's facility operates four rotary kilns and a calcining kiln (JTToday 2006). Operational data for the rotary kilns and calcining kiln were not available. The rotary kilns were assumed to operate at 24 MMBtu/hour and calcining kiln at 50MMBtu/hour and were assumed to consume natural gas based on permit data collected for secondary lead production rotary kilns (Indiana DOEM 2007) and silicon carbide production calcining kilns (Illinois EPA 2004). These devices were assumed to run 24 hours/day, 365 days/year at 90% of capacity, totaling 1,151,064 MMBtu/year and GHG emissions of 61,135 Mt of CO₂e. Because the Horsehead Holding Corporation facilities differ in size and capacity, this estimate was scaled to approximate the size of each of the six Horsehead facilities and applied as a proxy for plant specific data. Due to limited availability of information regarding the Votorantim Metals facilities' equipment, the estimate for Horsehead's Palmerton, PA facility was also scaled and applied to these two facilities. The Nyrstar NV Clarksville, TN facility operates an auxiliary boiler, a roaster preheater, a primary acid plant preheater, and a secondary acid plant preheater (TN Department of Environment and Conservation, 2002). Information on energy consumption of this equipment was retrieved from Title V documentation (Tennessee Department of Environment and Conservation 2002). Operational data for this equipment were not available. These devices were assumed to run 24 hours/day, 365 days/year at 90% of capacity, totaling 1,222,020 MMBtu/year and GHG emissions of 89,712 Mt of CO₂e. This estimate was applied only to the Nyrstar NV facility.⁶

Emissions were estimated by multiplying the energy consumption (MMBtu/year) by the carbon content of natural gas (14.47 Tg C/QBtu) provided by the *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2006* as well as CH₄ and N₂O emission factors provided by Table 2.3 of the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006). These factors are for Manufacturing Industries and Construction.

⁶ During research it was noted that the Horsehead Holding Corporation's Monaca, PA facility operates a 110 megawatt coal-fired power plant that provides them with electricity. They sell approximately one-fifth of this plant's electricity production capacity. This plant was not included in these combustion emissions calculations.

4.2.3 Emissions Thresholds

Table 4 presents the estimated emissions and number of facilities that would be subject to GHG emissions reporting, based upon emission estimates using production capacity data for a total of nine U.S. zinc production facilities. As presented in Table 5, four of the nine facilities exceed a threshold of 100,000 metric tons/year, and five of the nine facilities exceed a threshold of 25,000 metric tons/year. Eight of the nine exceed the threshold of 10,000 metric tons/year. All 9 facilities exceed a threshold of 1,000 metric tons/year.

Table 5. Threshold Analysis for Zinc Production

Threshold Level (MtCO ₂ e/yr)	Nationwide Annual GHG Emissions (MtCO ₂ e/yr)			Total Number of Entities	Subject to GHG Reporting			
	Process Emissions	Combustion Emissions	Total		Emissions		Entities	
					MtCO ₂ e/yr	Percent	Number	Percent
100,000	528,777	322,931	851,708	9	712,181	84%	4	44%
25,000	528,777	322,931	851,708	9	801,893	94%	5	56%
10,000	528,777	322,931	851,708	9	843,154	99%	8	89%
1,000	528,777	322,931	851,708	9	851,708	100%	9	100%

5. Options for Monitoring Methods

5.1 Option 1: Simplified Emission Calculation

The simplified emission calculation method uses a default process emission factor per unit of output multiplied by national production activity data. This is a simplified emission calculation method using only default emission factors to estimate CO₂ emissions. The method requires multiplying the amount of zinc produced by the appropriate default emission factors from the 2006 IPCC guidelines. This option is equivalent to IPCC's Tier 1 option.

5.2 Option 2: Facility-Specific Calculations

The method requires performing monthly measurements of the carbon content of specific process inputs and measuring the mass rate of these inputs. This is the IPCC Tier 3 approach and the higher order methods in the Canadian and Australian reporting programs. Implementation of this method requires owners and operators of affected zinc smelters to determine the carbon contents of materials added to the electrothermic furnace or Waelz kiln by analysis of representative samples collected of the material or from information provided by the material suppliers. In addition, the quantities of these materials consumed during production are measured and recorded. To obtain the process-related CO₂ emission estimate, the material carbon content would be multiplied by the corresponding mass of material consumed and a conversion of carbon to CO₂. This method assumes that all of the carbon is converted during the reduction process. Each facility owner or operator would be required to conduct quality assurance (QA) of supplier-provided information on the carbon content of the input materials by collecting a composite sample of material and sending it to a third-party, independent laboratory for chemical analysis to verify the supplier's information. This QA procedure would be required to be conducted annually.

The hybrid monitoring method requires facility specific measurements and reporting of process and stationary combustion emissions consistent with the IPCC Tier 3 method of estimating zinc emissions.

Implementation of this method requires facilities employing the electrothermic, Imperial Smelting Furnace, or Waelz Kiln processes to perform on-site sampling of the amount of carbon contained in the reducing agent, usually metallurgical coke, and to maintain records of the masses of each reductant consumed. To obtain a process emission estimate, the carbon content measurement would be multiplied by the mass of reductant consumed and a conversion of C to CO₂. This method assumes that all of the carbon is converted during the reduction process. If several different types of reductants are used, each should be sampled and individual masses consumed during production obtained to determine emissions from each type of reductant. No equation is given by the IPCC guidelines for this method.

5.3 Option 3: Direct Measurement (Annual Reporting)

For industrial source categories for which the process emissions and/or combustion GHG emissions are contained within a stack or vent, direct measurement constitutes either measurements of the GHG concentration in the stack gas and the flow rate of the stack gas using a Continuous Emissions Monitoring System (CEMS), or periodic measurement of the GHG concentration in the stack gas and the flow rate of the stack gas using periodic stack testing. Under either a CEMS approach or a stack testing approach, the emissions measurement data would be reported annually.

5.3.1 Continuous Emissions Monitoring

Elements of a CEMS include a platform and sample probe within the stack to withdraw a sample of the stack gas, an analyzer to measure the concentration of the GHG (e.g., CO₂) in the stack gas, and a flow meter within the stack to measure the flow rate of the stack gas. The emissions are calculated from the concentration of GHGs in the stack gas and the flow rate of the stack gas. The CEMS continuously withdraws and analyzes a sample of the stack gas and continuously measures the GHG concentration and flow rate of the stack gas.

5.3.2 Stack testing

For direct measurement using stack testing, sampling equipment would be periodically brought to the site and installed temporarily in the stack to withdraw a sample of the stack gas and measure the flow rate of the stack gas. Similar to CEMS, for stack testing the emissions are calculated from the concentration of GHGs in the stack gas and the flow rate of the stack gas. The difference between stack testing and continuous monitoring is that the CEMS data provide a continuous measurement of the emissions while a stack test provides a periodic measurement of the emissions.

6. Options for Estimating Missing Data

Options and considerations for missing data vary will vary depending on the proposed monitoring method. Each option would require a complete record of all measured parameters as well as parameters determined from company records that are used in the GHG emissions calculations (e.g., reducing agent carbon contents). Therefore, whenever a quality-assured value of a required parameter is unavailable (e.g., if a monitor or CEMS malfunctions during unit operation or if a required parameter is not obtained), a substitute data value for the missing parameter must be used in the calculations.

6.1 Procedures for Option 1: Simplified Emission Calculation

If facility-specific production data is missing for one year, an average value using the production data from the year prior and the year after the missing year may be calculated. Default emission factors are readily available through IPCC guidelines (IPCC 2006).

6.2 Procedures for Option 2: Facility-Specific Calculations

When assuming a 100% conversion of C to CO₂, no missing data procedures would apply because this factor would be multiplied by the materials input, which are readily available. If this amount of carbonaceous agent input is not available, a facility would need to extrapolate from previous years taking into consideration any changes in production or process.

6.3 Procedures for Option 3: Direct Measurement

6.3.1 Continuous Emission Monitoring Data (CEMS)

For options involving direct measurement of CO₂ flow rates or direct measurement of CO₂ emissions using CEMS, Part 75 establishes procedures for management of missing data. Procedures for management of missing data are described in Part 75.35(a), (b), and (d). In general, missing data from operation of the CEMS may be replaced with substitute data to determine the CO₂ flow rates or CO₂ emissions during the period in which CEMS data are missing.

Under Part 75.35(a), the owner or operator of a unit with a CO₂ continuous emission monitoring system for determining CO₂ mass emissions in accordance with Part 75.10 (or an O₂ monitor that is used to determine CO₂ concentration in accordance with appendix F to this part) shall substitute for missing CO₂ pollutant concentration data using the procedures of paragraphs (b) and (d) of this section. Subpart (b) covers operation of the system during the first 720 quality-assured operation hours for the CEMS. Subpart (d) covers operation of the system after the first 720 quality-assured operating hours are completed.

Under Part 75.35(b), during the first 720 quality assured monitor operating hours following initial certification at a particular unit or stack location (i.e., the date and time at which quality assured data begins to be recorded by a CEMS at that location), or (when implementing these procedures for a previously certified CO₂ monitoring system) during the 720 quality assured monitor operating hours preceding implementation of the standard missing data procedures in paragraph (d) of this section, the owner or operator shall provide substitute CO₂ pollutant concentration data or substitute CO₂ data for heat input determination, as applicable, according to the procedures in Part 75.31(b). Note that for CEMS that are measuring process CO₂

emissions rather than combustion CO₂ emissions, the term “heat input determination” may be replaced with the term “raw material input determination.”

Under Part 75.35(d), upon completion of 720 quality assured monitor operating hours using the initial missing data procedures of Part 75.31(b), the owner or operator shall provide substitute data for CO₂ concentration or substitute CO₂ data for heat input determination, as applicable, in accordance with the procedures in Part 75.33(b) except that the term "CO₂ concentration" shall apply rather than "SO₂ concentration," the term "CO₂ pollutant concentration monitor" or "CO₂ diluent monitor" shall apply rather than "SO₂ pollutant concentration monitor," and the term "maximum potential CO₂ concentration, as defined in section 2.1.3.1 of appendix A to this part" shall apply, rather than "maximum potential SO₂ concentration."

6.3.2 Stack Testing Data

For options involving direct measurement of CO₂ flow rates or direct measurement of CO₂ emissions using stack testing, “missing data” is not generally anticipated. Stack testing conducted for the purposes of compliance determination is subject to quality assurance guidelines and data quality objectives established by the U.S. EPA, including the Clean Air Act National Stack Testing Guidance published in 2005 (US EPA 2005). The 2005 EPA Guidance Document indicates that stack tests should be conducted in accordance with a pre-approved site-specific test plan to ensure that a complete and representative test is conducted. Results of stack tests that do not meet pre-established quality assurance guidelines and data quality objectives would generally not be acceptable for use in emissions reporting, and any such stack test would need to be re-conducted to obtain acceptable data.

U.S. EPA regulations for performance testing under 40 CFR § 63.7(c)(2)(i) state that before conducting a required performance test, the owner/operator is required to develop a site-specific test plan and, if required, submit the test plan for approval. The test plan is required to include “a test program summary, the test schedule, data quality objectives, and both an internal and external quality assurance (QA) program” to be applied to the stack test. Data quality objectives are defined under 40 CFR § 63.7(c)(2)(i) as “the pre-test expectations of precision, accuracy, and completeness of data.” Under 40 CFR § 63.7(c)(2)(ii), the internal QA program is required to include, “at a minimum, the activities planned by routine operators and analysts to provide an assessment of test data precision; an example of internal QA is the sampling and analysis of replicate samples.” Under 40 CFR § 63.7(c)(2)(iii) the external QA program is required to include, “at a minimum, application of plans for a test method performance audit (PA) during the performance test.” In addition, according to the 2005 Guidance Document, a site-specific test plan should generally include chain of custody documentation from sample collection through laboratory analysis including transport, and should recognize special sample transport, handling, and analysis instructions necessary for each set of field samples (US EPA 2005).

U.S. EPA anticipates that test plans for stack tests anticipated to be used to obtain data for the purposes of emissions reporting would be made available to EPA prior to the stack test and that the results of the stack test would be reviewed against the test plan prior to the data being deemed acceptable for the purposes of emissions reporting.

7. QA/QC Requirements

Facilities should conduct quality assurance and quality control of the production and consumption data, supplier information (e.g., carbon contents), and emission estimates reported. Facilities are encouraged to prepare an in-depth quality assurance and quality control plan which would include checks on production data, the carbon content information received from the supplier and from the lab analysis, and calculations performed to estimate GHG emissions. Several examples of QA/QC procedures are listed below.

7.1 Combustion Emissions

Facilities should follow the guidelines described in the Stationary Combustion Source section of this TSD.

7.2 Facilities Using CEMS for Direct Measurement of Process Emissions

For units using CEMS to measure CO₂ flow rates or CO₂ emissions, the equipment should be tested for accuracy and calibrated as necessary by a certified third party vendor. These procedures should be consistent in stringency and data reporting and documentation adequacy with the QA/QC procedures for CEMS described in Part 75 of the Acid Rain Program.

7.3 Equipment Maintenance

For methods using data obtained from flow meters to directly measure the flow rate of fuels, raw materials, products, or process byproducts, flow meters should be calibrated on a scheduled basis according to equipment manufacturer specifications and standards. Flow meter calibration is generally conducted at least annually. A written record of procedures needed to maintain the flow meters in proper operating condition and a schedule for those procedures should be part of the QA/QC plan for the capture or production unit.

An equipment maintenance plan should be developed as part of the QA/QC plan. Elements of a maintenance plan for equipment include the following: (1) conduct regular maintenance of equipment, e.g. flow meters; (2) maintain a written record of procedures needed to maintain the monitoring system in proper operating condition and a schedule for those procedures; and (3) maintain a record of all testing, maintenance, or repair activities performed on any monitoring system or component in a location and format suitable for inspection. A maintenance log may be used for this purpose.

7.4 Data Management

Data management procedures should be included in the QA/QC Plan. Elements of the data management procedures plan are as follows:

- For measurements of carbon content of reducing agents, assess representativeness of the carbon content measurement of reducing agents and other process inputs by comparing values received from supplier and/or laboratory analysis with IPCC default values.

- Check for temporal consistency in production data, process inputs, and emission estimate. If outliers exist, they should be explained by changes in the facility's operations or other factors. A monitoring error is probable if differences between annual data cannot be explained by:
 - Changes in activity levels,
 - Changes concerning process inputs material,
 - Changes concerning the emitting process (e.g. energy efficiency improvements) (European Commission 2007).
- Determine the “reasonableness” of the emission estimate by comparing it to previous year's estimates and relative to national emission estimate for the industry:
 - Comparison of data on fuel or input material consumed by specific sources with fuel or input material purchasing data and data on stock changes,
 - Comparison of fuel or input material consumption data with fuel or input material purchasing data and data on stock changes,
 - Comparison of emission factors that have been calculated or obtained from the fuel or input material supplier, to national or international reference emission factors of comparable fuels or input materials,
 - Comparison of emission factors based on fuel analyses to national or international reference emission factors of comparable fuels, or input materials,
 - Comparison of measured and calculated emissions (European Commission 2007).
- Maintain data documentation, including comprehensive documentation of data received through personal communication:
 - Check that changes in data or methodology are documented.

8. Types of Emissions to be Reported

Zinc smelting owners and operators would report annual CO₂ emissions. Owners and operators would estimate annual CO₂ emissions by estimating both process (CO₂) and combustion related greenhouse gas emissions (CO₂, CH₄, and N₂O). Depending on the monitoring method used (discussed in Section 6), additional information would be reported to assist in the verification of the reported emissions. Such information could include facility operation information routinely recorded at the facility such as the total number of operated at the facility, zinc product production quantities, raw material quantities purchased and consumed, and fossil fuel usage. In addition, facility owners and operators would report additional information to assist in QA/QC of any site-specific GHG emissions data used for the reported emissions determination.

8.1 Additional Data to be Retained Onsite

Facilities should be required to retain data concerning monitoring of GHG emissions onsite for a period of [at least five] years from the reporting year. For CEMS these data would include CEMS monitoring system data including continuous-monitored GHG concentrations and stack gas flow rates, calibration and quality assurance records. For stack testing these data would include stack test reports and associated sampling and chemical analytical data for the stack test. Process data including process raw material and product feed rates and carbon contents should also be retained on site for a period of [at least five years] from the reporting year. EPA could use such data to conduct trend analyses and potentially to develop process or activity-specific emission factors for the process.

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