

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

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## **1. Industry Description**

Lead is a metal used to produce various products such as batteries, ammunition, construction materials, electrical components and accessories, and vehicle parts. Approximately, 89 percent of lead is used to produce batteries. The lead production source category is defined to consist of primary lead smelters and secondary lead smelters. A primary lead smelter produces lead metal from lead sulfide ore concentrates through the use of pyrometallurgical processes. A secondary lead smelter produces lead and lead alloys from lead-bearing scrap metal.

For the primary lead smelting process used in the United States, lead sulfide ore concentrate is first fed to a sintering process to burn sulfur from the lead ore. The sinter is smelted with a carbonaceous reducing agent in a blast furnace to produce molten lead bullion. From the furnace, the bullion is transferred to dross kettle furnaces to remove copper and other metal impurities. Following further refining steps to obtain high purity lead metal, the lead is cast into ingots or used to produce alloy products.

The feed materials predominately processed at U.S. secondary lead smelters are used lead-acid automobile batteries. These facilities can also process other lead-bearing scrap materials including wheel balance weights, pipe, solder, drosses, and lead sheathing. These incoming lead scrap materials are first pre-treated to partially remove metal and nonmetal contaminants. The resulting lead scrap is smelted (U.S. secondary lead smelters typically use either a blast furnace or reverberatory furnace). The molten lead from the smelting furnace is refined in kettle furnaces, and then casted into ingots or used to produce lead alloy products

Most of the lead produced in the United States is from secondary lead production. In 2006, U.S. secondary lead production totaled 1,161,000 metric tons, primarily from the recycling of lead-acid batteries (USGS 2007). There are approximately 26 U.S. secondary lead smelters with annual lead production capacities ranging from 130,000 metric tons to less than 1,000 metric tons (USGS 2007). An additional 153,000 metric tons of lead was produced in 2006 by the sole operating U.S. primary lead smelter.

## **2. Total Emissions**

Lead production results in both combustion and process-related greenhouse gas (GHG) emissions (discussed further in Sections 4 and 5). Table 5 in section 5.2 presents the estimated GHG emissions from U.S. facilities in 2006. Total nationwide GHG emissions from lead production in the United States were estimated to be approximately 0.9 million metric tons CO<sub>2</sub> equivalent (MMTCO<sub>2</sub>e) in 2006. These emissions include both on-site stationary combustion emissions (CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O) and process-related emissions (CO<sub>2</sub>). The majority of these emissions were from the combustion of natural gas and other carbon-based fuels burned to produce heat for the lead smelting processes. Combustion GHG emissions were estimated to be 0.6 MMTCO<sub>2</sub>e emissions (69 percent of the total emissions). The remaining estimated 0.3 MMTCO<sub>2</sub>e were process-related GHG emissions (31 percent of the total emissions).

### **2.1 Process Emissions**

Process-related CO<sub>2</sub> emissions are released from the lead smelting process due to the addition of a carbonaceous reducing agent such as metallurgical coke or coal to the smelting furnace. The reduction of lead oxide to lead metal during the process produces the CO<sub>2</sub> emissions. At the

primary lead smelter, sinter roast which consists of lead oxides and other metallic oxides, is feed into a blast furnace for smelting together with smelter by-products and metallurgical coke. The reduction of lead oxide during this process produces CO<sub>2</sub> emissions. Secondary lead production consists primarily of recycling lead acid batteries by either crushing the recycled lead batteries using a hammer mill and entering into a smelter or by directly entering the batteries in a smelter whole (with or without desulphurization). Several different furnace types can be used for smelting the batteries as well as other recycled scrap lead. In the U.S., the majority of secondary lead smelting is conducted using a blast furnace or reverberatory furnace.

## 2.2 Combustion Emissions

For most of the metallurgical process equipment used at primary and secondary lead smelters, the only source of carbon is the natural gas or another fuel the burned in the unit to produce heat for drying, roasting, sintering, calcining, melting, or casting operations. These types of combustion devices can include roasters, furnaces (other than induction furnaces which use electricity to produce heat for melting), refining kettles, sinter machines, rotary kilns, casting machines, boilers, and space heaters. The blast furnace also consumes metallurgical coke as a charge for the reduction process. Emissions associated with metallurgical coke consumption are considered process emissions. For a full discussion of stationary combustion, please refer to (EPA-HQ-OAR-2008-0508-004).

## 3. Review of Existing Programs and Methodologies

Four existing GHG emissions reporting programs and methodologies were identified for calculating GHG emissions from lead production: the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, the U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006, the Australian National Greenhouse Gas Reporting Program, and the Canadian Mandatory Greenhouse Gas Reporting Program.

### 3.1 2006 IPCC Guidelines

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories considers three different methods for calculating emissions from lead production (IPCC 2006). The IPCC Tier 1 method uses a default emission factor by production type listed in Table 1 multiplied by lead production quantity. The equation is as follows:

$$E_{CO_2} = (DS \times EF_a) + (ISF \times EF_b) + (S \times EF_c)$$

Where:

$E_{CO_2}$  = Emissions of CO<sub>2</sub>, metric ton

DS = Lead produced by direct smelting, metric ton

ISF = Lead produced from the Imperial smelting furnace, metric ton

S = Lead produced from secondary materials, metric ton

$EF_{a,b,c}$  = Applicable emission factor, metric tons CO<sub>2</sub>/metric ton product

**Table 1. Default Emission Factors for Lead Production**

Production Type	Emission Factor (metric ton CO <sub>2</sub> /metric ton product)
Imperial Smelt Furnace (ISF)	0.59
Direct Smelting (DS)	0.25
Treatment of Secondary Raw Materials	0.20

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories

The IPCC Tier 2 method calculates emission factors specific to each production type (e.g., secondary lead production) based on country-specific information about the use of reducing agents, furnace types, and other process materials. Carbon contents presented in Table 2 can be used to develop emission factors. IPCC Tier 2 is more accurate than IPCC Tier 1 because it accounts for the materials and furnace types used by the country rather than assuming a world-wide production average.

**Table 2. Material-Specific Carbon Content for Lead Production**

Process Materials	Carbon Content (kg carbon/kg material)
Blast Furnace Gas	0.17
Charcoal*	0.91
Coal <sup>a</sup>	0.67
Coal Tar	0.62
Coke	0.83
Coke Oven Gas	0.47
Coking Coal	0.73
EAF Carbon Electrodes <sup>b</sup>	0.82
EAF Charge Carbon <sup>c</sup>	0.83
Fuel Oil <sup>d</sup>	0.86
Gas Coke	0.83
Natural Gas	0.73
Petroleum Coke	0.87

<sup>a</sup> Assumed other bituminous coal

<sup>b</sup> Assumed 80 percent petroleum coke and 20 percent coal tar

<sup>c</sup> Assumed coke oven coke

<sup>d</sup> Assumed gas/diesel fuel

\* Charcoal if derived from biomass emissions are zero, but above carbon content should be used to calculate emissions and should be reported as a memo item

Source: 2006 IPCC Guidelines for national Greenhouse Gas Inventories

The IPCC Tier 3 method consists of either direct measurement of CO<sub>2</sub> emissions at lead production facilities (aggregated for national reporting) or calculating plant-specific emissions based on plant-specific data on reducing agents and process materials. IPCC Tier 3 is more accurate than IPCC Tier 2 because individual smelters can differ substantially in the furnaces and other process equipment used.

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

The protocol used for the U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks (US EPA 2008) to estimate GHG emissions from U.S. primary and secondary lead production facilities was the IPCC Tier 1 method (described in Section 3.1).

### 3.3 Australian National Government's Greenhouse and Energy Reporting Program

The Australian National Government's Greenhouse and Energy Reporting Program (Australian DCC 2007) requires reporting of CO<sub>2</sub> emissions from lead producing facilities that emit at least 25,000 mtCO<sub>2</sub>e, or produce or consume at least 100 terajoules of energy; or their corporate group emits at least 125,000 mtCO<sub>2</sub>e, or it produces or consumes at least 500 terajoules of energy. The program uses a method for estimating emissions from lead production facilities based on the National Greenhouse Account (NGA) default method. This method calculates emissions based on the following equation:

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

Where:

$E_I$  = emissions of CO<sub>2</sub> from the production of the metal, metric tons

$Q_C$  = the quantity of each carbon reductant used, metric tons

$EC_C$  = the energy content of the reductant, gigajoule per metric ton

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

The program protocol encourages the development of facility-specific emission factors from the carbon content of the reducing agent. This higher accuracy method is similar to the method specified by the IPCC Tier 3 method (described in Section 3.1).

### 3.4 Canadian Mandatory Greenhouse Gas Reporting Program

The Canadian Mandatory Greenhouse Gas Reporting Program (Environment Canada 2008) requires reporting of CO<sub>2</sub> emissions from lead producing facilities if they emit 100,000 mtCO<sub>2</sub>e. The method used for estimating emissions is based on the following equation:

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

Where:

$\text{Emissions}_{\text{CO}_2}$  = Emissions of CO<sub>2</sub> from the production of the metal, metric ton

$EF_{\text{RA}}$  = Emission factor for the reducing agent, mtCO<sub>2</sub>/mt reducing agent

$M_{\text{RA}}$  = Mass of reducing agent consumed, metric ton

$M_{\text{C in Metal Ore}}$  = Mass of carbon in the metal ore feed, metric ton

44/12 = Stoichiometric ratio of CO<sub>2</sub>/C

The protocol suggests that facility-specific emission factors be developed for the reducing agent consumed and used to ensure accuracy of the estimates. However, they also provide the IPCC default emissions factors in the case that facility-specific emission factors can not be calculated.

## 4. Options for Reporting Threshold

### 4.1 Options Considered

Options considered for the reporting threshold include mandatory GHG reporting from primary and secondary smelters based on emission thresholds of 1,000, 10,000, 25,000, and 100,000 mtCO<sub>2</sub>e. For this analysis, process and combustion emissions were estimated for primary and secondary lead smelters as presented in Section 5.2.

### 4.2 Emissions and Facilities Covered Per Option

#### 4.2.1 Combustion Emissions

Nationwide combustion GHG emissions from lead production facilities were estimated using data collected from Title V air permits for the primary lead smelter and a representative secondary lead smelter (Tables 3 and 4). The combustion devices at each facility are natural-gas fired. The GHG emissions were estimated by multiplying the combustion device heat rating (MMBtu/year) by the carbon content of natural gas (14.47 Tg C/QBtu) and using the default CH<sub>4</sub> and N<sub>2</sub>O emission factors for stationary combustion in manufacturing industries and construction obtained from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006). For the purpose of estimating annual GHG emissions, each combustion device was assumed to operate 24 hours/day, 365 days/year at 90% of capacity. To estimate facility-level combustion CO<sub>2</sub> emissions for secondary lead smelters, the annual estimated combustion emissions value calculated for the secondary lead smelter used to prepared Table 4 was divided by the corresponding facility's annual lead production to obtain a combustion GHG emissions factor for secondary lead smelters in terms of lead production (metric tons CO<sub>2</sub>e emitted per metric ton of lead produced). This emissions factor was then applied to each of the facilities listed in Table 5 using the facility's annual lead production capacity presented in the table.

**Table 3. Primary Lead Smelter Stationary Combustion Sources**

Combustion Device <sup>a</sup>	Fuel Burned <sup>a</sup>	Heat Rating <sup>a</sup> (MMBtu/Hour)	Estimated GHG Emissions (metric tons CO <sub>2</sub> e) <sup>b</sup>
Kettle burners	Natural Gas	5.04	25,325
Dross kettle burners	Natural Gas	5.04	4,221
Office boiler	Natural Gas	2.84	1,189
Furnace vent	Natural Gas	5.05	2,115
Space heater	Natural Gas	10	4,187
Strip mill kettle burners	Natural Gas	5.04	4,221
Change house boilers	Natural Gas	5.46	4,573
Low alpha smelting system	Natural Gas	2.94	1,231
Acid plant preheater	Natural Gas	5.88	2,462
Silver dross liquation kettles	Natural Gas	3.36	1,407
<b>Total</b>			<b>50,930</b>

<sup>a</sup> Facility data from Missouri DNR (2006) Part 70 Operating Permit Number OP2006-011

<sup>b</sup> Estimate assumes combustion device operated 24 hours/day, 365 days/year at 90% of capacity.

**Table 4. Secondary Lead Smelter Stationary Combustion Sources**

<b>Combustion Device<sup>a</sup></b>	<b>Fuel Burned<sup>a</sup></b>	<b>Heat Rating<sup>a</sup> (MMBtu/Hour)</b>	<b>Estimated GHG Emissions (metric tons CO<sub>2</sub>e)</b>
Reverberatory furnace	Natural Gas	32	13,399
Refining kettle	Natural Gas	4	13,399
Refining kettle	Natural Gas	4.25	1,780
Casting machine	Natural Gas	0.3	126
Rotary dryer	Natural Gas	14	5,862
HVAC	Natural Gas	0.07	29
<b>Total</b>			<b>34,596</b>

<sup>a</sup> Air permit data for selected facility from Indiana DOEM (2007) Administrative Amendment to Part 70 Operating Permit TO97-6201-00079.

<sup>b</sup> Estimate assumes combustion device operated 24 hours/day, 365 days/year at 90% of capacity.

#### **4.2.2 Process Emissions**

Nationwide process CO<sub>2</sub> emissions from lead smelters were estimated using the IPCC Tier 1 method (see Section 3.1). Total national primary and secondary lead production was multiplied by the emission factors provided in Table 1 for direct smelting and secondary production, respectively. Facility-level emission estimates were made to better characterize the distribution of emissions within the sector. To estimate facility-level process CO<sub>2</sub> emissions for secondary lead smelters, the total estimated nationwide emissions value for secondary production was prorated among the facilities listed in Table 5 based on annual lead production capacity for each facility.

**Table 5. Estimated 2006 U.S. Lead smelter GHG Emissions**

Facility	Smelter Type	Annual Production Capacity (metric tons)	Estimated Process CO <sub>2</sub> Emissions (metric tons)	Estimated Combustion CO <sub>2</sub> e Emissions (metric tons)	Estimated Total CO <sub>2</sub> e Emissions (metric tons)
Plant 1	Primary	220,000	38,250	50,930	89,180
Plant 2	Secondary	130,000	25,538	59,966	85,503
Plant 3	Secondary	110,000	21,609	50,740	72,349
Plant 4	Secondary	110,000	21,609	50,740	72,349
Plant 5	Secondary	110,000	21,609	50,740	72,349
Plant 6	Secondary	90,000	17,680	41,515	59,195
Plant 7	Secondary	88,000	17,287	40,592	57,879
Plant 8	Secondary	80,000	15,715	39,208	55,906
Plant 9	Secondary	85,000	15,715	36,902	52,617
Plant 10	Secondary	75,000	14,733	34,596	49,329
Plant 11	Secondary	75,000	14,733	34,596	49,329
Plant 12	Secondary	66,000	12,965	30,444	43,409
Plant 13	Secondary	58,000	11,394	26,754	38,148
Plant 14	Secondary	30,000	5,893	13,838	19,732
Plant 15	Secondary	30,000	5,893	13,838	19,732
Plant 16	Secondary	24,000	4,715	11,071	15,785
Plant 17	Secondary	10,000	1,964	4,613	6,577
Plant 18	Secondary	1,000E	196	461	658
Plant 19	Secondary	1,000E	196	461	658
Plant 20	Secondary	1,000E	196	461	658
Plant 21	Secondary	1,000E	196	461	658
Plant 22	Secondary	1,000E	196	461	658
Plant 23	Secondary	1,000E	196	461	658
Plant 24	Secondary	1,000E	196	461	658
Plant 25	Secondary	1,000E	196	461	658
Plant 26	Secondary	1,000E	196	461	658
Plant 27	Secondary	1,000E	196	461	658
Primary Lead Smelter Total		220,000	38,250	50,930	89,180
Secondary Lead Smelter Total		1,181,000	232,000	544,765	776,765
<b>Nationwide Total</b>		<b>1,401,000</b>	<b>270,250</b>	<b>595,695</b>	<b>865,945</b>

Note: Information on specific lead production plant capacity is proprietary.

E – Estimated. There are ten small secondary lead production plants whose annual capacity ranges from <1,000 to approximately 4,000 metric tons per year. In total, these plants do not exceed lead production capacity of 10,000 metric tons per year. This value (10,000 metric tons) was divided equally among the ten plants.

Source: Guberman 2008.

### 4.2.3 Emissions Thresholds

As presented in Table 5, total nationwide lead production capacity is approximately 1,401,000 metric tons with approximately 16 percent coming from primary lead production and 84 percent coming from secondary lead production. Estimated process and combustion emissions from lead production total 0.9 MMTCO<sub>2</sub>e. These emissions originate from approximately 26 secondary lead smelters and one primary lead smelter. In developing the threshold for lead smelters, annual GHG emissions-based threshold levels of 1,000, 10,000, 25,000 and 100,000 Mt CO<sub>2</sub>e were considered. Table 6 presents the estimated emissions and number of facilities that would be subject to GHG emissions reporting, based on existing facility lead production capacities, under these various threshold levels.

**Table 6. Threshold Analysis for Lead Production**

Threshold Level (mtCO <sub>2</sub> e/yr)	Nationwide Annual GHG Emissions (mtCO <sub>2</sub> e/yr)			Total Number of Facilities	Subject to GHG Reporting			
	Process Emissions	Combustion Emissions	Total		GHG Emissions		Facilities	
					mtCO <sub>2</sub> e/yr	Percent	Number	Percent
100,000	270,250	595,695	865,945	0	0	0	0	0%
25,000	270,250	595,695	865,945	13	859,368	92%	13	48%
10,000	270,250	595,695	865,945	16	852,791	98%	16	59%
1,000	270,250	595,695	865,945	17	797,543	99%	17	63%

As presented in Table 6, no facility exceed a threshold of 100,000 mtCO<sub>2</sub>e/year, approximately 48 percent (13) of all facilities exceed a threshold of 25,000 mtCO<sub>2</sub>e/year, approximately 59 percent (16 facilities) of all facilities exceed a threshold of 10,000 mtCO<sub>2</sub>e/year, and approximately 63 percent (17 facilities) exceed a threshold of 1,000 mtCO<sub>2</sub>e/year. Based on these estimates, approximately 92 percent of emissions result from facilities that emit more than 25,000 mtCO<sub>2</sub>e annually, approximately 98 percent of emissions result from facilities that emit more than 10,000 mtCO<sub>2</sub>e annually, and approximately 99 percent of emissions result facilities that emit more than 1,000 mtCO<sub>2</sub>e annually. To include all facilities in the reporting framework, a threshold of approximately 500 mtCO<sub>2</sub>e would be required.

## 5. Options for Monitoring Methods

As described in Section 4, lead smelters can release both combustion and process-related GHG emissions. The process-related GHG emissions are produced at primary and secondary lead smelters operating smelting furnaces (e.g., blast furnace) in which coke or another carbonaceous reducing agent is charged. This section describes monitoring method options for estimating process-related GHG emissions from the lead production source category.

### **5.1 Option 1: Simplified Emission Calculation**

The monitoring method is a simplified emission calculation method using only default emission factors to estimate CO<sub>2</sub> emissions. The method requires multiplying the amount of lead produced for a specific reporting period (e.g., annual) by the appropriate default emission factors applicable to the lead smelter operations obtained from the 2006 IPCC guidelines. This option is the IPCC Tier 1 method described in Section 3.1. Implementation of this method requires facility owners and operators to keep records of metric tons of lead produced. As these records are expected to already be maintained, this method is the easiest option for the facility owner or operator to implement. However, because lead smelters can differ substantially in the number and types of furnaces operated and other site-specific factors, use of default emission factors introduces the greatest level of uncertainty to the annual GHG emissions determinations for individual facilities.

### **5.2 Option 2: Facility-Specific Carbon Balance Calculation**

The monitoring method requires performing monthly measurements of the carbon content of specific process inputs and the mass rate of these inputs. This is the IPCC Tier 3 method and the higher order methods in the Canadian and Australian reporting programs. This method requires facility owners and operators to determine the carbon contents of materials added to the source 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 lead production are measured and recorded. To obtain the process-related CO<sub>2</sub> emission estimate, the material carbon content would be multiplied by the corresponding mass of material consumed and a conversion of carbon to CO<sub>2</sub> assuming that all of the carbon is converted during the reduction process. This method is more accurate than Option 1 because it accounts for the process materials actually used by the each individual facility. However, the method does require more recordkeeping and computations on the part of the facility owner or operator.

For this method, the facility owner or operator would report in addition to GHG emissions, the facility lead product produced, carbon content of reducing agents consumed, and quantity of carbon recovered for downstream use, if any. In addition, 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 on a periodic basis (e.g., annually).

### **5.3 Option 3: Facility-Specific Emission Factor Using Stack Test Data**

This monitoring method is applicable to lead smelter sources for which the GHG emissions are contained within a stack or vent. The monitoring method uses stack test data to develop a site-specific process emissions factor which is then applied to quantity measurement data of feed material or product for the specified reporting period. For this method, a CO<sub>2</sub> emissions measurement stack test would be performed concurrently with measuring the input material feed rate or product output rate during the test, and the fuel usage during the test (if applicable to the unit) to determine the site-specific CO<sub>2</sub> process emissions factor for the source (e.g., metric ton of CO<sub>2</sub> emitted per metric ton of lead product produced). The total annual CO<sub>2</sub> process emissions for the source would be calculated by multiplying this site-specific CO<sub>2</sub> process emission factor

by the total amount of the appropriate input material or product, as applicable to the emissions factor, recorded for the operation of the source during the specified reporting period.

For stack testing, sampling equipment would be periodically brought to the site and installed temporarily in the stack to collect a sample of the stack gas for analysis to determine the CO<sub>2</sub> concentration in the gas stream. During the test, the flow rate of the stack gas would also be measured allowing the calculation of the CO<sub>2</sub> mass emission rate for the source. For a lead smelter source for which both combustion and process-related emissions are released by the source (e.g. blast furnace), measuring fuel usage during the stack test would allow an emissions factor for process-related emissions to be calculated by subtracting the contribution due to the carbon in the fuel burned from the total emissions measured by the test.. The performing of a stack test requires additional cost and time to implement the method compared to Options 1 and 2.

In general, the facility-specific emission factor should be re-established on a periodic basis by performing a new stack test. The facility owner or operator would report for each stack test conducted the measured GHG concentrations in the stack gas, the monitored stack gas flow rate for each monitored emission point, and the time period during which the stack test was conducted. The process operating conditions (e.g., raw material feed rates) during the time period when the test was conducted would be reported.

This method can offer a higher level of accuracy than either Options 1 or 2 since actual stack test data are used for each facility to obtain facility-specific GHG emission factors. However, the method may not be appropriate for all lead smelters depending on the site-specific operations conducted at the facility. A method using periodic, short-term stack testing would be appropriate for those facilities where process inputs (e.g., feed materials, carbonaceous reducing agents) and process operating parameters remain relatively consistent over time. In cases where there is the potential for significant variations in the process input characteristics or operating conditions, continuous or more frequent measurements would be needed to accurately record changes in the actual GHG emissions from the sources resulting from any process variations.

#### **5.4 Option 4: Direct Measurement Using CEMS**

Another monitoring method applicable to lead smelter sources for which the GHG emissions are contained within a stack or vent is direct measurement using a continuous emissions monitoring system (CEMS). The CEMS measures total CO<sub>2</sub> emissions in the exhaust gas stream from a source so the recorded results would represent the combined combustion and process-related emissions for those lead smelter sources in which a fossil-fuel is burned.

Direct measurements of the GHG concentration in the stack gas and the flow rate of the stack gas can be made using a CEMS. The difference between this option and Option 3 is using a CEMS provides a continuous measurement of the emissions while a stack test provides a periodic measurement of the emissions. Because a CEMS would continuously measure actual CO<sub>2</sub> emissions from a given lead smelter source when it is in operation, this method is the most accurate monitoring method for determining GHG emissions from a specific source. The costs for installing and operating a CEMS for direct measurements of GHG emissions from a given lead smelter would be higher than for using one of the other monitoring method options.

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., CO<sub>2</sub>) 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. Under a CEMS approach, the results of the recorded emissions measurement data would be reported annually.

## **6. Procedures for Estimating Missing Data**

Procedures for estimating missing data vary depending on the monitoring method used for determining annual GHG emissions from a source. Each of the options described in Section 6 would require a complete record of 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, 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 available from the IPCC guidelines (IPCC 2006).

### **6.2 Procedures for Option 2: Facility-Specific Carbon Balance Calculation**

When assuming a 100% conversion of C to CO<sub>2</sub>, 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 owner or operator would need to extrapolate a value from previous years operating data taking into consideration any changes in production or process.

### **6.3 Procedures for Option 3: Facility-Specific Emission Factor Using Stack Test Data**

For a method requiring measurement of CO<sub>2</sub> 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 (US EPA 2005). The 2005 Guidance Document states 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. 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. The test plan for a stack test used to obtain data for the purposes of emissions reporting would be made available for review prior to performing the stack test, and the stack test results would be reviewed with respect to the test plan prior to the data being deemed acceptable for the purposes of emissions reporting. 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.

## **7.4 Procedures for Option 4: Direct Measurement Using CEMS**

For a method requiring direct measurement of CO<sub>2</sub> emissions using CEMS, procedures for management of missing data established by the U.S. EPA in 40 CFR Part 75 could be used. These 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 CO<sub>2</sub> flow rates or CO<sub>2</sub> emissions during the period in which CEMS data are missing.

## **7. QA/QC Requirements**

Facility owners and operators should conduct quality assurance (QA) and quality control (QC) of the information used for each GHG emissions determination including production and consumption data, supplier information (e.g., carbon contents), and emission estimates calculations performed. Facility owners and operators 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 described below.

### **7.1 Combustion Emissions**

Facility owner and operators can find more information on the QA/QC requirements associated with methods for estimating CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions from stationary combustions in the General Stationary Combustion Source Technical Support Document at EPA-HQ-OAR-2008-0508-004.

### **7.2 Process Emissions**

The QA/QC requirements vary depending on the monitoring method used for determining annual GHG emissions from a source. Each option would require QA/QC measures appropriate to the particular methodology used to ensure proper emission monitoring and reporting.

#### **7.2.1 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.

### 7.2.2 Stack Test Data

For a method requiring measurement of CO<sub>2</sub> emissions using stack testing, the stack test should be performed according to the quality assurance guidelines and data quality objectives established by the U.S. EPA, including the Clean Air Act National Stack Testing Guidance (US EPA 2005).

### 7.2.3 CEMS

For a method requiring direct measurement of CO<sub>2</sub> emissions using CEMS, 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 (EPA 2008a).

## 7.3 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 Emission Information to be Reported**

Lead smelter owners and operators would report annual process CO<sub>2</sub> emissions. Depending on the monitoring method used (discussed in Section 6), additional information could 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 smelting furnaces operated at the facility, lead product production quantities, raw material quantities purchased and consumed, and fossil fuel usage. In addition, facility owners and operators could report additional information to assist in QA/QC of any site-specific GHG emissions data used for the reported emissions determination.

For a full discussion of stationary combustion reporting options, please refer to (EPA-HQ-OAR-2008-0508-004).

### **8.1 Additional Data to be Retained Onsite**

Owners and operators of facilities reporting GHG emissions should be required to retain certain process configuration information and operating data used for their GHG emissions determinations onsite for a period of at least three years from the reporting year. Process configuration information would include combustion device types, numbers, and sizes, and identification of process equipment using carbonaceous input materials. Process operating data would include process raw material feed rates and carbon contents, and lead product production quantities. These data could be used to conduct trend analyses and potentially to develop process or activity-specific emission factors for lead smelters. For method using stack testing, these data would include stack test reports and associated sampling and chemical analytical data for the stack test. For method using emission monitoring systems, data would include measured GHG concentrations and stack gas flow rates, calibration and quality assurance records.

## 9. References

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