CASE STUDY #2: POINT SOURCE - FOUNDRY

Part 4: Solution

The solution to this case study has three parts: the Inventory Preparation Plan/Quality Assurance Plan, and the emissions calculations and documentation.

Solution – Inventory Preparation Plan/Quality Assurance Plan

The contents of the Inventory Preparation Plan/Quality Assurance Plan should be based upon the outline provided in Part 3, above. Time limitations will dictate the level of detail that can be included in the Inventory Preparation Plan/Quality Assurance Plan. An example of the minimum level of detail that should be included in the Inventory Preparation Plan/Quality Assurance Plan for this case study is as follows:

- Background and purpose of the inventory – There have been no previous efforts to develop emission estimates for this facility. The basis for this point source inventory is to aid in policy making by the local air quality regulating agency.
- Inventory area status – attainment vs. nonattainment status;
- Inventory scope:
  1. Inventory area/facility: Gray iron foundry;
  2. Pollutants of concern: NO_x, SO_x, CO, VOC, PM_{10}, and $PM_{2.5}$;
  3. Sources: Materials handling (2 conveyors), metal melting (4 furnaces), iron refining (fugitive emissions), mold and core production (2 sand handling units), casting and finish (fugitive emissions); and
  4. Temporal resolution: Annual emissions for the year 2004.
- Data quality objectives:
  1. The inventory should include all the sources listed; and
  2. Emission estimates should be 100% correct.
- Inventory resources:
  1. Team
  2. Overall project manager
  3. Team manager
  4. Data evaluator

- Emissions estimation methodologies – Emission factors and activity data; stack monitoring data.

Table1. Emission Estimation Methodology: Uncontrolled Emissions

Process	**Pollutant**	**Methodology**	**Equation**	**Data needed**
Materials Handling: 2 Conveyor belts	$PM_{2.5}$ PM_{10}	Emission Factor and Activity Data	EF = k x 0.0016 x $[(U/2.2)^{1.3}/(M/2)^{1.4}]$ E = EF x A x 12 month/year EF = Emission factor (kg/Mg of material) k = Particle size multiplier (k = 0.35 for PM_{10} and 0.11 for $PM_{2.5}$) U = Mean wind speed, meters per second (m/s) M = Material moisture content (%) E = Emissions (Mg/Year) A = Throughput (Mg/month)	U M A
Metal Melting: Degreasing – 2 booths	VOC	Material Balance	E = S x VOC E = Emissions (g/year) S = Solvent used (liters/year) VOC = VOC content of solvent (g/liter)	S VOC
Metal Melting: 4 Electric Arc Furnaces	PM	Source test	E = (PM test/V) x FR x 60 x (1kg/1000g) E = Emissions (kg/hr) PM test = PM collected on filter (g) V = volume of gas sampled (dscm) FR = flow rate (dscmm)	PM test V FR
Metal Melting: 4 Electric Arc Furnaces	SO2 NOx CO	CEM	E = (P conc x MW x FR x 60)/(24.07 m3/kg-mole x 10^6) E = Emissions (kg/hr) P conc = pollutant concentration (ppmv) MW = molecular weight of pollutant (kg/kg-mole) FR = stack flow rate (dscmm)	P conc MW FR
Metal Melting: 4 Electric Arc Furnaces	VOC	Emission Factor and Activity Data	E = EF x A E = Emissions (kg/yr) EF = emission factor =0.09 kg/Mg Iron produced A = Mg iron produced /yr	A

Process	Pollutant	Methodology	Equation	Data needed
Iron Refining	PM	Emission Factor and Activity Data	E = EF x A x 0.49 for PM_{10}	A
			E = EF x A x 0.24 for $PM_{2.5}$	
Iron Refining			E = Emissions (kg/yr)	
Magnesium treatment			EF = emission factor	
			EF = 2 kg/Mg for iron refining	
			EF = 0.2 kg/Mg for magnesium treatment	
			A = Mg material/yr	
Mold and Core Production:	PM	Emission Factor and Activity Data	E = EF x A x 0.70 for PM_{10}	A
			E = EF x A x 0.42 for $PM_{2.5}$	
Shakeout			E = Emissions (kg/yr)	
Sand handling – 2 units			EF = emission factor	
			EF = 1.6 kg/Mg for shakeout	
Baking			EF = 1.8 kg/Mg for sand handling	
			EF = 0.6 kg/Mg for baking	
			A = Mg material /yr	
Casting and Finishing: Pouring	PM	Emission Factor and Activity Data	E = EF x A x 0.49 for PM_{10}	A
			E = EF x A x 0.24 for $PM_{2.5}$	
Finishing			E = Emissions (kg/yr)	
			EF = emission factor	
			EF = 2.1 kg/Mg for pouring	
			EF = 0.05 kg/Mg for finishing	
			A = Mg material /yr	

What units have hourly emissions that need to be converted? What is equation to convert hourly emissions to annual?

For Electric Arc Furnaces emissions of PM, SO2, CO and NOx, convert hourly emissions to annual emissions by using operational data for facility.

Emissions (kg/yr) = emissions (kg/hr) x 12 (hrs/day) x 5 (days/week) x 52 (weeks/yr) = 3120 (hr/yr) x emissions (kg/hr)

What is equation to calculate controlled emissions?

For controlled emissions, use capture and control efficiency data.

Controlled emissions = Uncontrolled emissions (1 – (CapEff x ConEff))

Cap Eff – Capture efficiency expressed as a fraction

Con Eff – Control efficiency expressed as a fraction

Complete Table 2 to calculate controlled emissions.

Table 2. Control Emissions Data

Process	**Unit**	**Pollutant**	**Control Equipment**	**Capture Efficiency (%)**	**Control Efficiency (%)**	**Equation**
Materials Handling	Coke	PM	Baghouse with fabric filter	85	95	Controlled emissions = Uncontrolled emissions x (1- (0.95 x 0.85))
Materials Handling	Pellet	PM	Baghouse with fabric filter	100	95	Controlled emissions = Uncontrolled emissions x (1- (1 x 0.95))
Metal Melting		PM	Baghouse	100	95	Controlled emissions = Uncontrolled emissions x (1- (1 x 0.95))

- QA/QC procedures – Internal QC steps should be briefly outlined in the Inventory Preparation Plan, and could include:

  1. Checking emission calculations for errors;
  2. Checking emission factors to ensure the appropriateness of the factors used; and
  3. Documenting all the assumptions made during emission calculations.

Solution - Calculations

See attached spreadsheet.

Part 5: Documentation

Due to time limitations, it is not possible to develop a complete emissions inventory report. However, an outline or annotated outline can be developed which contains the following elements:

- Description of the source category (i.e., gray iron foundries);
- Explanation of the methods used for data collection, and sources of data collected (e.g., source tests for some sources);
- Explanation of the assumptions made in data collection and in the data analysis phase (e.g., assume equal production for each furnace);
- Emission estimation methods;
- Emission factors and their sources;
- Emission calculations and assumptions;
- Internal QC checks implemented and results of external QA including findings and corrections made; and
- Results (e.g., tables, pie charts) and analysis (e.g., comparisons/controls) among sub-categories.

ATTACHMENT

SOLUTION FOR
POINT SOURCE - FOUNDRY CASE STUDY
(SPREADSHEET)