

# Dispersion Modeling Analysis for Cuyahoga County, Ohio

## Lead NAAQS Partial Nonattainment Area

### Introduction

This document was prepared to support Ohio's June 25, 2012 lead attainment demonstration for the partial Cuyahoga County nonattainment area in the State of Ohio. This partial nonattainment area encompasses emissions from the Ferro Corporation Cleveland Frit Plant (herein referred to as "Ferro"). Ferro (Ohio EPA facility identification # 1318170235) is located at 4150 East 56th Street, Cleveland, Ohio, 44101. Ferro is the only source of lead emissions in this nonattainment area.

Per U.S. EPA's guidance (2008 Lead (Pb) National Ambient Air Quality Standards (NAAQS) Implementation Questions and Answers, July 8, 2011 (herein referred to as "Q&A Guidance"), "modeling for attainment demonstrations is used to show that a nonattainment area will be in attainment by the attainment date. The modeling is used to show the effectiveness of control measures on the sources."

Two dispersion modeling analyses were performed for this SIP analysis. One was an analysis relevant to a period in 2010 when exceedances were occurring and prior to Ferro repairing degraded equipment (base case). Ohio EPA's analysis demonstrates the level of lead emissions that had to have occurred during a representative period when the facility's control equipment necessitated repair. The second analysis demonstrates when the equipment is functioning properly and maintained properly, Ferro's federally enforceable permit limits will provide for attainment of the standard (future case). The two analyses are discussed in greater detail below.

The base case analysis evaluated a reasonable estimate of maximum actual emissions to determine the contribution of excessive emissions from the degraded equipment at Ferro that contribute to the highest monitored concentrations. For this analysis, Ohio EPA selected the 3-month period of October to December 2010, when the highest three-month rolling average of 0.531 ug/m<sup>3</sup> occurred.

The future case analysis evaluated the existing controls which Ohio EPA determined were Reasonably Available Control Measures, federally enforceable permit limits, and the absence of excessive emissions resulting from the degraded equipment. Ferro implemented a Preventative Maintenance Plan intended to ensure excessive emissions of lead at the baghouses will be eliminated in the future. Dispersion modeling was used to validate that the control strategies and permit limits will provide for attainment of the standard.

### Modeling Approach

Per U.S. EPA's Q&A Guidance, modeling analyses should conform with EPA's guidelines on air quality models contained in Appendix W to 40 CFR part 51. ([http://www.epa.gov/ttn/scram/guidance/guide/appw\\_05.pdf](http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf).) Modeling input data, including emission rates, are addressed in Section 8.0 of Appendix W. The averaging period for the 2008 Lead NAAQS is a rolling 3-month average evaluated over a 3-year period. Accordingly, modeled emissions

rates should be based on concentration estimates for this same period (3-month average) as described in Section 10.2.3 of Appendix W.

The recommended dispersion model for SIP modeling for lead is the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) modeling system. There are two input data processors that are regulatory components of the AERMOD modeling system: AERMET, a meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP, a terrain data preprocessor that incorporates complex terrain using United States Geological Survey (USGS) Digital Elevation Data.

### **Meteorological Data**

In order to generate meteorological input data for use with AERMOD, AERMET, along with AERSURFACE for the modeling domain was conducted to generate the surface (.sfc) and profile (.pfl). Ohio EPA used the AERMINUTE pre-processing module. This module accepts as input 1-minute ASOS meteorological surface observations, calculates an hourly average for each hour in the modeled time period, and substitutes any missing values from the co-located ISHD surface data. Use of AERMINUTE reduces the number of calm hours in the input files and is therefore considered more representative of local meteorological conditions.

Meteorological data from 2007 through 2011 from the Cleveland (OH) surface station (Station # 14820) and the Buffalo (NY) upper air station (Station # 14733) were used in these analyses. These sites were determined to be representative of Cleveland, Ohio. AERSURFACE was run using twelve sectors and four seasons.

### **Background**

Ohio EPA does not believe a background concentration is necessitated as a part of these analyses. Only point sources emissions, specifically from Ferro are addressed as a part of this submittal. This nonattainment area does not contain any additional sources of lead emissions that warrant inclusion in this analysis. It was determined during the designation process that Ferro was the source of the elevated lead concentrations in Cuyahoga County, and therefore, Ohio EPA recommended, and U.S. EPA established a nonattainment boundary around only this facility. However, Ohio EPA did receive comment from U.S. EPA regarding the use of background concentrations. Although Ohio EPA believes the modeling conducted is extremely conservative in nature, Ohio EPA is including a background concentration analysis per U.S. EPA's request. Addition of this background results in an even greater level of conservatism in this demonstration of attainment.

As stated above, Ohio EPA modeled two different scenarios at Ferro. The base case modeling shows the source and cause of the exceedance, while the attainment modeling shows the control measures that ensure no future modeled exceedances.

### **Base Case Analysis**

The base case analysis compared modeled predicted rolling three-month average concentrations to actual monitored concentrations during the same period. The modeled base case was a reasonable attempt to replicate actual conditions. The purpose of modeling actual conditions was to determine the

cause of the exceedance and the contribution to the modeled exceedance by each source. The period for base case simulation for lead for Ferro was October to December 2010.

Emission Sources

The release points of the Ferro emission units are located within a couple of hundred meters of the monitor (Figure 1). Ohio EPA modeled each of the eight emission units, exhausting from five stacks. As stated in the Attainment Demonstration analysis document, it has been determined that equipment degradation, such as several small cracks in the canisters and damage to hopper dump slide gates, on several baghouses caused exceedances at the monitor. Modeled emission rates for the lead sources at Ferro are based on federally enforceable allowable emission rates from the sources without degraded equipment (FEM 12 and FEM 8) and replicated actual emissions for the sources with degraded equipment (FEM 9 and FEM 10) during the period of excess emissions. Table 1 below shows the source parameters modeled and the federally enforceable permit allowables.

Sources	Description	X (m)	Y (m)	Elev. (m)	Stk Hgt. (m)	Temp.(K)	Exit Velo. (m/s)	Stk Dia. (m)	Emission Rate (lb/hr)
P064, P065	FEM8	445675	4588330	216.18	6.096	338.71	24.26	0.2438	0.020
P066, P067	FEM9	445675	4588340	216.18	6.096	338.71	24.26	0.2438	2.000
P068, P069	FEM10	445675	4588347	216.18	6.096	338.71	24.26	0.2438	1.000
P071	FEM12	445770	4588339	216.12	6.096	310.93	9.57	0.1524	0.002
P915	CERC	445809	4588403	216.12	9.144	338.71	16.54	0.3566	0.000

Table 1: Base Case modeling source parameters for Ferro

Building downwash from the Ferro facility was included in the modeling.

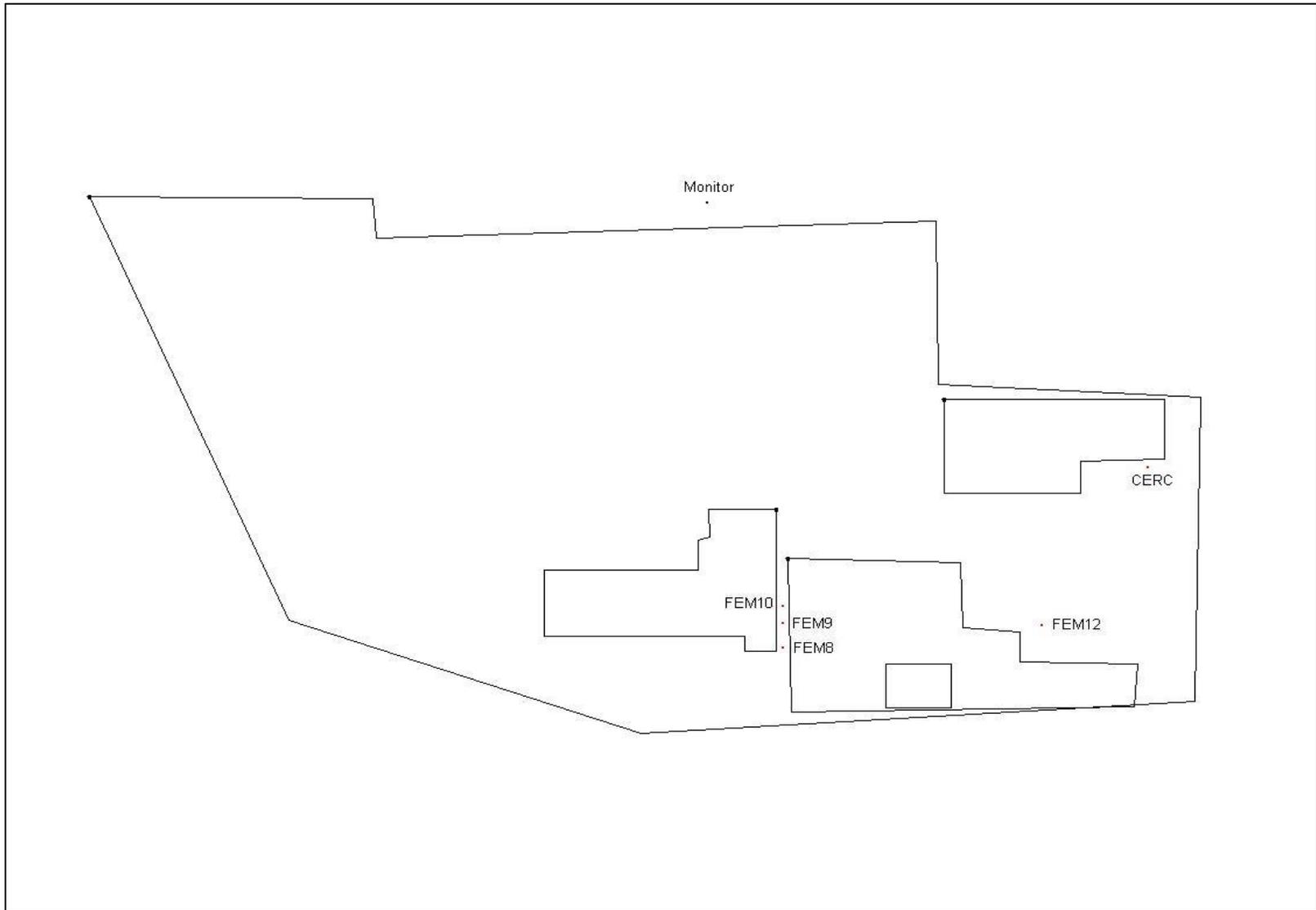


Figure 1: Ferro showing point sources, the fugitive emissions source, and the lead monitor

## Receptors

It was only necessary for a single receptor, at the location of the monitor (see Figure 1 above), to be modeled for the base case as the purpose of this scenario was to duplicate the monitored exceedance. The modeled results were then compared to the 3-month rolling average for the exceedance period that occurred at the monitor and then ratioed appropriately.

## Meteorology

In order to replicate actual conditions during the violating period, the base case was modeled using only 2010 meteorological data. The lead post processor was run for the exceedance period only, October through December 2010, to provide a direct comparison to the exceedance period.

## Results

Post files for each source were created and contributions from each of the sources were processed by the lead post processor. Modeled results for the violating period shows the highest average to be 3.4614  $\mu\text{g}/\text{m}^3$  for the rolling three-month period ending on December, 2010. Ohio EPA is using the model as a tool to back-calculate unknown emission rates to help accurately characterize the facility. This procedure for each scenario is detailed below.

AERMOD model results were ratioed, or scaled to determine the emission from the sources with degraded equipment, Emission Units P066, P067 (FEM9), P068, and P069 (FEM10). Due to the unknown lead emission rate of these sources, results had to be scaled so the total modeled concentration matches the monitored value. The scaled value was determined by calculating each source's contribution to the maximum modeled concentration. First, Ohio EPA subtracted the contribution from each of the sources with known emission rates from the total modeled concentration, leaving only the contribution of units controlled by FEM9 and FEM10 remaining. For those sources whose emission rates are known, the contribution to the monitor value will not change. The fractional contribution of FEM9 and FEM10 to this remainder was then calculated. To determine the contribution of FEM9 and FEM10 to the monitored value, the contribution of the known sources was subtracted from the monitored value, and the remainder multiplied by the fractional contribution of each unknown source. Lastly, the emission rates for those sources controlled by FEM9 and FEM10 were calculated by multiplying the monitor contribution of each source by its modeled emission rate and dividing this result by the modeled contribution. Results of these calculations are shown in Table 2.

Emissions Unit	Description of Source Emissions	Maximum Modeled Contribution ( $\mu\text{g}/\text{m}^3$ )	Monitor Normalized Contribution ( $\mu\text{g}/\text{m}^3$ )	Percent Contribution ( $\mu\text{g}/\text{m}^3$ )
P064, P065 (FEM8)	Melter #s 1 and 2	0.0220	0.0220	4.15%
P066, P067 (FEM9)	Melter #s 3 and 5	2.2765	0.3361	63.29%
P068, P069 (FEM10)	Melter #s and 10	1.1614	0.1714	32.28%
P071 (FEM12)	Solvent Dryers	0.0015	0.0015	0.28%
<b>Facility Total</b>		<b>3.4614</b>	<b>0.5310</b>	

Table 2: Base Case modeled source group contribution to maximum concentration for Ferro

Qualitative agreement would not be exact agreement between modeled and monitored concentrations in time and space but would represent similarity in concentration trends over time and dispersion patterns in a general area. Once the current actual conditions have been sufficiently replicated, the effectiveness of the control strategies can be estimated through the future case analysis.

### **Future Case Analysis**

The purpose of this analysis was to evaluate the repair of the degraded equipment evaluated under the base case and to also evaluate the proposed emissions limitations.

This modeling scenario should demonstrate attainment of the 2008 lead NAAQS in this nonattainment area.

### Emissions Rates

As discussed in the Attainment Demonstration analysis document, Ohio EPA believes the changes made by the facility and the implementation of the Preventative Maintenance Plan will eliminate the excessive emissions experienced due to the degraded equipment. Table 3 below shows the modeled federally enforceable allowable emission rates for the Future Case and the source parameters.

Sources	Description	X (m)	Y (m)	Elev. (m)	Stk Hgt. (m)	Temp.(K)	Exit Velo. (m/s)	Stk Dia. (m)	Emission Rate (lb/hr)
P064, P065	FEM8	445675	4588330	216.18	6.096	338.71	24.26	0.2438	0.020
P066, P067	FEM9	445675	4588340	216.18	6.096	338.71	24.26	0.2438	0.020
P068, P069	FEM10	445675	4588347	216.18	6.096	338.71	24.26	0.2438	0.020
P071	FEM12	445770	4588339	216.12	6.096	310.93	9.57	0.1524	0.002
P915	CERC	445809	4588403	216.12	9.144	338.71	16.54	0.3566	0.000

Table 3: Future Case modeled source parameters for Ferro

U.S. EPA's Q&A guidance states "for attainment modeling, maximum allowable or federally enforceable permit limits should be the basis of the model input emissions, as described in Section 8.1 and Table 8-1 of Appendix W and the Guideline for Air Quality Models." The emission rates identified above are federally enforceable.

Ferro was issued a renewal Title V permit effective September 20, 2011 and October 6, 2014. Emission units P064-P069 each have a limit for particulate matter of 0.01 lb/hr. In order to be extremely conservative, Ohio EPA applied this particulate matter limit as if the particulates were 100 percent lead. These units also exhaust through three different stacks.

### Receptors

A total of 3758 receptors, within a 1 km radius of the facility, were modeled, as seen in Figure X below. A discrete receptor was added at the monitor location.

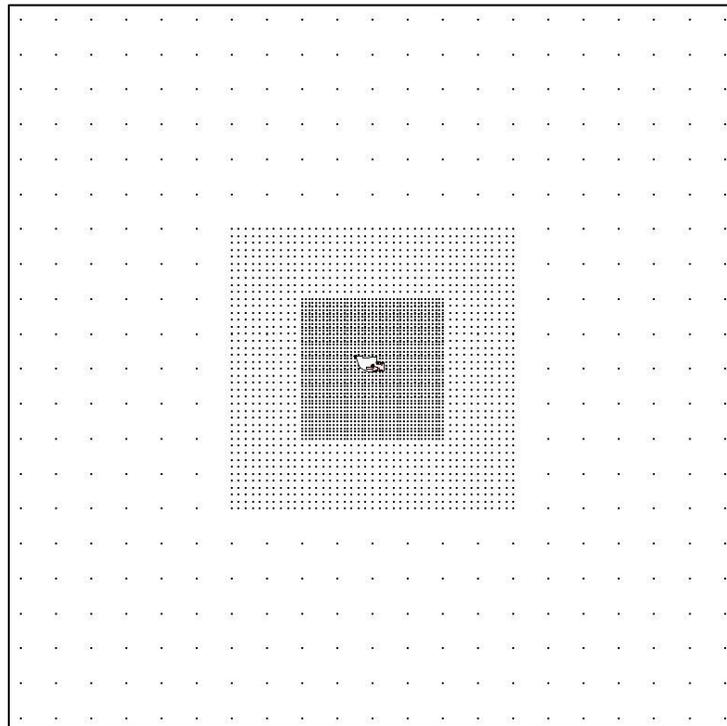


Figure 2: Ferro receptor grid, showing 50 meter spacing for the innermost receptor grid.

### Meteorology

This analysis was based on 5-year meteorological data (January 2007-December 2011) as described in the general meteorology section at the beginning of this document.

### Results

Two emission scenarios were considered for modeling attainment. Scenario 1 modeled emission rates from each unit (P064-P069) based on the particulate emissions limits of 0.01 lb/hr contained in the permit. This produced a combined limit of all sources (FEM8, FEM9, and FEM10) of 0.06 lb/hr. In

Scenario 2, the modeling was conducted at ninety percent of the maximum permit limits of each emission unit at 0.009 lb/hr with total emission from all sources (FEM8, FEM9, and FEM10) at 0.054 lb/hr.

*Scenario 1. FEM8, FEM9 and FEM10 with maximum permit limits of 0.01 lb/hr per emissions unit (P064 - P096).*

In this modeled emissions scenario, the contribution of all emission units were evaluated. A maximum hourly emissions limit of 0.06 lb/hr was apportioned equally to the egress points representing FEM8, FEM9, and FEM10. Also included in this scenario were the emissions from P071 (FEM12), and the emissions of P915 were set to zero. Modeled emission rates are summarized in Table 4, below.

Sources	Description	X (m)	Y (m)	Elev. (m)	Stk Hgt (m)	Temp.(K)	Exit Velo. (m/s)	Stk Dia (m)	Emission Rate (lb/hr)
P064, P065	FEM8	445675.0	4588330.0	216.18	6.096	338.71	24.26	0.2438	0.020
P066, P067	FEM9	445675.0	4588340.0	216.18	6.096	338.71	24.26	0.2438	0.020
P068, P069	FEM10	445675.0	4588347.0	216.18	6.096	338.71	24.26	0.2438	0.020
P071	FEM12	445770.0	4588339.0	216.12	6.096	310.93	9.57	0.1524	0.002
P915	CERC	445809.0	4588403.0	216.12	9.144	338.71	16.54	0.3566	0.000

Table 4: Emission rates for all units (P064-P069) operating at maximum allowable limit (0.01 lb/hr)

The lead post-processor calculated the maximum three-month average concentration modeled during the 2007 to 2011 period, as well as the contribution of each source (FEM8, FEM9, FEM10, and FEM12) to this maximum. The results of the post-processing analysis are shown in Table 5, below.

Source Group	3-month Max Concentration (ug/m3)	Percent Contribution
FEM8	0.0475267	31.17
FEM9	0.0496600	32.57
FEM10	0.0511533	33.54
FEM12	0.0041500	2.72
TOTAL	0.1524930	

Table 5: FEM8, FEM9, and FEM10 with emission rate of 0.01 lb/hr each unit (P064 – P069)

The maximum modeled concentration from all sources was 0.152493 ug/m3, demonstrating that the federally enforceable permit limitations along with the repairs and strategies discussed in the Attainment Demonstration analysis document provide for attainment of the 2008 lead standard.

However, as discussed above, U.S. EPA has requested an analysis of potential background contribution to be included in this already conservative analysis. Ohio EPA analyzed meteorology (wind direction) and

monitor readings during the 2010 to 2011 period (Table 6). During any 24-hour period when the monitor is collecting possible lead data, wind direction readings are taken as a 2-minute average once per hour. The result is approximately 48 minutes of wind patterns during the day (1440 minutes) determining the predominant wind pattern for that day. A background concentration was derived using only monitored days where those 48 minutes indicated wind patterns from predominantly the north (WNW to ENE). Ohio EPA stresses that this is highly conservative as this represents less than 4% of the day's wind patterns while the monitor is collecting lead data continuously for that 24-hour period. It is likely that emissions from Ferro could have contributed to the monitor values during this period as wind patterns can shift throughout the day. Therefore, Ohio EPA believes this background analysis is extremely conservative.

<b>Date</b>	<b>ug/m3</b>
1/2/2010	0.015
3/3/2010	0.009
3/15/2010	0.029
4/26/2010	0.022
12/22/2010	0.019
5/3/2011	0.00916
5/9/2011	0.01920
6/2/2011	0.02010
6/14/2011	0.01870
9/6/2011	0.00577
<b>Average</b>	<b>0.016693</b>

Table 6: Background average lead concentration at the monitor.

Applying the conservative background concentration to the already conservative modeling analysis above provides for a predicted concentration of 0.169186 ug/m3. Regardless, Ohio EPA believes the weight-of-evidence demonstrates that the area will attain the standard by the attainment date. Specifically, AERMOD is a conservative model alone and Ohio EPA made additional assumptions that are extremely conservative in nature. The future case attainment analysis assumes that all six (P064 to P069) 220 lbs product/cycle electric glass melters are running at full capacity simultaneously. The particulate emissions limit of 0.01 lb/hr is based upon FIRE 6.22 emissions factors for frit smelting with a fabric filter (0.02 lb/ton) at the maximum production rate for the emissions unit. In reality all six units have never, and would never, run at maximum capacity simultaneously. The analysis assumes that 100% of the particulate emissions are in the form of lead. In reality this could never occur. Ferro's raw lead containing ingredient is only 90% lead in the form of lead oxide. In addition, no single product made by Ferro requires a chemistry of 100% lead oxide. All products require the addition of other raw materials that contribute to the particulate emissions. Ohio EPA performed an additional modeling analysis to further demonstrate this weight-of-evidence approach ensures attainment of the standard

#### *Weight-of-Evidence Modeling Analysis*

Using the same methodologies as in the Scenario 1 future-case attainment modeling analysis, Ohio EPA performed a weight-of-evidence modeling analysis that maintains very conservative assumptions and demonstrates attainment even with the addition of a very conservative background concentration. As

discussed above, 100% of the particulate emissions could never be 100% lead. Ohio EPA is using a conservative assumption that 90% of the particulate emissions are in the form of lead. Ohio EPA consulted with Ferro to determine a realistic level of lead emissions that could result when Ferro produces a “worst-case” lead-based product. The worst-case lead-based product would result in significantly less than 90% lead as particulate. However, Ohio EPA modeled at 90% the particulate emissions rate to maintain this conservative approach to demonstrating attainment. In addition, this modeling still assumes all six emissions units are running at full capacity when Ferro has confirmed this has never been the case, nor would it be in the future.

*Scenario 2. FEM8, FEM9 and FEM10 with 90% of maximum permit limits: 0.054 lb/hr per emissions unit (P064 - P096).*

In this modeled emissions scenario, the contribution of all emission rate allocated to each unit was 90% of maximum permissible particulate limit, i.e., 0.009 lb/hr. The hourly emissions limit of 0.054 lb/hr was apportioned equally to the egress points representing FEM8, FEM9, and FEM10. Also included in this scenario were the emissions from P071 (FEM12), and the emissions of P915 were set to zero. Modeled emission rates are summarized in Table 7, below.

Sources	Description	X (m)	Y (m)	Elev. (m)	Stk Hgt (m)	Temp.( K)	Exit Velo. (m/s)	Stk Dia (m)	Emission Rate (lb/hr)
P064, P065	FEM8	445675.0	4588330.0	216.18	6.096	338.71	24.26	0.2438	0.018
P066, P067	FEM9	445675.0	4588340.0	216.18	6.096	338.71	24.26	0.2438	0.018
P068, P069	FEM10	445675.0	4588347.0	216.18	6.096	338.71	24.26	0.2438	0.018
P071	FEM12	445770.0	4588339.0	216.12	6.096	310.93	9.57	0.1524	0.002
P915	CERC	445809.0	4588403.0	216.12	9.144	338.71	16.54	0.3566	0.000

Table 7: Emission rates for all units (P064-P069) operating at 90% of the maximum allowable limit (0.009 lb/hr)

The lead post-processor calculated the maximum three-month average concentration modeled during the 2007 to 2011 period, as well as the contribution of each source (FEM8, FEM9, FEM10, and FEM12) to this maximum. The results of the post-processing analysis are shown in Table 8, below.

Source Group	3-month Max Concentration (ug/m3)	Percent Contribution
FEM8	0.0427733	31.07
FEM9	0.0446933	32.47
FEM10	0.0460367	33.44
FEM12	0.0041500	3.01
TOTAL	0.1376600	

Table 8: FEM8, FEM9, and FEM10 with emission rate of 0.009 lb/hr each unit (P064 – P069)

The maximum modeled concentration from all sources at ninety percent of the federally enforceable particulate permit limitations for sources FEM8, FEM9, and FEM10 was 0.137660 ug/m<sup>3</sup>, demonstrating that the removal of permitted allowable lead emissions from emission unit P915, along with the repairs and strategies discussed in the Attainment Demonstration document provide for attainment of the 2008 lead standard.

The above modeling analysis results in a predicted concentration of 0.137660 ug/m<sup>3</sup>. Applying the conservative background concentration to the already conservative modeling analysis above provides for a predicted concentration of 0.154343 ug/m<sup>3</sup>. Based on the weight-of-evidence provided above, this analysis further demonstrates attainment of the standard.