EXAMPLE CALCULATIONS FOR THE REFRACTORY PRODUCTS NESHAP

Introduction

The national emissions standards for hazardous air pollutants (NESHAP) for manufacturers of refractory products were finalized on April 16, 2003 (Federal Register Volume 68, Number 73, pages 18730 to 18785). To determine if you are subject to these standards, you must determine if you are a major source of hazardous air pollutants (HAP) emissions. If you are subject to these standards, you must meet the testing requirements included in the rule. Determining the applicability of the standards to your facility and following the testing procedures in the rule requires that you perform complex calculations. To assist you in these calculations, we have developed example calculations that you may use as guidance.

The example calculations in this document are presented in three sections. Section I provides example calculations that demonstrate how to determine whether your source is a major source of HAP and therefore subject to the rule. Section II provides example calculations for demonstrating compliance and establishing operating limits using performance test data for facilities manufacturing refractory products containing organic HAP. Section III provides example calculations for demonstrating compliance and establishing operating limits using performance test data for facilities manufacturing clay refractory products. Both Sections II and III also include example calculations that are specific to the testing of batch processes.

I. Example Calculations for Determining Total HAP Emissions

If you emit, or have the potential to emit, 10 tons per year (tons/yr) of any one HAP or 25 tons/yr of any combination of HAP then you will be subject to the emission limits and work practice standards included in the rule. Determining the total HAP emissions for your facility is the first step in determining whether or not you will be subject to the standard. For this purpose, we have provided some example calculations for manufacturers of refractory products containing organic HAP and clay refractory products. Although it is not possible to provide example calculations that cover every possible scenario, we have tried to provide several examples that we believe cover the most common situations that exist within the industry.

In developing the NESHAP for the refractory products manufacturing industry, EPA collected test data from refractory products manufacturing facilities. EPA used these test data to develop uncontrolled HAP emission factors for the industry. These emission factors, presented in Table 1, represent EPA's best estimate based on the data available to them. However, differences in the types of products manufactured, the additives used in those products, and process parameters such as curing time and temperature can all impact the amount of HAP emitted from a particular facility. Therefore, to determine the most representative estimates of HAP emissions from your facility, you should use the results of emission tests performed on your sources. In the absence of such site-specific test data, the uncontrolled HAP emission factors contained in Table 1 can be used in calculating your actual and potential emissions.

These emission factors reflect the amount of a particular pollutant that is actually emitted as a factor of the amount of the pollutant that is used or processed. For example, the emission factor for phenol for the curing and firing of resin-bonded products is 290 pounds per ton (lbs/ton) of phenol. This means that for every ton of phenol that is processed or used, 290 pounds is actually emitted.

Table 1. Summary of Uncontrolled HAP Emission Factors for Refractory Products Manufacturing Sources

Product type	Process/source[a]	Pollutant	Emission factor	Units
Resin-bonded	Curing and firing[b]	Phenol	290	lbs/ton of phenol
		Formaldehyde	790	lbs/ton of formaldehyde
		Methanol	2,000	lbs/ton of methanol
		Ethylene glycol	280	lbs/ton of ethylene glycol
Pitch-impregnated	Coking oven	POM	860	lbs/ton of pitch
	Defumer	POM	2.3	lbs/ton of pitch
	Working tank	POM	0.25	lbs/ton of pitch
	Main pitch storage tank	POM	0.030	lbs/ton of pitch
	Shape preheater	POM	0.33	lbs/ton of pitch
Pitch-bonded	Entire process line	POM	860	lbs/ton of pitch
	Heated mixer	POM	3.9	lbs/ton of pitch
	Main pitch storage tank	POM	0.030	lbs/ton of pitch
Other products that contain organic HAP	Dryer	Phenol	290	lbs/ton of phenol
		Formaldehyde	790	lbs/ton of formaldehyde
		Methanol	2,000	lbs/ton of methanol
		Ethylene glycol	280	lbs/ton of ethylene glycol
Chromium	Kiln[c]	Chromium compounds as Cr_2O_3	0.21	lbs Cr_2O_3/ton Cr_2O_3
		Cr^{+6}	0.0090	lbs Cr^{+6}/ton Cr_2O_3
Clay	Kiln	HF	0.38	lbs/ton clay
		HCl	0.26	lbs/ton clay
	Calciner	HF	0.19	lbs/ton clay
		HCl	0.13	lbs/ton clay
	Calciner (with venturi scrubber)	HF	0.0019	lbs/ton clay
		HCl	0.0013	lbs/ton clay

[a] Emission factors are for uncontrolled emissions unless noted.
[b] Factors apply to entire process line, including those which consist of curing only and those which consist of curing and firing.
[c] Emission factors are in units of pounds of pollutant per tons of chromium oxide (Cr_2O_3); Cr^{+6} = hexavalent chromium.

Part A of this section includes a general discussion concerning actual and potential emissions. Example calculations for facilities manufacturing refractory products containing organic HAP are presented in Part B. Examples for facilities manufacturing clay refractory products are presented in Part C.

A. Actual Emissions Versus Potential Emissions

The first step in determining if your facility is a major source of HAP, and is therefore subject to the standard, is to calculate your actual emissions. Calculating your facility's actual emissions is a relatively straightforward process. Actual emissions from a facility manufacturing refractory products containing organic HAP are a function of the HAP content of the refractory products and the production rate of those products. For clay refractory products, HAP emissions are a function of the percentage of uncalcined clay in the refractory products and the production rate of those products. The example calculations presented in Parts B and C of this section provide guidelines for determining your actual emissions.

If the actual HAP emissions for your facility are greater than 25 tons/yr (or 10 tons/yr of any one HAP), then you will be subject to the standard. However, even if your actual emissions are less than 10/25 tons/yr, you may still be subject to the standard if your potential emissions are greater than 10/25 tons/yr. Therefore, the second step for facilities with actual emissions less than 10/25 tons/yr is to determine your potential emissions to evaluate whether or not you are subject to the standard.

The definition of potential to emit is as follows:

"Potential to emit means the maximum capacity of a stationary source to emit a pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the stationary source to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is federally enforceable."

If your facility manufactures refractory products containing organic HAP, your potential emissions would be based on the maximum production rate for the facility at 8,760 hours/yr (24 hours/day x 365 days/yr), unless there is some physical or operational limit on the design or operation of your facility that prevents you from operating that many hours. For example, you may not be able to operate a kiln or other piece of equipment over that many hours because it would have to undergo maintenance a few weeks a year in order to operate properly. In that case, your maximum production could be based on something less than 8,760 hours/yr.

You would also have to assume that you were manufacturing the refractory product with the highest organic HAP processing rate for that 8,760 hours. If your facility manufactures clay refractory products, your potential emissions would be based on the maximum production rate for the facility at 8,760 hours/yr. You would also have to assume that you were manufacturing the product with the highest percentage of uncalcined clay for those 8,760 hours.

However, you can limit your potential to emit by agreeing to Federally enforceable limitations on your operations. Typically, these limitations would be included in your permit. For example, your facility may only operate 5,000 hours/yr. If you agree to limit your facility's annual operating time to 5,000 hours in your permit, your emissions would be based on your production at 5,000 hours/yr. On the other hand, if you only manufacture limited quantities of your highest emitting refractory product because there is no market for larger quantities, you could agree in your permit to limit your production of that product. In that case, your potential to emit would be based on that production limit.

There are a number of options for facilities that have actual emissions less than 10/25 tons/yr and potential emissions greater than 10/25 tons/yr. The examples presented in Parts B and C of this section attempt to address some of these options.

B. Example Emissions Calculations for Facilities Manufacturing Products Containing Organic HAP

This part presents example calculations that facilities manufacturing products containing organic HAP may find useful in determining their major source status with respect to HAP emissions.

Example 1: Calculation of Actual HAP Emissions from Resin-Bonded Refractory Production

The facility manufactures three types of resin-bonded products. The composition and production rate for each of these products is described below.

- Resin-bonded product 1: The resin used in this product contains 10 percent phenol and the product mix contains 8 percent resin. The facility manufactures 6,000 tons of the product per year.
- Resin-bonded product 2: The resin used in this product contains 9 percent phenol, 20 percent ethylene glycol, and 5 percent methanol. The product mix contains 6 percent resin. The facility manufactures 11,000 tons of the product per year.
- Resin-bonded product 3: The resin used in this product contains 6 percent phenol. The product mix contains 5 percent resin. The facility manufactures 3,000 tons of the product per year.

The first step in calculating actual emissions is to determine the annual organic HAP processing rate for each individual HAP in each product. Although the annual organic HAP processing rate only represents the amount of that HAP used or the amount of that HAP contained in the products manufactured during the year, the facility's actual emissions of that HAP are based on that value.

Resin-bonded product 1

The only HAP in this product is phenol. The annual organic HAP processing rate for phenol is:

6,000 tons x 10/100 x 8/100 = 48 tons phenol/yr

Resin-bonded product 2

This product contains phenol, ethylene glycol and methanol. The annual organic HAP processing rates are as follows:

11,000 x 9/100 x 6/100 = 59.4 tons phenol/yr
11,000 x 20/100 x 6/100 = 132 tons ethylene glycol/yr
11,000 x 5/100 x 6/100 = 33 tons methanol/yr

Resin-bonded product 3

This product also contains only phenol. The annual organic HAP processing rate for phenol is:

3,000 tons x 6/100 x 5/100 = 9 tons phenol/yr

Only a percentage of the HAP that is processed by the facility is actually emitted. As shown in Table 1, EPA developed emission factors for the industry to use in calculating actual HAP emissions. The emission factors for phenol, ethylene glycol, and methanol used in resin-bonded products are as follows:

- Phenol – 290 lbs/ton of phenol = 14.5 percent of phenol emitted
- Ethylene glycol – 280 lbs/ton of ethylene glycol = 14 percent of ethylene glycol emitted
- Methanol – 2,000 lbs/ton of methanol = 100 percent of methanol emitted

Using the annual organic HAP processing rates calculated above and the emission factors from Table 1, we can calculate total actual emissions of each HAP.

Phenol

(48 tons + 59.4 tons + 9 tons) x 14.5/100 = 16.9 tons of phenol

Ethylene glycol

132 tons x 14/100 = 18.5 tons of ethylene glycol

Methanol

33 tons x 100/100 = 33 tons of methanol

Total HAP emissions = 68.4 tons

Because the facility's actual HAP emissions are greater than 10/25 tons/yr, there is no need to calculate the facility's potential emissions. The facility is a major source of HAP based on its actual emissions and therefore will be subject to the standard.

Example 2: Calculation of Actual HAP Emissions from Pitch-Bonded Refractory Production

The facility manufactures two types of pitch-bonded products. The composition and production rate for both of these products are described below.

- Pitch-bonded product 1: The product mix contains 8 percent pitch. The facility manufactures 15,000 tons of the product per year.
- Pitch-bonded product 2: The product mix contains 7 percent pitch. The facility manufactures 10,000 tons of the product per year.

The first step in calculating actual emissions is to determine the annual organic HAP processing rate for polycyclic organic matter (POM) for each product. Pitch is considered to be 100 percent POM.

<u>Pitch-bonded product 1</u>

15,000 tons x 8/100 = 1,200 tons of POM

<u>Pitch-bonded product 2</u>

10,000 tons x 7/100 = 700 tons of POM

Based on EPA's emission factors, 860 pounds of POM are emitted for every 2,000 pounds that are processed, that is, 43 percent of the POM is emitted. Therefore, total POM emissions for the facility can be calculated as follows:

(1,200 tons + 700 tons) x 43/100 = 817 tons of POM

Because the facility's actual POM emissions are more than 10 tons/yr, the facility does not have to determine its potential emissions. The facility is a major source based on its actual emissions and is therefore subject to the standard.

<u>Example 3: Calculation of Actual HAP Emissions from Pitch-Impregnated Refractory Production</u>

The facility manufactures 1 type of pitch-impregnated product. The product contains 10 percent pitch. The facility produces 23,000 tons of the product per year. The annual organic HAP processing rate for POM for the product is:

23,000 tons x 10/100 = 2,300 tons of POM

Based on the emission factors developed by EPA, the coking oven is the primary source of POM emissions for the manufacture of pitch-impregnated products. The emission factor for the coking oven is 860 lbs of POM emitted per ton of pitch used. Therefore, 43 percent of the POM used is emitted in the coking oven.

2,300 tons x 43/100 = 989 tons POM

POM is also emitted in small quantities from the defumer, working tank, main pitch storage tank, and shape preheater. However, based on EPA's emission factors, these sources represent less than 1 percent of the total emissions. For example, emissions from the defumer and shape preheater are 2.3 and 0.33 lbs POM/ton of pitch, respectively. For this example, POM emissions from these sources would be negligible.

2.3/2,000 = 0.12 percent of pitch is emitted from the defumer
0.33/2,000 = 0.017 percent of pitch is emitted from the shape preheater

Total emissions from the defumer and preheater are as follows:

2,300 tons x 0.12/100 = 2.8 tons POM from the defumer
2,300 tons x 0.017/100 = 0.4 tons POM from the preheater

Emissions from the working tank and main pitch storage tank are based on the amount of pitch filled or added to the tank. EPA's emission factor for the working tank is 0.25 lb POM/ton of pitch (0.013 percent). The emission factor for the main pitch storage tank is 0.03 lb POM/ton of pitch (0.0015 percent). Assuming for this example that the amount filled or added to these tanks is equivalent to the annual processing rate, that is, 2,300 tons, POM emissions from these tanks can be calculated as follows:

2,300 x 0.013/100 = 0.3 tons POM from the working tank
2,300 x 0.0015/100 = 0.03 tons POM from the main storage tank

Total POM emissions from the coking oven, defumer, preheater, working tank, and main storage tank are:

989 tons + 2.8 tons + 0.4 tons + 0.3 tons + 0.03 tons = 992.5 tons

It is obvious from this example that if you are only interested in calculating your actual emissions to determine if you are a major source, it may well be sufficient to only calculate the emissions from the coking oven. However, you may be required to calculate your emissions from the other smaller emission sources for your permit so we have included those calculations here as an example.

Example 4: Calculation of Potential HAP Emissions from Resin-Bonded Refractory Production

The facility manufactures 1 type of resin-bonded product. The resin contains 12 percent phenol and the refractory product mix contains 6 percent resin. The facility manufactures 6,000 tons of product per year.

The annual organic HAP processing rate for phenol can be calculated as follows:

6,000 tons x 12/100 x 6/100 = 43.2 tons of phenol

The EPA emission factor for phenol is 290 pounds/ton of phenol processed, or 14.5 percent. Therefore, total emissions of phenol are:

43.2 tons x 14.5/100 = 6.3 tons of phenol

The facility's actual emissions of phenol are less than 10 tons/yr and the facility does not emit any other HAP. However, the facility may still be a major source based on its potential emissions. The facility only operates 4,500 hours/yr, although the facility's potential emissions are based on 8,760 hours/yr. Therefore, the facility's potential emissions can be calculated as follows:

6.3 tons x 8,760/4,500 = 12.3 tons phenol/yr

In this case, the facility has two options. The facility may choose to include a limit on its operating hours in its permit that will restrict its potential emissions to less than 10 tons/year of phenol. Or the facility may determine that it does not want to agree to a limit on its operating hours because it would like to increase production in the near future. In that case, the facility would be considered a major source and would be subject to the requirements of the standard.

Example 5: Calculation of Potential HAP Emissions from Resin-Bonded Refractory Production

The facility manufactures both a resin-bonded refractory product and another type of refractory product that contains no organic HAP. Both products are manufactured using the same equipment. When operating 8,760 hours/yr, the facility manufactures 5,000 tons of the resin-bonded product per year and 20,000 tons of the refractory product that contains no organic HAP.

The resin used in the resin-bonded product contains 8 percent phenol and the refractory product mix contains 5 percent resin. The annual organic HAP processing rate for phenol is:

5,000 tons x 8/100 x 5/100 = 20 tons of phenol

The EPA emission factor for phenol for resin-bonded products is 290 lbs/ton of phenol or 14.5 percent. Therefore, total actual phenol emissions are:

20 tons x 14.5/100 = 2.9 tons of phenol/yr

This is well below the major source emission rate of 10 tons/yr, but because the facility uses the same equipment to manufacture both types of refractory products, and the production rate is the same for both types of products, the facility's potential emissions are based on the total production of 25,000 tons/yr of the resin-bonded product. At this production rate, the annual organic HAP processing rate for phenol is:

25,000 tons x 8/100 x 5/100 = 100 tons of phenol

Total potential phenol emissions are:

100 tons x 14.5/100 = 14.5 tons of phenol/yr

In this case, the facility's potential emissions of phenol are greater than 10 tons/yr, so the facility could be considered a major source.

However, the resin-bonded product is a specialty product that has a limited market. The facility would never make 25,000 tons of the specialty resin-bonded product because there is no market for that much product.

Because the facility will never need to produce 25,000 tons of the specialty resin-bonded product, its best option to avoid being subject to the standard is to agree to a production limit for the resin-bonded specialty product. The production limit on the resin-bonded product will ensure that phenol emissions from the facility never exceed 10 tons/year.

Example 6: Calculation of Actual HAP Emissions from Pitch-Bonded Refractory Production

The facility has two processing lines. Both lines are used to manufacture pitch-bonded refractory products. Line 1 is an older line that is uncontrolled. However, when the facility installed the second line the permitting authority required the facility to install a thermal oxidizer to control emissions from that line. The facility must calculate the total emissions for the facility based on the emissions from both lines.

Line 1 (no control)

On this line, the facility manufactures a pitch-bonded product that contains 8 percent pitch. Total production for the product is 10,000 tons/yr. The annual organic HAP processing rate for POM can be calculated as follows:

10,000 x 8/100 = 800 tons of POM

The EPA emission factor for POM for pitch-bonded products is 860 lbs/ton of pitch or 43 percent. Therefore, total POM emissions for Line 1 are:

800 tons x 43/100 = 344 tons POM/yr

Line 2 (with thermal oxidizer)

On this line, the facility manufactures a pitch-bonded product that contains 5 percent pitch. Total production is 8,000 tons/yr. The annual organic HAP processing rate for POM can be calculated as follows:

8,000 x 5/100 = 400 tons of POM

The EPA emission factor for POM for pitch-bonded products is 860 lbs/ton of pitch or 43 percent. Therefore, total uncontrolled emissions for Line 2 are:

400 tons x 43/100 = 172 tons of POM

The facility has conducted performance tests on the thermal oxidizer controlling Line 2 and determined that the oxidizer achieves 95 percent control efficiency. Total emissions after control for Line 2 are:

172 – (172 x 0.95) = 8.6 tons POM/yr

Even though the total POM emissions from Line 2 are less than 10 tons of POM/yr, the facility is still a major source of HAP because emissions from Line 1 are uncontrolled and total POM emissions for the facility are 352.6 tons/yr. Therefore, the facility will be subject to the standard.

Example 7: Calculation of Potential HAP Emissions from Resin-Bonded Refractory Production – Batch Process Sources

The facility manufactures 1 type of resin-bonded refractory product using a batch process. Total production is 5,500 tons/yr while operating 3,750 hours. The refractory product contains 7.6 percent resin and the resin contains 6.9 percent phenol. The annual organic HAP processing rate for phenol is:

5,500 tons x 7.6/100 x 6.9/100 = 28.8 tons phenol/yr

Based on EPA's emission factors, only 14.5 percent of the phenol that is processed is actually emitted. Therefore, actual emissions for the facility are:

28.8 x 14.5/100 = 4.2 tons phenol/yr

If the facility operated 8,760 hours/yr, it could potentially produce 12,848 tons of refractory product per year. However, the capacity of each of the facility's two ovens is only 12 tons and the cycle time for each oven is 21 hours. Therefore, the maximum number of cycles for each oven is 417 cycles/yr (8,760/21). At a capacity of 12 tons/cycle, the annual capacity for each oven is only 5,004 tons/yr or a total capacity for the two ovens of 10,008 tons/yr.

Because of both the operational and physical design limits associated with the oven cycle time and capacity, the facility's maximum production is only 10,008 tons/yr. Therefore, the facility's potential emissions are based on a production of 10,008 tons/yr, not 12,844 tons/yr.

The potential annual organic HAP processing rate for phenol is:

10,008 tons x 7.6/100 x 6.9/100 = 52.5 tons phenol/yr

The facility's potential emissions are:

52.5 x 14.5/100 = 7.6 tons phenol/yr

Both the facility's actual and potential emissions are less than 10/25 tons/yr so the facility is not a major source and not subject to the standard.

C. Example Calculations for Facilities Manufacturing Clay Refractory Products

This part contains example emissions calculations for facilities manufacturing clay refractory products. The examples should be useful to clay refractory products manufacturers performing emissions calculations to determine the applicability of the standard to their operations.

Example 1: Calculation of Actual HAP Emissions from Clay Refractory Production

The facility manufactures two types of clay refractory products. Clay refractory product 1 contains 80 percent uncalcined clay and clay refractory product 2 contains 70 percent uncalcined clay. The facility manufactures 50,000 tons of clay refractory product 1 and 40,000 tons of clay refractory product 2.

The first step in calculating the facility's emissions is to calculate the annual processing rate of uncalcined clay for each product. For product 1, the uncalcined clay annual processing rate can be calculated as follows:

50,000 tons x 80/100 = 40,000 tons of uncalcined clay/yr

For product 2, the annual processing rate for uncalcined clay is:

40,000 tons x 70/100 = 28,000 tons of uncalcined clay/yr

The facility total annual processing rate for uncalcined clay is:

40,000 + 28,000 = 68,000 tons of uncalcined clay/yr

In developing the NESHAP requirements for clay refractory manufacturers, EPA developed emission factors for HF and HCl. These emission factors are based on the amount of uncalcined clay processed. The emission factor for HF is 0.38 lbs/ton of uncalcined clay processed and the emission factor for HCl is 0.26 lbs/ton of uncalcined clay processed. The second step in calculating total HAP emissions is to apply these emission factors to the results from step 1 above. Therefore, total HF and HCl emissions can be calculated as follows:

0.38 lbs HF/ton x 68,000 tons = 25,840 lbs HF = 12.9 tons

0.26 lbs HF/ton x 68,000 tons = 17,680 lbs HCl = 8.84 tons

The facility emits more than 10 tons of HF annually so it is a major source of HAP and therefore subject to the standard.

Example 2: Calculation of Potential HAP Emissions from Clay Refractory Production with On-Site Calciner

The facility manufactures three types of clay refractory products. The facility manufactures 40,000 tons of product 1, which contains 85 percent uncalcined clay. The facility manufactures 35,000 tons of product 2, which contains 20 percent uncalcined clay. The facility also manufactures 25,000 tons of product 3, which contains 40 percent calcined clay. Because product 3 contains only calcined clay, the firing of that product does not contribute to the facility's HF and HCl emissions. However, the facility does have a calciner onsite to process the clay used in product 3, and the calciner is a source of HF and HCl emissions.

All HAP emitting sources at a facility must be included when determining the major source status of the facility, not just those sources covered by the refractory products rule. Therefore, the facility must include emissions from the calciner in determining its total emissions.

The facility's actual emissions from the kilns are calculated based on the uncalcined clay annual processing rate as follows:

Product 1: 40,000 tons x 85/100 = 34,000 tons of uncalcined clay/yr

Product 2: 35,000 tons x 20/100 = 7,000 tons of uncalcined clay/yr

The total uncalcined clay annual processing rate is:

34,000 tons + 7,000 tons = 41,000 tons uncalcined clay/yr

Total actual HF and HCl emissions from the kilns can be calculated as follows:

0.38 lbs HF/ton x 41,000 = 15,580 lbs HF = 7.8 tons

0.26 lbs HCl/ton x 41,000 = 10,660 lbs HCl = 5.3 tons

In addition to the kiln emissions from the manufacturing of the clay refractory products 1 and 2, the facility must also calculate emissions from the calciner. The calciner processes 10,000 tons of clay per year. Using the emission factors developed by EPA and shown in Table 1, actual emissions from the calciner can be calculated as follows:

0.19 lbs HF x 10,000 tons of clay = 1,900 lbs HF = 0.95 tons HF

0.13 lbs HCl x 10,000 tons of clay = 1,300 lbs HCl = 0.65 tons HCl

Total HF emissions from the kiln and the calciner are 8.8 tons. Total HCl emissions from the kiln and the calciner are 5.95 tons. Based on its actual emissions, the facility is not a major source. HF and HCl emissions are both less than 10 tons/yr and total emissions for the pollutants combined are less than 25 tons/yr.

Although actual emissions are less than 10/25 tons/yr, the facility needs to calculate its potential emissions to determine if it may be a major source. Because emissions are dependent upon the amount of uncalcined clay the facility processes, the facility's potential emissions are based on the production of the product with the highest percentage of uncalcined clay. The production rates for products 1, 2 and 3 are the same, therefore the facility can potentially produce 100,000 tons of product 1 (40,000 tons + 35,000 tons + 25,000 tons). The facility must calculate its potential emissions based on the production of 100,000 tons of product 1, which contains 85 percent uncalcined clay. The facility's potential uncalcined clay processing rate is:

100,000 tons x 85/100 = 85,000 tons of uncalcined clay

Total potential HF and HCl emissions from the kiln are calculated as follows:

0.38 lbs HF/ton x 85,000 tons = 32,300 lbs HF = 16.2 tons

0.26 lbs HCl/ton x 85,000 tons = 22,100 lbs HCl = 11.1 tons

If the facility is manufacturing 100,000 tons of product 1, it cannot manufacture any of product 3. Therefore, the calciner is not operating under this scenario and the only source of emissions is the kiln. Total potential HF emissions are 16.2 tons and total potential HCl emissions are 11.1 tons.

Based on its potential emissions, the facility is a major source and would therefore be subject to the standard. However, the facility can avoid being subject to the rule if it agrees to permit limits that ensure its potential emissions are also less than 10/25 tons/year. For example, the facility may agree to a limit on the production of product 1 to ensure that its HF emissions are less than 10 tons/yr.

Example 3: Calculation of Potential HAP Emissions from Clay Refractory Production

The facility manufactures one type of clay refractory product. This product contains 75 percent uncalcined clay. The facility manufactures 32,000 tons of the product while operating 3,000 hours/yr. The facility's actual emissions are based on the production of 32,000 tons of product with an uncalcined clay content of 75 percent. The annual uncalcined clay processing rate is:

32,000 tons x 75/100 = 24,000 tons of uncalcined clay

Actual HF and HCl emissions are:

0.38 lb HF/ton x 24,000 tons = 9,120 lbs = 4.6 tons
0.26 lbs HCl/ton x 24,000 tons = 6,240 lbs = 3.1 tons

The facility's actual emissions are less than 10/25 tons/yr, but its potential emissions are based on 8,760 hours/yr. Therefore, the potential production is:

32,000 x 8,760/3,000 = 93,440 tons

The potential annual uncalcined clay processing rate is:

93,440 tons x 75/100 = 70,080 tons uncalcined clay

Potential HF and HCl emissions are:

0.38 lbs HF/ton x 70,080 = 26,630 lbs = 13.3 tons HF

0.26 lbs HCl/ton x 70,080 = 18,221 lbs = 9.1 tons HCl

The facility's potential emissions of HF are greater than 10 tons/yr so the facility is a major source and subject to the requirements of the standard. However, the facility may agree to limit its operating hours in its permit to ensure that HF emissions are less than 10 tons/yr. In that case, the facility would not be subject to the requirements of the standard.

Example 4: Calculation of Potential HAP Emissions from Clay Refractory Production with Limiting Process

The facility manufactures 50,000 tons/yr of one type of clay refractory product. The product contains 85 percent uncalcined clay. The annual uncalcined clay processing rate is:

50,000 x 85/100 = 42,500 tons uncalcined clay/yr

The facility's actual emissions are:

0.38 lbs HF x 42,500 tons = 16,150 lbs/yr = 8.1 tons HF/yr

0.26 lbs HCl x 42,500 tons = 11,050 lbs/yr = 5.5 tons HCl/yr

The facility currently operates 6,200 hours/yr so it could potentially produce 70,645 tons in 8,760 hours/yr. However, the maximum design capacity of the presses that are used for forming operations is only 6.5 tons/hr or 56,940 tons/yr for 8,760 hours/year. All of the other process units have sufficient design capacity to produce at least 70,645 tons/yr, but the physical design of the press limits the facility's production to 56,940 tons/yr.

The capacity of the equipment can limit the facility's potential to emit. Therefore, the facility's potential emissions are based on 56,940 tons/yr, not 70,645 tons/yr.

The potential uncalcined clay processing rate is:

56,940 tons/yr x 85/00 = 48,399 tons uncalcined clay/yr

The facility's potential emissions are:

0.38 lbs HF x 48,399 tons = 18,392 lbs/yr = 9.2 tons HF/yr

0.26 lbs HCl x 48,399 tons = 12,584 lbs/yr = 6.3 tons HCl/yr

The facility's actual and potential emissions are both less than 10/25 tons/yr so the facility is not a major source and is not subject to the standard.

II. Example Compliance Calculations for Facilities Manufacturing Products Containing Organic HAP

This section provides example calculations for facilities manufacturing the following products:

- Resin-bonded refractory products
- Pitch-bonded refractory products
- Pitch-impregnated refractory products
- Other formed products that use additives that contain or form organic HAP

The calculations are applicable to the following emission sources:

- Shape dryers
- Curing ovens
- Kilns
- Coking ovens
- Defumers
- New shape preheaters

The example calculations presented in this section are primarily related to demonstrating compliance with emission limits and developing operating limits using data collected during performance tests.

The compliance calculations vary depending upon whether the facility manufactures products using a continuous or batch process. These differences are due primarily to the differences in testing requirements for continuous and batch processes.

Part A of this section provides example calculations for facilities using a continuous process, and Part B provides example calculations for facilities using a batch process.

A. Continuous Process Compliance Options and Associated Calculations for Facilities Manufacturing Products Containing Organic HAP

1. *Example calculations for demonstrating compliance with the emission limits.* The rule provides two different compliance options for facilities manufacturing products containing organic HAP using a continuous process. These two different options are meeting a THC concentration limit or meeting a THC percentage reduction limit. Different calculations are used for each of the two compliance options. Following are example calculations for demonstrating compliance for each of these options using performance test data.

Example 1: Demonstrating Compliance with the THC Concentration Limits for a Continuous Process Using the Performance Test Data

Table 1 provides data for an example test run for a facility equipped with a thermal oxidizer. The data include both the THC concentrations and the oxygen concentrations for each minute of the 1-hour test run.

Using the data presented in Table 1, calculate the average THC concentration for the 1-hour run. Then calculate the average oxygen concentration for the 1-hour test run. Using Equation 1 of 63.9800(g)(1) of the rule, then calculate the hourly average THC concentration corrected to 18 percent oxygen.

In the example test run presented in Table 1, the hourly average THC concentration is 14.9 ppmvd and the hourly average oxygen concentration is 18.6. Therefore, the corrected THC concentration for the test run is:

Corrected THC = (2.9 x 14.9)/(20.9-18.6) = 18.8 ppmvd

For a continuous process, the THC concentration for the performance test is based on the average of the corrected concentrations for each test run. Therefore, if the corrected THC concentrations for the other two test runs are 15.2 ppmvd and 17.8 ppmvd, the average corrected THC concentration for the three test runs is:

(18.8 + 15.2 + 17.8)/3 = 17.3 ppmvd

Therefore, the results of the performance test indicate the facility is in compliance with the emission limit of 20 ppmvd, corrected to 18 percent oxygen.

Table 1. Example THC and Oxygen Concentration Data for 1-Hour Performance Test

Time	THC Concentration (ppmvd)	Oxygen Concentration (percent)
1510	15	18.1
1511	16	19.2
1512	12	18.7
1513	18	17.9
1514	19	19.1
1515	20	17.8
1516	22	18.4
1517	21	18.4
1518	21	18.5
1519	22	19.1
1520	23	17.5
1521	20	17.6
1522	18	17.7
1523	17	17.8
1524	17	17.9
1525	16	19.1
1526	14	19.2
1527	14	20.1
1528	13	20.2
1529	10	19.9
1530	12	19.8
1531	12	18.1
1532	12	18.1
1533	12	18.1
1534	14	18.9
1535	14	17.8
1536	12	17.5
1537	9.3	17.7
1538	8.5	18.2
1539	8.3	19.1
1540	10	19.1
1541	12	19.1
1542	14	19.9
1543	15	19.5
1544	15	19.5
1545	17	18.8
1546	20	18.9
1547	21	19.1
1548	19	19.0
1549	18	19.1
1550	18	19.1
1551	16	19.2
1552	15	18.3
1553	15	17.9
1554	15	17.8
1555	14	17.9
1556	14	18.4
1557	13	18.1
1558	12	18.5
1559	12	18.6
1600	12	18.8
1601	11	19.2
1602	13	18.9
1603	13	17.9
1604	15	18.2
1605	15	19.1
1606	14	18.3
1607	12	18.2
1608	11	19.0
1609	10	17.8
Average	14.9	18.6

Example 2: Demonstrating Compliance with the THC Percentage Reduction Limit for a Continuous Process

You may choose to meet the emission limits in the rule by meeting the THC percentage reduction requirement of 95 percent. If you choose this option, measure the THC concentration at both the inlet and outlet of the control device. Using the 1-minute THC measurements for the test run and the volumetric flow rate values, calculate the pounds of THC emitted per hour for each hour of the test run at both the inlet and outlet of the control device. Using the inlet and outlet mass emission rates, then calculate the percentage reduction achieved by the control device using Equation 2 of Section 63.9800(g)(2) of the rule, which is as follows:

$$PR = (ER_i - ER_o)/ER_i \text{ x } 100$$

Where:

PR = percentage reduction, percent
ER_i = THC mass emission rate entering the control device (lbs/hr)
ER_o = THC mass emission rate exiting the control device (lbs/hr)

Using the data for the example test runs presented below, we have calculated the percentage reduction for the control device.

Run 1

THC emission rate at inlet = 20 lbs/hr

THC emission rate at outlet = 1 lbs/hr

Percentage reduction for Run 1 = (20 – 1)/20 = 95 percent reduction

Run 2

THC emission rate at inlet = 17.5 lbs/hr

THC emission rate at outlet = 0.7 lbs/hr

Percentage reduction for Run 2 = (17.5-0.7)/17.5 = 96 percent reduction

Run 3

THC emission rate at inlet = 18.8 lbs/hr

THC emission rate at outlet = 0.8 lbs/hr

Percentage reduction for Run 3 = (18.8 – 0.8)/18.8 = 95.7 percent reduction

The average for the three test runs is:

(95 + 96 + 95.7)/3 = 95.6 percent reduction

This is greater than the required reduction of 95 percent so the results from the performance test demonstrate the facility is in compliance with the THC percentage reduction emission limit.

Example 3: Performance Test Data Indicate Non-Compliance with the THC Percentage Reduction Requirements for a Continuous Process

In this example, the facility is also trying to demonstrate compliance with the THC percentage reduction limit of 95 percent. The facility is using a continuous process to manufacture refractory products containing organic HAP. To demonstrate compliance with the THC percentage reduction limit, the facility measures the THC concentration at both the inlet and outlet of the control device. Using the 1-minute THC measurements and the flow rate measurements, the facility calculates the THC mass emission rate at both the inlet and outlet of the control device. Using Equation 2 of Section 63.9800(g)(2), the facility calculates the THC percentage reduction for each test run.

Using the example data presented below for each test run, we have calculated the percentage reduction for each test run.

Run 1

THC Emission Rate at Inlet = 15.3 lbs/hour
THC Emission Rate at Outlet = 1.5 lbs/hour

Percentage reduction for Run 1 = (15.3 – 1.5)/15.3 = 90.2 percent

Run 2

THC Emission Rate at Inlet = 16.1 lbs/hour
THC Emission Rate at Outlet = 1.9 lbs/hour

Percentage reduction for Run 2 = (16.1-1.9)/16.1 = 88.2 percent

Run 3

THC Emission Rate at Inlet = 16.2 lbs/hour
THC Emission Rate at Outlet = 1.8 lbs/hour

Percentage reduction for Run 3 = (16.2-1.8)/16.2 = 88.9 percent

The average percentage reduction for the three test runs is:

(90.2 + 88.2 + 88.9)/3 = 89.1 percent

In this case, the results from the performance test indicate that the facility is not achieving the THC percentage reduction limit of 95 percent. The facility should notify its permitting authority immediately upon determining that it has failed the compliance test. The permitting authority will address failed compliance tests on a case-by-case basis.

2. *Example calculations for establishing operating limits.* Facilities manufacturing refractory products containing organic HAP using a continuous process must establish operating limits for the maximum allowable organic HAP processing rate and the oxidizer temperature for each source subject to the standard. The operating limit for the oxidizer temperature is the minimum temperature that you must maintain for your oxidizer while manufacturing products containing organic HAP. For facilities equipped with a thermal oxidizer, the oxidizer temperature is based on the combustion chamber temperature. For facilities equipped with a catalytic oxidizer, the oxidizer temperature is based on the temperature at the inlet to the catalyst bed. The following example calculations demonstrate how to establish operating limits for the maximum allowable organic HAP processing rate and the oxidizer temperature.

Example 4: Calculating the Operating Limit for the Maximum Allowable Organic HAP Processing Rate

The maximum allowable organic HAP processing rate is based on the organic HAP content of any resins, binders or additives in the refractory product, the percentage of those resins, binders or additives in the refractory product mix, and the production rate for the refractory product during the compliance test.

In all cases, the compliance test should be conducted while manufacturing the product with the highest organic HAP processing rate. In this example, the product with the highest organic HAP processing rate is a resin-bonded product. The resin contains 10 percent phenol and the refractory product contains 8 percent resin. The production rate is approximately 8,000 lbs/hr, but it varies slightly for each test run.

Run 1

Production rate is 8,100 lbs/hr

Organic HAP processing rate = 8,100 x 10/100 x 8/100 = 64.8 lbs/hr

Run 2

Production rate is 7,800 lbs/hr

Organic HAP processing rate = 7,800 x 10/100 x 8/100 = 62.4 lbs/hr

Run 3

Production rate is 8,250 lbs/hr

Organic HAP processing rate = 8,250 x 10/100 x 8/100 = 66 lbs/hr

The operating limit for the maximum allowable organic HAP processing rate is the average organic HAP processing rate for the three test runs plus 10 percent. The average for the three test runs is 64.4 lbs/hour, so the operating limit is 64.4 + (0.1 x 64.4) = 70.8 lbs/hour.

Example 5: Calculating the Operating Limit for the Oxidizer Temperature

As discussed earlier, the operating limit for the oxidizer temperature is based on the combustion chamber temperature if you have a thermal oxidizer, and the temperature at the inlet to the catalyst bed if you have a catalytic oxidizer. However, the procedure for calculating the operating limit for the oxidizer temperature is the same regardless of the type of oxidizer that you have.

During each test run, you need to measure the oxidizer temperature every 15 minutes. Then calculate the average oxidizer temperature for each hour of the test run. The operating limit is based on the average temperature for the three test runs. Following is an example calculation for a facility equipped with a thermal oxidizer.

Run 1

During the 1-hour test run, the facility measured the combustion chamber temperature 4 times. The combustion chamber temperatures were as follows:

1530°F
1538°F
1541°F
1542°F

The average combustion chamber temperature for Run 1 is:

(1530 + 1538 + 1541 + 1542)/4 = 1538°F

Run 2

During Run 2, the combustion chamber temperatures were:

1545°F
1550°F
1543°F
1547°F

The average combustion chamber temperature for Run 2 is:

(1545 + 1550 + 1543 + 1547)/4 = 1546°F

Run 3

During Run 3, the combustion chamber temperatures were:

1551°F
1543°F
1544°F
1538°F

The average combustion chamber temperature for Run 3 is:

(1551 + 1543 + 1544 + 1538)/4 = 1544°F

The average combustion chamber temperature for the three test runs is:

(1538 + 1546 + 1544)/3 = 1543°F

The operating limit for the oxidizer temperature is the average for the three test runs minus 25°F or:

1543 – 25 = 1518°F

For the facility to be in continuous compliance with the operating limit for oxidizer temperature, the rolling average for each 3-hour period of operation must be at least 1518°F.

B. Example Compliance Calculations for Facilities Manufacturing Products Containing Organic HAP Using a Batch Process

1. *Example Calculations for Developing an Emissions Profile.* Testing batch processes is typically more complicated than testing continuous processes. Because many of the batch processes associated with the manufacturing of refractory products containing organic HAP are very long, lasting 12 hours or more, the rule contains a provision that allows facilities to limit testing to the peak emissions period. To do this, the facility must first develop an emissions profile. Developing an emissions profile can simplify the testing process. Example 6 provides an example calculation for determining the peak emissions period and developing an emissions profile.

Example 6: Calculation for Determining the Peak Emissions Period and Developing an Emissions Profile

The rule contains options for reducing the total testing time for facilities using a batch process to manufacture products containing organic HAP. One option is to develop an emissions profile.

The goal of developing an emissions profile is to determine the peak emissions period, that is, the period of 3 consecutive hours during the batch when emissions are at their highest. The data from the example test run presented in Table 2 will be used to demonstrate how to develop an emissions profile.

As shown in the right-hand column of Table 2, to develop an emissions profile you have to calculate the total emission rate at the control device inlet for each consecutive 3-hour period of the batch. In this case, the value represents the total emission rate for the 3-hour period ending at that hour. For example, the total emission rate for hours 1 through 3 is:

$$3.2 + 5.1 + 5.5 = 13.8$$

As shown in the table, the highest total emission rate at the control device inlet for any consecutive 3-hour period for this example test run is 53.8. This total emission rate occurs between hours 9 and 11 of the test. This represents the peak emissions period for this source.

Table 2. Example Test Data for Developing an Emissions Profile

Hour	THC Emission Rate at Inlet (lbs/hr)	Total Emission Rate for 3-Hour Period
1	3.2	
2	5.1	
3	5.5	13.8
4	6.5	17.1
5	8.5	20.5
6	10.7	25.7
7	12.7	31.9
8	16.8	40.2
9	17.9	47.4
10	18.4	53.1
11	17.5	53.8
12	16.2	52.1
13	16.1	49.8
14	15.1	47.4
15	14.0	45.2
16	11.2	40.3
17	11.1	36.3
18	9.4	31.7
19	8.8	29.3
20	5.9	24.1
21	4.2	18.9
22	3.5	13.6
23	2.1	9.8
24	1.2	6.8
25	1.5	4.8

Unless you begin to manufacture a product with a maximum allowable organic HAP processing rate that is greater than the operating limit you have established, then for all future testing of this emission source you only have to conduct testing during this peak emissions period, that is, during hours 9 through 11 of the batch. If you wish to establish a new operating limit for the maximum allowable organic HAP processing rate, you must also develop a new emissions profile. In addition, the provision to limit testing to the peak emissions period does not apply if you wish to cut off or reduce the temperature of the thermal oxidizer, as discussed in item 8.a.i(4) of Table 4 of the rule.

2. *Example Calculations for Demonstrating Compliance with the Emission Limits.* The rule provides two options for demonstrating compliance with the emission limits. The first option is to meet a THC concentration limit. The second option is to meet a THC percentage reduction requirement. Example calculations for each of these options are presented below.

Example 7: Calculation for Demonstrating Compliance with the THC Concentration Limit (Compliance Option 1) for a Batch Process

To demonstrate compliance with the THC concentration limit, you must perform the following calculations for each test run:

1. Calculate the average THC concentration for each hour of the performance test using the 1-minute measurements.
2. Calculate the average oxygen content for each hour of the performance test using the 1-minute measurements.
3. Using the hourly averages calculated for steps (1) and (2) above, calculate the average hourly THC concentration corrected to 18 percent oxygen using Equation 1 of 63.9800(g)(6). For example, if the average hourly concentration is 11 ppmvd and the average oxygen concentration for that same hour is 19.0, the corrected THC concentration is as follows:

   Corrected THC = 2.9 x 11/(20.9 – 19) = 16.8 ppmvd

4. Determine the period of 3 consecutive hours over which the sum of the hourly average corrected THC concentrations calculated in step (3) is greater than the sum for any other period of 3 consecutive hours during the test run as shown in the right-hand column of Table 3 below.
5. Calculate the average of the hourly average corrected THC concentrations for the 3-hour period identified in step (4).
6. Calculate the average peak THC concentration for the two test runs.

Table 3 provides an example test run for a batch that demonstrates how to determine compliance with the THC concentration limit using the performance test data. Note that the right-hand column of the table represents the total corrected THC concentration for the 3-hour period ending at that hour.

Table 3. Example Test Run for Demonstrating Compliance with the THC Concentration Limit for a Batch Process

Hour	Average THC Concentration (ppmvd)	Average Oxygen Concentration (percent)	Average THC Concentration Corrected to 18% Oxygen	Total Corrected THC Concentration for 3-Hour Period
1	10	18.5	12.1	
2	9	18.6	11.3	
3	8	19	12.2	35.6
4	11	19.2	18.8	42.3
5	12	19.1	19.3	50.3
6	9	19.5	18.6	56.7
7	8	19.4	15.5	53.4
8	6	19.3	10.9	45.0
9	5	19.3	9.1	35.5
10	3	18.8	4.1	24.1
11	2	18.5	2.4	15.6
12	2	18.6	2.5	9.0

Based on the results from the example test run in Table 3, the 3-hour peak occurred between hours 4 and 6, with a total corrected THC concentration of 56.7. The average hourly-corrected THC concentrations for those three hours are 18.8, 19.3, and 18.6. The average THC concentration for the peak period for the test run is 18.9 ppmvd ((18.8 + 19.3 + 18.6)/3), corrected to 18 percent oxygen.

For a batch process, you are required to conduct two test runs. Assuming that the average corrected THC concentration for the peak period for the second test run is 16.5 ppmvd, the average for the performance test would be 17.7 ppmvd ((18.9 + 16.5)/2). This is less than the limit of 20 ppmvd, so the calculations demonstrate the facility is in compliance with the THC concentration limits.

Example 8: Performance Test Data Indicate Non-Compliance with the THC Concentration Limits for a Batch Process

In this example, the facility is also attempting to demonstrate compliance with the THC concentration limits for a batch process. Table 4 presents data for an example test run. Using the data presented in Table 4, the facility followed steps 1-6 as presented in Example 7. As shown in the right-hand column of Table 4, the peak emissions period occurs between hours 6 and 8 of the test run. The average corrected THC concentrations for hours 6, 7, and 8 are 39.2 ppm, 39.8 ppm, and 53.8 ppm. Therefore, the corrected THC concentration for the test run is 44.3 ppm (39.2 + 39.8 + 53.8/3).

For batch sources, the facility is required to conduct two test runs. Assuming that the average corrected THC concentration for the peak emissions period is 34.1 ppm, the average for the performance test is 39.2 ppm. This is greater than the THC concentration limit of 20 ppm, corrected to 18 percent oxygen. Therefore, the facility is not in compliance with the rule.

In this case, the facility should contact its permitting authority immediately upon determining that the performance test indicates the facility is not in compliance with the standard. The permitting authority will address all failed compliance tests on a case-by-case basis.

Table 4. Example Test Run for Demonstrating Compliance with the THC Concentration Limits for a Batch Process

Hour	Average THC Concentration (ppm)	Average Oxygen Concentration (percent)	Average THC Concentration Corrected to 18% Oxygen (ppm)	Total Corrected THC Concentration for 3-Hour Period
1	8.2	19.2	13.4	
2	8.5	19.4	16.4	
3	9.6	18.9	13.9	43.7
4	13.4	19.1	21.6	51.9
5	16.3	19.0	24.9	60.4
6	18.9	19.5	39.2	85.7
7	19.2	19.5	39.8	103.9
8	20.4	19.8	53.8	132.8
9	18.8	19.4	36.3	129.9
10	18.2	19.5	37.7	127.8
11	17.5	18.9	25.4	99.4
12	14.2	19.0	21.7	84.8
13	13.1	19.1	21.2	68.3
14	12.7	18.7	16.7	59.6

Example 9: Calculation for Demonstrating Compliance with the THC Percentage Reduction Limit (Compliance Option 2) for a Batch Process

To demonstrate compliance with the THC percentage reduction limit, you must perform the following calculations:

1. Calculate the hourly THC mass emission rate (lbs THC/hr) at both the inlet and outlet of the control device for each hour of the test run.
2. Using the hourly THC mass emission rates for the control device inlet calculated in step (1), calculate the total THC mass emission rate for each period of 3 consecutive hours as shown in Table 5.
3. Using the 3-hour total mass emission rates calculated in step (2), determine the period of 3 consecutive hours when the sum of the inlet mass emission rates is greater than any other 3-hour period.
4. Calculate the average THC percentage reduction for that 3-hour period for each test run using Equation 2 of 63.9800(g)(2):

$PR = (ER_i - ER_o)/ER_i \times 100$

Where:

PR = Percentage reduction, percent
ER_i = mass emission rate of THC at the inlet to the control device, lbs/hr
ER_o= mass emission rate of THC at the outlet of the control device, lbs/hr

For example, in Table 5 below, the inlet THC mass emission rate for the first hour of the test run is 5.0 lbs/hr. The outlet rate for that hour is 0.21 lbs/hr. Therefore, the percentage reduction may be calculated as follows:

$PR = (5.0 - 0.21)/5.0 \times 100 = 95.8$ percent reduction

5. Calculate the average percentage reduction for both test runs.

Table 5 presents data from an example test run that demonstrates how to show compliance with the percentage reduction requirement for a batch process.

Table 5. Example Test Run for Demonstrating Compliance with the Percentage Reduction Requirement for a Batch Process

Hour	THC Mass Emission Rate, Inlet (lbs/hr)	3-Hour Total Mass Emission Rate, Inlet	THC Mass Emission Rate, Outlet (lbs/hr)	Percentage Reduction
1	5.0		0.21	95.8
2	6.1		0.30	95.1
3	8.6	19.7	0.35	95.9
4	9.2	23.9	0.43	95.3
5	12	29.8	0.56	95.3
6	11	32.2	0.40	96.4
7	7.9	30.9	0.37	95.3
8	6.8	25.7	0.31	95.4
9	5.5	20.2	0.25	95.5
10	3.8	16.1	0.17	95.5
11	3.2	12.5	0.13	95.9

The highest 3-hour total for this example test run occurs between hours 4 and 6, with a total mass emission rate during that period of 32.2. The percentage reductions for hours 4, 5, and 6 are 95.3, 95.3, and 96.4 percent respectively. Therefore the average percentage reduction for this test run is:

$(95.3 + 95.3 + 96.4)/3 = 95.7$ percent

Assuming that the average reduction for the second test run is 96.4 percent, the average percentage reduction for the performance test is 96.1 percent. Therefore, the results of the performance test demonstrate the facility is in compliance with the rule.

3. *Example calculations for establishing operating limits.* Facilities manufacturing refractory products containing organic HAP using a batch process must establish operating limits for the maximum allowable organic HAP processing rate and the oxidizer temperature. For facilities equipped with a thermal oxidizer, the oxidizer temperature is based on the combustion chamber temperature. For facilities equipped with a catalytic oxidizer, the oxidizer temperature is based on the temperature at the inlet to the catalyst bed. The following example calculations demonstrate how to establish operating limits for the maximum allowable organic HAP processing rate and the oxidizer temperature.

Example 10: Calculation for Establishing the Operating Limit for the Maximum Allowable Organic HAP Processing Rate for a Batch Process

The organic HAP processing rate for a batch process is a function of the HAP content of any binders, resins, or additives used in the refractory product, the percentage of the HAP containing constituent in the refractory product, and the amount of product produced during the batch.

The operating limit for the maximum allowable organic HAP processing rate is based on the organic HAP processing rate for the products manufactured during the performance test.

All performance tests should be conducted while manufacturing the product with the highest organic HAP processing rate.

For this example, the product with the highest organic HAP processing rate is a pitch-bonded product. The pitch contains 100 percent POM and the refractory product mix contains 8 percent pitch. The production for each batch varies slightly. The organic HAP processing rate for each test run is calculated as follows:

Run 1

Total production for the batch is 17,250 lbs. Therefore, the organic HAP processing rate for Run 1 is:

17,250 lbs/batch x 8/100 = 1,380 lbs POM/ batch

Run 2

During the second run, the total production for the batch is 16,900 lbs. The organic HAP processing rate for Run 2 is:

16,900 lbs/batch x 8/100 = 1,352 lbs POM/batch

The operating limit for the maximum allowable organic HAP processing rate is based on the average of the two test runs plus 10 percent. The average for the two test runs in this example is 1,366 lbs POM/batch. Therefore, the operating limit for the maximum allowable organic HAP processing rate is:

1,366 + (0.1 x 1,366) = 1,503 lbs/batch

Example 11: Calculation for Establishing the Operating Limit for Oxidizer Temperature for a Batch Process

As discussed earlier, the operating limit for oxidizer temperature is based on the combustion chamber temperature if the source is controlled by a thermal oxidizer. If the source is controlled by a catalytic oxidizer, the operating limit is based on the temperature at the inlet to the catalyst bed. However, the calculations for establishing the operating limit for oxidizer temperature are the same regardless of the type of oxidizer.

During the performance test, monitor and record the oxidizer temperature every 15 minutes. For batch operations, the operating limit is based on the temperature of the oxidizer during the peak 3-hour emissions period. For a source choosing to comply with the THC concentration limits, the peak 3-hour emissions period is the period of 3 consecutive hours during which the total corrected THC concentration at the outlet of the control device or in the stack is greater than the total corrected THC concentration for any other consecutive 3-hour period (see Example Calculation 7). For facilities choosing to comply with the THC percentage reduction limit, the peak 3-hour emissions period is the period of 3 consecutive hours during the test during which mass emission rates at the control device inlet are greater than any other 3-hour period (see Example Calculations 6 and 9). For each test run, calculate the average hourly oxidizer temperature for each hour of the peak 3-hour period. Then calculate the average temperature for that 3-hour period based on the hourly averages. The operating limit is based on the average for the two test runs.

In this example, the facility is using a thermal oxidizer to control emissions. Therefore, they are required to measure and record the combustion chamber temperature during each test run.

Run 1

The peak 3-hour emissions period for the batch occurs between the beginning of hour 4 and the end of hour 6. The average combustion chamber temperature for each hour is provided below:

Hour 4 – 1575°F
Hour 5 – 1560°F
Hour 6 – 1565°F

The average combustion chamber temperature for the peak 3-hour period for the test run is:

(1575 + 1560 + 1565)/3 = 1567°F

Run 2

Again, the peak emissions period is between hour 4 and 6 of the batch. The average combustion chamber temperature for each hour is:

Hour 4 – 1550°F
Hour 5 – 1565°F
Hour 6 – 1570°F

The average combustion chamber temperature for Run 2 during the peak 3-hour period is:

$$(1550 + 1565 + 1570)/3 = 1562°F$$

The average combustion chamber temperature for the two test runs is 1565°F. The operating limit for the oxidizer combustion chamber temperature is the average for the two test runs, 1565°F, minus 25°F, or 1540°F.

III. Example Compliance Calculations for Facilities Manufacturing Clay Refractory Products

These example calculations apply to new kilns used to manufacture clay refractory products using uncalcined clay. Because the testing requirements vary depending upon whether the clay refractories are manufactured using a continuous process or a batch process, the calculations also vary depending upon the manufacturing process. Therefore, this section presents example calculations for facilities using a continuous process, and calculations for facilities using a batch process.

A. Example Compliance Calculations for Facilities Manufacturing Clay Refractory Products Using a Continuous Process

1. *Example Calculations for Demonstrating Compliance with the Emission Limits.*

> The rule contains two compliance options for facilities manufacturing clay refractory products using a continuous process. Facilities may meet production-based emission limits for HF and HCl or they may meet percentage reduction requirements for HF and HCl.

Example calculations for both options are presented below.

Example 1: Calculations for Demonstrating Compliance with the HF and HCl Production-Based Emission Limits

To demonstrate compliance with the HF and HCl production-based emission limits, you must perform the following calculations:

1. Using the production data and product formulation data, calculate the average rate at which you processed uncalcined clay (tons/hr) during each test run.

2. Calculate the HF and HCl mass emission rates for each test run.

3. Calculate the hourly production-based emission rate for HF and HCl using the following equation, which is Equation 3 of section 63.9798(g)(3) of the rule:

   MP = ER/P
   Where:

   MP = mass per unit of production (lbs/ton) of uncalcined clay processed
   ER = mass emission rate of HF or HCl during each performance test (lbs/hr)
   P = average uncalcined clay processing rate for the performance test, tons of uncalcined clay processed per hour

4. Calculate the 3-hour block average of the emission rate for each pollutant as the average emission rate for the three test runs.

Following is the calculation procedure using data from an example performance test.

The uncalcined clay processing rate is a function of the production rate and the fraction of uncalcined clay in the refractory product. During the first test run, the production rate for the example facility is 4 tons/hr. The refractory product manufactured during the test run has an uncalcined clay fraction of 50 percent. The processing rate for the uncalcined clay can be calculated as follows:

4 tons/hr x 0.5 = 2 tons of uncalcined clay per hour

The facility used Method 26A to measure HF and HCl. Based on the results from Method 26A, the mass emission rate for HF during the first test run was 0.070 lbs/hr. The mass emission rate for HCl was 0.34 lbs/hr. Using the uncalcined clay processing rate of 2 tons/hr, the production-based emission rates for HF and HCL can be calculated as follows:

(0.070 lbs HF/hr)/(2 tons/hr) = 0.035 lbs HF/ton of uncalcined clay

(0.34 lbs HCl/hr)/(2tons/hr) = 0.17 lbs HCl/ton of uncalcined clay

Following the same procedure, the facility determined the production-based emission rates for HF and HCl for Runs 2 and 3. For HF, the emission rate was 0.036 for Run 2 and 0.038 for Run 3. Therefore, the 3-hour block average for HF was:

(0.035 + 0.036 + 0.038)/3 = 0.036 lbs HF/ton of uncalcined clay

This production-based mass emission rate is less than the HF emission limit of 0.038 lbs HF/ton of uncalcined clay, so the source is in compliance for HF.

For HCl, the emission rate was 0.16 for Run 2 and 0.15 for Run 3. The 3-hour block average for HCl was:

(0.17 + 0.16 + 0.15)/3 = 0.16 lbs HCl/ton of uncalcined clay

This production-based mass emission rate is less than the HCl emission limit of 0.18 lbs HCl/ton of uncalcined clay, so the source is in compliance for HCl.

Example 2: Calculation for Demonstrating Compliance with the Percentage Reduction Requirements for HF and HCl for a Continuous Process

To demonstrate compliance with the percentage reduction requirements for HF and HCl, you must perform the following calculations:

1. Determine the mass emission rates for HF and HCl in lbs/hr at both the inlet and outlet of the control device.
2. Calculate the hourly HF and HCl percentage reductions using the following equation, which is Equation 2 of section 63.9800(g)(2) of the rule:

   $PR = (ER_i - ER_o)/ER_i \times 100$

   Where:

   PR = percentage reduction, percent
   ER_i = mass emission rate of HF or HCl entering the control device (lbs/hr)
   ER_o = mass emission rate of HF or HCl exiting the control device (lbs/hr)

3. Calculate the 3-hour block average as the average of the percentage reductions for each test run.

The data from an example performance test can be used to illustrate these calculation procedures.

Run 1

Using Method 26A, the facility determines the mass emission rates for HF and HCl as follows:

HF inlet emission rate = 0.83 lbs/hr
HF outlet emission rate = 0.040 lbs/hr
HCl inlet emission rate = 0.46 lbs/hr
HCl outlet emission rate = 0.22 lbs/hr

The percentage reduction for HF for Run 1 can be calculated as follows:

(0.83 – 0.040)/0.83 x 100 = 95.2 percent

The percentage reduction for HCl is:

(0.46 – 0.22)/0.46 = 52.2 percent

The facility conducted two additional test runs and, using the same procedures, determined that the HF percentage reduction for Run 2 was 91.5 percent and the reduction for Run 3 was 92.3 percent. The 3-hour block average for the performance test was

(95.2 + 91.5 + 92.3)/3 = 93.0 percent

For HCl, the reduction for Run 2 was 41.2 percent and the reduction for Run 3 was 45.4 percent. The 3-hour block average for the performance test was:

(52.2 + 41.2 + 45.4)/3= 46.3 percent

The rule requires facilities to reduce HF emissions by 90 percent and HCl emissions by 30 percent, so in this example the results from the performance test indicate that the facility is in compliance with the rule.

B. Example Compliance Calculations for Facilities Manufacturing Clay Refractory Products Using a Batch Process

1. *Example Calculation for Determining the Peak HF Emissions Period and Developing an Emissions Profile*

Batch cycle times for clay refractory kilns may be 12 hours or more. Therefore, the rule contains provisions that allow the facility to only test during the peak HF emissions period if the facility first develops an emissions profile. The peak HF emissions period is the period of 3 consecutive hours during the batch during which the total HF mass emission rate at the control device inlet is greater than during any other 3-hour period of the batch.

Example 3: Calculation for Determining the Peak HF Emissions Period and Developing an Emissions Profile

Table 6 presents data from an example test run that can be used to demonstrate how to determine the peak HF emissions period and develop an emissions profile.

Table 6. Example Test Data for Developing an Emissions Profile for a Clay Refractory Kiln

Hour	HF Mass Emission Rate at Control Device Inlet (lbs/hr)	Total Mass Emission Rate for 3-Hour Period
1	0.40	
2	0.50	
3	0.65	1.55
4	0.82	1.97
5	0.96	2.43
6	1.25	3.03
7	1.08	3.29
8	0.87	3.20
9	0.78	2.73
10	0.63	2.28
11	0.51	1.92
12	0.42	1.56
13	0.37	1.30
14	0.29	1.08
15	0.15	0.81
16	0.11	0.55
17	0.07	0.32
18	0.04	0.22

As shown in the right-hand column of Table 6, to develop an emissions profile you have to calculate the total emission rate for each consecutive 3-hour period of the batch. In this case, the value represents the total emission rate for the 3-hour period ending at that hour. For example, the total emission rate for hours 1 through 3 is:

$$0.40 + 0.50 + 0.65 = 1.55$$

For the example test run presented in Table 6, the highest total is 3.29. This peak emissions period occurs between hours 5 and 7. Because this is the peak emissions period for this particular source, you will only have to conduct testing during hours 5 through 7 of the batch for all future testing of this kiln. You must begin testing at the beginning of hour 5 and you may end testing at the end of hour 7.

2. *Example Calculations for Demonstrating Compliance with the Emission Limits*

The emission limits for clay refractory kilns using a batch process are based on a percentage reduction requirement. Facilities must achieve a 90 percent reduction in HF emissions and a 30 percent reduction in HCl emissions. Example 4 presents the calculation procedures for demonstrating compliance with the percentage reduction requirement.

Example 4: Calculations for Demonstrating Compliance with the Percentage Reduction Requirements for a Batch Process

You should follow these steps to demonstrate compliance with the percentage reduction requirements in the rule.

1. Determine the hourly HF and HCl mass emission rates (lbs/hr) at the inlet and outlet of the control device using one of the approved test methods.
2. Identify the period of 3 consecutive hours during the test run when the sum of the hourly HF emission rates at the inlet to the control device is greater than any other period of 3 consecutive hours. This 3-hour period is referred to as the peak HF emissions period.
3. Calculate the HF and HCl percentage reduction for each hour of the peak emissions period using Equation 2 of 63.9800(g)(2). For example, in Table 7 below, the percentage reduction for HF for Hour 1 is calculated as follows:

   (0.50 – 0.050)/0.50 x 100 = 90 percent

4. For each test run, calculate the average percentage reduction for HF and HCl for the 3-hour peak HF emissions period.
5. Calculate the average HF and HCl percentage reduction for the two test runs. This is the percentage reduction for the performance test.

Table 7 presents data from an example test run that can be used to demonstrate the procedure for showing compliance with the percentage reduction requirements.

Table 7. Example Test Run For Demonstrating Compliance with the Percentage Reduction Requirements for a Clay Refractory Batch Process

Hour	HF Emission Rate, Inlet (lbs/hr)	3-Hour Total HF Emission Rate, Inlet	HF Emission Rate, Outlet (lbs/hr)	HF Percentage Reduction	HCl Emission Rate, Inlet (lbs/hr)	HCl Emission Rate, Outlet (lbs/hr)	HCl Percentage Reduction
1	0.50		0.050	90	0.11	0.070	36.4
2	0.60		0.054	91	0.13	0.090	30.8
3	0.92	2.02	0.072	92.2	0.21	0.14	33.3
4	1.03	2.55	0.075	92.7	0.32	0.22	31.3
5	1.16	3.11	0.078	93.3	0.35	0.23	34.3
6	1.23	3.42	0.083	93.3	0.38	0.25	34.2
7	1.09	3.48	0.077	92.9	0.38	0.26	31.6
8	0.87	3.19	0.073	91.6	0.31	0.21	32.3
9	0.63	2.59	0.055	91.3	0.19	0.13	31.6
10	0.48	1.98	0.043	91.0	0.12	0.08	33.3
11	0.28	1.39	0.027	90.4	0.08	0.05	37.5

The peak HF emissions period for this example test run occurs between hours 5 and 7. Therefore, following step (4) above, you must determine the average reduction for both HF and HCl during that 3-hour period.

For HF, the percentage reductions for hours 5, 6, and 7 are 93.3, 93.3 and 92.9, respectively. Therefore, the average percentage reduction for HF for this test run is 93.2 percent.

For HCl, the percentage reduction for hours 5, 6 and 7 are 34.3, 34.2 and 31.6, respectively. Therefore, the average percentage reduction for HCl for this test run is 33.4 percent.

Following step (5), next calculate the average reduction for the two test runs. Assuming that the average percentage reduction for HF for the peak emissions period for the second test run was 91.8, the average percentage reduction for HF for the performance test is:

$$(93.2 + 91.8)/2 = 92.4$$

For HCl, the average percentage reduction for the peak emissions period for the second test run was 31.8. Therefore, the average for the two test runs was 32.6 percent.

The rule requires at least 90 percent reduction for HF and at least 30 percent reduction for HCl, therefore the results of the performance test indicate the facility is in compliance with the rule.