

Calculating PM₁₀ and PM_{2.5} Emissions For #4, #5 and #6 Fuel Oils Using EPA FIRE 6.24 Formulas

The following information should be used to calculate uncontrolled emissions for PM₁₀-PRI (Primary PM₁₀), PM₁₀-FIL (Filterable PM₁₀), PM_{2.5}-PRI (Primary PM_{2.5}) and PM_{2.5}-FIL (Filterable PM_{2.5}) and Source Classification Codes (SCCs) listed. This information should be used when stack test, CEM (Continuous Emission Monitoring) or other information acceptable to the Emissions Inventory Development group is not available. PM Condesible can be automatically calculated in the i-STEPS system for the SCCs listed below.

There has been some confusion, when calculating PM_x emissions for Residual Oil burning combustion equipment using formula in EPA's FIRE database. The Factor Information REtrieval (FIRE) Data System is a database containing EPA's emission estimation factors. Part of the reason for the confusion is historically when calculating emissions the variable "A" has represented the % Ash in the fuel. In the underlined formula in the table below this is not the case. "A" is a variable represented by a formula. "A" = ((x * S) + the constant 0.37). For #6 oil x=1.12. See the Notes column for more information.

Please note that EPA has determined states shall use the identifiers PM25-FIL and PM25-PRI when reporting PM2.5 Filterable and PM2.5 Primary. See the instructions included in the cover letter to the facilities for additional information on Particulate Matter emissions.

SCC	Pollutant	Units		EPA FIRE 6.24 Notes	EPA FIRE 6.24 Formula
10100401	PM10-FIL	1000 Gallons	Burned	S=% Sulfur	$5.9E0*(1.12*S+0.37)$
10100401	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	$(5.9E0*(1.12*S+0.37))+(1.500E0)$
10100401	PM25-FIL	1000 Gallons	Burned	S=% Sulfur	$4.3E0*(1.12*S+0.37)$
10100401	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	$(4.3E0*(1.12*S+0.37))+(1.500E0)$
10100404	PM10-FIL	1000 Gallons	Burned	S=% Sulfur	$5.9E0*(1.12*S+0.37)$
10100404	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	$(5.9E0*(1.12*S+0.37))+(1.500E0)$
10100404	PM25-FIL	1000 Gallons	Burned	S=% Sulfur.	$4.3E0*(1.12*S+0.37)$
10100404	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	$(4.3E0*(1.12*S+0.37))+(1.500E0)$
10100405	PM10-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil	<u>$5.9E0*A$</u>

				combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84.; (Factor is derived: 71% of the PM, filterable factor)	
10100405	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	<u>(5.9E0*A)+(1.50E0)</u>
10100405	PM25-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84.; (Factor is derived: 52% of the PM, filterable factor)	<u>4.3E0*A</u>
10100405	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	<u>(4.3E0*A)+(1.50E0)</u>
10100406	PM10-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84.; (Factor is derived: 71% of the PM, filterable factor)	<u>5.9E0*A</u>
10100406	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	<u>(5.9E0*A)+(1.50E0)</u>

				factors	
10100406	PM25-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84.; (Factor is derived: 52% of the PM, filterable factor)	<u>4.3E0*A</u>
10100406	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	<u>(4.3E0*A)+(1.50E0)</u>
10100504	PM10-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84.; (Factor is derived: 71% of the PM, filterable factor)	<u>5.9E0*A</u>
10100504	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	<u>(5.9E0*A)+(1.50E0)</u>
10100504	PM25-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84.; (Factor is derived: 52% of the PM,	<u>4.3E0*A</u>

				filterable factor)	
10100504	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	<u>(4.3E0*A)+(1.50E0)</u>
10200401	PM10-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84.	<u>7.17E0*A</u>
10200401	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	<u>(7.17E0*A)+(1.500E0)</u>
10200401	PM25-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84.	<u>4.67E0*A</u>
10200401	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	<u>(4.67E0*A)+(1.500E0)</u>
10200402	PM10-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84.	<u>7.17E0*A</u>

10200402	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	$(7.17E0 * A) + (1.50E0)$
10200402	PM25-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: $A=1.12(S)+0.37$. For Number 5 Oil: $A=1.2$. For Number 4 Oil: $A=0.84$.	$4.67E0 * A$
10200402	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	$(4.67E0 * A) + (1.50E0)$
10200403	PM10-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: $A=1.12(S)+0.37$. For Number 5 Oil: $A=1.2$. For Number 4 Oil: $A=0.84$.	$7.17E0 * A$
10200403	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	$(7.17E0 * A) + (1.50E0)$
10200403	PM25-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: $A=1.12(S)+0.37$. For Number 5 Oil: $A=1.2$. For Number 4 Oil: $A=0.84$.	$4.67E0 * A$
10200403	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	$(4.67E0 * A) + (1.50E0)$

				factors	
10200405	PM10-FIL	1000 Gallons	Burned	Multiply the emission factor provided by the weight percent sulfur content of the fuel to obtain emission factor in lb/activity units; where S is the wt. % of the sulfur in the oil.	$7.90E0*S+2.77E0$
10200405	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	$(7.90E0*S+2.77E0) + 1.50E0$
10200405	PM25-FIL	1000 Gallons	Burned	Multiply the emission factor provided by the weight percent sulfur content of the fuel to obtain emission factor in lb/activity units. Where S is the wt. % of the sulfur in the oil. Derived factor: 56% of uncontrolled PM-FIL factor based on AP-42, Tables 1.3-1 and 1.3-5.	$1.226(S)+1.803E0$
10200405	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	$(1.226(S)+1.803E0) + 1.50E0$
10201404	PM10-FIL	1000 Gallons	Burned	Multiply the emission factor provided by the weight percent sulfur content of the fuel to obtain emission factor in lb/activity units; where S is the wt. % of the sulfur in the oil. Emission factor was transferred from other oil-burning boilers assuming process similarity.	$7.90E0*S+2.77E0$
10201404	PM25-FIL	1000 Gallons	Burned	Multiply the emission factor provided by the weight percent sulfur content of the fuel to obtain emission factor in lb/activity units. Where S is the wt. % of the sulfur in the oil. Derived factor: 56% of uncontrolled PM-FIL factor based on AP-42, Tables 1.3-1 and 1.3-5.	$1.226(S)+1.803E0$
10300401	PM10-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur	<u>$5.17E0*A$</u>

				content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84. For Number 2 Oil: A=0.24.	
10300401	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	<u>(5.17E0*A)+(1.500E0)</u>
10300401	PM25-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84. For Number 2 Oil: A=0.24.	<u>1.92E0*A</u>
10300401	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	<u>(1.92E0*A)+(1.500E0)</u>
10300402	PM10-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84. For Number 2 Oil: A=0.24.	<u>5.17E0*A</u>
10300402	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	<u>(5.17E0*A)+(1.50E0)</u>
10300402	PM25-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the	<u>1.92E0*A</u>

				oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84. For Number 2 Oil: A=0.24.	
10300402	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	<u>(1.92E0*A)+(1.50E0)</u>
10300403	PM10-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84. For Number 2 Oil: A=0.24.	<u>5.17E0*A</u>
10300403	PM10-PRI	1000 Gallons	Burned	Sum of PM10-FIL and PM-CON emission factors	<u>(5.17E0*A)+(1.50E0)</u>
10300403	PM25-FIL	1000 Gallons	Burned	Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content where S is the weight % of sulfur in the oil. For example, if the fuel is 1.00% sulfur, then S=1. For Number 6 Oil: A=1.12(S)+0.37. For Number 5 Oil: A=1.2. For Number 4 Oil: A=0.84. For Number 2 Oil: A=0.24.	<u>1.92E0*A</u>
10300403	PM25-PRI	1000 Gallons	Burned	Sum of PM25-FIL and PM-CON emission factors	<u>(1.92E0*A)+(1.50E0)</u>

Sample Calculations

Calculation for PM10 Filterable (PM10-FIL) for Residual Oil for SCC 10200401:

PM10-FIL = Annual Throughput x (7.17 x ((1.12 x S) + 0.37))
EPA FIRE formula (7.17E0*A) For number 6 Oil: A=1.12(S)+0.37

Where:

S = % Sulfur in fuel

Annual Throughput = The amount of residual oil per (1000 gallons) burned in a specified year.

7.17 = lbs/1000 Gallons Burned = EPA emission factor

1.12 = constant value

0.37 = constant value

Example:

If SCC = 10200401

If Annual Throughput = 587.159 (1000 gallons)

Then:

S = 1.0%

PM10-FIL = (587.159) x (7.17 x ((1.12 x (1)) + 0.37))

PM10-FIL = 6272.80 lbs /2000

PM10-FIL = 3.13 Tons

Calculation for PM10 Primary (PM10-PRI) for Residual Oil for SCC 10200401:

PM10-PRI = PM10-FIL + PM-CON

Where:

PM10-FIL = PM₁₀-FIL (Filterable PM₁₀)

PM-CON = Condensable Particulate Matter calculated in i-STEPS

PM10-PRI = PM₁₀-PRI (Primary PM₁₀)

Example:

If PM10-FIL = 3.14 Tons

If PM-CON = 0.44 Tons

Then:

PM10-PRI = 3.14 + 0.44

PM10-PRI = 3.58 Tons

Calculation for PM25-FIL for Residual Oil for SCC 10200401:

PM25-FIL = Annual Throughput x (4.67 x ((1.12 x S) + 0.37))

Where:

S = % Sulfur

Annual Throughput = The amount of residual oil per (1000 gallons) burned in a specified year.

4.67 = Numerical value dependent on SCC

1.12 = constant value

0.37 = constant value

Example:

If SCC = 10200401

If Annual Throughput = 587.159(1000 gallons)

Then:

S = 1

PM25-FIL = (587.159) x (4.67 x ((1.12 x (1)) + 0.37))

PM25-FIL = 4085.63lbs/2000

PM25-FIL = 2.04 Tons

Calculation for PM25-PRI Residual Oil for SCC 10200401:

PM25-PRI = PM10-FIL + PM-CON

Where:

PM25-FIL = PM-FIL_{2.5} (Filterable PM_{2.5})

PM-CON = Condensable Particulate Matter

PM25-PRI = PM_{2.5}-PRI (Primary PM_{2.5})

Example:

IF PM25-FIL = 2.0 Tons

IF PM-CON = 0.44 Tons

Then:

PM25-PRI = 2.04 + 0.4404

PM25-PRI = 2.48