



The Industrial Process Equipment Rule

Industrial process equipment often creates airborne dust or particulate matter as a normal part of operations. For many types of equipment, such as boilers, specific state rules or federal regulations limit the amount of particulate matter that can be emitted to the atmosphere.

Particulate matter emissions from equipment to which no specific state rule or federal regulation apply are limited under the general “Industrial Process Equipment Rule” (Minn. R. 7011.0700 - 7011.0735). The rule includes a maximum limit that is never to be exceeded. This limit does not apply specifically to particulate matter smaller than 10 microns (PM₁₀ or PM_{2.5}).

The owner or operator of an emissions source is responsible for determining the limit imposed by the rule and must meet the limit at all times.

By following the instructions in this fact sheet, you can determine the emission limit that applies to your process equipment. While stack emission test data are not necessary when using this fact sheet to calculate emission limits, testing is the only way to know for sure whether your equipment complies with the limit in the rule.

Note that this rule, like all other federally enforceable state rules and federal regulations, limits a facility’s potential to emit to that allowed by the rule. Remember this if you are determining whether a permit or an amendment is required for your facility.

The rule allows an exemption from meeting the limits if a source has air pollution control equipment and meets one of the following conditions:

- An emission unit may be allowed to exceed the applicable limit if it has pollution control equipment that has a control efficiency of 99 percent or more, depending on the date of initial operation. If the equipment was in operation before July 9, 1969, it must have a control efficiency of 99 percent to qualify for this exemption. If it was not in operation until July 9, 1969, or later, it must have an efficiency of 99.7 percent or greater.
- An emission unit may be allowed to exceed the applicable if it is located outside the Minneapolis-St. Paul Air Quality Control Region and outside the city of Duluth; is more than one quarter mile from a public road or residence; has control equipment with an efficiency of at least 85 percent; and does not cause or contribute to a violation of an ambient air standard.

The rule includes two ways to calculate emissions limits: by process weight rate and by exhaust gas airflow. When emission limits are calculated by both methods, the applicable limit is the more lenient or higher emission rate, of the two.

Table 1 of the rule (Minn. R. 7011.0730) uses the process weight rate to determine the allowed emission limit. The definition of process weight rate from the rule is included in Step 1, which describes how to find the process weight rate. In general, it is the rate at which materials that may cause emission of particulate matter are introduced into any industrial process equipment. As an example, for most spray painting operations, the process weight rate is the weight per hour of paint that can be sprayed.

After determining the process weight rate, you can find the applicable emission limit from Table 1 or by calculating it yourself using equations provided below.

Table 2 of the rule (Minn. R. 7011.0735) uses source gas volume to determine the allowed emissions. To use Table 2, you will need to know or be able to determine the airflow to the atmosphere from the process equipment. Then use the table or the equation to determine the emission limit corresponding to that airflow.

Step 1

Determine the “Process Weight Rate” (the amount of dry material that is processed by the equipment) in pounds per hour.

There may be more than one operating condition for which a process weight rate needs to be determined. For example, if two or more units exhaust through one stack and can operate independently, determine the emission limit separately for each unit. The attached worksheet (last page of fact sheet) may be used to record emission points and operating conditions in columns “a” and “b” and the associated process weight rate in column “c.”

“Process weight rate” as defined in the rules is the total weight in a given time period of all materials introduced into any industrial process equipment that may cause any emission of particulate matter. Note that the definition of “Particulate Matter” in Minn. R. ch. 7005 includes any material (except water) that is liquid or solid at standard conditions.

Solid fuels are considered as part of the process weight, but liquid and gaseous fuels and combustion air are not. For a cyclical or batch operation, the process weight per hour is derived by dividing the total process weight by the number of hours in one complete cycle of the operation, from the beginning of any given process to the completion thereof, excluding any time during which the equipment is idle. For a continuous operation, the

process weight per hour is derived by dividing the process weight for a typical period of time by the number of hours in that period of time.

Step 2

Determine the allowed emission rate based on process weight rate.

Table 1 may be used to determine the allowed emission rate based on process weight rate. This emission rate may be recorded in column “d” on the attached worksheet (Table 3).

Step 3

Determine the airflow and exit temperature.

To use Table 2, a corrected airflow through the stack is required. The airflow from the process equipment at 68 degrees Fahrenheit and one atmosphere pressure should be used.

This airflow must also be adjusted for moisture content, and it must be the airflow when emissions are at a maximum. This is usually at the maximum production capacity of the process equipment, but there may be cases when the highest emissions occur at a lower production rate. Both the maximum production rate situation and the maximum emission rate situation may require analysis.

If you know your airflow and exit temperature, go to Step 4; if not, use the following instructions to determine your airflow and exit temperature.

Under each type of equipment or emission unit, several methods of estimating flow rate and temperature may be given. The first method is the most preferred and should provide the most accurate data, but the other methods are also acceptable.

A. Equipment burning common fuels (except boilers and other indirect-fired units)

A(1) Preferred method

Determine the maximum rate at which each fuel can be burned based on the overall facility design, and contact the equipment manufacturer for the stack flow rate and temperature at that fuel-burning rate.

A(2) Alternate Method

Calculate the stack flow rate using the following procedure:

For each fuel, obtain an analysis (ultimate analysis) for weight fraction carbon (C), hydrogen (H), sulfur (S), nitrogen (N), oxygen (O₂), and fuel moisture to two decimal places (e.g., 0.86C, 0.14H). For common commercial fuels such as fuel oils sold as Grades 1, 2, 4, 5, or 6, typical analyses in engineering handbooks are acceptable. For other fuels, consult your supplier or have a laboratory perform an ultimate analysis.

Write the fuel analysis by weight for your fuel here. You will need the numbers for your calculations.

Fuel weight fraction for carbon = _____. This is C.

Fuel weight fraction for hydrogen = _____. This is H.

Fuel weight fraction for sulfur = _____. This is S.

Fuel weight fraction for nitrogen = _____. This is N.

Fuel weight fraction for oxygen = _____. This is O₂.

Obtain the manufacturer's recommended excess air for that fuel or use the following:

Fuel	Excess air
Distillate fuel oil	25%
Residual fuel oil	35%
Residual fuel oil	35%
Wood	50%
Coal	50%

Calculate the minimum amount of oxygen to burn a unit weight of fuel using the following equation:

$$\text{Min O}_2 = 2.66(C) + 8.0(H) + S - O$$

where C, H, S, and O are the weight fractions of carbon, hydrogen, sulfur, and oxygen in the fuel.

Calculate the total oxygen from:

$$\text{Total O}_2 = (1 + E/100) \times \text{Min O}_2$$

where E is the percentage excess air.

Complete the following:

Combustion product	Weight per unit fuel weight
CO ₂	3.67 x C = _____
H ₂ O	9.0 x H + fuel moisture = _____
SO ₂	2.0 x S = _____
N ₂	3.25 x total O ₂ + N = _____
Total weight of products per unit weight of fuel (sum of the above) _____	

Calculate the volume of combustion products at standard conditions by multiplying the above sum by 13.33:

$$V_{\text{std conditions}} = 13.33 \times \text{sum}$$

Correct this volume to actual stack temperature as follows:

$$V_{\text{actual}} = V_{\text{std conditions}} \times (\text{stack temperature} + 460) \div 528$$

where V_{actual} is the volume in cubic feet per unit weight of fuel burned.

Calculate the stack flow rate for Form GI-04 by multiplying V_{actual} by the maximum fuel combustion rate in pounds per hour. Maximum fuel combustion rate can be obtained from the manufacturer or by dividing the rated nameplate heat input by the heat value of the fuel per pound.

A(3) Alternate method

Performance test data may be used to provide flow rate and temperature. If the test is not conducted at the design fuel-burning rate, the measured flow rate may need to be extrapolated to the design conditions.

B. Fan-powered ventilation systems

B(1) Preferred method

Consult purchase documents for the fan specifications, which will usually indicate the volumetric flow rate of air for which the fan is designed. If the air is cleaned by a baghouse, scrubber, cyclone, or other air pollution control equipment, the purchase documents for that equipment will usually specify the design gas flow rate. If both are available, the smaller number should be reported.

B(2) Alternate method

Measure the air volume in a straight run of duct using a pitot tube and U.S. Environmental Protection Agency,

(EPA) Methods 1 and 2. Stack tests already performed may be adequate if conducted at the design conditions. EPA test methods are found in the Appendices in Title 40 of the Code of Federal Regulations, Part 60 (40 CFR pt. 60).

B(3) Alternate method

Determine the fan model number from the manufacturer's nameplate and speed from the motor and drive, and measure the static pressure at the fan inlet. Consult the manufacturer's performance curve for the fan, or call the manufacturer to determine the fan performance.

B(4) Last-resort-method

This may also be used to provide a quick verification of other methods. Multiply the cross-sectional area of the fan outlet or exhaust stack, in square feet, by 4,000 feet per minute.

C. Natural draft ventilation systems

A natural draft ventilation system usually consists of a roof opening with a weather hood designed to facilitate exhaust of indoor air due to temperature difference (the indoor air is usually warmer) and may be assisted by wind.

Obtain the manufacturer's model number from purchasing records if available or from nameplates if accessible and contact the manufacturer for estimated air flow. If the name of the architect or engineering company that designed the building is still available, they may have design calculations of the required ventilation flow rate.

Step 4

Determine the cored airflow for Table 2.

Most industrial equipment does not operate at exactly 68 degrees Fahrenheit and the pressure is seldom exactly one atmosphere or 14.7 pounds per square inch (psi).

Start with the actual airflow in cubic feet per minute, the actual temperature in degrees Fahrenheit, the actual pressure in psi, and the actual percent moisture. To correct this airflow to standard conditions

(68 degrees, one atmosphere, and no moisture), use the following equation:

FR_{corrected} =

$$FR_{\text{actual}} \times [528 \div (T + 460)] \times [P \div 14.7] \times [1 - (\% \text{ moisture} \div 100)]$$

where:

FR_{actual} = the actual airflow (flow rate) in ft³/minute

T = temperature in degrees Fahrenheit

P = pressure in psi

FR_{corrected} = the corrected airflow (flow rate) in ft³/minute

Record this corrected air flow (FR_{corrected}) on the worksheet at the end of this fact sheet, in column "e."

Step 5

Determine your applicable emission limit

Use Table 2 to determine you're allowed concentration in grains per dry standard cubic foot (gr/dscf).¹

Record the allowed concentration in column "f" in Table 3. To convert the concentration to an emission rate, use the following equation and record the result on the worksheet at the end of this fact sheet, in column "g."

$$E = c \times V \times (60 \div 7000)$$

Where:

E = emission rate in lb/hour

c = concentration in gr/dscf

V = gas volume in dscfm

Determine which of the two emission limits calculated above (i.e. from Table 1 and Table 2) is less stringent. The less stringent limit is the limit with which you must comply. However, if Table 1 is the less stringent limit but results in a dust load of more than 0.3 grains per dry standard cubic foot, then the limit is 0.3 grain per dry standard cubic foot.

Enter the limit in column "g" on the worksheet at the end of this fact sheet.

More questions

If you have additional questions about how to use the Industrial Process Equipment Rule, contact the Minnesota Pollution Control Agency at 651-296-6300 or toll free at 800-657-3864.

¹ 7000 grains = 1 pound.

Table 1: Process weight rate and associated emission limit

Process rate (lb/hr)	Allowed emission rate (lb/hr)	Process rate (lb/hr)	Allowed emission rate (lb/hr)
100	0.55	50,000	26.41
200	0.86	60,000	29.60
300	1.11	70,000	30.57
400	1.32	80,000	31.19
500	1.53	90,000	31.83
600	1.70	100,000	32.37
700	1.87	110,000	32.87
800	2.03	120,000	33.28
900	2.19	130,000	33.76
1,000	2.25	140,000	34.16
2,000	3.59	150,000	34.54
3,000	4.62	160,000	34.85
4,000	5.52	170,000	35.24
5,000	6.34	180,000	35.56
6,000	7.09	190,000	35.87
7,000	7.81	200,000	36.11
8,000	8.48	250,000	37.48
9,000	9.12	300,000	38.59
10,000	9.73	350,000	39.55
11,000	10.33	400,000	40.35
12,000	10.90	500,000	41.88
13,000	11.46	600,000	43.12
14,000	12.00	700,000	44.19
15,000	12.52	800,000	45.15
16,000	13.03	900,000	46.01
17,000	13.53	1,000,000	46.72
18,000	14.02	2,000,000	52.28
19,000	14.50	3,000,000	55.78
20,000	14.99	4,000,000	58.41
30,000	19.24	5,000,000	60.53
40,000	23.00	6,000,000	62.32
		7,000,000	63.88

If the process weight rate is between two values in the table, the following equation must be used to interpolate. **Numbers in bold in Table 1 are as published in Minn. R. 7011.0730.** Other entries have been calculated using the following equations.

For P ≤ 60,000 lb/hr	$E = 3.59 \times (P \div 2000)^{0.62}$
For P > 60,000 lb/hr	$E = 17.31 \times (P \div 2000)^{0.16}$

Where: P = process weight rate, in lb/hr
E = emission rate, in lb/hr

Table 2: Airflow and associated emission limit

Source gas volume (dscfm)	Allowed concentration (gr/dscf)	Source gas volume (dscfm)	Allowed concentration (gr/dscf)
≤ 7,000	0.100	90,000	0.044
8,000	0.096	95,000	0.043
9,000	0.092	100,000	0.042
10,000	0.089	120,000	0.040
11,000	0.086	140,000	0.038
12,000	0.084	160,000	0.036
13,000	0.082	180,000	0.035
14,000	0.080	200,000	0.034
15,000	0.078	250,000	0.032
20,000	0.071	300,000	0.030
25,000	0.066	350,000	0.028
30,000	0.062	400,000	0.027
35,000	0.059	450,000	0.026
40,000	0.057	500,000	0.025
45,000	0.055	550,000	0.024
50,000	0.053	600,000	0.024
55,000	0.051	650,000	0.023
60,000	0.050	700,000	0.022
65,000	0.049	750,000	0.022
70,000	0.047	800,000	0.021
75,000	0.046	850,000	0.021
80,000	0.045	900,000	0.021
85,000	0.044	≥ 950,000	0.020

If the source gas volume is between two values in the table, the following equations must be used to interpolate. **Numbers in bold in Table 2 are as published in Minn. R. 7011.0735.** Other entries have been calculated using the following equations.

$$c = 1.7627 \times FR_{\text{corrected}}^{-0.3241}$$

Where:

c = concentration in gr/dscf

$FR_{\text{corrected}}$ = gas volume in dscfm (from Step 4)

Note that if your corrected airflow is 7000 dscfm or less, the limit is 0.1 grains per dry standard cubic foot.

Table 3: Worksheet

(a) Emission point	(b) Operating condition	(c) Process weight rate (P), lb/hr	(d) Emission limit (E) based on the process weight rate, lb/hr	(e) Gas volume (FR _{corrected}), dscfm	(f) Emission concentration based on airflow (C), gr/dscf	(g) Emission (E) based on airflow, lb/hr	(h) Emission limit based on the rule