Air Permits Division

Calculations Guidance Package

Grain Elevators

Compiled, published, and distributed by the
Air Permits Division
Texas Commission on Environmental Quality
Post Office Box 13087 - MC 163
Austin, Texas 78711-3087
(512) 239-1250

SAMPLE EMISSION CALCULATIONS FOR GRAIN ELEVATORS

The following emission calculations are provided only as an example. These calculations are based on typical equipment and commodities that are processed at a grain elevator operation. Emission calculations submitted to the TCEQ should include any assumptions and references for all emissions factors used and samples of all emission calculations performed. The following steps should be taken when calculating emissions from a grain elevator facility.

Step 1. Identify all emission points. Normally, these emission points are commodity receiving pits (truck or railcar), all open transfer points, any grain dryers, and commodity loadout areas (truck or railcar).

Step 2. List all commodities received including hourly and annual receiving rates. Hourly receiving rates are determined by the maximum number of truck or railcar loads that can be unloaded in the facility's receiving pits in one hour. Annual receiving rates are estimated on the annual usage of each commodity. An estimation of receiving rates should be conducted for all commodities.

Step 3. Make a fan chart for all proposed abatement devices including the emission point number, the fan's purpose (i.e. truck receiving), type of control device (ie. bagfilter), and average and maximum flow rates (dscfm).

Step 4. Estimate the hourly and annual emission rates for each emission point. All emission rates should be based on the maximum hourly and annual throughput capacity for that particular emission point. In addition, any control efficiencies used to reduce the emissions from an emission point should be justified and provided in the emission calculations.

EXAMPLE CALCULATIONS

Emission Points

Emission Point No. 1: Truck Receiving Pit

Emission Point No. 2: Railcar Receiving Pit No. 1 Bagfilter

Emission Point No. 3: Railcar Receiving Pit No. 2

Emission Point No. 4: Truck Loadout

Emission Point No. 5: Dryer

Emission Point No. 6: Cleaner

Commodities Received in Truck and Railcar Receiving Pits

Commodity	Tons/ Truck	Tons/ RRcar	Trucks/ Hour	RRcars/ Hour	Max Hrly Truck Rec. (TPH)	Max Hrly Rail Rec. (TPH)	Max Ann. Trucks Rec. (TPY)	Max Ann. Rail Rec. (TPY)
Whole Grains	25	200	8	1	200	200	100,000	336,200
Soybean Meal	25	200	8	1	200	200	45,400	100,000
Totals:							145,400	436,200

Grain Cleaning Throughputs

Emission Point No.	Purpose	Control Device	Hourly Tonnage Cleaned	Annual Tonnage Cleaned
6	Grain Cleaning Operations	Cyclone	84	350,000

Fan Chart

Emission Point No.	Purpose	Control Device	Expected Flowrate
2	Railcar Receiving Pit No. 1	Baghouse	12,400 (dscfm)

EMISSION CALCULATIONS FOR TRUCK AND RAILCAR RECEIVING

1. TRUCK RECEIVING PIT:

- Assume emissions are reduced by 90% during choke feeding, which is already included in the emission factors.
- Assume that PM is total particulate matter, suspended in the atmosphere.

Hourly:

$$PM = 200 \frac{\text{tons}}{\text{hour}} \times 0.017 \frac{\text{lbs}^{(a)}}{\text{ton}} = \mathbf{3.40} \frac{\textbf{lbs}}{\textbf{hour}}$$

$$PM_{10} = 200 \frac{\text{tons}}{\text{hour}} \times 0.0025 \frac{\text{lbs}^{(a)}}{\text{ton}} = \mathbf{0.50} \frac{\textbf{lbs}}{\textbf{hour}}$$

Annual:

$$PM = 145{,}400 \frac{\text{tons}}{\text{year}} \times 0.017 \frac{\text{lbs}^{(a)}}{\text{ton}} \times \frac{1 \text{ ton}}{2000 \text{ lbs}} = \mathbf{1.24} \frac{\textbf{tons}}{\textbf{year}}$$

$$PM_{10} = 145{,}400 \frac{\text{tons}}{\text{year}} \times 0.0025 \frac{\text{lbs}^{(a)}}{\text{ton}} \times \frac{1 \text{ ton}}{2000 \text{ lbs}} = \mathbf{0.18} \frac{\textbf{tons}}{\textbf{year}}$$

2. RAILCAR RECEIVING PIT NO. 1 (BAGFILTER SYSTEM):

- Assume that since this railcar receiving area is in a building with suction being pulled and the doors are closed while receiving grain and commodities, this emission point will not have any fugitive emissions. The only emissions from this point will be point source emissions from the bagfilter system.
- Assume emissions from the bagfilter are PM_{10} or smaller.

Hourly:

$$PM_{10} = 0.01 \frac{\text{gr}^{(b)}}{\text{dscf}} \times 12{,}400 \frac{\text{dscf}}{\text{min.}} \times \frac{1 \text{ lb}}{7000 \text{ grains}} \times 60 \frac{\text{min.}}{\text{hour}} = \mathbf{1.06} \frac{\textbf{lbs}}{\textbf{hour}}$$

Annual:

- Assume this railcar receiving pit receives half of the total annual railcar throughput.

Total Material Received = 436,200 tons/yr ÷ 2

= 218,100 tons/year

$$PM_{10} = 1.06 \frac{\text{lbs}}{\text{hour}} \times 218{,}100 \frac{\text{tons}}{\text{year}} \div 200 \frac{\text{tons}}{\text{hour}} \times \frac{1 \text{ ton}}{2000 \text{ lbs}} = \mathbf{0.58} \frac{\textbf{tons}}{\textbf{year}}$$

3. RAILCAR RECEIVING PIT NO. 2:

- Assume emissions are reduced by 90% during choke feeding.
- Assume PM is total particulate matter, suspended in the atmosphere.

Hourly:

$$PM = 200\ \frac{\text{tons}}{\text{hour}} \times 0.017\ \frac{\text{lbs}^{(a)}}{\text{ton}} = \mathbf{3.40\ \frac{lbs}{hour}}$$

$$PM_{10} = 200\ \frac{\text{tons}}{\text{hour}} \times 0.0025\ \frac{\text{lbs}^{(a)}}{\text{ton}} = \mathbf{0.50\ \frac{lbs}{hour}}$$

Annual:

- Assume this railcar receiving pit receives half of the total annual railcar throughput.

Total Material Received = 436,200 tons/yr ÷ 2

= 218,100 tons/year

$$PM = 218{,}100\ \frac{\text{tons}}{\text{year}} \times 0.017\ \frac{\text{lbs}^{(a)}}{\text{ton}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{1.85\ \frac{tons}{year}}$$

$$PM_{10} = 218{,}100\ \frac{\text{tons}}{\text{year}} \times 0.0025\ \frac{\text{lbs}^{(a)}}{\text{ton}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{0.27\ \frac{tons}{year}}$$

4. TRUCK LOADOUT:

- Assume no more than one truck loads out at a time.
- Assume the loadout area is totally enclosed with no suction being pulled; assume 90% control of emissions.
- Assume PM is total particulate matter suspended in the atmosphere.

Hourly:

8 trucks/hr x 25 tons/truck = 200 tons/hr

$$PM = 200\ \frac{\text{tons}}{\text{hour}} \times 0.086\ \frac{\text{lbs}^{(c)}}{\text{ton}} \times (1-.90)^{(d)} = \mathbf{1.72\ \frac{lbs}{hour}}$$

$$PM_{10} = 200\ \frac{\text{tons}}{\text{hour}} \times 0.029\ \frac{\text{lbs}^{(c)}}{\text{ton}} \times (1-.90)^{(d)} = \mathbf{0.58\ \frac{lbs}{hour}}$$

Annual:

Total Materials = 145,400 TPY + 436,200 TPY

= 581,600 TPY

$$PM = 581{,}600\ \frac{\text{tons}}{\text{year}} \times 0.086\ \frac{\text{lbs}^{(c)}}{\text{ton}} \times (1\text{-}.90)^{(d)} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{2.50\ \frac{tons}{year}}$$

$$PM_{10} = 581{,}600\ \frac{\text{tons}}{\text{year}} \times 0.029\ \frac{\text{lbs}^{(c)}}{\text{ton}} \times (1\text{-}.90)^{(d)} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{0.84\ \frac{tons}{year}}$$

5. DRYER:

- Assume 3000 bushels/hour (84 tons/hour) commercial dryer at 2.9 million BTU/hour.
- Assume maximum fuel flow rate of 2,990 ft^3/hour and 26,186,000 ft^3/year of natural gas.
- Assume only non-methane VOC emissions are quantified (8.0 lbs/10^6 ft^3 x 0.66 non-methane emissions = 5.28 lbs/10^6 ft^3).
- Assume maximum annual throughput: 15% of grain received (87,000 TPY)

Hourly:

$$PM = 84\ \frac{\text{tons}}{\text{hour}} \times 0.22\ \frac{\text{lbs}^{(c)}}{\text{ton}} = \mathbf{18.48\ \frac{lbs}{hour}}$$ (grain dust)

$$PM_{10} = 84\ \frac{\text{tons}}{\text{hour}} \times 0.055\ \frac{\text{lbs}^{(c)}}{\text{ton}} = \mathbf{4.62\ \frac{lbs}{hour}}$$ (grain dust)

$$PM_{10} = 2{,}990\ \frac{\text{ft}^3}{\text{hour}} \times \frac{7.6\ \text{lbs}^{(e)}}{10^6\ \text{ft}^3} = \mathbf{0.02\ \frac{lbs}{hour}}$$ (products of combustion)

$$SO_2 = 2{,}990\ \frac{\text{ft}^3}{\text{hour}} \times \frac{0.6\ \text{lbs}^{(e)}}{10^6\ \text{ft}^3} = \mathbf{0.002\ \frac{lbs}{hour}}$$

$$NO_x = 2{,}990\ \frac{\text{ft}^3}{\text{hour}} \times \frac{100\ \text{lbs}^{(e)}}{10^6\ \text{ft}^3} = \mathbf{0.30\ \frac{lbs}{hour}}$$

$$CO = 2{,}990\ \frac{\text{ft}^3}{\text{hour}} \times \frac{84\ \text{lbs}^{(e)}}{10^6\ \text{ft}^3} = \mathbf{0.25\ \frac{lbs}{hour}}$$

$$VOC = 2{,}990\ \frac{\text{ft}^3}{\text{hour}} \times \frac{5.5\ \text{lbs}^{(e)}}{10^6\ \text{ft}^3} = \mathbf{0.02\ \frac{lbs}{hour}}$$

Annual:

- For annual emissions (including combustion emissions), assume the dryer operates only when grain is actually being dried (i.e. 87,000 tons/yr ÷ 84 tons/hr = 1036 hrs/yr). Calculate grain dust PM_{10} on maximum annual throughput.

$$PM = 87{,}000\ \frac{\text{tons}}{\text{year}} \times 0.22\ \frac{\text{lbs [c]}}{\text{ton}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{9.57\ \frac{tons}{year}} \quad \text{(grain dust)}$$

$$PM_{10} = 87{,}000\ \frac{\text{tons}}{\text{year}} \times 0.055\ \frac{\text{lbs [c]}}{\text{ton}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{2.39\ \frac{tons}{year}} \quad \text{(grain dust)}$$

$$PM_{10} = 0.02\ \frac{\text{lbs}}{\text{hour}} \times 1036\ \frac{\text{hours}}{\text{year}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{0.01\ \frac{tons}{year}} \quad \text{(products of combustion)}$$

$$SO_2 = 0.002\ \frac{\text{lbs}}{\text{hour}} \times 1036\ \frac{\text{hours}}{\text{year}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{0.001\ \frac{tons}{year}}$$

$$NO_x = 0.30\ \frac{\text{lbs}}{\text{hour}} \times 1036\ \frac{\text{hours}}{\text{year}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{0.16\ \frac{tons}{year}}$$

$$CO = 0.25\ \frac{\text{lbs}}{\text{hour}} \times 1036\ \frac{\text{hours}}{\text{year}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{0.13\ \frac{tons}{year}}$$

$$VOC = 0.02\ \frac{\text{lbs}}{\text{hour}} \times 1036\ \frac{\text{hours}}{\text{year}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{0.01\ \frac{tons}{year}}$$

6. CLEANER:

Hourly:

$$PM = 84\ \frac{\text{tons}}{\text{hour}} \times 0.075\ \frac{\text{lbs [c]}}{\text{ton}} = \mathbf{6.30\ \frac{lbs}{hour}}$$

$$PM_{10} = 84\ \frac{\text{tons}}{\text{hour}} \times 0.019\ \frac{\text{lbs [c]}}{\text{ton}} = \mathbf{1.60\ \frac{lbs}{hour}}$$

Annual:

$$PM = 350{,}000\ \frac{\text{tons}}{\text{year}} \times 0.075\ \frac{\text{lbs [c]}}{\text{ton}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{13.13\ \frac{tons}{year}}$$

$$PM_{10} = 350{,}000\ \frac{\text{tons}}{\text{year}} \times 0.019\ \frac{\text{lbs [c]}}{\text{ton}} \times \frac{1\ \text{ton}}{2000\ \text{lbs}} = \mathbf{3.33\ \frac{tons}{year}}$$

References:

All assumptions should be justified and references should be provided where applicable.

[a] AP-42, EPA Compilation of Air Pollutant Emission Factors, Particulate Emission Factors for Grain Processing Facilities, Table 9.9.1-2, 2003. Assume dust generated during the receiving of all bulk commodities is similar to the receiving operations at an animal feedmill.

[b] AP-40, Air Pollution Engineering Manual, Air and Waste Management Association, 1991, pg 115. "Well designed and operated baghouses have been shown to be capable of reducing overall particulate emissions to less than 0.01 gr/dscf"...."in some cases as low as 0.01 - 0.005 gr/dscf".

[c] AP-42, EPA Compilation of Air Pollutant Emission Factors, Particulate Emission Factors for Grain Elevators, Table 9.9.1-1, 2003.

[d] Accepted efficiencies given for certain control devices/measures that minimize <u>fugitive emissions only</u> (not to be utilized on point sources). Any other control efficiencies should be well justified and submitted with references if possible. Accepted efficiencies include:

- Enclosed receiving or loadout area with doors and/or flexible strips (canvas or plastic) and suction being pulled = 100%

- Flexible strips (canvas or plastic) and choke feeding = 95%

- Enclosed receiving or loadout area with no suction = 90%

- Choke feeding on receiving operations = 90%

- Mineral oil application = 90%

[e] AP-42, EPA Compilation of Air Pollutant Emission Factors from Natural Gas Combustion, Table 1.4-1, 1.4-2, and 1.4-3, 1998.

Best Available Control Technology emission factors determined for fuel fired equipment. Any other emission factors or control efficiencies should be well justified and submitted with references if possible. Accepted factors include:

NO_X emission factor for fuel fired equipment with an hourly BTU rating greater than 10 million and less than or equal to 40 million = 0.10 lb/10^6 BTU

NO_X emission factor for fuel fired equipment with an hourly BTU rating greater than 40 million = 0.06 lb/10^6 BTU