

# Guidelines for Calculating Emissions from Cooling Towers

## *Introduction:*

Beginning 2006, facilities are required to report the particulate matter (PM), volatile organic compounds (VOCs), and toxics air contaminant (TAC) emissions from their cooling towers. The PM emissions are the result of the total dissolved solids in the circulating water which are carried out with the water that is entrained in the air being discharged from the tower. VOC emissions typically result from the leakage from process heat exchangers that service hydrocarbon (HC) process streams as well as from chemical treatment with VOC containing material added to the circulating water. VOC emissions are expected from cooling towers used in refineries and chemical plants, where the circulating water is used to cool down the process stream. VOC emissions are not expected from cooling towers used in Heating, Ventilating, and Air Conditioning (HVAC) and other industries such as power plant facilities, high rise buildings, hotels, hospitals, etc). TACs emissions are typically from the toxic constituents of PM and/or VOC in the circulating water.

## *Emission Calculations Procedures:*

1. Facilities may use the default emission factors listed below to estimate the PM and VOC emissions using the equation below:

$$E = Q \times EF \quad (\text{Eq. 1})$$

Where:

E = Annual Emissions in pounds per year (lb/yr)

Q = Cooling tower circulating water in **million gallons or equipment rating (ton)**

EF = Emission factor expressed in lb/throughput unit

## *Default Emission Factors for Cooling Towers:*

Type of Industry	Throughput Unit	VOC EF	PM EF
Refineries	Million gallon	<b>0.7</b>	<b>19</b>
Chemical mfg Plant	Million gallon	<b>0.7</b>	<b>19</b>
Others	Million gallon	–	<b>19</b>
HVAC	Ton	–	<b>1.643</b>

References:

VOC: AP-42, Section 5.1, Table 5.1-2

PM: AP-42, Section 13.4, Table 13.4-1

HVAC: Operating 8,760 hours/year; at 3 GPM circulating water rate; with 2500 ppm solid in water; and drift loss of 0.005%. Cooling capacity (1 ton = 12,000 Btu/hr)

**2. Alternative PM Emission Factor Calculation Method:** Alternatively, facilities may use this equation to calculate PM emissions using site specific parameters:

$$EF = TDS \times \frac{\eta_{Drift}}{100} \times \rho_{H_2O} \quad (\text{Eq. 2})$$

Where:

- $EF$  = emission factor, lb/mmgal
- $TDS$  = Concentration of total dissolved solids in circulating water (PPM by weight)
- $\eta_{Drift}$  = Drift loss of circulating water (%)

**3. Toxic Air Contaminants:** Facility may also use this equation using Eq 1 to calculate TACs emissions (if applicable). TAC emission factor calculation is shown below:

$$EF_{TAC} = EF_{VOC \text{ or } PM} \times W \quad (\text{Eq. 3})$$

Where:

- $EF_{TAC}$  = Toxics air contaminants emission factor (lb/mmgal)
- $EF_{VOC \text{ or } PM}$  = VOC or PM emission factor used to report cooling towers emissions (lb/mmgal)
- $W$  = Weight fraction of TAC in VOC or PM (decimal format)

### **EXAMPLE ON HOW TO REPORT THE EMISSIONS:**

A chemical plant operates a mechanical draft cooling tower circulating 3,650 million gallons for the year of water to cool down process stream. Source test indicated 0.2% Nickel present in the PM emissions from the cooling tower.

Facilities are required to report their VOC, PM, and TAC emissions from the cooling tower using the new AER web program.

### Image 1:

Since the cooling tower is not a permitted source, it must be added to the list by clicking Add New Emission Source (in blue font).

The screenshot shows the 'Build Reporting Structure' page for Facility ID: 999115. The 'Emission Sources (ES) Classification' section is active. It contains a search form with fields for A/N, Permit NO, AER Device ID, and Permit Device ID, and a 'Search Emission Sources' button. Below the search form is a blue link 'Add New Emission Source' which is circled. A table below shows three existing emission sources:

Action	A/N	Permit NO	Permit Device ID	Permit Equipment Description	AER Device ID	ES Name	Source Group	Has Emissions	Equipment	ES Status	Process Reference
<a href="#">Open</a>						ES6 Chicken Farm	Other Processes	Y	Other process equipment	Work in progress	<a href="#">Reference</a>
<a href="#">Open</a>						ES5 Animals Waste Handling	Other Processes	Y	Other process equipment	Work in progress	<a href="#">Reference</a>
<a href="#">Open</a>	111111	121212	D1			ES4 Dairy	Other Processes	Y	Other process equipment	Work in progress	<a href="#">Reference</a>

### Image 2:

Fill out relevant information to the added Emission Source by identifying ES Name (example, Cooling Tower) and selecting the Operating ES Status (i.e., Normal Operation) from drop-down menu.

The screenshot shows the 'Edit Emission Source' page for Facility ID: 999115. The form contains the following fields:

- Permitted:
- A/N:
- Permit No:
- Permit Device ID:
- AER Device ID: will be assigned upon saving
- ES Name:
- Operating ES Status:
- Comment:
- Emission Source Group:
- Design Capacity:

At the bottom, there are buttons for 'Save and return to List of Emission Sources', 'Save and proceed to Process Reporting', and 'Cancel'. An optional button 'Optional: Save and Mark as Completed' is also present.

**Image 3:**

After clicking **Determine Emission Source Group Type**, this image will pop-out. Select No. 7 and click “[click here](#)” (blue font)” to mark Other Process Equipment. Click the box designated as Other process equipment, and click Save button.

Permitted	A/N	Permit No	Permit Device ID	Permit Equipment Description	AER Device ID	ES Name
No						Cooling Tower

- External Combustion Equipment (e.g., boiler, dryer, oven, furnace, heater, afterburner, flare, kiln or incinerator) [click here](#) to select one the following Equipment:
- Internal Combustion Equipment (e.g., internal combustion engine (excluding vehicles), turbine or micro turbine) [click here](#) to select one of the following Equipment:
- Spray Coating/Spray Booth (e.g., coatings, solvents, adhesives, etc.) [click here](#) to select one of the following Equipment:
- Other Use of Organics (e.g., coatings, solvents, inks, adhesives, etc.) except in Spray Coating/Spray Booth, [click here](#) to select one of the following Equipment:
- Storage Tank (e.g. Underground, Aboveground, Small Tanks, Dispensing Systems) [click here](#) to select one of the following Equipment:
- Fugitive Components (Emission Leaks from Process Components per Rule 1173 and 1176), [click here](#) to select all applicable Equipment:
- Other Processes (does not fit in any of the groups mentioned above), click [click here](#) to mark "Other Process Equipment":  
 Other process equipment

Save Cancel

**Image 4:**

After saving, the program reverts to Image 2 (below). Click **Save and proceed to Process Reporting** button to start reporting emissions for the added Process.

AER Home Access Facility Facility Home

Facility ID: 999115 · ABC · Reporting period: 2012

Facility ID: 999115

**Edit Emission Source**

Providing correct information and proper selection categories would help to classify emission source.

Permitted

A/N

Permit No

Permit Device ID

AER Device ID will be assigned upon saving

ES Name Cooling Tower

Operating ES Status Normal Operation

Comment

Design Capacity

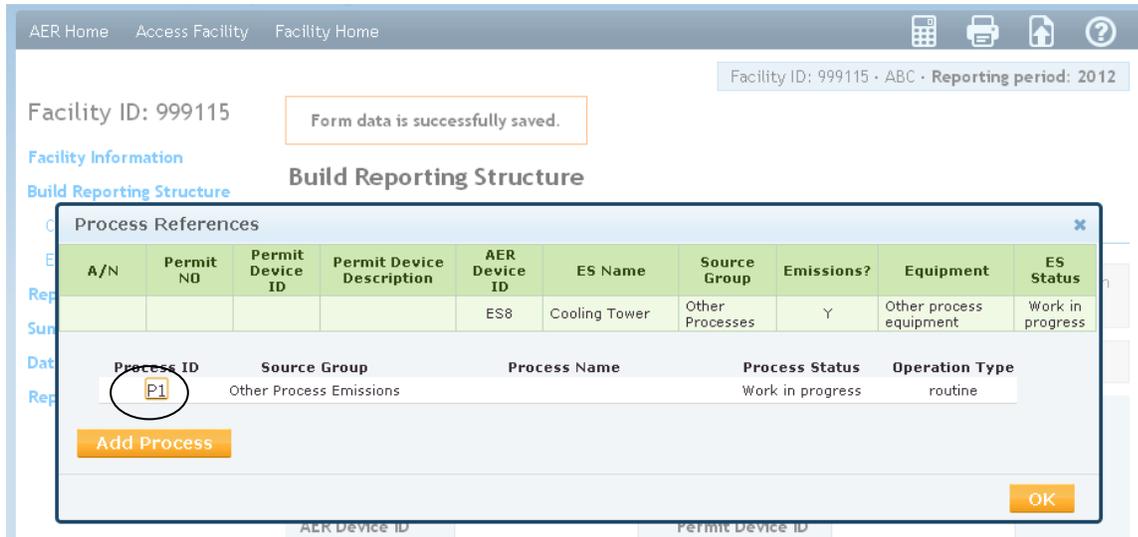
?

Save and return to List of Emission Sources or **Save and proceed to Process Reporting** or Cancel

Optional: Save and Mark as Completed

**Image 5:**

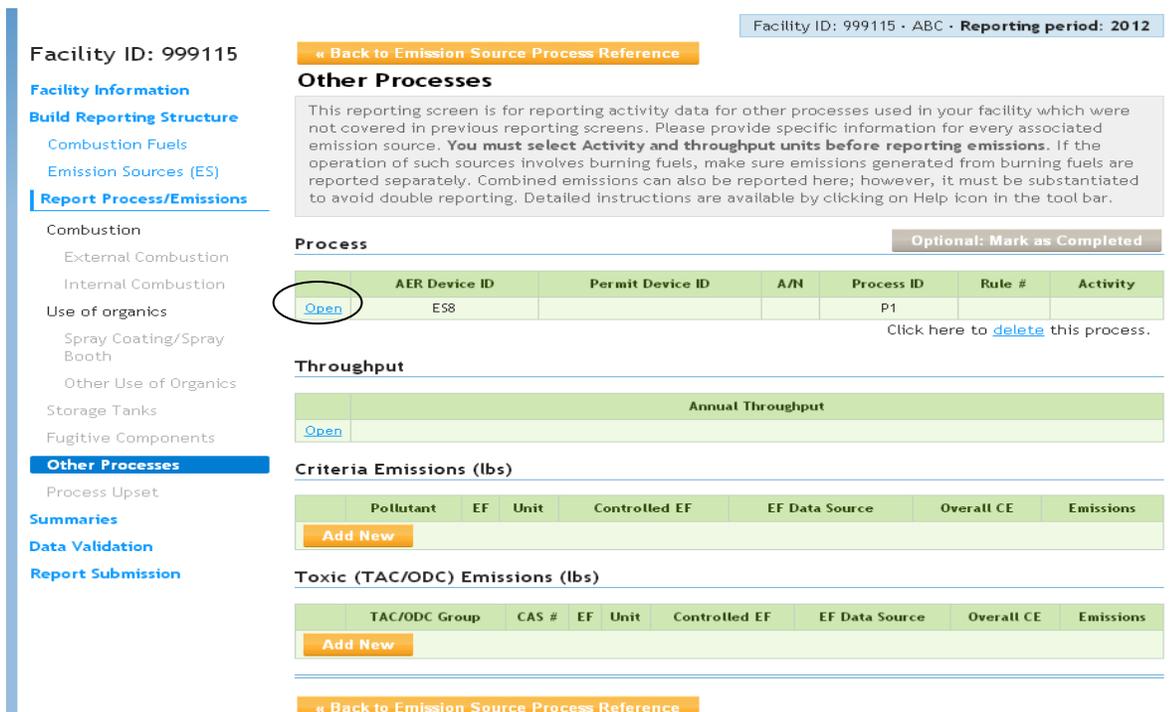
This image will pop-out after clicking **Save and proceed to Process Reporting** button. The new Process added is shown as P1 (process 1). Click the box indicating P1 to begin entering information, such as, process throughputs, criteria emissions and emission factors, and TACs.



**Image 6:**

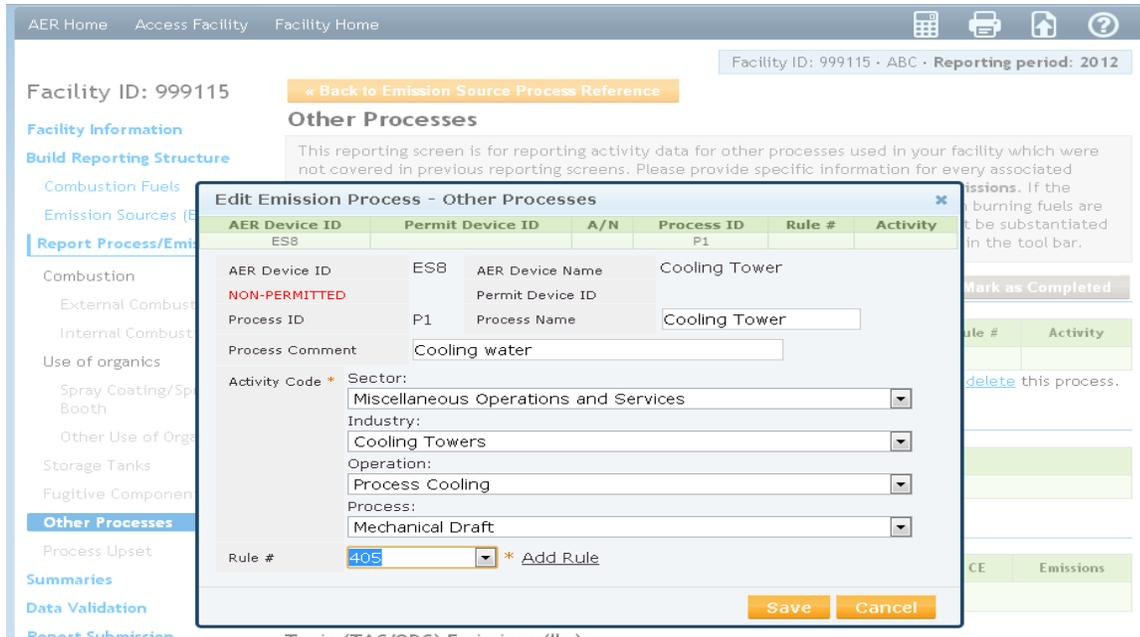
There are 4 main information needed for reporting air emissions for the process, namely, Process, Throughput, Criteria Emissions, and Toxic (TAC/ODC) Emissions.

- A. **Process:** -Open the Process section (by clicking the blue font **Open**) to identify the Name, Activity Code, and select the appropriate Sector, Industry, Operation, Process, and applicable Rule by clicking the Drop-down arrow at the corner of each box.



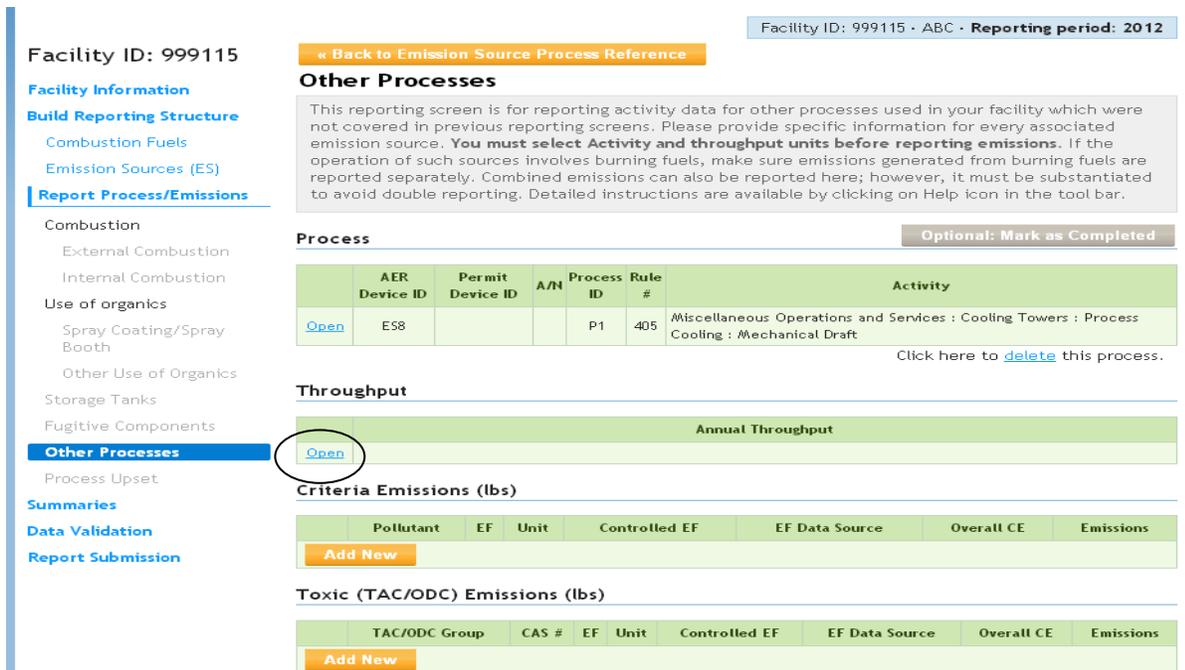
**Image 7:**

After clicking **Open**, this image will pop-out. Identify the Process Name for the process P1 and fill out the Activity Code by selecting the appropriate information from the drop-down menu from each box. Example shows correct sector, industry, operation, process, and rule for the Cooling Tower. Click Save button.



**Image 8:**

**B. Throughput** - After saving, the program returns to this image (below). This time, open the **Throughput** section to enter the Annual Throughput, Type, Comment, for the Process, as shown below.



**Image 9:**

After clicking **Open**, this image will pop-out. Enter the Annual Throughput and its unit measure, Type, Comment, as shown for example Process, below. Click Save button.

AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity
ES1			P1	405	Miscellaneous Operations and Services : Cooling Towers : Process Cooling : Mechanical Draft

**Annual Throughput**  
3.65 MM gal

Annual Throughput: 3650 \* MM gal \*

Throughput Type: Input \*

Throughput Comment: measured by totalizing meter

Save Cancel

**Image 10:**

C. **Criteria Emissions** - After saving, the program returns to Image 6. To add the Criteria Emissions involved in the Process, click “Add New” (yellow button)”under **Criteria Emissions** section. This action will show the image below, to select the type of emissions (VOC in this example), emission factor (from Table) and its reference. It also calculates the specific air emissions for the process. Click Save button.

AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity
ES1			P1	405	Miscellaneous Operations and Services : Cooling Towers : Process Cooling : Mechanical Draft

**Annual Throughput**  
3,650.0 MM gal

Pollutant: VOC - Volatile Organic Compounds

Emission Factor (EF): 0.7000 \* lbs/MM gal

Controlled EF value  
(mark checkbox if EF listed represents EF determined after control)

Overall Control Efficiency: [ ]

Emission Factor Comment: Per Guidelines and AP-42, Chapter 5.1

Emission Factor Data Source: AP-42 \*

Emissions: 2,555.00 lbs

[Click here to delete this Emission.](#)

Save Cancel

**Image 11:**

After saving VOC information, the program reverts to Image 6. To add the next pollutant, like PM, for the same Process P1, click the **Add New** button under **Criteria Emissions** section again. Select the type of pollutant, (PM) from drop-down menu, enter the applicable emission factor (from Table), emission factor comment and its source and enter them at appropriate boxes. Click Save button.

**Image 12:**

**D. Toxic (TAC/ODC) Emissions** - After saving the criteria emissions, the program reverts to Image 6 (as shown below). To add TAC/ODC emissions from the same Process P1, (Nickel, in this example), click the **Add New** under **Toxic (TAC/ODC) Emissions** section.

« Back to Emission Source Process Reference

### Other Processes

This reporting screen is for reporting activity data for other processes used in your facility which were not covered in previous reporting screens. Please provide specific information for every associated emission source. **You must select Activity and throughput units before reporting emissions.** If the operation of such sources involves burning fuels, make sure emissions generated from burning fuels are reported separately. Combined emissions can also be reported here; however, it must be substantiated to avoid double reporting. Detailed instructions are available by clicking on Help icon in the tool bar.

**Process** Optional: Mark as Completed

	AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity
<a href="#">Open</a>	ES1			P1	405	Miscellaneous Operations and Services : Cooling Towers : Process Cooling : Mechanical Draft

[Click here to delete](#) this process.

**Throughput**

	Annual Throughput
<a href="#">Open</a>	3,650.0 MM gal

**Criteria Emissions (lbs)**

	Pollutant	EF	Unit	Controlled EF	EF Data Source	Overall CE	Emissions
<a href="#">Open</a>	VOC	0.7000	lbs / MM gal	Yes	AP-42		2,555.00
<a href="#">Open</a>	PM	19.0000	lbs / MM gal	Yes	AQMD default		69,350.00

[Add New](#)

**Toxic (TAC/ODC) Emissions (lbs)**

	TAC/ODC Group	CAS #	EF	Unit	Controlled EF	EF Data Source	Overall CE	Emissions
<a href="#">Add New</a>								

**Image 13:**

Select the pollutant, Nickel, from drop-down menu and enter applicable Emission Factor, Control Efficiency, and enter them at appropriate boxes. Click Save button.

$$\text{Note: } EF_{\text{Nickel}} = 0.2\% \times 19 \text{ lb/mmgal} = 0.038 \text{ lb/mmgal}$$

The screenshot shows a software dialog box titled "Open Toxic (TAC/ODC) Emission Information - Other Processes". At the top, there is a table with columns: AER Device ID, Permit Device ID, A/N, Process ID, Rule #, and Activity. The data row shows: ES1, (blank), (blank), P1, 405, and "Miscellaneous Operations and Services : Cooling Towers : Process Cooling : Mechanical Draft". Below the table is a section for "Annual Throughput" with a value of "3,650.0 MM gal". The main form area is titled "TAC/ODC Toxic Pollutants / Ozone Depleting Compounds" and contains the following fields:

- Pollutant: A dropdown menu with "17 - Nickel" selected.
- TAC Group: A dropdown menu with "17 - Nickel" selected.
- CAS # (Pollutant): A text field with "7440020 - Nickel".
- Emission Factor (EF): A text field with "3.80000e-2" and a unit label "\* lbs/MM gal".
- Controlled EF value: A checked checkbox with the text "(mark checkbox if EF listed represents EF determined after control)".
- Overall Control Efficiency: A text field.
- Emission Factor Comment: A large text area.
- Emission Factor Data Source: A dropdown menu with "Source Test" selected.
- Emissions: A text field with "1.387e+2 lbs".

At the bottom right, there are "Save" and "Cancel" buttons.

After clicking Save button, the program reverts to Image 6. If there is additional TAC/ODC from the same process, repeat the steps shown in Images 12 and 13. When all air emissions have been reported, the program will revert to Image 6. Follow all remaining steps in completing the report.