Guidelines for Calculating VOC Emissions from Printing Operations

Revised December 2024

The following methodology should be used to calculate VOC emissions from printing operations. This methodology has been developed by the South Coast AQMD in cooperation with the Printing Industries Association.

Printing Inks

$$\textbf{Emissions} = \textbf{Q} * \textbf{EF} * \textbf{(1 - RF)} * \textbf{(1 - CEoverall)} \qquad \text{Eq. (1)}$$

where:

Emissions	=	Emissions of volatile organic compounds (lb)
Q	=	Throughput (quantity of ink applied in lb or gallon)
EF	=	Emission Factor (lb/lb ink or lb/gal)
RF	=	Retention factor (ink type specific in decimal)
$CE_{overall}$	=	Overall Efficiency of Control System (decimal)

(1) User may refer to the product Safety Data Sheet (SDS) to determine the emission factor (EF) based on volatile organic compounds (VOC) content of the ink. This may include, but not limited to, one or more of the following:

a) Volatile organic compounds (VOC)
b) Lithographic oil content (LOC) such as:
- Petroleum-based oils
- Vegetable-based oils
- Oxidizing oils
- Middle distillates
- Linseed oil
- White mineral oil
- Other oils

If SDS provides both VOC and LOC percentages or fractions, use the higher number for calculation purposes. **NOTE:** Unit of EF must be consistent with that of ink applied (Q), i.e., EF in weight fraction of lb/lb for Q in pounds.

(2) Depending on type of inks, the following retention factors are applicable for equation (1):

HEATSET INKS: **RF = 0.20**

NON-HEATSET INKS: **RF = 0.95**

NOTES:

(1) RF is applicable to Conventional Products that contain VOC and/or LOC;

(2) RF is not applicable to the following:

a. Printing inks in Flexography, Gravure, Screen, Letterpress, and Inkjet;

b. UV-curable inks

(3) Overall efficiency ($CE_{overall}$) of a control system is defined as:

$$\mathbf{CE_{overall} = CE_{cap} * CE_{des}} \qquad \text{Eq. (2)}$$

Where,

CE_{cap} = Capture Efficiency of Control System (values less than one)

CE_{des} = Destruction Efficiency of Control Equipment (values less than one)

In general, control system performance is tested to determine capture and control efficiencies. In the absence of project-specific source tested capture efficiency results, a default **capture efficiency** of 99.5% ($\mathbf{CE_{cap}} = 0.995$) is allowed for **heatset materials only**. Any deviation from this default capture efficiency must be substantiated with supporting documentation.

Assumptions for Other Printing Ink Operations

Fountain solutions and blanket/roller washes do not possess the same characteristics as inks; therefore, retention factors are not applicable to emissions from the use of these materials. However, in the absence of a specific source test, a carry-over factor is allowed as follows:

- 70% of emissions from **fountain solution** are allowed as default carry-over to the **heat set dryer**, provided that the dryer is vented to the afterburner. The VOC emissions from the use of fountain solutions ($\mathbf{E_{fountain}}$) are calculated using the following equation:

$$\mathbf{E_{fountain} = Q * EF * \left[1 - (0.70 * CE_{overall})\right]} \qquad \text{Eq. (3)}$$

- 40% of emissions from **blanket/roller washes** are allowed as default carry-over to the **heat set dryers only** for **automatic wash operations** provided that the dryers are vented to afterburners. The VOC emissions from the use of blanket/roller washes ($\mathbf{E_{wash}}$) are calculated using the following equation:

$$\mathbf{E_{wash} = Q * EF * \left[1 - (0.40 * CE_{overall})\right]} \qquad \text{Eq. (4)}$$

Where,

$E_{fountain}$ = Emissions of VOC (lb) from the use of fountain solutions

E_{wash} = Emissions of VOC (lb) from the use of blanket/roller washes

Q = Throughput (quantity of material applied in lb or gallon)

EF = Emission factor (lb/lb or lb/gal)

$C_{overall}$ = Overall Efficiency of Control System (decimal)

STEPS TO REPORT EMISSIONS

Example: One web fed heat set printer used 4,000 pounds of black ink (VOC = 0.375 lb/lb per SDS); 20 gallons fountain solution (VOC = 0.8 lb/gal per SDS); and 10 gallons universal blanket/roller wash with an automatic cleaning system (VOC = 6.7 lb/gal per SDS) in this reporting period. The operation is vented to a control system operating at 99.5 % overall.

Emissions for the black ink are calculated below using Eq. (1):

E_{ink} = 4000 lb * 0.375 lb/lb * (1-0.2)] * (1 – 0.995) =6.0 lb

Emissions for the fountain solution are calculated using Eq. (3):

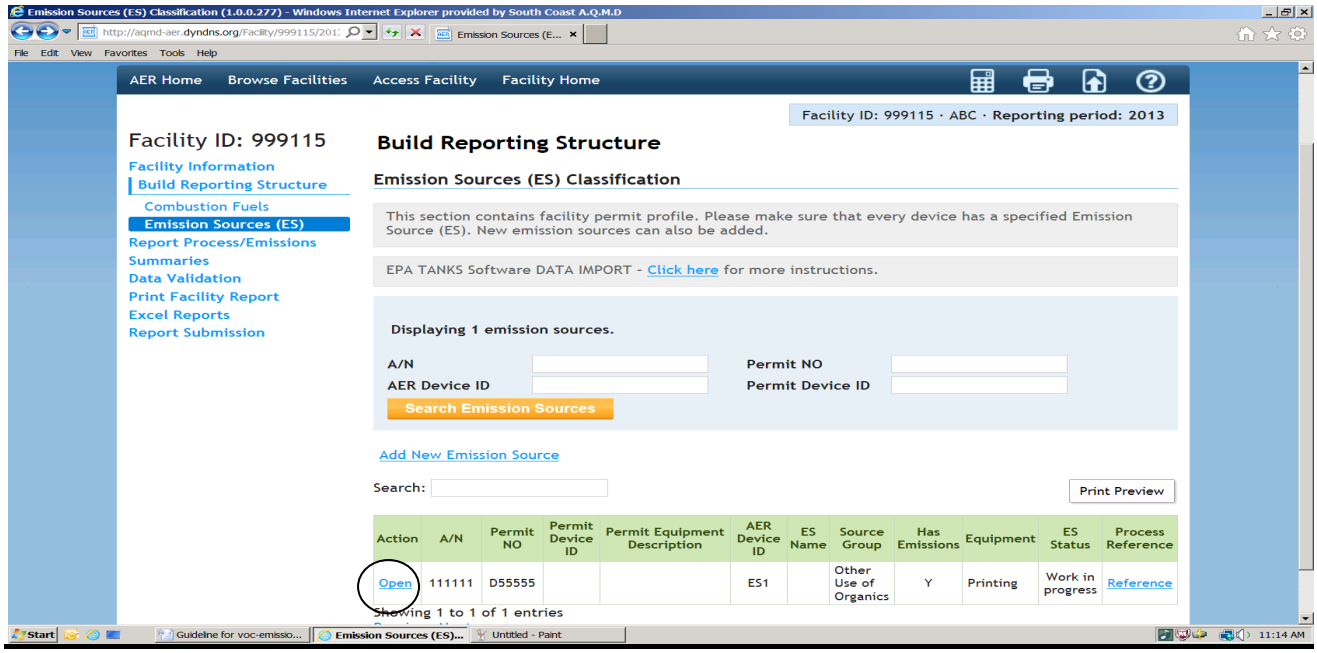
$E_{fountain}$ = 20 gal * 0.8 lb/gal * [1 – (0.70 * 0.995)] = 4.86 lb

Emissions for the blanket wash are calculated using Eq. (4):

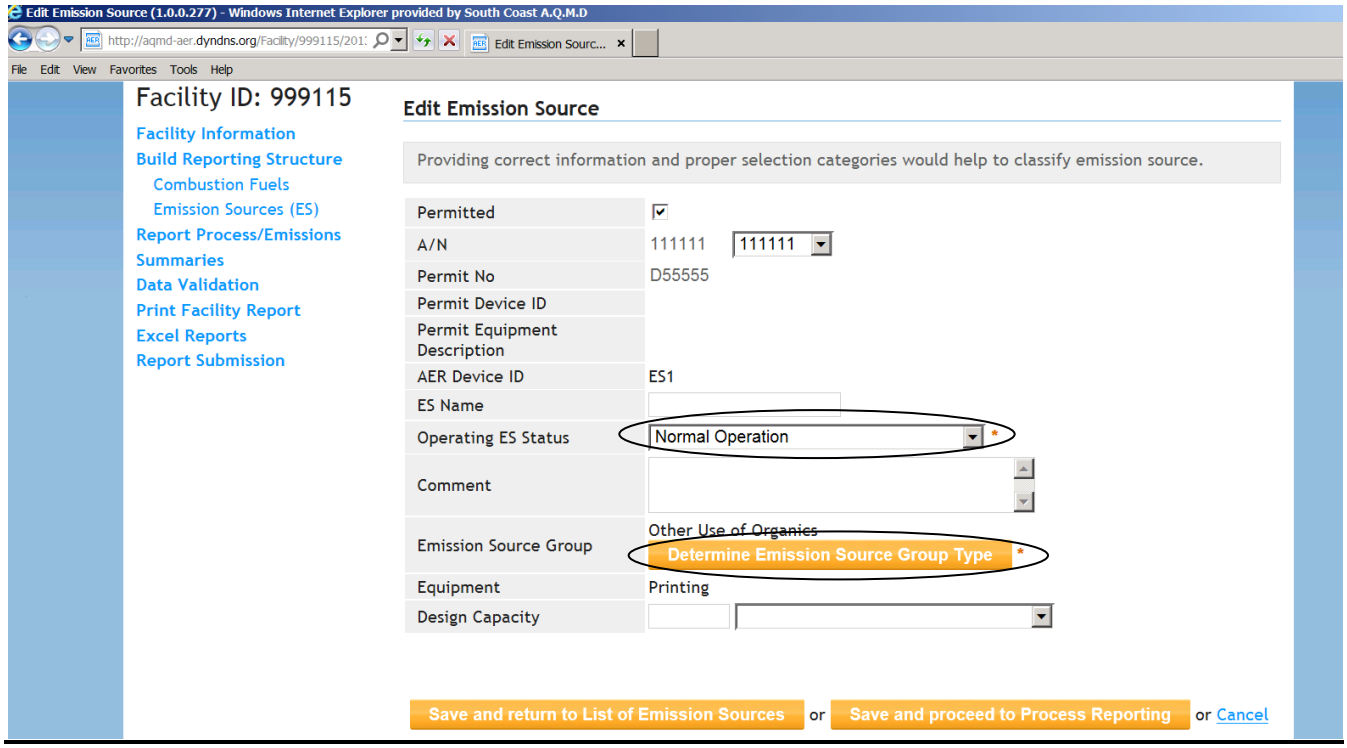
E_{wash} = 10 gal * 6.7 lb/gal * ([1 – (0.4 * 0.995)] = 40.33 lb

AER Tool Data Entry For The Above Example

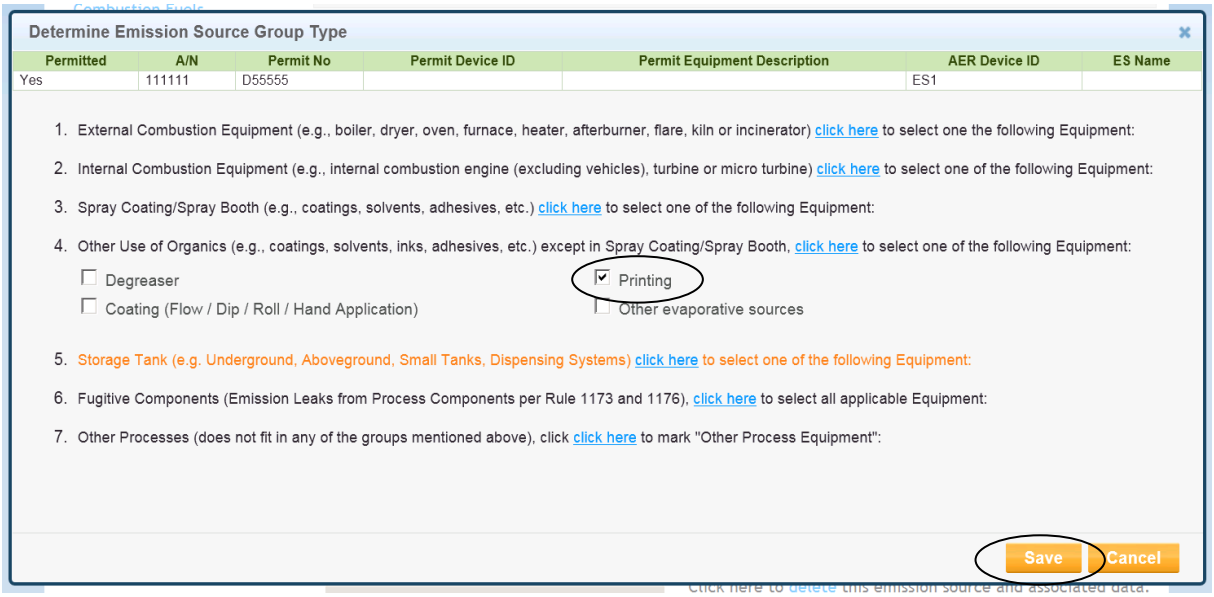
- Click **Emissions Sources (ES)** to see the equipment list (left side of split screen). Click **Open** to access AER device ID ES1.



- Click down arrow for **Operating ES Status** and select **normal operation** from the drop down menu. Next, click on the button for **Determine Emission Source Group Type.**

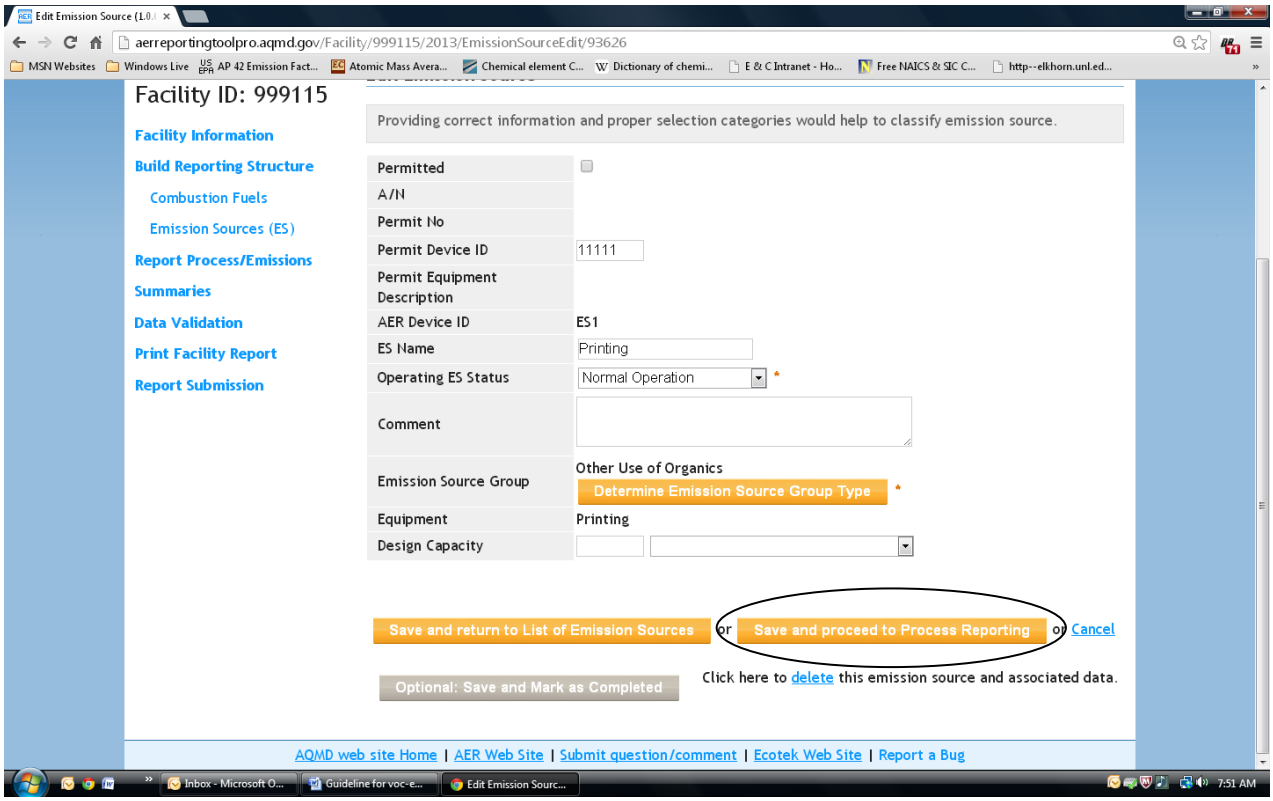


- The following screen will appear and click on **click here** number 4 **Other Use of Organics.** Select **Click Here**
- Checkmark **Printing** box by clicking on it
- Click **Save**



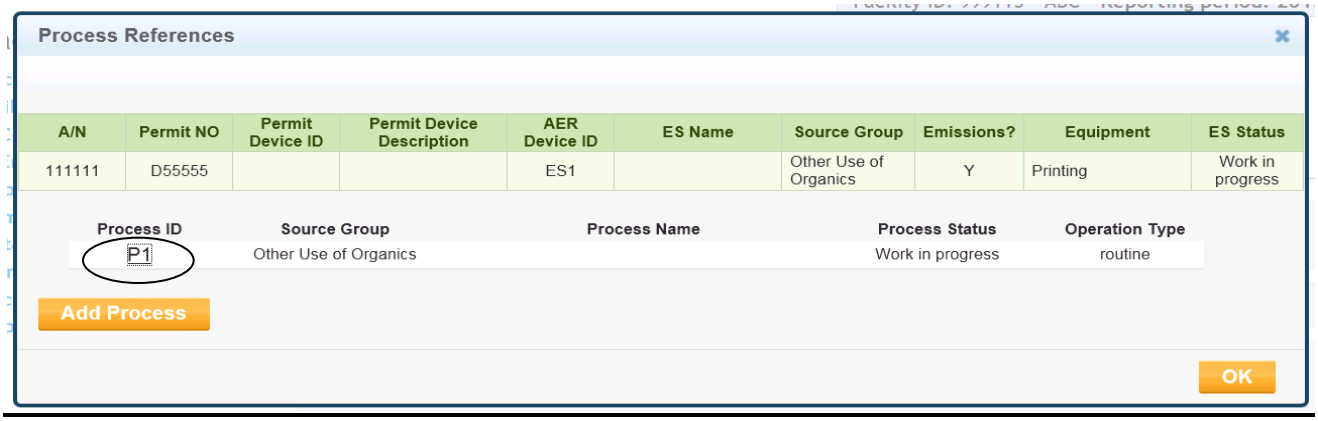
Display returns to previous image.

- Click **Save and Proceed to Process Reporting**.

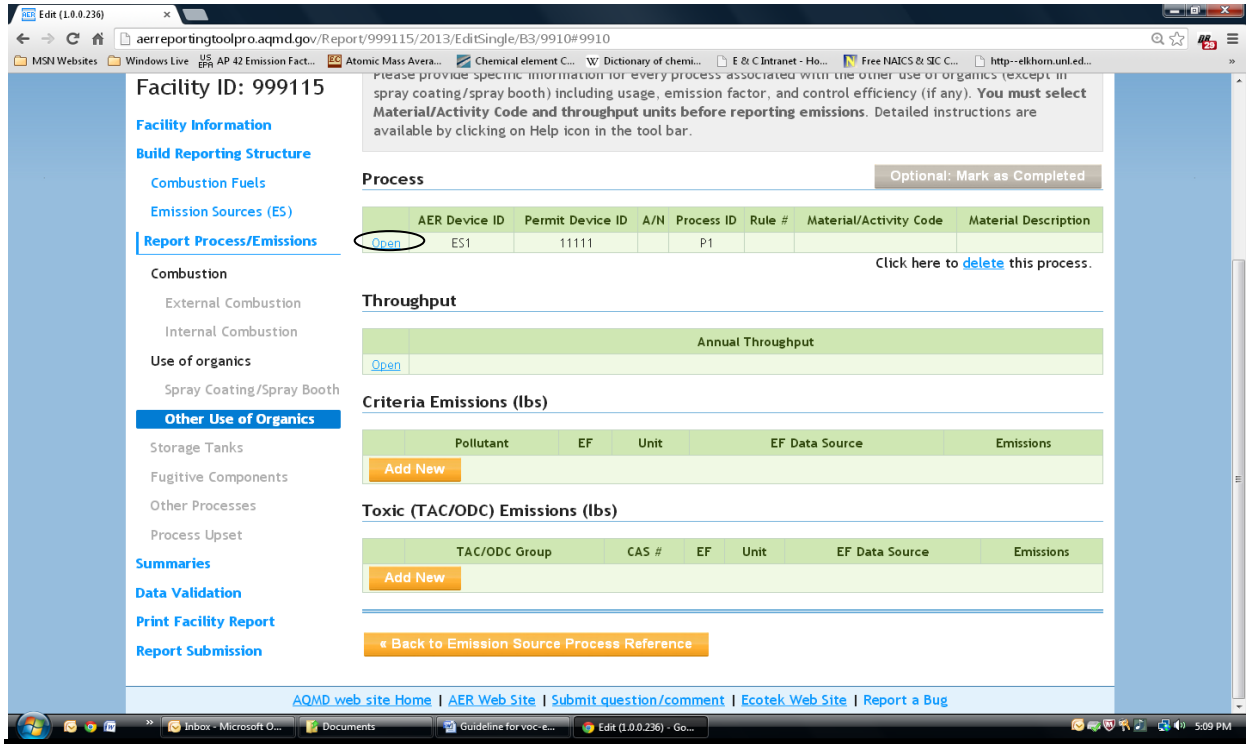


- Click on P1 for the first process.

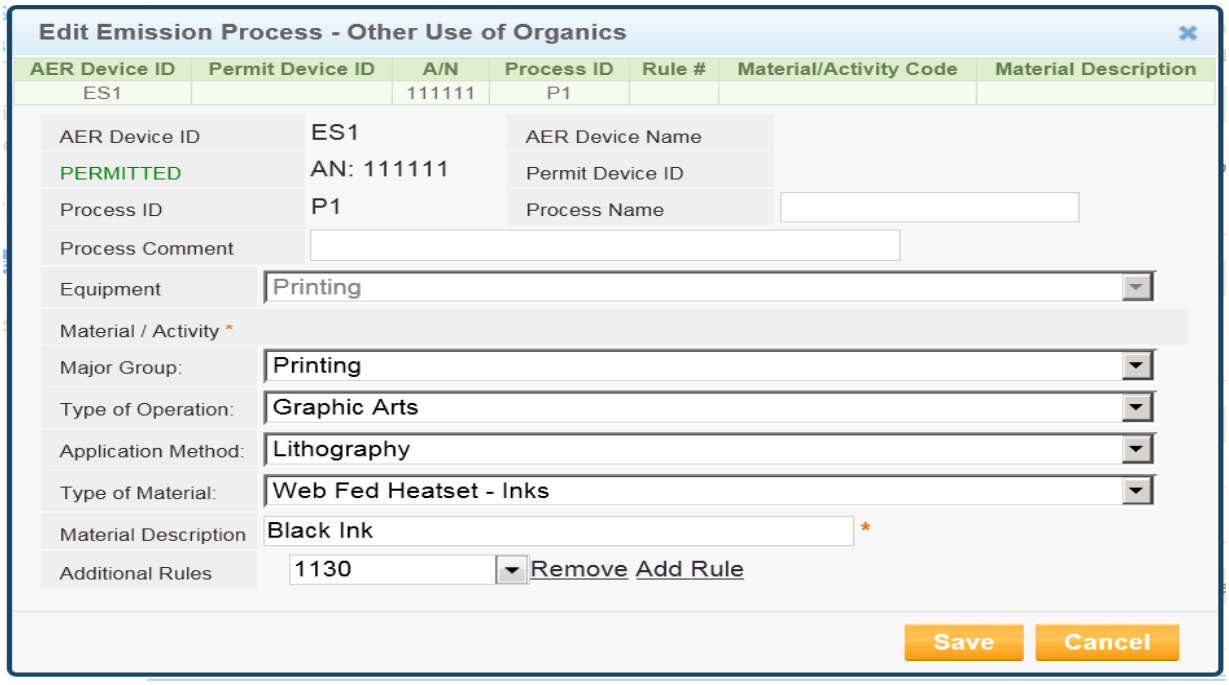
  Process, in printing operation represent materials used in the printing operation. For each material type (Inks, Varnish, Coatings, Fountain Solution, Metering Roller wash, Roller wash, Blanket wash, etc.), there will be a new process number P1, P2, P3, ...Pn and will be generated by clicking on material type from "Other Use Of Organic" drop-down menu below "Add Process" command, after clicking on "**Back to Emission Source Process Reference"** command for the same permit or emission source from top or bottom left of the data-entry screen for P1. The drop-down menu is generated by clicking on "Add Process" command.



- Under **Process** click **Open**



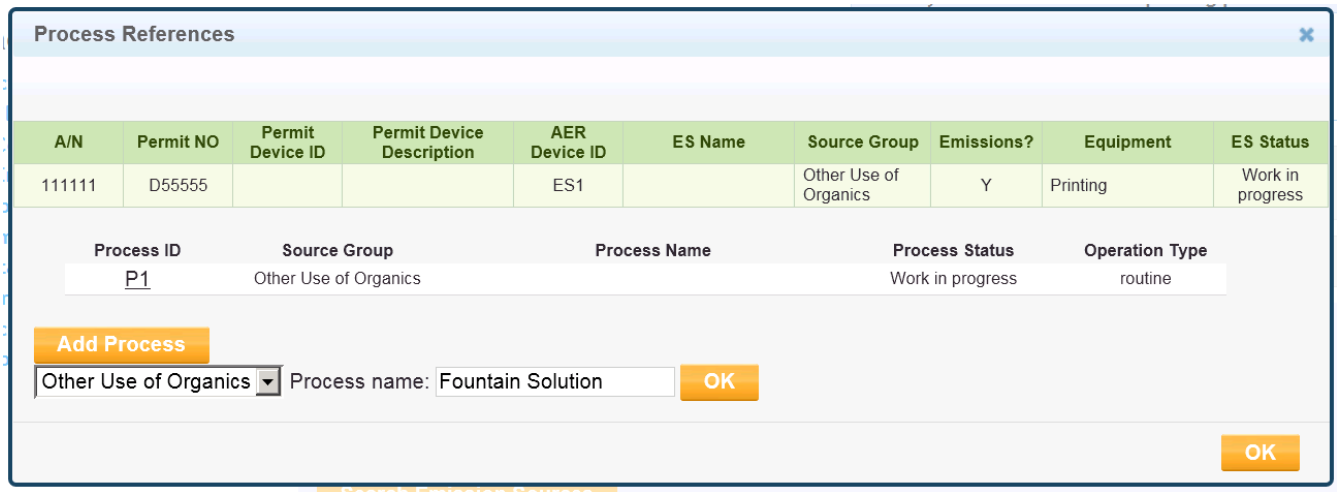
- The following screen will appear. Fill out and select appropriate data: **Process Name, Major Group, Type of Operation, Application Method, Material Description,** and **Additional Rule** by clicking the drop-down arrow for each field.
- Click **Save.**



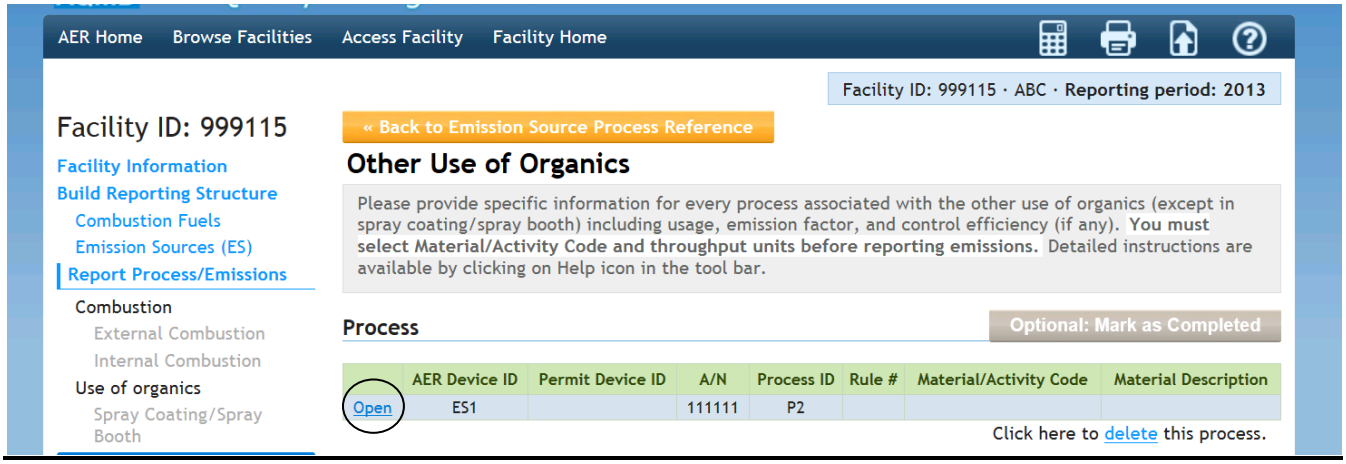
At this point, add the other two processes that emit VOCs (Fountain Solution and Blanket/Roller Wash), to complete the individual process associated with this example for Emission Source ES1.

- Click "**Back to Emission Source Process Reference".**

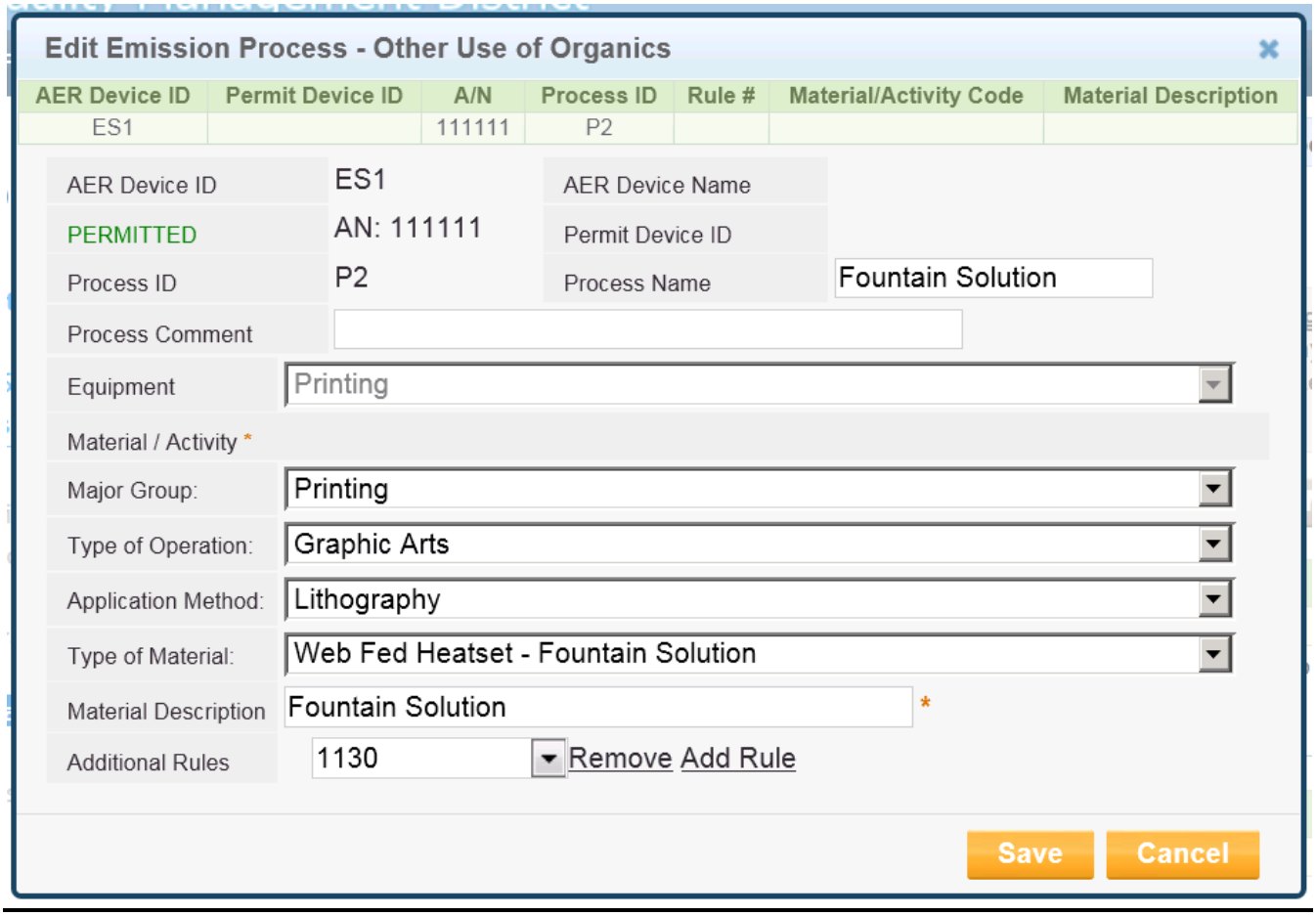
- Click **Add Process**; select '**Other use of Organics"** from the down arrow pick list. Call the process name **Fountain Solution** and click on **OK**.



- Click on **Open**

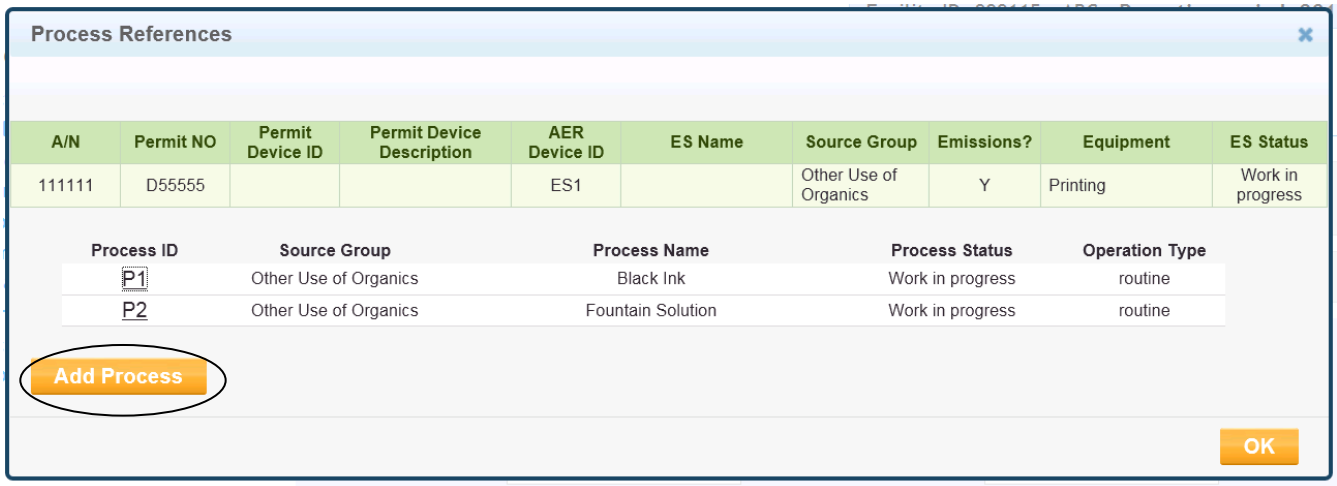


- The following screen pops up. Fill out and select appropriate data: **Process Name, Major Group, Type of Operation, Application Method, Material Description, Additional Rule** by clicking the drop-down arrow for each field.
- Click **Save. This becomes process P2.**

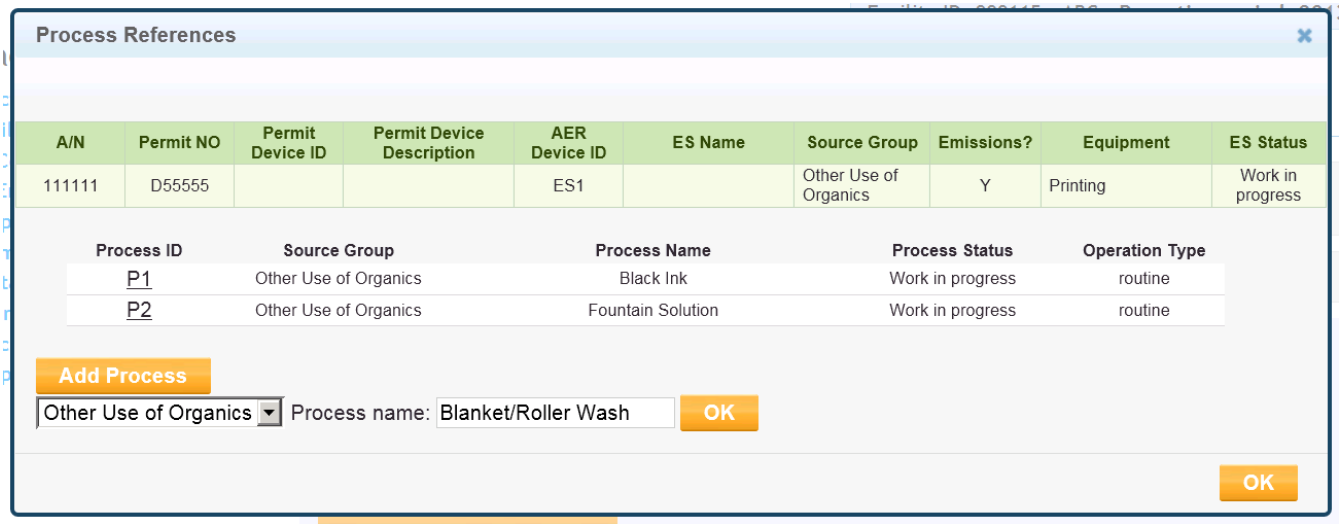


- Click on the **Back to Emission Source Process Reference** button at the bottom of the subsequent screen.

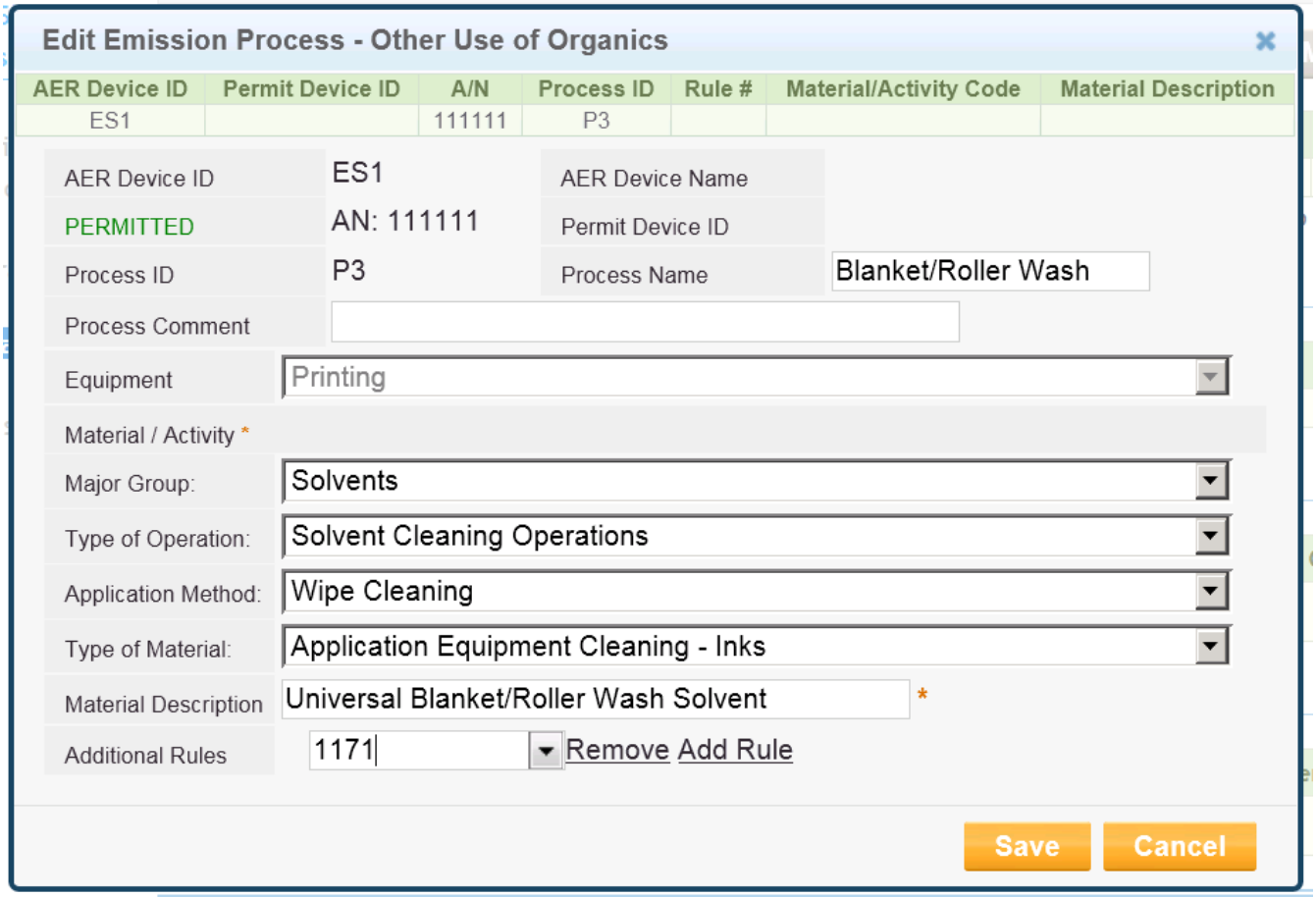
- The following screen pops up. Select **Add Process.**



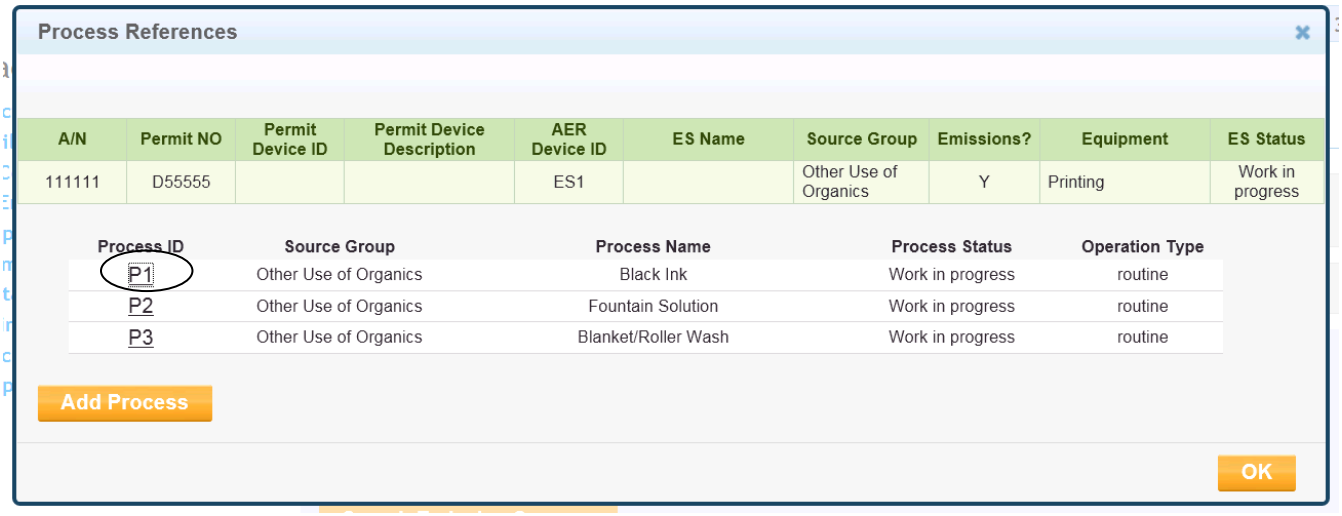
- The following screen pops up. Select **Other use of Organics** from the down arrow pick list. Call the process name **Blanket/Roller wash** and click on **OK**.



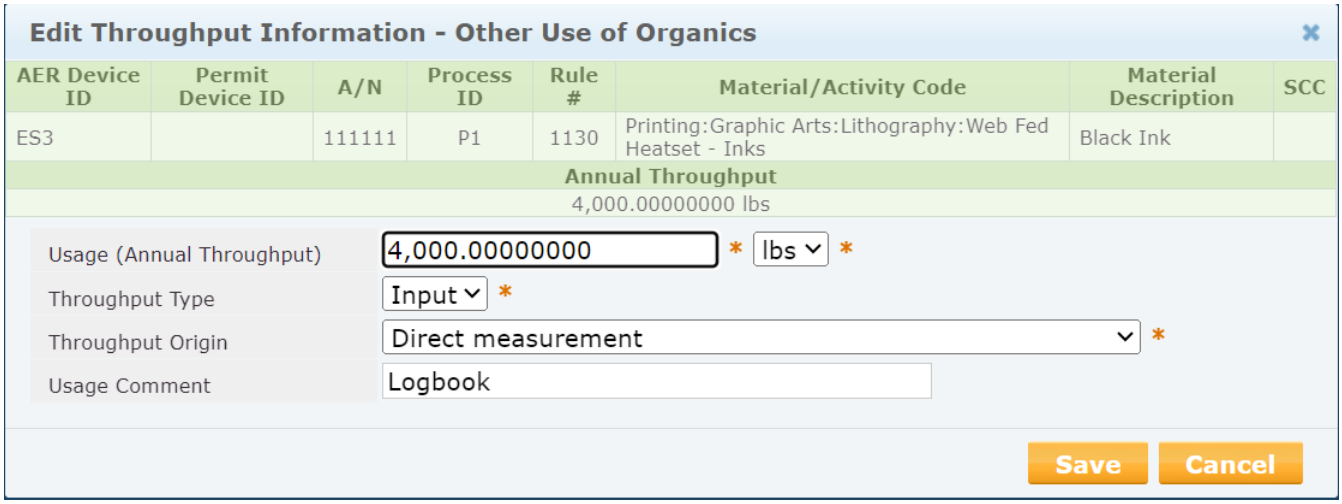
- Click down arrows and select appropriate group, operation, application method, type of material, material description, and Rule 1171. Click **Save**. **This becomes process P3.**



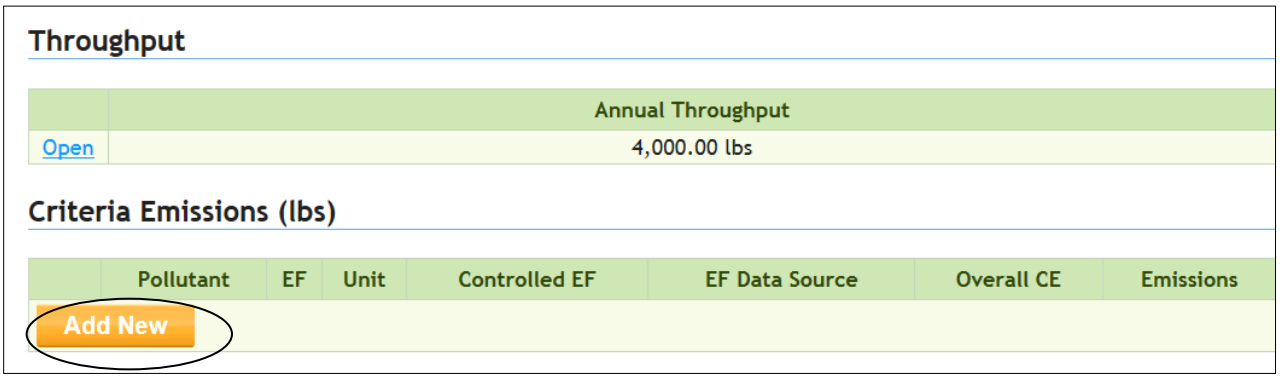
- Click on the **Back to Emission Source Process Reference** button at the bottom of the subsequent screen.



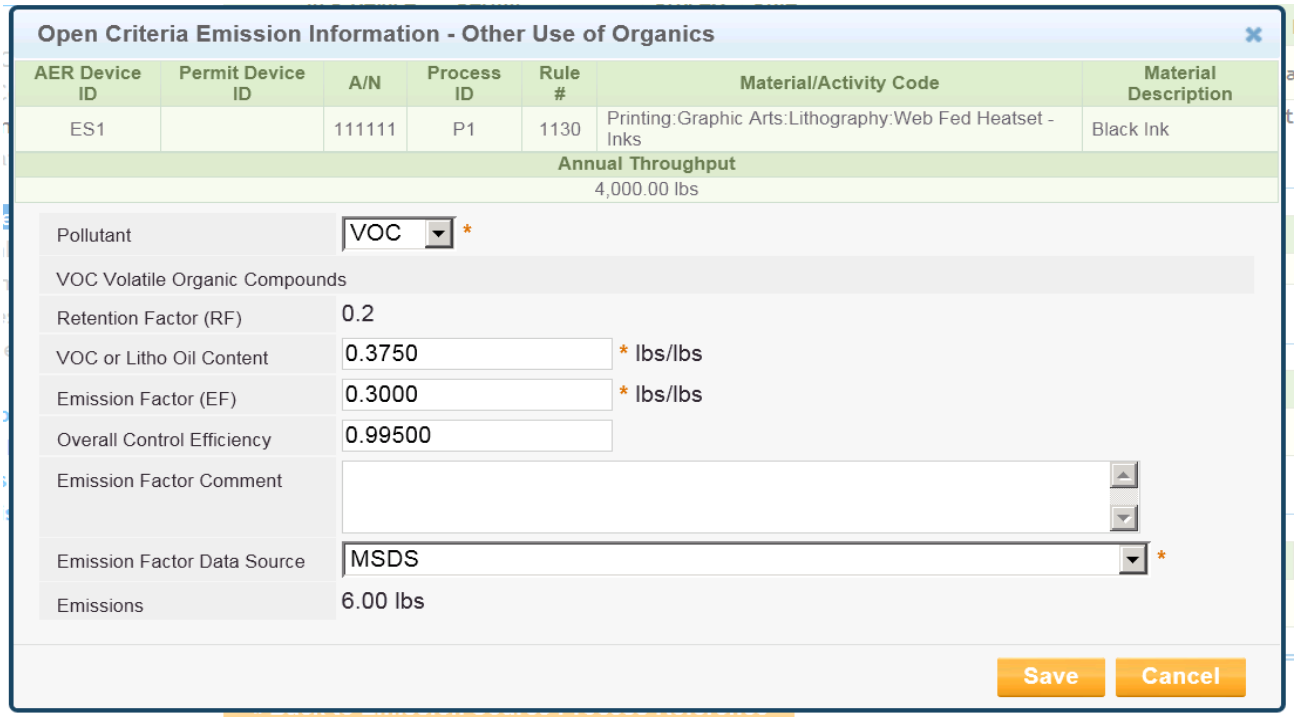
- Click on **P1** to begin data entry of throughput (4,000 lb ink as input). Click **Save.**



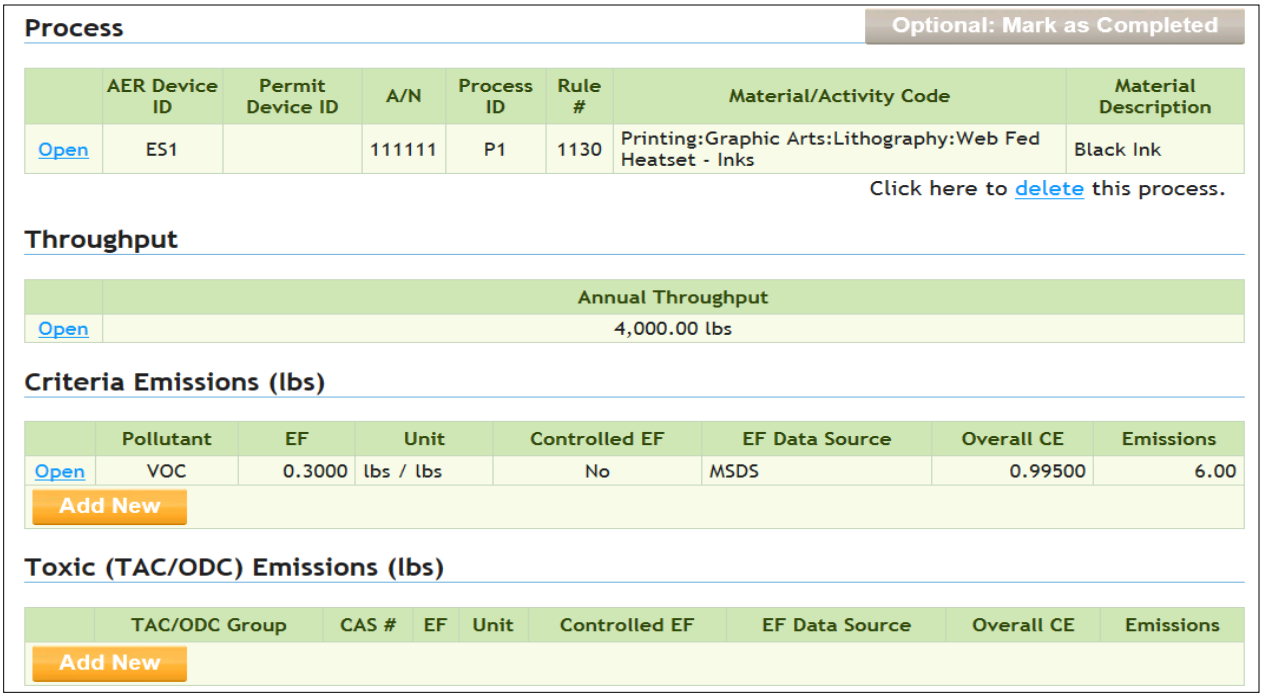
- After entering the throughput, click on **Add New** (Criteria Emissions).



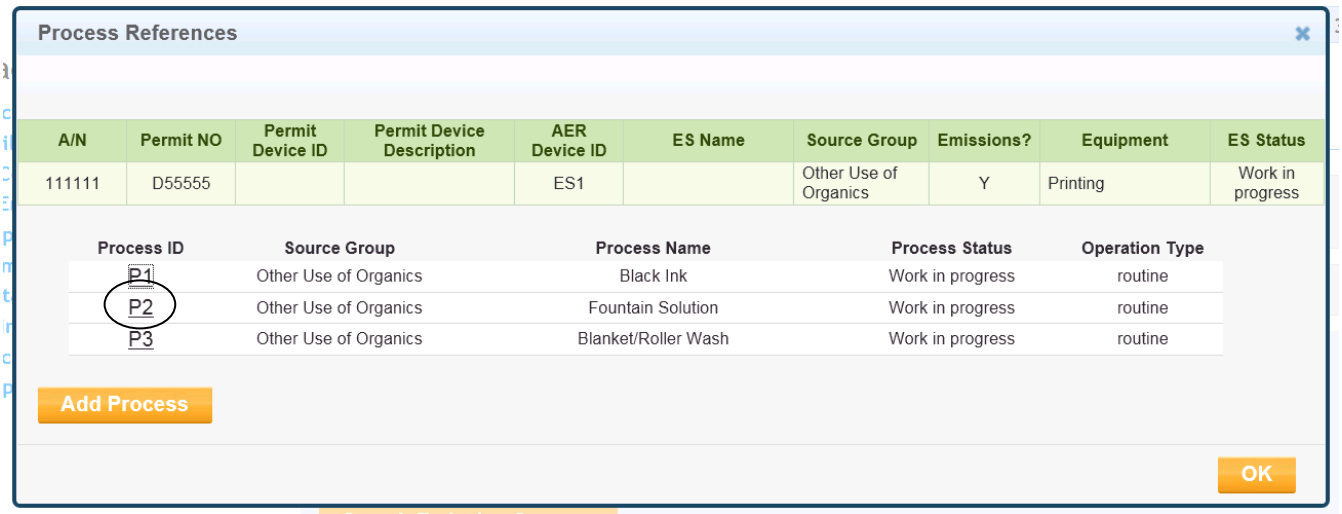
- Enter the **VOC content** of 0.375 lb/lb, and the **overall control efficiency** of 0.995. The retention factor and the emission factor if applicable will be populated for you. Heat set ink oils are 20% retentive (80% evaporative in the heat set dryer). Click **Save.**



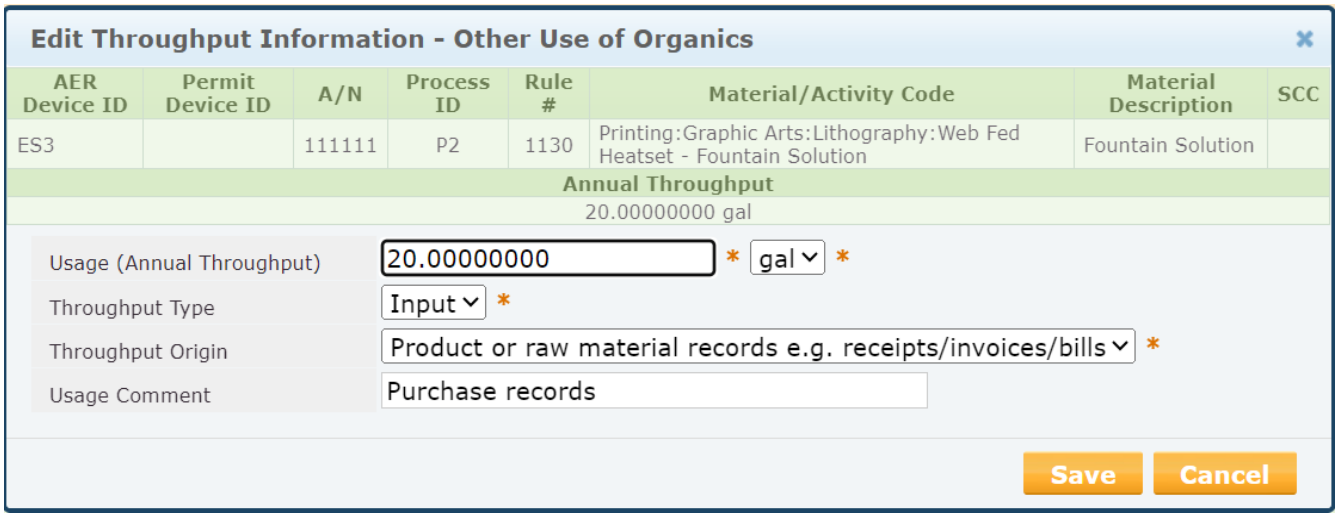
Data entry for the ink, complete as per the next screenshot. The ink SDS shows no standard toxic content.



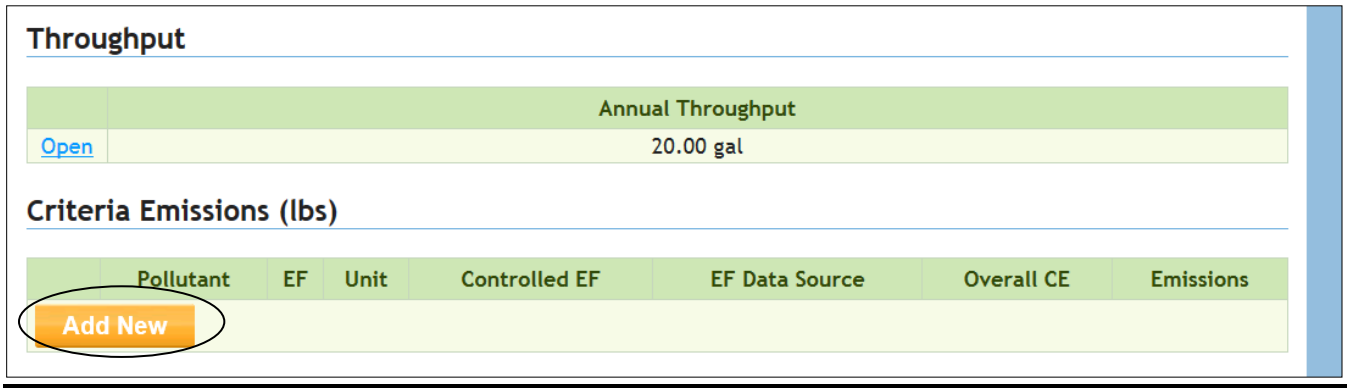
- Click **Back to Emission Source Process Reference**, and Select process **P2**.



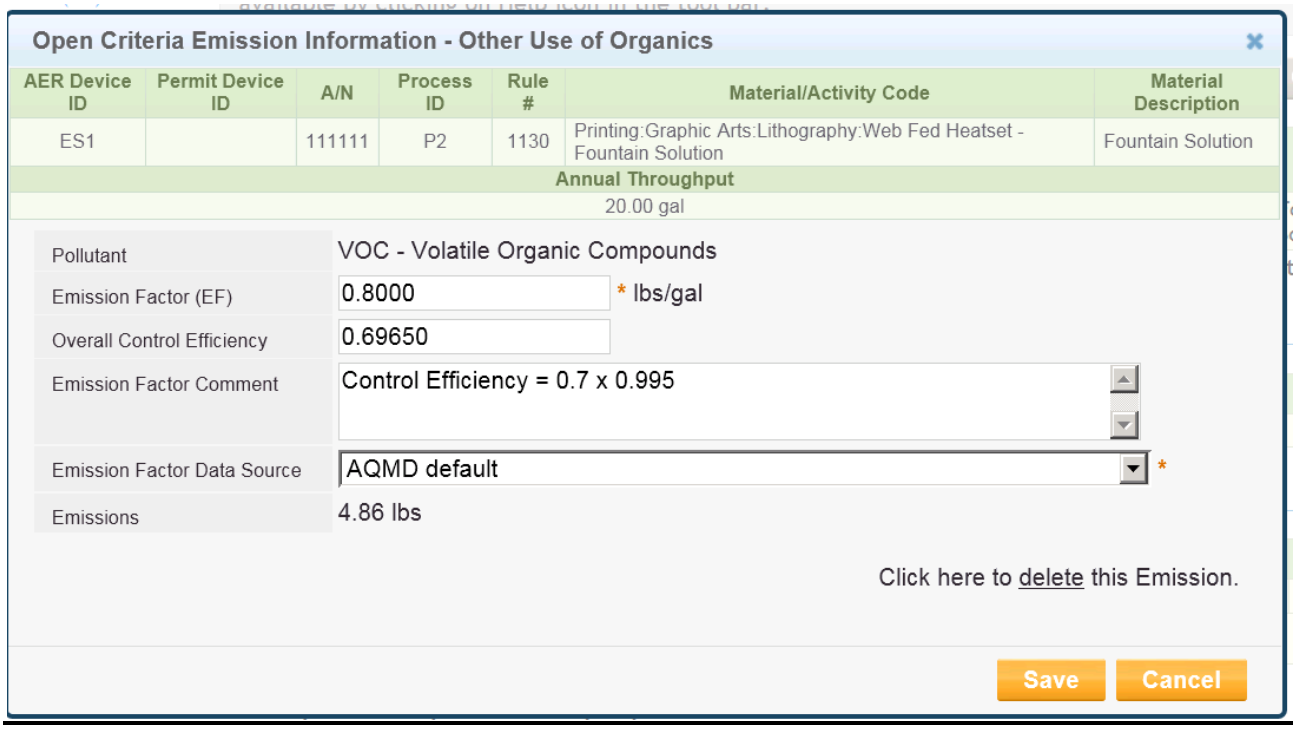
- Select **Throughput** and enter data (20 gallons fountain solution input). Click **Save**.



- After saving throughput data, click on **Add New** (Criteria Emissions).

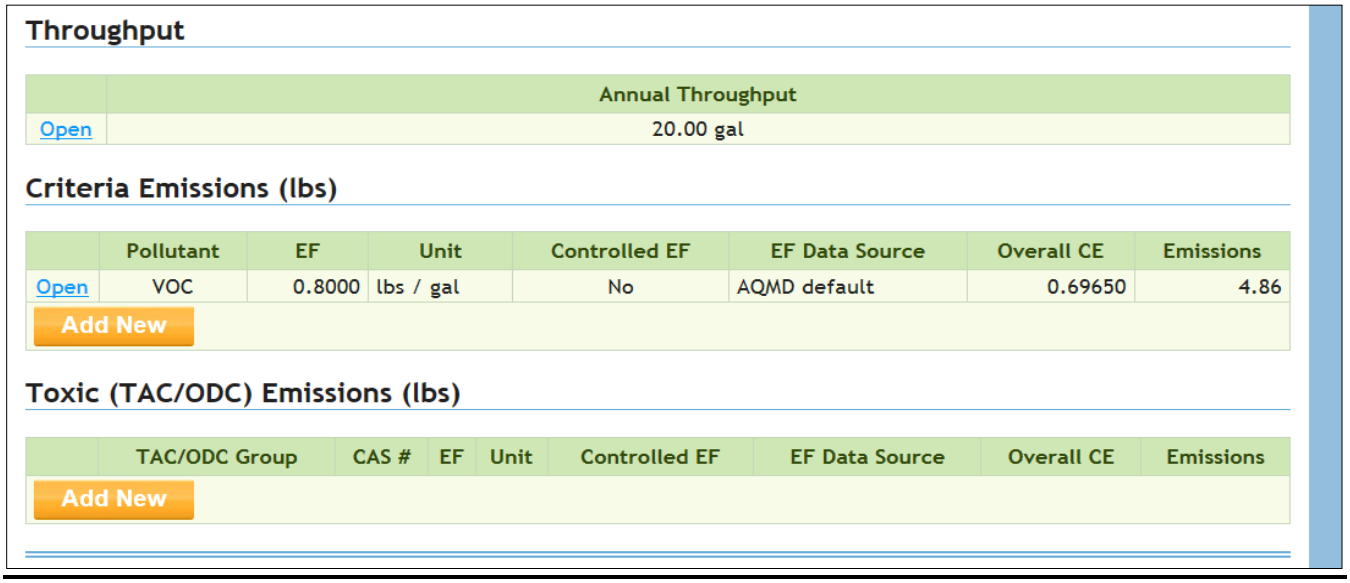


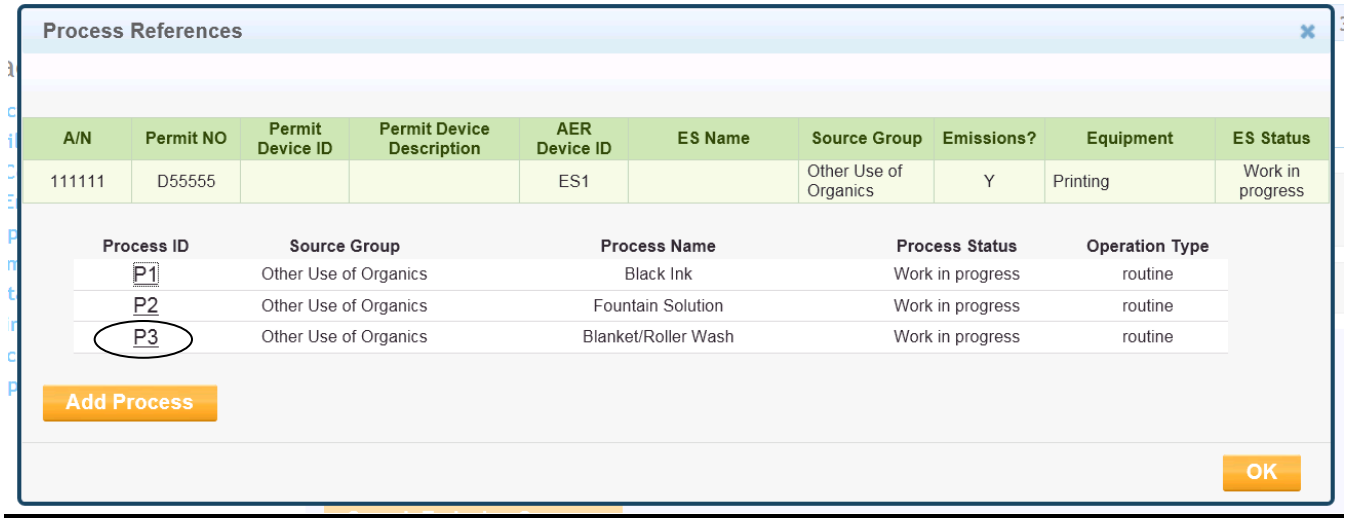
- Enter the **VOC content** of 0.8 lb/gal, and the **overall control efficiency** *as the product of the capture efficiency and the destruction efficiency (*0.7 x 0.995 = 0.6965). Calculation is performed automatically. Click **Save.**



Data entry for the **Fountain Solution** is complete as per the next screenshot. The ink SDS shows no standard toxic content.

- Click **Back to Emission Source Process Reference**, and Select process **P3**.





- Repeat steps for Process ID P3 as for P1 and P2. *The throughput is 10 gallons and the emission factor for this example is 6.7 lb/gal. The overall efficiency will be 0.4 x 0995 = 0.398* when entering criteria emission information. The final screenshot below shows all three processes input into the program, as viewed in **Report Process/Emissions.**