

Calculating EtO commercial sterilizer emissions for the 2018 AirToxScreen assessment

The table below summarizes the average emission factors for ethylene oxide (EtO) from specific areas/equipment within a sterilizer facility as a percentage of the annual EtO usage. (In one case – Indoor EtO Storage – the percentage is not reported because the information is claimed as Confidential Business Information or CBI.) The percentage values were calculated using industry responses from the December 2019 and September 2021 Information Collection Requests (ICRs) collected under Section 114 of the Clean Air Act, available performance test data, and other data provided by facilities, and are a simple arithmetic mean of the facilities' data.

Emission Process Group	Industry avg percentage of EtO Use	# of facilities' data used for average*
Aeration Room Vent	4%	15
Chamber Exhaust Vent	1%	18
Indoor EtO Storage	CBI	N/A
EtO Dispensing	0.1%	3
Injection rooms at single-item sterilizers	0.4%	1
Vacuum Pump Operation	0.1%	5
Pre-Aeration Handling Sterilized Material	0.2%	1
Post-Aeration Handling Sterilized Material	0.3%	15
Non-oxidizer APCD Area	0.04%	1

This column shows the number of facilities whose data were used to calculate each value. These facilities' data came from responses to the December 2019 and September 2021 questionnaires for ethylene oxide emissions from commercial sterilizers.

Example Calculation: Centurion Medical Products in Salisbury NC

Basic breakdown of emissions based on company-provided data as part of the responses to the December 2019 and September 2021 questionnaires:

Emission Process Group (EPG)	Stack or Fugitive?	% EtO use going to this EPG ^(a)	Source of %EtO to EPG: Industry Average or Facility Specific	Control Device Removal efficiency	Removal efficiency (source)	Emissions (pounds per year)
Sterilization Chamber Vent	Stack	93.462%		99.991%	6/11/15 state permit application	4.168
Aeration Room Vent	Stack	4%	Industry Average	99.995%	6/27/19 state inspection (2013 performance test)	0.099
Chamber Exhaust Vent	Stack	1%	Industry Average	99.995%	6/27/19 state inspection (2013 performance test)	0.025
EtO storage/Sterilizer Room (Vacuum Pump Operation + EtO Dispensing + Pre-Aeration Handling Sterilized Material)	Uncontrolled Vent	0.048%	Facility Specific	0%	N/A	23.784
QC area, front warehouse, hall (Post-Aeration Handling Sterilized Material)	Fugitive	0.45%	Facility Specific	0%	N/A	222.971
Fugitives from Scrubber (Non-oxidizer APCD Area)	Fugitive	0.04%	Facility Specific	0%	N/A	19.820

^(a) When calculating emissions for a particular year, the emission factor calculated from reported data is used and applied to the year-specific EtO throughput to calculate emissions for the process group.

Estimating Fugitive Emissions

Emission Process Group	Room floor area (A, sqft)	Room height (h, ft)	# Air changes per hour (n)	Summer Temp (Ts, F)	Winter Temp (Tw, F)	Spring/Fall Temp (Ti, F)	EtO Concentration (C, ppm)
EtO storage/Sterilizer Room	1260	12.9	15.5	105.0	105.0	105.0	0.1209
QC area/back warehouse (and half hall)	14600	20.1	1.9	98.0	68.0	73.0	0.0921
Front warehouse (and half hall)	50850	14.3	2.0	98.0	68.0	73.0	0.0599

The annual operating hours for this facility (t) = 8,760. This information can be plugged into the equation below (derived from the ideal gas law) to get the amount of EtO being emitted from each room area in pounds per year:

$$\frac{44 \times A \times C \times h \times n}{0.73 \times 10^6} \times \left(\frac{t \div 4}{T_s + 459.69} + \frac{t \div 4}{T_w + 459.69} + \frac{t \div 2}{T_i + 459.69} \right)$$

The molecular weight of EtO is 44 lb/lb-mol, 0.73 is the ideal gas constant for these units (ft^3 , R, atm, and lb-mol), and 459.69 is used to convert the temperatures to Rankine (an [absolute scale](#) of [thermodynamic temperature](#)).) If we assume all other inputs are constant, the only variable that will impact the amount of EtO being emitted is the temperature, which is reflected in the equation.