

**DRAFT TECHNICAL REVIEW AND EVALUATION
OF THE SOIL VAPOR EXTRACTION UNIT GENERAL PERMIT**

I. INTRODUCTION

The Soil Vapor Extraction Unit (SVEU) General Permit (GP) covers statewide facilities that are similar in nature, have substantially similar emissions, and would be subject to the same or substantially similar requirements. Equipment that is covered under the general permit will be required to have an Authorization-To-Operate (ATO). The ATO will identify the piece of equipment by providing the manufacturer, date of manufacture, maximum capacity, and serial number or equipment number.

The SVEU GP allows for portable soil vapor extraction units to move to other locations statewide. An owner or operator that applies for an ATO under the SVEU GP shall pay the Arizona Department of Environmental Quality (ADEQ) a flat application fee of \$500. The owner or operator must continue to pay, for each calendar year, the applicable administrative or inspection fees as described in the Arizona Administrative Code Title 18, Chapter 2, Article 5, Section 511.

II. PROCESS DESCRIPTION

Soil vapor extraction units (SVEUs) are used to remove volatile contaminants from below ground for treatment above ground. One or more extraction wells are drilled into the contaminated soil and connected to a blower or vacuum pump. The vacuum system extracts contaminated vapors from the soil to the surface. The extracted air and vapor are routed to an air-water separator to remove moisture, and then treated to remove any harmful levels of contaminants. Following treatment, the exhaust gas is released to the atmosphere in accordance with emission limitations and standards as prescribed in the SVEU GP and the Arizona Administrative Code (A.A.C.).

III. HALOGENATED COMPOUNDS

A. What is a halogenated compound?

A halogenated compound is an organic compound in which one or more hydrogen atoms bonded to carbon have been replaced by a halogen such as chlorine, bromine and fluorine. For sites treated with a SVEU, the most common occurring halogenated compound are those containing a chlorine atom such as trichloroethylene (TCE). TCE is one of the most prevalent pollutants and is most likely to lead to higher hydrochloric acid (HCL) and dioxin/furans (D/F) emissions.

B. Halogenated Compounds in SVEUs Equipped with Catalytic/Thermal Oxidizers

1. Dioxin and Furans

Dioxins and furans are the abbreviated are a family of toxic compounds that share similar chemical structures. According to the U.S. Environmental Protection Agency (EPA), prolonged exposure to high levels of D/F may

result in adverse health effects, including hormone changes and cancer. Among the dioxins and furans, 2,3,7,8-tetrachloro-p-dibenzo-dioxin (2,3,7,8 TCDD) is considered the most toxic.

Although D/F formations are not fully characterized, literature indicates that D/F formation is highly temperature-dependent, with an optimal formation range between 200 degree Celsius (°C) and 500 °C, and peak formation between 300 °C to 350 °C. Under the SVEU GP, thermal oxidizers are required to operate at temperatures greater than 1,400°F (760 °C), and catalytic oxidizers must operate above 600 °F (315 °C). Thermal oxidizers operate above the ideal formation temperature range and thus, they are less likely to produce D/F emissions.

Thermal and catalytic oxidizers operating at comparable temperatures and treating similar source streams have been evaluated for the formation of D/F compounds. These evaluations indicate that thermal oxidizers do not form D/F compounds. For these, the maximum recorded stack emissions were 1.07 ng/m³ toxic equivalents (TEQ) occurring at an operating temperature of 293 °C.

To ensure a conservative assessment, ADEQ used the maximum reported emission value to model ambient D/F concentrations for comparison with the Arizona Ambient Air Quality Guidelines (AAAQGs).

Equation 1:

$$Q_c = \frac{C_c \times F}{3.28^3 \text{ ft}^3 / \text{m}^3 \times 10^9 \times 60 \text{ sec} / \text{min}}$$

where:

- Q_c = Mass Emission Rate of Pollutant c, g/s
- C_c = Concentration of Pollutant c, ng/m³
- F = Flowrate, SCFM

A 500 SCFM is the maximum flowrate capacity for permitted SVEUs.

$$Q_c = \frac{1.07 \text{ ng} / \text{m}^3 \times 500 \text{ ft}^3 / \text{min}}{3.28^3 \text{ ft}^3 / \text{m}^3 \times 10^9 \times 60 \text{ sec} / \text{min}} = 2.52E - 10 \text{ g} / \text{sec}$$

2. Hydrochloric Acid (HCL)

Another concern with halogenated compounds is the formation of acid gases such as HCL. In order to limit the production of acid gases exiting SVEUs, ADEQ calculated an inlet mass emission rate as seen in Equation 2. For this calculation, ADEQ assumed an inlet limit for TCE at 40 parts per million by volume (ppmv), which is significantly higher than most test reports of contaminated sites evaluated, and an inlet flowrate of 500 SCFM

because this is the maximum flowrate capacity for permitted SVEUs. The calculation also assumed 100 percent conversion to HCL. In order to be conservative, the concentration of all halogenated compounds is added, not only TCE. The following equation calculates a mass emission rate for a pollutant based on data for concentration and flowrate.

Equation 2:

$$Q_c = \frac{(C_c \times F \times MW_c \times 60 \text{ min/hr} \times 24 \text{ hrs/day})}{(10^6 \times V)}$$

Where: Q_c = Mass Emission Rate of Pollutant c, lbs/day

C_c = Concentration of Pollutant c, ppmv

F = Flowrate, SCFM

MW_c = Molecular Weight of Contaminant c
= 131.4 lb/lb-mole for TCE

V = Molar Volume = 385.3 ft³/lb-mol

The assumptions used in this example are 500 SCFM and 40 ppmv of TCE. However, owners or operators must input the inlet flowrate data to calculate this for the SVEU. Inputting these values into the above equation, the following is obtained:

$$Q_c = \frac{(40 \text{ ppmv} \times 500 \text{ Ft}^3/\text{min} \times 131.4 \text{ lb/lb-mole} \times 60 \text{ min/hr} \times 24 \text{ hrs/day})}{(10^6 \times 385.3 \text{ Ft}^3/\text{lb-mole})}$$

Q_c = 9.82 lbs/day – converting to grams per minute = 0.052 g/sec = 3.1 g/min

This mass emission rate is the maximum allowable halogenated compound inlet concentration for each SVEU. However, since this equation assumes a maximum flowrate of 500 SCFM, the emission limitation is expressed as the concentration multiplied by the flowrate in the SVEU GP. Rearranging Equation 2 above to solve for concentration multiplied by flowrate as follows:

Equation 3:

$$C_c \times F = \frac{(3.1 \text{ g/min} \times 1 \text{ lb}/454 \text{ g} \times 385.3 \text{ Ft}^3/\text{lb-mole} \times 10^6)}{(131.4 \text{ lb/lb-mole})}$$

$C_c \times F$ = 20,000

Where:

Cc = Sum of all halogenated compounds, ppmv
F = Flowrate, SCFM

Compliance with the emission limitation must be demonstrated by Equation 3 above, where the owner or operator must input its specific flowrate and sum of halogenated compounds in the inlet of the SVEU to ensure they are below 20,000.

In order to determine the outlet concentration of HCL to be used in the modeling analysis, a simple ratio was calculated. Since one TCE molecule is assumed to produce 3 molecules of HCL, a ratio was performed to determine the outlet emission rate of HCL. This ratio is based on the molecular weight of the two molecules:

MW TCE = 131.4 lb/lb-mole
MW HCL = 36 lb/lb-mole x 3 molecules = 108 lb/lb-mole

Where:

MW = molecular weight in lb/lb-mole

Equation 4:

$$\left(\frac{108 \text{ lb/lb-mole HCL}}{131.4 \text{ lb/lb-mole TCE}} \right) \times 0.052 \text{ g/sec TCE} = 0.042 \text{ g/sec HCL}$$

The mass emission rate calculated above for HCL was used in the modeling analysis to ensure it is within the guidelines set forth under the applicable Acute/Chronic Ambient Air Concentration (AAC).

IV. MODELING ANALYSIS

ADEQ conducted air dispersion modeling to estimate ambient concentrations for both D/F and HCL and compared results against the applicable Acute/Chronic AACs or AAAQGs. Table 1 summarizes the air modeling input parameters. Owner or operator inputs were based on permitted SVEUs.

Table 1: Modeling Parameters

Parameters	Input	Input values
Source	Source type	POINT
	Stack height	3.96 m
	Stack diameter	0.41 m
	Stack exit temperature	588 K
	Stack exit velocity	2.29 m/s
Building	Include building downwash	Yes
	Building height	10 m

Parameters	Input	Input values
	Maximum horizontal dimension	30 m
	Orientation of maximum building dimension to orth	90°
	Minimum horizontal dimension	20 m
	Direction of stack from North	0°
	Distance from stack to building	20 m
Meteorology	Minimum temperature	267.6 K
	Maximum temperature	323.1 K
	Minimum wind speed	0.5 m/s
	Anemometer height	10 m
	Source of surface	Albedo: .25, B/R: 10, R/L: 0.15
Other Inputs	Input units	Metric
	Rural/urban	Rural
	Ambient distance	1 - 5000 m
	Use flagpole receptors	No

Table 2 summarizes the modeled results for D/F and HCL. The results demonstrate that the emission limitation of 0.052 g/sec of halogenated compounds assuming full conversion to HCL are well below the Acute/Chronic AAC for HCL under the SVEU GP. The modeled concentrations of D/F using the worst-case emission rate of 2.52E-10 g/sec are well below the AAAQG for 2,3,7,8-TCDD. That is the most stringent public health screening level for D/F.

Table 2: Modeled Results

HAPs	Emission Rate (g/s)	Averaging Period	Modeled Concentration (µg/m³)	Acute/Chronic AAC or AAAQG (µg/m³)
D/F	2.52E-10	1-hour	7.99E-07	4.20E-02 (1-hr AAAQG ¹)
		24-hour	4.79E-07	1.10E-02 (24-hr AAAQG ¹)
		Annual	7.99E-08	2.40E-05 (Annual AAAQG ¹)
HCL	0.042	1-hour	132.9	16,000 (Acute AAC)
		Annual	13.3	20.9 (Chronic AAC)

¹The modeled concentrations of D/F were compared to the AAAQG for 2,3,7,8-TCDD which is the most toxic D/F.

V. APPLICABLE REGULATIONS

ADEQ has identified the applicable regulations that apply to SVEUs.

Table 3: Statewide Applicable Regulations

Equipment	Control Equipment	Applicable Regulation	Discussion
SVEUs	Thermal Oxidizer, Catalytic Oxidizer or Carbon Adsorption	A.A.C. R18-2-702.B.3 and A.A.C. R18-2-730 A.A.C R18-2-513	These standards are applicable to all unclassified sources. There standards are applicable to portable sources covered under a general permit.

Table 4 summarizes ADEQ's evaluation of applicable regulations for SVEU operations located in Maricopa County.

Table 4: Applicable Regulations for Maricopa County

Equipment	Control Equipment	Applicable Regulation	Discussion
SVEUs	Thermal Oxidizer, Catalytic Oxidizer or Carbon Adsorption	Maricopa County Rule 300 Maricopa County Rule 320 Maricopa County Rule 323 Maricopa County Rule 330	Maricopa County Rule for visible emissions. Maricopa County Rule for odors and gaseous air contaminants. Maricopa County Rule for fuel-burning equipment from industrial/commercial/institutional sources. Maricopa County Rule for volatile organic compounds.

Table 5 summarizes ADEQ's evaluation of applicable regulations for SVEU operations located in Pima County.

Table 5: Applicable Regulations for Pima County

Equipment	Control Equipment	Applicable Regulation	Discussion
SVEUs	Thermal Oxidizer, Catalytic Oxidizer or Carbon Adsorption	Pima County Code (P.C.C.) 17.16 P.C.C.17.16.430	These standards are applicable to all unclassified sources.

Table 6 summarizes the Department's evaluation of applicable regulations for SVEU operations located in Pinal County.

Table 6: Applicable Regulations for Pinal County

Equipment	Control Equipment	Applicable Regulation	Discussion
SVEUs	Thermal Oxidizer, Catalytic Oxidizer or Carbon Adsorption	Pinal County Air Quality Control District Code of Regulations Visibility Limiting Standard 2-8-300 General Provisions 3-9-800 Fugitive Dust 4-2-030 General Applicable Minimum Standards of Performance 5-24-1030 Federally Enforceable Minimum Standards of Performance 5-24-1032	These standards are applicable throughout Pinal County. These standards are applicable to all portable sources. These standards are applicable to all existing and new non-point sources. These standards are applicable to all unclassified sources.

VI. MONITORING, RECORDKEEPING AND REPORTING REQUIREMENTS

Table 7 contains an inclusive, but not an exhaustive list of the monitoring, recordkeeping and reporting requirements prescribed under the SVEU GP. The table below is intended to provide insight to the public for how the Permittee is required to demonstrate compliance with the emission limits in this general permit.

Table 7: Monitoring, Recordkeeping and Reporting Requirements

Pollutant	Emission LimitationS	Monitoring Requirements	Recordkeeping Requirements	Reporting Requirements
VOCs	90 tpy	Collect inlet and outlet vapor stream upon startup at each new location biweekly for six (6) weeks, monthly	Record VOC emissions at the end of each month on a 12-month rolling basis.	Submit a written report of the results of all grab samples performed during the

Pollutant	Emission Limitations	Monitoring Requirements	Recordkeeping Requirements	Reporting Requirements
Halogenated Compounds	0.052 g/s	for six (6) months, and quarterly thereafter, using EPA Method 8260D, EPA Method TO-15A, or approved equivalent methods by ADEQ.	Maintain records of all required monitoring data and support documentation for a minimum of five (5) years from the date of generation.	compliance term.
SO ₂	600 ppm	N/A	N/A	Report excess emissions and deviations if applicable.
NO _x	500 ppm	N/A	N/A	Report excess emissions and deviations if applicable.
PM	20 Percent Opacity	Monitor opacity.	Record results and any corrective action taken.	Report excess emissions and deviations if applicable.

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VII. PREVIOUS GENERAL PERMIT CONDITIONS

Table 8 compares the sections in the previous SVEU GP with the conditions of the renewed SVEU GP.

Table 8: Previous Permit Conditions

Section	Determination			Comments
	Revised	Added	Deleted	
Att. "A"	X			General Provisions: Revised to represent the most recent template language.
Att. "B"	X			Facility-Wide Requirements: Revised to represent the most recent template language.
Att. "B" Section IV	X			Thermal and Catalytic Oxidizer Requirements: Revised to represent the most recent template language.
Att. "B" Section V	X			Carbon Adsorption Requirements: Revised to represent the most recent template language.
Att. "C"	X			Requirements for SVEUs Operating in Maricopa County: Updated.
Att. "C"		X		Requirements for SVEUs Operating in Pinal County: Added.

VIII. LIST OF ABBREVIATIONS

2,3,7,8-TCDD.....	2,3,7,8-tetrachlorodibenzo-p-dioxin
A.A.C.	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
AAACs.....	Acute Ambient Air Concentrations
AAAQGs.....	Arizona Ambient Air Quality Guidelines
D/F	Dioxin/Furans
EPA	The Environmental Protection Agency
ft ³	Cubic Feet
g	Grams
HCL	Hydrochloric Acid
hr	Hour
lb.....	Pound
m.....	Meter
MW	Molecular Weight
µg/m ³	Nanogram per Cubic Meter
NO _x	Nitrogen Oxides
PM	Particulate Matter
SCFM	Standard Cubic Feet per Minute
sec.....	Seconds
TCE	Trichloroethylene
TEQ.....	Toxic Equivalency
tpy.....	Tons per Year
µg/m ³	Microgram per Cubic Meter
U.S. EPA	U.S Environmental Protection Agency
VOCs.....	Volatile Organic Compounds
yr.....	Year