

SMAQMD BACT CLEARINGHOUSE

ACTIVE

CATEGORY Type:

MANUFACTURING PROCESS

BACT Category: MINOR SOURCE

BACT Determination Number: 334	BACT Determination Date: 9/12/2023
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Equipment Information

Permit Number: N/A -- Generic BACT Determination
Equipment Description: CANNABIS OIL EXTRACTION
Unit Size/Rating/Capacity: ALL
Equipment Location:

BACT Determination Information

District Contact: Matt Baldwin Phone No.: (279) 207-1119 email: mbaldwin@airquality.org

ROCs	Standard:	95% solvent recovery or control
	Technology Description:	Closed-loop system for volatile and nonvolatile extraction units
	Basis:	Achieved in Practice
NOx	Standard:	No Standard
	Technology Description:	
	Basis:	
SOx	Standard:	No Standard
	Technology Description:	
	Basis:	
PM10	Standard:	No Standard
	Technology Description:	
	Basis:	
PM2.5	Standard:	No Standard
	Technology Description:	
	Basis:	
CO	Standard:	No Standard
	Technology Description:	
	Basis:	
LEAD	Standard:	No Standard
	Technology Description:	
	Basis:	

Comments: .

BEST AVAILABLE CONTROL TECHNOLOGY (BACT) DETERMINATION

DETERMINATION NO.: 334
DATE: September 7, 2023
ENGINEER: Matt Baldwin

Category/General Equip Description: Manufacturing Process
BACT Category: Minor Source BACT
Equipment Specific Description: Cannabis Oil Extraction
Equipment Size/Rating: All
Previous BACT Det. No.: 260 (Draft Only)

This BACT determination (No. 334) is a new determination for Cannabis Manufacturing Facilities. Please note that BACT No. 260 for Cannabis Oil Extraction was proposed on February 1, 2021, but not adopted by the Sacramento Metropolitan Air Quality Management District (SMAQMD). BACT No. 334 includes additional information that supports the original conclusions stated in the non-adopted BACT No. 260.

Cannabis cultivation is not covered by this determination because it is considered an agricultural operation and exempt from permitting when facility emissions are less than half the major source threshold for a given criteria pollutant.

In short, a cannabis manufacturer is anyone who makes or packages a prepared cannabis product.¹ Cannabis products include edibles, topicals, tinctures, extracts, vape cartridges, capsules and more. The process of concern for this BACT determination is extraction. Extraction is the process of separating cannabinoids from cannabis plant material using chemical solvents or mechanical methods. There are two types of processes commonly used for extraction – volatile and nonvolatile. Volatile extraction uses a solvent that produces a flammable gas or vapor. Examples of volatile solvents are butane, hexane, and propane. Nonvolatile extraction uses any other type of solvent for cannabis extraction; examples include ethanol and carbon dioxide (CO₂).

The City of Sacramento is currently the only jurisdiction in Sacramento County that allows manufacturing of cannabis products. Both nonvolatile and volatile solvent extraction methods are allowed by the city.²

Nonvolatile Extraction – Ethanol

One method of nonvolatile extraction uses food grade ethanol as a solvent to extract plant material. Methods vary, but one common method chills the ethanol to < -20°C (-4°F) either in a cold room or freezer and then pumps it into a container of cannabis.

¹ [“Cannabis Manufacturing Licenses – Definitions and Basic Information”](#), California Department of Public Health, February 27, 2019.

² [“Nonvolatile and Volatile Cannabis Manufacturing”](#), City of Sacramento Office of Cannabis Management, retrieved October 22, 2019 and March 16, 2023.

After a soaking period, the ethanol solution is either filtered or the plant material removed in a 'tea bag' fashion. The resultant mother liquor of ethanol and extract is then concentrated by removing the ethanol by distillation. The distilled ethanol is typically recycled and reused in subsequent batches. Residual ethanol content in cannabis products is limited to 5,000 micrograms/gram.³ Typical distillation apparatus used to remove the ethanol include rotary evaporators, falling film evaporators or a batch vacuum distillation system.

Nonvolatile Extraction – CO₂

CO₂ extraction utilizes carbon dioxide that is pressurized to its subcritical or supercritical state. The CO₂ stream passes through a chamber containing cannabis material. The distillate can be isolated easily by reducing the pressure which evaporates the CO₂, leaving a cannabis extract with no solvent. Altering the temperature and pressure affords CO₂ systems the ability to yield extracts without denaturing or damaging desirable aromatic oils.

Sophisticated extraction apparatus can also incorporate fractionation, which enables process tuning to isolate desired components. Refrigerated chillers that are integrated into these systems facilitate recycling of the CO₂ by condensing the gas back to a liquid state.

Volatile Extraction – Volatile extraction uses butane, propane or other low molecular weight hydrocarbons. The solvents are pressurized to a liquid form. The liquid hydrocarbon passes through a bed of cannabis material and filter, yielding an extract solution of hydrocarbon and plant extract. Like the CO₂ method, a reduction in pressure evaporates the hydrocarbon liquid, yielding a solvent-free plant extract.

This method requires great attention to safety due to the flammability of the hydrocarbon used. Maintaining the pressurized hydrocarbon in the liquid state requires low temperatures. Recirculating temperature control units (TCUs) that can provide cooling to -60°C (-76°F) and below facilitates this process. Heating circulators are also incorporated to increase the liquid hydrocarbon evaporation to isolate the extract and recycle the hydrocarbon.

³ Title 16, Cal. Code Regs. §5718

BACT/T-BACT ANALYSIS

A. ACHIEVED IN PRACTICE (Rule 202, §205.1a):

The following control technologies are currently employed as BACT/T-BACT for cannabis manufacturing by the following agencies and air pollution control and air quality management districts:

United States Environmental Protection Agency (US EPA)

BACT

Source: [EPA RACT/BACT/LAER Clearinghouse](#)

Cannabis Manufacturing	
VOC	N/A – No BACT determinations found
NOx	N/A – No BACT determinations found
SOx	N/A – No BACT determinations found
PM10	N/A – No BACT determinations found
PM2.5	N/A – No BACT determinations found
CO	N/A – No BACT determinations found

T-BACT

There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS

There are no New Source Performance Standards (NSPS) or National Emission Standards for Hazardous Air Pollutants (NESHAP) applicable to this source category.

California Air Resources Board (CARB)

BACT

Source: [CARB BACT Clearinghouse](#)

Cannabis Manufacturing	
VOC	N/A – No BACT determinations found
NOx	N/A – No BACT determinations found
SOx	N/A – No BACT determinations found
PM10	N/A – No BACT determinations found
PM2.5	N/A – No BACT determinations found
CO	N/A – No BACT determinations found

CARB – continued

T-BACT

There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS

The Air Resources Board does not have statewide rule requirements for cannabis manufacturing. However, the California Department of Public Health (CDPH) does set safety standards for cannabis manufacturing in California (Title 17, Cal. Code Regs., Division 1, Chapter 13. [Manufactured Cannabis Safety](#)). The state issues two types of licenses for extractions, Type 6 for nonvolatile extractions (CO₂ and ethanol), and Type 7 for volatile. For CO₂ and volatile extraction, a closed-loop system that is designed to recover the solvents must be used for extraction (Title 17 Cal Code Regs., §40220). For nonvolatile solvents, such as ethanol, the system must be approved by the local fire code official. The 2016 California Fire Code, which the City of Sacramento has adopted into its city codes, requires that plant processing and extraction facilities utilize a hazardous exhaust fume hood to capture vapors when flammable and combustible liquids are used (Title 24 Cal Code Regs, §3801 et. al.).

Sacramento Metropolitan AQMD (SMAQMD)

BACT

Within SMAQMD's jurisdiction, BACT is required for emission increases greater than 0 lb/day. SMAQMD uses conventional rounding methods where 0.49 lb/day rounds down to 0 and 0.5 lb/day rounds up to 1.

Source: [SMAQMD BACT Clearinghouse](#).

Cannabis Manufacturing	
VOC	N/A – No BACT determinations found
NOx	N/A – No BACT determinations found
SOx	N/A – No BACT determinations found
PM10	N/A – No BACT determinations found
PM2.5	N/A – No BACT determinations found
CO	N/A – No BACT determinations found

T-BACT

There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS

[Rule 441 – Organic Solvents \(Adopted 12/06/1978\)](#)

SMAQMD Rule 441 limits the emissions of organic solvents into the atmosphere that may result from the use of organic solvents.

SMAQMD – continued

RULE 441, §301 through §304 Emission Limits			
Material	lb/day	lb/hr	Or (A)
Organic materials that come into contact with flame	≤ 15	≤ 3.1	85% reduction
Photochemically reactive solvents	≤ 39.7	≤ 7.9	85% reduction
Non-photochemically Reactive Solvents	≤ 2,970	≤ 441	85% reduction
Solvent Disposal	≤ 1.3	N/A	N/A

(A) If a person emits more than the mass emission limits, they must reduce mass emissions by the percentage listed.

Rule 464 – Organic Chemical Manufacturing Operations (Last amended 04/28/2016)

SMAQMD Rule 464 limits the emissions of VOCs from organic chemical manufacturing plants. Organic chemical manufacturing plants are defined as those facilities that have a two-digit Standard Industrial Classification (SIC) code of 28. Cannabis manufacturing is classified under SIC code 2833 - Medicinal Chemicals and Botanical Products. Therefore, this rule applies.

Rule 464 requires reactors, distillation columns, crystallizers, evaporators, or centrifuges that emit more than 15 pounds per day to vent emissions to a control device that has a combined system efficiency of 85% by weight and a control efficiency of at least 90% by weight. Additionally, except for cleaning of laboratory equipment and in-line solvent cleaning of process units and piping, a person must not use solvents for cleaning unless it meets a VOC content limit of 25 g/L.

South Coast AQMD (SCAQMD)

BACT

Within SCAQMD's jurisdiction, BACT is required for emission increases that equal or exceed 1.0 lb/day for any nonattainment air contaminant, any ozone depleting compound, or ammonia.

Source: [SCAQMD BACT Guidelines \(Part D\) for Non-Major Polluting Facilities](#)

Cannabis Manufacturing	
VOC	N/A – No BACT determinations found
NOx	N/A – No BACT determinations found
SOx	N/A – No BACT determinations found
PM10	N/A – No BACT determinations found
PM2.5	N/A – No BACT determinations found
CO	N/A – No BACT determinations found

SCAQMD – continued

T-BACT

There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS

[Regulation XI, Rule 1173 – Control of Volatile Organic Compound Leaks and Releases from Components at Petroleum Facilities and Chemical Plants \(last amended 02/06/2009\)](#)

This rule limits emissions of VOCs from chemical plants. However, this rule defines a chemical plant as a facility with a three-digit SIC code of 282. Therefore, this rule is not applicable.

Existing Authority/Permit to Construct or Permit to Operate for Cannabis Oil Extraction

For the past few years, the SCAQMD has been reviewing BACT for Cannabis Extraction/Processing. Their preliminary review in 2020 had determined that $\geq 95\%$ solvent recovery was achieved in practice using butane and ethanol.⁴ At the end of 2022, a source test demonstrated $\geq 95\%$ solvent recovery using butane/propane extraction (not ethanol) for a facility that had been in operation since March 2018.⁵ Earlier this year, SCAQMD proposed their BACT limit at 95% solvent recovery for Cannabis Extraction/Processing using butane/propane, which was originally anticipated for adoption at the end of 2023. The source test from the facility mentioned above was the basis for the achieved in practice determination.

SCAQMD recently removed the proposed BACT for Cannabis Extraction/Processing from their 2023 BACT Guideline updates because the facility mentioned above has been permanently closed due to an economic downturn in this industry. Although SCAQMD had issued several permits for cannabis manufacturing equipment, including a Permit to Construct using ethanol that requires 95% control using a mass balance and a Permit to Operate using ethanol extraction,⁶ SCAQMD has stated that all these permits have been canceled.

San Joaquin Valley APCD (SJVAPCD)

BACT

Within SJVAPCD's jurisdiction, BACT is required for emission increases greater than or equal to 2 lb/day.

Source: [SJVAPCD BACT Guidelines](#)

⁴ Proposed Updates to BACT Guidelines, Scientific Review Committee presentation, February 25, 2020 (slide 17) http://www.aqmd.gov/docs/default-source/Agendas/bact/bact-src-presentation-2-25-20/2-25-20_-bact-src-meeting_proposed-updates-to-bact-guidelines_slides.pdf

⁵ Proposed Updates to BACT Guidelines, Scientific Review Committee presentation, February 23, 2023 (slide 11) http://www.aqmd.gov/docs/default-source/bact/2-23-23-bact-guidelines-proposed-updates/proposed-updates-to-bact-guidelines_src_february23_2023_final.pdf

⁶ South Coast AQMD engineering evaluation A/N 620797 and permit to construct granted on 9/23/2020. South Coast AQMD permit to operate G52124 issued on 5/3/2018.

SJVAPCD – continued

Cannabis Manufacturing	
VOC	N/A – No BACT determinations found
NOx	N/A – No BACT determinations found
SOx	N/A – No BACT determinations found
PM10	N/A – No BACT determinations found
PM2.5	N/A – No BACT determinations found
CO	N/A – No BACT determinations found

T-BACT

There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS:

[Rule 4461 – Organic Solvents \(Last amended 09/20/2007\)](#)

Except for sources otherwise exempted or covered by another rule, this rule limits the emissions of organic solvents into the atmosphere that may result from the use of organic solvents.

RULE 4461, §5.8 through §5.10 Emission Limits	
Facility wide emissions ≤ 833 lb/month	Facility wide emissions > 833 lb/month
No additional requirements	VOC emission control system capable of a capture efficiency of 90% by weight and a control efficiency of 95% by weight.

Existing Authority/Permit to Construct or Permit to Operate for Cannabis Oil Extraction

Several Permits to Operate have been issued for cannabis oil extraction/distillation using ethanol and/or butane that require ≥ 95% solvent recovery efficiency. The solvent emission limits for each process on these permits were below the SJVAPCD BACT trigger level of 2.0 lbs/day for VOC. Additionally, SJVAPCD does not require source testing to prove compliance with the solvent recovery efficiency, but they do require annual source testing for the one permit that contains the Regenerative Thermal Oxidizer (RTO), which must achieve 98% VOC control efficiency.⁷

San Diego County APCD (SDAPCD)

BACT

Within SDAPCD's jurisdiction, BACT is required for emission increases greater than or equal to 10 lb/day.

Source: [SDAPCD NSR Requirements for BACT](#)

⁷ San Joaquin Valley APCD permit unit C-9541-1-1 and permit unit C-9644-2-0.

SDAPCD – continued

Cannabis Manufacturing	
VOC	N/A – No BACT determinations found
NOx	N/A – No BACT determinations found
SOx	N/A – No BACT determinations found
PM10	N/A – No BACT determinations found
PM2.5	N/A – No BACT determinations found
CO	N/A – No BACT determinations found

T-BACT

There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS

[Regulation IV, Rule 67.15. Pharmaceutical and Cosmetic Manufacturing Operations \(Rev. Adopted & Effective 5/15/96\)](#)

This rule applies to manufacturers of botanical and/or biological products by the extraction of organic chemicals from vegetative materials or animal tissues. This rule does not apply to any stationary source that emits less than 15 lb/day of VOC.

RULE 67.15 Standards	
Reactors, distillation columns, crystallizers or centrifuges that emit ≥ 15 lb/day of VOC	Air dryers or other production equipment that, in combination, emit ≥ 33 lb/day of VOC
All device vents must be equipped with surface condensers and the outlet exhaust gas temperatures are limited to section (d)(1), OR combined VOC collection and abatement efficiency of 90% by weight	VOC emissions are reduced of 90% by weight

Bay Area AQMD (BAAQMD)

BACT

Within BAAQMD's jurisdiction, BACT is required for emission increases greater than or equal to 10 lb/day.

Source: [BAAQMD BACT/TBACT Workbook](#)

BAAQMD – continued

Cannabis Manufacturing	
VOC	N/A – No BACT determinations found
NOx	N/A – No BACT determinations found
SOx	N/A – No BACT determinations found
PM10	N/A – No BACT determinations found
PM2.5	N/A – No BACT determinations found
CO	N/A – No BACT determinations found

T-BACT

There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS

[Regulation 8, Rule 2 – Organic Compounds from Miscellaneous Operations \(last amended 07/20/2005\)](#)

RULE 2, §8-2-201 Emission Limits			
Material	lb/day	ppmvd	Or (A)
Organic materials	≤ 15	300 as total carbon	85% reduction

(A) Regulation 8, Rule 1, Section 8-1-110.3 exempts any operation from the above mass and concentration limit when a control device capable of reducing mass emissions by 85% is installed.

[Regulation 8, Rule 4 – General Solvent and Surface Coating Operations \(last amended 10/16/2002\)](#)

RULE 4, §8-4-302 Solvents Requirements	
VOC emissions < 5 tons/year from any source	VOC emissions ≥ 5 tons/year from any source
No additional requirements	VOC emission control system capable of a combined capture and control efficiency of 85%.

Other Air Districts

Information from other Air Quality Management and Air Pollution Control Districts was reviewed. Santa Barbara County APCD (SBCAPCD), San Luis Obispo APCD (SLO APCD), and Monterey Bay Air Resources District (MBARD) have information about cannabis manufacturing. Each Air District requires permits for cannabis manufacturing operations. However, none of the Air Districts' guidance has identified a BACT standard for cannabis manufacturing. Each Air District has a BACT trigger threshold of 25 pounds per day for VOC, so likely these sources have not yet triggered BACT.

Source: MBARD – https://www.mbard.org/files/7fea413f5/Cannabis-Advisory_10242017.pdf
SBCAPCD – <https://www.ourair.org/wp-content/uploads/SBCAPCD-Can-nabis-Permitting-Requirements.pdf>
SLO APCD – <https://www.slocleanair.org/rules-regulations/cannabiscultivation.php>

Summary of Achieved in Practice Control Technologies

Discussion on closed-loop systems:

Although CDPH does not associate an efficiency with a closed-loop system, the common technologies used by the cannabis industry are distillation units and refrigerated condensers. These technologies allow for the separation of the solvent from the desired cannabinoids. Solvents that can be recovered are reused or disposed of in liquid form. Manufacturers of cannabis extraction equipment typically claim solvent recovery rates of $\geq 95\%$.⁸

SMAQMD considers 95% solvent recovery for nonvolatile and volatile solvent extraction methods as achieved in practice because (1) the technology commonly used for solvent recovery in the cannabis industry is capable of achieving 95% recovery, (2) closed-loop systems are required for volatile extraction and nonvolatile extraction using CO₂, (3) other Air Districts have issued Authority/Permits to Construct or Permits to Operate that require a minimum of 95% solvent recovery for butane or ethanol extraction, and (4) a source test in another Air District (SCAQMD) demonstrated $\geq 95\%$ solvent recovery using butane/propane extraction (not ethanol) for a facility that had been in operation since March 2018.

The following control technologies have been identified and are ranked based on stringency:

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES	
Pollutant	Standard
VOC	<ol style="list-style-type: none"> 1. Closed-loop system for volatile, nonvolatile and CO₂ extraction (95% solvent recovery) [CDPH, SCAQMD (preliminary)] 2. Existing Permits to Operate requiring a minimum of 95% solvent recovery for butane or ethanol extraction [SJVAPCD] 3. Source Test demonstration proving $\geq 95\%$ solvent recovery for a butane/propane extraction process is achievable [SCAQMD] 4. Existing Authority/Permit to Construct, where the engineering evaluation states the permit conditions will require a minimum of 95% solvent recovery efficiency for ethanol extraction, even though the permit has been canceled [SCAQMD] 5. ≤ 15 pounds per day VOC, or 85% combined system efficiency and 90% control efficiency for distillation units [SMAQMD] 6. < 15 pounds per day VOC, or 90% overall control [SDAPCD] 7. ≤ 833 pounds per month VOC (27.4 pounds per day), or 90% capture efficiency and 95% control efficiency [SJVAPCD] 8. ≤ 15 pounds per day VOC, or 85% overall control [BAAQMD] 9. ≤ 39.7 pounds per day VOC, or 85% overall control [SMAQMD]
NOx	No standard
SOx	No standard
PM10	No standard
PM2.5	No standard
CO	No standard
T-BACT	No standard

⁸ <https://bhogart.com/pages/faqs>; <https://deltaseparations.com/extraction-yield-considerations/>

Summary of Achieved in Practice Control Technologies – continued

The following control technologies have been identified as the most stringent, achieved in practice control technologies:

BEST CONTROL TECHNOLOGIES ACHEIVED		
Pollutant	Standard	Source
VOC	Closed-loop system for volatile and nonvolatile extraction units (95% solvent recovery or control);	CDPH, SCAQMD, SJVAPCD
NOx	No standard	US EPA, CARB, SMAQMD, SCAQMD, SDAPCD, BAAQMD, SJVAPCD
SOx	No standard	
PM10	No standard	
PM2.5	No standard	
CO	No standard	
T-BACT	No standard	

B. TECHNOLOGICALLY FEASIBLE AND COST EFFECTIVE (RULE 202, §205.1.b.)

Technologically Feasible Alternatives:

Any alternative basic equipment, fuel, process, emission control device or technique, singly or in combination, determined to be technologically feasible by the Air Pollution Control Officer.

The table below shows the technologically feasible alternatives identified as capable of reducing emissions beyond the levels determined to be “Achieved in Practice” as per Rule 202, §205.1. a.

Pollutant	Technologically Feasible Alternatives
VOC	No other technologically feasible option identified
NOx	No other technologically feasible option identified
SOx	No other technologically feasible option identified
PM10	No other technologically feasible option identified
PM2.5	No other technologically feasible option identified
CO	No other technologically feasible option identified

The achieved in practice standard is generally achieved using condensers, adsorbers, or oxidizers capable of meeting the 95% overall solvent recovery or control efficiency.

Cost Effective Determination:

A cost effectiveness determination does not need to be performed for technology that the SMAQMD has determined to be achieved in practice. Additionally, a cost effectiveness determination does not need to be performed for the technologically feasible alternatives since no other technologically feasible options have been identified for the regulated pollutants.

C. SELECTION OF BACT:

Based on the review of SMAQMD, SCAQMD, SJVAPCD, SDAPCD, BAAQMD, CARB and US EPA BACT Clearinghouses and cost effectiveness determinations, BACT for Cannabis Oil Extraction will be the following:

BACT # 334 for Cannabis Oil Extraction		
Pollutant	Standard	Source
VOC	Closed-loop system for volatile and nonvolatile extraction units (95% solvent recovery or control)	CDPH, SCAQMD, SJVAPCD
NOx	No standard	US EPA, CARB, SMAQMD, SCAQMD, SDAPCD, BAAQMD, SJVAPCD
SOx	No standard	US EPA, CARB, SMAQMD, SCAQMD, SDAPCD, BAAQMD, SJVAPCD
PM10	No standard	US EPA, CARB, SMAQMD, SCAQMD, SDAPCD, BAAQMD, SJVAPCD
PM2.5	No standard	US EPA, CARB, SMAQMD, SCAQMD, SDAPCD, BAAQMD, SJVAPCD
CO	No standard	US EPA, CARB, SMAQMD, SCAQMD, SDAPCD, BAAQMD, SJVAPCD

T-BACT for Cannabis Oil Extraction		
Pollutant	Standard	Source
T-BACT (toxics)	No standard	US EPA, CARB, SMAQMD, SCAQMD, SDAPCD, BAAQMD, SJVAPCD

APPROVED BY: Brian F Krebs DATE: 09-12-2023