SMAQMD BACT CLEARINGHOUSE

ACTIVE

CATEGORY Type: **COATING - SOLVENT PREP**

BACT Category: Minor Source BACT

BACT Determination Number: 280	**BACT Determination Date:** 4/13/2021

Equipment Information

Permit Number: 26743
Equipment Description: WIPE CLEANING PROCESS
Unit Size/Rating/Capacity: Using ≤ 160 fluid ounces/day aerosol solvents and/or only removing cured adhe
Equipment Location: APPLE COMPUTER
2911 LAGUNA BLVD ELK GROVE, CA

BACT Determination Information

District Contact: Permitting Section Phone No.: (279) 207-1122 email: Permitting@airquality.org

ROCs	**Standard:**	7.9 lb/hour and 39.7 lb/day
	Technology Description:	
	Basis:	Achieved in Practice
NOx	**Standard:**	
	Technology Description:	
	Basis:	
SOx	**Standard:**	
	Technology Description:	
	Basis:	
PM10	**Standard:**	
	Technology Description:	
	Basis:	
PM2.5	**Standard:**	
	Technology Description:	
	Basis:	
CO	**Standard:**	
	Technology Description:	
	Basis:	
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments:

Printed: 5/11/2022

777 12th Street, Third Floor

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

Sacramento, CA 95814

BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

DETERMINATION NO.: 280

DATE: December 8, 2020

ENGINEER: Michelle Joe

Category/General Equip Description: Solvent Cleaning

Equipment Specific Description: Wipe Cleaning of Electronic Components

Equipment Size/Rating: Minor Source BACT

Previous BACT Det. No.: N/A

This Best Available Control Technology (BACT) determination is for the previously unevaluated category of solvent cleaning operations, specifically wipe cleaning of electronic components using ≤ 160 fluid ounces of aerosol solvents per day per stationary source, or when removing cured adhesives. Electronic components are defined in Rule 466 – Solvent Cleaning as "the portion of an assembly, including circuit board assemblies, printed wire assemblies, printed circuit boards, soldered joints, ground wires, bus bars, and other electrical fixtures, except for the actual cabinets in which the components are housed."

This BACT determination was made under A/C 26719 (Pegatron Technology Service Inc.) and A/C 26743 (Apple Inc.), where both companies perform wipe cleaning solvent operations to remove cured adhesives from cell phones. Apple additionally uses aerosol solvents to clean main logic boards and to sanitize ear buds. Due to the sensitivity of the electronic devices being cleaned and repaired, low VOC solvents are not proposed since the high water content can cause damage to the internal components.

BACT/T-BACT ANALYSIS:

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

The following control technologies are currently employed as BACT/T-BACT for solvent cleaning operations for wipe cleaning of electronic components using aerosol solvents or when removing cured adhesives:

US EPA

BACT: Source: EPA RACT/BACT/LAER Clearinghouse

There are no BACT standards published in the clearinghouse for this category (see Attachment A for a summary of the EPA BACT Clearinghouse determinations reviewed).

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

RULE REQUIREMENTS:
40 CFR Part 60 – New Source Performance Standards (NSPS):
There are currently no 40 CFR, Part 60 NSPS sections that apply to this source category.

40 CFR Part 61 – National Emission Standards for Hazardous Air Pollutants (NESHAPS):
There are currently no 40 CFR, Part 61 NESHAPs that apply to this source category.

40 CFR Part 63 – NESHAPS for Source Categories (MACT Standards):
There are currently no 40 CFR, Part 63 NESHAPs that apply to this source category.

California Air Resources Board (CARB)

BACT: Source: ARB BACT Clearinghouse

There are no BACT standards published in this clearinghouse for this category, based on the following search keywords: "solvent cleaning," "solvent wipe cleaning," and "adhesive removal."

Source: CARB BACT Control List

For search keyword: "solvent"			
Control Type	Controls	Key Terms	EPA Code Match
Vapor Control	Low Solvent Coatings	Low VOC, printing (A)	Low Solvent Coatings
Vapor Control	Low Solvent Powder Coatings	Low VOC, printing (A)	Powder Coatings
Vapor Control	Low Solvent Waterborne Coatings	Water Based Coating (A)	Waterborne Coatings
Vapor Control	Low Solvent Coatings (rule)	Low VOC, Coating, printing	No determinations
Vapor Control	Low Solvent Coatings (beyond rule)	Low VOC, Coating, printing	No determinations

(A) Excluded from the scope of this determination according to the following criteria: specifically for printing, coating, powder coating, or high water content – not wipe cleaning of electronic components.

Source: BACT Guidelines Tool

For search keyword: "solvent cleaning"			
Agency	District ID	Date	Title
Bay Area	149A.2.1	10/25/1991	Semiconductor Manufacturing Operations – Semiconductor Fab - Solvent Cleaning Stations (A)

(B) Excluded from the scope of this determination according to the following criteria: specifically for semiconductor fabrication – not wipe cleaning of electronic components.

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

RULE REQUIREMENTS:
ARB Airborne Toxic Control Measures (ATCM):
There are currently no ATCMs that apply to this source category.

Sacramento Metropolitan AQMD

BACT: Source: SMAQMD BACT Clearinghouse

There are no BACT standards published in the clearinghouse for this category, based on the following search keywords: "solvent cleaning," "solvent wipe cleaning," and "adhesive removal."

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

RULE REQUIREMENTS:
Rule 441 - Organic Solvents (adopted 12/6/1978) – This rule limits emissions of organic solvents into the atmosphere that may result from the use of organic solvents and organic materials where the volatile content is photochemically reactive. Organic materials are defined as chemical compounds of carbon excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides, metallic carbonates, and ammonium carbonate. Photochemically reactive is defined as any solvent with an aggregate or more than 20% of its total volume composed of chemical compounds classified below or which exceed any of the following individual percentage composition limitations, referred to the total volume of solvent:

a. A combination of hydrocarbons, alcohols, aldehydes, esters, ethers, or ketones having an olefinic or cycle-olefinic type of unsaturation: 5%.
b. A combination of aromatic compounds with eight or more carbon atoms to the molecule except ethylbenzene: 8%.
c. A combination of ethylbenzene, ketones having branched hydrocarbon structures, trichloroethylene or toluene: 20%.

Specifically, this rule requires the following (emphasis added to applicable sections in **bold** below):

Total emissions of organic compounds containing photochemically reactive substances (such as isopropyl alcohol, as a VOC defined by EPA) is limited to 39.7 pounds of organic material during any one day and no more than 7.9 pounds in any one hour.

Total emissions of organic compounds containing non-photochemically reactive substances is limited to 1,350 pounds of organic material during any one day and no more than 441 pounds in any one hour.

Rule 466 - Solvent Cleaning (amended 10/28/2010) – This rule limits the VOC content of solvents used in solvent cleaning operations and activities, and from the storage and disposal of new and spent cleaning solvents (emphasis added to applicable sections in **bold** below).

Section 110.3 provides that the provisions of this rule, except for the recordkeeping requirements in Section 501, shall not apply to the following:

A. Cleaning of sterilization ink indicating equipment provided that the solvent usage is less than 1.5 gallons per day;
B. Cleaning with aerosol provided that 160 fluid ounces or less of aerosol products are used per day, per stationary source.
C. Sanitizing products which are labeled and applied to food-contact surfaces that are used to process dry and low-moisture food products and are not rinsed prior to contact with food.

Section 110.5 provides that the provisions of Section 301.1 shall not apply to materials used for the stripping of cured inks, cured coatings, or cured adhesives.

Section 301 requires that the VOC content of solvents used for the following activities shall not exceed the following limits:

Solvent Cleaning Activity	VOC Content g/l (lb/gal)
General (wipe cleaning, maintenance cleaning)	25 (0.21)
Product Cleaning During Manufacturing Process or Surface Preparation for Coating, Adhesive, Sealants, or Ink Application	
General	25 (0.21)
Electrical Apparatus Components and Electronic Components	100 (0.83)
Medical Devices and Pharmaceuticals	800 (6.7)
Platelets	800 (6.7)
Repair and maintenance cleaning	
General	25 (0.21)
Electrical Apparatus Components and Electronic Components	100 (0.83)
Medical Devices and Pharmaceuticals	
General Work Surfaces	600 (5.0)
Tools, Equipment, and Machinery	800 (6.7)
Platelets	800 (6.7)
Architectural Coating Application Equipment	
Water based Coatings	
Enclosed Gun Cleaner	25 (0.21)
No Enclosed Gun Cleaner	25 (0.21)
Solvent based Coatings	
Enclosed Gun Cleaner	25 (0.21)
No Enclosed Gun Cleaner, cleaning at jobsite	25 (0.21)
No Enclosed Gun Cleaner, cleaning not at jobsite	25 (0.21)
Sterilization of food manufacturing and processing equipment	200 (1.68)

Section 302 requires that solvent cleaning be performed using one of the following cleaning devices or methods:

A. Wipe cleaning
B. Non-propellant spray bottles or containers
C. Using cleaning equipment which has a solvent container that is closed during cleaning operations
D. Using remote reservoir degreaser, non-vapor degreaser, or vapor degreaser
E. Using solvent flushing methods
F. An enclosed gun cleaner
G. Soaking application equipment parts in a closed container

Section 303.1 requires that all solvents and material contaminated with solvent shall be stored in closed, non-leaking, and non-absorbent containers when not in use.
Section 303.2 requires that all spent solvents be disposed of properly in closed containers, where spent cleanup solvents may be classified as hazardous waste. The owner or operator shall obtain approval from the applicable local, state, or federal water pollution control agency prior to disposing of spent solvent in the sewer or storm drain systems.

Therefore, the VOC content limits in Section 301 of this rule do not apply to the proposed solvent cleaning operations for wipe cleaning of electronic components using aerosol solvents or when removing cured adhesives.

South Coast AQMD

BACT: Source: SCAQMD BACT Guidelines for Non-Major Polluting Facilities (revised 2/1/2019)

There are no BACT standards published in the clearinghouse for this category, based on the following search keywords: “solvent cleaning,” “solvent wipe cleaning,” and “adhesive removal.”

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

RULE REQUIREMENTS:
Regulation XI, Rule 1171 – Solvent Cleaning Operations (amended 5/1/2009) – This rule applies to all persons who use solvent materials in solvent cleaning operations during the production, repair, maintenance, or servicing of parts, products, tools, machinery, equipment, or general work areas; all persons who store and dispose of these materials used in solvent cleaning operations; and all solvent suppliers who supply, sell, or offer for sale solvent cleaning materials for use in solvent cleaning operations. A person shall not use a solvent to perform solvent cleaning operations unless the solvent complies with the requirements from paragraph (c)(1) below:

Solvent Cleaning Activity	VOC Limits g/L (lb/gal)
(A) Product Cleaning During Manufacturing Process or Surface Preparation For Coating, Adhesive, or Ink Application	
(i) General	25 (0.21)
(ii) Electrical Apparatus Components & Electronic Components	100 (0.83)
(iii) Medical Devices & Pharmaceuticals	800 (6.7)
(B) Repair and Maintenance Cleaning	
(i) General	25 (0.21)
(ii) Electrical Apparatus Components & Electronic Components	100 (0.83)
(iii) Medical Devices & Pharmaceuticals	
(A) Tools, Equipment, & Machinery	800 (6.7)
(B) General Work Surfaces	600 (5.0)
(C) Cleaning of Coatings or Adhesives Application Equipment	25 (0.21)
(D) Cleaning of Ink Application Equipment	
(i) General	25 (0.21)
(ii) Flexographic Printing	25 (0.21)
(iii) Gravure Printing	
(A) Publication	100 (0.83)
(B) Packaging	25 (0.21)
(iv) Lithographic (Offset) or Letter Press Printing	
(A) Roller Wash, Blanket Wash, & On-Press Components	100 (0.83)
(B) Removable Press Components	25 (0.21)
(v) Screen Printing	100 (0.83)
(vi) Ultraviolet Ink/ Electron Beam Ink Application Equipment (except screen printing)	100 (0.83)
(vii) Specialty Flexographic Printing	100 (0.83)
(E) Cleaning of Polyester Resin Application Equipment	25 (0.21)

Section (g)(2) provides that the following solvent cleaning operations or activities are not subject to any provision of this rule (emphasis added to applicable sections in **bold** below):

(A) Cleaning carried out in batch loaded cold cleaners, vapor degreasers, conveyorized degreasers, or motion picture film cleaning equipment.
(B) Cleaning operations subject to Rule 1102 – Petroleum Solvent Dry Cleaners, and Rule 1421 – Control of Perchloroethylene Emissions from Dry Cleaning Operations.
(C) Cleaning operations subject to Rule 1164 – Semiconductor Manufacturing.
(D) Cleaning operations subject to Rule 1124 – Aerospace Assembly and Component Manufacturing Operations, except coating application equipment cleaning, and storage and disposal of VOC containing materials used in solvent cleaning operations.
(E) Cleaning operations subject to Rule 1141 – Control of Volatile Organic Compound Emissions from Resin Manufacturing, and Rule 1141.1 – Coatings and Ink Manufacturing.
(F) Janitorial cleaning, including graffiti removal.
(G) Stripping of cured coatings, cured ink, or cured adhesives.

Section (g)(4) provides that cleaning with aerosol products shall not be subject to the VOC limits in paragraph (c)(1) and the general prohibition in paragraph (d)(1) if 160 fluid ounces or less of non-compliant aerosol products are used per day, per facility. The use of such product shall comply with CARB regulations.

Therefore, the VOC limits in paragraph (c)(1) and general prohibition in paragraph (d)(1) do not apply to the proposed solvent cleaning operations for wipe cleaning of electronic components using aerosol solvents. This rule does not apply to the proposed solvent cleaning operations for removing cured adhesives.

San Diego County APCD

BACT: Source: NSR Requirements for BACT (dated 6/2011)

There are no BACT standards published in the clearinghouse for this category, based on the following search keywords: “solvent cleaning,” “solvent wipe cleaning,” and “adhesive removal.”

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

RULE REQUIREMENTS:
Regulation II, Rule 11 – Exemptions from Rule 10 Permit Requirements (revised adopted July 8, 2020) – This rule exempts the following from the requirements of Rule 10 – Permits Required (emphasis added to applicable sections in **bold** below):

Section (16) SOLVENT APPLICATION EQUIPMENT AND OPERATIONS:
- (ix) Surface preparation or solvent cleaning, including wipe cleaning:
  - (A) for quality control or quality assurance purposes, or
  - (B) **using non-refillable handheld aerosol spray containers,** or
  - (C) for routine janitorial maintenance, including graffiti removal or
  - (D) performed in conjunction with welding of 5XXX series aluminum structures for Navy ships and in accordance with quality assurance standards for such structures, or

(E) not associated with any permitted operation, provided:
(1) the cleaning materials have a VOC content of 25 grams per liter (0.21 lbs/gal), or less, as used, or
(2) **the uncontrolled VOC emissions from all such cleaning operations located at the stationary source do not exceed 3,650 pounds per consecutive 12-months**, or the total purchase or usage of solvents for such cleaning operations does not exceed 550 gallons per consecutive 12-months. The volume of materials applied from operations specified in Subsections (d)(16)(ix)(A) through (E)(1) above shall not be included when determining the applicability of this exemption. All data and/or records necessary to demonstrate that this exemption is applicable shall be maintained on-site for three years and made available to the District upon request.

Therefore, this rule does not apply to the proposed solvent cleaning operations for wipe cleaning using aerosol solvents or to the source when emitting uncontrolled VOC emissions from all cleaning operations at less than 3,650 pounds per consecutive 12 months.

Regulation IV, Rule 66.1 – Miscellaneous Surface Coating Operations and Other Process Emitting Volatile Organic Components (adopted and effective 5/11/2016) – This rule shall not apply to the following from Section (b)(1) (emphasis added to applicable sections in **bold** below):

(i) Surface coatings, surface preparation or solvent cleaning materials applied using hand-held non-refillable aerosol spray containers.
(ii) Any surface coating operation where 20 gallons or less of surface coatings are applied per consecutive 12-month period. To claim applicability of this exemption monthly coating usage records shall be maintained on site for three years and made available to the District upon request.
(iii) Any surface coating or other VOC emitting operation where the total VOC emissions, excluding emissions from cleaning or surface preparation materials, are 150 lbs or less per consecutive 12-month period. To claim applicability of this exemption all records necessary to calculate VOC emissions shall be maintained on site for three years and made available to the District upon request.
(iv) The use of pesticides, including insecticides, rodenticides or herbicides.
(v) Research and development operations or testing for quality control or quality assurance purposes.
(vi) Operations involved in the manufacture of biotechnology pharmaceutical and bio-agricultural products that are exempt from the District permit to operate requirements by Rule 11, Section (d).
(vii) Laboratory operations located at secondary schools, colleges, or universities and used exclusively for instruction.
(viii) Touch-up operations.
(ix) Stripping of cured inks, coatings and adhesives.
(x) Digital printing operations.
(xi) Any solvent cleaning, including wipe cleaning, or surface preparation of electrical or electronic components, medical devices, laser optics or precision optics components.
(xii) Surface preparation or solvent cleaning, including wipe cleaning, for quality control or quality assurance purposes.
(xiii) Surface preparation or solvent cleaning, including wipe cleaning, for routine janitorial maintenance, including graffiti removal.

(xiv) Any solvent cleaning, including wipe cleaning, performed in conjunction with welding of 5XXX series aluminum structures for Navy ships and in accordance with quality assurance standards for such structures.

The VOC limits of Subsection (d)(2) and the recordkeeping requirements of Section (f) shall not apply to the following from Section (b)(2)(iii):
Any surface preparation or solvent cleaning, including wipe cleaning, not associated with a coating operation, where the combined total amount of cleaning materials used at the stationary source does not exceed 550 gallons per consecutive 12 months or **the total VOC emissions from all such cleaning materials used at the stationary source do not exceed 3,650 lbs per consecutive 12 months.**

Section (d) requires that a person shall not conduct a surface preparation or solvent cleaning operation, including wipe cleaning but excluding cleaning of coating application equipment, unless:
(i) the total VOC vapor pressure of cleaning material is 8 mm Hg at 20oC (68°F) or less, or
(ii) for Aerospace Components, not associated with a surface coating operation, 45 mm Hg at 20°C (68°F) or less; or

(iii) the VOC content of cleaning material complies with the following limits expressed as either grams of VOC per liter of material (g/L) or pounds of VOC per gallon of material (lb/gal), as used:

Category	VOC Limits	
	g/L	lb/gal
General	50	0.42
Aerospace Components	200	1.7
Ultra-High Purity Chemical Manufacturing	840	7.0

Therefore, this rule does not apply to the proposed solvent cleaning operations for wipe cleaning of electronic components using aerosol solvents or when removing cured adhesives. Additionally, the VOC limits and recordkeeping requirements of this rule do not apply to non-coating operation solvent cleaning operations where the total VOC emissions from all such cleaning operations are less than 3,650 pounds per consecutive 12 months.

Bay Area AQMD

BACT: Source: BAAQMD BACT Guideline

Document # 179B.1 – Wipe Cleaning Operation (2/4/1993)	
VOC	1. Wipe cleaning in a hood, booth, or room vented to a control device, with emissions controlled to overall capture/destruction efficiency >90% (Technologically Feasible/Cost Effective) (A) 2. Minimizing use of solvents; and use of lowest practical vapor pressure solvents; and use of controlled flow solvent dispenser (e.g., squeeze bottle); and all cloths/papers and solvents not in active use kept in closed containers (Achieved in Practice) (B)
NOx	N/A – No standard
SOx	N/A – No standard
PM10	N/A – No standard
PM2.5	N/A – No standard
CO	N/A – No standard

(A) Typical technology to meet this BACT is a collection system vented to a carbon adsorber or afterburner.
(B) Typical technology to meet this BACT is good operating practice.

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

RULE REQUIREMENTS:

Regulation 8 – Organic Compounds, Rule 4 – General Solvent and Surface Coating Operations (revised 4/24/2018) – This rule limits the emissions of volatile organic compounds from the use of solvents and surface coatings in any operation other than those specified by other Rules of this Regulation 8. The provisions of this Rule shall apply, but are not limited to, model making, printed circuit board manufacturing and assembly, electrical and electronic component manufacturing, surface coating of test panels, training facilities where the application of coating is for training purposes, stencil coatings, low usage coating activities exempt from other Regulation 8 Rules, coatings specifically exempt from other Regulation 8 Rules or solvent usage not specified by other Regulation 8 Rules. The following applicable sections of the rule were reviewed (emphasis added to applicable sections in **bold** below):

Section 8-4-116 specifies a limited exemption whereby the surface preparation standards in Section 8-4-313 shall not apply to (i) the surface preparation of electrical and electronic components, precision optics, or numismatic dies; (ii) stripping of cured inks, coatings and adhesives or cleaning of resin, coating, ink and adhesive mixing, molding and application equipment; or, (iii) surface preparation associated with research and development operations; medical device or pharmaceutical manufacturing operations; performance testing to determine coating, adhesive or ink performance; or testing for quality control or quality assurance purposes.

Section 8-4-313 prohibits using a solvent with a VOC content that exceeds 50 g/l (0.42 lbs/gal), as applied, for surface preparation in any operation subject to this rule unless emissions to the atmosphere are controlled to an equivalent level by an approved emission control system with an overall abatement efficiency of at least 85 percent.

Section 8-4-222 defines electrical and electronic components as components and assemblies of components that generate, convert, transmit, or modify electrical energy. Electrical and electronic components include, but are not limited to, wires, windings, stators, rotors, magnets, contacts, relays, printed circuit boards, printed wire assemblies, wiring boards, integrated circuits, resistors, capacitors and transistors. Cabinets in which electrical and electronic components are housed are not considered electrical and electronic components.

Section 8-4-302 requires that a person shall not use solvents or apply surface coatings unless one or more of the following requirements are satisfied:

Section 302.1: A person shall not emit more than 4,533 kg (5 tons) of volatile organic compounds (VOC) from any source during any calendar year; or

Section 302.2: Emissions are controlled by an approved emission control system with an overall abatement efficiency of 85% on a mass basis. If reduction is achieved by incineration, at least 90% by weight of the organic compound emissions shall be oxidized to carbon dioxide; or

Section 302.3: The coating operation uses a coating with a VOC content less than or equal to 420 grams per liter (3.5 lb/gal) of coating as applied.

Section 8-4-312 requires that unless emissions to the atmosphere are controlled by an approved emission control system with an overall abatement efficiency of at least 85%, any person using organic solvent for surface preparation and cleanup or any person mixing, using or disposing of organic solvent:

Section 312.1: Shall use closed containers for the storage or disposal of cloth or paper used for solvent surface preparation and cleanup.

Section 312.2: Shall not use organic solvent for the cleanup of spray equipment, including paint lines, with a VOC content in excess of 50 g/l (0.42 lb/gal) unless either, (i) solvent is pressurized though spray equipment with atomizing air off or dispensed from a small non-atomizing container, and collected and stored in a closed container until recycled or properly disposed of offsite, or (ii) a spray gun washer subject to and in compliance with the requirements of Regulation 8, Rule 16 is used.

Section 312.3: Shall close containers of solvent or coating when not in use.

Therefore, the surface preparation standards in Section 8-4-313 of this rule do not apply to the surface preparation of electrical and electronic components.

Regulation 8 – Organic Compounds, Rule 16 – Solvent Cleaning Operations (revised 4/24/2018) – This rule limits the emissions from solvent cleaning operations, defined as any process, including wipe cleaning, used to clean or dry metal and non-metal surfaces typically using a cold, vapor or conveyorized solvent cleaner.

The following applicable section of the rule was reviewed (emphasis added to applicable sections in **bold** below):

Section 8-16-111 provides an exemption from the requirements of Section 8-16-301 through 304 (for vapor solvent cleaners, conveyorized solvent cleaners, and cold cleaners, and for compliance with the NESHAP for Halogenated Solvent Cleaners) for any solvent cleaning operation using only wipe cleaning. In addition to any VOC limitations in other Regulation 8 rules, **wipe cleaning is subject to the requirements of Section 8-16-501.3 (recordkeeping)**, and may be subject to VOC limitations in other Regulation 8 rules.

Therefore, except for the recordkeeping requirements in Section 8-16-501.3, this rule does not apply to the proposed solvent cleaning operations for wipe cleaning of electronic components.

San Joaquin Valley APCD

BACT: Source: SJVAPCD BACT Clearinghouse (Searchable)

SJVUAPCD BACT Guideline 4.10.5 (5/28/20) – Medical Grade Silicon Products – Wipe Cleaning Operations		
Pollutant	Achieved in Practice or in the SIP	Technologically Feasible
VOC	Use of solvents with VOC content (less water and exempt compounds) of 7.2 lb/gal, or lower, and evaporative minimization methods, which include: - use of controlled flow dispensers (e.g. squeeze bottles) and - keeping all cloth/papers and solvent, which are not in active use, stored in closed containers	1. Capture and control using an enclosed booth and thermal/catalytic oxidation system 2. Capture and control using a hood and thermal/catalytic oxidation system
NOx	No Standard	No Standard
SOx	No Standard	No Standard
PM10	No Standard	No Standard
PM2.5	No Standard	No Standard
CO	No Standard	No Standard

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

RULE REQUIREMENTS:
Rule 4663 - Organic Solvent Cleaning, Storage and Disposal (amended 9/20/2007) – This rule applies to any organic solvent cleaning performed outside a degreaser during the production, repair, maintenance, or servicing of parts, products, tools, machinery, equipment, or in general work areas at stationary sources, and applies to the storage and disposal of all solvents and waste solvent materials at stationary sources.

The following applicable sections of the rule were reviewed (emphasis added to applicable sections in **bold** below):

Section 4.2 exempts stripping of cured coatings, cured adhesives, and cured inks, except the stripping of such materials from spray application equipment, **from the provisions of this rule.**

Except for the records required in Section 6.2.4, Section 4.4 exempts the provisions of Section 5.1 (requirements) from applying to an operator using 55 gallons or less of organic solvent products in all source operations subject to Rule 4663 in a stationary source, in any rolling, consecutive 365-day period.

Section 4.8 provides that cleaning with aerosol products shall not be subject to the VOC content limits of Table 1 and the work practices of Section 5.2.2 if 160 fluid ounces or less of non-compliant aerosol products are used per day, per facility. The use of such product shall comply with ARB regulations.

Section 5.1 requires that organic solvents used for cleaning operations shall not exceed the VOC content limits specified in Table 1 below:

Table 1 – Organic Solvent VOC Content Limits:

Type of Solvent Cleaning Operation	Effective on and after September 21, 2008 VOC Content Limit Grams of VOC/liter of material (lb/gal)
A. Product Cleaning During Manufacturing Process or Surface Preparation for Coating Adhesive, or Ink Application	
1. General	25 (0.21)
2. Electrical Apparatus Components and Electronic Components	100 (0.84)
3. Medical Devices and Pharmaceuticals	800 (6.7)
B. Repair and Maintenance Cleaning	
1. General	25 (0.21)
2. Electrical Apparatus Components and Electronic Components	100 (0.84)
3. Medical Devices and Pharmaceuticals	
3.1 Tools, Equipment, and Machinery	800 (6.7)
3.2 General Work Surfaces	600 (5.0)
C. Cleaning of Coating or Adhesive Application Equipment	25 (0.21)

Section 5.2.3 specifies that an operator performing cleaning operations from Table 1 (other than Category A.1, Category B.1 or Category C) and using solvent with VOC content greater than 25 g/L shall meet the requirements of Sections 5.2.5 through 5.2.7 in addition to meeting the applicable VOC content limits of Table 1.

Cleaning activities that use solvents shall be performed by one or more of the following methods:

Section 5.2.5.1: Wipe cleaning; or

Section 5.2.5.2: Application of solvent from hand-held spray bottles from which solvents are dispensed without a propellant-induced force; or

Section 5.2.5.3: Non-atomized solvent flow method in which the cleaning solvent is collected in a container or a collection system which is closed except for solvent collection openings and, if necessary, openings to avoid excessive pressure build-up inside the container; or

Section 5.2.5.4: Solvent flushing method in which the cleaning solvent is discharged into a container that is closed except for solvent collection openings and, if necessary, openings to avoid excessive pressure build-up inside the container. The discharged solvent from the equipment must be collected into containers without atomizing into the open air. The solvent may be flushed through the system by air or hydraulic pressure, or by pumping.

Section 5.2.6 specifies that solvent shall not be atomized into the open air unless it is vented to a VOC emission control system. This provision shall not apply to the cleaning of nozzle tips of automated spray equipment systems, except for robotic systems, and cleaning with spray bottles or containers described in Section 5.2.5.2.

Section 5.2.7 specifies that an operator shall not use VOC-containing materials to clean spray equipment used for the application of coatings, adhesives, or ink, unless an enclosed system or equipment that is proven to be equally effective at controlling emissions is used for cleaning. If an enclosed system is used, it must totally enclose spray guns, cups, nozzles, bowls, and other parts during washing, rinsing and draining procedures, and it must be used according to the manufacturer's recommendations and must be closed when not in use.

Therefore, this rule does not apply to the proposed solvent cleaning operations for removing cured adhesives. The VOC content limits of Table 1 do not apply to the proposed solvent cleaning operations for wipe cleaning of electronic components using aerosol solvents or to the source when using 55 gallons or less of organic solvent products in all source operations in a stationary source, in any rolling, consecutive 365-day period.

Placer County APCD

BACT: Source: ARB BACT Clearinghouse

There are no BACT standards published in the clearinghouse for this category, based on the following search keywords: "solvent cleaning," "solvent wipe cleaning," and "adhesive removal."

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

RULE REQUIREMENTS:

Regulation XI, Rule 1171 – Solvent Cleaning Operations (amended 5/1/2009) – This rule applies to all persons who engage in the production, repair, maintenance, or servicing of parts, products, tools, machinery, or equipment, and storage and disposal of VOC-containing materials used in solvent cleaning operations (emphasis added to applicable sections in **bold** below).

Section 104.4.2 provides exemption from the provisions of this rule, except for the recordkeeping requirements in Sections 501.1, 501.3.1, and 502, for cleaning with aerosol, provided that 160 fluid ounces or less of aerosol product are used per day, per stationary source with solvents that contain more than 50 g/L VOC as applied including water and exempt compounds.

Section 301.2 requires that the VOC content of solvents used for the following activities shall not exceed the following limits:

Solvent Cleaning Activity	VOC Content g/l (lb/gal)
General (wipe cleaning, maintenance cleaning)	50 (0.42)
Product Cleaning During Manufacturing Process or Surface Preparation for Coating, Adhesive, Sealants, or Ink Application	
General	50 (0.42)
Electrical Apparatus Components and Electronic Components	500 (4.2)
Medical Devices and Pharmaceuticals	800 (6.7)
Repair and maintenance cleaning	
General	50 (0.42)
Electrical Apparatus Components and Electronic Components	**900 (7.5)**
Medical Devices and Pharmaceuticals	
General Work Surfaces	600 (5.0)
Tools, Equipment, and Machinery	800 (6.7)
Platelets	800 (6.7)
Architectural Coating Application Equipment	
Water based Coatings	50 (0.42)
Solvent based Coatings – Jobsite and No Enclosed Gun Cleaner	300 (2.5)

Therefore, except for the recordkeeping requirements in Sections 501.1, 501.3.1, and 502, this rule does not apply to the proposed solvent cleaning operations for wipe cleaning of electronic components using aerosol solvents. For the proposed solvent cleaning operations for wipe cleaning of electronic components when removing cured adhesives, the VOC content limit for repair and maintenance cleaning – electrical apparatus components and electronic components applies.

Summary of Achieved in Practice Control Technologies:
The following control technologies have been identified and are ranked based on stringency:

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES	
VOC	1. 7.9 lb/hour and 39.7 lb/day [SMAQMD] 2. 900 g/L (7.5 lb/gal) [PCAPCD] 3. No standard (A) [SMAQMD, SCAQMD, SJVAPCD, PCAPCD] 4. No standard (B) [SDCAPCD] 5. No standard (C) [SMAQMD, SCAQMD, SJVAPCD] 6. No standard (D) [SDCAPCD, BAAQMD] 7. No standard (E) [SDCAPCD] 8. No standard (F) [SDCAPCD] 9. No standard (G) [SJVAPCD]

(A) Provided the source performs solvent cleaning using aerosol solvents at 160 fluid ounces or less per day per stationary source.
(B) Provided the source performs solvent cleaning using hand-held non-refillable aerosol spray containers.
(C) Provided the source performs solvent cleaning for removing cured adhesives.
(D) Provided the source performs solvent cleaning or surface preparation on electrical or electronic components.
(E) Provided the source performs wipe cleaning for quality control or quality assurance purposes.
(F) Provided the source performs solvent cleaning where the combined total amount of cleaning materials used at the stationary source does not exceed 550 gallons per consecutive 12 months or the total VOC emissions from all such cleaning materials used at the stationary source do not exceed 3,650 pounds per consecutive 12 months.
(G) Provided the source uses 55 gallons or less of organic solvent products in all source operations in a stationary source, in any rolling, consecutive 365-day period.

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

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
VOC	7.9 lb/hour and 39.7 lb/day	SMAQMD

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	1. Collection system vented to thermal oxidizer 2. Collection system vented to catalytic oxidizer 3. Collection system vented to carbon adsorber 4. Using low VOC solvents

The following control technologies are not considered to be technologically feasible for VOC:

Low VOC Solvents:
Not technologically feasible, since low VOC solvents contain more water which causes damage to the internal components of the electrical components being cleaned. Various solvents with water content had been tested, but none where found which could comply with SMAQAMD Rule 466 VOC content limits (100 g/L or 0.83 lb/gal for electrical apparatus components and electronic components) and also not cause damage to the electrical components being cleaned.

After eliminating the technologically infeasible option of low VOC solvents above, collection systems vented to a thermal oxidizer, catalytic oxidizer, and carbon adsorption system were identified as technologically feasible alternatives.

Cost Effectiveness Determination:
After identifying the technologically feasible alternatives, a cost analysis is performed to take into consideration economic impacts for all technologically feasible controls identified. A control technology is considered to be cost-effective if the cost of controlling one ton of that air pollutant is less than the limits specified below (except coating operations):

Pollutant	Maximum Cost ($/ton)
ROG	17,500
NOx	24,500
PM10	11,400
SOx	18,300
CO	TBD if BACT triggered

All possible control technologies would require a collection system (such as a hood, enclosed booth, or enclosed room). As proposed, both Pegatron Technology Service Inc. and Apple Inc. perform their solvent cleaning operations amongst numerous open workstations located throughout their respective warehouses. The following exhaust flow rates were estimated for each company, for use in cost effectiveness comparison calculations:

Pegatron Technology Service Inc.:
Total Exhaust Flow Rate from Building: 9,000 cfm (provided by applicant)

Apple Inc. Building 1:
Number of Workstations: 57 stations
Assumed Canopy Hood Size: 1 ft x 1 ft = 1 ft^2 per workstation
Exhaust Flow Rate per Canopy Hood: 200 ft/min x 1 ft^2 = 200 cfm (as per EPA/452/B-02-001, Table 1.2)
Total Estimated Exhaust Flow Rate: 200 cfm x 57 hoods = 11,400 cfm (Building 1)

Apple Inc. Building 2:
Number of Workstations: 11 stations
Assumed Canopy Hood Size: 1 ft x 1 ft = 1 ft^2 per workstation
Exhaust Flow Rate per Canopy Hood: 200 ft/min x 1 ft^2 = 200 cfm (as per EPA/452/B-02-001, Table 1.2)
Total Estimated Exhaust Flow Rate: 200 cfm x 11 hoods = 2,200 cfm

Based on the above, the lowest exhaust flow rate of 2,200 cfm was selected to be used in the cost effectiveness calculations to represent the worst case scenario.

Recuperative Thermal Oxidizer Cost Effectiveness Analysis

As shown in Attachment B, the cost effectiveness for the add-on recuperative thermal oxidizer to control VOC was calculated to be $104,671.49 per ton (see Attachment B – Recuperative Thermal Oxidizer Cost Effectiveness Analysis). The following basic parameters were used in the analysis.

Exhaust Gas Flow Rate	= 2,200 scfm
VOC Control Level	= 99%
VOC Baseline Level	= 2.67 tons VOC/year
Equipment Life	= 20 years
Total Capital Investment	= $189,695
Direct Annual Cost	= $240,908
Indirect Annual Cost	= $35,861
Total Annual Cost	= $276,769
VOC Removed	= 2.64 tons
Cost of VOC Removal	**= $104,671.49 per ton reduced**

Since this exceeds the $17,500 per ton cost effectiveness threshold for VOC, the add-on recuperative thermal oxidizer is considered not cost effective and is eliminated.

Catalytic Oxidizer Cost Effectiveness Analysis

As shown in Attachment C, the cost effectiveness for the add-on catalytic oxidizer to control VOC was calculated to be $62,584.58 per ton (see Attachment C – Catalytic Oxidizer Cost Effectiveness Analysis). The following basic parameters were used in the analysis.

Exhaust Gas Flow Rate	= 2,200 scfm
VOC Control Level	= 99%
VOC Baseline Level	= 2.67 tons VOC/year
Equipment Life	= 20 years
Total Capital Investment	= $224,207
Direct Annual Cost	= $125,951
Indirect Annual Cost	= $39,533
Total Annual Cost	= $165,484
VOC Removed	= 2.64 tons
Cost of VOC Removal	**= $62,584.58 per ton reduced**

Since this exceeds the $17,500 per ton cost effectiveness threshold for VOC, the add-on catalytic oxidizer is considered not cost effective and is eliminated.

Carbon Adsorber Cost Effectiveness Analysis

As shown in Attachment D, the cost effectiveness for the add-on carbon adsorber to control VOC was calculated to be $24,391.42 per ton (see Attachment D – Carbon Adsorber Cost Effectiveness Analysis). The following basic parameters were used in the analysis.

Exhaust Gas Flow Rate	= 2,200 scfm
VOC Control Level	= 98%
VOC Baseline Level	= 2.67 tons VOC/year
Equipment Life	= 15 years
Total Capital Investment	= $153,300
Direct Annual Cost	= $29,241
Indirect Annual Cost	= $36,206
Total Annual Cost	= $63,723
VOC Removed	= 2.61 tons
Cost of VOC Removal	**= $24,391.42 per ton reduced**

Since this exceeds the $17,500 per ton cost effectiveness threshold for VOC, the add-on carbon adsorber is considered not cost effective and is eliminated.

C. SELECTION OF BACT:

Based on the above analysis, BACT for VOC for solvent cleaning operations, specifically wipe cleaning of electronic components using ≤ 160 fluid ounces of aerosol solvents per day per stationary source and/or when removing cured adhesives, is listed below:

BACT FOR SOLVENT CLEANING OPERATIONS FOR ELECTRONIC COMPONENTS		
Pollutant	**Standard**	**Source**
VOC	7.9 lb/hour and 39.7 lb/day	SMAQMD

D. SELECTION OF T-BACT:

There are no Federal NSPS's, NESHAP's nor State ATCM's for this source category. None of the sources surveyed have any toxic T-BACT determinations published. Therefore, T-BACT standards will be considered as meeting the BACT standards identified above.

APPROVED BY: *Brian Krebs* **DATE:** **04-13-2021**

Attachment A

Review of BACT Determinations published by EPA

List of applicable BACT determinations published in EPA's RBLC Clearinghouse:

Process Code 49.008 – Organic Solvent Cleaning & Degreasing, except Halogenated Solvent Cleaners								
Description and Capacity	**RBLC ID**	**Date**	**Case-By-Case Basis**	**VOC**	**NOx**	**SOx**	**PM10/2.5**	**CO**
Auto Body Shop – Body Wipe Cleaning Process	MI-0444	08/26/2019	LAER	17.1000 tons/year over 12-month rolling time period, using high transfer efficiency application	N/A	N/A	N/A	N/A
Flexographic Printing Facility – Plate Making System, Parts Cleaner, Solvent Recovery System	IL-0127	10/05/2018	BACT-PSD	98.0000% control over rolling 3-hour average, using permanent total enclosure, regenerative thermal oxidizer, work practices	N/A	N/A	N/A	N/A
Liquid Crystal Module (LCM) Assembly Plant – Fugitive Wipe Cleaning Operations for Flat Panel Displays	WI-0283	04/24/2018	BACT-PSD	0.25 lb/gal for industrial cleaning operations, using cleaning product containing 97% water + 3% butane	N/A	N/A	N/A	N/A
Light-Duty Truck Manufacturing Plant – Body Wipe Cleaning Process	MI-0428, MI-0422	11/02/2017, 10/20/2016	BACT-PSD	82.6000 tons/year over 12-month rolling time period, using high transfer efficiency application method, low VOC coating materials, RTO and purge solvent recovery system	N/A	N/A	N/A	N/A
Process Code 49.999 – Other Organic Evaporative Loss Sources								
Description and Capacity	**RBLC ID**	**Date**	**Case-By-Case Basis**	**VOC**	**NOx**	**SOx**	**PM10/2.5**	**CO**
Stationary Automotive Components Manufacturing Plant – Machining and Washing Process, 4.10 gallons of solvent per hour	IN-0306	10/24/2015	OTHER	4.1600 lb/hour, using thermal oxidizer	N/A	N/A	N/A	N/A

= Excluded from the scope of this determination according to the following criteria: not wipe cleaning of electronic components, not adhesive removal from electronic components, high water content, or determinations made on a basis other than BACT.

Attachment B

Recuperative Thermal Oxidizer Cost Effectiveness Analysis

Cost Estimate

Direct Costs			
Total Purchased equipment costs (in 2018 dollars)			
Incinerator + auxiliary equipment[a] (A) = Equipment Costs (EC) for Recuperative Thermal Oxidizer	= (10,294 x Qtot^(0.2355))x (2018 CEPI/1999 CEPCI) =	$92,496	in 2018 dollars
Instrumentation[b] =	0.10 × A =	$9,250	
Sales taxes =	0.03 × A =	$2,775	
Freight =	0.05 × A =	$4,625	
	Total Purchased equipment costs (B) =	$109,146	in 2018 dollars

Footnotes

a - Auxiliary equipment includes equipment (e.g., duct work) normally not included with unit furnished by incinerator vendor.

b - Includes the instrumentation and controls furnished by the incinerator vendor.

Direct Installation Costs (in 2018 dollars)			
Foundations and Supports =	0.08 × B =	$8,732	
Handling and Erection =	0.14 × B =	$15,280	
Electrical =	0.04 × B =	$4,366	
Piping =	0.02 × B =	$2,183	
Insulation for Ductwork =	0.01 × B =	$1,091	
Painting =	0.01 × B =	$1,091	
Site Preparation (SP) =		$0	
Buildings (Bldg) =		$0	
	Total Direct Installation Costs =	$32,744	
Total Direct Costs (DC) =	Total Purchase Equipment Costs (B) + Total Direct Installation Costs =	$141,890	in 2018 dollars

Total Indirect Installation Costs (in 2018 dollars)			
Engineering =	0.10 × B =	$10,915	
Construction and field expenses =	0.05 × B =	$5,457	
Contractor fees =	0.10 × B =	$10,915	
Start-up =	0.02 × B =	$2,183	
Performance test =	0.01 × B =	$1,091	
	Total Indirect Costs (IC) =	$30,561	
Continency Cost (C) =	CF(IC+DC)=	$17,245	
Total Capital Investment =	**DC + IC +C =**	**$189,695**	**in 2018 dollars**

Direct Annual Costs

Annual Electricity Cost	= Fan Power Consumption × Operating Hours/year × Electricity Price =	$1,148
Annual Fuel Costs for Natural Gas	= $Cost_{fuel}$ × Fuel Usage Rate × 60 min/hr × Operating hours/year	$213,889
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$8,061
	Supervisor = 15% of Operator	$1,209
Maintenance Costs	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$8,300
	Materials = 100% of maintenance labor	$8,300

Direct Annual Costs (DC) = $240,908 in 2018 dollars

Indirect Annual Costs

Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	$15,523
Administrative Charges	= 2% of TCI	$3,794
Property Taxes	= 1% of TCI	$1,897
Insurance	= 1% of TCI	$1,897
Capital Recovery	= CRF x TCI	$12,751

Indirect Annual Costs (IC) = $35,861 in 2018 dollars

Total Annual Cost = DC + IC = $276,769 in 2018 dollars

Cost Effectiveness

Cost Effectiveness = (Total Annual Cost)/(Annual Quantity of VOC/HAP Pollutants Destroyed)

Total Annual Cost (TAC) =	$276,769	per year in 2018 dollars
VOC/HAP Pollutants Destroyed =	2.64	tons/year
Cost Effectiveness =	**$104,671.49**	**per ton of pollutants removed in 2018 dollars**

Attachment C

Catalytic Oxidizer Cost Effectiveness Analysis

Cost Estimate

Direct Costs			
Total Purchased equipment costs (in 2018 dollars)			
Incinerator + auxiliary equipment[a] (A) = Equipment Costs (EC) for a Fixed Bed Catalytic Oxidizer	= (1,105 x Qtot ^(0.5471)) x (2018 CEPI/1999 CEPCI) =	$109,325	in 2018 dollars
Instrumentation[b] =	0.10 × A =	$10,932	
Sales taxes =	0.03 × A =	$3,280	
Freight =	0.05 × A =	$5,466	
	Total Purchased equipment costs (B) =	$129,003	in 2018 dollars

Footnotes

a - Auxiliary equipment includes equipment (e.g., duct work) normally not included with unit furnished by incinerator vendor.

b - Includes the instrumentation and controls furnished by the incinerator vendor.

Direct Installation Costs (in 2018 dollars)			
Foundations and Supports =	0.08 × B =	$10,320	
Handling and Erection =	0.14 × B =	$18,060	
Electrical =	0.04 × B =	$5,160	
Piping =	0.02 × B =	$2,580	
Insulation for Ductwork =	0.01 × B =	$1,290	
Painting =	0.01 × B =	$1,290	
Site Preparation (SP) =		$0	
Buildings (Bldg) =		$0	
	Total Direct Installation Costs =	$38,701	
Total Direct Costs (DC) =	Total Purchase Equipment Costs (B) + Total Direct Installation Costs =	$167,704	in 2018 dollars

Total Indirect Installation Costs (in 2018 dollars)			
Engineering =	0.10 × B =	$12,900	
Construction and field expenses =	0.05 × B =	$6,450	
Contractor fees =	0.10 × B =	$12,900	
Start-up =	0.02 × B =	$2,580	
Performance test =	0.01 × B =	$1,290	
	Total Indirect Costs (IC) =	$36,121	
Continency Cost (C) =	CF(IC+DC)=	$20,382	
Total Capital Investment =	**DC + IC +C =**	**$224,207**	**in 2018 dollars**

Direct Annual Costs			
Catalyst Replacement Cost	= 1.08 × CC × Vol_{cat} × FWF Where CC is the $/ft^3 cost for the replacement catalyst; Vol_{cat} is the volume of catalyst required based on the waste gas flow rate (Q_{ft}) and the catalyst space velocity (Φ); and FWF is the future worth factor.	$392	
Annual Electricity Cost	= Fan Power Consumption × Operating Hours/year × Electricity Price =	$1,722	
Annual Fuel Costs for Natural Gas	= $Cost_{fuel}$ × Fuel Usage Rate × 60 min/hr × Operating hours/year	$97,967	
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$8,061	
	Supervisor = 15% of Operator Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$1,209	
Maintenance Costs	Materials = 100% of maintenance labor	$8,300	
		$8,300	
Direct Annual Costs (DC) =		**$125,951**	**in 2018 dollars**

Indirect Annual Costs			
Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	$15,523	
Administrative Charges	= 2% of TCI	$4,484	
Property Taxes	= 1% of TCI	$2,242	
Insurance	= 1% of TCI	$2,242	
Capital Recovery	= CRF[TCI-1.08(cat. Cost)]	$15,042	
Indirect Annual Costs (IC) =		**$39,533**	**in 2018 dollars**

Total Annual Cost =	**DC + IC =**	**$165,484**	**in 2018 dollars**

Cost Effectiveness

Cost Effectiveness = (Total Annual Cost)/(Annual Quantity of VOC/HAP Pollutants Destroyed)

Total Annual Cost (TAC) =	$165,484	per year in 2018 dollars
VOC/HAP Pollutants Destroyed =	2.64	tons/year
Cost Effectiveness =	**$62,584.58**	**per ton of pollutants removed in 2018 dollars**

Attachment D

Carbon Adsorber Cost Effectiveness Analysis

Cost Estimate

Capital Costs

Estimated capital costs for a Fixed-Bed Carbon Adsorber with Steam Regeneration with the following characteristics:

VOC Controlled/Recovered =	Acetone
Adsorber Vessel Orientation =	Horizontal
Operating Schedule =	Continuous Operation

Total Capital Investment (TCI) (in 2018 dollars)

Parameter	Equation	Cost
Costs for Each Carbon Adsorber Vessel (C_v) =	$271 \times F_m \times S^{0.778}$ =	$7,911
Total Cost for All Carbon Adsorber Vessels and Carbon(EC_{Adsorb}) =	$5.82 \times Q^{-0.133} \times [C_c + (N_A + N_D) \times C_v]$ =	$52,335
Auxiliary Equipment (EC_{aux}) =	(Based on design costs or estimated using methods provided in Section 2)	$32,000
Total Purchased Equipment Costs for Carbon Adsorber (A) =	= $EC_{Adsorb} + EC_{aux}$ =	$84,335
Instrumentation =	0.10 × A =	Included in A
Sales taxes =	0.03 × A =	$2,530
Freight =	0.05 × A =	$4,217
Total Purchased Equipment Costs (B) =		$91,082

Direct Installation Costs (in 2018 dollars)

Parameter	Equation	Cost
Foundations and Supports =	0.08 × B =	$7,287
Handling and Erection =	0.14 × B =	$12,751
Electrical =	0.04 × B =	$3,643
Piping =	0.02 × B =	$1,822
Insulation =	0.01 × B =	$911
Painting =	0.01 × B =	$911
Site Preparation (SP) =		$0
Buildings (Bldg) =		$0
Total Direct Costs (DC) =	B + (0.3 × B) + SP + Bldg =	$118,406

Total Indirect Installation Costs (in 2018 dollars)			
Parameter	**Equation**	**Cost**	
Engineering =	0.10 × B =	$9,108	
Construction and field expenses =	0.05 × B =	$4,554	
Contractor fees =	0.10 × B =	$9,108	
Start-up =	0.02 × B =	$1,822	
Performance test =	0.01 × B =	$911	
	Total Indirect Costs (IC) =	$25,503	
Contingency Cost (C) =	CF(IC+DC)=	$14,391	
Total Capital Investment (TCI) =	**DC + IC + C = (1.28 × B) + SP + Bldg. + C =**	**$158,300**	**in 2018 dollars**

Annual Costs

Direct Annual Costs			
Parameter	**Equation**	**Cost**	
Annual Electricity Cost =	$Q_{Elec} \times P_{elec}$ =	$721	
Annual Steam Cost (C_s) =	3.50 x m_{voc} x Θ_s x P_s =	$93	
Annual Cooling Water Cost (C_{cs}) =	3.43 x C_s/P_s x P_{wc} =	$227	
Operating Labor Costs:	Operator = 0.5 hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$8,325	
	Supervisor = 15% of Operator	$1,249	
Maintenance Costs:	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$9,158	
	Materials = 100% of maintenance labor	$9,158	
Carbon Replacement Costs:	Labor = CRF_{carbon} x (Labor Rate × M_c)/CRR =	$5	
	Carbon = CRF_{carbon} x CC x M_c x 1.08 =	$305	
Direct Annual Costs (DAC) =		**$29,241**	**in 2018 dollars**

Indirect Annual Costs			
Parameter	**Equation**	**Cost**	
Overhead	= 60% of sum of operator, supervisor, maintenance labor Plus maintenance materials	$16,733	

Administrative Charges	= 2% of TCI	$3,166	
Property Taxes	= 1% of TCI	$1,583	
Insurance	= 1% of TCI	$1,583	
Capital Recovery	= $CRF_{Adsorber}$ × (TCI - [(1.08 x CC x M_c) + (LR x M_c/CRR)] =	$13,141	
Indirect Annual Costs (IAC) =		**$36,206**	**in 2018 dollars**

Recovered Solvent Credit/Disposal Costs

Disposal Cost

Parameter	**Equation**	**Cost**	
VOC Disposal/Treatment Costs (*$Disposal_{cost}$*)	= m_{voc} x Θ_s x D_{voc} x E =	$0	

VOC Recovery Credit

Parameter	**Equation**	**Cost**	
Annual Recovery Credit for Condensate (RC)	= m_{voc} × Θ_s x P_{voc} x E =	$1,724	
Total Annual Cost (TAC) =	**DAC + IAC + C + $Disposal_{Cost}$ - RC =**	**$63,723**	**in 2018 dollars**

Cost Effectiveness

Cost Effectiveness

Parameter	**Equation**	**Cost**	
Total Annual Cost =	TAC =	$63,723	per year in 2018 dollars
Annual Quantity of VOC Removed/Recovered =	$W_{voc} = m_{voc}$ x Θ_s x E =	2.61	tons/year
Cost Effectiveness =	**Total Annual Cost (TAC) / Annual Quantity of VOC Removed/Recovered =**	**$24,391.42**	**per ton of pollutants removed/recovered in 2018 dollars**