SMAQMD BACT CLEARINGHOUSE

ACTIVE

CATEGORY Type: **PRINTING PROCESS**

BACT Category: Minor Source BACT

BACT Determination Number: 374	**BACT Determination Date:** 8/19/2024

Equipment Information

Permit Number: 27942
Equipment Description: DIGITAL PRINTING
Unit Size/Rating/Capacity: < 9,500 LB UNCONTROLLED VOC PER YEAR
Equipment Location: AMERICAN LITHOGRAPHERS DBA- PACIFIC STANDARD PRESS
1281 W. NATIONAL DR SACRAMENTO, CA

BACT Determination Information

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

ROCs	**Standard:**	80% Control
	Technology Description:	1.Integral air pollution control system, consisting of an oil/water separator and refrigerated condenser, with an assumed control efficiency of 80%(A) or equivalent system. 2.Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning.
	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: T-BACT:
1.A VOC control device that has an overall system efficiency (collection and destruction) of at least 98.5% for VOC.
2.Use of materials compliant with SMAQMD Rule 466 - Solvent Cleaning.
3.Comply with VOC emission standards of SMAQMD Rule 441 - Organic Solvents

Printed: 8/19/2024

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BACT Category: Minor Source BACT

BACT Determination Number: 375	**BACT Determination Date:** 8/19/2024

Equipment Information

Permit Number: 27942
Equipment Description: DIGITAL PRINTING
Unit Size/Rating/Capacity: ≥ 9,500 LB UNCONTROLLED VOC PER YEAR
Equipment Location: AMERICAN LITHOGRAPHERS DBA- PACIFIC STANDARD PRESS
1281 W. NATIONAL DR SACRAMENTO, CA

BACT Determination Information

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

ROCs	**Standard:**	98.5% Control
	Technology Description:	1.A VOC control device that has an overall system efficiency (collection and destruction) of at least 98.5% for VOC. 2.Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning.
	Basis:	Cost Effective
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: T-BACT:
1.A VOC control device that has an overall system efficiency (collection and destruction) of at least 98.5% for VOC.
2.Use of materials compliant with SMAQMD Rule 466 - Solvent Cleaning.
3.Comply with VOC emission standards of SMAQMD Rule 441 - Organic Solvents

Printed: 8/19/2024

777 12th Street, Ste. 300 SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT Sacramento, CA 95814

BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

DETERMINATION NO.:	374 & 375
DATE:	07/16/24
ENGINEER:	Matt Baldwin
Category/General Equip Description:	Printing Process
BACT Category:	Minor Source BACT / Non-major modification at a Major Source.
Equipment Specific Description:	Digital Printing / Liquid Electrophotography
Equipment Size/Rating:	< 9,500 lb VOC/year (BACT #374), and ≥ 9,500 lb VOC/year (BACT #375)
Previous BACT Det. No.:	263 & 264

This Best Available Control Technology (BACT) determination category was determined under the project for A/C 27942 (Pacific Standard Print). The applicant proposed to install a new digital printing press (liquid electrophotography).

This BACT determination will update determinations #263 & #264 for digital printing – liquid electrophotography.

BACT / T-BACT ANALYSIS

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

The following control technologies are currently employed as BACT/T-BACT for a digital printing press (liquid electrophotography) by the following agencies and air pollution control and air quality management districts:

US EPA

BACT
Source: EPA RACT/BACT/LAER Clearinghouse

Digital Printing – Liquid Electrophotography	
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

US EPA (continued)

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

RULE REQUIREMENTS:
40 CFR Part 63 Subpart KK – National Emission Standards for the Printing and Publishing Industry. This regulation applies to new and existing facilities that are a major source of hazardous air pollutants at which publication rotogravure, product and packaging rotogravure, or wide-web flexographic printing presses are operated.

Since liquid electrophotography does not qualify as publication rotogravure, product and packaging rotogravure, or wide-web flexographic printing presses, this rule will not generally be considered T-BACT for this source category. However, for projects that include digital printing as well as one of the affected printing processes, compliance with 40 CFR, 63, Subpart KK will be considered technologically feasible T-BACT for the project.

California Air Resources Board (CARB)

BACT
Source: CARB BACT Clearinghouse

The only BACT determination published in the clearinghouse is SMAQMD BACT Determination Nos. 263, which is discussed in the next section.

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

RULE REQUIREMENTS
There are no regulations with standards for this source category.

Sacramento Metropolitan AQMD

BACT
Source: SMAQMD BACT Determination No. 263
(Adopted 09/22/2020)

Digital Printing – Liquid Electrophotography < 12,667 lb Uncontrolled VOC Per Year	
VOC	1. Integral air pollution control system, consisting of an oil/water separator and refrigerated condenser, with an assumed control efficiency of 80%(A) or equivalent system. 2. Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning. 3. Comply with VOC emission standards of SMAQMD Rule 441 – Organic Solvents.
NOx	No Standard
SOx	No Standard
PM10	No Standard

Sacramento Metropolitan AQMD (continued)

Digital Printing – Liquid Electrophotography < 12,667 lb Uncontrolled VOC Per Year	
PM2.5	No Standard
CO	No Standard

T-BACT

Digital Printing – Liquid Electrophotography < 12,667 lb Uncontrolled VOC Per Year	
Organic HAP / VHAP	1. Integral air pollution control system, consisting of an oil/water separator and refrigerated condenser, with an assumed control efficiency of 80%(A) or equivalent system. 2. Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning. 3. Comply with VOC emission standards of SMAQMD Rule 441 – Organic Solvents.

RULE REQUIREMENTS

Rule 450 – Graphic Arts Operations (Amended 10/23/2008)

This rule applies to graphic arts operations. Graphic arts operations are defined as any gravure, screen printing, flexographic, lithographic, or letterpress printing operation, or any coating or laminating operation that manufactures flexible packaging material for the packing industry. Liquid electrophotography does not meet this definition and therefore this rule does not apply.

Rule 466 – Solvent Cleaning (Amended 10/28/2010)

This rule applies to all persons who use VOC-containing materials in solvent cleaning operations during the production, repair, maintenance or servicing of parts, products, tools, machinery, or equipment, or in general work areas, and to all persons who store and dispose of VOC-containing materials used in solvent cleaning.

Solvent Cleaning Activity	VOC limits g/l (lb/gal)
(A) General (wipe cleaning, maintenance cleaning)	25 (0.21)
(B) 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)
(C) Repair and Maintenance Cleaning	VOC limits g/l (lb/gal)
(i) General	25 (0.21)
(ii) Electrical apparatus components & electronic components	100 (0.83)

Sacramento Metropolitan AQMD (continued)

Rule 441 – Organic Solvents (Adopted 12/6/1978)
This rule limits the emissions of organic solvents into the atmosphere that may result from the use of organic solvents.

Material	Hourly Emission Limit kg/hr (lbs/hr)	Daily Emission Limit kg/day (lbs/day)
Organic Materials which come into contact with a flame or is baked, heat-cured or heat-polymerized, in the presence of oxygen	1.4 (3.1) or 85% control	6.8 (15) or 85% control
Photochemically Reactive Solvents	3.6 (7.9) or 85% control	18 (39.7) or 85% control
Non-photochemically reactive solvents	200 (441) or 85% control	1,350 (2,970) or 85% control

South Coast AQMD

BACT
Source: SCAQMD Evaluation A/N 562397 (See Appendix B)

Digital Printing – Liquid Electrophotography	
VOC	Integral air pollution control system, consisting of an oil/water separator and a refrigeration condenser.
NOx	No Standard
SOx	No Standard
PM10	No Standard
PM2.5	No Standard
CO	No Standard

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

RULE REQUIREMENTS

Reg. XI, Rule 1130 – Graphic Arts (Amended 05/02/2014)

This rule applies to any person performing graphic arts operations or who supplies, sells, offers for sale, markets, manufactures, blends, repackages, stores at a worksite, distributes, applies or solicits the application of graphic arts materials for use in the SCAQMD. Graphics arts operations are defined as gravure, letterpress, flexographic, and offset lithographic printing processes or related coating or laminating processes. Liquid electrophotography does not meet this definition and therefore this rule does not apply.

South Coast AQMD (continued)

Reg. XI, Rule 1171 – Solvent Cleaning Operations (Last 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.

This rule does not apply to cleaning operations in printing pre-press or graphic arts pre-press areas, including the cleaning of film processors, color scanners, plate processors, film cleaning, and plate cleaning.

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)
(C) Cleaning of coatings or adhesives application equipment	25 (0.1)
(D) Cleaning of Ink Application Equipment	
(i) General	25 (0.1)

San Joaquin Valley APCD

BACT
Source: SJVAPCD BACT Clearinghouse (Chapter 4.0 Evaporative Loss Sources)

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

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

San Joaquin Valley APCD (continued)

RULE REQUIREMENTS:

Rule 4607 Graphic Arts and Paper, Film, Foil and Fabric Coatings (Amended 12/18/2008)

This rule applies to any graphics arts printing operation, to digital printing operations, and to any paper, film, foil, or fabric coating operation and to the organic solvent cleaning materials and processes associated with such operations.

According to Section 4.0, the requirements of this rule, except for the record keeping requirements of Section 6.1, shall not apply to digital printers and digital printing operations.

Rule 4663 Organic Solvent Cleaning, Storage, and Disposal (Amended 9/20/2007)

The purpose of this rule is to limit the emissions of volatile organic compounds (VOCs) from organic solvent cleaning and from the storage and disposal of solvents and waste solvent materials.

This rule exempts any source that is subject to or specifically exempted from the Rules listed in Section 4.3. Section 4.3 lists Rule 4607 (Graphic Arts). Therefore, digital printing is exempt from Rule 4663 Organic Solvent Cleaning, Storage, and Disposal.

San Diego County APCD

BACT
Source: NSR Requirements for BACT

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

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

RULE REQUIREMENTS

Reg. IV, Rule 67.16 – Graphic Arts Operations (Effective 5/9/2012)

This rule applies to all continuous web or single sheet fed graphic arts printing, processing, laminating or drying operations and digital printing operations. This rule has an exemption for digital printing operations. Digital printing operations are exempt from provisions of this rule. However, digital printing operations that meet the definition of a “Large digital printing operation” are required to maintain records. Large digital printing operation is defined as a commercial digital printing operation where a print capacity of any individual printer that uses solvent based inks is 1,000 ft^2/hr or higher; or an operation where a print capacity of any individual printer that uses water based or UV inks is 10,000 ft^2/hr or higher.

Standards
For Large Commercial Digital Printing Operations

1. Maintain a current list of graphic arts materials and cleaning materials used.
2. Provide documentation containing the VOC content, less water, and exempt compounds of each graphic arts material (excluding thinner), as applied and VOC content of each

San Diego APCD (continued)

thinner and cleaning material and/or total VOC vapor pressure, as used.

3. Keep monthly records of the type and amount of graphic arts material cleaning material used.

Reg. IV, Rule 66.1 Miscellaneous Surface Coating Operations and Other Processes Emitting Volatile Organic Compounds (Adopted 2/24/10)

This rule is applicable to all surface coating, solvent cleaning or other operations or processes that may result in emissions of VOCs and are not subject to or exempt from, the following rule (see Rule 66.1 for full list).

Exemptions
This rule does not apply to digital printing operations [Section(b)(1)(X)].

Bay Area AQMD

BACT

Source: BAAQMD Application # 28111 (See Appendix C)

Digital Printing - Liquid Electrophotography	
VOC	Collect and control emissions with an overall emission rate equivalent to 2.5 lb/gal
NOx	No Standard
SOx	No Standard
PM10	No Standard
PM2.5	No Standard
CO	No Standard

T-BACT

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

RULE REQUIREMENTS

Reg. 8, Rule 20 Graphic Arts Printing and Coating Operations (Amended 11/19/2008)

This rule applies to graphic arts operations which is defined as a gravure, publication gravure, flexographic printing, digital printing, screen printing, letterpress, or lithographic printing operation; an associated coating, laminating, or adhesive operation to produce a printed product; and the use of solvents for any surface preparation or cleanup for any of the operations stated above.

However, Section 8-20-120, provides a limited exemption for Digital Printing from the flexographic, gravure, publication gravure, letterpress, and lithographic product limit requirements (Section 8-20-302) and the cleaning product requirements (Section 8-20-309) of this rule.

Bay Area AQMD (continued)

Solvent Evaporative Loss Minimization: Pursuant to Section 8-20-320, the requirements of this Section shall apply to the use of solvent for surface preparation and cleanup and to the use, mixing, storage, and disposal of ink, coating or adhesive:

1. An owner or operator shall not use open containers for the storage or disposal of cloth or paper impregnated with organic compounds that are used for surface preparation, cleanup or ink, coating or adhesive removal.
2. An owner or operator shall not store in open containers spent or fresh organic compounds used for surface preparation, cleanup or removal of inks, coatings, or adhesives.
3. An owner or operator shall not leave containers of ink, coating, adhesive or fountain solution open when not in use.

Reg. 8, Rule 4 General Solvent and Surface Coating Operations (Amended 10/16/2002)

This rule applies to the use of solvents and surface coatings in any operation other than those specified by other Rules of Regulation 8. Digital printing is regulated by Reg. 8 Rule 20 Graphics Art Printing. Therefore, Digital printing would be exempt from the requirements of this rule.

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	
Pollutant	**Standard**
VOC (A)	For Printing Operations: 1. Integral air pollution control system, consisting of an oil/water separator and refrigerated condenser, with an assumed control efficiency of 80%(A), comply with SMAQMD Rule 466 and 441. [SMAQMD] 2. Integral air pollution control system, consisting of an oil/water separator and refrigerated condenser, with an assumed control efficiency of 80%(A) [SCAQMD] 3. Collect and control equipment with an overall emission rate equivalent to 2.5 lb/gal [BAAQMD] 4. Comply with VOC emission standards of SCAQMD Rule 1171. [SCAQMD] 5. Comply with VOC emission standards BAAQMD Regulation 8, Rule 20, Sections 8-20-320 and 8-20-308. [BAAQMD] For Organic Solvent Operations: Comply with VOC emission standards of SMAQMD Rule 441. [SMAQMD]
NOx	No standard
SOx	No standard
PM10	No standard
PM2.5	No standard
CO	No standard
T-BACT	Same as achieved in practice BACT for VOC.

(A) A control efficiency of 80% is based on EPA's Air Pollution Control Cost Manual for Refrigerated Condensers, pg. 2-15 (https://www3.epa.gov/ttn/catc/dir1/cs3-1ch2.pdf).

Summary of Achieved in Practice Control Technologies (continued)

An integral air pollution control system consisting of an oil/water separator and refrigeration condenser is considered the most stringent control. Both SCAQMD and BAAQMD performed an evaluation on HP Indigo model printers which use the integral air pollution control system. SCAQMD determined that the control system is considered BACT while BAAQMD considers BACT to be an overall emission control system equivalent to less than 2.5 lb/gal. In BAAQMD's evaluation the integral air pollution system was calculated to have an overall emission control system equivalent to 0.55 lb/gal (see Appendix C). Since there is limited test data on these control systems, a standard percent control will be reevaluated as more systems and more test data become available. For now, an estimation of 80% for control efficiency will be used based on EPA's Air Pollution Control Cost Manual for Refrigerated Condensers.

Digital printing is exempt from all districts' graphic art rules and only requires record keeping for solvent and ink/coating usage. However, the digital printing operations would still be subject to solvent cleaning rules of SCAQMD, SMAQMD, and BAAQMD. The emission limits for solvent cleaning activities related to digital printing are consistent across SCAQMD Rule 1171 and SMAQMD Rule 466. Although the emission limits for solvent cleaning are the same for SCAQMD and SMAQMD Rules, the SCAQMD Rule exempts printing pre-press or graphic arts pre-press areas from the solvent cleaning limits and SMAQMD does not. Therefore, SMAQMD's rule is considered more stringent than SCAQMD's Rule. BAAQMD's solvent cleaning rule is less stringent with a surface preparation solvent VOC limit of 50 g/l (0.42 lbs/gal) compared to SCAQMD & SMAQMD general solvent cleaning VOC limit of 25 g/l (0.21 lbs/gal).

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

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
VOC	1. Integral air pollution control system, consisting of an oil/water separator and refrigerated condenser, with an assumed control efficiency of 80%(A) or equivalent system. 2. Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning. 3. Comply with VOC emission standards of SMAQMD Rule 441 – Organic Solvents.	SMAQMD
NOx	No standard	EPA, ARB, SMAQMD, SCAQMD, SJVAPCD, SDAPCD, BAAQMD
SOx	No standard	
PM10	No standard	
PM2.5	No standard	
CO	No standard	
T-BACT	Same as BACT for VOC	SMAQMD

(A) A control efficiency of 80% is based on EPA's Air Pollution Control Cost Manual for Refrigerated Condensers, pg. 2-15 (https://www3.epa.gov/ttn/catc/dir1/cs3-1ch2.pdf). This assumed control efficiency is subject to change as more test data becomes available.

Summary of Achieved in Practice Control Technologies (continued)

SMAQMD Rule 441 Emission Limits		
Material	Hourly Emission Limit kg/hr (lb/hr)	Daily Emission Limit kg/day (lb/day)
Organic Materials which come into contact with a flame or is baked, heat-cured or heat-polymerized, in the presence of oxygen	1.4 (3.1)	6.8 (15)
Photochemically Reactive Solvents	3.6 (7.9)	18 (39.7)
Non-photochemically reactive solvents	200 (441)	1,350 (2,970)

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.

Low VOC Ink Discussion

The BAAQMD released the Bay Area 2010 Clean Air Plan and discussed possible control techniques. The plan discussed the possibility of low-VOC inks but found that currently, no low-VOC inks are available. The BAAQMD states that "Lower VOC inks may be able to be developed, although the necessary properties of inks for some types of digital printing may preclude low-VOC formulations." Therefore, low-VOC inks are currently not technologically feasible.

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	Source
VOC	VOC control device with 98.5% overall system efficiency(A)	SMAQMD
NOx	No other technologically feasible option identified	EPA, ARB, SMAQMD, SCAQMD, SJVAPCD, SDAPCD, BAAQMD
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	

(A) An overall system efficiency of 98.5% is based on technologies such as carbon adsorbers and thermal oxidizers.

Cost Effective Determination:

After identifying the technologically feasible control options, a cost analysis is performed to take into consideration economic impacts for all technologically feasible controls identified.

Maximum Cost per Ton of Air Pollutants Controlled

A control technology is considered cost-effective if the cost of controlling one ton of that air pollutant is less than the limits specified below:

Pollutant	Maximum Cost ($/ton) (A)
NOx	36,700
VOC	26,300
CO	300
SOx	18,300
PM10 / PM2.5	11,400

(A) Cost effectiveness thresholds effective as of July 1, 2024.

Cost Effectiveness Analysis Summary

A previous general cost effectiveness analysis determined that 12,667 lb VOC/year was the highest allowable uncontrolled emission rate that did not require any add-on control devices. (SMAQMD BACT Determination No. 264, Appendix A). However, no digital printers permitted by SMAQMD have been required to install add-on controls since none of the digital printers have emissions greater than 12,667 lb VOC/year. HP Inc., Indigo Division (HP Indigo) had previously submitted vendor data for control costs of a digital printer to show that the cost effectiveness threshold of 8,683 lb VOC/year limit under BACT Determination No. 180 should be higher due to vendor cost quotes being higher than the EPA Cost Manual estimations. This BACT determination will continue to use the submitted vendor cost data.

The cost analysis was processed in accordance with the EPA OAQPS Air Pollution Control Cost Manual (sixth Edition) with the following assumptions:

- The sales tax rate was based on the SMAQMD standard rate of 8.5% as approved by the district on 10/17/16.
- The electricity rate (13.8 cents/kWh) was based on the commercial rates as approved by the SMAQMD on 10/17/16.
- The life of the equipment was based on the EPA cost manual recommendation.
- The interest rate was based on the previous 6-month average interest rate on United States Treasury Securities (based on the life of the equipment) and addition of two percentage points and rounding up to the next higher integer rate.
- The labor (Occupation Code 51-8099: Plant and System Operators) rate was based on data from the Bureau of Labor Statistics.

Other Basic assumptions:

- Single digital printing press.
- Press room dimensions: 40’W x 60’L x 20’H (because the press room is relatively small, a hood or smaller full enclosure is not necessary)
- The press room is assumed to be the enclosure with a collection efficiency of 100%, venting through a general ventilation system to a control device capable of achieving a 98.5% control efficiency. Therefore, the carbon adsorption system will have an over-all collection/control efficiency of 98.5%. This is similar to the collection/control efficiency listed as technologically feasible in the BAAQMD BACT Guideline 83.1.
- Cost calculations and assumptions are based on the EPA Air Pollution Control Cost Manual.

Carbon Adsorption System

Waste Gas Flow Rate	=	8,000 acfm (10 air changes per hour)
Equipment Life	=	10 years
Total Capital Investment	=	$554,802
Direct Annual Cost	=	$19,673 per year
Indirect Annual Cost	=	$106,576 per year
Total Annual Cost	=	$123,161 per year
VOC Removed	=	4.679 tons per year
Cost of VOC Removal	=	$26,324 per ton reduced

A detailed calculation of the cost effectiveness for VOC removal with a carbon absorber is shown in Appendix C. Uncontrolled VOC emissions of 9,500 lb/year or greater is the cost-effective threshold for control equipment using carbon absorption control technology.

Thermal Oxidizer:

Waste Gas Flow Rate	=	20,000 acfm (EPA Recommended Value)
Equipment Life	=	20 years
Total Capital Investment	=	$11,673,216
Direct Annual Cost	=	$74,122 per year
Indirect Annual Cost	=	$226,309 per year
Total Annual Cost	=	$300,431 per year
VOC Removed	=	11.42 tons per year
Cost of VOC Removal	=	$26,301 per ton reduced

A detailed calculation of the cost effectiveness for VOC removal with a thermal oxidizer is shown in Appendix E. Uncontrolled VOC emissions of 22,840 lb/year or greater is the cost-effective threshold for control equipment using thermal oxidation control technology.

Conclusion: As shown in the above, an uncontrolled VOC emission level of 9,500 lb per year or greater must be reached for a carbon absorption system option to be considered cost effective. An uncontrolled VOC emission level of 22,840 lb per year or greater must be reached for a thermal oxidizer to be considered cost effective.

Thus, the emissions level for which add-on controls are considered cost effective is 9,500 lb per year for VOC.

C. SELECTION OF BACT:

Based on the review of SMAQMD, SCAQMD, SDCAPCD, BAAQMD, SJVAPCD, SBCAPCD, ARB, and EPA BACT Clearinghouses and cost effectiveness determinations, BACT for VOC, NOx, SOx, PM10, PM2.5, and CO will be the following:

TABLE 1: BACT #374 FOR DIGITAL PRINTING – LIQUID ELECTROPHOTOGRAPHY < 9,500 LBS UNCONTROLLED VOC PER YEAR		
Pollutant	**Standard**	**Source**
VOC	1. Integral air pollution control system, consisting of an oil/water separator and refrigerated condenser, with an assumed control efficiency of 80%(A) or equivalent system. 2. Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning. 3. Comply with VOC emission standards of SMAQMD Rule 441 – Organic Solvents.	SMAQMD
NOx	No standard	EPA, ARB, SMAQMD, SCAQMD, SJVAPCD, SDAPCD, BAAQMD
SOx	No standard	
PM10	No standard	
PM2.5	No standard	
CO	No standard	

(A) A control efficiency of 80% is based on EPA's Air Pollution Control Cost Manual for Refrigerated Condensers, pg. 2-15 (https://www3.epa.gov/ttn/catc/dir1/cs3-1ch2.pdf). This assumed control efficiency is subject to change as more test data becomes available.

TABLE 2: BACT #375 FOR DIGITAL PRINTING – LIQUID ELECTROPHOTOGRAPHY ≥ 9,500 LBS UNCONTROLLED VOC PER YEAR		
Pollutant	**Standard**	**Source**
VOC	1. A VOC control device that has an overall system efficiency (collection and destruction) of at least 98.5% for VOC. 2. Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning. 3. Comply with VOC emission standards of SMAQMD Rule 441 – Organic Solvents.	SMAQMD, BAAQMD
NOx	No standard	EPA, ARB, SMAQMD, SCAQMD, SJVAPCD, SDAPCD, BAAQMD
SOx	No standard	
PM10	No standard	
PM2.5	No standard	
CO	No standard	

D. SELECTION OF T-BACT:

As previously established under BACT Determination Nos. 263 & 264, T-BACT will be compliance with BACT for VOCs with add on control. For projects also involving publication rotogravure presses, product and packaging rotogravure presses, or wide-web flexographic printing presses, T-BACT will be determined on a case-by-case basis:

T-BACT FOR DIGITAL PRINTING – LIQUID ELECTROPHOTOGRAPHY		
Pollutant	**Standard**	**Source**
Organic HAP/VHAP	1. A VOC control device that has an overall system efficiency (collection and destruction) of at least 98.5% for VOC. 2. Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning. 3. Comply with VOC emission standards of SMAQMD Rule 441 – Organic Solvents.	SMAQMD

APPROVED BY: *Brian F Krebs* **DATE:** 08-19-2024

Appendix A

BACT Determinations Published by Air District Clearinghouses

EXPIRED SMAQMD BACT CLEARINGHOUSE

CATEGORY Type: **PRINTING PROCESS**

BACT Size: MINOR SOURCE BACT

BACT Determination Number:	263	**BACT Determination Date:**	**9/22/2020**

Equipment Information

Permit Number: N/A – Generic BACT Determination
Equipment Description: PRINTING PRESS - DIGITAL PRINTER
Unit Size/Rating/Capacity: < 12,667 lbs uncontrolled VOC
Equipment Location:

BACT Determination Information

District Contact: Jeff Quok Phone No.: (279) 207-1145 email: jquok@airquality.org

ROCs	**Standard:**	
	Technology Description:	1.Integral air pollution control system, consisting of an oil/water separator and refrigerated condenser, with an assumed control efficiency of 80%(A) or equivalent system. 2.Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning.
	Basis:	Achieved in Practice
NOx	**Standard:**	
	Technology Description:	No Standard
	Basis:	
SOx	**Standard:**	
	Technology Description:	No Standard
	Basis:	
PM10	**Standard:**	
	Technology Description:	No Standard
	Basis:	
PM2.5	**Standard:**	
	Technology Description:	No Standard
	Basis:	
CO	**Standard:**	
	Technology Description:	No Standard
	Basis:	
LEAD	**Standard:**	
	Technology Description:	No Standard
	Basis:	

Comments: T-BACT:
1. A VOC control device that has an overall system efficiency (collection and destruction) of at least 98.5% for VOC.
2. Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning.
3. Comply with VOC emission standards of SMAQMD Rule 441 – Organic Solvents.

EXPIRED SMAQMD BACT CLEARINGHOUSE

CATEGORY Type: **PRINTING PROCESS**

BACT Size: MINOR SOURCE BACT

BACT Determination Number:	264	**BACT Determination Date:**	**9/22/2020**

Equipment Information

Permit Number: N/A – Generic BACT Determination
Equipment Description: PRINTING PRESS - DIGITAL PRINTER
Unit Size/Rating/Capacity: ≥ 12,667 LBS UNCONTROLLED VOC PER YEAR
Equipment Location:

BACT Determination Information

District Contact: Jeff Quok Phone No.: (279) 207-1145 email: jquok@airquality.org

ROCs	**Standard:**	
	Technology Description:	1. A VOC control device that has an overall system efficiency (collection and destruction) of at least 98.5% for VOC. 2. Use of materials compliant with SMAQMD Rule 466 – Solvent Cleaning. 3. Comply with VOC emission standards of SMAQMD Rule 441 – Organic Solvents.
	Basis:	Cost Effective
NOx	**Standard:**	
	Technology Description:	No Standard
	Basis:	
SOx	**Standard:**	
	Technology Description:	No Standard
	Basis:	
PM10	**Standard:**	
	Technology Description:	No Standard
	Basis:	
PM2.5	**Standard:**	
	Technology Description:	No Standard
	Basis:	
CO	**Standard:**	
	Technology Description:	No Standard
	Basis:	
LEAD	**Standard:**	
	Technology Description:	No Standard
	Basis:	

Comments: T-BACT is equivalent to BACT

Appendix B

SCAQMD Evaluation A/N 2562397

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

ENGINEERING AND COMPLIANCE OFFICE

APPLICATION PROCESSING AND CALCULATIONS

Pages 6	Page 1
A/N SEE BELOW	Date 7-31-15
Processed by RNL	Checked by

PO no PC

Digital Printing Press

Legal Owner or Operator: SOUTHERN CALIFORNIA GRAPHICS
8432 STELLER DR
CULVER CITY, CA 90232-2489

ID 62280

Equipment Location: SAME AS ABOVE

Equipment Description:

A/N 562397 (PO no PC, previously R219 Exempt)

Digital Laser Offset Printing, Hewlett Packard, Model HP Indigo 10000, S/N I15000132, 6-Color Units, 21.5-Inch Sheet Width.

History

The company is currently operating two sheet-fed IR-dried lithographic printing presses with a facility limit of 2038 pounds VOC per month per facility. The company has also accepted a 10-ton per year limit of VOC to be excluded from the Title V program.

In this project, the company is adding a laser offset printer as described above. This printer was installed in 2012 and had been operated under Rule 219 exemption status for low usages of VOC materials. The company is expecting higher usages, which will not be qualified for the Rule 219 exemption.

Based on the District compliance database, the facility has been operating at the above facility without creating any public nuisance and without receiving any NC or NOV.

Process Description

The company prints reports, inserts, magazines, brochures, and other printed items, using lithographic and digital printing technology. The following are its normal and maximum operating schedules:

	Hr/dy	dy/wk	wk/yr
Normal	24	7	52
Maximum	24	7	52

In this project, a new type of offsetting printing technology by HP is proposed. In the HP Indigo printing process, a laser beam creates an image on a smooth surface plate (called a PIP). Then, proprietary HP ink (called ElectroInk) adheres to the plate. Then,

the wet image is transferred to a heated blanket, before being printed on a final substrate

This added offset step enhances the creation of high image resolution, much better than conventional direct laser printing, since normal paper surfaces are either just too porous, too rough or too glossy, not an ideal surface for a high resolution image that a laser beam is capable to produce on a PIP. In addition, special ElectroInk, that is semi-transparent, can be used to adapt to different final substrate surfaces, forming as an intermediary base layer, to be followed by final printing layers. As a result, indigo printing output is much closer in appearance to conventional offset lithography.

The ElectroInk is currently not regulated, not subject to Rule 1130. However, these inks contain above 5 pounds of VOC per gallon. With high usage throughputs, VOC emissions above the Rule 219 exemption thresholds, 3 pounds per day or 66 pounds per calendar month, are expected from each printing unit. Therefore, each printing unit is then subject to Rule 201 and 203. In this project, the equipment was already installed and initially operated with low usage throughputs below Rule 219 exemption.

Emission Calculations

The emission sources are primarily organic solvents contained in ElectroInks and thinners (called imaging oil). The applicant estimates an average and maximum daily usage of 2.5 and 3.75 gallons respectively of ElectroInks and 0.5 and 0.75 gallons respectively of an imaging oil. ElectroInks contain a maximum VOC of 5.39 pounds per gallon. The imaging oil contains 6.34 pound of VOC per gallon. The following are the estimate VOC emissions from this printer:

MAXIMUM VOC (R1=R2) = (6.34X0.75)+(5.39X3.75) lbs/day = 24.97 lbs/day

AVERAGE VOC (R1=R2) = (6.34X0.5)+(5.39X2.5) lbs/day = 16.65 lbs/day

The following are AEI and NSR entries for this project:

AEIS:

VOC (R1=R2) = 16.65/24 lbs/hr = 0.69 lbs/hr

NSR:

VOC (R1=R2) = 24.97/24 lbs/hr = 1.04 lbs/hr

Please note that since the company proposes to bubble the above emissions into the monthly limit of 2038 pounds of ROG, the 30-DA in NSR is manually set to zero.

BACT Evaluation

The proposed equipment is equipped with an integral air pollution control (APC) system, consisting of an oil/water separator and a refrigeration condenser.

Spent water from the press contains a small amount of imaging oil. The built-in separator separates the imaging oil from spent water. The recycled water is safe and legal to discharge in the city waste water stream. The recycled oil is being re-used in the press.

VOC emissions from the use of imaging oil in this press are captured and passing through a built-in refrigeration condenser. The condensed VOC is being re-used in the press without the need to constantly adding imaging oil as compared to older models of laser offset printing presses manufactured by HP.

The equipment, including the press and the built-in APC, is not vented outside the building. The APC is working in a closed-loop system, without any stack opening. Fugitive emissions from the equipment are negligible, without creating any odors around the equipment.

The built-in APC system is therefore considered BACT to control VOC emissions from this type of digital printing press.

Rule Evaluation

Rule 212(c)(1): This section requires a public notice for all new or modified permit units that may emit air contaminants located within 1,000 feet from the outer boundary of a school.

A Rule 212(c) (1) notice will be triggered since there is a school within 1,000 ft from the facility.

Rule 212(c)(2): This section requires a public notice for all new or modified facilities that have on-site emission increases exceeding any of the daily maximums as specified by Rule 212(g).

The proposed project results in no net emission increases facility-wide. Therefore, a Rule 212(c)(2) public notice will not be triggered.

Rule 212(c)(3): This section requires a public notice for all new or modified permit unit with increases in emissions of toxic air contaminants listed in Table I of Rule 1401 resulted in MICR greater than 1E-6 per permit unit or greater than 10E-6 per facility.

The proposed project does not result in any emission increases of TACs. A Rule 212(c)(3) public notice will not be triggered.

Rule 212(g): This section requires a public notice for all new or modified sources that have equipment emission increases exceeding any of the daily maximums as specified by Rule 212(g).

The proposed project results in emission increases of VOC emissions. The proposed condition No. 8 limits the monthly emissions from all digital printing operations to less than 833 pounds per month, equivalent to less than 30 pounds of VOC per day. Therefore, a Rule 212(g) public notice will not be triggered.

Rule 401: Visible emissions are not expected with the proper operation of the equipment.

Rule 402: Nuisance is not expected with the proper operation of the equipment. There is no complaint history for this company at this location based on the District computer database.

Rule 442: All VOC emissions from digital printing operations at this facility shall be conditioned to a maximum limit of not more 833 pounds per month, in compliance with Rule 442 (Condition No. 8).

Rule 1130: Graphic art materials as defined in Rule 1130 are not used in the proposed digital printer. Therefore, this project is not subject to Rule 1130 requirements.

Rule 1171: VOC-containing materials are not used for cleaning in the proposed project. Therefore, this project is expected to be in compliance with Rule 1171 requirements.

Rule 1401: Based on the supplied MSDS, ElectroInks and image oil do not contain any Rule 1401 TACs. Therefore, compliance with this rule is expected.

Recommendation

The proposed project is expected to comply with all applicable District Rules and Regulations. Approval of a permit to operate with the following conditions is recommended:

1. Operation of this equipment shall be conducted in accordance with all data and specifications submitted with the application under which this permit is issued unless otherwise noted below.

2. This equipment shall be properly maintained and kept in good operating condition at al times.

3. This equipment shall be operated in compliance with Rules 442 and 1171.

4. The owner/operator shall maintain all press doors in the closed position at all times when the press is operating. The owner/operator shall only open the doors to change consumables, repair paper jams, or conduct urgent maintenance. Once the doors opened, the press shall be automatically shut down.

5. The owner/operator shall operate the integral VOC recovery systems of the press at all times in accordance with the HP Indigo owner's manual.

6. The owner/operator shall not leave containers of ElectroInk, Imaging Oil, or any other VOC-containing materials open when not in use.

7. The owner/operator shall store all ElectroInk, Imaging Oil, and any other VOC-containing materials in vapor tight containers.

8. Materials used in this equipment shall not contain any toxic air contaminants identified in Rule 1401, Table 1 with an effective date of September 10, 2010 or earlier.

9. The total quantity of volatile organic compounds (VOC) emissions released to the atmosphere from this facility shall be less than 2038 pounds in any calendar month.

10. The total quantity of volatile organic compounds (VOC) emissions released to the atmosphere from all digital printing operations at this facility shall be less than 833 pounds in any calendar month.

11. In addition to the record keeping requirements in Rule 109, the operator shall keep adequate records for this facility to verify the following:

A. Density of each ink in pounds per gallon.

B. The percentage by weight of lithographic oils in each ink.

C. The ink absorption factor as specified by current District guidelines.

D. The VOC content of fountain solutions, wash materials, and any other

materials used in pounds per gallon as applied, including water and exempt compounds, and in volume percent (fountain solution only).

E. Other data as required to verify compliance with conditions specified in this permit.

12. To maintain exemption from the Title V requirements, the total quantity of VOC emissions from this facility shall be less than 10 tons (20,000 pounds) in any 12 calendar month period. If the records generated after the end of any calendar month show that the total facility VOC emissions for the previous 12 calendar months exceed the emission limit of this condition, the operator shall submit an initial Title V permit application and obtain a Title V permit pursuant to the requirements specified in Rule 3003. Exceedance of the VOC emission limit of this condition shall not subject any equipment at this facility to new source review requirements if the operator complies with all other permit conditions that are applicable to such equipment.

13. To ensure compliance with the emission limits of this permit, the operator shall:
A. In addition to the recordkeeping requirements of Rule 109, the operator shall keep adequate records for all equipment and operations that are required to have written permits or are exempt from written permits pursuant to Rule 219 at this facility to verify VOC emission in pounds and the VOC content of each material as applied (including water and exempt compounds)..
B. Within 14 calendar days after the end of each calendar month, total and record VOC emissions for the calendar month and for the previous 12 calendar month period from all equipment and operations that are required to have written permits or are exempt from written permits pursuant to Rule 219. The record shall include any procedures used to account for control device efficiencies and/or waste disposal. It shall be signed and certified for accuracy by the highest ranking individual responsible for compliance with District Rules.
C. Maintain a single list which includes only the name and address of each person from whom the facility acquired VOC-containing material regulated by the District that was used or stored at the facility during the preceding 12 months.
D. Retain all purchase invoices for all VOC-containing material used or stored at the facility, and all waste manifests for all waste VOC-containing material removed from the facility.

14 . Material safety data sheets for all materials used at this facility shall be kept current and made available to District personnel upon request.

15 . All records required by this permit shall be prepared in a format which is acceptable to the District, retained at the facility for a minimum of five years, and made available to any District representative upon request.

Appendix C

BAAQMD Evaluation Application #28111

EVALUATION REPORT

Company **Collotype Labels International Inc.**
Application # **28111**
Plant # **17834**

1. Background:

Collotype Labels International Inc. (CLII) has applied for an Authority to Construct and/or Permit to Operate the following equipment:

S-22 UV Press-Sheetfed Press UV Coaters, Heidelberg, SM74
S-23 CO2 Multi Coatings Printing Press, Heidelberg, CD74
S-24 6000 Indigo, HP Indigo 6000 Digital Press
S-25 6600 Indigo, HP Indigo 6600 Digital Press
S-26 6800 Indigo, HP Indigo 6800 Digital Press
S-27 UV Presses (2 Digicon Series 2 and 1 Digicon Series 3), Omega Digicon Series 2 and 3

CLII is preparing to install and operate two lithographic presses, three digital presses and three flexographic UV presses in the Fall of 2016. These presses are being installed as part of an expansion project at their location at 21 Executive Way, Napa, CA.

Because the estimated emissions from the flexographic presses which only use ultraviolet coatings are less than 3,000 lbs/yr, the UV Presses are grouped as one source as allowed in the District's grouping policy (Grouping of Coating, Adhesive, or Printing Operations into a Single Permitted Source) and identified as S-27.

2. Emission Calculations:

S-22 and S-23 Heidelberg Presses
Based on the proposed new permit conditions for the S-22 and S-23, the following emissions are estimated:

Table I – Emission Calculations for S-22 and S-23

Material Name	Material Manufacturer	Usage (lb/yr)	Usage (gal/yr)	VOC (lb/gal)	Retention Factor [2] (%)	POC (lb/yr)	POC[1] (lb/day)
Ink							
Soy-Based Offset	Great Western Ink	21000	2488	0.81	95	100.8	0.4
UV Offset Ink	Siegwerk	3500	415	0	95	0.0	0.0
Varnish							
Rub Resistant	Great Western Ink	15000	1777	1.18	95	104.9	0.4
Aqueous Varnish	Nicoat		6000	0.74	95	222.0	0.9
UV Flexo Varnish	Siegwerk	23500	2784	0	95	0.0	0.0
UV Anti Scuff	Varnish	8000	948	0	95	0.0	0.0

[1] 260 days/yr of operation
[2] Retention Factor of 95% for Non-Heatset Lithographic Printing Operations per Regulation 8-20-409.

Material Name	Material Manufacturer	Usage (lb/yr)	Usage (gal/yr)	VOC (lb/gal)	Retention Factor [2](%)	POC (lb/yr)	POC[1] (lb/day)
Clean-up							
Alpha 8	Explorer Press Solutions		1050	0.8		840.0	3.2
California Wash	Bottcher Systems		700	0.48		336.0	1.3
VOC Exempt Motor Cleaner	Nora Products		800	0.81		648.0	2.5
Fountain Solution Concentrate							
Supreme 8168	Varn International		65	3.97		258.1	1.0
Druck Fount	Siegwerk		65	1.29		83.9	0.3
TOTAL COMBINED EMISSIONS FOR S-22 and S-23						2593.5	**10.0**

For operating flexibility in the event that the POCs in the inks and cleanup solvents can be replaced with NPOCs, an equal amount of NPOC emissions is estimated from S-22 and S-23.

NPOC = 2593.5 lb/yr
NPOC = 10 lb/day

S-24, S-25, and S-26 HP Digital Presses

S-24 6000 Indigo Digital Press is a pre-certified source (Application # 24060), per 2-1-415.3. S-25 and S-26 6600 and 6800 Digital Presses are second and third generation models of the same pre-certified 6000 model. Enhancements have been made to the newer presses to improve capture, control, and reuse of VOC materials. Hence, the emissions profile of the pre-certified 6000 press are a conservative estimate for the 6600 and 6800 models.

Emissions of a digital press depend on the print job. The 2010 performance test of the HP Indigo 6000 press was conducted over a variety of operations. It was concluded that the worst case print job (one that has high coverage using the highest amount of ink for a 24-hour period) results in an organic emissions rate of 0.63 lb/hr. To reduce their facility potential to emit, the applicant agreed to limit operation of all three digital presses to 240 days per year of operation per press. Assuming the organic emissions are POC, the total emissions for a 24 hour, 240 day per year operation are as follows:

TABLE II – Emissions for 6000 Indigo Digital Press (Application 24060, P# 21086)

Pollutant	Lb/hr	Lb/day	Lb/year	Tons/year
POC	0.63	15.12	3629	1.81

The emissions above are for all materials used for the press. Based on the performance test that estimated worst case emissions, the throughputs of the materials used in this press are the following:

HP ElectroInks	44465 lb/yr
HP Recycle Agent	118 gal/yr
HP Imaging Oil	215 gal/yr
HP Imaging Agent	24 gal/yr

Because the facility agreed to 240 days per year of operation for each digital press, the pre-certified press template permit condition will not be imposed. Instead, the permit conditions for the digital press will be similar to the template conditions adjusted to reflect the less operating days.

S-27 UV Presses

The ultraviolet coatings used at S-27 have no VOC content. But there is solvent cleanup of the presses. The following emissions are estimated from the solvent cleanup (CeramClean Solv-It) at S-27:

POC = 100 gal/yr(2.10 lb/gal) = 210 lbs/yr
NPOC = 210 lb/yr

NPOC is estimated to be same as POC to allow for operating flexibility. Their daily emissions (operating 260 days/yr) is estimated to be the following:

POC = 210 lb/yr/260 days/yr = 0.8 lb/day
NPOC = 0.8 lb/day

TABLE III – Application Cumulative Increase Summary

Source	POC (lb/yr)	POC (TPY)	NPOC (lb/yr)	NPOC (TPY)
S-22 & S-23	2594	1.30	2594	1.30
S-24	3629	1.81		
S-25	3629	1.81		
S-26	3629	1.81		
S-27	210	0.11	210	0.11
TOTAL	**13,691**	**6.85**	**2804**	**1.41**

TOXICS

Review of the Material Safety Data Sheets for printing operation indicates the existence of butyl glycol ethers from S-22, S-23 (CAS# 112-3-4 of Nicoat Aqueous Varnish and CAS# 111-76-2 of Druck Fount, VOC Exempt Metering Roller Cleaner, Supreme 8168), and S-27 (CAS# 111-76-2 in CeramClean Solv-It MSDS). Comparing total POC Emissions to the screening level shows that total POC emissions are below screening trigger level:

Table IV – Toxic Emissions

Toxic	POC (lb/yr)	POC (lb/hr)*	Trigger Level (lb/hr)
Glycol Ether	2594 + 210 = 2,804	3	31

* Assumes worst-case operation of 260 days per year and 4 hours per day.

Hence, a Health Risk Screening Analysis (HRSA) is not required.

3. **Statement of Compliance:**

The new printing presses (S-22 through S-27) are subject to and will comply with District Regulation 8, Rule 20, and Section 302 and Section 309. Regulation 8-20-302 identifies the VOC standards for inks, coatings, and adhesives, while Regulation 8-20-309 identifies the VOC standards for cleaning products. The ink used by CLII is either UV or very low in VOC's if any. In addition, the cleaning products are also very low in VOC's.

Best Available Control Technology (BACT)

Because the daily emissions from S-22 through S-26 will exceed 10 pounds per worst-case day (See Table I and II), BACT review is required.

BACT 1 for POC and NPOC abatement has been determined to emissions controlled to an overall capture and destruction efficiency of at least 90% by weight. BACT 1 requires an overall capture and destruction efficiency of VOC by at least 90%.

Sources S-22 through S-26 are housed in the same building. To collectively abate S-22 through S-26 to a single abatement device would require at least a 5,000 cfm regenerative thermal oxidizer. Anguil provided an Equipment Cost (EC) of $265,000 for a 5000 cfm thermal oxidizer (not including installation, ducting, utilities, or taxes). Using the EPA Control Cost Manual, Table 2.8 (Capital Cost Factors for Thermal and Catalytic Incinerators), the purchased equipment cost (PEC) was estimated to be:

PEC = Oxidizer EC + Sales Tax (0.09 EC) + Freight (0.05 EC)*
PEC = EC(1.14)
PEC = $265,000(1.14) = $302,100

Note: * Instrumentation is included with Oxidizer and already included in cost.

Ductwork and stack installation would be required to collect the emissions from the S-22 through S-26. Review of the EPA Control Cost Manual, Chapter 1 provides a cost of approximately $36,000 for the ductwork and stack installation. With the oxidizer's PEC, the following total equipment cost (TEC) is estimated to be:

TEC = 302,100 + 36,000 = 338,100

The Total Capital Investment is made up of the direct and indirect equipment costs. Per Table 2.8 of EPA Control Cost Manual, the Total Capital Investment (TCC) was estimated from the TEC:

TCC = 1.61TEC
TCC = 1.61($338,100) = $544,341

The annualized cost of abatement was estimated adding the direct and indirect annual costs:

Table V – Annualized Cost of Abatement

	Formula	Reference	Annual Cost ($)
Direct Annual Cost			
Labor			
Operator	0.5 hr per day at $20/hr	Bay Area Estimate	3,650
Supervisor	15% of operator cost	EPA Cost Manual	548
Maintenance			
Labor	0.5 hr per day at $30/hr	District Estimate	5,475
Materials	100% of Maintenance Labor	EPA Cost Manual	5,475
Utilities			
Natural Gas & Elec	$0.82/hr (gas + elec)}	Anguil Estimate	4723 (24 hrs/day, 240 days/yr)
Total Direct Annual Cost (DAC)			**19,871**

	Formula	Reference	Annual Cost ($)
Indirect Annual Cost (IAC)			
Capital Recovery	0.136 TCC	BAAQMD BACT Workbook	74,030
Property Tax	0.01 TCC	BAAQMD BACT Workbook	5,443
Insurance	0.02 TCC	BAAQMD BACT Workbook	10,887
General and Administrative	0.02 TCC	BAAQMD BACT Workbook	10,887
Operation & Maintenance	0.05 TCC	BAAQMD BACT Workbook	27,217
Total Indirect Annual Cost (IAC)			**128,464**
Total Annualized Cost (TAC)	**TAC = DAC + IAC**		**148,335**

For 90% abatement of the emissions from S-22 through S-26 to be abated would result in the following emissions reduction:

Emissions Reduced = (1.30 + 1.81 + 1.81 + 1.81) (90%) = 6.06 TPY

Hence, the cost-effectiveness of abating S-22 through S-26 is estimated to be:

Cost-Effectiveness = $148,335/6.06 TPY = $24,478/ton of emissions reduced

The cost of abatement for S-22 through S-26 exceeds the BACT1 cost-effectiveness threshold of $17,500. Therefore it is not cost effective to implement add-on abatement (BACT1). BACT has been determined to compliance with existing Regulation 8-20 requirements.

BACT2 requirements for graphic arts operations is met, because the applicant will use UV inks and cleaning products which meet the Regulation 8-20-309 standards. The use of ultra-low or no-VOCs in the UV inks and cleaning materials is considered BACT for graphic arts operations.

The HP Indigo presses each have an integrated VOC recovery system that includes a vapor collection system and condenser that recovers and reuses organic liquids and reduces usage and emissions. The VOC recovery system is considered BACT for digital presses (per Application # 24060). In Application # 24060, District review also found BACT1 not to be justified for the HP Indigo Press.

BACT 2 for digital presses is not included in the BACT guidelines. Most printing press BACT 2 is the use of low VOC materials. However, this technology is not extendable to digital presses, where the electrophotography technology requires the ElectroInk materials. One BACT 2 technology is to collect and control emissions such that the overall emission would effectively be less than 2.5 lb/gal (Document 146.1, Rotogravure Printing). The HP Indigo 6000 press collection/condensing system complies with this requirement, as demonstrated in the following table:

TABLE VI – Collection/Condensing Summary

Total Ink lb/yr	Typical Ink Density lb/gal	Total Ink gal/yr	Typical Ink VOC lb/gal	Total Ink VOC lb/yr	Total Ink VOC lb/day
44,465	6.8	6,539	5.3	34,657	144
			Permitted POC Limit:		15.12
			Effective VOC lb/gal:		0.55
			Effective abatement:		89.6%

Note: Effective VOC lb/gal = 15.12 lb/day / (6,539 gal / 240 day/yr) = 0.55 lb/gal
Effective abatement = (5.3-0.55)/5.3 = 89.6%

The HP Indigo Digital Printing Press complies with BACT and is considered to have a BACT 2 level of control.

Offsets

The facility emissions are the following:

Table VII – POC Cumulative Increases

post 4/5/91 P O C increases as of 07-27-16 .
Collotype Label USA, Inc [plant: 17834]

Application	incr.	contemp reduction	ratio	offsets	Bank No.
14706	5.080	1.00	5.080	157	
15121	.590	1.00	.590	157	
15423	1.180	1.00	1.180	157	
15979	.800	1.00	.800	157	
17181	1.720	1.00	1.720	157	
24435	.400	1.00	.400	157	
25237	.500	1.00	.500	157	
25891	1.200	1.00	1.200	157	

11.470 tpy POC permitted since 4/5/91(*)
.000 tpy POC currently subject to offsets
4.043 tpy POC in 2016 emissions inventory

Offsets are triggered because facility POC emissions are greater than 10 TPY. Adding the existing cumulative, this application would result in a total cumulative increase of 18.32to b TPY:

POC Cumulative Increase = 11.47 (existing) + 6.85 TPY (new) = 18.32 TPY

The facility owns no offsets. Because facility emissions are less than 35 tons per year, they qualify for offsets from the small facility bank per Regulation 2-4-414:

Offsets from SFB = 6.85 TPY

NSPS & NESHAP

S-22 through S-27 are not subject to NSPS Subpart QQ "Standards of Performance for the Graphic Arts Industry: Publication Rotogravure Printing" which apply to rotogravure presses. S-22 through S-27 are not located at a major source of HAPs and therefore, are not subject to NESHAP Subpart KK "National Emission Standards for the Printing and Publishing Industry" which apply to printing operations which are major sources of HAPs.

This application is ministerial (Permit Handbook Chapter 5.4); the requirements of the California Environmental Quality Act (CEQA) are not triggered. The facility is not located within 1000 feet of any K-12 school. As a result, no public notification requirements are triggered.

4. Conditions

I recommend that the following conditions for S-22 and S-23 (Condition # 26372):

1. The owner/operator shall ensure the combined usage of the following materials at S-22 and S-23 does not exceed the following usage limits during any consecutive twelve-month period:

Great Western Soy-Based Ink	21000 Pounds
Great Western Rub Resistant Ink	15000 Pounds
UV Ink	No Limit
Nicoat Aqueous Varnish	6000 Gallons
Explorer Press Solutions Alpha 8	1050 Gallons
Bottcher Systems California Wash	700 Gallons
Nora Products VOC Exempt Meter Cleaner	800 Gallons
Varn International Supreme 8168	65 Gallons
Siegwerk Druch Fount	65 Gallons

(Basis: Cumulative Increase)

2. The owner/operator may use an alternate coating(s) or cleanup solvent(s) other than the materials specified in Part 1 and/or usages in excess of those specified in Part 1, provided that the owner/operator can demonstrate that all of the following are satisfied:
   a. Total POC emissions from S-27 do not exceed 2,594 pounds in any consecutive twelve month period;
   b. Total NPOC emissions from S-27 do not exceed 2,594 pounds in any consecutive twelve month period; and
   c. The use of these materials does not increase toxic emissions above any risk screening trigger level of Table 2-5-1 in Regulation 2-5.

   (Basis: Cumulative Increase; Toxics)

3. To determine compliance with the above parts, the owner/operator shall maintain the following records and provide all of the data necessary to evaluate compliance with the above parts, including the following information:
   a. Quantities of each type of coating and cleanup solvent used at this source on a monthly basis.
   b. If a material other than those specified in Part 1 is used, POC/NPOC and toxic component contents of each material used; and mass emission calculations to demonstrate compliance with Part 2, on a monthly basis;
   c. Monthly usage and/or emission calculations shall be totaled for each consecutive twelve-month period.
   d. Demonstration that any toxic air contaminants in new solvents in the coating and cleanup materials in Part 2, do not exceed the acute and chronic trigger levels by calculating toxic air contaminant emissions on a lb/hour and lb/year basis, respectively.

   All records shall be retained on-site for two years, from the date of entry, and made available for inspection by District staff upon request. These recordkeeping requirements shall not replace the recordkeeping requirements contained in any applicable District Regulations.
   (Basis: Cumulative Increase; Toxics)

I recommend the following permit condition for S-24, S-25, and S-26 (Condition # 26377):

1. The Owner/Operator of the HP Indigo 6000-series Digital Printing Presses S-24, S-25, and S-26 shall not exceed the following limits of gross material usage for each consecutive 12-month period per press:
   a. HP ElectroInks — 44,465 pounds
   b. HP Imaging Oil — 118 gallons
   c. HP Recycle Agent — 215 gallons
   d. HP Imaging Agent — 24 gallons
   (Basis: Cumulative Increase)

2. The Owner/Operator of S-24, S-25 and S-26 shall not exceed the following limits:
   a. 15.12 pounds of organic emissions per day at each of the above presses, based on a calendar month average.
   b. Each press shall not operate for more than 240 days in any consecutive 12-month period.
   (Basis: Cumulative Increase, BACT)

3. The Owner/Operator of S-24, S-25 and S-26 shall not operate any of the above presses within 1000 feet of any school or school grounds unless there are no Toxic Air Contaminant emissions. "School" or "School Grounds" means any public or private school used for the purposes of the education of more than 12 children in kindergarten or any of grades 1 to 12, inclusive, but does not include any private school in which education is primarily conducted in a private home(s). "School" or "School Grounds" includes any building or structure, athletic field, or other areas of school property but does not include unimproved school property. (Basis: Regulations 2-1-106, 2-1-412)

4. The owner/operator of S-24, S-25 and S-26 shall maintain all press doors at each of the above presses in the closed position at all times when the press is operating. The owner/operator of S-24, S-25 and S-26 may open the doors to change consumables, repair paper jams, or conduct urgent maintenance. However, once the doors at the presses are opened, the press is designed to be unable to operate and the owner/operator must not defeat or in any way compromise this shutdown feature. (Basis: Cumulative Increase, BACT)

5. The owner/operator of S-24, S-25 and S-26 shall operate the integral oil recovery systems of the press at all times in accordance with the HP Indigo owner's manual. (Basis: Cumulative Increase, BACT)

6. The owner/operator of S-24, S-25 and S-26 shall not use open containers for the storage or disposal of cloth or paper impregnated with organic compounds that are used for surface preparation, cleanup or ink removal. (Basis: Regulation 8-20-320.1)

7. The owner/operator of S-24, S-25 and S-26 shall not store in open containers spent or fresh organic compounds used for surface preparation, cleanup or removal of inks. (Basis: Regulation 8-20-320.2)

8. The owner/operator of S-24, S-25 and S-26 shall not leave containers of ink, Imaging Oil, Imaging Agent, Recycle Agent or waste/spent organic material open when not in use. (Basis: Regulation 8-20-320.3)

9. The owner/operator of S-24, S-25 and S-26 shall maintain the following records for each press in a District-approved log book, and shall make the records available to District staff upon request:

a. Maintain a list of all inks, coatings, adhesives, makeup solvents, and cleaning products currently in use and document the VOC content and density of each material.
b. Record and add up on a monthly basis the type and amount (in pounds) of each ink, coating, adhesive, makeup solvent, surface preparation solvent, and cleaning product used during that month. In order to determine compliance with Part 1, HP Imaging Oil, HP Recycle Agent and HP Imaging Agent shall also be recorded in gallons.
c. Record the total pounds of VOC of each ink, coating, adhesive, makeup solvent, surface preparation solvent, and cleaning product used during that month.
d. Record the amount of organic material that is collected and sent off site or accumulated prior to being sent off site.
e. For each calendar month, the owner/operator of S-24, S-25 and S-26 shall determine compliance with Part 2 by subtracting the total pounds of organic material recorded in Part 9d from the total pounds of VOC recorded in Part 9c, and dividing the difference by the number of operating days in the month.
f. The owner/operator of S-24, S-25 and S-26 shall retain all records for a period of 24-months from the last date of entry. (Basis: Regulation 8-20-503, Cumulative Increase)

I recommend the following conditions for S-27 (Condition # 26371):

1. The owner/operator of S-27 shall not exceed the following usage limits during any consecutive twelve-month period:

UV Ink	No Limit
CeramClean Solv-It	100 Gallons

(Basis: Cumulative Increase)

2. The owner/operator may use an alternate coating(s) or cleanup solvent(s) other than the materials specified in Part 1 and/or usages in excess of those specified in Part 1, provided that the owner/operator can demonstrate that all of the following are satisfied:
   a. Total POC emissions from S-27 do not exceed 210 pounds in any consecutive twelve month period;
   b. Total NPOC emissions from S-27 do not exceed 210 pounds in any consecutive twelve month period; and
   c. The use of these materials does not increase toxic emissions above any risk screening trigger level of Table 2-5-1 in Regulation 2-5.

   (Basis: Cumulative Increase; Toxics)

3. To determine compliance with the above parts, the owner/operator shall maintain the following records and provide all of the data necessary to evaluate compliance with the above parts, including the following information:
   a. Quantities of each type of coating and cleanup solvent used at this source on a monthly basis.
   b. If a material other than those specified in Part 1 is used, POC/NPOC and toxic component contents of each material used; and mass emission calculations to demonstrate compliance with Part 2, on a monthly basis;
   c. Monthly usage and/or emission calculations shall be totaled for each consecutive twelve-month period.
   d. Demonstration that any toxic air contaminants in new solvents in the coating and cleanup materials in Part 2, do not exceed the acute and chronic trigger levels by calculating toxic air contaminant emissions on a lb/hour and lb/year basis, respectively.

   All records shall be retained on-site for two years, from the date of entry, and made available for inspection by District staff upon request. These recordkeeping requirements shall not

replace the recordkeeping requirements contained in any applicable District Regulations. (Basis: Cumulative Increase; Toxics)

5. Authority to Construct:

I recommend that the Authority to Construct issued to CLII for the following:

S-22 UV Press-Sheetfed Press UV Coaters, Heidelberg, SM74
S-23 CO2 Multi Coatings Printing Press, Heidelberg, CD74
S-24 6000 Indigo, HP Indigo 6000 Digital Press
S-25 6600 Indigo, HP Indigo 6600 Digital Press
S-26 6800 Indigo, HP Indigo 6800 Digital Press
S-27 UV Presses (2 Digicon Series 2 and 1 Digicon Series 3), Omega Digicon Series 2 and 3

6. Exemptions:

None.

12/80-ER1

By M.K. Carol Lee
Senior Air Quality Engineer

Date

Appendix D

Cost Effectiveness Determination for Carbon Adsorption

Data Inputs	
Select the type of carbon adsorber system:	**Fixed-Bed Carbon Adsorber with Steam Regeneration**
For fixed-bed carbon adsorbers, provide the following information:	
Select the type of operation:	**Continuous Operation**
Select the type of material used to fabricate the carbon adsorber vessels:	**Stainless Steel, 304**
Select the orientation for the adsorber vessels:	**Horizontal**

Enter the design data for the proposed Fixed-Bed Carbon Adsorber with Steam Regeneration

Number of operating hours per year (Θs)	2,080	hours/year	
Waste Gas Flow Rate (Q)	8,000	acfm*	*acfm is actual cubic feet/min
VOC Emission Rate (mvoc)	4.5673	lbs/hour	
Required VOC removal efficiency (E)	98.5	percent	
Superficial Bed Velocity (vb)	75.00	ft/min	
Estimated equipment life of adsorber vessels and auxiliary Equipment (n)	10	Years	
Estimated Carbon life (n)	5	Years	
Total Number of carbon beds (Ntotal)	3	Beds*	* 3 beds is the default. User should enter actual number of beds, if known.
Number of carbon beds adsorbing VOC when system is operating (NA)	2	Beds*	* 2 beds is the default. User should enter actual number of beds, if known.
Total time for adsorption (ΘA)	12	hours*	* 12 hours is a default value. User should enter actual value, if known.
Total time for desorption (ΘD)	6	hours	
Estimated Carbon Replacement Rate (CRR)	379	lbs/hour*	* 379 lbs./hour is a default value. User should enter actual value, if known.

Enter the Characteristics of the VOC/HAP:

Name of VOC/HAP	Toluene	
Partial Pressure of Toluene in waste gas stream	0.0104	psia
Parameter "k" for Toluene	0.551	Note:
Parameter "m" for Toluene	0.110	Typical values of "k" and "m" for some common VOCs are shown in Table A.

Enter the cost data for the carbon adsorber:

Desired dollar-year	2024			
CEPCI* for 2024	800.7	CEPCI value for 2024	390.6	1999
Annual Interest Rate (i)	6.5	percent (Current bank prime rate)		

* CEPCI is the Chemical Engineering Plant Cost Index. The use of CEPCI in this spreadsheet is not an endorsement of the index for purpose of cost escalation or de-escalation but is there merely to allow for availability of a well-known cost index to spreadsheet users. Use of other well-known cost indexes (e.g., M&S) is acceptable.

Enter the cost data for the carbon adsorber:

Electricity (Pelec)	$0.1380	per kWh	
Steam (Ps)	$5.00	per 1,000 lbs*	* $5.00/1,000 lbs is a default value. User should enter actual value, if known.
Cooling Water (Pcw)	$3.55	per 1,000 gallons of water*	* $3.55/1,000 gallons is a default value. User should enter actual value, if known.
Operator Labor Rate	$28.80	per hour	
Maintenance Labor Rate	$31.68	per hour	
Carbon Cost (CC)	$4.20	per lb	* $4.20/lb is a default value based on 2018 market price. User should enter actual value, if known.
Re-Sale Value of Recovered VOC (Pvoc)	$0.33	per lb*	* $0.33/lb is a default value for recovered toluene based on 2018 data. User should enter actual value of recovered VOC/HAP, if known. Enter zero if the recovered VOC/HAP cannot be sold or re-used onsite.
Disposal/Treatment Cost for Recovered VOC (Dvoc)	$0.00	per lb*	* $0/lb is a default value for disposal and/or treatment of recovered VOC/HAP. User should enter actual value, if known. Enter zero if the recovered VOC/HAP can be sold or re-used onsite without additional treatment.

If known, enter any additional costs for site preparation and building construction/modification:

Site Preparation (SP) =	$0	* Default value. User should enter actual value, if known.
Buildings (Bldg) =	$0	* Default value. User should enter actual value, if known.
Equipment Costs for auxiliary equipment (e.g., ductwork, dampers, and stack) (ECaux) =	$32,200	
Contingency Factor (CF)	10.0 percent*	* 10 percent is a default value. The contingency factor should be between 5 and 15 percent.

Data Sources for Default Values Used in Calculations:

Data Element	Default Value	Sources for Default Value	If you used your own site-specific values, please reference the source from which the site-specific value was derived.	Recommended data sources for site-specific information
Carbon Cost ($/lb)	$1.90	January 2018 market price for virgin carbon.		Check with activated carbon vendors for current prices.
Operator Labor Rate ($/hour)	$27.48	Bureau of Labor Statistics, May 2017 National Occupational Employment and Wage Estimates – United States, May 2017 (https://www.bls.gov/oes/current/oes_nat.htm). Hourly rates for operators based on data for plant and System Operators – other (51-8099).	Bureau of Labor Statistics, May 2023 National Occupational Employment and Wage Estimates – United States, May 2023 (https://www.bls.gov/oes/current/oes_nat.htm). Hourly rates for operators based on data for plant and System Operators – other (51-8099).	Use payroll data, if available, or check current edition of the Bureau of Labor Statistics, National Occupational Employment and Wage Estimates – United States (https://www.bls.gov/oes/current/oes_nat.htm).
Maintenance Labor Rate ($/hour)	$30.23	Estimated as 110 percent of operator labor rate.		Use payroll data, if available, or check current edition of the Bureau of Labor Statistics, National Occupational Employment and Wage Estimates – United States (https://www.bls.gov/oes/current/oes_nat.htm).

Data Sources for Default Values Used in Calculations:

Value of Recovered VOC ($/lb.)	$0.33	January 2018 market price for recovered toluene.		Check with reagent vendors for current prices.
Disposal/Treatment Cost for Recovered VOC ($/lb)	$0.00	No additional treatment or disposal costs - Recovered VOC can be sold to a solvent recovery company.		Check with reagent recyclers for current prices or enter estimated costs for onsite treatment, as applicable.
Steam ($/1,000 lb)	$5.00	Price of steam was estimated by multiplying the average price of natural gas for industrial facilities ($4.00/MMBtu) by 1.3 and converting to $/1,000 lb of steam. Natural gas price is the 2017 average price for industrial facilities published by the U.S. Department of Energy, Energy Information Administration (see https://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_a.htm).		Use actual values if known or estimate steam cost as 1.3 x Fuel Cost for oil and gas-fired facilities. See also Department of Energy, Energy Efficiency and Renewable Energy, A Best Practices Steam Technical Brief: How to Calculate the True Cost of Steam, DOE/GO-102003-1736, September 2003 (available at https://www.energy.gov/sites/prod/files/2014/05/f15/tech_brief_true_cost.pdf).
Cooling Water ($/1,000 gallons)	$3.55	Average water rates for industrial facilities in 2013, compiled by Black & Veatch. (see 2012/2013 "50 Largest Cities Water/Wastewater Rate Survey." Available at http://www.saws.org/who_we_are/community/RAC/docs/2014/50-largest-cities-brochure-water-wastewater-rate-survey.pdf.		Use actual values if known or estimate steam cost as 1.3 x Fuel Cost for oil and gas-fired facilities. See also Department of Energy, Energy Efficiency and Renewable Energy, A Best Practices Steam Technical Brief: How to Calculate the True Cost of Steam, DOE/GO-102003-1736, September 2003 (available at https://www.energy.gov/sites/prod/files/2014/05/f15/tech_brief_true_cost.pdf).
Electricity Cost ($/kWh)	$0.07	Average annual electricity cost for industrial plants is based on 2017 price data compiled by the U.S. Energy Information Administration from data reported on Form EIA-861 and 861S, (http://www.eia.gov/electricity/data.cfm#sales).	The electricity rate (13.8 cents/kWh) was based on the commercial rates as approved by the SMAQMD on 10/17/16.	Plant's utility bill or use U.S. Energy Information Administration (EIA) data for most recent year. Available at http://www.eia.gov/electricity/data.cfm#sales.

Design Parameters

The following design parameters for the carbon adsorber were calculated based on the values entered on the *Data Inputs* tab. These values were used to prepare the costs shown on the *Cost Estimate* tab.

Type of Carbon Adsorber:	**Fixed-Bed Carbon Adsorber with Steam Regeneration**
Name of VOC Controlled:	**Toluene**

Parameter	Equation	Calculated Value	Units
Quantity of Toluene Recovered:			
Quantity of Toluene Recovered (Wvoc) =	$W_{voc} = m_{voc} \times \Theta_s \times E =$	4.679	tons/year
Time required for Desorption (Θ_D) =		6	hours
Time for Adsorption (Θ_A) =		12	hours
Time Available for Desorption =	$\Theta_A (N_D/N_A) =$	6	hours
Adsorber Parameters:			
Equilibrium Capacity at the Inlet ($W_{e(max)}$) =	$k \times P^m =$	0.333	lb. VOC/lb. Carbon
Working Capacity (w_c) =	$0.5 \times w_{e(max)} =$	0.167	lb. VOC/lb. Carbon
Adjustment Factor for Adorber Vessel Material (F_m) =		1.0	(* Stainless Steel, 304)
Number of Bed Desorbing (N_D) =	$N_{total} - N_A =$	1	Bed
Number of Bed Adsorbing (N_A) =		2	Bed
Volumetric Flow Rate for each Vessel (Q') =	$Q/N_A =$	4,000	acfm/Bed
Carbon Bed Thickness (t_b) =	Vendor Specs	3.30	ft.
Pressure Drop (ΔP_s) =	$t_b \times (0.03679 v_b + 1.107 \times 10^{-4} v_b^2) + 1 =$	12.16	inches
Cooling Fan Operating Time (Θ_{cf}) =	$0.4 \times \Theta_D \times (N_A \times \Theta_s)/\Theta_A =$	832	hours
Estimated Carbon Required:			
Estimated Carbon Consumption (M_c) for a continuously operated system =	$(m_{voc}/w_c) \times \Theta_A (1 + N_D/N_A) =$	493	lbs.
Carbon Required for each Vessel (M_c') =	$M_c /(N_A + N_D) =$	164	lbs./Bed
Estimated Adsorber Vessel Dimensions and Surface Area:			
Vessel Orientation =		**Horizontal**	
Vessel Diameter (D) =	Vendor Specs	8.24	ft.
Vessel Length (L) =	Vendor Specs	7.30	ft.
Surface Area of Adsorber Vessel (S) =	$\pi \times D \times (L+D/2) =$	296	sq.ft
Electricity Consumption:			
Electricity Consumed by the system fan (Q_{sf}) =	$(0.746 kW/hp) \times 2.5 \times 10^{-4} \times Q \times \Delta P_s \times \Theta_s =$	37,738	kWh/year
Electricity Consumed by the cooling fan (Q_{cf}) =	$(0.746 kW/hp) \times 2.5 \times 10^{-4} \times Q_{cf} \times \Delta P_s \times \Theta_{cf} =$	5,661	kWh/year
Electricity Consumed by the Cooling Water Fan (Q_{cwf}) =	$(0.746 kW/hp) \times [2.52 \times 10^{-4} \times 100/\eta] \times [\Theta_{cwp}/(0.6 \times \Theta_D \times N_A \times \Theta_D/\Theta_A) \times$ 60 mins/hour] =	164	kWh/year
Total Estimated Electricity Consumption (Q_{Elec}) =	Qsf + Qcf + Qcsf =	43,562	kWh/year
Steam Consumption:			
Total Steam Consumption (Q_{Steam}) =	$= 3.5 \times M_{voc} \times \Theta_s =$	33,250	lbs./year
Cooling Water Consumption:			

Design Parameters			
Total Cooling Water Consumption (Q_{cw}) =	= 3.43 x C_s/P_s =	114,047	gallons/year
Capital Recovery Factor:			
Capital Recovery Factor for adsorber vessels and auxiliary equipment (CFRabsorber)=	$[i \times (1 + i)^n] / [(1 + i)^n - 1]$ = Where n = Equipment Life and i = Interest Rate	0.1391	
Capital Recovery Factor for carbon (CRF_{Carbon}) =	$[i \times (1 + i)^n] / [(1 + i)^n - 1]$ = Where n = Carbon Life and i = Interest Rate	0.2406	

Cost Estimate

Capital Costs

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

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

Total Capital Investment (TCI) (in 2024 dollars)

Parameter	Equation	Cost	
Costs for Each Carbon Adsorber Vessel (C_v) =	271 x F_m x $S^{0.778}$ =	$46,446	
Total Cost for All Carbon Adsorber Vessels and Carbon (EC_{Adsorb}) =	5.82 x $Q^{-0.133}$ x [C_c + (N_A + N_D) x C_v] =	$249,050	
Auxiliary Equipment (EC_{aux}) =	(Based on design costs or estimated using methods provided in Section 2)	$32,200	
Total Purchased Equipment Costs for Carbon Adsorber (A) =	= EC_{Adsorb} + EC_{aux} =	$281,250	
Instrumentation =	0.10 × A =	Included in A	
Sales taxes =	0.085 × A =	$23,906	
Freight =	0.05 × A =	$14,062	
	Total Purchased Equipment Costs (B) =	$319,218	

Direct Installation Costs (in 2024 dollars)

Parameter	Equation	Cost	
Foundations and Supports =	0.08 × B =	$25,537	
Handling and Erection =	0.14 × B =	$44,691	
Electrical =	0.04 × B =	$12,769	
Piping =	0.02 × B =	$6,384	
Insulation =	0.01 × B =	$3,192	
Painting =	0.01 × B =	$3,192	
Site Preparation (SP) =		$0	
Buildings (Bldg) =		$0	
	Total Direct Costs (DC) = B + (0.3 × B) + SP + Bldg =	$414,984	

Total Indirect Installation Costs (in 2024 dollars)

Parameter	Equation	Cost	
Engineering =	0.10 × B =	$31,922	
Construction and field expenses =	0.05 × B =	$15,961	
Contractor fees =	0.10 × B =	$31,922	
Start-up =	0.02 × B =	$6,384	
Performance test =	0.01 × B =	$3,192	
	Total Indirect Costs (IC) =	$89,381	
Contingency Cost (C) =	CF(IC+DC)=	$50,437	
Total Capital Investment (TCI) =	**DC + IC + C = (1.28 × B) + SP + Bldg. + C =**	**$554,802**	**in 2024 dollars**

Annual Costs

Direct Annual Costs

Annual Costs

Parameter	Equation	Cost	
Annual Electricity Cost =	$Q_{Elec} \times P_{elec}$ =	$6,012	
Annual Steam Cost (C_s) =	3.50 x m_{voc} x Θ_s x P_s =	$166	
Annual Cooling Water Cost (C_{cs}) =	3.43 x C_s/P_s x P_{wc} =	$405	
Operating Labor Costs:	Operator = 0.5 hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$3,744	
	Supervisor = 15% of Operator	$562	
Maintenance Costs:	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$4,118	
	Materials = 100% of maintenance labor	$4,118	
Carbon Replacement Costs:	Labor = CRF_{carbon} x (Labor Rate × M_c)/CRR =	$10	
	Carbon = CRF_{carbon} x CC x M_c x 1.08 =	$538	
Direct Annual Costs (DAC) =		**$19,673**	**in 2024 dollars**
Indirect Annual Costs			
Parameter	**Equation**	**Cost**	
Overhead	= 60% of sum of operator, supervisor, maintenance labor Plus maintenance materials	$7,525	
Administrative Charges	= 2% of TCI	$11,096	
Property Taxes	= 1% of TCI	$5,548	
Insurance	= 1% of TCI	$5,548	
Capital Recovery	= $CRF_{Adsorber}$ × (TCI - [(1.08 x CC x M_c) + (LR x M_c/CRR)] =	$76,859	
Indirect Annual Costs (IAC) =		**$106,576**	**in 2024 dollars**
Recovered Solvent Credit/Disposal Costs			
Disposal Cost			
Parameter	**Equation**	**Cost**	
VOC Disposal/Treatment Costs (*$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)	= $m_{voc} \times \Theta_s$ x P_{voc} x E =	$3,088	
Total Annual Cost (TAC) =	**DAC + IAC + C + $Disposal_{Cost}$ - RC =**	**$123,161**	**in 2024 dollars**

Cost Effectiveness

Cost Effectiveness

Parameter	Equation	Cost	
Total Annual Cost =	TAC =	$123,161	per year in 2024 dollars
Annual Quantity of VOC Removed/Recovered =	$W_{voc} = m_{voc} \times \Theta_s \times E =$	4.679	tons/year
Cost Effectiveness =	Total Annual Cost (TAC) / Annual Quantity of VOC Removed/Recovered =	$26,323.62	per ton of pollutants removed/ recovered in 2024 dollars

Appendix E

Cost Effectiveness Determination for Thermal Oxidizers

Data Inputs

Select the Type of Oxidizer	Regenerative Thermal Oxidizer

Enter the following information for your emission source:

Composition of Inlet Gas Stream				
Pollutant Name	Concentration (ppmv)	Lower Explosive Limit (LEL) (ppmv)*	Heat of Combustion (Btu/scf)	Molecular Weight
Toluene	2,560	11,000	4,274	92.13

Note: The lower explosion limit (LEL), heat of combustion and molecular weight for some commonly used VOC/HAP are provided in the table below. In addition, the heat of combustion to be entered in column D is a lower heating value (LHV), not a higher heating value (HHV).

Enter the design data for the proposed oxidizer:

Number of operating hours/year	2,080	hours/year
Inlet volumetric flow rate(Q_{wi}) at 77°F and 1 atm.	20,000	scfm*
Pressure drop (ΔP)	19	inches of water
Motor/Fan Efficiency (ε)	60	percent*
Inlet Waste Gas Temperature (T_{wi})	100	°F*
Operating Temperature (T_{fi})	2,000	°F*
Destruction and Removal Efficiency (DRE)	98.5	percent
Estimated Equipment Life	20	Years*
Heat Loss (η)	1	percent*

Percent Energy Recovery (HR) = 70 Percent

* 20,000 scfm is a default volumetric flow rate. User should enter actual value, if known.
* 19 inches of water is a default pressure drop for thermal oxidizers. User should enter actual value, if known.
* 60% is a default fan efficiency. User should enter actual value, if known.
* 100°F is a default temperature. User should enter actual value, if known.
* Note: Default value for Tfi is 2000°F for thermal regenerative oxidizers. Use actual value if known. Tfi for regenerative oxidizers typically between 1800 and 2000°F.

* 20 years is the typical equipment life. User should enter actual value, if known.
* 1 percent is a default value for the heat loss. User should enter actual value, if known. Heat loss is typically between 0.2 and 1.5%.

Enter the cost data:

Desired dollar-year	2024				
CEPCI* for 2024	800.7	Enter the CEPCI value for 2024	536.4	2016 CEPCI	*Enter dollar year first.
Annual Interest Rate (i)	6.50	%			
Electricity ($Cost_{elect}$)	0.138	$/kWh			
Natural Gas Fuel Cost ($Cost_{fuel}$)	0.00804	$/scf			
Operator Labor Rate	$28.80	per hour			
Maintenance Labor rate	$31.68	per hour			
Contingency Factor (CF)	10.0	Percent			* 10 percent of the total capital investment F45is a default value for construction contingencies. User may enter values between 5 and 15 percent.

* CEPCI is the Chemical Engineering Plant Cost Escalation/De-escalation Index. The use of CEPCI in this spreadsheet is not an endorsement of the index for purposes of cost escalation or de-escalation, but is there merely to allow for availability of a well-known cost index to spreadsheet users. Use of other well-known cost indexes (e.g., M&S) is acceptable.

Data Sources for Default Values Used in Calculations:

Parameters for Common Compounds:

Compound	LEL (ppmv)	Heat of Combustion (Btu/scf)	Molecular Weight
Methane*	50,000	911	16.04
Ethane	30,000	1,631	30.07
Propane	21,000	2,353	44.09
Butane	19,000	3,101	58.12
Pentane	14,000	3,709	72.15
Hexane	11,000	4,404	86.17
Octane	10,000	5,796	114.23
Nonane	8,000	6,493	128.25
Decane	8,000	7,190	142.28
Ethylene**	27,000	1,499	28.05
Propylene	20,000	2,182	42.08
Cyclohexane	13,000	4,180	84.16
Benzene**	14,000	3,475	78.11
Toluene**	11,000	4,274	92.14
Methyl Chloride (Chloromethane)**	82,500	705	50.49

Footnotes
* Greenhouse gas.
** Hazardous air pollutant.

Data Element	Default Value	Sources for Default Values used in the calculation . . .	If you used your own site-specific values, please enter the value used and the reference source . . .	Recommended data sources for site-specific information
Electricity Cost ($/kWh)	0.0641	Average annual electricity cost for industrial plants is based on 2016 price data compiled by the U.S. Energy Information Administration from data reported on Form EIA-861 and 861S, (https://www.eia.gov/electricity/annual/html/epa_02_04.html).	The electricity rate (13.8 cents/kWh) was based on the commercial rates as approved by the SMAQMD on 10/17/16.	Plant's utility bill or use U.S. Energy Information Administration (EIA) data for most recent year. Available at http://www.eia.gov/electricity/data.cfm#sales.
Fuel Cost ($/Mscf)	3.51	Annual average price paid for natural gas by industrial facilities in 2016 from the U.S. Energy Information Administration. Available at http://www.eia.gov/dnav/ng/hist/n3035us3A.htm.	The electricity rate (8.04 $/MCF) was based on the commercial rates as approved by the SMAQMD on 10/17/16.	Check with fuel supplier or use U.S. Energy Information Administration (EIA) data for most recent year." Available at http://www.eia.gov/dnav/ng/hist/n3035us3A.htm.
Operator Labor ($/hour)	26.61	Bureau of Labor Statistics, May 2016 National Occupational Employment and Wage Estimates – United States, May 2016 (https://www.bls.gov/oes/current/oes_nat.htm). Hourly rates for operators based on data for plant and System Operators – other (51-8099).	Bureau of Labor Statistics, May 2023 National Occupational Employment and Wage Estimates – United States, May 2023 (https://www.bls.gov/oes/current/oes_nat.htm). Hourly rates for operators based on data for plant and System Operators – other (51-8099).	Use plant-specific labor rate.
Maintenance Labor ($/hour)	27.40	Bureau of Labor Statistics, May 2016 National Occupational Employment and Wage Estimates – United States, May 2016 (https://www.bls.gov/oes/current/oes_nat.htm). Hourly rates for maintenance workers based on electrical and electronics commercial and industrial equipment repairers (49-2094).		Use plant-specific labor rate.

Design Parameters

The following design parameters for the oxidizer were calculated based on the values entered on the *Data Inputs* tab. These values were used to prepare the costs shown on the *Cost Estimate* tab.

Composition of Inlet Gas Stream		
Pollutant Name	Concentration in Waste Stream (ppmv) From Data Inputs Tab	Adjusted Concentration with Dilution Air (ppmv)
Toluene	2,560	NA
0	0	NA
0	0	NA
0	0	NA
0	0	NA
0	0	NA
0	0	NA
0	0	NA
0	0	NA
0	0	NA
Total	2,560	0

Constants used in calculations:

Temperature of auxiliary fuel (T_{af}) =	Reference Temperature (T_{ref}) =	77.0	°F
Density of auxiliary Fuel at 77 °F (ρ_{af}) =		0.0408	lb/ft^3
Heat Input of auxiliary fuel ($-\Delta h_{caf}$) =		21,502	Btu/lb
Density of waste gas at 77 °F (ρ_{wi}) =		0.0739	lb/ft^3
Mean Heat Capacity of Air (C_{pmair})	(For thermal oxidizers)	0.255	Btu/lb °F

Parameter	Equation	Calculated Value	Units	Calculated Value	Units
Sum of volume fraction of combustible components =	$= (\sum x_i)$ =	2,560	ppmv		
Lower Explosive Limit of waste gas (LEL_{mix})	$= [\sum((x_j)/((\sum x_i) \times LEL_j))]^{-1}$ = Where x_j is the volume fraction and LEL_j the lower explosive limit for each combustible component in the waste gas.	11,000	ppmv		
% LEL_{mix}	= (Total Combustible Conc. In Mixture/LEL_{mix}) × 100 =	23.27	percent	* Note: Since the LEL of the waste gas stream is below 25%, no dilution air is needed.	
Dilution Factor	= (LEL_{mix} x 0.249)/($\sum x_i$) =	Not applicable			
Lower Explosive Limit (LEL) of waste gas after addition of dilution air	= (Total Adjusted Conc. With Dilution Air/LEL_{mix}) × 100 =	Not Applicable			
Inlet volumetric flow rate(Qwi) at 77°F and 1 atm.	(From Data Entry Tab) =	20,000	scfm		
Oxygen Content of gas stream	= 100 - ($\sum x_j \times 100/10^6$) =	20.85	percent		
Fan Power Consumption (FP)	= $[(1.17 \times 10^{-4}) \times Q_{wi} \times \Delta P]/\varepsilon$	74.1	kW		
Q_{wo}	$\approx Q_{wi}$ =	20,000	scfm		
Operating temperature of oxidizer (T_{fi})	(From Data Entry Tab) =	2,000	°F		
Temperature of waste gas at outlet to preheater (T_{wo})	= Heat Recovery × (T_{fi} - T_{wi}) + T_{wi} =	1,430	°F	Note: this temperature is relevant for incinerators, but not for the RTOs (both regenerative and recuperative).	

Parameter	Equation	Calculated Value	Units		Calculated Value	Units
Temperature of flue gas exiting the regenerative oxidizer (T_{fo})	= T_{fi} - 0.95(T_{fi} - T_{wi}) =	195	°F			
Heat Input of waste gas ($-\Delta h_{cwi}$)	= $\sum$ ($-\Delta h_{ci}$) x_i Where ($-\Delta h_{ci}$) is the heat of combustion and x_i the fraction of component "i" at 77 °F.	10.94	Btu/scf		148.0	Btu/lb
Estimated Auxiliary Fuel Flow (Q_{af}) at 77 °F and 1 atm.	(Calculated using Equation 2.45 in Appendix B)	-208.40	scfm	Note: Negative value for calculated Qaf indicates that the waste gas is sufficient to support combustion.		
Auxiliary fuel Energy Input =		0	Btu/min			
Minimum Energy required for combustion stabilization =	= 5% × Total Energy Input = 0.05 × ρ_{fi} × Q_{fi} × C_{pmfi} × (T_{fi} - T_{ref}) =	35,243	Btu/min			
Is the calculated auxiliary fuel sufficient to stabilize combustion? (Note: If the auxiliary fuel energy input > 5% of Total Energy Input, then the auxilary fuel is sufficient.)		No		Note: Additional auxiliary fuel equivalent to 5% of total energy input is required to stabilize combustion.		
Auxiliary fuel flow (Qaf) (adjusted for fuel required for combustion stabilization) at 77°F and 1 atm. =		40	scfm			
Total Volumetric Throughput (Q_{tot}) at 77 °F and 1 atm.	= Q_{fi} = Q_{wo} + Q_a + Q_{af} = Q_{wi} + Q_{af} =	20,040	scfm			

Capital Recovery Factor:

Parameter	Equation	Calculated Value
Capital Recovery Factor (CRF) =	i (1+ i)^n/(1+ i)^n - 1 = Where n = Equipment Life and i= Interest Rate	0.0908

Cost Estimate Direct Costs			
Total Purchased equipment costs (in 2024 dollars)			
Incinerator + auxiliary equipment[a] (A) =			
Equipment Costs (EC) for Regenerative Oxidizer	=(2.204 x 100,000 + 11.57 Qtot) x (2024 CEPI/1999 CEPCI) =	$815,869	in 2024 dollars
Instrumentation[b] =	0.10 × A =	$81,587	
Sales taxes =	0.03 × A =	$24,476	
Freight =	0.05 × A =	$40,793	
	Total Purchased equipment costs (B) =	$962,725	in 2024 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 2024 dollars)			
Foundations and Supports =	0.08 × B =	$77,018	
Handling and Erection =	0.14 × B =	$134,781	
Electrical =	0.04 × B =	$38,509	
Piping =	0.02 × B =	$19,254	
Insulation for Ductwork =	0.01 × B =	$9,627	
Painting =	0.01 × B =	$9,627	
Site Preparation (SP) =		$0	
Buildings (Bldg) =		$0	
	Total Direct Installaton Costs =	$288,817	
Total Direct Costs (DC) =	B + C + SP + Bldg =	$1,251,542	in 2024 dollars
Total Indirect Installation Costs (in 2024 dollars)			
Engineering =	0.10 × B =	$96,272	
Construction and field expenses =	0.05 × B =	$48,136	
Contractor fees =	0.10 × B =	$96,272	
Start-up =	0.02 × B =	$19,254	
Performance test =	0.01 × B =	$9,627	
	Total Indirect Costs (IC) =	$269,563	
Continency Cost (C) =	CF(IC+DC)=	$152,111	
Total Capital Investment =	**DC + IC +C =**	**$1,673,216**	**in 2024 dollars**

Direct Annual Costs			
Annual Electricity Cost	= Annual Electricity Usage × Operating Hours/year × Electricity Price =	$21,270	
Annual Fuel Costs for Natural Gas	= $Cost_{fuel}$ × Fuel Usage Rate × 60 min/hr × Operating hours/year	$40,309	
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$3,744	
	Supervisor = 15% of Operator	$562	
Maintenance Costs	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$4,118	
	Materials = 100% of maintenance labor	$4,118	
Direct Annual Costs (DC) =		**$74,122**	**in 2024 dollars**
Indirect Annual Costs			
Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	$7,525	
Administrative Charges	= 2% of TCI	$33,464	
Property Taxes	= 1% of TCI	$16,732	
Insurance	= 1% of TCI	$16,732	
Capital Recovery	= CRF[TCI-1.08(cat. Cost)]	$151,855	
Indirect Annual Costs (IC) =		**$226,309**	**in 2024 dollars**
Total Annual Cost =	**DC + IC =**	**$300,431**	**in 2024 dollars**

Cost Effectiveness

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

Total Annual Cost (TAC) =	$300,431	per year in 2024 dollars
VOC/HAP Pollutants Destroyed =	11.4	tons/year
Cost Effectiveness =	$26,301	per ton of pollutants removed in 2024 dollars