SMAQMD BACT CLEARINGHOUSE

CATEGORY Type: **PRINTING PROCESS**

BACT Category: MINOR SOURCE

BACT Determination Number: 250	**BACT Determination Date:** 3/24/2020

Equipment Information

Permit Number: N/A -- Generic BACT Determination
Equipment Description: PRINTING PRESS
Unit Size/Rating/Capacity: Lithographic Offset Heatset
Equipment Location:

EXPIRED

BACT Determination Information

District Contact: Joe Carle Phone No.: (916) 874 - 4838 email: jcarle@airquality.org

ROCs	**Standard:**	98% control efficiency
	Technology Description:	Dryer waste gas vented to a control device with 98% control efficiency or an outlet VOC concentration of 10 ppmv and compliance with the material limits in SMAQMD Rule 450 Sections 301 and 302.
	Basis:	Achieved in Practice
NOx	**Standard:**	30 ppmvd @ 3% O2
	Technology Description:	Dryer combustion emissions no more than 30 ppmvd @ 3% O2
	Basis:	Achieved in Practice
SOx	**Standard:**	
	Technology Description:	No standard
	Basis:	
PM10	**Standard:**	VOC Control Device
	Technology Description:	Vent dryer waste gas to a VOC control device
	Basis:	Achieved in Practice
PM2.5	**Standard:**	
	Technology Description:	No standard
	Basis:	
CO	**Standard:**	Natural Gas Fueled Dryer
	Technology Description:	Natural gas fuel used in drying oven
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	No standard
	Basis:	

Comments: This is a generic BACT determination based on BACT determinations made, and published, by other air agencies in California and/or other States.

Printed: 3/24/2020

SMAQMD BACT CLEARINGHOUSE

CATEGORY Type: **PRINTING PROCESS**

BACT Category: MINOR SOURCE

BACT Determination Number: 251	**BACT Determination Date:** 3/24/2020

Equipment Information

Permit Number: N/A -- Generic BACT Determination
Equipment Description: PRINTING PRESS
Unit Size/Rating/Capacity: Lithographic Offset Non-Heatset
Equipment Location:

EXPIRED

BACT Determination Information

District Contact: Joe Carle Phone No.: (916) 874 - 4838 email: jcarle@airquality.org

ROCs	**Standard:**	Low VOC Materials
	Technology Description:	Compliance with the material limits in SMAQMD Rule 450 Sections 301 and 302. If the total uncontrolled VOC emissions from the unit are ≥ 6,480 lbs per year then a VOC control system must be installed with at least 98.5% overall system efficiency (capture and destruction).
	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: This is a generic BACT determination based on BACT determinations made, and published, by other air agencies in California and/or other States.

Printed: 3/24/2020

777 12th Street, Third Floor

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

Sacramento, CA 95814

BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

EXPIRED

DETERMINATION NOS.:	250 and 251
DATE:	3/24/20
ENGINEER:	J. Carle

Category/General Equip Description:	Printing Process
Equipment Specific Description:	Printing Press
Equipment Size/Rating:	Lithographic Offset Printing Presses: Heatset and Non-Heatset
Previous BACT Det. No.:	138 – Non-Heatset Lithographic Offset 76 – All: Lithographic Printing Presses

These determinations will focus on lithographic offset printing presses. Determination 250 will be for a heatset process and determination 251 will be for a non-heatset process.

This determination will also include Best Available Control Technology for Toxics (T-BACT) for the hazardous air pollutants (HAP) that could potentially be an ingredient in the inks, coatings, solutions, or solvents used in the printing process.

BACT/T-BACT ANALYSIS

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

The following control technologies are currently employed as BACT for lithographic offset printing presses by the following agencies and air pollution control districts:

US EPA

BACT

Source: EPA RACT/BACT/LAER Clearinghouse (See Attachment A)

No determinations were found for non-heatset lithographic offset printing presses in the EPA Clearinghouse. Below shows the most stringent VOC content standards and the VOC control standards for heatset lithographic offset printing presses that were found.

RBLC# IN-0193 (11/13/13)

Press Type:	Heatset Web Offset Lithography
Control Device Efficiency:	98% VOC destruction or 10 ppmv outlet concentration
Material VOC Content Limits:	As recommended by EPA CTG for Offset Lithographic Printing and Letterpress Printing

All applicable BACT determinations found in the EPA Clearinghouse were from the Indiana Department of Environmental Management. Most determinations required a control device with 98% VOC destruction efficiency and then required limits equivalent to that which is recommended by the EPA's Control Techniques Guidelines for Offset Lithographic Printing and Letterpress Printing.

RULE REQUIREMENTS:

Although there are no EPA regulations that apply to this source category the EPA has Control Technique Guidelines (CTG) for lithographic printing and the recommended control options will be summarized below.

Control Techniques Guidelines for Offset Lithographic Printing and Letterpress Printing (September 2006)

For heatset web lithographic presses EPA recommends a VOC control device with 95% control efficiency. The CTG does not recommend a control device when inlet emissions are less than 25 tons per year of VOC or for presses that are sheet fed or coldset.

VOC Content for Fountain Solution Materials		
Material Type		**VOC Content Limits % by weight**
Heatset Web Offset Lithography		
Fountain Solutions Containing Alcohol	Chilled Using Refrigerated Chiller	3
	Non-Chilled	1.6
Fountain Solutions Containing No Alcohol		5
Coldset Web Offset Lithography		
Fountain Solutions Containing Alcohol		Not allowed
Fountain Solutions Containing No Alcohol		5
Sheet-fed Offset Lithography with Maximum Sheet Size > 11 x 17 Inches or Total Solution Reservoir > 1 Gallon		
Fountain Solutions Containing Alcohol	Chilled using Refrigerated Chiller	8.5
	Non-Chilled	5
Fountain Solutions Containing No Alcohol		5

The CTG recommends use of solvents for blanket washing, roller washing, metering roller cleaners, and other cleaners used for cleaning a press, press parts, or to remove dried ink from areas around the press with a VOC composite vapor pressure less than 10 mm Hg at 20^{o}C or containing less than 70% VOC by weight.

California Air Resource Board (CARB)

BACT

CARB has informed the District that their BACT Clearinghouse is currently being updated and the existing data on their website is out of date. All new data is being reviewed and is not ready to be released. The District's prior BACT determinations for these source categories show only SCAQMD determinations as found in the CARB BACT Clearinghouse. Current SCAQMD standards will be examined later in this determination.

RULE REQUIREMENTS:

None

Sacramento Metropolitan AQMD

BACT

Source: BACT Determination #76 – All: Lithographic Printing Presses (Appendix C)
Date: 2/11/2014

Lithographic Offset, Heatset	
Pollutant	**Standard**
VOC	Requires low VOC inks, coatings, and fountain solutions compliant with Rule 450 VOC standards.
NOx	No standard
SOx	No standard
PM10	No standard
PM2.5	No standard
CO	No standard

Source: BACT Determination #138 – Non-Heatset Lithographic Offset
Date: 1/13/2017

Lithographic Offset, Non-Heatset	
Pollutant	**Standard**
VOC	All sources use materials compliant with SMAQMD Rule 450 – Graphic Arts Operations. Additionally, sources emitting ≥ 4,697 lbs uncontrolled VOC per year must use a control device that has an overall system efficiency (control and destruction) of at least 98.5%.
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:
Rule 450 – Graphic Arts Operations (Adopted 10/23/08)
This rule applies to any graphic arts operation.

Standards:

General Printing Materials	
Material Type	**VOC Content g/l (lb/gal) Less water and exempt compounds**
Printing Ink	300 (2.5)
Adhesive	150 (1.25)
Coating	300 (2.5)

VOC Content for Fountain Solution Materials		
Material Type		**VOC Content Limits % by weight**
Heatset Web Offset Lithography		
Fountain Solutions Containing Alcohol	Chilled Using Refrigerated Chiller	3
	Non-Chilled	1.6
Fountain Solutions Containing No Alcohol		5
Coldset Web Offset Lithography		
Fountain Solutions Containing Alcohol		Not allowed
Fountain Solutions Containing No Alcohol		5
Sheet-fed Offset Lithography with Maximum Sheet Size > 11 x 17 Inches or Total Solution Reservoir > 1 Gallon		
Fountain Solutions Containing Alcohol	Chilled using Refrigerated Chiller	8.5
	Non-Chilled	5
Fountain Solutions Containing No Alcohol		5
All Other Presses		
Fountain Solutions Chilled Using Refrigerated Chiller		10
Fountain Solutions Non-Chilled		8

Solvent Cleaning Materials		
Material Type		**VOC Content g/l (lb/gal) Including water and exempt compounds**
General Cleaning		25 (0.21)
Application Equipment Cleaning	On-Press Components	100 (0.83)
	Removable Press Components	25 (0.21)
	Ultraviolet/Electron Beam Inks	100 (0.83)

Heatset web offset lithographic printing presses that have the potential to emit from the drying oven, prior to emissions control equipment, greater than or equal to 25 tons/year of VOC must install air pollution control equipment with an overall system efficiency of 95%.

South Coast AQMD

BACT
Source: SCAQMD BACT Guidelines for Non-Major Polluting Facilities, page 106 & 107 (2/1/19)

Lithographic Offset, Heatset	
Pollutant	**Standard**
VOC	Low VOC Fountain Solution (≤ 8% by vol. VOC) Low VOC (≤ 100 g/l) Blanket and Roller Washes Oil-Based or UV-Curable Inks Compliance with SCAQMD Rules 1130 and 1171 and Oven Venting to an Afterburner (≥ 0.3 sec. Retention Time at ≥ 1400 ^{o}F; 95% Overall Efficiency) (Afterburner must comply with SCAQMD Rule 1147 for NOx)
NOx	No standard
SOx	No standard
PM10	Venting to an Afterburner (≥ 0.3 sec. Retention Time at ≥ 1400 ^{o}F) (Afterburner must comply with SCAQMD Rule 1147 for NOx)
PM2.5	No standard
CO	No standard

Lithographic Offset, Non-Heatset	
Pollutant	**Standard**
VOC	Low VOC Fountain Solution (≤ 8% by vol. VOC) Low VOC (≤ 100 g/L) Blanket and Roller Washes Oil-Based or UV-Curable Inks Compliance with SCAQMD Rules 1130 and 1171
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 (5/2/14)

This rule is applicable any graphic arts operation.

Standards:

Inks, Adhesive, and Coatings	
Graphic Arts Material	VOC Content (g/L)
Adhesive	150
Coating	300
Offset Lithographic Ink	300

VOC Content for Fountain Solution Materials		
Material Type		**VOC Content Limits (g/L)**
Heatset Web-Fed		
Using Alcohol	Without Refrigerated Chiller	16
	With Refrigerated Chiller	30
Using Alcohol Substitute		50
Sheet-Fed		
Using Alcohol	Without Refrigerated Chiller	50
	With Refrigerated Chiller	85
Using Alcohol Substitute		50
Non-Heatset Web-Fed		
Using Alcohol		Prohibited
Using Alcohol Substitute		50

An owner or operator may install a control device which reduces VOC by 95% by weight from an emission collection system that collects at least 90% of the VOC emissions generated by the source instead of complying with the VOC content limits in the tables above.

Reg XI, Rule 1171 – Solvent Cleaning Operations (5/1/09)
This rule applies to any operation where solvent cleaning is conducted as part of a business.

Solvent Cleaning of Ink Application Equipment		
Type		**VOC Content Limit g/l (lb/gal)**
General		25 (0.21)
Lithographic (Offset)	Roller Wash, Blanket Wash, & On-Press Components	100 (0.83)
	Removable Press Components	25 (0.21)
Ultraviolet Ink/ Electron Beam Ink Application Equipment		100 (0.83)

Reg XI, Rule 1147 – NOx Reductions from Miscellaneous Sources (7/7/17)
This rule applies to ovens, dryers, dehydrators, heaters, kilns, calciners, furnaces, crematories, incinerators, heated pots, cookers, roasters, fryers, closed and open heated tanks and evaporators, distillation units, afterburners, degassing units, vapor incinerators, catalytic or thermal oxidizers, soil and water remediation units and other combustion equipment with nitrogen oxide emissions that require a District permit and are not specifically required to comply with a nitrogen oxide emission limit by other District Regulation XI rules.

Equipment Category	**NOx Emission Limit PPM @ 3% O2, dry or pound/MMBtu heat input**		
	Process Temperature		
	≤800° F	**>800° F and <1200° F**	**≥1200 ° F**
Oven, Dehydrator, Dryer, Heater, Kiln, Calciner, Cooker, Roster, Furnace, or Heated Storage Tank	30 ppm or 0.036 lb/MMBtu	30 ppm or 0.036 lb/MMBtu	60 ppm or 0.073 lb/MMBtu

San Joaquin Valley APCD

BACT
Source: SJVAPCD BACT Guideline 4.7.1 (6/25/99)

Offset Lithographic Printing – Publication Printing, High-end Graphics, Heatset using with a Drying Oven		
Pollutant	**Standard**	
	Achieved in Practice	**Technologically Feasible**
VOC	Using low VOC fountain solutions and inks compliant with SJVAPCD Rule 4607 (only for facilities subject to Rule 4607)	1. VOC capture and incineration using high-end graphics heatset inks with a VOC content < 45% by weight (less water and exempt compounds) and fountain solutions with a VOC content of < 15% by volume. 2. VOC and carbon adsorption system using high-end graphics heatset inks with a VOC content of < 45% by weight (less water and exempt compounds) and fountain solutions with a VOC content of < 15% by volume. 3. Using low VOC fountain solutions and inks compliant with SJVAPCD Rule 4607 (Graphic Arts)
NOx	Natural gas fuel used in drying oven	N/A
SOx	N/A	N/A
PM10	N/A	N/A
PM2.5	N/A	N/A
CO	Natural gas fuel used in drying oven	Catalytic Oxidation

Source: SJVAPCD BACT Guideline 4.7.2 (10/15/10)

Offset Lithographic Printing – Non-heat Set Press		
Pollutant	**Standard**	
	Achieved in Practice	**Technologically Feasible**
VOC	Using materials with the following VOC contents: Inks: less than 5% VOC by weight (less water and exempt compounds) or less than 30% VOC by weight (less water and exempt compounds) for high end graphics. Fountain Solutions: less than 5% by volume for coldset web offset lithographic, less than 5% by volume for sheet-fed offset lithographic with maximum sheet size greater than 11x17 inches, and less than 8% by volume for high end graphics	VOC capture and incineration; or VOC capture and carbon adsorption and using materials with the following VOC contents: Inks: less than 5% VOC by weight (less water and exempt compounds) or less than 30% VOC by weight (less water and exempt compounds) for high end graphics. Fountain Solutions: less than 5% by volume for coldset web offset lithographic, less than 5% by volume for sheet-fed offset lithographic with maximum sheet size greater than 11x17 inches, and less than 8% by volume for high end graphics
NOx	N/A	N/A
SOx	N/A	N/A
PM10	N/A	N/A
PM2.5	N/A	N/A
CO	N/A	N/A

T-BACT

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

RULE REQUIREMENTS:

Rule 4607 – Graphic Arts and Paper, Film, Foil and Fabric Coatings (12/18/08)

The VOC material standards are applicable to any graphic arts printing operation that emits 200 pounds or more VOC per 12 rolling consecutive calendar months.

VOC Content Limits for Inks, Coatings, and Adhesives	
Material	**Grams of VOC per liter (lb/gal), less water and exempt compounds, as applied**
Inks	300 (2.5)
Coatings	300 (2.5)
Adhesives	150 (1.25)

VOC Content Limits for Fountain Solution	
Material	**Percent VOC by Volume**
Heatset Web Offset Lithographic	1.6
Coldset Web Offset Lithographic	5.0
Sheet-fed Offset Lithographic with maximum sheet size greater than 11 x 17 inches	5.0
All Other Presses	8.0

VOC Content Limits for Solvent Cleaning	
Type of Solvent Cleaning Operation	**Grams of VOC per liter (lb/gal)**
Surface Preparation for Coating, Ink, or Adhesive Application	25 (0.21)
Repair and Maintenance Cleaning	25 (0.21)
Cleaning of Coating or Adhesive Application Equipment	25 (0.21)
Lithographic (Offset) Roller Wash, Blanket Wash, and On-Press Components	100 (0.83)
Lithographic (Offset) Removable Press Components	25 (0.21)
Ultraviolet Ink / Electron Beam Ink Application Equipment	100 (0.83)

In lieu of complying with the material limits in this rule a VOC emission control system may be used that has an overall VOC capture and control efficiency of 75% for lithographic offset printing presses.

San Diego County APCD

BACT
Source: NSR Requirements for BACT (June 2011), (pg 3-14)

Graphics Arts Operations (< 5 tons/year)		
Pollutant	**Standard**	
	Achieved in Practice	**Technologically Feasible**
VOC	1. Use of low VOC fountain solution (< 6% VOC by volume), 2. Capture & recycle blanket and roller tray wash, 3. Use of cleanup solvent which has either less than 200 grams VOC per liter or vapor pressure of less than 5 mm Hg at 20°C, 4. Use of metering roll cleanup solvent which has less than 100 grams VOC per liter or vapor pressure of less than 10 mm Hg at 20°C, and 5. Use of inks which have a VOC content of less than 300 grams per liter (2.5 lb/gal).	1. Use of low VOC fountain solution (< 5% VOC by volume), 2. Capture & recycle blanket and roller tray wash, 3. Use of cleanup solvent which has either less than 100 grams VOC per liter or vapor pressure of less than 5 mm Hg at 20°C, 4. Use of metering roll cleanup solvent which has less than 100 grams VOC per liter or vapor pressure of less than 5 mm Hg at 20°C, and 5. Use of inks which have a VOC content of less than 225 grams per liter (1.9 lb/gal).
NOx	N/A	N/A
SOx	N/A	N/A
PM10	N/A	N/A
PM2.5	N/A	N/A
CO	N/A	N/A

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

RULE REQUIREMENTS:
Rule 67.16 – Graphic Arts Operations (5/9/12)
This rule applies to all continuous web or single sheet fed graphic arts printing, processing, laminating or drying operations and digital printing operations.

The material standards of this rule do not apply to stationary sources which emit less than an average of 15 lbs of VOC from all graphic arts operations per day of operation, excluding digital printing operations, for each calendar month.

Graphic arts materials (except adhesives): < 300 grams of VOC per liter (2.5 lb/gal) as applied, less water and exempt compounds.

Adhesives: ≤ 150 grams of VOC per liter (1.25 lb/gal), as applied, less water and exempt compounds.

Fountain solutions: ≤ 5% VOC by volume or ≤ 8.5% VOC by volume refrigerated to a temperature below 60°F

Cleaning material: < 100 grams VOC per liter or the total VOC vapor pressure is 5 mm of Hg at 20°C or less.

In lieu of complying with the material standards install and operate a VOC emission capture and control device with efficiency of at least 85% by weight.

Bay Area AQMD

BACT
Source: BAAQMD BACT Guideline 110.1.1 (8/24/98)

Lithographic or Offset Printing - Heatset		
Pollutant	**Standard**	
	Achieved in Practice	**Technologically Feasible**
VOC	Low VOC fountain solution (≤ 8% by vol.); and minimum possible VOC blanket wash & roller & tray washes; and cleanup solvents w/ ≤ 7.5 lb VOC/gal and VOC vapor pressure ≤ 25 mm Hg or ≤ 30% by vol. VOC; and kerosene-like oil based inks	Low VOC fountain solution (≤ 6% by vol.); an automatic blanket & roller wash w/ solvent capture & recycle; and cleanup solvents w/ ≤ 2.5 lb VOC/gal or VOC vapor pressure ≤ 5 mm Hg; and kerosene-like oil based inks. If cost-effective, capture and vent VOC to afterburner or carbon adsorption system w/ ≥ 98.5% destruction / recovery device efficiency; or VOC outlet ≤ 10 ppmv
NOx	N/A	N/A
SOx	N/A	N/A
PM10	Compliance with Reg. 6, Visible Emissions.	Oven venting to an afterburner (≥ 0.3 sec. retention time at ≥ 1400 °F) w/ overall capture/destruction efficiency ≥ 90%
PM2.5	N/A	N/A
CO	N/A	N/A

Source: BAAQMD BACT Guideline 110.2.1 (8/24/98)

Offset Lithographic Printing – Non-heat Set Press		
Pollutant	**Standard**	
	Achieved in Practice	**Technologically Feasible**
VOC	Low VOC fountain solution (≤ 8% by vol.); and minimum possible VOC blanket wash & roller & tray washes; and cleanup solvents w/ ≤ 7.5 lb VOC/gal and VOC vapor pressure ≤ 25 mm Hg or ≤ 30% by vol. VOC; and kerosene-like oil based inks	Low VOC fountain solution (≤ 6% by vol.); an automatic blanket & roller wash w/ solvent capture & recycle; and cleanup solvents w/ ≤ 2.5 lb VOC/gal or VOC vapor pressure ≤ 5 mm Hg; and kerosene-like oil based inks. If cost-effective, capture and vent VOC to afterburner or carbon adsorption system w/ ≥ 98.5% destruction / recovery device efficiency; or VOC outlet ≤ 10 ppmv
NOx	N/A	N/A
SOx	N/A	N/A
PM10	N/A	N/A
PM2.5	N/A	N/A
CO	N/A	N/A

T-BACT

T-BACT standard is referenced as the VOC standard for both heatset and non-heatset lithographic offset printing presses.

RULE REQUIREMENTS:

Regulation 8, Rule 20 – Graphic Arts Printing and Coating Operations (11/19/08)

This rule applies to all graphic arts operations.

Product Limits	
Material	**grams VOC per liter of product as applied, less water and exempt solvent (lbs/gal)**
Ink	300 (2.5)
Coating	300 (2.5)
Adhesive	150 (1.25)
Web Splicing Adhesive	300 (2.5)

Fountain Solution is limited to 8% VOC by volume.

Cleaning Product Limits	
Equipment	**VOC g/l (lb/gal) including water**
Specialty Lithographic Press	100 (0.83)
Lithographic Press, by Manual Washing	100 (0.83)
Lithographic Press, by Automatic Washing	100 (0.83)
Adhesive Application Equipment	25 (0.21)
Ultraviolet Ink Removal	100 (0.83)
Other Press Parts[1]	25 (0.21)

[1] Press parts that do not come into contact with inks, adhesives, or coatings. Other press parts include, but are not limited to, pressure rollers, motors, and belts.

In lieu of compliance with the above material limits a VOC emission control system is installed that has an overall efficiency of at least 75% on a mass basis.

Summary of Achieved in Practice Control Technologies

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

Heatset Printing Presses – VOC

Controls for limiting VOC emissions rely on either reducing the VOC content of the materials used in the printing operation and/or use of a VOC emission control device. In a heatset printing process the waste gas from the dryer would be vented to a VOC control device if required, which would control most VOC emissions from the process. In terms of stringency a control device would reduce VOC emissions more than using low VOC printing material and, therefore, will be ranked as such.

Achieved in Practice VOC Standards for Lithographic Offset Heatset Printing					
Rank	Standard (ppmvd @ 15% O_2)	Technology Description	Source	Year	Comments
1	VOC control device with 98% destruction or 10 ppmv outlet; Use of fountain solutions and cleaning solvents as recommended in the CTG	Thermal Oxidizer and Low VOC Materials	EPA BACT	2015	

Achieved in Practice VOC Standards for Lithographic Offset Heatset Printing					
Rank	Standard (ppmvd @ 15% O_2)	Technology Description	Source	Year	Comments
2	Afterburner with 95% overall efficiency; Fountain solution ≤ 8% VOC by volume; Blanket and roller washes ≤ 100 g/l VOC content; Compliance with Graphic Arts Rule 1130 and Solvent Cleaning Rule 1171	Thermal Oxidizer and Low VOC Materials	SCAQMD BACT	2019	
3	Compliance with Graphic Arts Rule 450	Low VOC Materials	SMAQMD BACT	2014	Rule last amended in 2008
3	Compliance with Graphic Arts Rule 4607	Low VOC Materials	SJVAPCD BACT	1999	Rule last amended in 2008
4	Fountain Solution < 6% VOC by volume; Capture & recycle blanket and roller tray wash; Cleanup solvent with < 200 g/l VOC or with a vapor pressure of < 5 mm Hg at 20°C; Metering roll wash < 100 g/l VOC or vapor pressure of < 10 mm Hg at 20°C; Inks < 300 g/l VOC or Compliance with Graphic Arts Rule 67.16	Low VOC Materials	SDCAPCD BACT/Rule	2011/ 2012	Parts of the Graphic Arts rule is more stringent then the BACT and vice versa. Therefore, facilities would need to comply with the most stringent standard between the two This BACT determination is not specific to heatset printers and is only required for operations

Achieved in Practice VOC Standards for Lithographic Offset Heatset Printing					
Rank	Standard (ppmvd @ 15% O_2)	Technology Description	Source	Year	Comments
5	Inks, coatings, web splicing adhesive ≤ 300 g/l General adhesive ≤ 150 g/l Fountain solution ≤ 8% by volume Solvent cleaning for specialty presses, manual washing, automatic washing and ultraviolet ink removal ≤ 100 g/l General solvent cleaning and for adhesive application equipment ≤ 25 g/l	Low VOC Materials	BAAQMD Rule	2008	

Heatset Printing Presses – NOx

Emissions for NOx in heatset printing come from fuel combustion for the dryer. EPA AP-42 Section 4.9.1 for Graphic Arts states that typical temperatures for lithographic dryers range from 400 to 500 ^{o}F. Although, SCAMQD has a less stringent NOx standard for dryers with a process temperature of at least 1,200^{o}F, it will not be listed because process temperatures at this level are unrealistic for this type of application.

Achieved in Practice NOx Standards for Lithographic Offset Heatset Printing			
Rank	Standard	Source	Year
1	30 ppm @ 3% O_2	SCAQMD Rule	2017
2	Natural gas fuel used in drying oven	SJVAPCD BACT	1999
3	No standard	EPA, SMAQMD, SDCAPCD, BAAQMD	N/A

Heatset Printing Presses – CO

The SJVAPCD BACT determination lists the only achieved in practice standard for CO, which is to use natural gas fuel in the drying oven.

Heatset Printing Presses – PM10

Heatset inks typically will contain a petroleum based oil and during the heating process the oils will condense and form PM10 droplets. The BAAQMD specifically lists in their BACT determination that PM10 emissions must comply with the visible emissions regulations. Although, this requirement is not listed for other air districts (because it is not specifically outlined in a BACT determination) typically any equipment regardless of BACT standard being set is required to comply with visible emission requirements.

Achieved in Practice PM10 Standards for Lithographic Offset Heatset Printing			
Rank	PM10 Standard	Source	Year
1	Venting to an Afterburner (≥ 0.3 sec. Retention Time at ≥ 1400 ^{o}F)	SCAQMD BACT	2019
2	Compliance with Reg. 6, Visible Emissions	BAAQMD BACT	1998
3	No standard	EPA, SMAQMD, SJVAPCD, SDCAPCD	N/A

Non-heatset Printing Presses – VOC

Emission limits for fountain solutions vary from rule to rule mostly based on how the emission limit is expressed. SCAQMD lists emission limits for fountain solutions in grams per liter while SMAQMD expresses the limit in percent VOC by mass, and SJVUAPCD expresses the limits in percent VOC by volume. It is difficult to compare these limits because percent by mass and volume can vary from solution to solution depending upon its physical properties.

The EPA Control Techniques Guidelines for Offset Lithographic Printing and Letter Press Printing (CTG) list recommends emission standards as percent mass. The SMAQMD Rule also lists these identical standards as a percent mass. SCAQMD updated their emission limits for fountain solutions in 2014. In their staff report for these amendments they state that their emission limits are equivalent to those of the CTG except they have converted the limits to grams per liter to remain consistent with the previous emission limits for fountain solutions. Additionally, in 2008 amendments were made to SJVUAPCD Rule 4607, according to the associated staff report, to align the emission standards to that of other districts and the CTG.

Even though the emission limits for fountain solutions differ in the way they are expressed between the SCAQMD, SMAQMD, and SJVUAPCD all districts claim to be equivalent to the recommendations in the CTG.

The previous SMAQMD BACT Determination required a VOC control device for units emitting at least 4,697 lbs of uncontrolled VOC per year. This emissions threshold was based on what was considered cost effective at the time the determination was developed. Since this determination was adopted the EPA updated their Air Pollution Control Cost Manual. Therefore, the standard will be considered to be to install a VOC control device if annual emissions are large enough to make the control device cost effective. The cost effectiveness threshold for VOC is a maximum cost of $17,500 per ton of VOC reduced. A

summary of the cost effectiveness calculations using the updated 2018 EPA Air Pollution Cost Control Manual calculations and assumptions are show below.

Basic assumptions:

1) Single 4-color lithographic printing press operation.
2) Operation based on 8 hours per day, 5 days per week, 52 weeks per year.
3) Press room dimensions: 40'W x 60'L x 20'H (because the press room is relatively small a hood is not necessary)
4) The press room is assumed to be the enclosure with an overall system efficiency of 98.5% and venting to the control device through a general ventilation system.
5) Overall design of the system specified was chosen because it yielded the lowest annual costs.
6) Electricity cost was set at $0.138 per kWh and natural gas cost was set at $7.12 per 1,000 scf. Both were based on the most current local rates.
7) Cost adjusted to 2020 dollars.
8) Cost calculations and assumptions are based on the EPA Air Pollution Control Cost Manual (2018).

Carbon Adsorption System

System Type: Horizontal Stainless Steel (304) Fixed-Beds with Steam Regeneration

Waste Gas Flow Rate = 8,000 acfm (10 air changes per hour)

Equipment Life = 15 years (EPA recommended value)

Total Capital Investment = $274,980

Direct Annual Cost = $13,443 per year

Indirect Annual Cost = $44,524 per year

VOC Recovery Credit = $2,106 per year

Total Annual Cost = $55,860 per year

VOC Removed = 3.19 tons per year

Cost of VOC Removal = $17,506 per ton reduced

A detailed calculation of the cost effectiveness for VOC removal with a carbon absorber is shown in Attachment B. Uncontrolled VOC emissions of 6,480 lb/year or greater is the cost-effective threshold for control equipment using carbon absorption control technology.

Thermal Oxidizer:

System Type: Regenerative Thermal Oxidizer

Waste Gas Flow Rate = 20,000 scfm (EPA recommended value)

Equipment Life = 20 years (EPA recommended value)

Total Capital Investment = $1,120,944

Direct Annual Cost = $74,737 per year

Indirect Annual Cost = $141,446 per year

Total Annual Cost = $216,184 per year

VOC Removed = 12.31 tons per year

Cost of VOC Removal = $17,566 per ton reduced

A detailed calculation of the cost effectiveness for VOC removal with a thermal oxidizer is shown in Attachment C. Uncontrolled VOC emissions of 24,983 lb/year or greater is the cost-effective threshold for control equipment using thermal oxidation control technology.

Conclusion: In this analysis, different emission operating levels are presented with the corresponding total cost per ton of VOC controlled using either a carbon adsorption control or a thermal oxidizer. Uncontrolled VOC emission level of 6,480 lb per year or greater must be reached in order for the carbon absorption control option to be cost effective. Uncontrolled VOC emission level of 24,983 lb per year or greater must be reached in order for a thermal oxidizer to be cost effective. The emissions levels for the cost effectiveness of controls is based on the District cost effective limit for ROC of $17,500 per ton controlled. Therefore, using the updated 2018 EPA Air Pollution Cost Control Manual calculations and assumptions the achieved in practice VOC standard for the SMAQMD requires a VOC control device if total uncontrolled VOC emissions are at least 6,480 lbs

Achieved in Practice VOC Standards for Lithographic Offset Non-heatset Printing				
Rank	VOC Standard	Source	Year	Comments
1	• Inks & Coatings: 300 g/l (2.5 lb/gal) • Adhesives: 150 g/l (1.25 lb/gal) • Fountain solutions equivalent to CTG • Cleaning solvents for on-press components or ultraviolet/electron beam inks: 100 g/l (0.83 lb/gal) • Solvents for general or removable press component cleaning: 25 g/l (0.21 lb/gal) • If the unit emits ≥ 6,480 lbs of uncontrolled VOC per year a VOC control device must be installed with an overall control efficiency of at least 98.5%	SMAQMD BACT	2017	VOC threshold for a control device adjusted for updates to EPA guidelines. Determined to be most stringent due to no other standards required a VOC control device.

Achieved in Practice VOC Standards for Lithographic Offset Non-heatset Printing				
Rank	VOC Standard	Source	Year	Comments
2	• Inks: 5% by weight for low end graphics (A); 30% by weight for high end graphics (A) or 300 g/l (2.5 lb/gal) whichever is more stringent. • Coatings: 300 g/l (2.5 lb/gal) • Adhesives: 150 g/l (1.25 lb/gal) • Fountain solutions equivalent to CTG • Cleaning solvents for on-press components or ultraviolet/electron beam inks: 100 g/l (0.83 lb/gal) Solvents for general or removable press component cleaning: 25 g/l (0.21 lb/gal)	SJVUAPCD BACT/Rule	2010/ 2008	Rule limits were used for material standards not specified in the BACT determination
3	• Inks & Coatings: 300 g/l (2.5 lb/gal) • Adhesives: 150 g/l (1.25 lb/gal) • Fountain solutions equivalent to CTG (at least 8% by volume) • Cleaning solvents for on-press components or ultraviolet/electron beam inks: 100 g/l (0.83 lb/gal) • Solvents for general or removable press component cleaning: 25 g/l (0.21 lb/gal)	SCAQMD BACT	2019	SCAQMD BACT requires compliance with Graphic Arts Rule 1130 and Solvent Cleaning Operations Rule 1171
4	• Inks & Coatings: 300 g/l (2.5 lb/gal) • Adhesives: 150 g/l (1.25 lb/gal) • Fountain solutions: 5% by volume or 8.5% by volume if refrigerated to a temperature below 60^{o}F • Capture and recycle blanket and roller tray wash • Cleaning solvents: 100 g/l (0.83 lb/gal) or a vapor pressure of 5 mm Hg at 20^{o}C.	SDCAPCD Rule/BACT	2012/ 2011	Requirement to capture and recycle washes is from the BACT determination otherwise standards are from Rule
5	• Inks & Coatings: 300 g/l (2.5 lb/gal) • Web Splicing Adhesive: 300 g/l (2.5 lb/gal) • All Other Adhesives: 150 g/l (1.25 lb/gal) • Fountain solutions: 8% by volume • Cleaning solvents for on-press components or ultraviolet/electron beam inks: 100 g/l (0.83 lb/gal) • Solvents for general or adhesive application equipment cleaning: 25 g/l (0.21 lb/gal)	BAAQMD Rule	2008	

(A) According to SJVAPCD permit language, high end graphic print jobs are defined as any print job that has a glossy finish, multiple colors, highly refined graphic image, or very high letter-quality printing. Low end graphic print jobs are defined as anything not high end graphic.

Toxics

The only T-BACT standard found was from the BAAQMD where T-BACT is equivalent to their VOC standard for both heatset and non-heatset lithographic printing presses.

Summary Table

The following control technologies have been identified as the most stringent, achieved in practice control technologies. The SMAQMD Rule 450 material standards have been referenced for convenience, for enforcement purposes, when possible:

Best Control Technologies Achieved in Practice for Heatset Lithographic Offset Printing			
Pollutant	Standard	Source	Comments
VOC	Dryer waste gas vented to a control device with 98% control efficiency or an outlet VOC concentration of 10 ppmv and compliance with the material limits in SMAQMD Rule 450 Sections 301 and 302.	EPA/ SCAQMD	As the EPA determination had no limits for inks & coatings the top two most stringent determinations were combined. SMAQMD Rule 450 material limits are as stringent as SCAQMD material limits.
NOx	30 ppmvd @ 3% O_2	SCAQMD Rule	
SOx	No standard	N/A	
PM10	Vent dryer waste gas to a VOC control device	SCAQMD BACT	
PM2.5	No standard	N/A	
CO	Natural gas fuel used in drying oven	SJVAPCD BACT	
Organic HAP/VHAP (T-BACT)	Low VOC fountain solution (≤ 8% by vol.); and minimum possible VOC blanket wash & roller & tray washes; and cleanup solvents w/ ≤ 7.5 lb VOC/gal and VOC vapor pressure ≤ 25 mm Hg or ≤ 30% by vol. VOC; and kerosene-like oil based inks	BAAQMD BACT	

Best Control Technologies Achieved in Practice for Non-Heatset Lithographic Offset Printing			
Pollutant	Standard	Source	Comments
VOC	Compliance with the material limits in SMAQMD Rule 450 Sections 301 and 302. If the total uncontrolled VOC emissions from the unit are ≥ 6,480 lbs per year then a VOC control system must be installed with at least 98.5% overall system efficiency (capture and destruction).	SMAQMD	
NOx	No standard	N/A	
SOx	No standard	N/A	
PM10	No standard	N/A	
PM2.5	No standard	N/A	
CO	No standard	N/A	
Organic HAP/VHAP (T-BACT)	Low VOC fountain solution (≤ 8% by vol.); and minimum possible VOC blanket wash & roller & tray washes; and cleanup solvents w/ ≤ 7.5 lb VOC/gal and VOC vapor pressure ≤ 25 mm Hg or ≤ 30% by vol. VOC; and kerosene-like oil based inks	BAAQMD BACT	

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

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

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

Technologically Feasible Alternatives			
Pollutant	**Emission Source Category**	**Standard**	**Source of Standard**
VOC	Heatset	No other technologically feasible option identified	N/A
	Non-Heatset	No other technologically feasible option identified	N/A
NOx	All Presses	No other technologically feasible option identified	N/A

Technologically Feasible Alternatives			
Pollutant	**Emission Source Category**	**Standard**	**Source of Standard**
SOx	All Presses	No other technologically feasible option identified	N/A
PM10	All Presses	No other technologically feasible option identified	N/A
PM2.5	All Presses	No other technologically feasible option identified	N/A
CO	Heatset	Catalytic Oxidizer	SJVAPCD BACT
	Non-Heatset	No other technologically feasible option identified	N/A
Organic HAP/VHAP (T-BACT)	Heatset	Capture and vent VOC control device with at least 98.5% destruction / recovery device efficiency	BAAQMD
	Non-Heatset	Capture and vent VOC control device with at least 98.5% destruction / recovery device efficiency	BAAQMD

Cost Effective Determination:
SJVAPCD lists in their technologically feasible BACT determination for heatset lithographic printing presses is a catalytic oxidizer for CO emissions. In the details portion of the determination they noted that this was not required because it was determined not to be cost effective. Therefore, because this control technology has already been shown to not be cost effective it will not be required as part of BACT.

C. SELECTION OF BACT:

Based on the above analysis, BACT for VOC, NOx, SOx, PM10, and CO will remain at what is currently achieved in practice.

BACT DETERMINATION #250 FOR HEATSET LITHOGRAPHIC OFFSET PRINTING		
Pollutant	**Standard**	**Source**
VOC	Dryer waste gas vented to a control device with 98% control efficiency or an outlet VOC concentration of 10 ppmv and compliance with the material limits in SMAQMD Rule 450 Sections 301 and 302.	EPA/SCAQMD
NOx	Dryer combustion emissions no more than 30 ppmvd @ 3% O_2	SCAQMD
SOx	No standard	N/A
PM10	Vent dryer waste gas to a VOC control device	SCAQMD
PM2.5	No standard	N/A
CO	Natural gas fuel used in drying oven	SCAQMD
Organic HAP/VHAP (T-BACT)	Capture and vent VOC control device with at least 98.5% destruction / recovery device efficiency	BAAQMD

BACT DETERMINATION #251 FOR NON-HEATSET LITHOGRAPHIC OFFSET PRINTING		
Pollutant	**Standard**	**Source**
VOC	Compliance with the material limits in SMAQMD Rule 450 Sections 301 and 302. If the total uncontrolled VOC emissions from the unit are ≥ 6,480 lbs per year then a VOC control system must be installed with at least 98.5% overall system efficiency (capture and destruction).	SMAQMD
NOx	No standard	N/A
SOx	No standard	N/A
PM10	No standard	N/A
PM2.5	No standard	N/A
CO	No standard	N/A
Organic HAP/VHAP (T-BACT)	Capture and vent VOC control device with at least 98.5% destruction / recovery device efficiency	BAAQMD

APPROVED BY: *Brian F Krebs* **DATE:** **3-24-20**

Attachment A

Review of BACT Determinations published by EPA

List of BACT determinations published in EPA's RACT/BACT/LAER Clearinghouse (RBLC) for Lithographic Offset Printing Presses:

Surface Coating/Printing/Graphic Arts (Process 41.000) – Lithographic Offset Printing Presses							
RBLC#	**Process Number**	**Permit Date(A)**	**Drying**	**Pollutant**	**Standard**	**Control Technology**	**Case-By-Case Basis**
IN-0193	41.021	11/13/2013	Heatset	VOC	98% destruction or 10 ppmv; Fountain solution ≤ 3% VOC; Washes ≤ 10 mm Hg at 20°C	Thermal oxidizer; Low VOC materials; good work practices	Other
IN-0277	41.022	3/31/2018	Heatset	VOC	98% destruction or 50 ppmv; Fountain solution ≤ 3% VOC; Washes ≤ 10 mm Hg at 20°C or VOC ≤ 2.5 lb/gal	Thermal oxidizer; Low VOC materials; Good work practices	Other
IN-0211	41.022	6/12/2015	Heatset	VOC	98% destruction; Fountain solution ≤ 15% VOC; Washes ≤ 10 mm Hg at 20°C or VOC ≤ 7.0 lb/gal	Thermal oxidizer; Low VOC materials	Other
IN-0207	41.022	11/26/2014	Heatset	VOC	98% destruction or 50 ppmv; Fountain solution ≤ 3% VOC; Washes ≤ 10 mm Hg at 20°C or VOC ≤ 2.5 lb/gal	Thermal oxidizer; Low VOC materials; Good work practices	Other
IN-0164	41.023	6/28/2013	Heatset	VOC	98% destruction or 10 ppmv; Fountain solution ≤ 15% VOC; Washes ≤ 10 mm Hg at 20°C or VOC ≤ 7.0 lb/gal	Thermal oxidizer; Low VOC materials	Other
IN-0130	41.023	1/3/2011	Heatset	VOC	98% destruction or 10 ppmv; Fountain solution ≤ 3% VOC; Washes ≤ 10 mm Hg at 20°C or VOC ≤ 5.6 lb/gal	Thermal oxidizer; Low VOC materials	Other

(A) Due to the large number of entries only determinations made (based on Permit Date) entered since 01/01/2009 are included in the above table.

= Selected as the most stringent and most current BACT determination achieved in practice.

Attachment B

Detailed Cost Calculation 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: Intermittent 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 (Θ_s)	2,080	hours/year	
Waste Gas Flow Rate (Q)	8,000	acfm (at atmospheric pressure and 77°F)	
VOC Emission Rate (m_{voc})	3.115	lbs/hour	
Required VOC removal efficiency (E)	98.5	percent	
Superficial Bed Velocity (v_b)	75.00	ft/min	
Estimated equipment life of adsorber vessels and auxiliary Equipment (n)	15	Years*	* 15 years is a default equipment life. User should enter actual value, if known.
Estimated Carbon life (n)	5	Years	
Total Number of carbon beds (N_{total})	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 (N_A)	2	Beds*	* 2 beds is the default. User should enter actual number of beds, if known.
Total time for adsorption (Θ_A)	12	hours*	* 12 hours is a default value. User should enter actual value, if known.
Total time for desorption (Θ_D)	5	hours*	* 5 hours is a default value. User should enter actual value, if known.
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	2020			
CEPCI* for 2020	567.5	CEPCI value for 2020	390.6	1999
Annual Interest Rate (i)	5	percent*		* 5 percent is a default value. User should enter current prime bank 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.

Electricity (P_{elec})	$0.1380	per kWh	
Steam (P_s)	$5.00	per 1,000 lbs*	* $5.00/1,000 lbs is a default value. User should enter actual value, if known.
Cooling Water (P_{cw})	$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	$27.48	per hour*	* $27.48/hour is a default value. User should enter actual value, if known.
Maintenance Labor Rate	$30.23	per hour*	* $30.23/hour is a default value. User should enter actual value, if known. If the rate is not known, use 1.10 x operator labor rate.
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 (P_{voc})	$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
Disposal/Treatment Cost for Recovered VOC (D_{voc})	$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.

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) (EC_{aux}) =	$32,000	* Default value. User should enter actual value, if known.
Contingency Factor (CF)	10.0 percent*	* 10 percent is a default value. The contingency factor should be between 5 and 15 percent.

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 = Intermittent Operation

Total Capital Investment (TCI) (in 2020 dollars)

Parameter	Equation	Cost
Costs for Each Carbon Adsorber Vessel (C_v) =	$271 \times F_m \times S^{0.778}$ =	$21,199
Total Cost for All Carbon Adsorber Vessels and Carbon(EC_{Adsorb}) =	$5.82 \times Q^{-0.133} \times [C_c + (N_A + N_D) \times C_v]$ =	$114,497
Auxiliary Equipment (EC_{aux}) =	(Based on design costs or estimated using methods provided in Section 2)	$32,000
Total Purchased Equipment Costs for Carbon Adsorber (A) =	= $EC_{Adsorb} + EC_{aux}$ =	$146,497
Instrumentation =	0.10 × A =	Included in A
Sales taxes =	0.03 × A =	$4,395
Freight =	0.05 × A =	$7,325
	Total Purchased Equipment Costs (B) =	$158,217

Direct Installation Costs (in 2020 dollars)

Parameter	Equation	Cost
Foundations and Supports =	0.08 × B =	$12,657
Handling and Erection =	0.14 × B =	$22,150
Electrical =	0.04 × B =	$6,329
Piping =	0.02 × B =	$3,164
Insulation =	0.01 × B =	$1,582
Painting =	0.01 × B =	$1,582
Site Preparation (SP) =		$0
Buildings (Bldg) =		$0
	Total Direct Costs (DC) = B + (0.3 × B) + SP + Bldg =	$205,682

Total Indirect Installation Costs (in 2020 dollars)

Parameter	Equation	Cost
Engineering =	0.10 × B =	$15,822
Construction and field expenses =	0.05 × B =	$7,911
Contractor fees =	0.10 × B =	$15,822
Start-up =	0.02 × B =	$3,164
Performance test =	0.01 × B =	$1,582
	Total Indirect Costs (IC) =	$44,301
Contingency Cost (C) =	CF(IC+DC)=	$24,998

Total Capital Investment (TCI) =	**DC + IC + C = (1.28 × B) + SP + Bldg. + C =**	**$274,980**	**in 2020 dollars**

Annual Costs

Direct Annual Costs

Parameter	Equation	Cost	
Annual Electricity Cost =	$Q_{Elec} \times P_{elec}$ =	$729	
Annual Steam Cost (C_s) =	$3.50 \times m_{voc} \times \Theta_s \times P_s$ =	$113	
Annual Cooling Water Cost (C_{cs}) =	$3.43 \times C_s/P_s \times P_{wc}$ =	$276	
Operating Labor Costs:	Operator = 0.5 hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$3,572	
	Supervisor = 15% of Operator	$536	
Maintenance Costs:	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$3,930	
	Materials = 100% of maintenance labor	$3,930	
Carbon Replacement Costs:	Labor = $CRF_{carbon} \times$ (Labor Rate × M_c)/CRR =	$4	
	Carbon = $CRF_{carbon} \times CC \times M_c \times 1.08$ =	$352	

Direct Annual Costs (DAC) =	**$13,443**	**in 2020 dollars**

Indirect Annual Costs

Parameter	Equation	Cost	
Overhead	= 60% of sum of operator, supervisor, maintenance labor Plus maintenance materials	$7,181	
Administrative Charges	= 2% of TCI	$5,500	
Property Taxes	= 1% of TCI	$2,750	
Insurance	= 1% of TCI	$2,750	
Capital Recovery	= $CRF_{Adsorber}$ × (TCI - [(1.08 x CC x M_c) + (LR x M_c/CRR)] =	$26,344	

Indirect Annual Costs (IAC) =	**$44,524**	**in 2020 dollars**

Recovered Solvent Credit/Disposal Costs

Disposal Cost

Parameter	Equation	Cost
VOC Disposal/Treatment Costs (*Disposal $_{cost}$*)	$= m_{voc} \times \Theta_s \times D_{voc} \times E$ =	$0

VOC Recovery Credit

Parameter	Equation	Cost
Annual Recovery Credit for Condensate (RC)	$= m_{voc} \times \Theta_s \times P_{voc} \times E$ =	$2,106

Total Annual Cost (TAC) =	**DAC + IAC + C + $Disposal_{Cost}$ - RC =**	**$55,860**	**in 2020 dollars**

Cost Effectiveness

Cost Effectiveness

Parameter	Equation	Cost	
Total Annual Cost =	TAC =	$55,860	per year in 2020 dollars
Annual Quantity of VOC Removed/Recovered =	$W_{voc} = m_{voc} \times \Theta_s \times E =$	3.19	tons/year
Cost Effectiveness =	Total Annual Cost (TAC) / Annual Quantity of VOC Removed/Recovered =	$17,505.51	per ton of pollutants removed/recovered in 2020 dollars

Attachment C

Detailed Cost Calculation 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	42	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.

s

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*	* 20,000 scfm is a default volumetric flow rate. User should enter actual value, if known.
Inlet volumetric flow rate(Q_{wi}) (actual conditions)	20,900	acfm*	* 20,900 acfm is a default volumetric flow rate. User should enter actual value, if known.
Pressure drop (ΔP)	23	inches of water*	* 23 inches of water is the default pressure drop for thermal oxidizers; 19 inches of water is the default pressure drop for catalytic oxidizers. Enter actual value, if known.
Motor/Fan Efficiency (ε)	60	percent*	* 60% is a default fan efficiency. User should enter actual value, if known.
Inlet Waste Gas Temperature (T_{wi})	77	°F	
Operating Temperature (T_{fi})	2,000	°F*	* 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.
Destruction and Removal Efficiency (DRE)	98.5	percent	
Estimated Equipment Life	20	Years*	* 20 years is the typical equipment life. User should enter actual value, if known.
Heat Loss (η)	1	percent*	* 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%.

Percent Energy Recovery (HR) = 70 percent

Enter the cost data:

Desired dollar-year	2020			
CEPCI* for 2020	541.7	Enter the CEPCI value for 2020	541.7	2016 CEPCI
Annual Interest Rate (i)	5	Percent		
Electricity ($Cost_{elect}$)	0.138	$/kWh		
Natural Gas Fuel Cost ($Cost_{fuel}$)	0.00712	$/scf		
Operator Labor Rate	$26.61	per hour		
Maintenance Labor rate	$27.40	per hour		
Contingency Factor (CF)	10.0	Percent		

* $26.61 per hour is a default labor rate. User should enter actual value, if known.

* $27.40 per hour is a default labor rate. User should enter actual value, if known.

* 10 percent is 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.

Cost Estimate

Direct Costs			
Total Purchased equipment costs (in 2020 dollars)			
Incinerator + auxiliary equipment[a] (A) =			
Equipment Costs (EC) for Regenerative Oxidizer	=[2.664 x 100,000 + (13.98 x Qtot)] x (2020 CEPI/2016 CEPCI) =	$546,578	in 2020 dollars
Instrumentation[b] =	0.10 × A =	$54,658	
Sales taxes =	0.03 × A =	$16,397	
Freight =	0.05 × A =	$27,329	
	Total Purchased equipment costs (B) =	$644,962	in 2020 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 2020 dollars)			
Foundations and Supports =	0.08 × B =	$51,597	
Handlong and Errection =	0.14 × B =	$90,295	
Electrical =	0.04 × B =	$25,798	
Piping =	0.02 × B =	$12,899	
Insulation for Ductwork =	0.01 × B =	$6,450	
Painting =	0.01 × B =	$6,450	
Site Preparation (SP) =		$0	
Buildings (Bldg) =		$0	
	Total Direct Installaton Costs =	$193,489	
Total Direct Costs (DC) =	Total Purchase Equipment Costs (B) + Total Direct Installation Costs =	$838,450	in 2020 dollars
Total Indirect Installation Costs (in 2020 dollars)			
Engineering =	0.10 × B =	$64,496	
Construction and field expenses =	0.05 × B =	$32,248	
Contractor fees =	0.10 × B =	$64,496	
Start-up =	0.02 × B =	$12,899	
Performance test =	0.01 × B =	$6,450	
	Total Indirect Costs (IC) =	$180,589	
Continency Cost (C) =	CF(IC+DC)=	$101,904	
Total Capital Investment =	**DC + IC +C =**	**$1,120,944**	**in 2020 dollars**

Direct Annual Costs		
Annual Electricity Cost	= Fan Power Consumption × Operating Hours/year × Electricity Price =	$26,906
Annual Fuel Costs for Natural Gas	= $Cost_{fuel}$ × Fuel Usage Rate × 60 min/hr × Operating hours/year	$36,729
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$3,459
	Supervisor = 15% of Operator	$519
Maintenance Costs	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$3,562
	Materials = 100% of maintenance labor	$3,562
Direct Annual Costs (DC) =		**$74,737 in 2020 dollars**

Indirect Annual Costs		
Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	$6,661
Administrative Charges	= 2% of TCI	$22,419
Property Taxes	= 1% of TCI	$11,209
Insurance	= 1% of TCI	$11,209
Capital Recovery	= CRF[TCI-1.08(cat. Cost)]	$89,947
Indirect Annual Costs (IC) =		**$141,446 in 2020 dollars**

Total Annual Cost =	**DC + IC =**	**$216,184 in 2020 dollars**

Cost Effectiveness

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

Total Annual Cost (TAC) =	$216,184	per year in 2020 dollars
VOC/HAP Pollutants Destroyed =	12.31	tons/year
Cost Effectiveness =	$17,566	per ton of pollutants removed in 2020 dollars