777 12th Street, Third Floor

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

Sacramento, CA 95814

BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

DETERMINATION NO.: 149 & 176

DATE: 11/20/17

ENGINEER: Felix Trujillo, Jr.

Category/General Equip Description: Printing Process

Equipment Specific Description: Printing Press/Box Finishing - Flexographic – and Non-Heatset

Equipment Size/Rating: <8,683 lbs VOC/year (BACT #149) and ≥ 8,683 lbs VOC/year (BACT #176)

Previous BACT Det. No.: None

A review of the District's permit database showed the District's only flexographic printing presses are for box finishing corrugated packaging operations. Therefore, this BACT determination will only apply to box finishing operations. The San Joaquin Valley Air Pollution Control District's graphic arts rule (Rule 4607) includes a category for flexographic specialty inks with VOC content limits that are higher than for other flexographic inks. Sacramento Air Quality Management District's Rule 450 (Graphic Arts Operations) does not include a category for flexographic specialty inks. Therefore, SMAQMD Rule 450 is more stringent for these inks. The SMAQMD rule does not include any heat set flexographic printing operations. Therefore, this BACT will not address heat set flexographic printing operations.

This BACT will apply to an individual press and will assume it is enclosed in a room that will not require the use of a hood or the construction of a permanent total enclosure (PTE). This will ensure this BACT covers all scenarios. Therefore, only the cost of the carbon adsorption system will be evaluated. This is a conservative estimate since the addition of hoods and PTE would add to the cost of the control system.

BACT ANALYSIS

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

The following control technologies are currently employed as BACT for flexographic printing presses that are non-heatset by the following air pollution control districts:

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>US EPA</td><td>
<u>BACT</u>
Source: EPA RACT/BACT/LAER Clearinghouse

<table>
<tr><td>VOC</td><td>N/A – No BACT determinations found for flexographic printing</td></tr>
<tr><td>NOx</td><td>N/A – No BACT determinations found for flexographic printing</td></tr>
<tr><td>SOx</td><td>N/A – No BACT determinations found for flexographic printing</td></tr>
<tr><td>PM10</td><td>N/A – No BACT determinations found for flexographic printing</td></tr>
<tr><td>PM2.5</td><td>N/A – No BACT determinations found for flexographic printing</td></tr>
<tr><td>CO</td><td>N/A – No BACT determinations found for flexographic printing</td></tr>
</table>

<u>T-BACT</u>
There are no T-BACT standards published in the clearinghouse for this category.

<u>RULE REQUIREMENTS</u>:
40 CFR 63 Subpart KK – National Emission Standards for the Printing and Publishing Industry

This regulation applies to facilities at which publication rotogravure, product and packaging rotogravure, or wide-web flexographic printing presses are operated and that are located at a plant site that is a major source of HAPs as defined in 40 CFR 63 Subpart A, §63.2. Although this NESHAP applies only to major sources of HAPs, it will be considered achieved in practice in the T-BACT evaluation for minor sources.

Subpart KK limits organic HAP emissions of product and packaging rotogravure or wide-web flexographic printing (capable of printing substrates greater than 18 inches in width) to the following:

§63.825(b) Each product and packaging rotogravure or wide-web flexographic printing affected source shall limit organic HAP emissions to no more than 5 percent of the organic HAP applied for the month; or to no more than 4 percent of the mass of inks, coatings, varnishes, adhesives, primers, solvents, reducers, thinners, and other materials applied for the month; or to no more than 20 percent of the mass of solids applied for the month; or to a calculated equivalent allowable mass based on the organic HAP and solids contents of the inks, coatings, varnishes, adhesives, primers, solvents, reducers, thinners, and other materials applied for the month.
</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>ARB

ARB</td><td>

BACT
Source: ARB BACT Clearinghouse

Note: All BACT determinations published in the ARB BACT Clearinghouse are at least 10 years old.

<table>
<tr><th colspan="2">ARB BACT Clearinghouse*</th></tr>
<tr><td>VOC</td><td>Water based inks with VOC content not to exceed 1.5 lb/gal and use of clean up solvent containing no VOCs.</td></tr>
<tr><td>NOx</td><td>No standard</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>No standard</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>No standard</td></tr>
</table>

* This BACT determination was found to be the most stringent Achieved in Practice BACT determination published in the ARB clearinghouse based on the control description. This BACT determination was made by the SCAQMD on 1/3/01. The current SCAQMD BACT for flexographic printing was revised on 12/5/03. Therefore, the latest version of the SCAQMD BACT will be referenced for this BACT determination.

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

RULE REQUIREMENTS:
None

</td></tr>
<tr><td></td><td>

BACT

<table>
<tr><th colspan="2">Flexographic printing press</th></tr>
<tr><td>VOC</td><td>No standard</td></tr>
<tr><td>NOx</td><td>No standard</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>No standard</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>No standard</td></tr>
</table>

</td></tr>
</table>

<table>
<tr><td>District/Agency</td><td>Best Available Control Technology (BACT)/Requirements</td></tr>
<tr><td>SMAQMD

SMAQMD</td><td>
<u>T-BACT</u>
There are no T-BACT standards published in the clearinghouse for this category.

<u>RULE REQUIREMENTS</u>:

<u>Rule 450 – Graphic Arts Operations (10/23/2008)</u>

<table>
<tr><th>MATERIAL TYPE</th><th>VOC CONTENT LIMITS g/l (lb/gal)
Less water and exempt compounds</th></tr>
<tr><td>Printing Ink</td><td>300 (2.5)</td></tr>
<tr><td>Adhesive</td><td>150 (1.25)</td></tr>
<tr><td>Coating</td><td>300 (2.5)</td></tr>
</table>

VOC Content for Solvent Cleaning Materials:
<table>
<tr><th>MATERIAL TYPE</th><th>VOC Content Limits
g/l (lb/gal)
Including Water and Exempt Compounds</th></tr>
<tr><td>General (e.g., maintenance, repair, solvent, wipe) Cleaning</td><td>25 (0.21)</td></tr>
<tr><td colspan="2">Application Equipment Cleaning</td></tr>
<tr><td>General (not specifically listed below)</td><td>25 (0.21)</td></tr>
<tr><td>Flexographic Printing</td><td>25 (0.21)</td></tr>
<tr><td>Specialty Flexographic Printing</td><td>100 (0.83)</td></tr>
</table>

Control Devices Control Efficiency:
Control Devices for flexographic Printing Presses must have an overall system efficiency of 67%.
</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>South Coast AQMD</td><td>

BACT
Source: SCAQMD BACT Guidelines for Non-Major Polluting Facilities, page 100.

<table>
<tr><th colspan="2">Printing (Graphic Arts) - Flexographic</th></tr>
<tr><td>VOC</td><td>Inks with ≤ 1.5 lbs VOC/gal, less water and exempt compounds; and compliance with AQMD rules 1130 and 1171 (7-14-2006)</td></tr>
<tr><td>NOx</td><td>No standard</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>No standard</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>No standard</td></tr>
</table>

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

RULE REQUIREMENTS:
Reg XI, Rule 1130 – Graphic Arts (5/2/2014)

<table>
<tr><th>Graphic Art Material</th><th>VOC CONTENT LIMITS
g/l Less water and exempt compounds</th></tr>
<tr><td>Adhesive</td><td>150</td></tr>
<tr><td>Coating</td><td>300</td></tr>
<tr><td>Flexographic Fluorescent Ink</td><td>300</td></tr>
<tr><td>Flexographic Ink: Non-Porous Substrate</td><td>300</td></tr>
<tr><td>Flexographic Ink: Porous Substrate</td><td>225</td></tr>
</table>

An emission control device must have a control efficiency of at least 95% and the emission collection system must have a collection efficiency of at least 90%.

</td></tr>
</table>

<table>
<tr><td>District/Agency</td><td>Best Available Control Technology (BACT)/Requirements</td></tr>
<tr><td></td><td>
<u>Reg XI, Rule 1171 – Solvent Cleaning Operations (5/1/2009)</u>
<table>
<tr><th>Solvent Cleaning Activity</th><th>VOC Limits g/l (lb/gal)</th></tr>
<tr><td>Cleaning of Coatings or Adhesives Application Equipment</td><td>25 (0.21)</td></tr>
<tr><td colspan="2">Cleaning of Ink Application Equipment</td></tr>
<tr><td>General</td><td>25 (0.21)</td></tr>
<tr><td>Flexographic Printing</td><td>25 (0.21))</td></tr>
<tr><td>Specialty Flexographic Printing</td><td>100 (0.83)</td></tr>
</table>
</td></tr>
<tr><td>San Diego County APCD</td><td>
<u>BACT</u>
Source: NSR Requirements for BACT, page 3-14.
<table>
<tr><th colspan="2">Graphic Arts Operations (< 5 tons/year)</th></tr>
<tr><td>VOC</td><td>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 g VOC/l or vapor pressure of less than 5 mm HG at 20^{O}C,
4. Use of metering roll cleanup solvent which has either less than 100 g VOC/l or vapor pressure less than 10 mm HG at 20^{O}C, and
5. Use of inks which have a VOC content of less than 300 g/l (2.5 lb/gal)</td></tr>
<tr><td>NOx</td><td>No standard</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>No standard</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>No standard</td></tr>
</table>
<u>T-BACT</u>
There are no T-BACT standards published in the clearinghouse for this category.

<u>RULE REQUIREMENTS</u>:

<u>Regulation 4, Rule 67.16 – Graphic Arts Operations (11/9/2011)</u>

a) Graphic arts materials, except adhesives, must contain < 300 g VOC/l (2.5 lb/gal)

b) Adhesives containing not more than 150 grams of VOC per liter (1.25 lb/gal), as applied, less water and less exempt compounds
</td></tr>
</table>

<table>
<tr><td>District/Agency</td><td>Best Available Control Technology (BACT)/Requirements</td></tr>
<tr><td></td><td>c) Cleaning material must have a VOC content less than 100 g/l or the total VOC vapor pressure of the cleaning material is 5mm of Hg at 20^{O}C or less.

d) Control devices must have a capture and control efficiency of 85% by weight.</td></tr>
<tr><td>Bay Area AQMD</td><td><u>BACT</u>
Source: BAAQMD BACT Guidelines, Document #110.2.1, Rev. 4, 8/24/98
<table>
<tr><td colspan="2">Flexographic Printing Line</td></tr>
<tr><td>VOC</td><td>Water reducible inks with either: < 1.5 lb VOC/gal coating or 10% by volume VOC: and no VOC clean-up solvents</td></tr>
<tr><td>NOx</td><td>No standard</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>No standard</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>No standard</td></tr>
</table>
<u>T-BACT</u>
This guideline also lists these standards as TBACT.

<u>RULE REQUIREMENTS</u>:

<u>Reg 8, Rule 20 – Graphic Arts Printing and Coating Operations (11/19/2008)</u>
<table>
<tr><td rowspan="2">Product</td><td>Product Limit
grams VOC per liter of product as applied, less water and exempt solvent
(lbs/gal)</td></tr>
<tr><td>Less than:</td></tr>
<tr><td>Ink</td><td>300 (2.5)</td></tr>
<tr><td>Flexographic Ink Porous Substrate</td><td>225 (1.9)</td></tr>
<tr><td>Flexographic Ink Non-Porous Substrate</td><td>300 (2.5)</td></tr>
<tr><td>Coating</td><td>300 (2.5)</td></tr>
<tr><td>Adhesive</td><td>150 (1.25)</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>District/Agency</td><td>Best Available Control Technology (BACT)/Requirements</td></tr>
<tr><td></td><td>
<table>
<tr><td>Web Splicing Adhesive</td><td>300 (2.5)</td></tr>
</table>
Cleaning Product Limits:
<table>
<tr><th>Equipment</th><th>VOC g/l (lb/gal) including water</th></tr>
<tr><td>For Press Equipment, except Other Press Parts</td><td></td></tr>
<tr><td>Adhesive Application Equipment</td><td>25 (0.21)</td></tr>
<tr><td>Ultraviolet Ink Removal, Any Press Type</td><td>100 (0.83)</td></tr>
<tr><td>Other Press Parts</td><td>25 (0.21)</td></tr>
</table>
Emission control systems must have an overall efficiency of 75% on a mass basis.
</td></tr>
<tr><td>San Joaquin Valley APCD</td><td>
<u>BACT</u>
Source: SJVUAPCD BACT Guideline 4.7.4 (9/22/06)
<table>
<tr><th colspan="2">Flexographic Printing – Corrugated Boxes, High-End Graphics</th></tr>
<tr><td>VOC</td><td>Use of inks with a VOC content not exceeding 1.1 lb/gal (less water & exempt compounds) for high-end graphics and use of inks with a VOC content not exceeding 2.5 lb/gal (less water & exempt compounds) for metallic inks.</td></tr>
<tr><td>NOx</td><td>No standard</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>No standard</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>No standard</td></tr>
</table>
The SVJAPCD defines high-end graphics as print jobs that require any of the following: a glossy finish, multiple colors, highly refined graphic image or very high letter-quality printing.

Source: SJVUAPCD BACT Guideline 4.7.15 (9/22/06)
</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>San Joaquin Valley APCD</td><td>
<table>
<tr><th colspan="2">Flexographic Printing – Corrugated Boxes, Low-End Graphics</th></tr>
<tr><td>VOC</td><td>Use of coating with a VOC content (less water and exempt compounds) as indicated, or lower: 0.3 lb/gal and evaporative minimization methods, which include keeping all solvents and solvent-laden cloths/papers, not in active use, in closed containers.</td></tr>
<tr><td>NOx</td><td>No standard</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>No standard</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>No standard</td></tr>
</table>
The SJVAPCD considers low-end graphics as graphics that are not considered high-end graphics.
Source: SJVUAPCD BACT Guideline 4.9.12 (9/22/06)
<table>
<tr><th colspan="2">Corrugated Box Gluer</th></tr>
<tr><td>VOC</td><td>Use of adhesives with a VOC content (less water and exempt compounds) not exceeding 0.044 lb/gal.</td></tr>
<tr><td>NOx</td><td>No standard</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>No standard</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>No standard</td></tr>
</table>
<u>RULE REQUIREMENTS</u>:
</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>San Joaquin Valley APCD</td><td>

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

VOC content limits for inks, coatings, and adhesives

<table>
<tr><th>Material</th><th>Grams of VOC per liter (lb/gal), less water and exempt compounds, as applied</th></tr>
<tr><td>Flexographic Ink on Porous Substrates</td><td>225 (1.88)</td></tr>
<tr><td>Inks</td><td>300 (2.5)</td></tr>
<tr><td>Coatings</td><td>300 (2.5)</td></tr>
<tr><td>Adhesives</td><td>150 (1.25)</td></tr>
</table>

VOC content limits for flexographic specialty ink

<table>
<tr><th>Material</th><th>Grams of VOC per liter (lb/gal), less water and exempt compounds, as applied</th></tr>
<tr><td>Metallic Ink</td><td>460 (3.8)</td></tr>
<tr><td>Matte Finish Ink</td><td>535 (4.5)</td></tr>
<tr><td>Metallic Ink and Matte Finish Ink on Flexible Package Printing</td><td>383 (3.2)</td></tr>
</table>

Facilities with the potential to emit or with actual emissions of at least 10 tons VOC in any calendar year shall not use specialty inks with VOC content greater than 300 grams VOC per liter.

VOC content limits for solvent cleaning

<table>
<tr><th>Type of Solvent Cleaning Operation</th><th>Limit Grams of VOC/Liter of Material (lb/gal)</th></tr>
<tr><td>Product Cleaning During Manufacturing Process; or Surface Preparation for Coating, Ink, or Adhesive Application</td><td>25 (0.21)</td></tr>
<tr><td>Repair and Maintenance Cleaning</td><td>25 (0.21)</td></tr>
<tr><td>Cleaning of Coating or Adhesive Application Equipment</td><td>25 (0.21)</td></tr>
<tr><th>Type of Solvent Cleaning Operation</th><th>Limit Grams of VOC/Liter of Material (lb/gal)</th></tr>
</table>

</td></tr>
</table>

<table>
<tr><td>District/Agency</td><td>Best Available Control Technology (BACT)/Requirements</td></tr>
<tr><td></td><td>
<table>
<tr><td colspan="2">Cleaning of Ink Application Equipment</td></tr>
<tr><td>General and Flexographic Printing</td><td>25 (0.21)</td></tr>
<tr><td>Ultraviolet Ink/Electron Beam Ink Application Equipment (except screen printing)</td><td>100 (0.83)</td></tr>
</table>
Flexographic printing presses venting to a control device must have an overall capture and control efficiency of 75% on a mass basis.
</td></tr>
</table>

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES	
VOC	1. Use of ink with a VOC content (less water and exempt compounds) of 0.3 lb/gal for low-end graphics, use of ink with a VOC content not exceeding 1.1 lb/gal (less water and exempt compounds) for high-end graphics and use of adhesives with a VOC content (less water and exempt compounds) not exceeding 0.044 lb/gal. – [SJVAPCD BACT Guidelines 4.7.4, 4.7.15 and 4.9.12, respectively] 2. Use of materials compliant with SCAQMD Rule 1130 and 1171, SMAQMD Rule 450, BAAQMD Regulation 8 Rule 20, SJVUAPCD Rule 4607 or SMAQMD Rule 450. – [SCAQMD, SMAQMD, BAAQMD, SJVUAPCD] 3. Use of materials compliant with SDCAPCD Rule 67.16. – [SDCAPCD]
NOx	No standard – [SMAQMD, SCAQMD, SDCAPCD, BAAQMD, SJVUAPCD]
SOx	No standard – [SMAQMD, SCAQMD, SDCAPCD, BAAQMD, SJVUAPCD]
PM10	No standard – [SMAQMD, SCAQMD, SDCAPCD, BAAQMD, SJVUAPCD]
PM2.5	No standard – [SMAQMD, SCAQMD, SDCAPCD, BAAQMD, SJVUAPCD]
CO	No standard – [SMAQMD, SCAQMD, SDCAPCD, BAAQMD, SJVUAPCD]

Emission limits for inks, coatings, adhesives and solvent cleaning are consistent across SCAQMD Rule 1130 and 1171, SMAQMD Rule 450, BAAQMD Regulation 8 Rule 20 and SJVUAPCD Rule 4607. The difference is the SJVAPCD Rule 4607 includes a category for flexographic specialty inks, with VOC content limits that are higher than for other flexographic inks, while the SMAQMD Rule 450 does not. Therefore, SMAQMD Rule 450 is more stringent for these inks. Also, the SCAQMD, BAAQMD and SJVAPCD rules separate the ink into porous (225 g/l) and non-porous (300 g/l) substrates, which the SMAQMD does not. For this application, the SCAQMD, BAAQMD and SJVAPCD rules would be more stringent for porous substrates. But this will not affect the selection of BACT for the ink, because the BACT limit will be set by the SJVAPCD BACT Guidelines 4.7.4 and 4.7.15.

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

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
VOC	Use of materials compliant with SMAQMD Rule 450 – Graphic Arts, use of ink with a VOC content (less water and exempt compounds) of 0.3 lb/gal for low-end graphics, use of ink with a VOC content not exceeding 1.1 lb/gal (less water and exempt compounds) for high-end graphics, use of adhesives with a VOC content (less water and exempt compounds) not exceeding 0.044 lb/gal, and no VOC clean-up solvents	SMAQMD, SCAQMD, SJVUAPCD, BAAQMD
NOx	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
SOx	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
PM10	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
PM2.5	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
CO	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD

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

Technologically Feasible Alternatives:

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

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

Pollutant	Technologically Feasible Alternatives
VOC	1. Thermal oxidizer 2. Carbon adsorber
NOx	None
SOx	None
PM10	None
PM2.5	None
CO	None

VOCs: As shown above, thermal oxidation and carbon adsorption are technologically feasible. According to the BAAQMD BACT Guideline 83.1, an overall system efficiency (capture and control efficiencies combined) of 98.5% for VOCs is technologically feasible for these types of operations.

Cost Effectiveness 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

1. A control technology is considered to be cost-effective if the cost of controlling one ton of that air pollutant is less than the limits specified below (except coating operations):

Pollutant	Maximum Cost ($/ton)
VOC	17,500
NO_X	24,500
PM10	11,400
SO_X	18,300
CO	TBD if BACT triggered

Cost Effectiveness Analysis Summary

The cost analysis was processed in accordance with the EPA OAQPS Air Pollution Control Cost Manual (Sixth Edition). The sales tax rate was based on the District's standard rate of 8.5% as approved on 10/17/16. The electricity (11.24 cents/kWh) and natural gas (6.41 dollars/1,000 cubic feet) rates were based on an industrial application as approved by the District 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 and addition of

two percentage points and rounding up the next higher integer rate. The labor (Occupation Code 51-5112: Printing press operators) and maintenance (Occupation Code 49-9099: Installation, maintenance, and repair workers, all others) rates were based on data from the Bureau of Labor Statistics.

Background:

The flexographic printing operation will be reviewed by using the pressroom as the emission source and updating the cost inputs in accordance with the EPA OAQPS Air Pollution Control Cost Manual (Sixth Edition). This BACT analysis will only look at the price of the control systems. This will ensure that a single flexographic printer enclosed in a small enough room does not require the addition of a hood or a permanent total enclosure to be covered under this BACT. The addition of a hood would increase the cost of the system due to the cost of the hood and associated equipment (ducting, louvers, dampers, air make-up units, etc.). Section 2, Chapter 1: Hoods, Ductwork and Stacks of the Cost Manual includes cost estimating methods that would increase the cost of the system. The addition of the hood would also require an increase in flowrate. A 6 ft x 6 ft (assumed to just cover the printing section of the printer) and 5 feet above the printing mechanism, would require a flowrate of 33,600 ft^3/min (based on equation 1.24 ($Q = 1.4Pxu_c$) of this section). This would require a bigger and more expensive emissions control system. Operational costs of the system would also be higher.

Section 2, Chapter 3: Permanent Total Enclosures (PTE) of the Cost Manual includes cost estimating information for enclosing a unit. This section of the Cost Manual includes cost information (cost of walls/ft^2, installation costs of walls, rollup door costs, makeup air fans, etc.) that would increase the cost of the control system. The PTE would also require additional ducting work to handle the higher air flow to the control device, which would further increase the cost. Therefore, the cost of just the control device is a conservative (low) estimate.

Basic assumptions:

1) Single flexographic printing press.
2) 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)
3) 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 or thermal oxidizer will have an over-all collection/control efficiency of 98.5%. This is the same as the collection/control efficiency listed as technologically feasible in the BAAQMD BACT Guideline 83.1.
4) General ventilation with an 8,000 CFM blower (10 air changes per hour).
5) Cost calculations and assumptions are based on the EPA Air Pollution Control Cost Manual.

Carbon Adsorption System

Equipment Life = 10 years

Total Capital Investment = $231,299.51

Annualized Total Capital Investment = $43,556.61 per year

Direct Annual Cost = $18,801.19 per year

Indirect Annual Cost = $12,482.97 per year

Total Annual Cost = $74,840.77 per year

VOC Removed = 4.28 tons per year

Cost of VOC Removal = $17,500.97 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 8,683 lb/year or greater is the cost-effectiveness threshold for control equipment using carbon absorption control technology.

Thermal Oxidizer:

Equipment Life = 10 years

Total Capital Investment = $401,329

Direct Annual Cost = $152,437.41 per year

Indirect Annual Cost = $94,909.62 per year

Total Annual Cost = $247,347.02 per year

VOC Removed = 14.13 tons per year

Cost of VOC Removal = $17,500.43 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 28,698 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 8,683 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 28,698 lb per year or greater must be reached in order for a thermal oxidizer to be cost effective. The emissions level for the cost effectiveness of controls is based on the District cost effective limit for VOC of $17,500 per ton controlled.

C: SELECTION OF BACT

BACT FOR FLEXOGRAPHIC PRINTING PRESS/BOX FINISHING THAT ARE NON-HEATSET (#149) EMITTING < 8,683 LBS UNCONTROLLED VOC PER YEAR		
Pollutant	**Standard**	**Source**
VOC	Use of materials (as defined in SMAQMD Rule 450 – Graphic Arts) compliant with SMAQMD Rule 450, use of inks with a VOC content (less water and exempt compounds) of 0.3 lb/gal for low-end graphics, use of ink with a VOC content not exceeding 1.1 lb/gal (less water and exempt compounds) for high-end graphics, use of adhesives with a VOC content (less water and exempt compounds) not exceeding 0.044 lb/gal, and no VOC clean-up solvents	SJVAPCD BACT Guidelines 4.7.4, 4.7.15 and 4.9.12, respectively BAAQMD BACT Guideline 83.1
NOx	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
SOx	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
PM10	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
PM2.5	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
CO	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD

BACT FOR FLEXOGRAPHIC PRINTING PRESS/BOX FINISHING THAT ARE NON-HEATSET (#176) EMITTING ≥ 8,683 LBS UNCONTROLLED VOC PER YEAR		
Pollutant	**Standard**	**Source**
VOC	Use of materials (as defined in SMAQMD Rule 450 – Graphic Arts) compliant with SMAQMD Rule 450 – Graphic Arts, use of inks with a VOC content (less water and exempt compounds) of 0.3 lb/gal for low-end graphics, use of VOC content not exceeding 1.1 lb/gal (less water and exempt compounds) for high-end graphics, use of adhesives with a VOC content (less water and exempt compounds) not exceeding 0.044 lb/gal, no VOC clean-up solvents and a VOC control device that has an overall system efficiency (collection and destruction) of at least 98.5% for VOC.	SJVAPCD BACT Guidelines 4.7.4, 4.7.15 and 4.9.12, respectively BAAQMD BACT Guideline 83.1
NOx	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
SOx	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
PM10	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
PM2.5	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD
CO	No standard	SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD

D: SELECTION OF T-BACT

Toxics are in the form of VOCs and may also be exempt compounds. T-BACT for flexographic printing presses/box finishing operations was determined to be the following:

T-BACT FOR FLEXOGRAPHIC PRINTING PRESSES/BOX FINISHING THAT ARE NON-HEATSET (#149) EMITTING < 8,683 LBS UNCONTROLLED VOC PER YEAR		
Pollutant	**Standard**	**Source**
Organic HAP/VHAP (T-BACT)	1. Compliance with the flexographic printing presses/box finishing BACT VOC limits and HAP emission limits of Section 63.825(b) to 40 CFR 63 Subpart KK.	NESHAP 40 CFR 63 Subpart KK

T-BACT FOR FLEXOGRAPHIC PRINTING PRESSES/BOX FINISHING THAT ARE NON-HEATSET (#176) EMITTING ≥ 8,683 LBS UNCONTROLLED VOC PER YEAR		
Pollutant	**Standard**	**Source**
Organic HAP/VHAP (T-BACT)	1. Compliance with the flexographic printing presses/box finishing BACT VOC limits and HAP emission limits of Section 63.825(b) to 40 CFR 63 Subpart KK and a VOC control device that has an overall system efficiency (collection and destruction) of at least 98.5% for VOC.	NESHAP 40 CFR 63 Subpart KK BAAQMD BACT Guideline 83.1

REVIEWED BY: _____ **DATE:** _____

APPROVED BY: _____ **DATE:** _____

Attachment A

Review of BACT Determinations

California Environmental Protection Agency
Air Resources Board

BACT Determination Detail

Category

Source Category:	Graphic Arts Printing and Coating Operation: Flexographic Printing Line
SIC Code	2653
NAICS Code	322211

Emission Unit Information

Manufacturer:	Ward
Type:	2-color, sheet-fed, air dry
Model:	150000
Equipment Description:	
Capacity / Dimentions	66 " sheet width
Fuel Type	Other
Multiple Fuel Types	

Operating Schedule (hours/day)/(days/week)/ (weeks/year)e	Variable (24/6/52)
Function of Equipment	Prints on porous media (facility produces corrugated boxes)
VOC Limit	136
VOC Limit Units	lbm/day
VOC Average Time	
VOC Control Method	
VOC Control Method Desc	Clean up sln contains no VOC
VOC Percent Control Efficiency	
VOC Cost Effectiveness (%/ton)	
VOC Incremental Cost Effectiveness (%/ton)	
VOC Cost Verified (Y/N)	
VOC Dollar Year	

Project / Permit Information

Application/Permit No.:	377979
Application Completeness Date:	
	Modification

New Construction/Modification:	
ATC Date:	01-03-2001
PTO Date:	01-03-2001
Startup Date:	
Technology Status:	BACT Determination
Source Test Available:	No
Source Test Results:	

Facility / District Information

Facility Name:	International Paper Co.
Facility Zip Code:	
Facility County:	
District Name:	South Coast AQMD
District Contact:	Martin Kay
Contact Phone No.:	(909) 396-3115
Contact E-Mail:	mkay@aqmd.gov

Notes

Notes:	Wate -based inks generally do not require organic solvent for cleanup. This is an example of a flexographic printing facility using waterbased inks. Zero VOC cleanup solvent may not be suitable for specialty flexographic printing (on polyehylene or polypropylene food packaging , fertilizer bags or liquid-tight food containers.) Water based inks with VOC content not to exceed 1.5 lbm/gal

Report Error In Determination

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
Best Available Control Technology (BACT) Guidelines for Non-Major Polluting Facilities*

10-20-2000 Rev. 0
12-5-2003 Rev. 1
7-14-2006 Rev 2

Equipment or Process: Printing (Graphic Arts)

	Criteria Pollutants					
Subcategory	**VOC**	**NOx**	**SOx**	**CO**	**PM_{10}**	**Inorganic**
Flexographic	Inks with ≤ 1.5 Lbs VOC/Gal, Less Water and Less Exempt Compounds (1990) Compliance with SCAQMD Rules 1130 and 1171 (12-5-2003)					
Letterpress	Compliance with SCAQMD Rules 1130 and 1171 (12-5-2003)					
Lithographic or Offset, Heatset	Low VOC Fountain Solution (≤ 8% by Vol. VOC); Low Vapor Pressure (≤ 10 mm Hg VOC Composite Partial Pressure[1]) or Low VOC (≤ 100 g/l) Blanket and Roller Washes; Oil-Based or UV-Curable Inks; and Compliance with SCAQMD Rules 1130 and 1171 (7-14-2006)				Oven Venting to an Afterburner (≥ 0.3 Sec. Retention Time at ≥ 1400 ^{0}F; 95% Overall Efficiency) (10-20-2000)	
Lithographic or Offset, Non-Heatset	Same As Above					
Rotogravure or Gravure—Publication and Packaging	Compliance with SCAQMD Rules 1130 and 1171 (10-20-2000)					
Screen Printing and Drying	Compliance with SCAQMD Rules 1130.1 and 1171 (12-5-2003)					

(Continued on Next Page)

* Means those facilities that are not major polluting facilities as defined by Rule 1302 - Definitions

San Joaquin Valley
Unified Air Pollution Control District

Best Available Control Technology (BACT) Guideline 4.7.4*

Last Update: 09/22/2006

Flexographic Printing - Corrugated Boxes, High End Graphics

Pollutant	Achieved in Practice or contained in the SIP	Technologically Feasible	Alternate Basic Equipment
VOC	Use of inks with a VOC content not exceeding 1.1 lb/gal (less water & exempt compounds) for high-end graphics and use of inks with a VOC content not exceeding 2.5 lb/gal (less water & exempt compounds) for metallic inks	1) capture of VOCs and thermal or catalytic oxidation. 2) capture of VOCs and carbon absorption 3) capture of VOCs and regenerative thermal oxidizer 4) use of inks with VOC content not exceeding 0.88 lb/gal (less water and exempt compounds) for high-end graphics printing	

BACT is the most stringent control technique for the emissions unit and class of source. Control techniques that are not achieved in practice or contained in s a state implementation plan must be cost effective as well as feasible. Economic analysis to demonstrate cost effectiveness is required for all determinations that are not achieved in practice or contained in an EPA approved State Implementation Plan.

***This is a Summary Page for this Class of Source**

San Joaquin Valley
Unified Air Pollution Control District

Best Available Control Technology (BACT) Guideline 4.7.15*

Last Update: 09/22/2006

Flexographic Printing - Corrugated Boxes, Low-end Graphics

Pollutant	Achieved in Practice or contained in the SIP	Technologically Feasible	Alternate Basic Equipment
VOC	use of coating with a VOC content (less water and exempt compounds) as indicated, or lower: 0.3 lb/gal and evaporative minimization methods, which include keeping all solvents and solvent-laden cloths/papers, not in active use, in closed containers.	1) capture of VOCs and thermal or catalytic oxidation 2) capture of VOCs and carbon absorption 3) capture of VOCs and regenerative thermal oxidizer	

BACT is the most stringent control technique for the emissions unit and class of source. Control techniques that are not achieved in practice or contained in s a state implementation plan must be cost effective as well as feasible. Economic analysis to demonstrate cost effectiveness is required for all determinations that are not achieved in practice or contained in an EPA approved State Implementation Plan.

***This is a Summary Page for this Class of Source**

San Joaquin Valley
Unified Air Pollution Control District

Best Available Control Technology (BACT) Guideline 4.9.12*

Last Update: 09/22/2006

Corrugated Box Gluer

Pollutant	Achieved in Practice or contained in the SIP	Technologically Feasible	Alternate Basic Equipment
VOC	use of adhesives with a VOC content (less water and exempt compounds) not exceeding 0.044 lb/gal	1) capture of VOCs and thermal or catalytic oxidation 2) capture of VOCs and carbon absorption 3) capture of VOCs and regenerative thermal oxidizer 4) use of adhesives with a VOC content (less water and exempt compounds) not exceeding 0.021 lb/gal	

Replaces BACT 4.7.3

BACT is the most stringent control technique for the emissions unit and class of source. Control techniques that are not achieved in practice or contained in s a state implementation plan must be cost effective as well as feasible. Economic analysis to demonstrate cost effectiveness is required for all determinations that are not achieved in practice or contained in an EPA approved State Implementation Plan.

***This is a Summary Page for this Class of Source**

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Best Available Control Technology (BACT) Guideline

Source Category

Source:	***Flexographic Printing Line***	Revision:	*2*
		Document #:	*83.1*
Class:	*All*	Date:	*06/20/95*

Determination

POLLUTANT	BACT 1. Technologically Feasible/ Cost Effective 2. Achieved in Practice	TYPICAL TECHNOLOGY
POC	1. Water reducible inks w/ <1 lb VOC/gal of coating and no VOC clean-up solvents. If cost-effective, capture and vent VOC to afterburner or carbon adsorption sytem w/ ≥ 98.5% destruction/recovery device efficiency, or VOC outlet ≤10 ppmv[a,b,T] 2. *Water reducible inks w/ either: <1.5 lb VOC/gal coating or <10% by volume VOC; and no VOC clean-up solvnets*[a,T]	1. *Low VOC Coatings and no VOC clean-up solvents; or BAAQMD approved Collection System and Abatement Device*[a,b,T] 2. *Low VOC Coatings and no VOC clean-up solvents*[a,T]
NOx	1. *n/a* 2. *n/a*	1. *n/a* 2. *n/a*
SO_2	1. *n/a* 2. *n/a*	1. *n/a* 2. *n/a*
CO	1. *n/a* 2. *n/a*	1. *n/a* 2. *n/a*
PM_{10}	1. *n/a* 2. *n/a*	1. *n/a* 2. *n/a*
NPOC	1. *Same as for POC above*[a,b,T] 2. *Same as for POC above*[a,b,T]	1. *Low or no NPOC Coatings and Solvents: or BAAQMD Approved Abatement System*[a,b,T] 2. *Low NPOC Coatings and Solvents*[a,T]

References

a. BAAQMD
b. For abatement devices, the following are acceptable: ≤10 ppmv at outlet; or ≥98.5% destruction/recovery efficiency if inlet VOC ≥2000 ppmv: or ≥97% efficiency if inlet VOC ≥200 to <2000 ppmv: or ≥90% efficiency if inlet VOC <200 ppmv.
T. TBACT

GRAPHIC ARTS OPERATIONS (< 5 tons/year) Fee Schedule 27 N

The BACT Control Options which have been determined to be technologically feasible (T/F - demonstrated but not necessarily proven in field application) or have achieved the BACT emission rate limits in practice (A/P - demonstrated in use for the specific equipment category) are listed below. The BACT Control Options are listed in descending order of control stringency. If the top-listed T/F control option is proposed, no further analysis is required. If the first T/F control option is not chosen, then the applicant must review and determine the cost-effectiveness of each T/F control option in the order listed. The first control option determined to be cost-effective must be installed to meet the BACT requirement. A control option is considered cost-effective if the annualized cost of implementing that control option is equal to or less than the reference cost-effectiveness value for the same pollutant shown in Table 2-4. If none of the T/F control options are determined to be cost-effective, the applicant must propose the A/P control option, propose an alternative technology that meets the BACT emission rate limit or perform a full Top-down BACT Analysis as described in Section 4. The applicant is responsible for ensuring that the installed equipment meets the specified BACT Emission Rate Limit. (See Section 2 for further guidance.)

	VOC	NOx	SOx	PM
BACT Control Option	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 either 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). (T/F) BACT emission rate limit not determined.	(N/A)	(N/A)	(N/A)
BACT Control Option	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, and 4. Use of metering roll cleanup solvent which has either 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). (A/P) BACT emission rate limit not determined.	(N/A)	(N/A)	(N/A)

The applicant may choose to limit the Potential to Emit (PTE) from the equipment to less than 10 pounds per day for each pollutant in lieu of meeting the stated BACT requirement.

Attachment B

Cost Effectiveness Analysis for Carbon Adsorption

COST EFFECTIVENESS ANALYSIS FOR CARBON ADSORPTION

This cost effectiveness analysis was performed using EPA's OAQPS Control Cost Manual
EPA Publication No. 452/B-02-001 Carbon Adsorbers (9/1999)

FACILITY NAME: Package One
LOCATION: 4225 Pell Drive, Sacramento, CA 95838
PERMIT NO.: 24803
EQUIPMENT DESCRIPTION: Flexographic Printing Press

VOC Parameters

VOC of concern (using the physical properties of toluene)		Various
Cost of pure VOC ($/ton)		100
Molecular weight of VOC (Refer to Control Cost Manual, pg 3-63)		92.13
Emission rate (lbs/hr - inlet)		4.17
Emission rate (lbs/yr - inlet)		8683
Inlet concentration (ppm)		38
k factor (Refer to Control Cost Manual, Table 1.1 pg 1-9)		0.551
m factor (Refer to Control Cost Manual, Table 1.1 pg 1-9)		0.11
Partial pressure (psi)		0.000552279

Gas Parameters

Total gas flow rate (acfm - inlet)		8,000
Total gas pressure (psi - inlet)		14.7

Equipment Parameters

Removal efficiency (%)		98.5%
Adsorption time (hours)		8
Desorption time (hours)		8
Number of adsorbing beds		1
Number of Desorbing beds		1
Equipment life (years)		10

Operating Parameters

Hours per day		8
Days per week		5
Weeks per year		52

Carbon Requirements

Carbon working capacity (lb VOC/lb carbon)	(k factor)*((partial pressure)^(m factor))/2	0.121
Amount of carbon needed (lbs)	(Emission Rate)*(hrs/day)/(Carbon Working Capacity)	553
Carbon cost	($1/lb carbon)*(lbs of carbon needed)	$1,107
Carbon life (years)		5

Adsorber Vessel Dimension and Cost

Superficial bed velocity (ft/min)		75
Diameter of each vessel (ft)		0.33
Length of each vessel (ft)		324

Surface area (sq. ft)		335
Fm factor (see Control Cost Manual, Table 1.2, p. 1-21 - Stainless Steel)		1.3
Cost per vessel		$32,471.47
Adsorber Equipment Cost		$116,327.36
Direct Costs:		
Purchased Equipment Cost		
Adsorber and auxiliary equipment	To be conservative assume auxiliary costs = $0	$116,327.36
Instrumentation	1% of equipment cost	$11,632.74
Sales taxes	8.5% of equipment cost	$9,887.83
Freight	5% of equipment cost	$5,816.37
Total Purchased Equipment Cost		$143,664.29
Direct installation costs		
Foundations & supports	8% of total equipment cost	$11,493.14
Handling & erection	14% of total equipment cost	$20,113.00
Electrical	4% of total equipment cost	$5,746.57
Piping	2% of total equipment cost	$2,873.29
Insulation	1% of total equipment cost	$1,436.64
Painting	1% of total equipment cost	$1,436.64
Direct installation costs		$43,099.29
Total Direct Cost	Total equipment cost + Direct installation costs	$186,763.58
Indirect Costs:		
Indirect Costs (installation)		
Engineering	10% of total equpment cost	$14,366.43
Construction and field expenses	5% of total equipment cost	$7,183.21
Contractor fees	10% of total equpment cost	$14,366.43
Start-up	2% of total equipment cost	$2,873.29
Performance test	1% of total equipment cost	$1,436.64
Contingencies	3% of total equipment cost	$4,309.93
Total Indirect Costs		$44,535.93
Total Capital Investment	total direct cost + total indirect costs	$231,299.51
Interest Rate		0.05
Equipment Life (years)		10
Capital Recovery Factor (CRF)		0.1295
Capital recovery cost	(total capital investment)*(CRF)	$29,954.34
Capital Recovery Inflation adjustment	(capital recovery cost)*[(1+0.0199)^19]	$43,556.61
(Avg. interest rate is from the Bureau of Labor Statistics website)		
Direct Annual Costs		
Operator wage ($/hr)		18.01
Maintenance wage ($/hr)		20.13
operator hour (hrs/shift)		0.5

shifts per day (shift/day)		2
days of work per year (days/year)		260
Operator labor		
Operator	(labor wage)*(hours/shift)*(shifts/day)*(days/year)	$4,682.60
Supervisor	15% of operator labor	$702.39
Maintenance		
Maintenance labor	(labor wage)*(hours/shift)*(shifts/day)*(days/year)	$5,233.80
Materials	100% of maintenance labor	$5,233.80
Utilities		
System Fan (kWh/yr)	Refer to EPA cost manual	4917
Bed drying/cooling fan (kWh/yr)	Refer to EPA cost manual	42
Cooling water pump (kWh/yr)	Refer to EPA cost manual	52
Total Power Used (kWh/yr)		5011
Electricity Cost	0.138 $/kWh = District Practice	$691.52
Steam Cost		$1,770.32
Cooling water		$202.41
Carbon Replacement		
Interest Rate		0.05
Carbon Life (yrs)		5
Capital Recovery Factor		0.2310
Replacement Labor	CRF*$0.05/lb*carbon needed	$6.39
Carbon Cost	CRF*initial carbon cost*1.0875	$277.97
Total Direct Annual Costs		$18,801.19
Indirect Annual Costs		
Overhead	60% of maintenance labor and materials	$3,230.99
Administrative Charges	2% of Total Capital Investment	$4,625.99
Property Tax	1% of Total Capital Investment	$2,313.00
Insurance	1% of Total Capital Investment	$2,313.00
Total Indirect Annual Costs		$12,482.97
Total Annual Costs	CRC and Inflation Total Capital Investment + Total Direct Annual Costs + Total Indirect Annual Costs	$74,840.77
Tons VOC reduced	(Emission Rate)*(reduction efficiency)*(hrs/yr)/2000	4.28
Cost of VOC Removal	(Total Annual Costs)/(Tons VOC Controlled)	$17,500.97

Attachment C

Cost Effectiveness Analysis for Thermal Oxidizers

COST EFFECTIVENESS ANALYSIS FOR THERMAL INCINERATION

This cost effectiveness analysis was performed using EPA's OAQPS Control Cost Manual
EPA publication No. 452/B-02-001 Incinerators (9/2000)

FACILITY NAME: Package One
LOCATION: 4225 Pell Drive, Sacramento, CA 95838
PERMIT NO.: 24803
EQUIPMENT DESCRIPTION: Flexographic Printing Press

VOC Parameters	
VOC of concern (Using the physical properties of toluene)	Various
Molecular weight of VOC	92.13
Heat of combustion (Btu/lb)	17,601
Heating value of VOC (Btu/scf)	4,074
Emission rate (lbs/hr - inlet)	13.8
Emission rate (lbs/yr - inlet)	28698.0
Inlet concentration (ppm)	120
Gas Parameters	
Total gas flow rate (scfm - inlet)	8000
Total gas pressure (psi - inlet)	14.7
Inlet gas temperature (deg F)	71
Equipment Parameters	
Level of energy recovery (0%, 35%, 50% or 70%)	70%
Control efficiency (%)	98.5%
Equipment life (years)	10
Operating Parameters	
Hours per day	8
Days per week	5
Weeks per year	52
Shifts per day	1
Incinerator Parameters	
Volumetric heat of combustion of effluent (Btu/scf)	0.49
Heat of combustion per pound of effluent (Btu/lb)	6.62
Temperature Required for incineration (deg F)	1,500.00
Gas temperature at exit of pre-heater (deg F)	1,071.30
Effluent gas temperature (deg F)	499.7
Electricity Usage	
Price of electricity ($/kWh)	$0.11
System fan (kWh/yr)	61,651.20
Total Power Used (kWh/yr)	61,651.20
Gas Usage	
Price of gas ($/1000 cu.ft.)	$6.41

Auxiliary fuel required (scfm)	171.98

CAPITAL COST

Direct Costs:

Incinerator	$201,840
Auxiliary equipment (if not included above)	$0
Equipment Cost (A)	**$201,840**
Instrumentation (0.1A if not included above)	$20,184
Sales taxes (0.085A)	$17,156
Freight (0.05A)	$10,092
Total Equipment Cost (B)	**$249,273**

Direct Installation Costs:

Foundation & Supports (0.08B)	$19,942
Handling & erection (0.14B)	$34,898
Electrical (0.04B)	$9,971
Piping (0.02B)	$4,985
Insulation for duct work (0.01B)	$2,493
Painting (0.01B)	$2,493
Direct Installation Cost	**$74,782**
Site preparation	$0
Facilities & buildings	$0
Total Direct Costs	**$324,054**

Indirect Costs (installation)

Engineering (0.10B)	$24,927
Construction & field expenses (0.05B)	$12,464
Contractor fees (0.10B)	$24,927
Start-up (0.02B)	$4,985
Performance test (0.01B)	$2,493
Contingencies (0.03B)	$7,478
Total Indirect Costs	**$77,275**

TOTAL CAPITAL INVESTMENT	$401,329

ANNUAL COST

Direct Annual Costs

Operating Cost	
Operator (@ $18.01/hr & .5 hr per shift)	$2,341.30
Supervisor (15% of operator)	$351.20
Operating materials	$0.00
Maintenance	
Labor (@20.13/hr & .5 hr per shift)	$2,616.90
Material (same as labor)	$2,616.90
Utilities	
Price of electricity ($/kWh)	$0.11
Price of gas ($/1000 cu.ft.)	$6.41
Electricity ($/yr)	$6,929.59
Natural Gas ($/yr)	$137,581.52
Total Direct Costs	**$152,437.41**

Indirect Annual Costs

Overhead	$4,755.78
Administrative charges	$8,026.58
Property taxes	$4,013.29
Insurance	$4,013.29
Interest rate (%)	5%
Equipment life (years)	10
CRF	0.1295
Capital recovery	$51,973.93
Capital Recovery Inflation Adjustment	$74,100.68
Total Indirect Costs	**$94,909.62**

TOTAL ANNUAL COST	$247,347.02

Annual Cost ($/yr)	$247,347.02
Annual Emissions Reductions (tons/yr)	14.13

(annual emissions based on BACT determination limit for add-on controls)

COST PER TON OF VOCs REDUCED ($/ton)	$17,500.43