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AIR QUALITY

December 19, 2022

Mr. Paul Waldman, Project Manager
PA DEP, Bureau of Air Quality, Northcentral Region
208 West Third Street, Suite 101
Williamsport, PA 17701-6448

Dear Mr. Waldman,

Enclosed, please find the RACT III permit application for Chance Aluminum's Williamsport Operations. The facility is considered to be a major emitter of volatile organic compounds (VOCs) because the facility-wide potential-to-emit (PTE) is greater than fifty tons. The facility is considered a minor contributor of various nitrogen oxide compounds (NO_x). Consequently, NO_x is not considered in this application.

The package includes:

- This cover letter with a narrative of the RACT III applicability and comments on specific sources,
- The PA DEP RACT III Notification Form,
- The TVOP application (used as a roadmap of the sources covered by RACT III),
- Updated Cost Analysis for RACT II demonstrating facility compliance, and
- Stack Testing Protocol.

RACT III Applicability and Compliance Plan

For sources listed in the application with the potential to emit less than 1.0 ton of VOC per 12-continuous monthly periods (12-CMP), the VOCs are tracked and reported on annual emissions statements. These include the annealing oven sources - P105, P016, P113, and P114. Also, small sources of solvent usage for maintenance, roll grinding, and slitting were identified in RACT I and continue to be monitored, recorded, and reported. Each of these insignificant sources has the potential to emit VOCs of less than 1.0 ton. Lastly, within these small sources of VOC, there are a number of external natural gas combustion sources onsite. Each of these individual sources is less than 10 MMBtus/hour, thus the VOC emissions from each source is less than 1.0 tons per 12-CMP. Although VOC emissions of the aggregate source groups are permitted at greater than 1.0 tons of VOC, all the individual natural gas combustion sources cannot emit more than 1.0 tons of VOC/12-CMP. As with all the other sources the VOC emissions are monitored, recorded, and reported on the annual emissions statements.

In addition to the exempted sources with less than 1.0 tons of VOC potential, other sources at the facility are exempted from the regulation because they are regulated under Control

Technique Guidelines (CTGs) in other parts of the PA Code. Sources at the Williamsport that are regulated under CTGs found elsewhere in the PA Code include: storage tanks and solvent degreasers (parts washers).

Each of the four rolling mills at JW Williamsport represents a source with the potential to emit more than 2.7 tons of VOC per 12-CMP and a cost analysis meeting the requirements of **§** 129.92 has been updated to show the facility is in compliance.

The executive summary includes tables that summarize the detailed studies found on subsequent pages, which evaluate the cost effectiveness of all technically feasible pollution control technologies for each mill. A table of contents is provided to drill into the details of the estimated capital and annual operating costs for each scenario described in the executive summaries.

Chance Aluminum is including an Alternate Compliance Plan for the VOC stack testing demonstration requirement of RACT III for the four rolling mills, as the testing cannot be performed prior to the deadline of December 31, 2022. A stack testing protocol is provided for testing scheduled for the week of March 20, 2023.

If there are questions related to this submission and or if clarification is needed, please let me know. Thank you for your consideration.

Best Regards,
Meridian Energy & Environment LLC

Tim Owens, PE, PhD
Principal

Attachments

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

CHAPTER 129. STANDARDS FOR SOURCES ADDITIONAL RACT REQUIREMENTS FOR MAJOR SOURCES OF NOx AND VOCs FOR THE 2015 OZONE NAAQS

Written notification, 25 Pa. Code §§129.111 and 129.115(a)

25 Pa. Code Sections 129.111 and129.115(a) require that the owner and operator of an air contamination source subject to the final-form RACT III regulations submit a notification describing how you intend to comply with the final-form RACT III requirements, and other information spelled out in subsection 129.115(a). The owner or operator may use this template to notify DEP. Notification must be submitted in writing or electronically to the appropriate Regional Manager located at the appropriate DEP regional office. In addition to the notification required by §§ 129.111 and 129.115(a), you also need to submit an applicable analysis or RACT determination as per § 129.114(a) or (i).

Is the facility major for NOx?	**Yes** ☐ **No** ☒
Is the facility major for VOC?	**Yes** ☒ **No** ☐

FACILITY INFORMATION					
Facility Name	Chance Aluminum Corporation				
Permit Number	41-00013	**PF ID if known**			
Address Line1	2475 Trenton Avenue				
Address Line2					
City	**Williamsport**	**State**	**PA**	**Zip**	**17701**
Municipality		**County**	Lycoming		
OWNER INFORMATION					
Owner	Chance Group LLC				
Address Line1	11616 Landstar Blvd.				
Address Line2					
City	**Orlando**	**State**	**FL**	**Zip**	**32824-9025**
Email	jack.cheng@aametals.com	Phone	407-377-0246 ext. 201		
CONTACT INFORMATION					
Permit Contact Name	Leslie Mayes				
Permit Contact Title	Plant Manager				
Address Line	2475 Trenton Avenue				
City	Williamsport	**State**	**PA**	**Zip**	**17701**

Email	Leslie.Mayes@chancealuminum.com	Phone	570-601-6455

Complete Table 1, including all air contamination sources that commenced operation on or before August 3rd, 2018. Air contamination sources determined to be exempt from permitting requirements also must be included. You may find this information in section A and H of your operating permit.

Table 1 - Source Information

Source ID	Source Name	Physical Location	Subject to RACT II?
031	SMALL RACT BOILERS & HEATERS	BLDG 1	1 ton to 2.7 tons per 12 CMP
032	LARGE RACT HEATERS	BLDG 1	1 ton to 2.7 tons per 12 CMP
033	SMALL HEATER	BLDG 1	1 ton to 2.7 tons per 12 CMP
034	LARGE HEATER & BOILER	BLDG 1	1 ton to 2.7 tons per 12 CMP
P101	COLD ROLL MILL 1	BLDG 1	**YES, > 2.7 tons per 12 CMP**
P102	COLD ROLL MILL 2	BLDG 1	**YES, > 2.7 tons per 12 CMP**
P103	COLD ROLL MILL 3	BLDG 1	**YES, > 2.7 tons per 12 CMP**
P104	COLD ROLL MILL 4	BLDG 1	**YES, > 2.7 tons per 12 CMP**
P105	2 ELECTRIC ANNEALING OVENS	BLDG 1	1 ton to 2.7 tons per 12 CMP
P106	COLD CLEANING DEGREASERS	BLDG 1	1 ton to 2.7 tons per 12 CMP
P108	QUALITY CONTROL LABORATORY OPERATIONS	BLDG 1	1 ton to 2.7 tons per 12 CMP
P109	STORAGE TANKS (EACH>2,000 GAL)	BLDG 1	1 ton to 2.7 tons per 12 CMP
P110	STORAGE TANKS (EACH<2,000 GAL)	BLDG 1	1 ton to 2.7 tons per 12 CMP
P111	STORAGE TANKS	BLDG 1	1 ton to 2.7 tons per 12 CMP
P113	OVEN #4	BLDG 1	1 ton to 2.7 tons per 12 CMP
P114	OVEN #3	BLDG 1	1 ton to 2.7 tons per 12 CMP
P211	DISTILLATION UNIT	BLDG 1	1 ton to 2.7 tons per 12 CMP
C001	VANE SEPARATOR – MILL 1	BLDG 1	1 ton to 2.7 tons per 12 CMP
C002	VANE SEPARATOR – MILL 2	BLDG 1	1 ton to 2.7 tons per 12 CMP
C003A	FILTER SYSTEM – MILL 3	BLDG 1	1 ton to 2.7 tons per 12 CMP
C003B	REGENERATIVE THERMAL OXIDIZER – MILL 3	BLDG 1	1 ton to 2.7 tons per 12 CMP
C004	TWO STAGE FILTER SYSTEM – MILL 4	BLDG 1	1 ton to 2.7 tons per 12 CMP
S001	MILL 1 STACK	BLDG 1	1 ton to 2.7 tons per 12 CMP
S002	MILL 2 STACK	BLDG 1	1 ton to 2.7 tons per 12 CMP
S003	REGENERATIVE THERMAL OXIDIZER EXHAUST – MILL 3	BLDG 1	1 ton to 2.7 tons per 12 CMP
S004	MILL 4 STACK	BLDG 1	1 ton to 2.7 tons per 12 CMP
S031	SMALL RACT BOILER & HEATER EXHAUSTS	BLDG 1	1 ton to 2.7 tons per 12 CMP
S032	LARGE RACT HEATER EXHAUSTS	BLDG 1	1 ton to 2.7 tons per 12 CMP
S033	SMALL HEATER STACK	BLDG 1	1 ton to 2.7 tons per 12 CMP
S034	LARGE HEATER STACK	BLDG 1	1 ton to 2.7 tons per 12 CMP
S108	QUALITY CONTROL STACK	BLDG 1	1 ton to 2.7 tons per 12 CMP
S113	ANNEALING OVEN STACK	BLDG 1	1 ton to 2.7 tons per 12 CMP
S114	ANNEALING OVEN #3 STACK	BLDG 1	1 ton to 2.7 tons per 12 CMP
Z001	FUGITIVE EMISSIONS	BLDG 1	1 ton to 2.7 tons per 12 CMP
Z105	ANNEALING OVENS EMISSIONS	BLDG 1	1 ton to 2.7 tons per 12 CMP
Z109	TANKS EMISSIONS > 2,000 GAL	BLDG 1	1 ton to 2.7 tons per 12 CMP
Z110	STORAGE TANS EMISSIONS < 2,000 GAL	BLDG 1	1 ton to 2.7 tons per 12 CMP
Z111	LINPAR 1416-V STORAGE TANK EMISSIONS	BLDG 1	1 ton to 2.7 tons per 12 CMP
FM001	NATURAL GAS LINE		
	INSIGNIFICANT SOURCES		
1	One Progressive ozone generator.	BLDG 1	< 1.0 tons per 12 CMP
2	Floor Cleaning.	PLANT	< 1.0 tons per 12 CMP

3	One (1) Cyclone Separator, Oliver model 496, to control the emissions from the core shop and shall be vented internally at all times	BLDG 1	< 1.0 tons per 12 CMP
4	(4) One (1) electric sample curing oven, Blue M model CW-6680F (Intermix)	BLDG 1	< 1.0 tons per 12 CMP
5	(5) One (1) Slitting trim cyclone separator, 8'-0" x 16'-0" tall shall be vented internally at all times.	BLDG 1	< 1.0 tons per 12 CMP
6	(6) One (1) Mills trim cyclone separator, 12'-0" diamter x 21'-0" tall shall be vented internally at all times.	BLDG 1	< 1.0 tons per 12 CMP
7	(7) One (1) Welding fume extractor (maintenance shop)	BLDG 1	< 1.0 tons per 12 CMP
8	(8) One (1) 75-gallon trash compactor hydraulic fluid tank (Bldg 7 West)	BLDG 7	< 1.0 tons per 12 CMP
9	One (1) 125-gallon trash compactor hydraulic fluid tank (Bdlg 7 West)	BLDG 7	< 1.0 tons per 12 CMP
10	(10) One (1) 240-gallon, hydraulic tank (Mill 3, Roll Balance)	BLDG 1	< 1.0 tons per 12 CMP
11	(11) One (1) 1,500-gallon oil tank (Mill 1 Bearing Oil, #008A)	BLDG 1	< 1.0 tons per 12 CMP
12	(12) One (1) 120-gallon oil tank (Mill 1 Bliss Screwdowns)	BLDG 1	< 1.0 tons per 12 CMP
13	(13) One (1) 100-gallon oil tank (Mill 1 Gear Oil)	BLDG 1	< 1.0 tons per 12 CMP
14	(14) One (1) 175-gallon oil tank (Mill 1 Payoff Hydraulics)	BLDG 1	< 1.0 tons per 12 CMP
15	(15) One (1) 500-galon oil tank (Mill 2 Plannish, #006A)	BLDG 1	< 1.0 tons per 12 CMP
16	(16) One (1) 125-gallon oil tank (Mill 2 Pushups)	BLDG 1	< 1.0 tons per 12 CMP
17	(17) One (1) 250-gallon oil tank (Mill 2 Gear Oil)	BLDG 1	< 1.0 tons per 12 CMP
18	(18) One (1) 540-gallon oil tank (Mill 4 Auxiliary Hydraulics)	BLDG 1	< 1.0 tons per 12 CMP
19	(19) One (1) 120-gallon oil tank (Mill 4 Roll Balance)	BLDG 1	< 1.0 tons per 12 CMP
20	(20) One (1) 1,200-gallon oil tank (Mill 4 Gear oil, #0013A)	BLDG 1	< 1.0 tons per 12 CMP
21	(21) One (1) 1,300-gallon oil tank (Mill 3 Bearing Oil, #011A)	BLDG 1	< 1.0 tons per 12 CMP
22	(22) One (1) 550-gallon oil tank (Mill 3 Auxiliary Hydraulics)	BLDG 1	< 1.0 tons per 12 CMP
23	(23) One (1) 600-gallon oil tank (Mill 3 DSR Hydraulics)	BLDG 1	< 1.0 tons per 12 CMP
24	(24) One (1) 200-gallon oil tank (Mill 3 Gear Oil)	BLDG 1	< 1.0 tons per 12 CMP
25	(25) Two (2) Lab exhaust hoods (Line 8 area & Plant-wide QC lab)	BLDG 1	< 1.0 tons per 12 CMP
26	(26) One (1) cyclone separator, Grizzly model 0601 shall be vented internally at all times (Machine Shop)	BLDG 1	< 1.0 tons per 12 CMP
27	(27) One (1) dust collector, Grizzly model G05837 shall be vented internally at all times (Packing Area)	BLDG 1	< 1.0 tons per 12 CMP
28	(28) One (1) portable, 172 brake horsepower, Onan model 850, natural gas-fired emergency generator		< 1.0 tons per 12 CMP

Complete Table 2 or 3 if the facility is a major NOx or VOC emitting facility. For the column with the title "How do you intend to comply", compliance options are:

- Presumptive RACT requirement under §129.112 (**PRES**),
- Facility-wide averaging (**FAC**) §129.113,

- System-wide averaging (**SYS**) §129.113, or
- Case by case determination §129.114 (**CbC**).

Please provide the applicable subsection if source will comply with the presumptive requirement under §129.112.

Table 2 – Method of RACT III Compliance, NOx

Source ID	Source Name	NOx PTE TPY	Exempt from RACT III (yes or no)	How do you intend to comply? (PRES, CbC, FAC or SYS)	Specific citation of rule if presumptive option is chosen
P101	Cold Roll Mill #1	n/a	Yes	n/a	n/a
P102	Cold Roll Mill #2	n/a	Yes	n/a	n/a
P103	Cold Roll Mill #3 With RTO	1.84	Yes	n/a	n/a
P104	Cold Roll Mill #4	n/a	Yes	n/a	n/a

Please complete Table 3 if the facility is a major VOC emitting facility. Please provide the applicable section if a source is complying with any RACT regulation listed in 25 Pa Code §§ 129.51, 129.52(a)—(k) and Table I categories 1—11, 129.52a—129.52e, 129.54—129.63a, 129.64—129.69, 129.71—129.73, 129.75 129.71—129.75, 129.77 and 129.101—129.107.

Table 3 – Method of RACT III Compliance, VOC

Source ID	Source Name	VOC PTE TPY	Exempt from RACT III (yes or no)	How do you intend to comply?	Specify citation of rule or subject to 25 Pa Code RACT regulation, (list the applicable sections)
P101	Cold Roll Mill #1	133.6	No	CbC	Subject to RACT, 25 Pa. Code §§ 129.111-129.115
P102	Cold Roll Mill #2	133.6	No	CbC	Subject to RACT, 25 Pa. Code §§ 129.111-129.115
P103	Cold Roll Mill #3 With RTO	8.4 (8000-hr limit)	No	CbC	Subject to RACT, 25 Pa. Code §§ 129.111-129.115
P104	Cold Roll Mill #4	26.3	No	CbC	Subject to RACT, 25 Pa. Code §§ 129.111-129.115

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF AIR QUALITY

FOR OFFICIAL USE ONLY
Title V OP Number: ________
Reviewed by: ________
Date: ________

TITLE V OPERATING PERMIT APPLICATION

Section 1 - General Information

1.1 Application Type

Type of permit for which application is made: (Check one)

☐ Initial

☐ Renewal Operating Permit No. 41-00013

☐ Application Revision - provide date of original Title V Application or OP No.: ________

1.2 Plant Information

Federal Tax ID/Plant Code: 87-1467330-1 **Firm Name:** CHANCE ALUM CORP/WILLIAMSPORT PLT

Plant Name: CHANCE ALUM CORP

NAICS Code: 331318 **SIC Code:** 3353

Description of NAICS Code: Other Aluminum Rolling, Drawing, and Extruding

Description of SIC Code: Manufacturing - Aluminum Sheet, Plate, And Foil

County: Lycoming **Municipality** Williamsport

Latitude: 41.233874° **Longitude:** -77.064186°

Horizontal Reference Datum: WGS84

Horizontal Collection Method: Google Maps

Reference Point: Plant entrance (general) - The general entrance to a plant

1.3 Contact Information

Name: LESLIE MAYES **Title:** PLT MGR

Address: 2475 TRENTON AVE
WILLIAMSPORT, PA 17701-7904

Telephone Number: (570) 393-7800 ext. 301

Email Address: Leslie.Mayes@ChanceAluminum.com

1.4 Certification of Truth, Accuracy and Completeness

Note: This certification must be signed by a responsible official. Applications without a signed certification will be returned as incomplete.

I certify under penalty of law that, based on information and belief formed after reasonable inquiry, the statements and information contained in this application are true, accurate, and complete.

(Signed) [signature] **Date:** 12/22/2022

Name (Typed): Leslie Mayes **Title:** Plant Manager

Section 2 - Applicable Requirements for the Entire Site

Describe and cite all applicable requirements pertaining to the entire site.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list site level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Citation No.	Citation Limitation	Limitation Used

Section 3 - Site Inventory
Give a complete list of all air pollution sources, control equipment, emission points, and fuel material locations within this site. For renewals, only list sources not included in current Title V Operating Permit or sources which are now subject to Compliance Assurance Monitoring (CAM) requirements of 40 CFR Part 64. If preprinted information is provided, correct and/or add any new sources as necessary. Note: one (1) of the following sections (5, 6 or 7) of the application must be completed for each new source listed here.

Unit ID	Company Designation	Unit Type	CAM
031	Small Ract Boilers & Heaters	Combustion Unit	
032	Large Ract Heaters	Combustion Unit	
033	Small Heater[	Combustion Unit	
034	Large Heater & Boiler	Combustion Unit	
P101	Cold Roll Mill 1	Process	
P102	Cold Roll Mill 2	Process	
P103	Cold Roll Mill 3	Process	
P104	Cold Roll Mill 4	Process	
P105	2 Electric Annealing Ovens	Process	
P106	Cold Cleaning Degreasers	Process	
P108	Quality Control Laboratory Operations	Process	
P109	Storage Tanks (Each>2,000 Gal)	Process	
P110	Storage Tanks (Each<2,000 Gal)	Process	
P111	Storage Tanks	Process	
P113	Oven #4	Process	
P114	Oven #3	Process	
P211	Distillation Unit	Process	
C001	Vane Separator-Mill 1	Control Device	
C002	Vane Separator-Mill 2	Control Device	
C003A	Filter System-Mill 3	Control Device	
C003B	Regenerative Thermal Oxidizer-Mill 3	Control Device	
C004	Two Stage Filter System-Mill 4	Control Device	
S001	Mill 1 Stack	Point of Air Emission	
S002	Mill 2 Stack	Point of Air Emission	
S003	Regenerative Thermal Oxidizer Exhaust-Mill 3	Point of Air Emission	
S004	Mill 4 Stack	Point of Air Emission	
S031	Small Ract Boiler & Heater Exhausts	Point of Air Emission	
S032	Large Ract Heater Exhausts	Point of Air Emission	
S033	Small Heater Stack	Point of Air Emission	
S034	Large Heater Stack	Point of Air Emission	

S108	Quality Control Stack	Point of Air Emission	
S113	Annealing Oven Stack	Point of Air Emission	
S114	Annealing Oven #3 Stack	Point of Air Emission	
Z001	Fugitive Emissions	Point of Air Emission	
Z105	Annealing Ovens Emissions	Point of Air Emission	
Z109	Tanks Emissions >2,000 Gal	Point of Air Emission	
Z110	Storage Tanks Emissions <2,000 Gal	Point of Air Emission	
Z111	LINPAR 1416-V Storage Tank Emissions	Point of Air Emission	
FM001	Natural Gas Line	Fuel Material Location	

Section 4 - Source Group (Optional)

4.1 Source Group Definition

Define groups of source(s) that are subject to one or more applicable requirements that apply to all source(s) in the group.

For renewals, only list source groups not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Group No.	Source ID (for source(s) in this group)

4.2 Applicable Requirements for Source Groups

For renewals, only list group level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Describe and cite all applicable requirements pertaining to all source groups.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

Group No.	Citation No.	Citation Limitation	Limitation Used

Section 5 - Combustion Operational Inventory

(Complete this section for each combustion source in this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new combustion unit listed in Section 3 of this application.

5.1 General Source Information

a. Unit ID: 031 b. Company Designation: SMALL RACT BOILERS & HEATERS

c. Plan Approval or Operating Permit No.: ______

d. Manufacturer: Various e. Model No.: Various

f. Source Description: Combustion Unit

g. Rated Heat Input/Throughput: ______ h. Installation Date: ______

i. Exhaust Temperature Various Units deg F j. Exhaust % Moisture ~2.5% w/w k. Exhaust Flow Volume: Various SCFM

5.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emissions limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both boxes are checked "Yes")

5.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
031	Combustion Unit	S031	Point of Air Emission	100

5.4 Source Classification Code (SCC) Listing for Standard Operation

Fuel/Material	Associated SCC	Max Throughput Rate	Firing Sequence
FM001	39000699	Various	NA

5.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML*	% Sulfur	% Ash	BTU Content (Units)
39000699	FM001	0	0	~1,050 Btu/ft^3

*FML = Fuel Material Location

5.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 5.1 of the application.

Maximum amount of hours of source operation per year: ____________

Fuel/SCC	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Thruput	Units/Time

5.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/SCC	Citation No.	Citation Limitation	Limitation Used

Section 5 - Combustion Operational Inventory

(Complete this section for each combustion source in this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new combustion unit listed in Section 3 of this application.

5.1 General Source Information

a. Unit ID: 032

b. Company Designation: LARGE RACT HEATERS

c. Plan Approval or Operating Permit No.:

d. Manufacturer: Various

e. Model No.: Various

f. Source Description: Combustion Unit

g. Rated Heat Input/Throughput: Various

h. Installation Date:

i. Exhaust Temperature: Various Units: deg F

j. Exhaust % Moisture: ~ 2.5%

k. Exhaust Flow Volume: Various SCFM

5.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emissions limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both boxes are checked "Yes")

5.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
032	Combustion Unit	S032	Point of Air Emission	100

5.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**
FM001	39000699	Various	NA

5.5 Maximum Fuel Physical Characteristics				
If taking limitations on Fuel Physical Characteristics, see instructions.				
SCC/Fuel Burned	**FML***	**% Sulfur**	**% Ash**	**BTU Content (Units)**
39000699	FM001	0	0	~1,050 Btu/ft^3

*FML = Fuel Material Location

5.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 5.1 of the application.

Maximum amount of hours of source operation per year: ______________________

Fuel/SCC	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Thruput	Units/Time

5.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/SCC	Citation No.	Citation Limitation	Limitation Used

Section 5 - Combustion Operational Inventory

(Complete this section for each combustion source in this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new combustion unit listed in Section 3 of this application.

5.1 General Source Information

a. Unit ID: 033 b. Company Designation: SMALL HEATER

c. Plan Approval or Operating Permit No.:

d. Manufacturer: Modine e. Model No.: IBS225

f. Source Description: Combustion Unit

g. Rated Heat Input/Throughput: 0.225 MMBtu/hr h. Installation Date:

i. Exhaust Temperature ~150 Units deg F j. Exhaust % Moisture 2.5% k. Exhaust Flow Volume: ~2,400 SCFM

5.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emissions limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both boxes are checked "Yes")

5.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
033	Combustion Unit	S033	Point of Air Emission	100

5.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**
FM001	39000699	~ 0.25 MCF/hr	NA

5.5 Maximum Fuel Physical Characteristics				
If taking limitations on Fuel Physical Characteristics, see instructions.				
SCC/Fuel Burned	**FML***	**% Sulfur**	**% Ash**	**BTU Content (Units)**
39000699	FM001	0	0	~1,050 Btu/ft^3

*FML = Fuel Material Location

5.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 5.1 of the application.

Maximum amount of hours of source operation per year: ______________________

Fuel/SCC	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Thruput	Units/Time

5.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/SCC	Citation No.	Citation Limitation	Limitation Used

Section 5 - Combustion Operational Inventory

(Complete this section for each combustion source in this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new combustion unit listed in Section 3 of this application.

5.1 General Source Information

a. Unit ID: 034 b. Company Designation: LARGE HEATER & BOILER

c. Plan Approval or Operating Permit No.: ____

d. Manufacturer: ____ e. Model No.: ____

f. Source Description: Combustion Unit

g. Rated Heat Input/Throughput: ____ h. Installation Date: ____

i. Exhaust Temperature ____ Units deg F j. Exhaust % Moisture ____ k. Exhaust Flow Volume: ____ SCFM

5.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emissions limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both boxes are checked "Yes")

5.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
034	Combustion Unit	S034	Point of Air Emission	100

5.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**
FM001	39000699	Various	

5.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML*	% Sulfur	% Ash	BTU Content (Units)
39000699	FM001	0	0	~1,050 Btu/ft^3

*FML = Fuel Material Location

5.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 5.1 of the application.

Maximum amount of hours of source operation per year: ________________

Fuel/SCC	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Thruput	Units/Time

5.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/SCC	Citation No.	Citation Limitation	Limitation Used

Section 6 - Incinerator Operational Inventory

(Complete this section for each incinerator at the site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new incinerator listed in Section 3 of this application.

6.1 General Source Information

a. Unit ID: NA b. Company Designation: ______

c. Plan Approval or Operating Permit No.: ______

d. Manufacturer: ______ e. Model No.: ______

f. Source Description: ______

g. Rated Heat Input/Throughput: ______ h. Installation Date: ______

i. Exhaust Temperature ______ Units ______ j. Exhaust % Moisture ______ k. Exhaust Flow Volume: ______ SCFM

l. Incin. Capacity: ______ Lbs/Hr m. Primary Burner Heat Input: ______ Units ______

n. Exhaust % CO_2: ______ o. Secondary Burner Heat Input: ______ Units ______

p. Incinerator Class: ______

q. Waste Type: ______ r. Waste BTU/Lb: ______

6.2 CAM Information

Yes	No	
☐	☐	Emissions unit uses a control device to achieve compliance with emissions limitations or standards.
☐	☐	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both boxes are checked "Yes")

6.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow

6.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel / Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**

6.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

Maximum amount of hours of source operation per year: ______________________

SCC/Fuel Burned	FML*	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

6.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 6.3 of this application.

Maximum amount of hours of source operation per year: ______________________

Fuel/Waste	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Thruput	Units/Time

6.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☐ No changes from current Title V Operating Permit.

Fuel/Waste	Citation No.	Citation Limitation	Limitation Used

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P101 b. Company Designation: COLD ROLL MILL 1

c. Plan Approval or Operating Permit Number: ______

d. Manufacturer: LOEWY e. Model Number: 4 HIGH

f. Source Description: Process

g. Rated Heat Input/Throughput: ______ h. Installation Date: 02/01/1991

i. Exhaust Temperature Ambient Units deg F j. Exhaust % Moisture 1 k. Exhaust Flow Volume: 36,569 SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☒	☐	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P101	Process	C001	Control Device	100
C001	Control Device	S001	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ______________________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P102 b. Company Designation: COLD ROLL MILL 2

c. Plan Approval or Operating Permit Number: ______

d. Manufacturer: PITTSBURGH e. Model Number: 4 HIGH

f. Source Description: Process

g. Rated Heat Input/Throughput: ______ h. Installation Date: 02/01/1991

i. Exhaust Temperature Ambient Units deg F j. Exhaust % Moisture 1 k. Exhaust Flow Volume: 36,154 SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☒	☐	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P102	Process	C002	Control Device	100
C002	Control Device	S002	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ____________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P103 b. Company Designation: COLD ROLL MILL 3

c. Plan Approval or Operating Permit Number: ______

d. Manufacturer: PITTSBURGH e. Model Number: 10'&28' X 64'&62'

f. Source Description: Process

g. Rated Heat Input/Throughput: ______ h. Installation Date: 06/01/2000

i. Exhaust Temperature 200 Units deg F j. Exhaust % Moisture 2 k. Exhaust Flow Volume: 23,609 SCFM

7.2 CAM Information

Yes	No	
☒	☐	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☒	☐	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes") No Change Requested –Incorporated into the existing permit

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P103	Process	C003A	Control Device	100
C003A	Control Device	C003B	Control Device	100
C003B	Control Device	S003	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ______________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P104 b. Company Designation: COLD ROLL MILL 4

c. Plan Approval or Operating Permit Number:

d. Manufacturer: UNITED ENGINEERING e. Model Number: 12'X 40'X 60' - 4 HIGH

f. Source Description: Process

g. Rated Heat Input/Throughput: h. Installation Date: 12/26/1996

i. Exhaust Temperature 70 Units deg F j. Exhaust % Moisture 2 k. Exhaust Flow Volume: 21,560 SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☒	☐	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P104	Process	C004	Control Device	100
C004	Control Device	S004	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ____________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P105 b. Company Designation: 2 ELECTRIC ANNEALING OVENS

c. Plan Approval or Operating Permit Number: ______

d. Manufacturer: ______ e. Model Number: ______

f. Source Description: Process

g. Rated Heat Input/Throughput: ______ h. Installation Date: ______

i. Exhaust Temperature ______ Units deg F j. Exhaust % Moisture ______ k. Exhaust Flow Volume: ______ SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P105	Process	Z105	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ______________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P106 b. Company Designation: COLD CLEANING DEGREASERS

c. Plan Approval or Operating Permit Number: ______

d. Manufacturer: ______ e. Model Number: ______

f. Source Description: Process

g. Rated Heat Input/Throughput: ______ h. Installation Date: ______

i. Exhaust Temperature ______ Units deg F j. Exhaust % Moisture ______ k. Exhaust Flow Volume: ______ SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P106	Process	Z001	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation

Fuel/Material	Associated SCC	Max Throughput Rate	Firing Sequence

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ______________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P108

b. Company Designation: QUALITY CONTROL LABORATORY OPERATIONS

c. Plan Approval or Operating Permit Number: ____________

d. Manufacturer: ____________

e. Model Number: ____________

f. Source Description: Process

g. Rated Heat Input/Throughput: ____________

h. Installation Date: ____________

i. Exhaust Temperature ________ Units deg F

j. Exhaust % Moisture ________

k. Exhaust Flow Volume: ________ SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P108	Process	S108	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation

Fuel/Material	Associated SCC	Max Throughput Rate	Firing Sequence

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ____________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: **A** Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P109 b. Company Designation: STORAGE TANKS (EACH>2,000 GAL)

c. Plan Approval or Operating Permit Number: ______

d. Manufacturer: ______ e. Model Number: ______

f. Source Description: Process

g. Rated Heat Input/Throughput: ______ h. Installation Date: ______

i. Exhaust Temperature ______ Units deg F j. Exhaust % Moisture ______ k. Exhaust Flow Volume: ______ SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P109	Process	Z109	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation

Fuel/Material	Associated SCC	Max Throughput Rate	Firing Sequence

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ______________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P110 b. Company Designation: STORAGE TANKS (EACH<2,000 GAL)

c. Plan Approval or Operating Permit Number: ______

d. Manufacturer: ______ e. Model Number: ______

f. Source Description: Process

g. Rated Heat Input/Throughput: ______ h. Installation Date: ______

i. Exhaust Temperature ______ Units deg F j. Exhaust % Moisture ______ k. Exhaust Flow Volume: ______ SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P110	Process	Z110	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ______________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P111 b. Company Designation: STORAGE TANKS

c. Plan Approval or Operating Permit Number: ______

d. Manufacturer: ______ e. Model Number: ______

f. Source Description: Process

g. Rated Heat Input/Throughput: ______ h. Installation Date: ______

i. Exhaust Temperature ______ Units deg F j. Exhaust % Moisture ______ k. Exhaust Flow Volume: ______ SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P111	Process	Z111	Point of Air Emission	90

7.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ______________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P113 b. Company Designation: OVEN #4

c. Plan Approval or Operating Permit Number: ______

d. Manufacturer: ______ e. Model Number: ______

f. Source Description: Process

g. Rated Heat Input/Throughput: ______ h. Installation Date: ______

i. Exhaust Temperature ______ Units deg F j. Exhaust % Moisture ______ k. Exhaust Flow Volume: ______ SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P113	Process	S113	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**

7.5 Maximum Fuel Physical Characteristics If taking limitations on Fuel Physical Characteristics, see instructions.				
SCC/Fuel Burned	**FML**	**% Sulfur**	**% Ash**	**BTU Content (Units)**

*FML = Fuel Material Location

7.6 Limitations on Source Operation Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application. Maximum amount of hours of source operation per year: ______________________						
Fuel	**Hours/Day**	**Days/Week**	**Days/Year**	**Hours/Year**	**Max Throughput**	**Units/Time**

7.7 **Source Applicable Requirements**

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 **Raw Materials**

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 **Processing Steps**

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P114 b. Company Designation: OVEN #3

c. Plan Approval or Operating Permit Number: ______

d. Manufacturer: ______ e. Model Number: ______

f. Source Description: Process

g. Rated Heat Input/Throughput: ______ h. Installation Date: ______

i. Exhaust Temperature ______ Units deg F j. Exhaust % Moisture ______ k. Exhaust Flow Volume: ______ SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P114	Process	S114	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation			
Fuel/Material	**Associated SCC**	**Max Throughput Rate**	**Firing Sequence**

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ______________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

Section 7 - Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new process listed in Section 3 of this application.

7.1 General Source Information

a. Unit ID: P211 b. Company Designation: DISTILLATION UNIT

c. Plan Approval or Operating Permit Number: ____

d. Manufacturer: ____ e. Model Number: ____

f. Source Description: Process

g. Rated Heat Input/Throughput: ____ h. Installation Date: ____

i. Exhaust Temperature ____ Units deg F j. Exhaust % Moisture ____ k. Exhaust Flow Volume: ____ SCFM

7.2 CAM Information

Yes	No	
☐	☒	Emissions unit uses a control device to achieve compliance with emission limitations or standards.
☐	☒	Potential precontrol emissions of applicable pollutant are at least 100 percent of the major source amount.

(Addendum 3 must be completed if both are checked "Yes")

7.3 Exhaust System Components

Explain how the exhaust components are configured:

From Unit	Unit Description	To Unit	Unit Description	Percent Flow
P211	Process	Z001	Point of Air Emission	100

7.4 Source Classification Code (SCC) Listing for Standard Operation

Fuel/Material	Associated SCC	Max Throughput Rate	Firing Sequence

7.5 Maximum Fuel Physical Characteristics

If taking limitations on Fuel Physical Characteristics, see instructions.

SCC/Fuel Burned	FML	% Sulfur	% Ash	BTU Content (Units)

*FML = Fuel Material Location

7.6 Limitations on Source Operation

Complete this section if you are requesting a limitation on operational hours and/or a permit limitation on the throughput rate equal to or lower than that stated in Section 7.3 of this application.

Maximum amount of hours of source operation per year: ______________________________

Fuel	Hours/Day	Days/Week	Days/Year	Hours/Year	Max Throughput	Units/Time

7.7 Source Applicable Requirements

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list source level requirements not included in the current Title V Operating Permit. If there are no changes, check the box to the right.

☒ No changes from current Title V Operating Permit.

Fuel/Product	Citation Number	Citation Limitation	Limitation Used

7.8 Raw Materials

List all of the raw materials used in this process to the extent that this information is needed to determine or regulate emissions.

____

7.9 Processing Steps

To the extent that this information is needed to determine or regulate emissions, list all of the processing steps and raw materials for each step utilized to complete the material or product.

Step	Description	Raw Materials

7.10 Request for Confidentiality

Do you request that the information on this page be considered kept confidential?

☐ Yes ☒ No

If yes, include a justification for confidentiality that meets the requirement of 25 Pa. Code § 127.411(d).

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____

Section 8 - Control Device Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new control device listed in Section 3 of this application.

8.1 General Control Device Information

a. Unit ID: C001

b. Company Designation: VANE SEPARATOR-MILL 1

c. Used by Source(s): P101

d. Type: Impingement Separator

e. Pressure Drop in H_2O: 1

f. Capture Efficiency:

g. Scrubber Flow Rate (GPM):

h. Manufacturer:

i. Model No.:

j. Installation Date: 02/01/1991

8.2 Control Device Efficiencies for this Control Device:

Pollutant Name	CAS No.	Estimate Control Efficiency	Basis for Efficiency Estimate
Volatile Organic Compounds	VOC	55.7 %	Stk Tst (eff. calc'd using stack results

Section 8 - Control Device Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new control device listed in Section 3 of this application.

8.1 General Control Device Information

a. Unit ID: C002

b. Company Designation: VANE SEPARATOR-MILL 2

c. Used by Source(s): P102

d. Type: Impingement Separator

e. Pressure Drop in H_2O: 1

f. Capture Efficiency:

g. Scrubber Flow Rate (GPM):

h. Manufacturer:

i. Model No.:

j. Installation Date: 02/01/1991

8.2 Control Device Efficiencies for this Control Device:

Pollutant Name	CAS No.	Estimate Control Efficiency	Basis for Efficiency Estimate
Volatile Organic Compounds	VOC	55.7 %	Stk Tst (eff. calc'd using stack results

Section 8 - Control Device Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new control device listed in Section 3 of this application.

8.1 General Control Device Information

a. Unit ID: C003A

b. Company Designation: FILTER SYSTEM

c. Used by Source(s): P103

d. Type:

e. Pressure Drop in H_20:

f. Capture Efficiency:

g. Scrubber Flow Rate (GPM):

h. Manufacturer: BUSCH

i. Model No.: PPS FILTER SYSTEM

j. Installation Date:

8.2 Control Device Efficiencies for this Control Device:

Pollutant Name	CAS No.	Estimate Control Efficiency	Basis for Efficiency Estimate
Particulate Matter < 10 Microns	PM10	99 %	Other

Section 8 - Control Device Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new control device listed in Section 3 of this application.

8.1 General Control Device Information

a. Unit ID: C003B

b. Company Designation: REGENERATIVE THERMAL OXIDIZER

c. Used by Source(s): C003A

d. Type: Direct Flame Incin. with heat exchange

e. Pressure Drop in H_20:

f. Capture Efficiency:

g. Scrubber Flow Rate (GPM):

h. Manufacturer: DURR

i. Model No.: HORIZONTAL REGENERATIVE THERMAL OXIDIZER

j. Installation Date:

8.2 Control Device Efficiencies for this Control Device:

Pollutant Name	CAS No.	Estimate Control Efficiency	Basis for Efficiency Estimate
Volatile Organic Compounds	VOC	98 %	Other
Methane	A303	98 %	No data available - VOC value used

Section 8 - Control Device Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new control device listed in Section 3 of this application.

8.1 General Control Device Information

a. Unit ID: C004

b. Company Designation: TWO STAGE FILTER SYSTEM-MILL 4

c. Used by Source(s): P104

d. Type:

e. Pressure Drop in H_2O: 20

f. Capture Efficiency: 100

g. Scrubber Flow Rate (GPM):

h. Manufacturer: BUSCH/CECO

i. Model No.: PPS/CECO

j. Installation Date: 12/26/1996

8.2 Control Device Efficiencies for this Control Device:

Pollutant Name	CAS No.	Estimate Control Efficiency	Basis for Efficiency Estimate
Total Suspended Particulate	TSP	99 %	Est Eff (eff. based on estimates)

Section 9 - Stack/Flue Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new stack/flue listed in Section 3 of this application.

9.1 General Stack/Vent Information

a. Unit ID: S001 b. Company Designation: MILL 1 STACK

c. Discharge Type: HORIZONTAL OR NEARLY HORIZONTAL

d. Diameter (ft): 4 Height (ft): 20 Base Elevation (ft): ______

e. Exhaust Temperature: 76 deg F Exhaust % Moisture: 1 Exhaust Velocity (m/Sec): 15.1

f. Exhaust Volume: 37,357 ACFM Exhaust Volume: 36,569 SCFM

g. Distance to Nearest Property Line (ft): ______

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: C001

j. Latitude: 41.233675° Longitude: -77.062128°

Horizontal Reference Datum: WGS84

Horizontal Collection Method: NA

Reference Point: Stack Outlet

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a. Unit ID: S002 b. Company Designation: MILL 2 STACK

c. Discharge Type: HORIZONTAL OR NEARLY HORIZONTAL

d. Diameter (ft): 4 Height (ft): 20 Base Elevation (ft): ______

e. Exhaust Temperature: 76 deg F Exhaust % Moisture: 1 Exhaust Velocity (m/Sec): 14.9

f. Exhaust Volume: 36,933 ACFM Exhaust Volume: 36,154 SCFM

g. Distance to Nearest Property Line (ft): ______

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: C002

j. Latitude: 41.233675° Longitude: -77.062370°

Horizontal Reference Datum: WGS84

Horizontal Collection Method: NA

Reference Point: Stack outlet

Section 9 - Stack/Flue Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new stack/flue listed in Section 3 of this application.

9.1 General Stack/Vent Information

a. Unit ID: S003 b. Company Designation: REGENERATIVE THERMAL OXIDIZER EXHAUST

c. Discharge Type:

d. Diameter (ft): Height (ft): ~45 Base Elevation (ft): Site surface

e. Exhaust Temperature: ~250 deg F Exhaust % Moisture: ~3.5 Exhaust Velocity : NA

f. Exhaust Volume: ~24,000 ACFM Exhaust Volume: ~18,000 f.

g. Distance to Nearest Property Line (ft):

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: C003B

j. Latitude: 41.233814° Longitude: -77.061589°

Horizontal Reference Datum: WGS84

Horizontal Collection Method: NA

Reference Point: Stack Outlet

---

a. Unit ID: S004 b. Company Designation: MILL 4 STACK

c. Discharge Type: VERTICAL: UNOBSTRUCTED OPENING

d. Diameter (ft): 4.5 Height (ft): 45 Base Elevation (ft): Site surface

e. Exhaust Temperature: Ambient Exhaust % Moisture: Ambient Exhaust Velocity (m/Sec): NA

f. Exhaust Volume: ~22,000 ACFM Exhaust Volume: ~ 21,000 f.

g. Distance to Nearest Property Line (ft):

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: C004

j. Latitude: 41.233899° Longitude: -77.061200°

Horizontal Reference Datum: WGS84

Horizontal Collection Method: NA

Reference Point: Stack Outlet

Section 9 - Stack/Flue Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new stack/flue listed in Section 3 of this application.

9.1 General Stack/Vent Information

a. Unit ID: S031   b. Company Designation: SMALL RACT BOILER & HEATER EXHAUSTS

c. Discharge Type: Various

d. Diameter (ft): Various   Height (ft): Various   Base Elevation (ft): Various

e. Exhaust Temperature: Various   Exhaust % Moisture: Various   Exhaust Velocity : Various

f. Exhaust Volume: Various ACFM   Exhaust Volume: Various SCFM

g. Distance to Nearest Property Line (ft): ______

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: 031

j. Latitude: Various   Longitude: Various

Horizontal Reference Datum: ______

Horizontal Collection Method: ______

Reference Point: Various

---

a. Unit ID: S032   b. Company Designation: LARGE RACT HEATER EXHAUSTS

c. Discharge Type: Various

d. Diameter (ft): Various   Height (ft): Various   Base Elevation (ft): Various

e. Exhaust Temperature: Various   Exhaust % Moisture: Various   Exhaust Velocity : Various

f. Exhaust Volume: Various ACFM   Exhaust Volume: Various SCFM

g. Distance to Nearest Property Line (ft): Various

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: 032

j. Latitude: Various   Longitude: Various

Horizontal Reference Datum: ______

Horizontal Collection Method: ______

Reference Point: ______

Section 9 - Stack/Flue Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new stack/flue listed in Section 3 of this application.

9.1 General Stack/Vent Information

a. Unit ID: S033 b. Company Designation: SMALL HEATER STACK

c. Discharge Type: ________

d. Diameter (ft): ________ Height (ft): ________ Base Elevation (ft): ________

e. Exhaust Temperature: 200 deg F Exhaust % Moisture: 3.5 Exhaust Velocity : ________

f. Exhaust Volume: 250 ACFM Exhaust Volume: 181 SCFM

g. Distance to Nearest Property Line (ft): ________

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: 033

j. Latitude: 41.233462° Longitude: -77.063079

Horizontal Reference Datum: WGS84

Horizontal Collection Method: NA

Reference Point: Exhaust Stack

---

a. Unit ID: S034 b. Company Designation: LARGE HEATER STACK

c. Discharge Type: ________

d. Diameter (ft): ________ Height (ft): ________ Base Elevation (ft): ________

e. Exhaust Temperature: 200 deg F Exhaust % Moisture: 10 Exhaust Velocity : ________

f. Exhaust Volume: 500 ACFM Exhaust Volume: 361 SCFM

g. Distance to Nearest Property Line (ft): ________

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: 034

j. Latitude: 41° 14 3.7677 Longitude: -77° 1 46.7442

Horizontal Reference Datum: ________

Horizontal Collection Method: ________

Reference Point: ________

Section 9 - Stack/Flue Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new stack/flue listed in Section 3 of this application.

9.1 General Stack/Vent Information

a. Unit ID: S108 b. Company Designation: QUALITY CONTROL STACK

c. Discharge Type: VERTICAL: UNOBSTRUCTED OPENING

d. Diameter (ft): ______ Height (ft): 35 Base Elevation (ft): ______

e. Exhaust Temperature: 999 deg F Exhaust % Moisture: 99 Exhaust Velocity : ______

f. Exhaust Volume: 2,752,555 ACFM Exhaust Volume: 9,999 SCFM

g. Distance to Nearest Property Line (ft): ______

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: P108

j. Latitude: 41° 14 3.7677 Longitude: -77° 1 46.7442

Horizontal Reference Datum: North American Datum of 1983

Horizontal Collection Method: Unknown

Reference Point: Plant entrance (general) - The general entrance to a plant

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a. Unit ID: S113 b. Company Designation: ANNEALING OVEN STACK

c. Discharge Type: VERTICAL: UNOBSTRUCTED OPENING

d. Diameter (ft): ______ Height (ft): 35 Base Elevation (ft): ______

e. Exhaust Temperature: 500 deg F Exhaust % Moisture: 10 Exhaust Velocity : ______

f. Exhaust Volume: 500 ACFM Exhaust Volume: 248 SCFM

g. Distance to Nearest Property Line (ft): ______

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: P113

j. Latitude: 41.234302° Longitude: -77.061054°

Horizontal Reference Datum: WGS84

Horizontal Collection Method: ______

Reference Point: ______

Section 9 - Stack/Flue Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new stack/flue listed in Section 3 of this application.

9.1 General Stack/Vent Information

a. Unit ID: S114 b. Company Designation: ANNEALING OVEN #3 STACK

c. Discharge Type: VERTICAL: UNOBSTRUCTED OPENING

d. Diameter (ft): ______ Height (ft): 35 Base Elevation (ft): ______

e. Exhaust Temperature: 200 deg F Exhaust % Moisture: 10 Exhaust Velocity : ______

f. Exhaust Volume: 5,000 ACFM Exhaust Volume: 3,614 SCFM

g. Distance to Nearest Property Line (ft): ______

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: P114

j. Latitude: 41.233893° Longitude: -77. 061054°

Horizontal Reference Datum: WGS84

Horizontal Collection Method: ______

Reference Point: ______

Section 9 - Stack/Flue Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new stack/flue listed in Section 3 of this application.

9.1 General Stack/Vent Information

a. Unit ID: Z001 b. Company Designation: FUGITIVE EMISSIONS

c. Discharge Type: FUGITIVE EMISSIONS

d. Diameter (ft): ______ Height (ft): ______ Base Elevation (ft): ______

e. Exhaust Temperature: 68 deg F Exhaust % Moisture: 0 Exhaust Velocity : ______

f. Exhaust Volume: 1 ACFM Exhaust Volume: 1 SCFM

g. Distance to Nearest Property Line (ft): ______

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: P106, P211

j. Latitude: 41° 14 3.7677 Longitude: -77° 1 46.7442
Horizontal Reference Datum: ______
Horizontal Collection Method: ______
Reference Point: ______

Section 9 - Stack/Flue Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new stack/flue listed in Section 3 of this application.

9.1 General Stack/Vent Information

a. Unit ID: Z105 b. Company Designation: ANNEALING OVENS EMISSIONS

c. Discharge Type: FUGITIVE EMISSIONS

d. Diameter (ft): ____ Height (ft): ____ Base Elevation (ft): ____

e. Exhaust Temperature: 999 deg F Exhaust % Moisture: 99 Exhaust Velocity : ____

f. Exhaust Volume: 2,752,555 ACFM Exhaust Volume: 9,999 SCFM

g. Distance to Nearest Property Line (ft): ____

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: P105

j. Latitude: 41° 14 3.7677 Longitude: -77° 1 46.7442

Horizontal Reference Datum: North American Datum of 1983

Horizontal Collection Method: Unknown

Reference Point: Plant entrance (general) - The general entrance to a plant

---

a. Unit ID: Z109 b. Company Designation: TANKS EMISSIONS >2,000 GAL

c. Discharge Type: FUGITIVE EMISSIONS

d. Diameter (ft): ____ Height (ft): ____ Base Elevation (ft): ____

e. Exhaust Temperature: 999 deg F Exhaust % Moisture: 99 Exhaust Velocity : ____

f. Exhaust Volume: 2,752,555 ACFM Exhaust Volume: 9,999 SCFM

g. Distance to Nearest Property Line (ft): ____

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: P109

j. Latitude: 41° 14 3.7677 Longitude: -77° 1 46.7442

Horizontal Reference Datum: North American Datum of 1983

Horizontal Collection Method: Unknown

Reference Point: Plant entrance (general) - The general entrance to a plant

Section 9 - Stack/Flue Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new stack/flue listed in Section 3 of this application.

9.1 General Stack/Vent Information

a. Unit ID: Z110 b. Company Designation: STORAGE TANKS EMISSIONS

c. Discharge Type: FUGITIVE EMISSIONS

d. Diameter (ft): ______ Height (ft): ______ Base Elevation (ft): ______

e. Exhaust Temperature: 999 deg F Exhaust % Moisture: 99 Exhaust Velocity : ______

f. Exhaust Volume: 2,752,555 ACFM Exhaust Volume: 9,999 SCFM

g. Distance to Nearest Property Line (ft): ______

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: P110

j. Latitude: 41° 14 3.7677 Longitude: -77° 1 46.7442

Horizontal Reference Datum: North American Datum of 1983

Horizontal Collection Method: Unknown

Reference Point: Plant entrance (general) - The general entrance to a plant

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a. Unit ID: Z111 b. Company Designation: LINPAR , MORG EMISSION

c. Discharge Type: FUGITIVE EMISSIONS

d. Diameter (ft): ______ Height (ft): ______ Base Elevation (ft): ______

e. Exhaust Temperature: 999 deg F Exhaust % Moisture: 99 Exhaust Velocity : ______

f. Exhaust Volume: 2,752,555 ACFM Exhaust Volume: 9,999 SCFM

g. Distance to Nearest Property Line (ft): ______

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources: P111

j. Latitude: 41° 14 3.7677 Longitude: -77° 1 46.7442

Horizontal Reference Datum: North American Datum of 1983

Horizontal Collection Method: Unknown

Reference Point: Plant entrance (general) - The general entrance to a plant

Section 10 - Fuel Material Location (FML) Information (Optional)

For renewals review and correct any pre-printed information and add additional sections for any new FML listed in Section 3 of this application.

10.1 Fuel Material Location Information

a. FML ID No.: FM001 b. Name: NATURAL GAS LINE

c. Capacity: ______ Units: ______ d. Fuel: Natural Gas

e. Maximum Fuel Characteristics: If fuel is coal, what is the moisture content? ______

% Ash 0 % Sulfur: 0 BTU Content: 1050 Units: lbs/gal/cu ft

f. Used by Source:

031, 032, 033, 034, P103, P113, P114

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a. FML ID No.: ______ b. Name: ______

c. Capacity: ______ Units: ______ d. Fuel: ______

e. Maximum Fuel Characteristics: If fuel is coal, what is the moisture content? ______

% Ash ______ % Sulfur: ______ BTU Content: ______ Units: ______

f. Used by Source:

---

a. FML ID No.: ______ b. Name: ______

c. Capacity: ______ Units: ______ d. Fuel: ______

e. Maximum Fuel Characteristics: If fuel is coal, what is the moisture content? ______

% Ash ______ % Sulfur: ______ BTU Content: ______ Units: ______

f. Used by Source:

Section 11 - Compliance Plan for the Facility

		Yes	No
11.1	Will your facility be in compliance with all applicable requirements at the time of permit issuance and continue to comply with these requirements during the permit duration?	☒	☐
11.2	Will your facility be in compliance with all applicable requirements presently scheduled to take effect during the term of the permit?	☒	☐
11.3	Will these requirements be met by the regulatory required dates?	☒	☐

If you checked "No" in Part 11.1, 11.2 or 11.3, answer the following questions:

11.4 Identify applicable requirement(s) for which compliance is not or will not be achieved:

Source ID No.	Citation No.
NA	NA

11.4.1 Briefly describe how compliance with this/these applicable requirement(s) will be achieved:

NA

11.4.2. Provide a detailed schedule of compliance for the noncomplying sources or activities identified in this section of the application. Include an enforceable sequence of corrective actions with milestone and projected compliance dates.

Date	Action/Milestone
NA	NA

11.4.3. Indicate the submittal frequency for the progress report (s): NA

11.4.4. Starting date for the submittal of the progress report(s): NA

Section 12 – Alternative Operating Scenario (optional)

Duplicate this section for each source participated in this alternative scenario.

12.1 General Information

a. Alternative Operating Scenario Name or ID No.: NA

b. Source ID No.: ____________ c. Source Name: ____________

d. Source Type (check one): ☐ Combustion ☐ Incinerator ☐ Process

e. Give a brief description of this alternative scenario stating how it is different from the standard operation:

12.2 Operational Flexibility Request

Check all that apply.

☐ Alternative exhaust system component configuration

If this box is checked, complete Sections 12.3 and 12.7

☐ Alternative type of fuel usage replacing or in addition to an existing fuel in standard operation.

If this box is checked, complete Sections 12.4 and/or 12.5 and 12.7

☐ Alternative process method replacing or in addition to a process SCC existing in standard operation.

If this box is checked, complete Section 12.6 and 12.7

12.3 Exhaust System Components

Specify the complete exhaust system component configuration for this alternative operating scenario.

From Component Type	From Component Number	To Component Type	To Component Number	Percent Flow	Begin Date	End Date

12.4 Source Classification Code (SCC) Listing for Alternative Operation			
Give a complete listing of all fuels burned, products produced by a process or waste incinerated for this alternative operating scenario.			
Fuel	**Associated SCC**	**Max Throughout Rate**	**Firing Sequence**

12.5 Alternative Fuel Physical Characteristics				
Give a complete listing of all fuels physical characteristics for this alternative operating scenario.				
SCC/Fuel Burned	**FML**	**% Sulfur**	**% Ash**	**BTU Content (Units)**

12.6 Alternative Process/Product Description			
a. Briefly describe the change(s) in raw materials and/or process methods used in this operating scenario, if applicable:			
b. Provide and briefly describe the process SCC associated with this alternative operating scenario:			
Process SCC:		SCC Description:	
c. Alternative Product(s):			

12.7 Source Potential to Emit

Give Potential Emission estimate for all air pollutants emitted at this source for this operating scenario.

Pollutant or CAS Number	Fuel	Emission/Activity Allowable per Unit	Calc. Method	Max. Capacity	Total Hours	Emission in TPY

Section 13 – Compliance Certification

13.1 Schedule for Compliance Certification Submission

a. Frequency of Submittal: ______

b. Schedule specified in current Title V Operating Permit or proposed starting date:

13.2 Monitoring Compliance

Is the site identified in this application in compliance with all applicable requirements and compliance certification requirements:

☒ Yes* ☐ No

If "NO", describe which requirements are not being met:

______

______

______

13.3 Certification of Compliance

Subject to the penalties of Title 18 Pa. C.S. Section 4904 and 35 P.S. Section 4009(b)(2), I certify that I have the authority to submit this Permit Application on behalf of the applicant herein and that based on information and belief formed after reasonable inquiry, the statements and information contained in this application are true, accurate, and complete.

(Signed) ______ Date 12/22/2022

Name (Type) Leslie Mayes

Title: Plant Manager

CHANCE ALUMINUM

RACT III Analysis with Alternate Compliance Plan For Chance Aluminum, Williamsport, PA Operations

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Compiled for RACT II by Jesse Hackenberg, PE
Hilltop Environmental Engineering
September 26, 2016

Updated for RACT III by
Meridian Energy & Environment LLC
December 19, 2022

MERIDIAN
Energy & Environment, LLC

Table of Contents

Appendices

Executive Summary

In 2015, the US EPA lowered the National Ambient Air Quality Standard (NAAQS) for ozone from 0.075 ppm (2008 ozone standard) to 0.070 ppm. With the change in the NAAQS for ozone, states not in compliance with the new standard developed a Federally approved State Implementation Plan (SIP) to meet the new standard. The RACT III regulation is Pennsylvania's solution to address the 2015 ozone standard of 0.070 ppm for ambient air quality.

The final-form rulemaking entitled "Additional RACT Requirements for Major Sources of NOx and VOCs for the 2015 Ozone NAAQS (RACT III)" (25 Pa. Code Section 129.115(a)) provides that the owner and operator of an air contamination source subject to the final-form RACT III shall submit a notification stipulating how the facility intends to comply with the final-form RACT III requirements. An alternate compliance plan is required for facilities that cannot meet the RACT III requirements by December 31, 2022.

Chance Aluminum (Chance) owns and operates a facility (Title V Operating Permit No. 41-00013), located in City of Williamsport, Lycoming County, that is subject to the final-form RACT III rulemaking requirements that apply to the owners and operators of facilities that emit or have a potential to emit 100 tpy or more of NOx or 50 tpy or more of VOCs.

The Chance Aluminum facility in Williamsport, Pennsylvania has NOx PTE emissions of 19 tons per year and VOC PTE emissions of 300 tons per year. Thus, the RACT III regulations apply to the facility's VOC emissions but not its NOx emissions. The facility's four (4) rolling mills are the relatively large VOC sources that preclude facility exemption from the RACT III regulations.

A RACT II evaluation was submitted for this facility on September 16, 2016 when JW Aluminum was the facility owner/operator. The facility does not fall under one of the nine (9) categories requiring presumptive control standards. Thus, the facility's four rolling mills are subject to the case-by-case evaluation required for large sources of VOC emissions. The RACT II evaluation comprised a cost analysis following established study methodology and was submitted to PA DEP for review and concurrence to demonstrate that economically reasonable pollution controls were already in place on each of the mills.

The plant was acquired by Chance Aluminum in 2021 from JW Aluminum. The final RACT III requirements indicate that if a source was previously subject to RACT II case-by-case determinations, and that source has not been modified or changed, the owner or operator may, in lieu of doing another full case-by-case proposal for RACT III, submit a limited analysis no later than December 31, 2022, as specified in 25 Pa. Code Section 129.114(i). There have been no new equipment additions or modifications that would change the RACT II evaluation other than cost changes due to inflation. Further, the facility is not subject to any of the seven (7) more stringent presumptive emission limitations under RACT III. Thus, Chance Aluminum is submitting a limited RACT II cost evaluation to demonstrate compliance with RACT III requirements.

While the cost analysis is included in this report, stack testing to demonstrate compliance for the VOC emissions of the four mills has not been conducted within the past 12 months. Thus, Chance is submitting this report as an alternate compliance plan with stack testing scheduled for the week of March 20, 2023.

DEP has suggested an approximate definition of a reasonable control floor for VOC control costs to be $12,000. In other words, if it costs less than $12,000 to remove the next incremental annual ton of VOC pollution by installing a new or different control method, that pollution control method is to be employed.

The following summary charts show the range of technically-viable VOC control options for each of the four rolling mills – Mill 1, Mill 2, Mill 3, and Mill 4. Each row shows the control method, statistics on pollution removal, the capital cost of control equipment, the annualized cost of operation and the overall cost for removing an incremental ton of VOC pollution. The table data is presented in the order of decreasing overall cost for removing an incremental ton of VOC pollution. Note that the analyses express potential pollution amounts and all costs assuming round–the-clock operation, 365 days per year, with exceptions for system maintenance or where permit limits specify otherwise.

As expected, the older mill installations, Mills 1 and 2 include fewer and less aggressive pollution controls and there is more opportunity for improvement on these mills. Mills 3 and 4 were installed later and include more sophisticated controls, thus additional VOC reductions on these mills is considerably more expensive. In every instance, the updated RACT III cost analyses demonstrate that the VOC controls already in place satisfy the definition of reasonable and no additional controls are required. Following successful stack test compliance demonstrations in March 2023, Chance Aluminum will be in full compliance with all RACT III requirements.

Table 1. Reasonably Available Control Technologies (RACT III) for Chance Aluminum, Williamsport, PA – Mill 1

Control Device	System Efficiency	Emission Reduction Potential (tons VOC per 12-months)	Estimated Emissions After Control (tons VOC per 12 months)	Total Capital Investment	Total Annual System Cost	Overall Cost Effectiveness $/Ton VOC Removed
Mill 1 Thermal Oxidation with No Heat Recovery	98%	128.5	2.6	$ 1,781,002	$ 5,518,704	$ 42,938
Mill 1 Catalytic Oxidation with No Heat Recovery	95%	124.6	6.6	$ 2,705,693	$ 3,692,850	$ 29,639
Mill 1 Thermal Oxidation with 35% Heat Recovery	98%	128.5	2.6	$ 2,100,651	$ 3,755,270	$ 29,218
Mill 1 Thermal Oxidation with 50% Heat Recovery	98%	128.5	2.6	$ 2,225,888	$ 3,163,812	$ 24,616
Mill 1 Catalytic Oxidation with 35% Heat Recovery	95%	124.6	6.6	$ 2,480,425	$ 2,706,626	$ 21,724

Control Device	System Efficiency	Emission Reduction Potential (tons VOC per 12-months)	Estimated Emissions After Control (tons VOC per 12 months)	Total Capital Investment	Total Annual System Cost	Overall Cost Effectiveness $/Ton VOC Removed
Mill 1 Catalytic Oxidation with 50% Heat Recovery	95%	124.6	6.6	$ 3,024,896	$ 2,435,271	$ 19,546
Mill 1 Thermal Oxidation with 70% Heat Recovery	98%	128.5	2.6	$ 2,454,531	$ 2,237,325	$ 17,407
Mill 1 Catalytic Oxidation with 70% Heat Recovery	95%	124.6	6.6	$ 3,245,852	$ 1,972,805	$ 15,834
Mill 1 Regenerative Thermal Oxidizer	98%	128.5	2.6	$ 4,507,945	$ 1,863,488	$ 14,499
Mill 1 Adsorber	93%	122.1	9.0	$ 6,482,198	$ 1,571,023	$ 12,867
Baseline Emissions			131.2			

Table 2. Reasonably Available Control Technologies (RACT III) for Chance Aluminum, Williamsport, PA – Mill 2

Control Device	System Efficiency	Emission Reduction Potential (tons VOC per 12-months)	Estimated Emissions After Control (tons VOC per 12 months)	Total Capital Investment	Total Annual System Cost	Overall Cost Effectiveness $/Ton VOC Removed
Mill 2 Thermal Oxidation with No Heat Recovery	98%	128.5	2.6	$ 1,634,992	$ 5,118,028	$ 39,821
Mill 2 Catalytic Oxidation with No Heat Recovery	95%	124.6	6.6	$ 2,234,644	$ 3,369,538	$ 27,044
Mill 2 Thermal Oxidation with 35% Heat Recovery	98%	128.5	2.6	$ 1,947,487	$ 3,591,139	$ 27,941
Mill 2 Thermal Oxidation with 50% Heat Recovery	98%	128.5	2.6	$ 2,071,003	$ 2,947,698	$ 22,934

Control Device	System Efficiency	Emission Reduction Potential (tons VOC per 12-months)	Estimated Emissions After Control (tons VOC per 12 months)	Total Capital Investment	Total Annual System Cost	Overall Cost Effectiveness $/Ton VOC Removed
Mill 2 Catalytic Oxidation with 35% Heat Recovery	95%	124.6	6.6	$ 2,306,126	$ 2,516,109	$ 20,195
Mill 2 Catalytic Oxidation with 50% Heat Recovery	95%	124.6	6.6	$ 2,816,189	$ 2,265,714	$ 18,185
Mill 2 Thermal Oxidation with 70% Heat Recovery	98%	128.5	2.6	$ 2,295,369	$ 2,093,109	$ 16,285
Mill 2 Catalytic Oxidation with 70% Heat Recovery	95%	124.6	6.6	$ 3,028,682	$ 1,838,660	$ 14,757
Mill 2 Regenerative Thermal Oxidizer	98%	128.5	2.6	$ 4,228,746	$ 1,743,847	$ 13,568
Mill 2 Adsorber	93%	122.1	9.0	$ 6,343,374	$ 1,539,289	$ 12,607
Baseline Emissions			131.2			

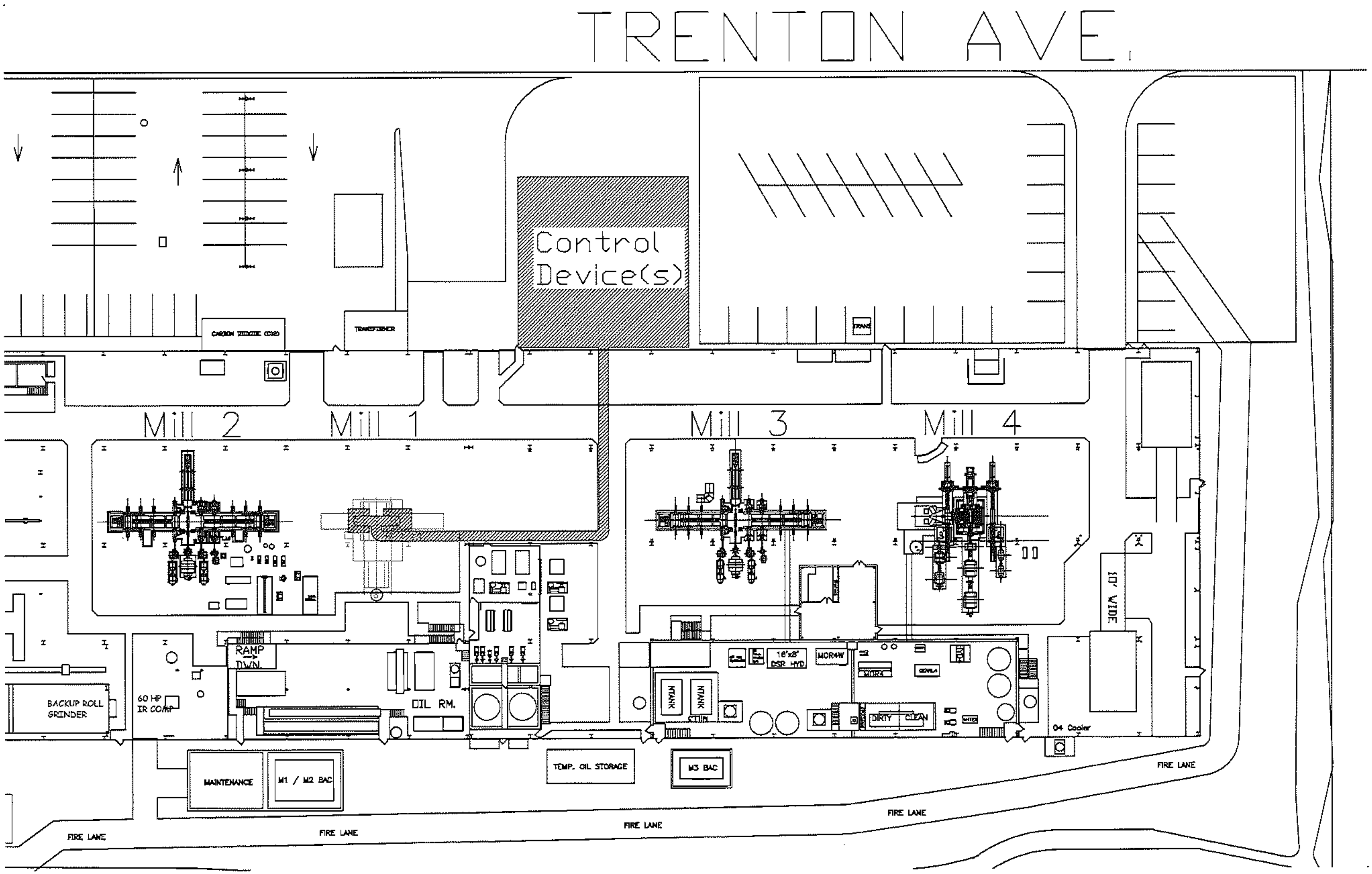
Table 3. Reasonably Available Control Technologies (RACT III) for Chance Aluminum, Williamsport, PA – Mill 3

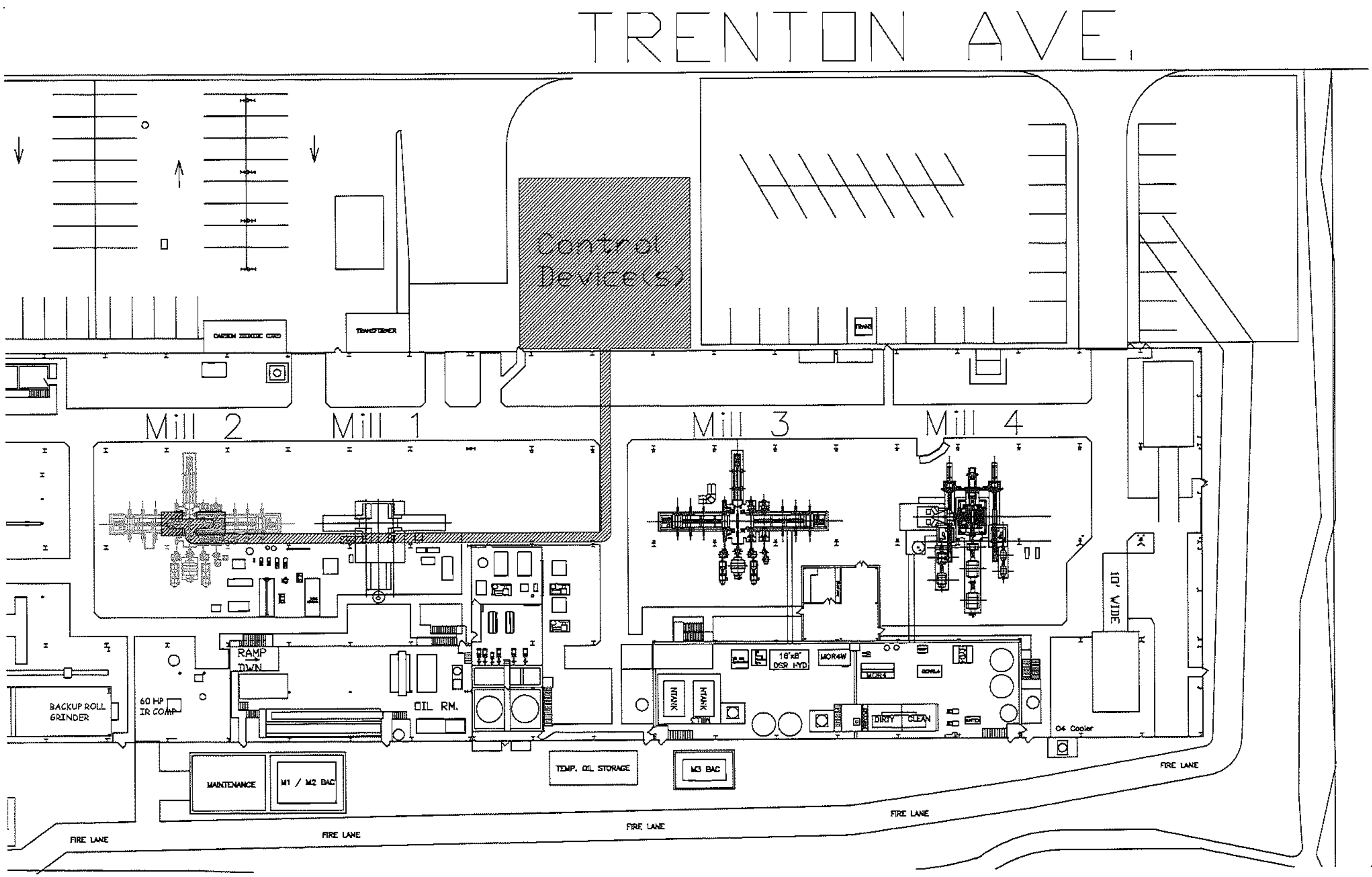
Control Device	System Efficiency	Emission Reduction Potential (tons VOC per 12-months)	Estimated Emissions After Control (tons VOC per 12 months)	Total Capital Investment	Total Annual System Cost	Overall Cost Effectiveness $/Ton VOC Removed
Mill 3 Thermal Oxidation with No Heat Recovery	98%	7.8	0.2	$ 1,003,571	$ 2,956,863	$ 377,151
Mill 3 Thermal Oxidation with 35% Heat Recovery	98%	7.8	0.2	$ 1,273,339	$ 2,107,565	$ 268,822
Mill 3 Thermal Oxidation with 50% Heat Recovery	98%	7.8	0.2	$ 1,386,185	$ 1,750,493	$ 223,277
Mill 3 Thermal Oxidation with 70% Heat Recovery	98%	7.8	0.2	$ 1,584,709	$ 1,279,351	$ 163,183
Mill 3 Regenerative Thermal Oxidizer	98%	7.8	0.2	$ 2,944,635	$ 1,136,783	$ 144,998
Baseline Emissions			8.0			

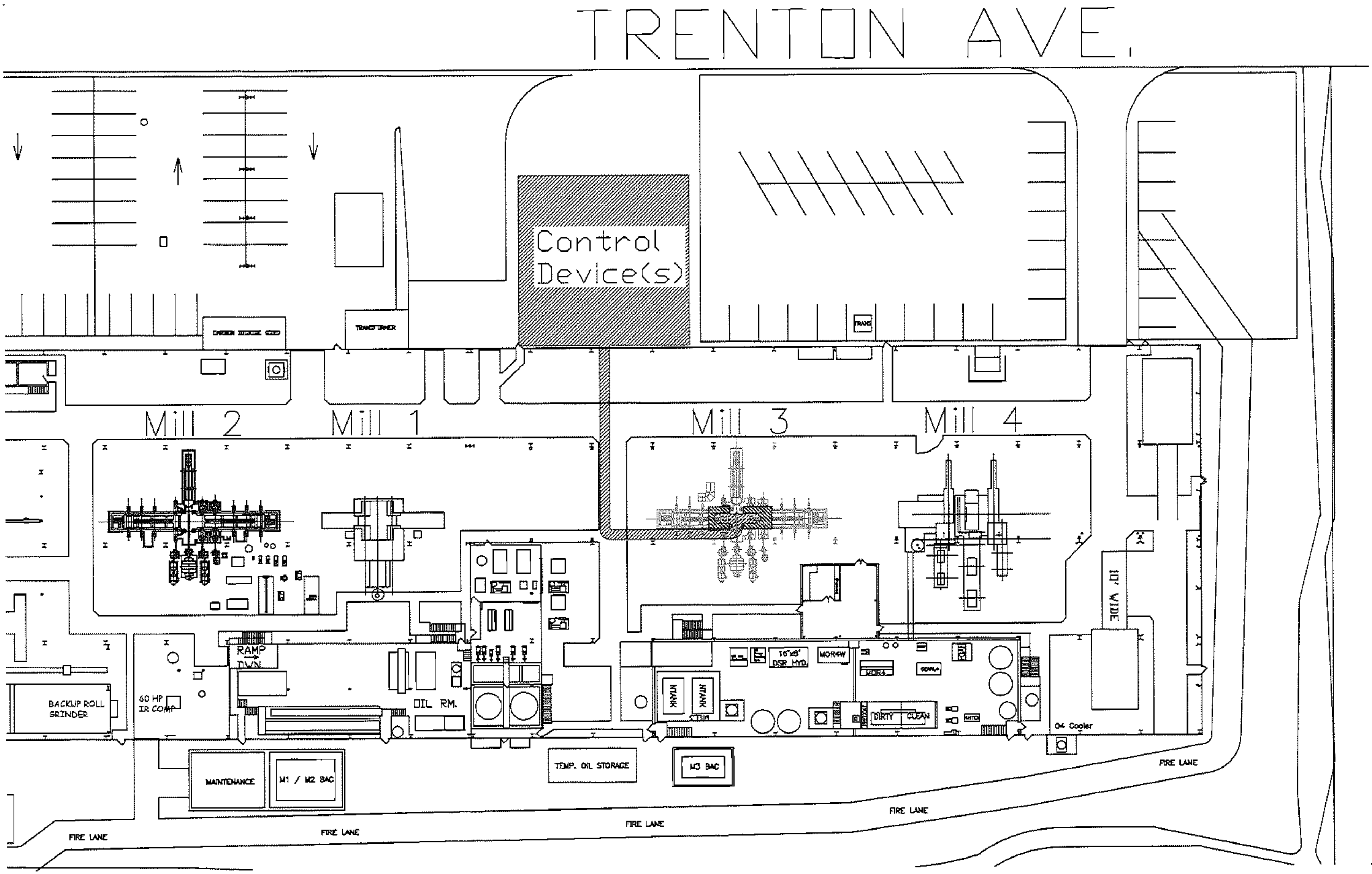
Table 4. Reasonably Available Control Technologies (RACT III) for Chance Aluminum, Williamsport, PA – Mill 4

Control Device	System Efficiency	Emission Reduction Potential (tons VOC per 12-months)	Estimated Emissions After Control (tons VOC per 12 months)	Total Capital Investment	Total Annual System Cost	Overall Cost Effectiveness $/Ton VOC Removed
Mill 4 Thermal Oxidation with No Heat Recovery	98%	25.8	0.5	$ 1,200,856	$ 2,958,356	$ 117,005
Mill 4 Catalytic Oxidation with No Heat Recovery	95%	25.0	1.3	$ 1,770,905	$ 2,078,280	$ 84,793
Mill 4 Thermal Oxidation with 35% Heat Recovery	98%	25.8	0.5	$ 1,463,394	$ 2,123,870	$ 84,001
Mill 4 Thermal Oxidation with 50% Heat Recovery	98%	25.8	0.5	$ 1,574,361	$ 1,773,276	$ 70,134
Mill 4 Catalytic Oxidation with 35% Heat Recovery	95%	25.0	1.3	$ 1,685,738	$ 1,574,054	$ 64,221

Control Device	System Efficiency	Emission Reduction Potential (tons VOC per 12-months)	Estimated Emissions After Control (tons VOC per 12 months)	Total Capital Investment	Total Annual System Cost	Overall Cost Effectiveness $/Ton VOC Removed
Mill 4 Catalytic Oxidation with 50% Heat Recovery	95%	25.0	1.3	$ 1,985,512	$ 1,434,890	$ 58,543
Mill 4 Thermal Oxidation with 70% Heat Recovery	98%	25.8	0.5	$ 1,768,456	$ 1,310,452	$ 51,829
Mill 4 Catalytic Oxidation with 70% Heat Recovery	95%	25.0	1.3	$ 2,142,921	$ 1,206,911	$ 49,242
Mill 4 Regenerative Thermal Oxidizer	98%	25.8	0.5	$ 3,053,619	$ 1,159,559	$ 45,861
Mill 4 Adsorber	93%	24.5	1.8	$ 4,085,409	$ 1,010,550	$ 42,072
Baseline Emissions			26.3			


TRENTON AVE.
Control Device(s)
TRANSFORMER
Mill 2
Mill 1
Mill 3
Mill 4
RAMP DWN.
BACKUP ROLL GRINDER
60 HP IR COMP
OIL RM.
16'x8' DSR HYD
MOR4W
DIRTY
CLEAN
10' WIDE
04 Cooler
MAINTENANCE
M1 / M2 BAC
TEMP. OIL STORAGE
M3 BAC
FIRE LANE
FIRE LANE
FIRE LANE
FIRE LANE
FIRE LANE


TRENTON AVE.
Control Device(s)
Mill 2
Mill 1
Mill 3
Mill 4
10' WIDE
RAMP DWN
60 HP IR COMP
BACKUP ROLL GRINDER
OIL RM.
16'x8' DSR HYD
MOR4W
MTANK
MTANK
DIRTY
CLEAN
O4 Cooler
MAINTENANCE
M1 / M2 BAC
TEMP. OIL STORAGE
M3 BAC
FIRE LANE
FIRE LANE
FIRE LANE
FIRE LANE
FIRE LANE



TRENTON AVE.
Control
Device(s)
TRANSFORMER
Mill 2
Mill 1
Mill 3
Mill 4
10' WIDE
RAMP
DWN
BACKUP ROLL
GRINDER
60 HP
IR COMP
OIL RM.
16"x8"
DSR HYD.
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MOR3
NTANK
NTANK
DIRTY
CLEAN
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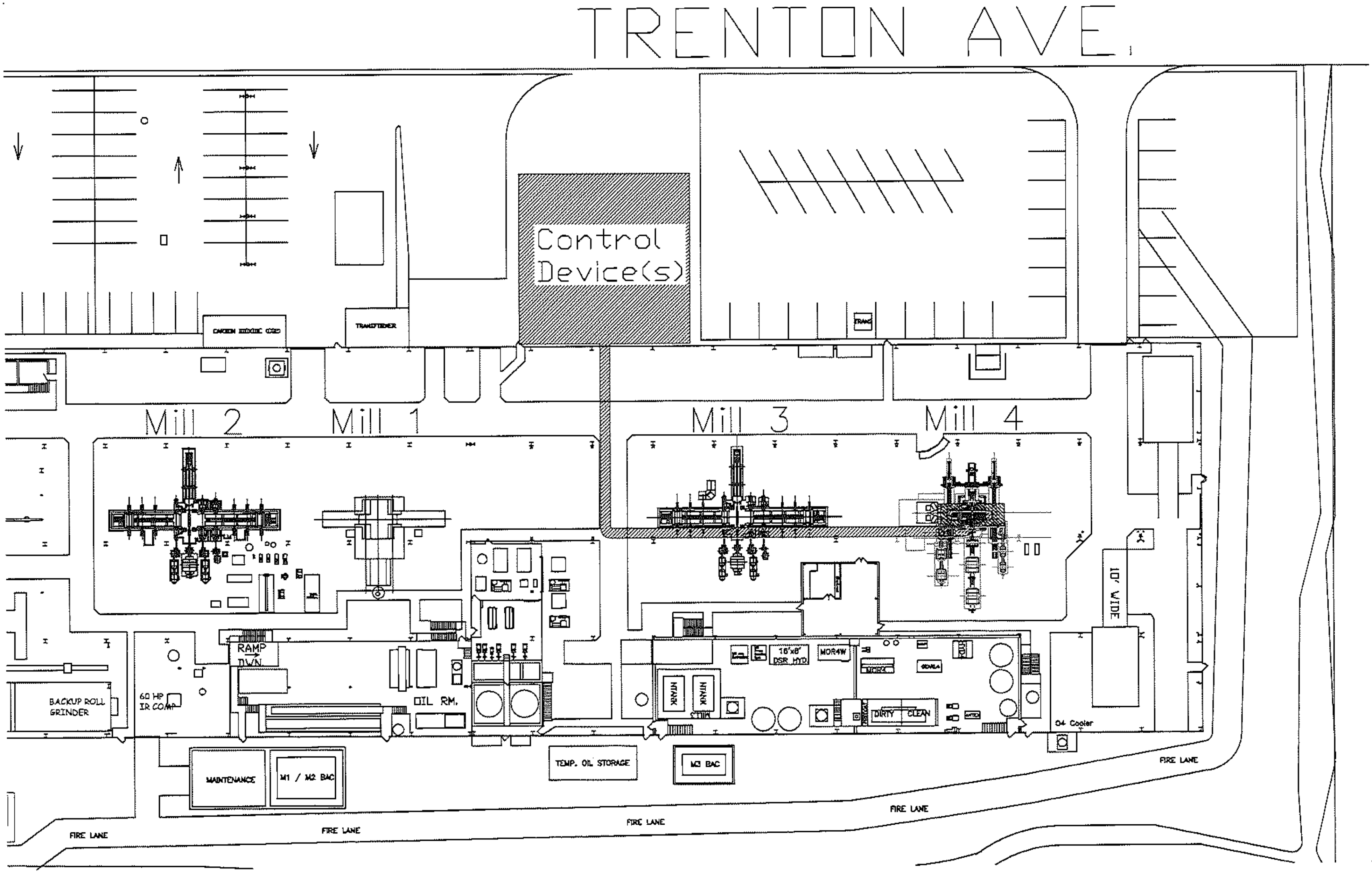
MAINTENANCE
M1 / M2 BAC
TEMP. OIL STORAGE
M3 BAC
FIRE LANE
FIRE LANE
FIRE LANE
FIRE LANE
FIRE LANE



TRENTON AVE.
Control Device(s)
TRANSFORMER
TRANS
Mill 2
Mill 1
Mill 3
Mill 4
10' WIDE
RAMP DWN.
OIL RM.
BACKUP ROLL GRINDER
60 HP IR COMP
16"x8" DSR HYD
MOR4W
DIRTY
CLEAN
O4 Cooler
MAINTENANCE
M1 / M2 BAC
TEMP. OIL STORAGE
M3 BAC
FIRE LANE
FIRE LANE
FIRE LANE
FIRE LANE
FIRE LANE

1. Background

In 2015, the US EPA lowered the National Ambient Air Quality Standard (NAAQS) for ozone from 0.075 ppm (2008 ozone standard) to 0.070 ppm. With the change in the NAAQS for ozone, states not in compliance with the new standard developed a Federally approved State Implementation Plan (SIP) to meet the new standard. The RACT III regulation is Pennsylvania's solution to address the 2015 ozone standard of 0.070 ppm for ambient air quality.

The final-form rulemaking entitled "Additional RACT Requirements for Major Sources of NOx and VOCs for the 2015 Ozone NAAQS (RACT III)" (25 Pa. Code Section 129.115(a)) provides that the owner and operator of an air contamination source subject to the final-form RACT III shall submit a notification stipulating how the facility intends to comply with the final-form RACT III requirements. An alternate compliance plan is required for facilities that cannot meet the RACT III requirements by December 31, 2022.

Chance Aluminum (Chance) owns and operates a facility (Title V Operating Permit No. 41-00013), located in City of Williamsport, Lycoming County, that is subject to the final-form RACT III rulemaking requirements that apply to the owners and operators of facilities that emit or have a potential to emit 100 tpy or more of NOx or 50 tpy or more of VOCs. Chance's PTE NOx emissions are below the 100 ton per year applicability threshold. However, the facility does have relatively large VOC emitting sources (four (4) secondary aluminum rolling mills) that subject the facility to RACT III.

In 2021, Chance removed coil coating lines 1, 2, 3, 4, 4b, 5, 6, and 8 (P201, P202, P203, P204, P204A, P205, P206, P210) along with the 2 VOC sources in the coating solutions mixing area (P207, P208) and related process heaters and ovens (P209). Also removed were related catalytic oxidizers C201, C203, C204, C204A, C205, C206 and one regenerative thermal oxidizer on coating line 8 (C210). These changes were included in the facility's Title V renewal application submitted in July 2022. As a result, facility VOC PTE emissions have decreased, and the updated PTE emissions are **19 tons per year for NOx and 300 tons per year for VOC emissions**.

Further, while the coating lines were VOC sources, they were subject to other PA DEP air regulations which precluded them being subject to RACT regulations. Similarly, aboveground storage tanks and solvent-based parts washers are excluded from the RACT III rule because other regulations specify control requirements. Nonetheless, the applicability of RACT III still applies to VOC emissions from the four rolling mills at Chance.

In accordance with the RACT III notification requirements, Chance confirms not all of the VOC sources at the facility are subject to at least one of the following: 25 Pa. Code Sections 129.51, 129.52(a)-(k) and Table I categories 1-11, 129.52a-129.52e, 129.54-129.63a, 129.64-129.69, 129.71-129.75, 129.77 and 129.101-129.107 (Chapter 129 VOC Regulations). Also, Chance is not listed as one of the nine (9) categories requiring presumptive control standards. Further, the facility is not subject to any of the seven (7) more stringent presumptive emission limitations under RACT III. However, the facility's four rolling mills are subject to the case-by-case evaluation required for large sources of VOC emissions.

Chance submitted a RACT II evaluation in October 2016 for its four (4) rolling mills for VOC emissions control. The final RACT III requirements indicate that if a source was previously subject to RACT II case-by-case determinations, and that source has not been modified or changed, the owner or operator may, in lieu of doing another full case-by-case proposal for RACT III, submit a limited analysis no later than December 31, 2022, as specified in 25 Pa. Code Section 129.114(i). This less resource intensive demonstration is being used by Chance to demonstrate that the previous case-by-case determination made under §§ 129.96—129.100 (RACT II) remains RACT for the 2015 8-hour ozone standard.

While the cost analysis is included in this report, part of the compliance demonstration requirements includes stack testing. As the last stack testing of the rolling mills was performed in 2015 (outside of the allowable one-year testing period), stack testing needs to be repeated as part of the compliance demonstration for RACT III. The facility is unable to schedule stack testing prior to the December 31, 2022 compliance deadline. Thus, Chance is submitting this report as an alternate compliance plan with stack testing scheduled for the week of March 20, 2023.

Following the RACT II evaluation, there have been no physical or operational changes or modifications to any source subject to RACT III, nor have there been any equipment additions that would be subject to RACT III. Further, there have been no changes in emission levels, or other site or source specific factors analyzed during the original determination for the facility's RACT II permits for applicable sources. Thus, Chance is submitting a limited cost analysis for a case-by-case RACT determination by updating relevant costs and other data in its previously submitted RACT II analysis.

Labor rates and utility costs were updated using the most recent data from the Bureau of Labor Statistics and U.S. Energy Information Agency. The CPI, Consumer Price Index, was the RACT II default index used to acknowledge the presence of inflation in the previous cost study. In this limited evaluation, the PPI, Producer Price Index, provided by the U.S. Bureau of Labor Statistics, is used as a more accurate measure of inflation of manufacturing-related equipment costs. Related calculations were modified to use the PPI instead of the previously used CPI.

As the RACT II evaluation was based on 1999 cost data adjusted for inflation from 1999-2015, Chance has adjusted the original equipment cost data for inflation from the 1999 PPI annual average of 143.3 to the 2022 PPI monthly average to date of 242.3, representing an increase by a factor of 1.7 from 1999.

The economic threshold for required VOC control equipment due to the RACT III evaluation is $12,000 per incremental ton of VOC pollution removed and this represents reasonably available control technology. The evaluation is to assure that economically reasonable controls are in use for each pollution source capable of annual VOC emissions greater than one ton per year (12-CMP (Continuous Monthly Period)). For each source, the Potential-To-Emit under maximum output, for round-the-clock operations, (PTE) is the critical measure, not the actual emissions.

In the following study, case-by-case cost evaluations are included for the four sources at Chance-Williamsport which exceed the 2.7 tons per 12-CMP RACT III threshold – Rolling Mills 1, 2, 3 and 4. The cost analyses are presented using the methodology from EPA's Air Pollution Control Cost Manual (6th Edition and related updated chapters in the 7th Edition). However, the calculation spreadsheets used for RACT II were updated and used in this limited evaluation.

Capital cost estimates are evaluated for each of the four mills. The analysis for each mill includes:

- Location of the source within the plant
- Rough sketch of the process flow
- Preliminary sizes and types of construction of any buildings required
- Rough estimates of utility requirements
- Preliminary flow sheet and specifications for ducts and piping
- Approximate sizes of motors required.
- In addition, the study includes estimated labor, supervisory, and engineering costs for the installation.

The capital expenditures are recovered under an appropriate discounting method and added to estimated ongoing costs to arrive at a Total Annualized Control Cost. All costs (and any incomes realized) are considered in today's dollars, so that all options will be compared equally. When related to the removal efficiency of the control technology, the resulting units will be provided in dollars per ton of potential VOC removed from the process. In this manner, various appropriate VOC control methods can be compared to one another and to the RACT III screening level, approximately $12,000 per ton of incremental VOC. Where possible, the costs used for the study are taken from the OAQPS Control Cost Manual and adjusted for inflation to the present, based on the PPI (producer price index) ratio defined in the Manual.

The four rolling mills at Chance Williamsport, the sources evaluated for add-on controls, are Mill 1, Mill 2, Mill 3, and Mill 4. Each of these rolling mills shares some common characteristics; but each is optimized for specific tasks, as well.

2. Rolling Mill Characteristics

Each Chance-Williamsport non-ferrous, cold rolling mill is a single-stand, four-high, non-reversing rolling mill. Simplified, each mill resembles a huge antique wringer washing machine, with a total of four rolls in a single stack applying pressure to the aluminum sheet which is threaded between the middle two rolls. During each pass, the coil of flat aluminum is made thinner as the rolls compress it, at the same time as the metal is pulled through the mill. The combination of compression and tension can create reductions as much as 50% in thickness, with each pass. After each mill pass, the coil is removed from the exit side of the mill and returned to the entry side of the mill for additional gauge reduction. Each of the four rolling mills is designed for specific gauges. The entry gauge can be as much as 0.100" thick and the exit gauge can be as little as 0.00025", depending on the mill. On each mill, rolling is done at ambient temperatures, not on pre-heated aluminum slabs. Although heat is generated from friction and material movement during rolling process, the metal is not preheated, thus, the Williamsport mills are all considered to be cold rolling mills.

Each of the four mills installed in Williamsport also shares the same initial pollution control technology of material substitution. For all – long-chained, linear paraffin oils have been substituted for the former norm, kerosene. Linear paraffin oils cost 40% more than kerosene and VOC emissions from the aluminum rolling process were reduced by an average of 30%, as a result of the material substitution. Each of the rolling mill installations at Williamsport included as the baseline use normal linear paraffin oils as the primary rolling lubricant. In addition to the material substitution, each of the four rolling mills at Chance Williamsport employs an inertial separator, designed to remove much of the liquid particulate droplets that are entrained in the exhaust air stream. The inertial separators return the liquid rolling oil to the process for cooling, filtration, and reuse.

Large volumes of air are exhausted from the mills to maintain visibility and safe operating conditions for mill personnel. Coupled with the high molecular weight, low evaporative potential of the rolling oil, the resulting exhaust air streams have very low concentrations of VOC. The range of the VOC in the mills' exhausts varies from 1 to 15 ppmv, presenting special challenges to improve control of the VOC emissions.

3. Rolling Mill Differences

The physical differences between the rolling mills are primarily function related. Mill 4 has the slowest operating speeds but can take incoming thicknesses of approximately 0.100". Mill 1 is capable of rolling intermediate gauges and speeds. Mill 2 and Mill 3 are typically used to make the finish rolling passes at light-gauges. Mill 2 and Mill 3 are also capable of doubling, that is rolling two sheets of aluminum at the entry to make finished foil at less than 0.001" in final thickness. Each of the four rolling mills located at Williamsport was manufactured in the middle of the last century; but each was designed and built to a specific task by three different manufacturers – Loewy, Davies, and United, with numerous sub-manufacturers for sub-assemblies. Consequently, each mill is physically different from the others with few interchangeable parts or physical configurations.

Beyond the physical differences between the mills, pollution controls are different based on when the mills were installed and the mill's function. Mill 3, a foil mill capable of high speeds and light gauges has an RTO as the end of pipe control. Mill 4 has a high pressure-drop filter to remove oil droplets, more prevalent in the exhaust due to the heavier gauges rolled on Mill 4.

4. Existing Pollution Controls on the Rolling Mills at Williamsport

The historical sequence of the installation of the rolling mills in the Williamsport facility played a significant role in the extent of pollution controls installed with each mill. With each generation of mill installations at the facility, additional pollution control technologies were included. The pollution control generational differences between the mills explain the RACT II analyses for each mill. Mills of an earlier permitting generation have fewer controls than mills installed later. The RACT II analyses demonstrated for each mill that the current controls met the economic thresholds of the RACT II and now, of the RACT III regulations. Later mill installations included more pollution controls and thus the number of available pollution control technologies to make improvements is fewer.

Mill 1 and Mill 2 were purchased and installed simultaneously at Williamsport in the early 1990's. Previously, these mills had been owned and operated by Kaiser Aluminum in Permanente, California. The mills had been permitted by Kaiser using state-of-the art technology at the time. At a significant operational cost increase NORPAR, the Exxon-branded, long-chained paraffin was substituted for the industry standard rolling oil, which had been kerosene and mineral oil. This material substitution resulted in VOC emissions 10 - 60 % below the industry norm[1] of the time. The same technology – the material substitution - use of normal paraffin rolling oil, used in conjunction with a mist eliminator, was determined to be Best Available Technology by PA DER when Mills 1 and 2 were installed in Williamsport.

Mills 1 and 2 also incorporate standard simplistic entry and exit fume capture hood designs, horizontal runs of rectangular ductwork, and vane axial fans; all state-of–the-art at the time and all less than ideal by today's standards. In evaluating the technical and economic feasibility of improved VOC controls on Mills 1 and 2, a cost estimate is made for improving the hoods and ductwork designs to improve the overall pollution control system effectiveness, following the cost model found in Chapter 1, Section 2 of the EPA's APCCM (Sixth Edition). But, similar to the cost model, no specific emission reductions are assigned as the direct result of improving the capture and delivery of VOCs to the control device. The added costs contribute to the overall system performance.

Note Mills 1 and 2 were permitted together. Each has a maximum hourly emission rate of 30.5 pounds of VOC per hour and combined, they share a twelve-month combined emission rate of 225 tons of VOC. The included cost analyses for mills 1 and 2 include the maximum hourly emission rate for each mill times the maximum number of operating hours possible in a twelve-month period, while allowing sufficient time for routine pollution control maintenance. This scheme presents the most stringent case for the economic reasonableness of the RACT II assessment (and now RACT III) and ignores the subsequent ramifications for the other mill of the two mills that share one annual emission limit.

Mill 4 was permitted next, as a step of vertical integration to bring more control and more processing in-house. Mill 4 "breaks down" incoming rerolled coil stock from as thick as 0.100" to the thinner gauges required to enter production on the downstream mills. Short production passes of heavy reductions are done on Mill 4, which means that VOC's in the exhaust tend more toward the liquid phase than the other Williamsport mills, which roll lighter gauges and tend more towards the vapor phase of VOC emissions. In addition to the material substitution and a mist eliminator, a high-efficiency filter (~8 inches w.c.) was installed on Mill 4 to attempt to return as much mist as possible to the system. In addition to the material substitution, the mist eliminator, and a high-efficiency filter, numerous smaller improvements were included in the pollution control for Mill 4 including improved entry and exit hoods- with integral gutters to return drained oil to the system, air curtains at the hoods, round ducts to minimize condensation and evaporation, pitched duct work to facilitate draining and reuse of the rolling oil, round exhaust stack, and a stack skimmer.

Mill 3, the most recent cold aluminum rolling mill installation at Williamsport includes a regenerative thermal oxidizer (RTO) to control VOC emissions below the Lowest Achievable Emissions Reduction (LAER) control requirements of Pennsylvania's NSR (New Source Review) regulation. Ironically, to keep emissions below the LAER threshold of 40 TPY (tons per year (12-continuous monthly periods)), the only proven technology capable of controlling VOC emissions from a cold rolling aluminum mill is incineration, the most likely control option required from a LAER determination. Regulatory justification aside, Mill 3 was installed using the material substitution of normal linear paraffin rolling oil, a mist eliminator, and an RTO was installed to control the VOC emissions. The mill installation also included the minor, but not insignificant, improvements of entry and exit hoods- with integral gutters to return drained oil to the system, air curtains at the hoods, round ducts to minimize condensation and evaporation, pitched duct work to facilitate draining and reuse of the rolling oil, aerodynamic transitions, round exhaust stack, and a stack skimmer.

Additional VOC emission reductions beyond these included controls present specific hurdles:

- The averages of the VOC in the mills' exhausts vary from 1 to 15 ppmv, due to large exhaust volumes and low rolling oil volatility.
- The uniform, long-chained normal linear paraffin rolling oil has a high molecular weight. All of these attributes contribute to the relative safety, lubricity, and quenching ability of the rolling oil; however, these same characteristics provide some specific challenges to VOC control.

5. VOC Emissions Potentials for Chance's Rolling Mills

The end result of the RACT II (RACT III) economic analyses is to determine the cost to remove the next incremental ton of potential pollution beyond the amount permitted today. The cost per ton then is greatly influenced by the denominator or the number of potential tons available. Given the differences in equipment capabilities and the different permitting generations for the four aluminum cold-rolling mills at Williamsport, each mill is permitted to exhaust the following amounts of VOC in any given 12-continuous monthly period (CMP):

Mill	**Hourly VOC Emission Rate**	**12-CMP rate**	**Notes**
Mill 1	30.5 pounds per hour	133.6 tons	Mill 1 and Mill 2 also share a combined limit of 225 tons per 12-CMP
Mill 2	30.5 pounds per hour	133.6 tons	
Mill 3	2.0 pounds per hour	8.4 tons	Includes an 8,000 hr limit
Mill 4	6.0 pounds per hour	26.3 tons	

As anticipated, the earlier installations, Mills 1 and 2 have the least number of controls and are the most amenable to additional pollution control and the latter installations, Mills 3 and 4, would cost more per ton to reduce the next incremental ton of pollution.

6. Technical Feasibility Considerations for VOC Control

The focus of the RACT II (RACT III) regulation is to first assess the technical feasibility of various pollution controls and then to determine which, if any, of the technically feasible options are economically reasonable – costing roughly less than $12,000 per ton of potential VOC pollution removed.

There are three basic means of VOC control detailed in the latest editions of EPA's Air Pollution Cost Control Manual (APCCM, Sixth/Seventh Editions) in order presented:

- Refrigerated condensation
- Recapture by adsorption and reuse or reduction through subsequent desorption
- Thermal treatment

Furthermore, each of these pollution control methods includes elements basic to all technologies – capturing, delivering, and exhausting the air to and from the pollution control equipment. The following discussions are in the order presented in the Air Pollution Control Cost Manual.

6.1. Hoods, Ducts, Fans, and Stacks

The need for capture and exhaust delivery equipment for cold rolling aluminum mills is common to all fume exhaust systems; but, because of the dynamic nature of the vapor/liquid phase separation, additional controls can add to the overall pollution control system efficiency. With each new generation of pollution control installed at the facility, fume capture and delivery methods have improved. The newer installations include improved entry and exit hoods- with integral gutters to return drained oil to the system, air curtains at the hoods, round ducts to minimize condensation and evaporation, pitched duct work to facilitate draining and reuse of the rolling oil, round exhaust stack, and a stack skimmer.

Mills 3 and 4 already include the newest hood and collection designs to minimize the creation and entrainment of air pollution. In the RACT II cost analyses, only Mills 1 and 2 include a separate item for the design, manufacture, and installation of custom capture hoods. Each mill hood system is estimated to cost slightly more than $100,000 and consists of large steel canopy hoods at both the mill entry and exit, and six individual slotted sweeps to increase the effectiveness of each of the hoods' three open sides. Mills 3 and 4 already include these improvements, so the hood cost is not included in the analyses for Mills 3 and 4. In each mill's technology evaluation, the cost for a regenerative thermal oxidizer (RTO) option is estimated. The Pollution Control Cost Manual specifies that the RTO model must include a separate fan and stack, as those components were not considered in the vendor estimates that constitute the cost model. For all other technology options, a system fan and exhaust stack are standard components included in the cost model and only the costs of retrofitted ducts and hoods, as required, are included in the facility cost estimates.

6.2. Permanent Total Enclosures

Although the cost model for Permanent Total Enclosures (PTEs) is detailed in Chapter 1, Section 2 of the OAQPS APCCM, PTEs are not included as technically feasible because of concerns about non-uniform pockets of explosive gas buildup and the risk to personnel and property.

6.3. Refrigerated Condensation

Refrigerated condensation of VOCs in an exhaust stream can concentrate the material for reuse or more economical destruction. High concentrations of low-boiling organics are cited as examples. However, based on the EPA's APCCM details, the mills' exhausts at Chance are not amenable to such control. The VOC concentrations in the exhausts are between 1 and 15 ppmv, three orders of magnitude below the Manual's minimum recommendation of 5,000 ppmv for refrigerated condensation. In addition, treatment by refrigerated condensation is technically impractical because the normal linear paraffin rolling oil freezes into a solid at 45 °F.

6.4. Adsorbent Technology

One method of VOC air pollution control involves adsorption/desorption technology. With correct conditions, dilute VOCs in exhaust air streams can be concentrated onto the surface of adsorbent materials and desorbed offline for reuse or reduction to less harmful pollutants. Although technically feasible, adsorbent technology is not easily or inexpensively adapted to controlling VOC emissions from the exhaust of non-ferrous rolling mills. The nature of the VOCs in the exhaust, the extremely dilute concentration of VOCs in the exhaust, and the high flow of air exhausted from the mills make adsorption/desorption especially challenging. Two systems are essentially needed to control pollution using adsorbent technology. The RACT II (RACT III) cost analysis assumes a large vessel containing zeolite adsorptive media collects and concentrates the VOCs from the main exhaust air stream and a smaller thermal oxidizer with heat recovery desorbs the VOCs from the zeolites offline and reduces the VOCs to less harmful CO_2 and water. The second system is smaller and can more efficiently treat the concentrated organics.

VOC capture and subsequent control can be accomplished using the unique surface characteristics of activated carbon, zeolites, or polymer adsorbents – collecting VOC's primarily on the huge surface area of each adsorbent particle and releasing the VOC's using an appropriate desorption process to reuse the product or reduce the VOC to a less harmful pollutant[2]. The selection of the correct adsorbent is paramount to the process and there are many to choose from. In 1992, there were more than one hundred specific zeolite adsorbents in use[3]. Activated carbon adsorption was attempted on one new installation of a non-ferrous rolling mill in the United States, but with little success[4]. The reason for the failure was not stated, but it could be that the inherent property of activated carbon to unselectively attract both non-polar (oil) and polar (water) molecules[5] minimizes the effectiveness of the collection system.

Evaluating the technical feasibility of adsorption/desorption to concentrate the VOCs for reuse or disposal includes a lot of uncertainty. EPA's Cost Control Manual acknowledges the difficulties and uncertainties of modeling the processes to arrive at cost analyses sufficiently accurate to meet the definition of a study estimate (+/- 30%). In a more in-depth review of adsorption/desorption, EPA's Adsorbent Technical Bulletin published in 1999 states that, "Adsorption technology can now extend the range of VOC concentration from 20 ppm to one-fourth of the Lower Explosive Limit (LEL). At the lower end of this range, such small concentrations may be difficult or uneconomical to control by another technology or even by all adsorbents." This statement underlines the technical challenges of adsorption/desorption given that the greatest average concentrations of VOC measured in the rolling mill exhausts are less than 15 ppmv.

6.5. Selection of adsorbent

Acknowledging the many variables of the pollution control technology, EPA's Pollution Control Cost Manual details a single example of adsorption/desorption of low-boiling VOC from solvent emissions using activated carbon. This single example of adsorption/desorption technology is used as the basis for the economic modelling of the control technology for the rolling mills at Chance Aluminum, but, with significant assumptions about the technical uncertainties, as adjustments to the base must be made. The first technical "leap" that must be made is the selection of an adequate adsorbent material for the VOCs in question. Activated carbon used in the base model is not adequate for adsorbing the VOCs from the exhaust of cold rolling mills for several reasons. First, activated carbon is about equal in its affinity for non-polar and polar substances. In the exhaust of the rolling mills, 15 ppm of VOCs (non-polar) is the highest VOC concentration anticipated, while the normal concentration of water (polar) is about 20,000 ppm. Being non-discriminatory, activated carbon will saturate with water, long before it effectively adsorbs the long-chained, normal linear paraffin oils that constitute the VOCs in the rolling mill exhaust. A second technical need to move beyond activated carbon as the adsorbent media is the temperature required to desorb the VOCs. The long-chained normal, linear paraffins are high-boiling temperature liquids and the desorption temperature required to boil the liquid exceeds the recommended desorption temperature of carbon (250 °F– 350 °F) per page 6 of EPA's Technical Bulletin, "CHOOSING AN ADSORPTION SYSTEM FOR VOC: CARBON, ZEOLITE, OR POLYMERS?"

To evaluate the adsorption/desorption technology for the RACT II (RACT III) analysis, the "correct" media was assumed by interpolating between the two EPA sources and the included Exxon-Mobil's process literature. The assumption is that a non-polar synthetic zeolite of a uniform 5Å pore size as a means of concentrating the dilute VOC emissions from the aluminum rolling process into a smaller exhaust stream in order to be oxidized. If the economic analysis from the evaluation appears to be reasonably available, further technical evaluation will be required. The adsorbent size, 5Å, was chosen based on the size of adsorbent used by Exxon-Mobil to refine the original normal linear paraffins from crude base oils. A zeolite material linear was chosen for several reasons. Zeolite was chosen over carbon because carbon has equal affinities for polar (water) and non-polar (oil) molecules. The exhaust air stream contains about 2% (20,000 ppmv) of water and a maximum of 15 ppmv of oil, so focused speciation is required of the correct adsorbent. Secondly, to be desorbed in a cost-effective manner, thermal oxidation is assumed to be the most effective method, with technical caveats. The caveats are that in the refining process, linear paraffin oils are not typically desorbed using thermal swings. Exxon-Mobil employs ammonia desorption and cracking to fractionate the solvent and the solute for reuse. For the pollution control study, it is assumed that a thermal swing to 900 °F would be sufficient to exceed the end boiling point of the oil, 544 °F, and yet not exceed the 1,000 °F degradation temperature. The literature states that coke formation and some thermal degradation are likely and will reduce the adsorbent capacity of the zeolite, so a three-year life is assumed for the zeolite. Lastly, a synthetic zeolite was chosen as the likely class of zeolites because the naturally occurring zeolites are hydrophilic and only synthetic zeolites can be manufactured as hydrophobic.

Based on EPA's Adsorption study, such a specialized zeolite could cost more than twenty times more than "standard" carbon adsorbents. (1999 cost for carbon - $2.00 per pound) $40.00 per pound at the 1999 cost is the estimate used for the adsorbent cost in the cost calculations. In addition to the relatively high costs, manufactured zeolites also have the disadvantage that the uniform pore size equates to less overall surface area for adsorption when compared to carbon. The equilibrium capacity of zeolite, as published by EPA, is good compared to carbon. 90% of the virgin capacity may be considered as the equilibrium capacity. This assumes the previous zeolite desorption assumptions are valid.

6.6. System sizing parameters for adsorption/desorption technology

Similar to the adsorbent choice, significant assumptions must be made about sizing an adsorption/desorption system for controlling the VOC emissions from the Chance rolling mills. The single sizing model detailed in the EPA's Pollution Control Cost Manual notes that in order for the VOC molecules to be attracted to the adsorbent by the "weak" Van der Vaal forces, a face velocity of sixty feet per minute (60 fpm) is required. The rolling mill exhaust sectional flow velocities vary between 1,800 and 2,500 fpm. In order to slow the exhaust velocity to the required velocity to allow the adsorbent molecular attraction, a large structure is required to present the adsorbent to the exhaust air. The sizing model in EPA's Pollution Control Cost Manual does not accommodate such a variance. In order to make a study estimate, the first edition of the Control Cost Manual was consulted where the author Vatuvak instructs to default to a maximum of twelve feet diameter collectors (based on realistic transportation maximums) to achieve the required face velocities. When more adsorbent face area is required, parallel beds are required.

In the cost estimate here, multiple stationary beds are assumed to achieve the required interaction velocities, rather than a single bed too large to be transported by conventional highway cargo. To support round-the-clock operation, two complete sets of stationary beds are assumed to be the most economical balance of adsorb/desorb cycles. The size of each bed must be large enough to handle the instantaneous exhaust flow. Assuming the desorption time is less than or equal to the adsorption time, two beds would provide the minimum adsorbent vessels to support continuous operation. No cost guidance is provided by EPA to extrapolate from stationary equipment examples to a moveable device – such as a rotary concentrator. It is likely that the cost and complexity of large moving parts to accommodate the large air flow would exceed the cost of two stationary bed systems.

6.7. Oxidation

Various forms of oxidation can convert most VOCs to less harmful CO_2 and water. Technically, all forms of incineration can accomplish reduction of the VOC in question. However, the simplest of combustion technologies, a flare, is prohibited by Federal New Source Performance Standards (NSPS) in § 60.18[6], based on the dilute concentration of VOC in the mill exhaust. At a minimum, these rules require flares to be used only when the net heating value of the gas to be combusted is 300 BTU per standard cubic foot (BTU/ dscf) or greater (if the flare is steam- or air-assisted), or 200 BTU/dscf or greater (if the flare is non-assisted). The oil used to roll aluminum, Linpar 1416V, contains approximately the same heat content as kerosene, 135,000 Btus per gallon. At 6.4 pounds per gallon, there are approximately 21,100 Btus per pound. In the twenty-five years of testing the Williamsport rolling mills, the "worst-case" emissions measured were 30.5 pounds of VOC per hour; this in an air stream of approximately 38,000 scfm. Thus, the concentration of VOCs during the highest emission measurements was 0.28 BTUs per standard cubic foot (BTU/dscf), nearly one thousand times more dilute than the minimum concentrations allowed to be flared according to NSPS regulations.

Other forms of oxidation are technically feasible and evaluated in this presentation, except fluidized bed catalytic oxidation. The cost model for fluidized catalytic beds is only accurate to 25,000 scfm and as such would not be accurate to estimate the cost of controlling VOC pollution on a rolling mill. Figure 2.8 in Section 3.2 of the APCCM shows that within the range of cost estimates provided to the writers, 2,000 to 25,000 scfm, the capital costs for fluidized catalytic bed technology are 25 – 30% greater than the costs for fixed catalytic bed technology. The operating parameters and annual costs for fluidized bed and fixed bed technology are approximately the same, with no gain in destruction efficiency, so only the more attractive fixed bed technology is studied.

6.8. Cost Analyses for Technically Viable Pollution Control Methods

The cost models used for the RACT II (RACT III) analyses are primarily from the sixth edition of EPA/452/B-02-001, EPA's Air Pollution Control Cost Manual. The seventh edition of this manual has been only partially completed, however, the relevant updated chapters confirm the cost estimating methodology used in the RACT II analysis for VOC control equipment. Further, much of the information in the sixth edition is repeated verbatim from previous editions, especially referencing 1992-1993 base-year costs from the first edition. Equipment prices in the models presented are adjusted for inflation to 2022, based on the specific referenced dates and using methodology prescribed in the manual. The inflation indices are included in the appendix. Annual operating costs, labor, utilities, and capital recovery costs are based on current costs or projected costs, where reliable projections are available.

The existing plant was built and expanded, as needed, over the last twenty-five years. All growth was managed tightly, and the costly space was used efficiently. Consequently, there is no inexpensive space available to install additional pollution controls. In each of the accompanying analyses, where technically viable techniques are evaluated for economic reasonableness, a building to house the pollution control equipment is included. Although some control technologies are built to withstand the rigors of outdoor operation, the long-chained paraffin rolling oil (VOC's) freeze at 45 °F, thus, the exhaust and the pollution control equipment must be protected from the outdoor temperatures through the winter months in order to work properly.

Also included in the cost analyses are plant shutdown costs[7] to varying extents. Shutting down production from each of the mills has implications for the remainder of the manufacturing plant. All of the plant's production is rolled on Mill 1, so shutting down Mill 1 for the final installation and tie-ins for pollution controls would involve the greatest amount of time the plant would be shutdown. About 90% of the facility production goes through Mill 4, so a Mill 4 shutdown for installation would idle the plant for ten percent less time than Mill 1. Mills 2 and 3 each handle 50% of the facility production. Theoretically, installing additional pollution controls on Mills 2 or 3 would mean a plant-wide shutdown of ½ the amount of time as required for Mill 1 installation.

In addition to facility shutdowns for production loss there is a safety factor involved that necessitates shutdowns during certain phases of construction. When duct installation, electrical, and mechanical work is done against the ceiling in the mill manufacturing area, manufacturing on the other mills is stopped because of the danger to workers in high lifts in case of a mill fire, an ever-present reality. As risky as being caught in a high lift during a mill fire is the risk of being overcome by the automatically-deployed CO_2 fire suppression systems designed to snuff mill fires. For the safety of the construction workers, plant operation will be halted during specific intervals when the work cannot be performed safely in conjunction with normal production activity. The cost estimates for plant downtime for installations are based on full round-the-clock capacity, just as the potential-to-emit is based.

[1]EPA-453/R-92-001pg. 64 of 86

[2]EPA-456/F-99-004, May 1999

[3]EPA-456/F-99-004, May 1999, page 8 of 32

[4]EPA-453/R-92-001pg. 82 of 86

[5]EPA-456/F-99-004, May 1999, page 12 of 32

[6]EPA NSPS Guidance on Use of Flares

[7] EPA-600/8-79-01 Bb June 1979, A Standard Procedure for Cost Analysis of Pollution Control Operations; Volume II. Appendices

7. Stack Testing Compliance Demonstration

The RACT III compliance demonstration requires stack testing of the facility's four (4) rolling mills by December 31, 2022. The last stack testing of the rolling mills was performed in 2015 and is outside of the allowable testing period for RACT III. Further, the facility cannot meet the December 31, 2022 deadline. Thus, Chance Aluminum is submitting this alternate compliance plan as specified in accordance with 25 Pa. Code Section 129.114(i) indicating when the testing can be performed and the protocol that will be followed.

The facility has scheduled stack testing for VOC emissions on rolling mills 1, 2, 3 and 4 for the week of March 20, 2023, to demonstrate compliance under RACT III. As in previous stack testing, PA Method 1470/1471 for Aluminum Rolling Mills will be used for VOC emissions testing. The stack testing protocol is provided as Appendix A.

EPA References

Timeline for Activities Needed for Development of EPA Air Pollution Control Cost Manual, 7th Edition – Revised to Include Completing 3 New Control Cost Manual Chapters https://www3.epa.gov/ttn/ecas/docs/cost_manual_timeline_2016-08-04.pdf

EPA Air Pollution Control Cost Manual Sixth Edition EPA/452/B-02-001 January 2002

EPA Air Pollution Control Cost Manual Seventh Edition, www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution#cost%20manual

CATC Technical Bulletin Choosing an Adsorption System for VOC: Carbon, Zeolite, or Polymers? EPA-456/F-99-004 May 1999

Control of VOC Emissions from Nonferrous Metal Rolling Processes EPA-453/R-92-001 June 1992

A Standard Procedure for Cost Analysis of Pollution Control Operations; Volume 11. Appendices EPA-600/8-79-01 8b June 1979

EPA Escalation Indexes for Air Pollution Control Costs EPA-452/R-95-006 October 1995

Organic Chemical Manufacturing Volume 5: Adsorption, Condensation, and Absorption Devices EPA-450/3-80-027 December 1980

Capital and Operating Costs of Selected Air Pollution Control Systems, EPA Contract # 68-02-2899, December 1978, prepared by Frank Bunyard and William Vatavuk

APPENDIX A

STACK TESTING PROTOCOL

Emissions Compliance Test Protocol
Cold Roll Mill 1-4 Stacks
Chance Aluminum
Title V Permit No. 41-00013

in

Williamsport, PA

Grace Consulting, Inc.
Project No. 23-

December 19, 2022

Submitted by:

Darryl Christy

Darryl Christy, PE, QI
Quality Manager & Technical Sales

Grace Consulting, Inc.
510 Dickson St.
Wellington, Ohio
877-GCI TEST

The following hereby certify that "to the best of our knowledge" the state and federal regulations, operating permits, or plan approvals applicable to each source or control device to be tested have been reviewed and that all testing requirements therein have been incorporated into the enclosed test plan.

Darryl Christy

Darryl Christy, PE, QI
Quality Manager
Grace Consulting, Inc.

Tim Owens, PhD, PE
Principal
Meridian Energy & Environment, LLC (Consultant)

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Attachments

Section 1.0
Introduction

Chance Aluminum has retained Grace Consulting, Inc. (GCI) to perform Emissions Compliance Testing (ECT) on Cold Roll Mill 1-4 Stacks (Source IDs P101-104) at their Facility, located at 2475 Trenton Avenue, Williamsport, PA 17701. The testing will be conducted in accordance with the emission testing requirements listed in PADEP Air Permit #41-00013. Testing will be conducted to determine the emission rate of total hydrocarbons (THC) from the exhaust of the four (4) rolling mills listed above.

The following test protocol is submitted to PADEP for review and subsequent approval prior to testing. This protocol consists of a source description (Section 2), an outline of the source test program (Section 3), a summary of the test methods to be used (Section 4), the final report format and permitted limits (Section 5), summary of services expected to be provided by Owner (Section 6), and the proposed test schedule (Section 7).

Section 2.0
Source Description

The Facility produces flat rolled aluminum products, industrial classification – Manufacturing – Aluminum Sheet, Plate and Foil (SIC 3353). The facility operates four (4) cold aluminum rolling mills. A process flow diagram is shown on the following page.

The stacks/ducts for Mills 1 and 2 are rectangular and the ports are accessible from mezzanines inside the facility. The stacks for Mills 3 and 4 are circular, exhaust through the roof, and the ports are accessible from roof level. Dimensions of each of these stacks/ducts and corresponding traverse points, determined in accordance with **Method** 1, are shown in Attachment 4.

Section 3.0

Test Program

A more detailed testing program schedule (proposed) is listed in Section 7.0 with test run durations for each parameter/pollutant. Testing will tentatively commence the week of March 20, 2023.

Testing conditions will be documented in the report and include:

All items must be performed as noted in Alcoa Methods (AM) 1470-94 and 1471-94 (or if available using the most current versions of each method) and be documented in the test report, as applicable, unless any modifications are proposed in writing and are approved prior to testing. Additionally, include the mass (in grams) in the test report for: the front half methylene chloride rinses (particulate hydrocarbons (HC)/mist fraction per the method); each of the front and back portions (vapor HC/vapor fraction per the method) of the charcoal tube; and the total mass of all fractions in the results summaries.

For the charcoal tube sampling procedures using AM1470-94 & AM1471-94, the following items must be addressed & performed in accordance with sections 2.8 & 3.2.2 of the Department's Source Testing Manual (Rev. 3.3) and EPA Course Module 340 titled: "VOC Sampling and Analysis" and documentation to verify that all items were addressed and performed must be included in the test report:

- Quantitative recovery of organic compounds from the adsorbent material must be known.
- Breakthrough sample gas volume for organic compounds for the adsorbent material must be known.
- Any effect of moisture (in the stack gas) on the adsorbent material collection capacity must be known. Moisture in the sample above 2 to 3 percent may severely reduce the adsorptive capacity.

During testing for Rolling Mill No. 3, the regenerative thermal oxidizer (RTO) must be operated at a combustion chamber temperature of 1,400 ° F during testing unless the permit reviewer and source contact for the Department's Northcentral Regional Office (NCRO) is contacted and gives approval of a different temperature in writing prior to the start of testing (include me as a cc: addressee on the correspondence and include it in the test report). This means that during testing the RTO must be operated at an average combustion chamber temperature within ± 5 % of 1,400 ° F (between a range of 1,350 to 1,400 ° F). If the RTO is not operated within this range (or within 5 % of a different NCRO approved temperature) during testing and during normal operations for the source, then VOC destruction reduction efficiency (DRE) testing or outlet retesting may be required.

All mills must be operated at a minimum of 90 % of production capacity. Additionally, note that each rolling mill source must be operated at conditions of maximum gauge reduction and at the speed the mills are typically operated in accordance with the permit. If the speeds and gauge % reduction values listed in Table 1 do not satisfy the permit conditions, then approval to operate as proposed must be granted by the NCRO source contact and permit reviewer prior to the start of testing.

All items proposed to be recorded in the Table 1 must be recorded as applicable every 15 minutes, or more frequently, and be documented in the test report. For each parameter, include in the test report, the test run average for the times that best bracket actual sampling periods for each test run and all applicable example calculations used to determine the test run averages. Also, include all field data sheets and control panel printouts with all units clearly labeled and explained for each parameter recorded in the test report.

The first page of the test report shall be a Test Results Summary (TRS). The TRS shall contain a table listing the following: the source and source ID numbers; the average result(s) of each pollutant measured in units of the permit limit(s); permit limit(s) for each pollutant measured; permit number(s) where limit was obtained; and whether results demonstrate compliance or non-compliance with the permit limit(s).

Table 1. Process Parameters to be Followed During Testing

Target Ranges*				
Parameter	**Mill 1**	**Mill 2**	**Mill 3**	**Mill 4**
Product Width, in	40-55	40-55	40-55	38-55
Incoming Gauge, in	0.0059-0.026	0.0019-0.013	0.0012-0.006	0.038-0.125
Percent Reduction, %	15-55	29-55	20-55	28-55
Mill Speed, fpm	765-1275	1025-1575	500-2700	500-700
Coolant Application Temp., °F	---	---	80-110	80-130
Bulk Lubricant Temp., °F	≤ 110	≤ 110	80-110	80-130
Coolant Flow, gpm	37-319	99-135	---	345-504
Busch Pressure Drop, in W.C.	---	---	0.2-0.5	4.2
RTO Pressure Drop, in W.C.	---	---	7.5-9.0	---
RTO Combustion Temp., °F	---	---	1400-1650	---
CECO Pressure Drop, in W.C.	---	---	---	8.0

*Target Ranges based on data collected from previous testing and current operations.

Section 4.0
Test Methods

All sampling and analyses will be performed using the reference methods listed below. The test coordinator shall orchestrate tests such that concurrent tests will be completed to allow correlation of results of different tests. Each method to be used is outlined below. During the tests, EPA Methods 1, 2, 3A (Mill 3), 4 and 19 will be conducted and used in conjunction with all gaseous sampling tests to determine emission rates. Further details concerning these methods, including example field data sheets, can be found in Attachment 1. Attachment 2 contains example calibration data sheets. Examples of the calculations to be used during testing are presented in Attachment 3.

4.1 THC Emissions – Alcoa Method

Testing for emissions of total hydrocarbons (THC) will be performed in accordance with Alcoa Method 1470-94/1471-94 at the stack locations. This method involves isokinetic sampling at ambient temperature, sample recovery, and analysis of the samples by gas chromatography for THC. The sampling train will be assembled as shown in Attachment 5. After the probe, a glass cyclone/flask assembly and charcoal sampling tube are connected.

EPA Method 1 will be used to select the number of sampling points (see expected traverse points in Attachment 4). Exhaust gas will be drawn from the stacks through the sample nozzle at an isokinetic rate (i.e., sample gas collection rate through the nozzle equal to [±10%] the stack flow rate). Sampling time will be 60 minutes per test run to collect sufficient sample. At the conclusion of each test run (after the final leak check) the nozzle and probe will be capped after they are disconnected from the cyclone inlet. The charcoal tube will also be disconnected and capped. In the recovery area, methylene chloride will be used to clean and rinse the inside of the probe, nozzle, cyclone, flask, U-tube, and glass ball fitting, with the rinse collected into one (1) labeled glass bottle and sealed with a Teflon-lined cap. End caps will cover the charcoal sampling tube and be secured with masking tape. The tubes will be stored in a cool, vapor-free environment until they are transported to a laboratory for Method 1471-94 analysis.

A type "S" pitot tube will be used for measuring stack gas velocity, and a type "K" thermocouple will be used for measuring flue gas temperature as outlined in EPA Reference **Method 2**. Velocity head pressure will be measured using an inclined manometer having a full range of 0 to 10 inches of H_2O. For the Mill 3 Test, O2/CO2 measurements will be conducted in accordance with **Method 3A**. Since all of the other sources are ambient, a molecular weight of 29.00 will be used in lieu of O2/CO2 measurements, as allowed by RM2 Section 8.6. Exhaust gas moisture concentrations will be determined using EPA **Method 4** procedures using a separate EPA Method 4 sampling train (also shown in Attachment 5). A measured volume of stack gas will be drawn through the impingers. The net increase in the weight of the impinger contents will be recorded as the volume of water collected (1 gram = 1 ml). This data will be used to determine exhaust gas dry molecular weight, which will be used in calculating the stack gas volumetric flow as dry standard cubic feet per minute (dscfm). THC results will be reported in lb/hr.

4.2 QA/QC Procedures

The following sections describe the quality assurance/quality control (QA/QC) procedures to be followed by ***GCI*** during this test program.

4.2.1 Equipment Calibrations

All sampling, analytical, and QA/QC procedures outlined in the referenced methods will be followed. All test equipment will be calibrated before use in the field. The dry gas meter/orifice consoles will be calibrated prior to this test program, and a post-test calibration check will also be performed. Pitots will likewise be calibrated in a wind tunnel before field use and visually inspected for damage during the test program. Example calibration data are presented in Attachment 2.

4.2.2 Sample Marking, Chain of Custody, Sample Storage Procedures

During mobilization, sampling containers are identified with a unique number. During sample retrieval, containers are labeled identifying the source, test number, and date. Upon return from the field, samples are transferred to laboratory personnel with an accompanying chain of custody form. Each sample is then assigned a unique number, which is used to denote the sample during its subsequent analysis and storage. Collected samples will be stored in a protected environment in the laboratory facilities for three months following submission of the test report.

4.2.3 Analytical Quality Control Procedures

All samples will be analyzed in approved laboratories, adhering to quality control procedures required by the EPA. Furthermore, all analyses will be performed using instrumentation calibrated with standard reference materials traceable to the NIST.

Section 5.0
Reports

A draft test report will be prepared and submitted to Owner/Engineer for review and comment within 20 calendar days after the completion of the field-testing. At a minimum, the draft report will contain all applicable details as specified within the PADEP Source Testing Manual, to include but not limited to the following information:

- Introduction and Summary of Test Results
- Description of the facility and processes
- Discussion of Results with attention to possible error or uncertainty
- Sampling and analytical procedures
- Copies of all field data
- Unit operating data
- Test equipment calibration data
- Test results summary
- Laboratory analytical data and reports

A summary of the applicable permitted limits is shown below:

Permitted Limits
THC 30.5 lb/hr - P101 and P102 (Mill 1 and Mill 2) with a combined limit of 225 tons per year. 2.0 lb/hr – P103 (Mill 3) 6.0 lb/hr – P104 (Mill 4)

Four copies of the final report will be submitted to Owner/Engineer within 30 calendar days after the completion of the field-testing if receipt of comments have been received no more than 25 calendar days after the completion of the field-testing.

Section 6.0

Items and Services to be provided by the Owner

The following is a list of items and services to be provided by the owner to insure timely completion of the test program:

1. Electrical service
   A. (1) 220V Single Phase 30 Amp service at the base of the Stack
   B. (2) independent 110V 15 Amp circuits within 50 feet of the test ports at the Stack location for the THC testing equipment

2. Access and Probe Supports
   A. Open and clean test ports at the test location with "hand tight bolts"
   B. Probe supports (monorails or I-beams with rollers) above the test ports for the THC test equipment

3. Plant Support
   A. Prior to testing, provide the testing laboratory with a sample of bulk rolling mill oil that is used at each mill, along with any additives that go in it. This is for analytical instrument calibration.
   B. Maintain prescribed loads/conditions for the duration of the test.
   C. Collection of plant data as required for the test report

Section 7.0

Test Schedule

Day	Location	Tests; Methods	Pollutant
0	Mill 1 Stack	Mobilization Safety Orientation, Equipment Setup, Preliminary Checks	
1	Mill 1 Stack	3, 60-min runs RM1-4, Alcoa Method 1470-94/1471-94 Move to Mill 2 Stack	Flow, O2/CO2, THC (as propane)
2	Mill 2 Stack	3, 60-min runs RM1-4, Alcoa Method 1470-94/1471-94 Move to Mill 3 Stack	Flow, O2/CO2, THC (as propane)
3	Mill 3 Stack	3, 60-min runs RM1-4, Alcoa Method 1470-94/1471-94 Move to Mill 4 Stack	Flow, O2/CO2, THC (as propane)
4	Mill 4 Stack	3, 60-min runs RM1-4, Alcoa Method 1470-94/1471-94 Demobilize, Transport Samples to Laboratory	Flow, O2/CO2, THC (as propane)

<u>20 Calendar Days after Day 4</u>

- Draft Report submitted electronically

<u>30 Calendar Days after Day 4</u>

- Final report submitted after receipt of final comments

Attachment 1
Example Field Data Sheets

Client			Date	/ /
Unit		Project #		

Run 1

	Time	O2	CO2
1			
.			
.			
.			
.			
.			
.			
.			
60			
	Average		

Grace Consulting, Inc.
Isokinetic Spreadsheet

Project Data:

Client	
Plant Name	
Source	
Sampling Location	
Project No.	

Equipment Information:

Nozzle Number	
Probe Number	
Meter Number	
Pitot Number	
Pitot Coefficient	#N/A
Delta H@ from Cal	#N/A
Meter Correction Factor	#N/A

Source Information:

Stack Diameter (feet)	
Duct Dimensions (feet)	
Port Length (inches)	
Scrubbed or Not Scrubbed	
Plant Load	
Assumed Moisture %	

Environmental Conditions:

Barometric Pressure	
Ambient Temperature	
Weather	
Wunderground.com Baro Press	
Height of test location	
Calculated Barometric Press	

Test Information:

Number of Points	
Time at each Point	
Number of Readings at each Point	
Test Date	
Trailer Operator	
Meter Reader	
Method Used (Choose one):	

Did the environmental conditions have any effect on the testing?	
If yes, please explain:	

F-Factor CO2 Based	

Nozzle Determination:

Avg. Delta P	
Avg. Stack Temperature	
Expected Meter Temperature	
Static Pressure	

Best Nozzle for .75 cfm	
Best Nozzle for .9 cfm	

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ISOKINETIC FIELD DATA SHEET

Client:	Plant Name:	Date				
Project No.	Operator:	Orsat Analysis				
		CO2	+O2	O2	M3A	
Sampling Location	Run No.				O2 %	
Filter No.	Total Impinger Weight:				CO2%	
	Initial	Final				
Stack Dia.	Area of Flue		Avg CO2		Avg O2	
Barometric Pressure	Static Pressure	Probe No.				
Load	Pitot Coefficient	Pitot No.				
Nozzle Diameter	Nozzle No.	Meter No.				
Meter Corr. Factor	Delta H@	Meter-Orifice				
			Leak Test (cfm)			
Sample Pt. Time min	Assumed % Moisture %		Initial	@ (in. Hg)	Final	@ (in. Hg)

Sample Point	Delta P	Sqrt. Delta P	Delta H	Temperatures °F						Vac.Pr (in. Hg)	Dry Gas Reading cf
				Stack	Probe	Oven	Filter Exit	< 68 Imp. Out	Meter Outlet		
Start											
Stop											

Pitot Tube Leak Check:	Before		After	
Integrated Bag Leak Check:	Before		After	

CYCLONIC FLOW

Client:	0	Date:	01/00/00
Plant Name:	0	Operator:	0 0
Project Number:	0	Load:	0
Sampling Location:	0	Meter Number:	0
Barometric Pressure:	0.00	Probe Number:	0
Run Number:	Cyclonic Flow Verification	Start Time:	0:00
Static Press:	0	Stop time:	0:00

Point	Delta P	Sqrt. ΔP	Stack Temp	Yaw Angle
A-1	0.00	0.000	0	0
A-2	0.00	0.000	0	0
A-3	0.00	0.000	0	0
A-4	0.00	0.000	0	0
A-5	0.00	0.000	0	0
A-6	0.00	0.000	0	0
B-1	0.00	0.000	0	0
B-2	0.00	0.000	0	0
B-3	0.00	0.000	0	0
B-4	0.00	0.000	0	0
B-5	0.00	0.000	0	0
B-6	0.00	0.000	0	0
C-1	0.00	0.000	0	0
C-2	0.00	0.000	0	0
C-3	0.00	0.000	0	0
C-4	0.00	0.000	0	0
C-5	0.00	0.000	0	0
C-6	0.00	0.000	0	0
D-1	0.00	0.000	0	0
D-2	0.00	0.000	0	0
D-3	0.00	0.000	0	0
D-4	0.00	0.000	0	0
D-5	0.00	0.000	0	0
D-6	0.00	0.000	0	0
avg	0.00	0.000	0	0
	Initial Pitot Leak:		0	
	Final Pitot Leak Check:	#REF!		

Grace Consulting Inc.

Moisture Field Data Sheet

Client:		Date	
Project No.		Operator	
Sampling Location		Run No	
Barometric Pressure		Probe Number	
Condensate		Silica Gel	
Meter Corr. Factor		Meter-Orifice	Meter #
Sample Pt Time		Leak Test @ [mm HG]	After @ [mm HG]

Sample Point			△ H	Temperature F Probe	Imp. Out	Meter Out	Vac. Pr (in. HG)	Dry Gas Meter Reading in Cu. Ft.
0	**Start Time**							
5								
10	Intial Leak							
15	Final Leak							
20								
25								
30	**End Time**							
	Avg.							
0	**Start Time**							
5								
10	Intial Leak							
15	Final Leak							
20								
25								
30	**End Time**							
	Avg.							
0	**Start Time**							
5								
10	Intial Leak							
15	Final Leak							
20								
25								
30	**End Time**							
	Avg.							

GRACE CONSULTING, INC.
EMISSIONS TESTING SERVICES

P.O. Box 58
510 Dickson St.
Wellington, OH 44090

Phone: 440-647-6672
Fax: 440-647-6673

Chain of Custody

Customer Name	Grace Consulting, Inc.	Report Attention	
Report Address	510 Dickson Street	Project Name	
Billing Address		Purchase Order #	
City Wellington	State: OH Zip: 44090	Indicate state where samples were collected:	
Phone		Compliance ⁱ Non-Compliance ⁱ	

Sample Identification	date collected	time collected	**Sample Description**	#ID	**Analysis Required**

Turnaround Time Requested: Normal Rush

Date Results are needed:____________________

Rush results requested by: Fax Mail

Fax # ______________________________

Notes:

Relinquished By:	Date	Time	Received By:	Date	Time
Relinquished By: 0	Date	Time	Received By:	Date	Time
Relinquished By:	Date	Time	Received By:	Date	Time
Relinquished By:	Date	Time	Recieved By:	Date	Time
Relinquished By:	Date	Time	Recieved By:	Date	Time

Attachment 2
Example Calibration Forms

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ANALYZER CALIBRATION DATA

Client:		Test Date:	
		Project ID:	
Source Identification:		Operator:	

Calibration Data for Sampling Runs: Gas Type: Span:	*Cylinder Number*	*Cylinder Value % or PPM*	*Analyzer Response*	*Absolute Difference % or PPM*	*Difference % of Span*
Zero Gas					
NO2 to NO Converter Check					
Mid-Range Gas					
High-Range Gas					

Calibration Data for Sampling Runs: Gas Type: Span:	*Cylinder Number*	*Cylinder Value % or PPM*	*Analyzer Response*	*Absolute Difference % or PPM*	*Difference % of Span*
Zero Gas					
Low-Range Gas					
Mid-Range Gas					
High-Range Gas					

Calibration Data for Sampling Runs: Gas Type: Span:	*Cylinder Number*	*Cylinder Value % or PPM*	*Analyzer Response*	*Absolute Difference % or PPM*	*Difference % of Span*
Zero Gas					
Low-Range Gas					
Mid-Range Gas					
High-Range Gas					

Calibration Data for Sampling Runs: Gas Type: Span:	*Cylinder Number*	*Cylinder Value % or PPM*	*Analyzer Response*	*Absolute Difference % or PPM*	*Difference % of Span*
Zero Gas					
Low-Range Gas					
Mid-Range Gas					
High-Range Gas					

GRACE CONSULTING, INC.

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client:

Source ID:

Test Date:

Project ID:

Operator:

Run No:	Initial Values			Final Values		
Gas Type:	Analyzer Response	System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	Drift % of Span
Span:						
Zero Gas						
Upscale Gas						

Run No:	Initial Values			Final Values		
Gas Type:	Analyzer Response	System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	Drift % of Span
Span:						
Zero Gas						
Upscale Gas						

Run No:	Initial Values			Final Values		
Gas Type:	Analyzer Response	System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	Drift % of Span
Span:						
Zero Gas						
Upscale Gas						

Run No:	Initial Values			Final Values		
Gas Type:	Analyzer Response	System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	Drift % of Span
Span:						
Zero Gas						
Upscale Gas						

$$\textit{System Calibration Bias} = \frac{\textit{System Cal. Response} - \textit{Analyzer Response}}{\textit{Span}} \times 100$$

$$\textit{Drift} = \frac{\textit{System Cal. Response} - \textit{Initial System Cal. Response}}{\textit{Span}} \times 100$$

Grace Consulting, Inc.
Thermocouple Calibrations

Part No:	
Calibration Date:	
Trendicator ID:	
Calibration Due:	

Must be < +/- 1.5% at all three points

Ice Bath (Reference point 32 °F)

Reading	TC	Ref. Therm.	% Diff.
1			
2			
3			
		AVG:	

Boiling water (Reference point 212 ° F)

Reading	TC	Ref. Therm.	% Diff.
1			
2			
3			
		AVG:	

Pitot Calibration Form

Operator:			Avg Yaw Angle		Avg Pc
Date:			Pitot #:		
Temp			Baro.		
Approx 60 fps		Side A			Calculations
Run #	DP std (in H_2O)	DP S Type (in H_2O)	Cp (s)	Deviation Cp(s) - Cp(A)	Deviation should be <.010
1					
2					
3					
	Average	Cp (Side A)			
Approx 90 fps		Side A			
Run #	DP std (in H_2O)	DP S Type (in H_2O)	Cp (s)	Deviation Cp(s) - Cp(A)	
1					
2					% Difference in Cp for High and Low Flow
3					
	Average	Cp (Side A)			=

Grace Consulting,Inc.
Nozzle Calibration Sheet

Date:

Nozzle	Measurement			
	A	B	C	Average
IN-32	0.205	0.206	0.206	**0.206**
IN-42-1	0.172	0.172	0.171	**0.172**

Grace Consulting, Inc.

EPA Method 5

522 Series Meter Box Calibration

Calibration Orifice Method

English Meter Box Units, English K' Factor

Date:	
Model:	
Serial:	

Barometric Pressure:		(inches Hg)
Theoretical Critical Vacuum:		(inches Hg)
Orifice for Calculation:		

Important: *For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum above.*

Important: *The Critical Orifice Coefficient, K', must be entered in English units, [(ft^3)(°R)1/2)]/[(in. Hg)(min)].*

DRY GAS METER READINGS

ΔH (inches H_2O)	Time (min)	Initial Volume (ft^3)	Final Volume (ft^3)	Total Volume (ft^3)	Initial Temp.(°F)	Final Temp.(°F)

CRITICAL ORIFICE READINGS

Orifice ID:	K' Orifice Coefficient (See Above)	Actual Vacuum (in. Hg)

AMBIENT TEMPERATURE

Initial Temp.(°F)	Final Temp.(°F)	Average Temp.(°F)

CORRECTED VOLUME

DGM	ORIFICE
Vcr (std) (ft^3)	Vcr (std) (ft^3)

DRY GAS METER

CALIBRATION FACTOR "Y"	
Value	Variation
Average:	

ORIFICE

CALIBRATION FACTOR "ΔH"	
Value (in. H_2O)	Variation (in. H_2O)
Average:	

Note: *For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is ±0.02.*

For Orifice Calibration Factor ΔH@, the orifice differential pressure in inches of H_2O that equates to 0.75 cfm of air at 68 °F and 29.92 inches of Hg, acceptable tolerance of individual values from the average is ±0.2.

Signature: ______________________ **Date:** ________

Attachment 3
Example Calculation Spreadsheets

SAMPLE FLOW CALCULATIONS

$$Ps = Pb + \left(\frac{Pf}{13.6}\right)$$

$$28.75 = 28.78 + \left(\frac{-0.45}{13.6}\right)$$

Vm = (Final Dry Gas Meter reading – Initial Dry Gas Meter reading) x Y

22.167 = (22.167 – 0.0) x 1.000

$$\text{Vm(std)} = Vm \times \frac{528}{Tm + 460} \times \left(\frac{Pb + \frac{DeltaH}{13.6}}{29.92}\right)$$

$$20.45 = 22.167 \times \frac{528}{553} \times \left(\frac{28.78 + \frac{1.919}{13.6}}{29.92}\right)$$

Vwc(std) = 0.04715 x Vlc

3.390085 = 0.04715 x 71.9

$$Bws = \frac{Vwc\ (std)}{Vwc\ (std) + Vm\ (std)}$$

$$0.1420 = \frac{3.390085}{3.390085 + 20.45}$$

%M = Bws x 100

14.20% = 0.1420 x 100

$$Bwsat = \frac{E'}{\left(Pb + \left(\frac{Pf}{13.6}\right)\right)}$$

$$0.1570 = \frac{4.525}{\left(28.78 + \left(\frac{-0.45}{13.6}\right)\right)}$$

%M = Bwsat x 100

15.70% = 0.1570 x 100

$\%N_2$ dry = 100 – ($\%CO_2$ + $\%O_2$ + %CO)

80.6 = 100 – (13.3 + 6.1 + 0)

Md = (0.44 x %CO2) + (0.32 x %O2) + (0.28 x (%N2+%CO))

30.37 = (0.44 x 13.3%) + (0.32 x 6.1%) + (0.28 x 80.6%)

Ms = Md (1-Bws) + (18.0 x Bws)

28.61 = 30.37 x (1 - 0.1420) + (18.0 x 0.1420)

$$KSCFH = 3600 \times v_{a\,(avg)} \times A \times \frac{528}{Ts+460} \times \left(\frac{Ps}{29.92}\right) \div 1{,}000$$

$$119{,}223 = 3600 \times 58.28 \times 660.5 \times \frac{528}{129.7+460} \times \left(\frac{28.75}{29.92}\right) \div 1{,}000$$

Adj. KSCFH = KSCFH x WAF

118,018.8 = 119,223 x 0.9899

SCFH = Adj. KSCFH x 1,000

118,019,000 = 118,018.8 x 1,000

*Sample calculations use rounded numbers and computer printouts carry all decimal places.

Grace Consulting, Inc.
Moisture Calculations (Runs x - xx)

Client:
Site:
Date:
Unit Number:
Load:

Run:	x	x	x
Total Impinger Content:	70.30	70.30	72.40
Volume Metered:	22.221	22.221	22.222
Meter Temperature:	101.00	101.00	101.00
Delta H:	1.919	1.919	1.919
Barometric Pressure:	28.78	28.78	28.78
Meter Correction Factor:	1.000	1.000	1.000
Volume Measured (DSCF):	20.21	20.21	20.21
Water Volume (SCF):	3.31	3.31	3.41
% Moisture in Flue Gas:	14.1	14.1	14.5
% Moisture Sat. Table:	15.8	15.8	15.8
Moisture Chosen:	14.1	14.1	14.5

Run:	xx
Total Impinger Content:	72.40
Volume Metered:	22.222
Meter Temperature:	101.00
Delta H:	1.919
Barometric Pressure:	28.78
Meter Correction Factor:	1.000
Volume Measured (DSCF):	20.21
Water Volume (SCF):	3.41
% Moisture in Flue Gas:	14.5
% Moisture Sat. Table:	15.8
Moisture Chosen:	14.5

Mois Calc 1

Alternative methods for determination of moisture content in stack gas:

	%M	Tf	Tw	Td	Pb	P(abs)	P static
Saturation Vapor Pressure Table:	0.153378	129	129	129	28.78	28.72632	-0.73
	RH	Tf	Tw	Td	Pb	P(abs)	Lb/Lb
Psychrometric Calculation:	100	129	129	129	28.78	28.72632	-0.6457

Percent Moisture 15.3

Water Vapor Pressure in gas mixture passing a wet and dry bulb thermometer assembly (Ea):	4.4054	ea
Proportion by volume of water vapor in gas mixture for saturated conditions (Bw):	0.153378	bw
Water Vapor pressure at saturated conditions and wet bulb temperature (E'):	4.406	e' From Wvp_Table
Absolute pressure of a gas mixture (Pmix):	28.72632	Pmix
Proportion by volume of water vapor in a gas (Bwo):	0.153358	Bwo
Absolute pressure at the wet bulb and dry bulb temperature assembly (Pa):	28.72632	Pa
Water vapor pressure in a gas mixture (Eo):	4.4054	eo
Absolute pressure of duct gas (Po):	28.72632	Po

Temperature Dry Bulb deg. F	Wet Bulb deg. F	Barometric Pressure PSIA	Specific Humidity	Relative Humidity %	stm32	stm	sps	spa	sw	c12	c13	w
129	129	0.079456	-0.645698	100	3.10406	2.164925	2.164925	-2.08547	-0.6457	1019.986	0	-0.6457

100% Relative Humidity Calculations Appear Below This Point.

stm32	stm	sps	spa	sw	c12	c13	w
3.10406	2.164925	2.164925	-2.08547	-0.6457	1019.986	0	-0.6457

THC CALCULATION
(as Propane)

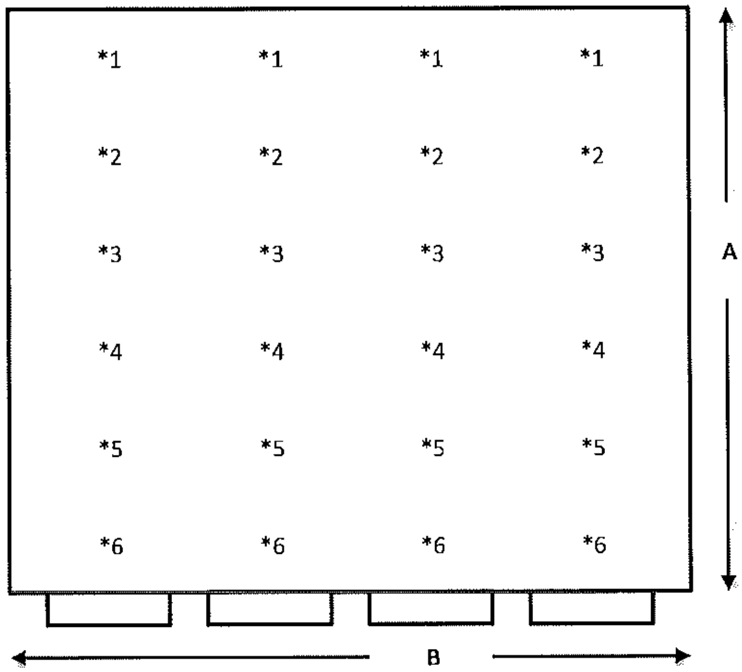
lb/dscf = $1.145 \times 10^{-7} \times$ ppm

Lb/hour = lb/dscf x DSCFM x 60 min./hr

Attachment 4

Stack Schematics

Chance Aluminum
Williamsport, PA
Cold Rolling Mill 1 Stack
Rectangular Duct - 4 Ports, 24 Traverse Points



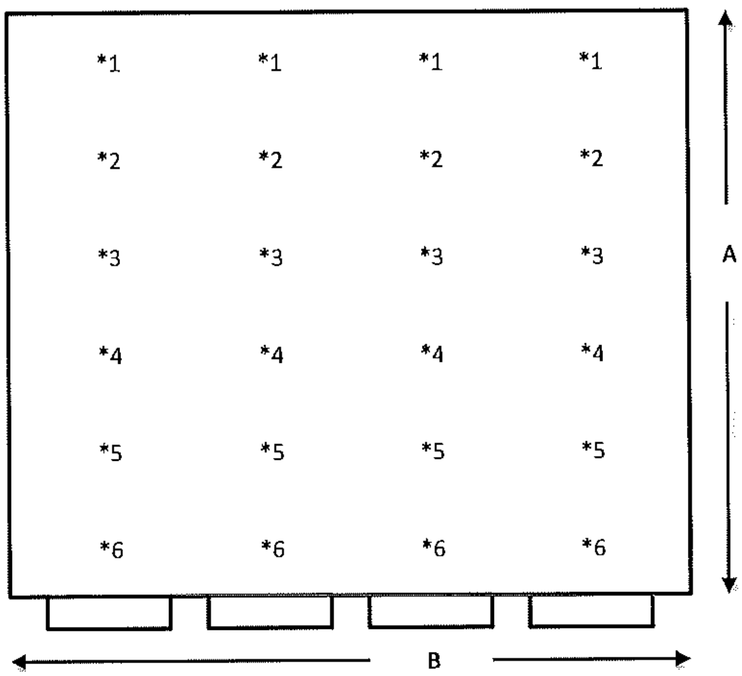
Add port depth of 2.5 inches

Traverse Points (Distance in Inches)

1	42.17	42 1/8
2	34.50	34 4/8
3	26.83	26 7/8
4	19.17	19 1/8
5	11.50	11 4/8
6	3.83	3 7/8

A:	3.83	***ft.***
B:	3.83	***ft.***
Stack Area:	14.7	***sq. ft.***

Chance Aluminum
Williamsport, PA
Cold Rolling Mill 2 Stack
Rectangular Duct - 4 Ports, 24 Traverse Points



Add port depth of 3 inches

Traverse Points (Distance in Inches)

1	36.67	36 5/8
2	30.00	30
3	23.33	23 3/8
4	16.67	16 5/8
5	10.00	10
6	3.33	3 3/8

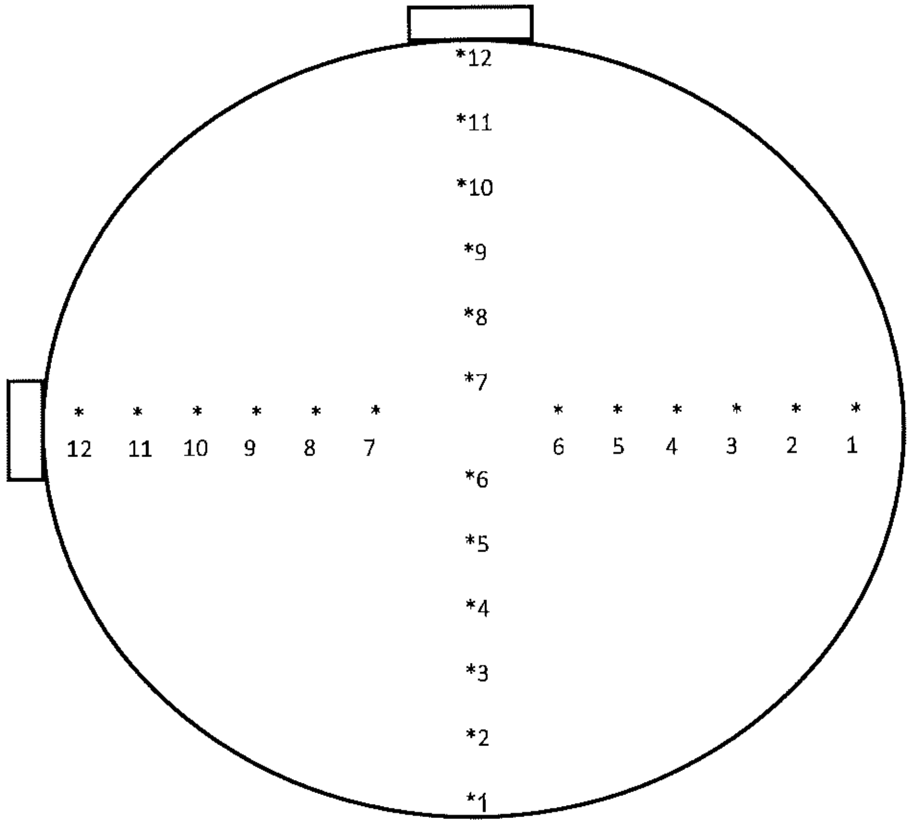
A:	3.33	***ft.***
B:	3.33	***ft.***
Stack Area:	11.1	***sq. ft.***

Chance Aluminum

Williamsport, PA

Cold Rolling Mill 3 Stack

2 ports, 24 Traverse Points



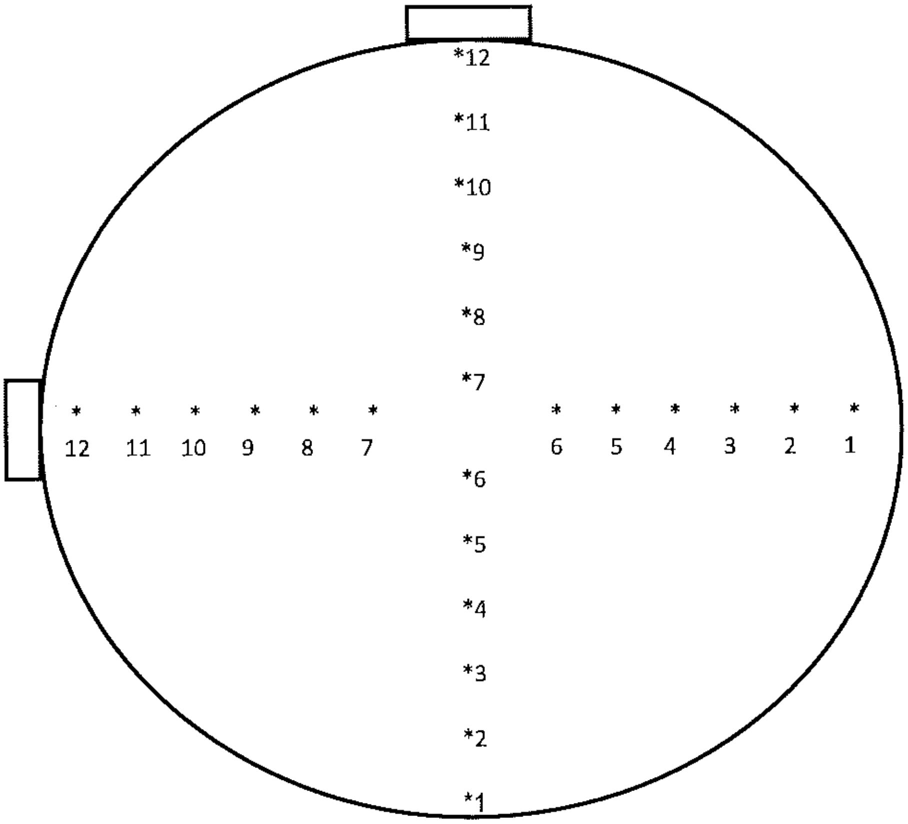
DRAWING NOT TO SCALE

	Traverse Points (Distance in Inches)	
1	39.16	39 1/8
2	37.32	37 3/8
3	35.28	35 2/8
4	32.92	32 7/8
5	30.00	30
6	25.76	25 6/8
7	14.24	14 2/8
8	10.00	10
9	7.08	7 1/8
10	4.72	4 6/8
11	2.68	2 5/8
12	0.84	7/8

Add port depth of 3.5 inches

Stack Area:	8.7	*sq. ft.*
Stack Diameter:	3.33	*ft.*

Chance Aluminum
Williamsport, PA
Cold Rolling Mill 4 Stack
2 ports, 24 Traverse Points



DRAWING NOT TO SCALE

Traverse Points (Distance in Inches)			Add port depth of 4 inches
1	52.87	52 7/8	
2	50.38	50 3/8	
3	47.63	47 5/8	
4	44.44	44 4/8	
5	40.50	40 4/8	
6	34.78	34 6/8	
7	19.22	19 2/8	
8	13.50	13 4/8	
9	9.56	9 4/8	
10	6.37	6 3/8	
11	3.62	3 5/8	
12	1.13	1 1/8	

Stack Area:	15.9	***sq. ft.***
Stack Diameter:	4.50	***ft.***

Attachment 5

Sampling Train Diagrams

Figure 1
Sampling Train

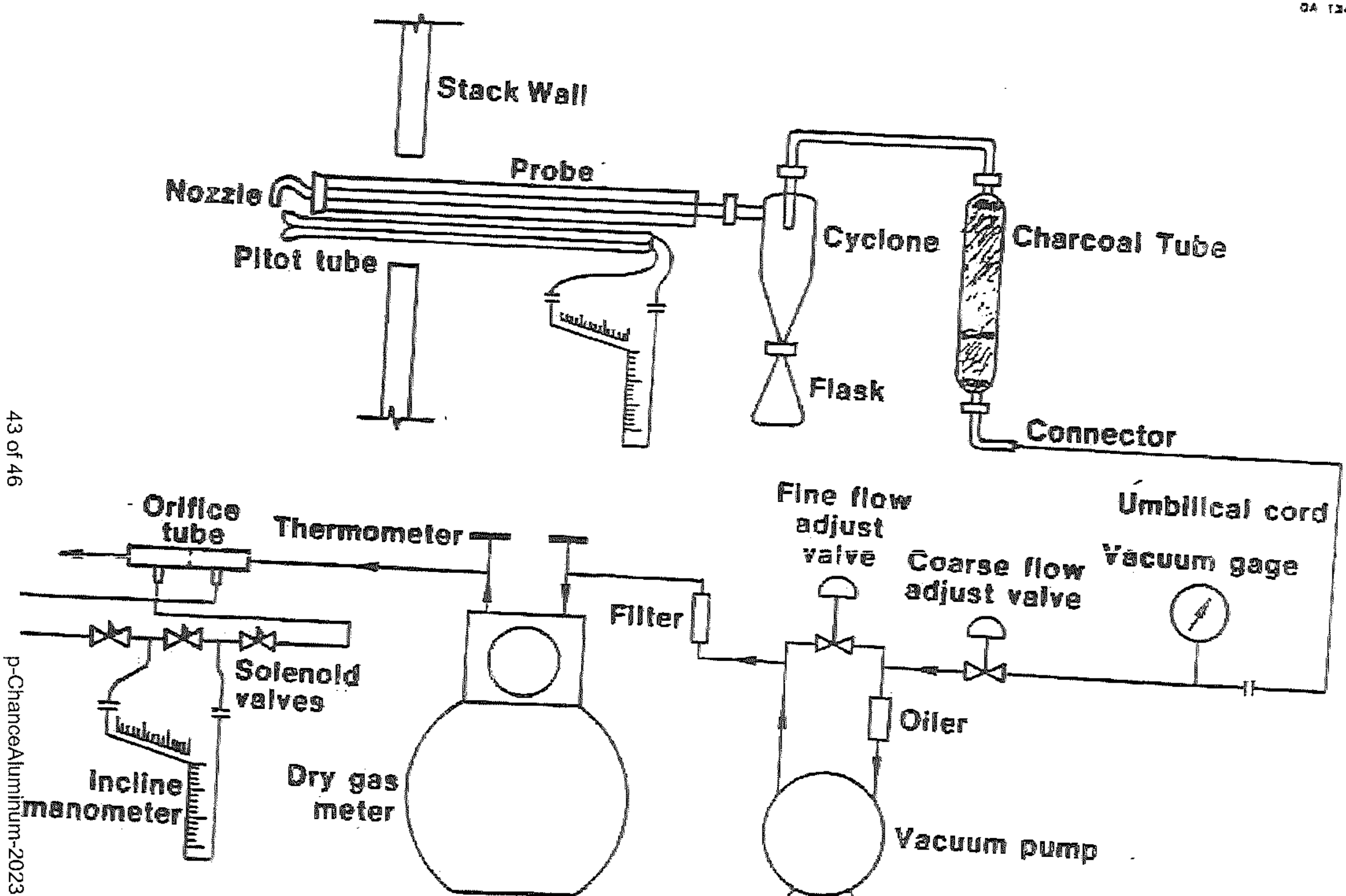
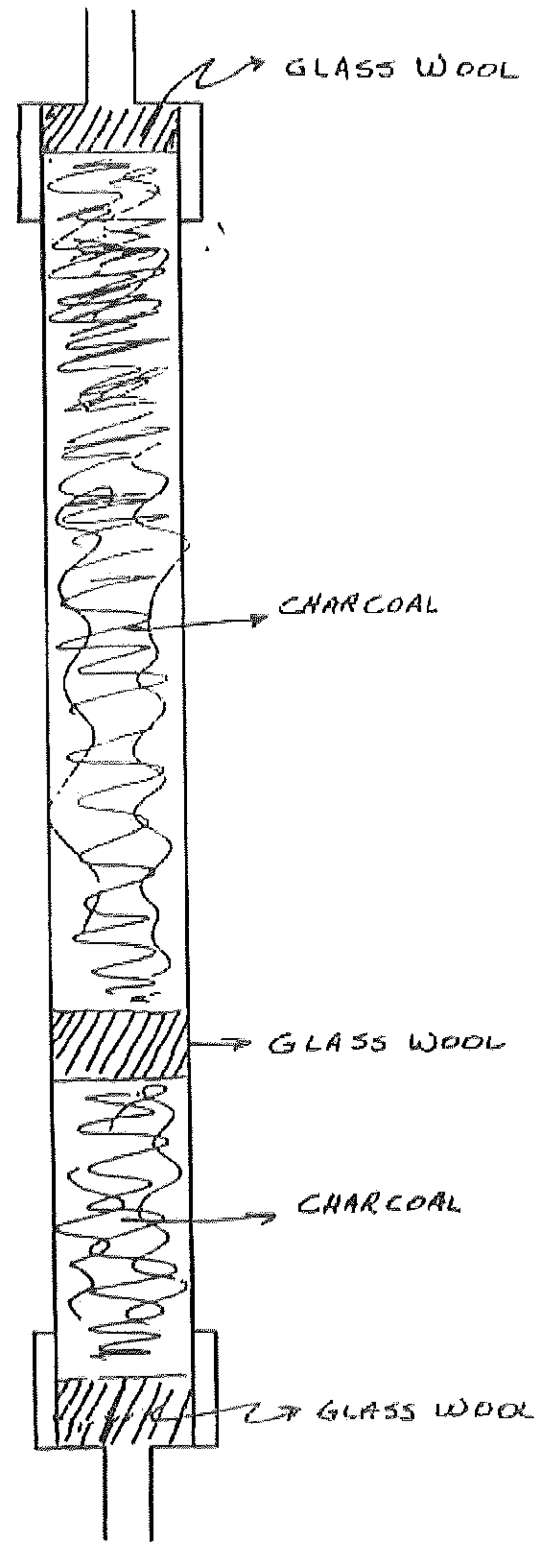
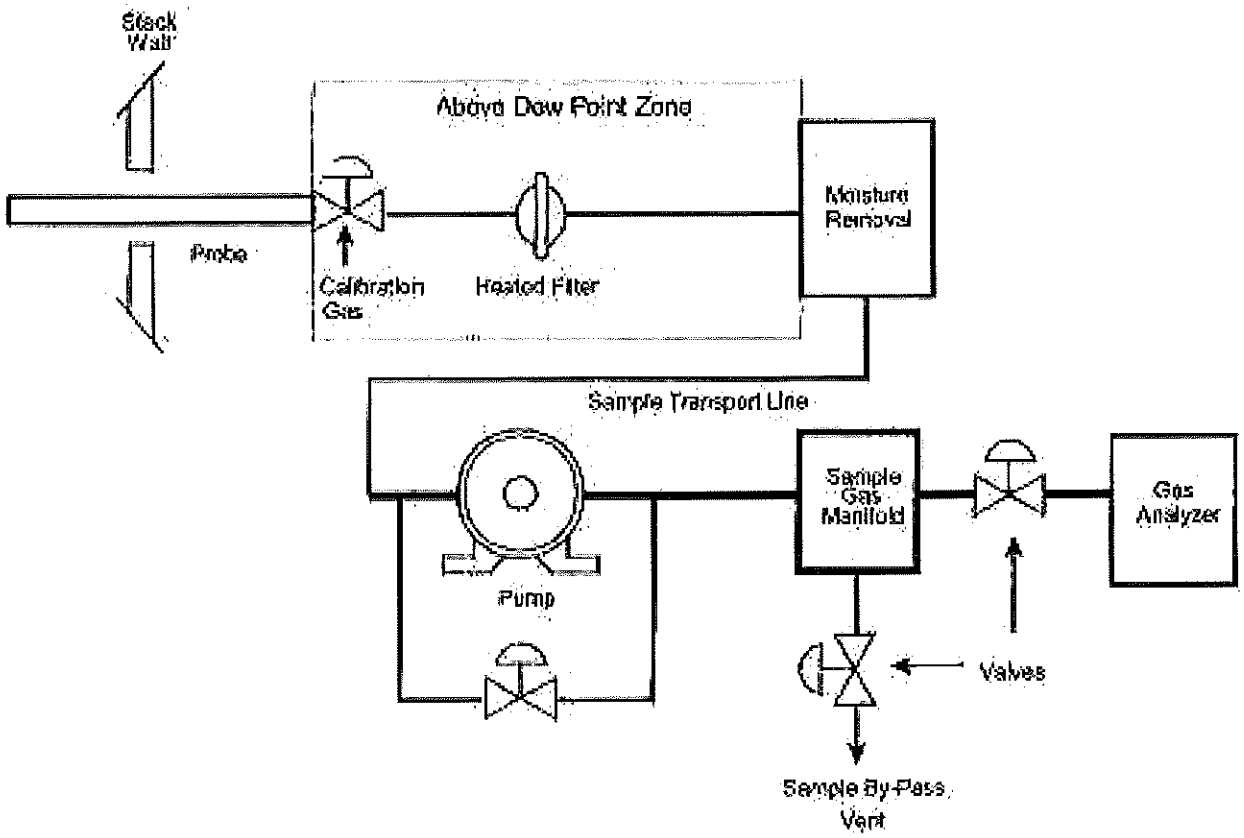
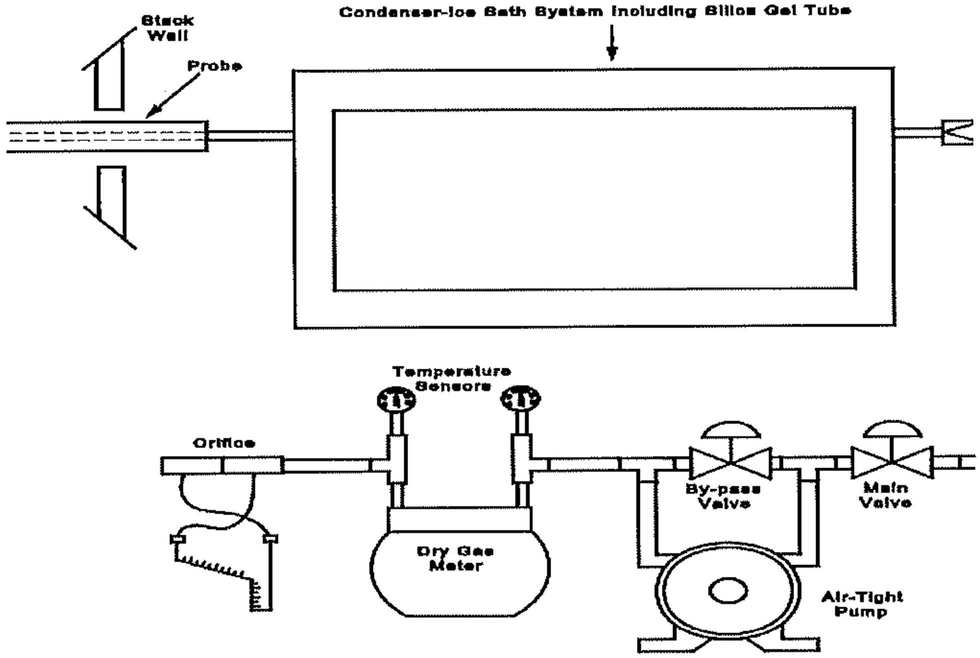


FIGURE 2



Multi-Component Gaseous Sampling Train - O2, CO2 (Mill 3 Test)
Methods 3A





Method 4 Sample Train

APPENDIX B

SITE SPECIFIC DATA

PPI Industry Data
Original Data Value

Series Id:	PCU331315331315
Series Title:	PPI industry data for Aluminum sheet, plate, and foil
Industry:	Aluminum sheet, plate, and foil mfg
Product:	Aluminum sheet, plate, and foil mfg
Base Date:	198106
Years:	1999 to 2021

Year	Oct
1999	143.3
2000	152.6
2001	143.7
2002	140.3
2003	140.9
2004	149.2
2005	156.0
2006	178.9
2007	180.6
2008	191.6
2009	161.1
2010	176.9
2011	188.4
2012	180.0
2013	171.4
2014	182.9
2015	168.2
2016	167.6
2017	188.7
2018	205.9
2019	191.5
2020	173.6
2021	242.255

PPI ratio from 1999 to 2021=
1.7

Average retail price of electricity Pennsylvania industrial monthly
https://www.eia.gov/opendata/v1/qb.php?category=1014&sdid=ELEC.PRICE.PA-IND.M
15:24:25 GMT-0400 (Eastern Daylight Time)
Source: U.S. Energy Information Administration

Month	Series ID: ELEC.PRICE.PA-IND.M cents per kilowatthour
Aug-22	9.28
Jul-22	8.94
Jun-22	8.53
May-22	8.08
Apr-22	7.54
Mar-22	7.31
Feb-22	7.67
Jan-22	7.52
Dec-21	6.96
Nov-21	7.28
Oct-21	6.96
Sep-21	6.85
Aug-21	6.77

AVG Industrial Electricity Cost 8/2021 to 8/2022:
$0.077

Pennsylvania Natural Gas Industrial Price Monthly
https://www.eia.gov/opendata/v1/qb.php?sdid=NG.N3035PA3.M
15:12:33 GMT-0400 (Eastern Daylight Time)
Source: U.S. Energy Information Administration

Month	Series ID: NG.N3035PA3.M Dollars per Thousand Cubic Feet
22-Aug	12.31
22-Jul	11.87
22-Jun	10.78
22-May	10.11
22-Apr	9.74
22-Mar	10.23
22-Feb	10.13
22-Jan	10.2
21-Dec	9.48
21-Nov	8.93
21-Oct	13.65
21-Sep	9.25
21-Aug	7.74

AVG Price 8/2021 to 8/2022:
$10.34 per thousand cubic feet

LINPAR® 1416V

Technical Data Sheet

This product is now classified as "non-regulated" for transportation! More info at www.sasoltechdata.com

sasol reaching new frontiers

Description

Sasol North America's LINPAR® 1416V paraffin is made of a high purity mixture of saturated alkanes in the C14 - C16 carbon range. It is a high purity hydrogenated paraffin. It is a clear, water-white oily liquid with a low viscosity. LINPAR® 1416V paraffin has an extremely low sulfur and nitrogen content.

Applications

LINPAR® 1416V paraffin may be used in a wide array of applications. Applications such as pesticide formulations, consumer products, lubricating oils, chemical process solvents, oilfied drilling fluids, liquid lamp fuel , metal rolling oils, etc.

Regulatory Compliance

If this material is used in a consumer product or in certain other specific applications, some exemptions may apply. Please contact a sales representative for more information on particular FDA regulations or for solvent status as an LVP-VOC for consumer products.

Contact Information

For sales/pricing and sampling information, please contact either of the following:

Sasol North America
Jonathan D'Hooge
900 Threadneedle
Houston, TX 77079-2990
Phone: (281)588-3310
Mobile: (713)269-4833
Jonathan.Dhooge@us.sasol.com

Sasol North America
John P. McGrail
1 Shoreby Drive
Bratenahl, OH 44108
Phone: (216) 268- 5778
Fax: (281) 368-1531
John.McGrail@us.sasol.com

Physical Properties

Typical physical properties are listed in the table below. Actual properties may vary from lot to lot.

Typical Properties	Method	LINPAR® 1416 Paraffin
Total n-paraffin, wt%	GC/UV	>97
C13 & lower		<1
C14		50 - 80
C15		20 - 28
C16		3 - 7
C17 & higher		<3
Flash Point, (PM) °F	ASTM D-93	242
Freeze Point, °F	ASTM D-2386	45
Pour Point, °F	ASTM D-97	37
Specific Gravity 60°F/60°F	ASTM D-287	0.768
Density, lbs/gal @ 60°F	ASTM D-287	6.41
Average Molecular Weight	API	201
Aromatics, wt%	UV	<0.5
Color, Saybolt Universal	ASTM D-156	+30
Relative Evaporative Rate (n-Butyl Acetate = 1)	ASTM D-3539	0.0012
Distillation Range, °F, IBP	ASTM D-86	476
EP		530
Vapor Pressure, torr @ 20°C	API, calc	<0.1
Viscosity, cSt @ 20°C	ASTM D-445	3.4
@ 40°C		2.5
Aniline Point, °F	ASTM D-611	195
Kauri-Butanol Value	ASTM D-1133	21.3
Bromine Number	ASTM D-1159	<0.04
Nitrogen, ppm		<1
Sulfur, ppm		<2
CAS Number		90622-46-1

SAFETY DATA SHEET

LINPAR® 1416-V Normal Paraffin

SECTION 1 IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

Trade name	LINPAR® 1416-V Normal Paraffin	
Synonyms	Mixture of Tetradecane, Pentadecane and Hexadecane	
Use	Industrial use, Lighting, Metal Processing, Oilfield Drilling	
Company	Sasol Chemicals (USA) LLC (an affiliate of Sasol Chemicals North America LLC)	
Address	12120 Wickchester Lane Houston TX 77079	
Telephone	CHEMTREC North America Transportation Emergency (24-hr)	(800) 424-9300
	CHEMTREC World Wide	(703) 527-3887
	Other Emergencies (24-hr)	(337) 494-5142
	MSDS and Product Information (8:00am-4:30pm CST)	(281) 588-3491
	Health and Safety Information (7:30am-4:00pm CST)	(281) 588-3492
E-mail address	SasolElectronicSDS@us.sasol.com	

SECTION 2 HAZARDS IDENTIFICATION

GHS Hazards

Aspiration hazard — Category 1

LABEL ELEMENTS

Hazard symbols

Signal word Danger

Hazard statements H304 May be fatal if swallowed and enters airways.

Precautionary statements

Response P301 + P310 IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician.
P331 Do NOT induce vomiting.

Storage P405 Store locked up.

Disposal P501 Dispose of contents/ container to an approved waste disposal plant.

SECTION 3 COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS-No.	Weight percent
C14-16 Normal Paraffins	90622-46-1	100

See Section 8 for Exposure Guidelines and Section 15 for Regulatory Classifications.

SECTION 4 FIRST AID MEASURES

Eye contact Rinse immediately with plenty of water for at least 15 minutes. If eye irritation persists, consult a specialist.

Skin contact In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes.

Inhalation Remove to fresh air. If breathing is irregular or stopped, administer artificial respiration. Call a physician immediately.

Ingestion Do NOT induce vomiting. Consult a physician.

SECTION 5 FIREFIGHTING MEASURES

FLAMMABLE PROPERTIES

Fire/explosion NFPA Class IIIB combustible liquid.

Suitable extinguishing media Water spray, Foam, Dry chemical, Carbon dioxide (CO_2)

Protective equipment and precautions for firefighters In the event of fire, wear self-contained breathing apparatus.

Further information Keep containers and surroundings cool with water spray.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Methods and materials for containment and cleaning up Evacuate the area and eliminate all sources of ignition. Contain spillage, and then collect with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see section 13).

SECTION 7 HANDLING AND STORAGE

Safe handling advice Ensure all equipment is electrically grounded before beginning transfer operations.

Storage/Transport pressure Ambient

Load/Unload temperature Ambient, above freezing point. (Product will freeze at 4°C)

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING MEASURES

Air contaminant levels should be controlled below the PEL or TLV for this product (see Exposure Guidelines).

PERSONAL PROTECTIVE EQUIPMENT

Eyes Wear as appropriate: Goggles, Face-shield

Skin Wear suitable protective clothing, gloves and eye/face protection.

Inhalation Respiratory protection is normally not required except in emergencies or when conditions cause excessive airborne levels of mists or vapors. Use NIOSH approved respiratory protection.

EXPOSURE GUIDELINES

Contains no substances with occupational exposure limit values., Sasol Chemicals (USA) LLC recommends an internal limit of 5 mg/m3 (8-hour TWA) for exposure to mists of this product.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Appearance liquid;

Colour water-white, oily

Form liquid

Odour Hydrocarbons

Odour Threshold no data available

Flash point 118 °C, 244 °F; PM;

Flammability Upper explosion limit: 4.7 %(V)

Lower explosion limit: 0.5 %(V)

Boiling point/boiling range 248 - 284 °C, 478 - 544 °F; ASTM D-86;

Melting point/range 4 °C, 39 °F; (Freeze pt.)

Auto-ignition temperature 204 °C, 400 °F;

Decomposition temperature	no data available
Flammability (solid, gas)	no data available
Vapour pressure	< 0.1 mm Hg @ 20 °C, 68 °F; API Calculation;
Vapour density	7.1
Density	no data available
Specific gravity	0.768 @16 °C, 61 °F;
Water solubility	negligible
Viscosity	2.3 - 2.5 cSt @ 40 °C, 104 °F;
pH	no data available
Evaporation rate	no data available
Partition coefficient: n-octanol/water	no data available

SECTION 10 STABILITY AND REACTIVITY

Reactivity	Stable under recommended storage conditions.
Chemical stability	No decomposition if stored and applied as directed.
Conditions to avoid	Keep away from heat and sources of ignition.
Hazardous decomposition products	Combustion products include carbon dioxide, carbon monoxide and possibly other unidentified organic compounds.
Materials to avoid	Oxidizing agents
Hazardous polymerisation	None known.

SECTION 11 TOXICOLOGICAL INFORMATION

Acute dermal toxicity	LD50 rabbit: > 2,000 mg/kg
Acute inhalation toxicity	LC50 rat (4 hours): > 5.8 mg/l
Acute oral toxicity	LD50 rat: > 2,000 mg/kg

Skin corrosion/irritation	(rabbit) Repeated exposure may cause skin dryness or cracking.
Eye damage/irritation	Primary irritation (rabbit): 1 hours; 5.7 (Max. score is 110.) (unwashed eyes), Not irritating
Respiratory or skin sensitization	no data available
Germ cell mutagenicity	**Genotoxicity in vitro:** no data available **Genotoxicity in vivo:** no data available **Assessment Mutagenicity:** no data available
Reproductive toxicity	**Reproductive toxicity:** no data available **Assessment Reproductive toxicity:** no data available **Teratogenicity:** no data available **Assessment teratogenicity:** no data available
STOT - single exposure	no data available
STOT - repeated exposure	no data available
Aspiration toxicity	May be fatal if swallowed and enters airways.
Carcinogenicity	**Assessment carcinogenicity:** Contains no ingredient listed as a carcinogen

SECTION 12 ECOLOGICAL INFORMATION

Aquatic toxicity	Not toxic to aquatic organisms (fish, daphnia, algae) up to water solubility.
Toxicity to fish	LL50 (Pimephales promelas (fathead minnow)) 96 hours In the range of water solubility not toxic under test conditions.
Toxicity to aquatic invertebrates	EL50 (Ceriodaphnia Dubia (water flea)) 192 hours In the range of water solubility not toxic under test conditions.
Toxicity to algae	no data available

Chronic toxicity to fish no data available

Chronic toxicity to aquatic invertebrates no data available

Biodegradation Readily biodegradable.

OECD Test Guideline 301F (28 d): 82 %
Test substance: LINPAR 1417

Bioaccumulation no data available

Mobility in soil no data available

Other adverse effects no data available

SECTION 13 DISPOSAL CONSIDERATIONS

Waste Code Any unused product or empty containers may be disposed of as non-hazardous in accordance with state and federal requirements. Re-evaluation of the product may be required by the user at the time of disposal, since the product uses, transformations, mixtures, contamination, and spillage may change the classification. If the resulting material is determined to be hazardous, please dispose in accordance with state and federal (40 CFR 262) hazardous waste regulations.

Disposal methods Dispose of only in accordance with local, state, and federal regulations.

Empty containers. Empty containers retain product residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Empty drums should be completely drained, triple-rinsed, properly bunged and promptly returned to a drum reconditioner, or properly disposed.

SECTION 14 TRANSPORT INFORMATION

DOT Not regulated.

IATA Not regulated.

IMDG Not regulated.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Remarks no data available

SECTION 15 REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS

OSHA Hazards (HCS 1994)
Non-hazardous substance

TSCA Inventory Listing

Components	CAS-No.
Alkanes, C14-16	90622-46-1

SARA 302 Status

Components	CAS-No.	Weight percent

SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 311/312 Classification
"Immediate (acute) health hazard"

SARA 313 Chemical

Components	CAS-No.	Weight percent

SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

US. EPA CERCLA Hazardous Substances (40 CFR 302)

Components	Reportable Quantity	Weight percent
none		

INTERNATIONAL REGULATIONS

WHMIS Classification
WHMIS hazardous composition: No ingredients are hazardous according to the CPR criteria.

European Union
Classification according to Regulation (EU) 1272/2008.

Aspiration hazard, Category 1
Repeated exposure may cause skin dryness or cracking.

Australia. Inventory of Chemical Substances (AICS)	Listed
Japan. Inventory of Existing and New Chemical Substances (ENCS)	Listed
Japan. Industrial Safety & Health Law (ISHL) Inventory	Listed
Canada. Domestic Substances List (DSL) Inventory This product or a component is the subject of a Significant New Activity (SNAc) notice under CEPA.	Listed
Canadian Non-Domestic Substance Listing (NDSL)	Not listed
European Inventory of Existing Commercial Chemical Substances	Listed

(EINECS) Listing

Philippines. Inventory of Chemicals / Chemical Substances (PICCS)	Listed
Korea. Existing Chemicals Inventory (KECI)	Listed
China. Inventory of Existing Chemical Substances (IECSC)	Listed
Mexico. National Inventory of Chemical Substances (INSQ)	Not listed
New Zealand. Inventory of Chemicals (NZIoC)	Listed
Switzerland. Inventory of Notified New Substances (CHINV)	Listed
Taiwan. National Existing Chemical Inventory (NECI)	Listed

Please note: The names and CAS numbers which are used for this product in the stated inventories may deviate from the information which is listed in Section 3.

STATE REGULATIONS

California Prop. 65

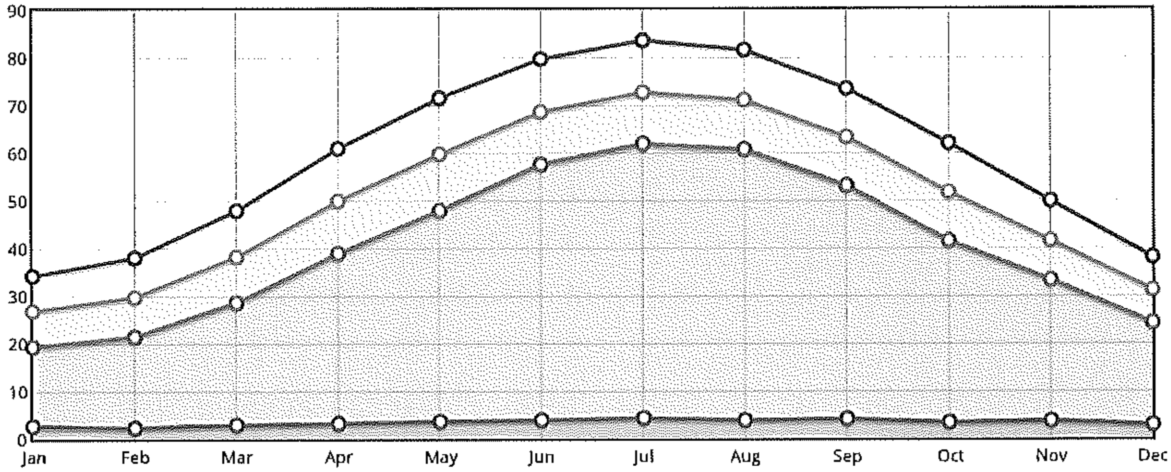
Components	CAS-No.
none	

SECTION 16 OTHER INFORMATION

HAZARD RATINGS

	Health	Flammability	Physical Hazard/ Instability
HMIS®	1	1	0
NFPA	1	1	0

WILLIAMSPORT LYCOMING CO AIRPORT, PA US



MONTH	PRECIP (IN)	MIN TMP (°F)	AVG TMP (°F)	MAX TMP (°F)
01	2.70	19.3	26.8	34.2
02	2.34	21.4	29.7	38.0
03	2.97	28.6	38.2	47.9
04	3.24	38.9	49.9	60.9
05	3.66	47.9	59.7	71.5
06	3.92	57.6	68.6	79.7
07	4.34	61.9	72.7	83.6
08	3.86	60.7	71.1	81.6
09	4.16	53.1	63.3	73.5
10	3.42	41.5	51.7	62.0
11	3.74	33.3	41.6	49.9
12	2.93	24.3	31.2	38.1

Current Results
weather and science facts

Annual Average Humidity in Pennsylvania

The average humidity year round is listed below for places in Pennsylvania. The tables give daily averages along with highest and lowest relative humidity levels.

Relative humidity measures the actual amount of moisture in the air as a percentage of the maximum amount of moisture the air can hold.

All the numbers here are averages for the years 1961 to 1990.

Average Humidity

In this table, the **Daily** number is the average of humidity readings taken every three hours throughout the day. **Morning** percentages are for 7 am and **Afternoon** measures are for 4 pm local standard time.

Average yearly relative humidity (%)

Daily	Place	Morning	Afternoon
68	Allentown	80	55
72	Erie	78	65
67	Harrisburg	77	54
67	Philadelphia	76	54
68	Pittsburgh	78	55
69	Wilkes-Barre & Scranton	80	57

Humidity
Wind

71	Williamsport	82	55

States
Temperature
Precipitation
Snow
Sun
Humidity

Extreme USA Weather
Best
Coldest
Hottest
Driest
Wettest
Snowiest
Stormiest
Sunniest

Highest and Lowest Humidity

Below are averages over the year for maximum and minimum humidity levels in Pennsylvania. The hours when the highest and lowest humidity readings usually occur are given in local standard time.

Annual averages for daily high and low relative humidity (%)

High	Time	Place	Low	Time
80.5	4 am	Allentown	54.6	4 pm
78.2	4 am	Erie	64.9	4 pm
77.3	4 am	Harrisburg	53.7	4 pm
77.9	4 am	Philadelphia	54.0	4 pm
78.4	7 am	Pittsburgh	55.4	4 pm
79.5	7 am	Wilkes-Barre & Scranton	57.1	4 pm
83.3	4 am	Williamsport	55.4	4 pm

Reference

World Data Center for Meteorology. Climate of the World.

Share

More Pennsylvania Weather Information
- Hot, Humid Weather in Pennsylvania
- Average Annual Temperatures for Pennsylvania
- Days of Sunshine in Pennsylvania
- Total Yearly Precipitation for Pennsylvania
- Annual Pennsylvania Snowfall
- Most Humid US Cities

Total Capital Investment						
Direct Costs						
Purchased Equipment Costs (PEC)						
	$	2,685,139	Primary Control Device (includes auxiliary equipment - desorbing thermal oxidizer, interconnections, entry and exit hoods, and ductwork)	1	EC = See derivation on Page 2 - Background and Calculations	
	$	268,514	Instrumentation	0.1	EC	Fire damper(s), integration/interlocks with existing controls
	$	80,554	Taxes, Duties, VAT	0.03	EC	
	$	134,257	Freight	0.05	EC	
Purchased Equip. Total	**$**	**3,168,465**		**1.18**	**EC = B**	
Direct Installation Costs						
	$	380,216	Foundations and supports	0.12	B	Retrofit penalty (50% above model) Landlocked - must move or avoid electric service, water service, sewer service, CO2 Service, Nitrogen service, Waste removal service
	$	554,481	Equipment erection and handling	0.18	B	Retrofit penalty (25% above model). See previous comment
	$	126,739	Electrical work	0.04	B	
	$	31,685	Piping	0.01	B	Desorption to be accomplished using thermal destruction (50% reduction)
	$	63,369	Insulation	0.02	B	Increased by 100% because of length, height, weather exposure, desire to minimize condensation, and hi-temperatures needed for desorption
	$	31,685	Painting	0.01	B	
	$	443,585	Fire suppression	0.14	B	Increased by 75% above standard to accommodate long duct at ceiling height and adsorption bed protection
	$	275,000	Building and Site Preparation		Building	5,000 ft^2 assumed at $55/ft^2. Required because rolling oil freezes at 45 °F.
Direct Installation Total	**$**	**1,906,759**		**1.52**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$**	**5,075,224**				
Indirect Costs (installation)						
	$	316,846	Engineering	0.1	B	
	$	158,423	Construction and field expenses	0.05	B	
	$	316,846	Contractor fees	0.1	B	
	$	63,369	Startup costs	0.02	B	
	$	104,559	Performance test costs	0.033	B	
	$	63,369	Contingencies	0.02	B	Redesign/modification of equipment, startup delays
	$	383,560	Plant Shutdown for Retrofit	Shutdown for retrofit		M1 = 21 shifts of full production downtime
Total Indirect Costs, IC	**$**	**1,406,974**		**0.32**	**B + Shutdown**	
Total Capital Investment	**$**	**6,482,198**				

Background and Calculations

			Design
Air Flow (dscfm)			41,423
Air Flow (acfm) = dscfm +8%, maximum variability in stack tests			44,737
Btus in Exhaust (Btus/dscf)			0.130
***(IA)* Inflation Adjustment for EC**			1.700
Cost of Entry Hood, Exit Hood and Air Curtains from Auxilliary Equipment worksheet	$	117,116	
Cost of Ductwork from Auxilliary Equipment worksheet	$	54,637	

Each operational bed consists of round vessels 12' in diameter, to maximize road transportation
Each vessel is .06 feet long with 3 feet of transition/access on each end (L)
To achieve 60 fpm face velocity, seven vessels are required accommodate 44,737 acfm,
The surface area of each vessel is $S=\pi D((L + 2Transitions) + D/2)$
$S= \pi 12(6.06+6)$, $S = 454.65\ ft^2$.
The cost of each vessel is given by the relationship $C_{vessel} = 271S^{0.778}$
The 1999 cost, C_{vessel} of a single vessel is $31,670
Each operational bed consists of seven vessels. To accommodate 24/7 operation, two sets of beds are required for a total of fourteen vessels.
1999 cost of the combined vessels, C_{Vessel}, is $443,374
Amount of Zeolite needed per hour - 30.5#/hr VOC / .225 (adsorbency factor)
Amount of Zeolite needed per 12-hour operational shift - 30.5#/hr VOC / .225 (adsorbency factor) x 12 = 1,626.67 pounds
Amount of Zeolite needed per day (shift x 2) = 3,253.33 pounds
1999 cost of system Zeolite charge, $C_{Adsorbent}$ (Zeolite lbs x $40/lb) = $65,067
To desorb the high MW VOCs, while avoiding thermal degradation of the zeolite, a 1,000 dscfm thermal oxidizer with 70% heat recovery
would maintain 1,000 °F desorb/preheat temperature, destruction temperature of 1,500 °F and 18% of the LEL (assuming uniform bed desorption).
1999 thermal recuperative desorber equipment costs, $C_{Thermal} = 21{,}342 \times Q_{total}^{0.2500}$, where Q = 1,000 scfm., EC = $120,015.
Total Purchase Cost of Equipment (1999), based on EPA's survey of equipment suppliers must be factored to include piping, controls, compressors, pumps, fans, etc.
It is assumed that auxiliary equipment, other direct costs, and the indirect costs for the thermal desorption system are similar percentages for the adsorption system.
Per page 1-20 Section 3.1 Chapter 1 of EPA PCCM, total purchased cost of the four sampled adsorber/desorber systems varied from 1.14 to 2.24 times the carbon and vessel cost.
The low concentration of the high MW VOCs puts the vessel size ***beyond the parameters of the standard equipment models***. Similarly, ***desorbing with 1,000 °F air is beyond the norm*** and switching hardware must be included to desorb multiple beds or provide a moving bed.
The ***high end of the cost range for auxiliary equipment is used to acknowledge extrapolating costs beyond four known systems*** to include the above variations
Therefore, the factor to accommodate piping, controls, compressors, pumps, etc, ***R = 2.24***
The estimated costs in 1999 for the adsorber/desorber control system is $C_{equip} = R(C_{Vessel} + C_{Adsorbent} + C_{Thermal})$ + Entry/Exit hoods + Ductwork

1999 C_{equip} =	$	1,579,494
1999 C_{equip} x IA = **2022 C_{equip}** =	**$**	**2,685,139**

Cost Item			Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70	$	13,276	A
		Supervisor	15% of operator		$	1,991	A
	Maintenance						
		Labor	0.5 hr/shift	$30.03	$	16,141	A
		Materials	100% of maintenance labor		$	16,141	A
	Replacement Parts, Zeolite (3-year life)						
		Labor			$	167	A, C, D, E
		Materials + freight	0.300245 (1,500 lbs. x $59.35/lb x 1.05)		$	44,591	D, E, Q
	Utilities						
		Natural Gas		$ 10.34 /MCF	$	12,623	A, F, I, J, K, L, S
		Electricity (75 Hp)		$ 0.0770 / kWhr	$	31,055	A, B, G, M, N, T
		Sewer and Water		0			
Total DC					$	**135,986**	
Indirect Annual Costs, IC							
	Overhead	60% of sum of Operating, supv., and maintenance labor and materials			$	28,530	A
	Administrative Charges	2% of Total Capital Investment			$	129,644	
	Property Taxes	1% of Total Capital Investment			$	64,822	
	Insurance	1% of Total Capital Investment			$	64,822	
	Capital Recovery				$	1,147,219	O
Total Indirect Costs					$	**1,435,037**	
Total Annual Costs					$	**1,571,023**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					$	**12,866.63**	A, H

Occupation code	Occupation title (click on the occupation title to view an occupational profile)	Level	Employment	Employment RSE	Percent of total employment	Median hourly wage	Mean hourly wage
51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	detail	1,870	16.20%	3.39%	$24.60	$24.70
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	broad	2,900	4.20%	5.26%	$29.20	$30.03

Comments

A	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
B	Mill Exhaust Air Flow (acfm)	44,737
C	Based on EPA APCCM Ed. 6 Example (labor hours/changeout)	4
D	Anticipated adsorbent life (years)	3
E	Capital Recovery Factor, CRF for zeolite replacement = 0.41635, 3-years at 12% - JWA Internal Opportunity Cost	0.41635
F	Offline Thermal Desorption System. 18% LEL assuming uniform desorption (scfm)	1,000
G	Fan capacity required for thermal desorber- oxidizer with 67% R.H., at 1,500 F. (acfm)	3,650
H	Combined System Destruction Removal Efficiency (DRE) , pg. 16 of EPA 456/F-99-004, CATC Technical Bulletin Choosing An Adsorption System for VOC: Carbon, Zeolite, or Polymers?	93%
I	Overall Temperature Rise Needed Thermal Desorption and Destruction with 70 Heat Recovery (1,500 - 77) x (100% - 70%) (°F)	426.9
J	Btus in Mill Exhaust (Btus/dscf)	0.130

Comments (cont'd,)

K	Btus in Mill Exhaust (Btus/dscf), Concentrated by Factor of 40 in Desorption Air Stream	5.200
L	Btus Required to Heat one dscf of desorb air to Required Net Temperature includes contribution from Exhaust VOC	2.4842
M	Mill Exhaust pressure drop assumed for ductwork, pressure changes, and carbon beds (in. w.c.)	4.0
N	Thermal desorber with 70% heat recovery pressure drop (in. w.c.)	19.0
O	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
P	1999 cost of zeolite ($/lb)	40.00
Q	2022 cost of zeolite ($/lb.)	68.00
R	Inflation Factor 1999 - 2022	1.7
S	PA Natural Gas Industrial Price, Average 2021/2022 ($/mcf)	10.34
T	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.077

Total Capital Investment						Comments
Direct Costs						
Purchased Equipment Costs (PEC)						
	$	505,969	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1	$EC = IA \times (10{,}294\ Q_{total}^{0.2355} + \text{Hoods and Ductwork})$, HR = None	A, B, C, D, L
	$	50,597	Instrumentation	0.1	EC	E
	$	15,179	Taxes, Duties, VAT	0.03	EC	F
	$	25,298	Freight	0.05	EC	
Purchased Equip. Total	**$**	**597,043**		**1.18**	**EC = B**	
Direct Installation Costs						
	$	47,763	Foundations and supports	0.08	B	
	$	125,379	Erecting and handling the equipment	0.21	B	G
	$	23,882	Electrical work	0.04	B	
	$	11,941	Piping	0.02	B	
	$	5,970	Insulation	0.01	B	
	$	5,970	Painting	0.01	B	
	$	71,645	Fire suppression	0.12	B	H
	$	275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$**	**567,551**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$**	**1,164,595**				
Indirect Costs (installation)						
	$	59,704	Engineering	0.1	B	
	$	29,852	Construction and field expenses	0.05	B	
	$	59,704	Contractor fees	0.1	B	
	$	11,941	Startup costs	0.02	B	
	$	59,704	Performance test costs	0.1	B	
	$	11,941	Contingencies	0.02	B	J
	$	383,560	Plant Shutdown for Retrofit	Shutdown for retrofit		K
Total Indirect Costs, IC	**$**	**616,407**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$**	**1,781,002**				

Comments:

A	Design Air Flow (dscfm)	41,423
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M1 = 21 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 4,985,142	B, C, D, E
		Electricity (150 Hp)		$ 0.0770	/ kWhr	$ 71,040	B, E, F, I
Total DC						**$ 5,103,732**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 35,620	
	Property Taxes	1% of Total Capital Investment				$ 17,810	
	Insurance	1% of Total Capital Investment				$ 17,810	
	Capital Recovery					$ 315,202	G
Total Indirect Costs						**$ 414,972**	
Total Annual Costs						**$ 5,518,704**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 42,938**	E, H

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	41,423
C	Overall Temperature Rise Needed for No Heat Recovery (1,400 - 77) (°F/°R)	1323
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	23.684
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal (in. of water column)	4
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Total Capital Investment					Comments
Direct Costs					
Purchased Equipment Costs (PEC)					
	$ 650,059	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1	EC = IA x (13,149 $Q_{total}^{0.2609}$ + Hoods and Ductwork), HR = 35%	A, B, C, D, L
	$ 65,006	Instrumentation	0.1	EC	E
	$ 19,502	Taxes, Duties, VAT	0.03	EC	F
	$ 32,503	Freight	0.05	EC	
Purchased Equip. Total	**$ 767,070**		**1.18**	**EC = B**	
Direct Installation Costs					
	$ 61,366	Foundations and supports	0.08	B	
	$ 161,085	Erecting and handling the equipment	0.21	B	G
	$ 30,683	Electrical work	0.04	B	
	$ 15,341	Piping	0.02	B	
	$ 7,671	Insulation	0.01	B	
	$ 7,671	Painting	0.01	B	
	$ 92,048	Fire suppression	0.12	B	H
	$ 275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$ 650,864**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,417,934**				
Indirect Costs (installation)					
	$ 76,707	Engineering	0.1	B	
	$ 38,353	Construction and field expenses	0.05	B	
	$ 76,707	Contractor fees	0.1	B	
	$ 15,341	Startup costs	0.02	B	
	$ 76,707	Performance test costs	0.1	B	
	$ 15,341	Contingencies	0.02	B	J
	$ 383,560	Plant Shutdown for Retrofit	Shutdown for retrofit		K
Total Indirect Costs, IC	**$ 682,717**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$ 2,100,651**				

Comments:

A	Design Air Flow (dscfm)	41,423
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M1 = 21 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

Cost Item			Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 3,230,765	B, C, D, E
		Electricity (225 Hp)		$ 0.0770	/ kWhr	$ 105,181	B, E, F, I
Total DC						**$ 3,383,497**	
Indirect Annual Costs, IC							
	Overhead	60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 42,013	
	Property Taxes	1% of Total Capital Investment				$ 21,007	
	Insurance	1% of Total Capital Investment				$ 21,007	
	Capital Recovery					$ 371,773	G
Total Indirect Costs						**$ 484,329**	
Total Annual Costs						**$ 3,755,270**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 29,218**	E, H

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	41,423
C	Overall Temperature Rise Needed for 35% Heat Recovery (1,400 - 77) x 35% (°F/°R)	859.95
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	15.3491
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 8", 35% Recovery (in. of water column)	8
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

					Comments
Total Capital Investment					
Direct Costs					
Purchased Equipment Costs (PEC)					
	$ 706,513	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1	EC = IA x (17,056 $Q_{total}^{0.2502}$ + Hoods and Ductwork), HR = 50%	**A, B, C, D, L**
	$ 70,651	Instrumentation	0.1	EC	**E**
	$ 21,195	Taxes, Duties, VAT	0.03	EC	**F**
	$ 35,326	Freight	0.05	EC	
Purchased Equip. Total	**$ 833,685**		**1.18**	**EC = B**	
Direct Installation Costs					
	$ 66,695	Foundations and supports	0.08	B	
	$ 175,074	Erecting and handling the equipment	0.21	B	**G**
	$ 33,347	Electrical work	0.04	B	
	$ 16,674	Piping	0.02	B	
	$ 8,337	Insulation	0.01	B	
	$ 8,337	Painting	0.01	B	
	$ 100,042	Fire suppression	0.12	B	**H**
	$ 275,000	Building and Site Preparation		Building	**I**
Direct Installation Total	**$ 683,506**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,517,191**				
Indirect Costs (installation)					
	$ 83,369	Engineering	0.1	B	
	$ 41,684	Construction and field expenses	0.05	B	
	$ 83,369	Contractor fees	0.1	B	
	$ 16,674	Startup costs	0.02	B	
	$ 83,369	Performance test costs	0.1	B	
	$ 16,674	Contingencies	0.02	B	**J**
	$ 383,560	Plant Shutdown for Retrofit	Shutdown for retrofit		**K**
Total Indirect Costs, IC	**$ 708,697**		0.39	**B + Shutdown**	
Total Capital Investment	**$ 2,225,888**				

Comments:

A	Design Air Flow (dscfm)	41,423
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M1 = 21 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

Cost Item			Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 2,478,889	B, C, D, E
		Electricity (275 Hp)		$ 0.0723	/ kWhr	$ 125,869	B, E, F, I
Total DC						**$ 2,652,309**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 44,518	
	Property Taxes	1% of Total Capital Investment				$ 22,259	
	Insurance	1% of Total Capital Investment				$ 22,259	
	Capital Recovery					$ 393,938	G
Total Indirect Costs						**$ 511,503**	
Total Annual Costs						**$ 3,163,812**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 24,616**	E, H

Annual Operating Costs

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	41,423
C	Overall Temperature Rise Needed for 50% Heat Recovery (1,400 - 77) x 50% (°F/°R)	661.5
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	11.777
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 8", 50% Recovery (in. of water column)	12
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

					Comments
Total Capital Investment					
Direct Costs					
	Purchased Equipment Costs (PEC)				
	$ 809,579	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1	EC = IA x (21,342 $Q_{total}^{0.2500}$ + Hoods and Ductwork), HR = 70%	A, B, C, D, L
	$ 80,958	Instrumentation	0.1	EC	E
	$ 24,287	Taxes, Duties, VAT	0.03	EC	F
	$ 40,479	Freight	0.05	EC	
Purchased Equip. Total	**$ 955,303**		**1.18**	**EC = B**	
	Direct Installation Costs				
	$ 76,424	Foundations and supports	0.08	B	
	$ 200,614	Erecting and handling the equipment	0.21	B	G
	$ 38,212	Electrical work	0.04	B	
	$ 19,106	Piping	0.02	B	
	$ 9,553	Insulation	0.01	B	
	$ 9,553	Painting	0.01	B	
	$ 114,636	Fire suppression	0.12	B	H
	$ 275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$ 743,099**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,698,402**				
Indirect Costs (installation)					
	$ 95,530	Engineering	0.1	B	
	$ 47,765	Construction and field expenses	0.05	B	
	$ 95,530	Contractor fees	0.1	B	
	$ 19,106	Startup costs	0.02	B	
	$ 95,530	Performance test costs	0.1	B	
	$ 19,106	Contingencies	0.02	B	J
	$ 383,560	Plant Shutdown for Retrofit	Shutdown for retrofit		K
Total Indirect Costs, IC	**$ 756,128**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$ 2,454,531**				

Comments:

A	Design Air Flow (dscfm)	41,423
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at \$55/ft^2)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M1 = 21 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 1,476,388	B, C, D, E
		Electricity (325 Hp)		$ 0.0723	/ kWhr	$ 152,273	B, E, F, I
Total DC						**$ 1,676,211**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 49,091	
	Property Taxes	1% of Total Capital Investment				$ 24,545	
	Insurance	1% of Total Capital Investment				$ 24,545	
	Capital Recovery					$ 434,403	G
Total Indirect Costs						**$ 561,114**	
Total Annual Costs						**$ 2,237,325**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 17,407**	E, H

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	41,423
C	Overall Temperature Rise Needed for 70% Heat Recovery (1,400 - 77) x 70% (°F/°R)	396.9
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	7.0142
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 15", 70% Recovery (in. of water column)	19
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.077

Total Capital Investment						**Comments**
Direct Costs						
Purchased Equipment Costs (PEC)						
	$	1,735,208	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, ductwork, fan, and stack	1	EC = IA x $((2.204 \times 10^5 + 11.57\ Q_{total})$ + Hoods, Ductwork, Fan, and Stack)	A, B, C, D, L
	$	173,521	Instrumentation	0.1	EC	E
	$	52,056	Taxes, Duties, VAT	0.03	EC	F
	$	86,760	Freight	0.05	EC	
Purchased Equip. Total	$	**2,047,545**		**1.18**	**EC = B**	
Direct Installation Costs						
	$	163,804	Foundations and supports	0.08	B	
	$	429,984	Erecting and handling the equipment	0.21	B	G
	$	81,902	Electrical work	0.04	B	
	$	40,951	Piping	0.02	B	
	$	20,475	Insulation	0.01	B	
	$	20,475	Painting	0.01	B	
	$	245,705	Fire suppression	0.12	B	H
	$	275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$**	**1,278,297**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$**	**3,325,842**				
Indirect Costs (installation)						
	$	204,755	Engineering	0.1	B	
	$	102,377	Construction and field expenses	0.05	B	
	$	204,755	Contractor fees	0.1	B	
	$	40,951	Startup costs	0.02	B	
	$	204,755	Performance test costs	0.1	B	
	$	40,951	Contingencies	0.02	B	J
	$	383,560	Plant Shutdown for Retrofit	Shutdown for retrofit		K
Total Indirect Costs, IC	**$**	**1,182,103**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$**	**4,507,945**				

Comments:

A	Design Air Flow (dscfm)	41,423
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M1 = 21 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods, Ductwork, Fan, and Stack	

Cost Item			Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 730,385	B, C, D, E
		Electricity (125 Hp)		$ 0.0770	/ kWhr	$ 78,889	B, E, F, I
Total DC						**$ 856,824**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 90,159	
	Property Taxes	1% of Total Capital Investment				$ 45,079	
	Insurance	1% of Total Capital Investment				$ 45,079	
	Capital Recovery					$ 797,816	G
Total Indirect Costs						**$ 1,006,664**	
Total Annual Costs						**$ 1,863,488**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						$ 14,499	E, H

Comments

A	**Inflation 1999 - 2022**	**1.7**
B	**Air Flow (dscfm)**	**41,423**

Annual Costs Mill1 RTO

Annual Operating Costs

C	Overall Temperature Rise Assumed per Existing Pollution Control Device (°F above ambient)	200
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	3.47
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 8" (in. of water column)	12
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

						Comments
Total Capital Investment						
Direct Costs						
	Purchased Equipment Costs (PEC)					
	$	922,797	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1	$EC = IA \times ((1105\ Q_{total}^{0.5471})$ + Hoods and Ductwork), No HR	**A, B, C, D, L**
	$	92,280	Instrumentation	0.1	EC	**E**
	$	27,684	Taxes, Duties, VAT	0.03	EC	**F**
	$	46,140	Freight	0.05	EC	
Purchased Equip. Total	**$**	**1,088,900**		**1.18**	**EC = B**	
	Direct Installation Costs					
	$	87,112	Foundations and supports	0.08	B	
	$	228,669	Erecting and handling the equipment	0.21	B	**G**
	$	43,556	Electrical work	0.04	B	
	$	21,778	Piping	0.02	B	
	$	10,889	Insulation	0.01	B	
	$	10,889	Painting	0.01	B	
	$	130,668	Fire suppression	0.12	B	**H**
	$	275,000	Building and Site Preparation		Building	**I**
Direct Installation Total	**$**	**808,561**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$**	**1,897,462**				
Indirect Costs (installation)						
	$	108,890	Engineering	0.1	B	
	$	54,445	Construction and field expenses	0.05	B	
	$	108,890	Contractor fees	0.1	B	
	$	21,778	Startup costs	0.02	B	
	$	108,890	Performance test costs	0.1	B	
	$	21,778	Contingencies	0.02	B	**J**
	$	383,560	Plant Shutdown for Retrofit	Shutdown for retrofit		**K**
Total Indirect Costs, IC	**$**	**808,231**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$**	**2,705,693**				

Comments:

A	Design Air Flow (dscfm)	41,423
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M1 = 21 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost	Extended	Comments
Direct Annual Costs, DC						
	Operating Labor					
		Operator	0.5 hr/shift	$24.70	$ 13,276	A, E
		Supervisor	15% of operator		$ 1,991	
	Maintenance					
		Labor	0.5 hr/shift	$30.03	$ 16,141	A, E
		Materials	100% of Maintenance labor		$ 16,141	
	Replacement Parts, Catalysts (2-year life)					
		Material & freight (5%) of noble metal catalyst		$ 5,551	$ 285,698	H, J, K, L
	Utilities					
		Natural Gas		$ 10.34 /MCF	$ 2,711,897	B, C, D, E
		Electricity (75 Hp)		$ 0.0770 / kWhr	$ 32,093	B, E, F, M
Total DC					$ 3,077,238	
Indirect Annual Costs, IC						
	Overhead	60% of sum of Operating, supv., and maintenance labor and materials			$ 28,530	
	Administrative Charges	2% of Total Capital Investment			$ 54,114	
	Property Taxes	1% of Total Capital Investment			$ 27,057	
	Insurance	1% of Total Capital Investment			$ 27,057	
	Capital Recovery				$ 478,854	G
Total Indirect Costs					$ 615,611	
Total Annual Costs					$ 3,692,850	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					$ 29,639	E, I

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	41,423
C	Overall Temperature Rise Needed for 70% Heat Recovery (800 - 77) (°F/°R)	723
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	12.884

E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX , No Heat Recovery (in. of water column)	6
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	83
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2016 cost of noble metal catalyst, 1.85022 inflation factor from 1988 to 2015	$5,551
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Occupation code	Occupation title (click on the occupation title to view an occupational profile)	Level	Employment	Employment RSE	Percent of total employment	Median hourly wage	Mean hourly wage	Annual mean wage	Mean wage RSE	NAICS 331300 - Alumina and Aluminum Production and Processing
51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	detail	1,870	16.20%	3.39%	$24.60	$24.70	#### ####	2.50%	Bureau of Labor Statistics
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	broad	2,900	4.20%	5.26%	$29.20	$30.03	#### ####	0.70%	Bureau of Labor Statistics

Total Capital Investment				Comments
Direct Costs				
Purchased Equipment Costs (PEC)				
	$ 821,252	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1 EC = IA x ((3623 $Q_{total}^{0.4189}$) + Hoods and Ductwork), HR = 35%	A, B, C, D, L
	$ 82,125	Instrumentation	0.1 EC	E
	$ 24,638	Taxes, Duties, VAT	0.03 EC	F
	$ 41,063	Freight	0.05 EC	
Purchased Equip. Total	**$ 969,077**		**1.18 EC = B**	
Direct Installation Costs				
	$ 77,526	Foundations and supports	0.08 B	
	$ 203,506	Erecting and handling the equipment	0.21 B	G
	$ 38,763	Electrical work	0.04 B	
	$ 19,382	Piping	0.02 B	
	$ 9,691	Insulation	0.01 B	
	$ 9,691	Painting	0.01 B	
	$ 116,289	Fire suppression	0.12 B	H
	$ 275,000	Building and Site Preparation	Building	I
Direct Installation Total	**$ 749,848**		**1.49 B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,718,925**			
Indirect Costs (installation)				
	$ 96,908	Engineering	0.1 B	
	$ 48,454	Construction and field expenses	0.05 B	
	$ 96,908	Contractor fees	0.1 B	
	$ 19,382	Startup costs	0.02 B	
	$ 96,908	Performance test costs	0.1 B	
	$ 19,382	Contingencies	0.02 B	J
	$ 383,560	Plant Shutdown for Retrofit	Shutdown for retrofit	K
Total Indirect Costs, IC	**$ 761,500**		**0.39 B + Shutdown**	
Total Capital Investment	**$ 2,480,425**			

Comments:

A	Design Air Flow (dscfm)	41,423
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M1 = 21 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost	Extended	Comments
Direct Annual Costs, DC						
	Operating Labor					
		Operator	0.5 hr/shift	$24.70	$ 13,276	A, E
		Supervisor	15% of operator		$ 1,991	
	Maintenance					
		Labor	0.5 hr/shift	$30.03	$ 16,141	A, E
		Materials	100% of Maintenance labor		$ 16,141	
	Replacement Parts, Catalysts (2-year life)					
		Material & freight (5%) of noble metal catalyst		$ 5,551	$ 285,698	H, J, K, L
	Utilities					
		Natural Gas		$ 10.34 /MCF	$ 1,753,156	B, C, D, E
		Electricity (125 Hp)		$ 0.0770 / kWhr	$ 53,489	B, E, F, M
Total DC					$ 2,139,893	
Indirect Annual Costs, IC						
	Overhead	60% of sum of Operating, supv., and maintenance labor and materials			$ 28,530	
	Administrative Charges	2% of Total Capital Investment			$ 49,609	
	Property Taxes	1% of Total Capital Investment			$ 24,804	
	Insurance	1% of Total Capital Investment			$ 24,804	
	Capital Recovery				$ 438,986	G
Total Indirect Costs					$ 566,733	
Total Annual Costs					$ 2,706,626	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					$ 21,724	E, I

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	41,423
C	Overall Temperature Rise Needed for 35% Heat Recovery (800 - 77) x 35% (°F/°R)	469.95
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	8.329

Annual Operating Costs

E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX plus 4", 35% Recovery (in. of water column)	10
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	83
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2016 cost of noble metal catalyst, 1.85022 inflation factor from 1988 to 2015	$5,551
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Occupation code	Occupation title (click on the occupation title to view an occupational profile)	Level	Employment	Employment RSE	Percent of total employment	Median hourly wage	Mean hourly wage	Annual mean wage	Mean wage RSE	NAICS 331300 - Alumina and Aluminum Production and Processing
51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	detail	1,670	16.20%	3.39%	$24.60	$24.70	##########	2.50%	Bureau of Labor Statistics
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	broad	2,900	4.20%	5.26%	$29.20	$30.03	##########	0.70%	Bureau of Labor Statistics

Total Capital Investment						**Comments**
Direct Costs						
			Purchased Equipment Costs (PEC)			
	$	1,066,686	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1	EC = IA x ((1215 $Q_{total}^{0.5575}$) + Hoods and Ductwork), HR = 50%	**A, B, C, D, L**
	$	106,669	Instrumentation	0.1	EC	**E**
	$	32,001	Taxes, Duties, VAT	0.03	EC	**F**
	$	53,334	Freight	0.05	EC	
Purchased Equip. Total	$	**1,258,689**		**1.18**	**EC = B**	
			Direct Installation Costs			
	$	100,695	Foundations and supports	0.08	B	
	$	264,325	Erecting and handling the equipment	0.21	B	**G**
	$	50,348	Electrical work	0.04	B	
	$	25,174	Piping	0.02	B	
	$	12,587	Insulation	0.01	B	
	$	12,587	Painting	0.01	B	
	$	151,043	Fire suppression	0.12	B	**H**
	$	275,000	Building and Site Preparation		Building	**I**
Direct Installation Total	$	**891,758**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	$	**2,150,447**				
Indirect Costs (installation)						
	$	125,869	Engineering	0.1	B	
	$	62,934	Construction and field expenses	0.05	B	
	$	125,869	Contractor fees	0.1	B	
	$	25,174	Startup costs	0.02	B	
	$	125,869	Performance test costs	0.1	B	
	$	25,174	Contingencies	0.02	B	**J**
	$	383,560	Plant Shutdown for Retrofit	Shutdown for retrofit		**K**
Total Indirect Costs, IC	$	**874,449**		**0.39**	**B + Shutdown**	
Total Capital Investment	$	**3,024,896**				

Comments:

A	Design Air Flow (dscfm)	41,423
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M1 = 21 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost	Extended	Comments
Direct Annual Costs, DC						
	Operating Labor					
		Operator	0.5 hr/shift	$24.70	$ 13,276	A, E
		Supervisor	15% of operator		$ 1,991	
	Maintenance					
		Labor	0.5 hr/shift	$30.03	$ 16,141	A, E
		Materials	100% of Maintenance labor		$ 16,141	
	Replacement Parts, Catalysts (2-year life)					
		Material & freight (5%) of noble metal catalyst		$ 5,551	$ 285,698	H, J, K, L
	Utilities					
		Natural Gas		$ 10.34 /MCF	$ 1,342,267	B, C, D, E
		Electricity (150 Hp)		$ 0.0770 / kWhr	$ 74,885	B, E, F, M
Total DC					$ 1,750,400	
Indirect Annual Costs, IC						
	Overhead					
		60% of sum of Operating, supv., and maintenance labor and materials			$ 28,530	
	Administrative Charges	2% of Total Capital Investment			$ 60,498	
	Property Taxes	1% of Total Capital Investment			$ 30,249	
	Insurance	1% of Total Capital Investment			$ 30,249	
	Capital Recovery				$ 535,346	G
Total Indirect Costs					$ 684,872	
Total Annual Costs					$ 2,435,271	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					$ 19,546	E, I

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	41,423
C	Overall Temperature Rise Needed for 70% Heat Recovery (800 - 77) x 50% (°F/°R)	361.5
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	6.377

E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX plus 8", 50% Recovery (in. of water column)	14
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	83
K	1988 Cost of noble metal catalyst per ft^3 not repeated in 2002 edition of APCCM	$3,000
L	2016 cost of noble metal catalyst, 1.85022 inflation factor from 1988 to 2015	$5,551
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Occupation code	Occupation title (click on the occupation title to view an occupational profile)	Level	Employment	Employment RSE	Percent of total employment	Median hourly wage	Mean hourly wage	Annual mean wage	Mean wage RSE	NAICS 331300 - Alumina and Aluminum Production and Processing
51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	detail	1,870	16.20%	3.39%	$24.60	$24.70	########	2.50%	Bureau of Labor Statistics
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	broad	2,900	4.20%	5.26%	$29.20	$30.03	########	0.70%	Bureau of Labor Statistics

Total Capital Investment						**Comments**
Direct Costs						
	Purchased Equipment Costs (PEC)					
	$	1,166,287	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1	$EC = IA \times ((1443\ Q_{total}^{0.5527})$+ Hoods and Ductwork), HR = 70%	**A, B, C, D, L**
	$	116,629	Instrumentation	0.1	EC	**E**
	$	34,989	Taxes, Duties, VAT	0.03	EC	**F**
	$	58,314	Freight	0.05	EC	
Purchased Equip. Total	$	**1,376,219**		**1.18**	**EC = B**	
	Direct Installation Costs					
	$	110,098	Foundations and supports	0.08	B	
	$	289,006	Erecting and handling the equipment	0.21	B	**G**
	$	55,049	Electrical work	0.04	B	
	$	27,524	Piping	0.02	B	
	$	13,762	Insulation	0.01	B	
	$	13,762	Painting	0.01	B	
	$	165,146	Fire suppression	0.12	B	**H**
	$	275,000	Building and Site Preparation		Building	**I**
Direct Installation Total	$	**949,347**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$**	**2,325,567**				
Indirect Costs (installation)						
	$	137,622	Engineering	0.1	B	
	$	68,811	Construction and field expenses	0.05	B	
	$	137,622	Contractor fees	0.1	B	
	$	27,524	Startup costs	0.02	B	
	$	137,622	Performance test costs	0.1	B	
	$	27,524	Contingencies	0.02	B	**J**
	$	383,560	Plant Shutdown for Retrofit	Shutdown for retrofit		**K**
Total Indirect Costs, IC	**$**	**920,285**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$**	**3,245,852**				

Comments:

A	Design Air Flow (dscfm)	41,423
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M1 = 21 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Replacement Parts, Catalysts (2-year life)						
		Material & freight (5%) of noble metal catalyst		$ 5,551		$ 285,698	H, J, K, L
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 794,415	B, C, D, E
		Electricity (225 Hp)		$ 0.0770	/ kWhr	$ 112,327	B, E, F, M
Total DC						**$ 1,239,990**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 64,917	
	Property Taxes	1% of Total Capital Investment				$ 32,459	
	Insurance	1% of Total Capital Investment				$ 32,459	
	Capital Recovery					$ 574,451	G
Total Indirect Costs						**$ 732,815**	
Total Annual Costs						**$ 1,972,805**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 15,834**	E, I

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	41,423
C	Overall Temperature Rise Needed for 70% Heat Recovery (800 - 77) x 70% (°F/°R)	216.9
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	3.774
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX plus 15", 70% Recovery (in. of water column)	21
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	83
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2016 cost of noble metal catalyst, 1.85022 Inflation factor from 1988 to 2015	$5,551
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Auxilliary Equipment Costs

Includes Entry Hood - Rectangular canopy 11.3' x 9.7' = 109.6 ft^2 *	$	31,359.18
Includes Exit Hood - Rectangular canopy 8.3' x 9.7' = 80.6 ft^2 *	$	26,826.28
Includes six air curtains each a steel backdraft slotted, each an average of 9.8' x .17' = 1.67ft^2 [1]	$	58,930.17
1999 Entry Hood, Exit Hood, and Air Curtains	**$**	**117,115.63**

Duct diameter (Eq. 1.27) $D_d = 1.128(Q/u)^{1/2}$

Q =		44,737	acfm
u =		3,000	fpm
D_d =		4.4	ft.
D_d =		52.3	in.
1999 Cost of Duct per foot (Eq. 1.40) Power cost model - circular, longitudinal, plate steel, one coat paint			
$C_{foot\ of\ pipe} = aD^b$			
a =	2.49		
b =	1.15		
$C_{foot\ of\ pipe}$ =	$	235.61	
Duct length from drawing		217.5	ft.
1999 Cost of Duct Pipe	**$**	**51,246.04**	

Exponential cost model, single walled, non-insulated elbow, a =	30.4	
b=	0.0594	
(Eq. 1.41) and Tbl 1.10 $C_{elbow} = ae^{bD}$	$	678.14
Number of Elbows		5
1999 Cost of Elbows	**$**	**3,390.69**

Stack diameter (Eq. 1.27) $D_d = 1.128(Q_c/u_c)^{1/2}$			
RTO temp. rise $_{max}$ 200 °R = (737/537), Q_c =		61,399	acfm
3,000 fpm (1.5 x wind speed, 34 mph), u_c =		3,000	fpm
Stack diamter, D_d =		5.1	ft.
D_d =		61.2	in.
$C_{foot\ of\ stack} = aD^b$			
a =	2.49		
b =	1.15		
$C_{foot\ of\ stack}$ =	$	282.66	
Stack height, from page 1-36, Section 2 Chapter 1		213	ft.
1999 Cost of Stack	**$**	**60,205.93**	
1999 Edition 6 of Control Cost Manual (most recent) does not include fan cost model - RTO only.	$	34,800.00	
125 Hp. Classs 3, backward inclined, 1,800 rpm TEFC, rated for 300 °F. Cost estimate is a lookup from the most recent (1978) EPA estimate, adjusted to 1999 by the CPI (2.56). **1999 Cost of Fan**	**$**	**89,088.00**	
	Totals		
Custom retrofitted	**$**	**117,116**	**Entry and Exit Hoods**
Custom retrofitted	**$**	**54,637**	**Duct and Elbows**
Only used with RTO, assumed to be part of other technology packages	**$**	**89,088**	**Backward inclined Fan**
Only used with RTO, assumed to be part of other technology packages	**$**	**60,206**	**Stack**

[1]Based on Eq (1.40) pg. 1-41 Sec. 2, Chptr. 1 EPA PCCM-6, upgraded by Table 1.12 multiplier for CRS from plastic (3.74/.393) per Table 1.8 steel for strength and to accommodate fire risk

Total Capital Investment						
	Direct Costs					
		Purchased Equipment Costs (PEC)				
		$	2,709,556	Primary Control Device (includes auxiliary equipment - desorbing thermal oxidizer, interconnections, entry and exit hoods, and ductwork)	1 EC = See derivation on Page 2 - Background and Calculations	
		$	270,956	Instrumentation	0.1 EC	Fire damper(s), integration/interlocks with existing controls
		$	81,287	Taxes, Duties, VAT	0.03 EC	
		$	135,478	Freight	0.05 EC	
Purchased Equip. Total		**$**	**3,197,277**		**1.18 EC = B**	
		Direct Installation Costs				
		$	383,673	Foundations and supports	0.12 B	Retrofit penalty (50% above model) Landlocked - must move or avoid electric service, water service, sewer service, CO2 Service, Nitrogen service, Waste removal service
		$	559,523	Equipment erection and handling	0.18 B	Retrofit penalty (25% above model). See previous comment
		$	127,891	Electrical work	0.04 B	
		$	31,973	Piping	0.01 B	Desorption to be accomplished using thermal destruction (50% reduction)
		$	63,946	Insulation	0.02 B	Increased by 100% because of length, height, weather exposure, desire to minimize condensation, and hi-temperatures needed for desorption
		$	31,973	Painting	0.01 B	
		$	447,619	Fire suppression	0.14 B	Increased by 75% above standard to accommodate long duct at ceiling height and adsorption bed protection
		$	275,000	Building and Site Preparation	Building	5,000 ft^2 assumed at \$55/ft^2. Required because rolling oil freezes at 45 °F.
Direct Installation Total		**$**	**1,921,597**		**1.52 B + Building and Site Preparation**	
Total Direct Costs, DC		**$**	**5,118,874**			
	Indirect Costs (installation)					
		$	319,728	Engineering	0.1 B	
		$	159,864	Construction and field expenses	0.05 B	
		$	319,728	Contractor fees	0.1 B	
		$	63,946	Startup costs	0.02 B	
		$	105,510	Performance test costs	0.033 B	
		$	63,946	Contingencies	0.02 B	Redesign/modification of equipment, startup delays
		$	191,780	Plant Shutdown for Retrofit	10.5 shifts for Shutdown for retrofit	
Total Indirect Costs, IC		**$**	**1,224,500**		**0.32 B + Shutdown**	
Total Capital Investment		**$**	**6,343,374**			

Background and Calculations

		Design
Air Flow (dscfm)		38,400
Air Flow (acfm) = dscfm +8%, maximum variability in stack tests		**41,472**
Btus in Exhaust (Btus/dscf)		0.130
(IA) Inflation Adjustment for EC		1.700
Ductwork	$	**69,000**
Cost of Entry Hood, Exit Hood and Air Knives from separate worksheet	$	**117,116**

Each operational bed consists of round vessels 12' in diameter, to maximize road transportation
Each vessel is .06 feet long with 3 feet of transition/access on each end (L)
To achieve 60 fpm face velocity, seven vessels are required accommodate 41,472 acfm,
The surface area of each vessel is $S = \pi D((L + 2Transitions) + D/2)$
$S = \pi 12(6.06+6)$, $S = 454.65\ ft^2$.
The cost of each vessel is given by the relationship $C_{vessel} = 271S^{0.778}$
The 1999 cost, C_{vessel} of a single vessel is $31,670
Each operational bed consists of seven vessels. To accommodate 24/7 operation, two sets of beds are required for a total of fourteen vessels.
1999 cost of the combined vessels, C_{Vessel}, is $443,374
Amount of Zeolite needed per hour - 30.5#/hr VOC / .225 (adsorbency factor)
Amount of Zeolite needed per 12-hour operational shift - 30.5#/hr VOC / .225 (adsorbency factor) x 12 = 1,626.67 pounds
Amount of Zeolite needed per day (shift x 2) = 3,253.33 pounds
1999 cost of system Zeolite charge, $C_{Adsorbent}$ (Zeolite lbs x $40/lb) = $65,067
To desorb the high MW VOCs, while avoiding thermal degradation of the zeolite, a 1,000 dscfm thermal oxidizer with 70% heat recovery
would maintain 1,000 °F desorb/preheat temperature, destruction temperature of 1,500 °F and 18% of the LEL (assuming uniform bed desorption).
1999 thermal recuperative desorber equipment costs, $C_{Thermal} = 21{,}342 \times Q_{total}^{0.2500}$, where Q = 1,000 scfm., EC = $120,015.
Total Purchase Cost of Equipment (1999), based on EPA's survey of equipment suppliers must be factored to include piping, controls, compressors, pumps, fans, etc.
It is assumed that auxiliary equipment, other direct costs, and the indirect costs for the thermal desorption system are similar percentages for the adsorption system.
Per page 1-20 Section 3.1 Chapter 1 of EPA PCCM, total purchased cost of the four sampled adsorber/desorber systems varied from **1.14 to 2.24** times the carbon and vessel cost.
The low concentration of the high MW VOCs puts the vessel size ***beyond the parameters of the standard equipment models***. Similarly, ***desorbing with 1,000 °F air is beyond the norm*** and switching hardware must be included to desorb multiple beds or provide a moving bed.
The ***high end of the cost range for auxiliary is used to acknowledge that we are extrapolating costs beyond four known systems*** to include the above variations
Therefore, the factor to accommodate piping, controls, compressors, pumps, etc, ***R = 2.24***
The estimated costs in 1999 for the adsorber/desorber control system is $C_{equip} = R(C_{Vessel} + C_{Adsorbent} + C_{Thermal})$ + Entry/Exit hoods

1999 C_{equip} =	$	1,593,857
1999 C_{equip} x IA = **2022 C_{equip}** =	$	**2,709,556**

Total Capital Investment					Comments
Direct Costs					
	Purchased Equipment Costs (PEC)				
	$	526,601	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1 EC = IA x (10,294 $Q_{total}^{0.2355}$ + Hoods and Ductwork), HR = None	A, B, C, D, L
	$	52,660	Instrumentation	0.1 EC	E
	$	15,798	Taxes, Duties, VAT	0.03 EC	F
	$	26,330	Freight	0.05 EC	
Purchased Equip. Total	$	**621,389**		**1.18 EC = B**	
	Direct Installation Costs				
	$	49,711	Foundations and supports	0.08 B	
	$	130,492	Erecting and handling the equipment	0.21 B	G
	$	24,856	Electrical work	0.04 B	
	$	12,428	Piping	0.02 B	
	$	6,214	Insulation	0.01 B	
	$	6,214	Painting	0.01 B	
	$	74,567	Fire suppression	0.12 B	H
	$	275,000	Building and Site Preparation	Building	I
Direct Installation Total	$	**579,481**		**1.49 B + Building and Site Preparation**	
Total Direct Costs, DC	$	**1,200,870**			
Indirect Costs (installation)					
	$	62,139	Engineering	0.1 B	
	$	31,069	Construction and field expenses	0.05 B	
	$	62,139	Contractor fees	0.1 B	
	$	12,428	Startup costs	0.02 B	
	$	62,139	Performance test costs	0.1 B	
	$	12,428	Contingencies	0.02 B	J
	$	191,780	Plant Shutdown for Retrofit	Shutdown for retrofit	K
Total Indirect Costs, IC	$	**434,122**		**0.39 B + Shutdown**	
Total Capital Investment	$	**1,634,992**			

Comments:

A	Design Air Flow (dscfm)	38,400
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M2 = 10.5 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

Cost Item			Suggested Factor	Unit Cost	Extended	Comments
Direct Annual Costs, DC						
	Operating Labor					
		Operator	0.5 hr/shift	$24.70	$ 13,276	A, E
		Supervisor	15% of operator		$ 1,991	
	Maintenance					
		Labor	0.5 hr/shift	$30.03	$ 16,141	A, E
		Materials	100% of Maintenance labor		$ 16,141	
	Replacement Parts, Catalysts (2-year life)					
		Material & freight (5%) of noble metal catalyst		$ 5,551	$ 264,848	H, J, K, L
	Utilities					
		Natural Gas		$ 10.34 /MCF	$ 2,513,986	B, C, D, E
		Electricity (75 Hp)		$ 0.0770 / kWhr	$ 29,751	B, E, F, M
Total DC					$ 2,856,135	
Indirect Annual Costs, IC						
	Overhead					
		60% of sum of Operating, supv., and maintenance labor and materials			$ 28,530	
	Administrative Charges	2% of Total Capital Investment			$ 44,693	
	Property Taxes	1% of Total Capital Investment			$ 22,346	
	Insurance	1% of Total Capital Investment			$ 22,346	
	Capital Recovery				$ 395,487	G
Total Indirect Costs					$ 513,403	
Total Annual Costs					$ 3,369,538	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					$ 27,044	E, I

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	38,400
C	Overall Temperature Rise Needed for 70% Heat Recovery (800 - 77) (°F/°R)	723
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	12.884

E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX, No Heat Recovery (in. of water column)	6
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	77
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2016 cost of noble metal catalyst, 1.85022 Inflation factor from 1988 to 2015	$5,551
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Occupation code	Occupation title (click on the occupation title to view an occupational profile)	Level	Employment	Employment RSE	Percent of total employment	Median hourly wage	Mean hourly wage	Annual mean wage	Mean wage RSE	NAICS 331300 - Alumina and Aluminum Production and Processing
51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	detail	1,870	16.20%	3.39%	$24.60	$24.70	########	2.50%	Bureau of Labor Statistics
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	broad	2,900	4.20%	5.26%	$29.20	$30.03	########	0.70%	Bureau of Labor Statistics

Total Capital Investment					Comments
Direct Costs					
Purchased Equipment Costs (PEC)					
	$	667,466	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1 EC = IA x (13,149 $Q_{total}^{0.2609}$ + Hoods and Ductwork), HR = 35%	A, B, C, D, L
	$	66,747	Instrumentation	0.1 EC	E
	$	20,024	Taxes, Duties, VAT	0.03 EC	F
	$	33,373	Freight	0.05 EC	
Purchased Equip. Total	$	**787,610**		**1.18 EC = B**	
Direct Installation Costs					
	$	63,009	Foundations and supports	0.08 B	
	$	165,398	Erecting and handling the equipment	0.21 B	G
	$	31,504	Electrical work	0.04 B	
	$	15,752	Piping	0.02 B	
	$	7,876	Insulation	0.01 B	
	$	7,876	Painting	0.01 B	
	$	94,513	Fire suppression	0.12 B	H
	$	275,000	Building and Site Preparation	Building	I
Direct Installation Total	$	**660,929**		**1.49 B + Building and Site Preparation**	
Total Direct Costs, DC	$	**1,448,539**			
Indirect Costs (installation)					
	$	78,761	Engineering	0.1 B	
	$	39,380	Construction and field expenses	0.05 B	
	$	78,761	Contractor fees	0.1 B	
	$	15,752	Startup costs	0.02 B	
	$	78,761	Performance test costs	0.1 B	
	$	15,752	Contingencies	0.02 B	J
	$	191,780	Plant Shutdown for Retrofit	Shutdown for retrofit	K
Total Indirect Costs, IC	$	**498,948**		**0.39 B + Shutdown**	
Total Capital Investment	$	**1,947,487**			

Comments:

A	Design Air Flow (dscfm)	38,400
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M2 = 10.5 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	**A, E**
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	**A, E**
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 2,994,988	**B, C, D, E**
		Electricity (225 Hp)		$ 0.0770	/ kWhr	$ 97,505	**B, E, F, I**
Total DC						**$ 3,140,043**	
Indirect Annual Costs, IC							
	Overhead	60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 38,950	
	Property Taxes	1% of Total Capital Investment				$ 19,475	
	Insurance	1% of Total Capital Investment				$ 19,475	
	Capital Recovery					$ 344,666	**G**
Total Indirect Costs						**$ 451,096**	
Total Annual Costs						**$ 3,591,139**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 27,941**	**E, H**

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	38,400
C	Overall Temperature Rise Needed for 35% Heat Recovery (1,400 - 77) x 35% (°F/°R)	859.95
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	15.3491
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 8", 35% Recovery (in. of water column)	8
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Total Capital Investment					Comments
Direct Costs					
Purchased Equipment Costs (PEC)					
	$	723,144	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1 EC = IA x (17,056 $Q_{total}^{0.2502}$ + Hoods and Ductwork), HR = 50%	A, B, C, D, L
	$	72,314	Instrumentation	0.1 EC	E
	$	21,694	Taxes, Duties, VAT	0.03 EC	F
	$	36,157	Freight	0.05 EC	
Purchased Equip. Total	$	**853,310**		**1.18 EC = B**	
Direct Installation Costs					
	$	68,265	Foundations and supports	0.08 B	
	$	179,195	Erecting and handling the equipment	0.21 B	G
	$	34,132	Electrical work	0.04 B	
	$	17,066	Piping	0.02 B	
	$	8,533	Insulation	0.01 B	
	$	8,533	Painting	0.01 B	
	$	102,397	Fire suppression	0.12 B	H
	$	275,000	Building and Site Preparation	Building	I
Direct Installation Total	$	**693,122**		**1.49 B + Building and Site Preparation**	
Total Direct Costs, DC	$	**1,546,432**			
Indirect Costs (installation)					
	$	85,331	Engineering	0.1 B	
	$	42,666	Construction and field expenses	0.05 B	
	$	85,331	Contractor fees	0.1 B	
	$	17,066	Startup costs	0.02 B	
	$	85,331	Performance test costs	0.1 B	
	$	17,066	Contingencies	0.02 B	J
	$	191,780	Plant Shutdown for Retrofit	Shutdown for retrofit	K
Total Indirect Costs, IC	$	**524,571**		**0.39 B + Shutdown**	
Total Capital Investment	$	**2,071,003**			

Comments:

A	Design Air Flow (dscfm)	38,400
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at \$55/ft^2)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M2 = 10.5 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 2,297,983	B, C, D, E
		Electricity (275 Hp)		$ 0.0770	/ kWhr	$ 124,269	B, E, F, I
Total DC						**$ 2,469,802**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 41,420	
	Property Taxes	1% of Total Capital Investment				$ 20,710	
	Insurance	1% of Total Capital Investment				$ 20,710	
	Capital Recovery					$ 366,526	G
Total Indirect Costs						**$ 477,896**	
Total Annual Costs						**$ 2,947,698**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 22,934**	E, H

Comments

Annual Operating Costs

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	38,400
C	Overall Temperature Rise Needed for 50% Heat Recovery (1,400 - 77) x 50% (°F/°R)	661.5
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	11.777
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 8", 50% Recovery (in. of water column)	12
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Total Capital Investment					Comments
Direct Costs					
		Purchased Equipment Costs (PEC)			
	$ 824,283	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1	EC = IA x (21,342 $Q_{total}^{0.2500}$ + Hoods and Ductwork), HR = 70%	A, B, C, D, L
	$ 82,428	Instrumentation	0.1	EC	E
	$ 24,728	Taxes, Duties, VAT	0.03	EC	F
	$ 41,214	Freight	0.05	EC	
Purchased Equip. Total	**$ 972,654**		**1.18**	**EC = B**	
		Direct Installation Costs			
	$ 77,812	Foundations and supports	0.08	B	
	$ 204,257	Erecting and handling the equipment	0.21	B	G
	$ 38,906	Electrical work	0.04	B	
	$ 19,453	Piping	0.02	B	
	$ 9,727	Insulation	0.01	B	
	$ 9,727	Painting	0.01	B	
	$ 116,718	Fire suppression	0.12	B	H
	$ 275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$ 751,600**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,724,254**				
Indirect Costs (installation)					
	$ 97,265	Engineering	0.1	B	
	$ 48,633	Construction and field expenses	0.05	B	
	$ 97,265	Contractor fees	0.1	B	
	$ 19,453	Startup costs	0.02	B	
	$ 97,265	Performance test costs	0.1	B	
	$ 19,453	Contingencies	0.02	B	J
	$ 191,780	Plant Shutdown for Retrofit	Shutdown for retrofit		K
Total Indirect Costs, IC	**$ 571,115**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$ 2,295,369**				

Comments:

A	Design Air Flow (dscfm)	38,400
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at \$55/ft^2)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M2 = 10.5 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 1,368,643	B, C, D, E
		Electricity (325 Hp)		$ 0.0770	/ kWhr	$ 150,337	B, E, F, I
Total DC						**$ 1,566,530**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 45,907	
	Property Taxes	1% of Total Capital Investment				$ 22,954	
	Insurance	1% of Total Capital Investment				$ 22,954	
	Capital Recovery					$ 406,234	G
Total Indirect Costs						**$ 526,579**	
Total Annual Costs						**$ 2,093,109**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 16,285**	E, H

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	38,400
C	Overall Temperature Rise Needed for 70% Heat Recovery (1,400 - 77) x 70% (°F/°R)	396.9
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	7.0142
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 15", 70% Recovery (in. of water column)	19
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.077

Total Capital Investment					Comments
Direct Costs					
		Purchased Equipment Costs (PEC)			
	$ 1,695,801	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, ductwork, fan, and stack	1	EC = IA x ((2.204 x 10^5 + 11.57 Q_{total}) + Hoods, Ductwork, Fan, and Stack)	A, B, C, D, L
	$ 169,580	Instrumentation	0.1	EC	E
	$ 50,874	Taxes, Duties, VAT	0.03	EC	F
	$ 84,790	Freight	0.05	EC	
Purchased Equip. Total	**$ 2,001,046**		**1.18**	**EC = B**	
		Direct Installation Costs			
	$ 160,084	Foundations and supports	0.08	B	
	$ 420,220	Erecting and handling the equipment	0.21	B	G
	$ 80,042	Electrical work	0.04	B	
	$ 40,021	Piping	0.02	B	
	$ 20,010	Insulation	0.01	B	
	$ 20,010	Painting	0.01	B	
	$ 240,125	Fire suppression	0.12	B	H
	$ 275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$ 1,255,512**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 3,256,558**				
Indirect Costs (installation)					
	$ 200,105	Engineering	0.1	B	
	$ 100,052	Construction and field expenses	0.05	B	
	$ 200,105	Contractor fees	0.1	B	
	$ 40,021	Startup costs	0.02	B	
	$ 200,105	Performance test costs	0.1	B	
	$ 40,021	Contingencies	0.02	B	J
	$ 191,780	Plant Shutdown for Retrofit		Shutdown for retrofit	K
Total Indirect Costs, IC	**$ 972,188**		**0.39**	**B + Shutdown**	
Total Capital Investment	$ 4,228,746				

Comments:

A	Design Air Flow (dscfm)	38,400
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M2 = 10.5 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 677,083	B, C, D, E
		Electricity (125 Hp)		$ 0.0770	/ kWhr	$ 73,132	B, E, F, I
Total DC						$ 797,764	
Indirect Annual Costs, IC							
	Overhead	60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 84,575	
	Property Taxes	1% of Total Capital Investment				$ 42,287	
	Insurance	1% of Total Capital Investment				$ 42,287	
	Capital Recovery					$ 748,403	G
Total Indirect Costs						$ 946,083	
Total Annual Costs						$ 1,743,847	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						$ 13,568	E, H

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	38,400

C	Overall Temperature Rise Assumed per Existing Pollution Control Device (°F above ambient)	200
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	3.47
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 8" (in. of water column)	12
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Total Capital Investment					Comments
Direct Costs					
	Purchased Equipment Costs (PEC)				
	$ 796,909	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1	EC = IA x (1105 $Q_{total}^{0.5471}$ + Hoods and Ductwork), No HR	A, B, C, D, L
	$ 79,691	Instrumentation	0.1	EC	E
	$ 23,907	Taxes, Duties, VAT	0.03	EC	F
	$ 39,845	Freight	0.05	EC	
Purchased Equip. Total	**$ 940,353**		**1.18**	**EC = B**	
	Direct Installation Costs				
	$ 75,228	Foundations and supports	0.08	B	
	$ 197,474	Erecting and handling the equipment	0.21	B	G
	$ 37,614	Electrical work	0.04	B	
	$ 18,807	Piping	0.02	B	
	$ 9,404	Insulation	0.01	B	
	$ 9,404	Painting	0.01	B	
	$ 112,842	Fire suppression	0.12	B	H
	$ 275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$ 735,773**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,676,126**				
Indirect Costs (installation)					
	$ 94,035	Engineering	0.1	B	
	$ 47,018	Construction and field expenses	0.05	B	
	$ 94,035	Contractor fees	0.1	B	
	$ 18,807	Startup costs	0.02	B	
	$ 94,035	Performance test costs	0.1	B	
	$ 18,807	Contingencies	0.02	B	J
	$ 191,780	Plant Shutdown for Retrofit		Shutdown for retrofit	K
Total Indirect Costs, IC	**$ 558,518**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$ 2,234,644**				

Comments:

A	Design Air Flow (dscfm)	38,400
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.470
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at \$55/ft^2)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M2 = 10.5 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost	Extended	Comments
Direct Annual Costs, DC						
	Operating Labor					
		Operator	0.5 hr/shift	$24.70	$ 13,276	A, E
		Supervisor	15% of operator		$ 1,991	
	Maintenance					
		Labor	0.5 hr/shift	$30.03	$ 16,141	A, E
		Materials	100% of Maintenance labor		$ 16,141	
	Replacement Parts, Catalysts (2-year life)					
		Material & freight (5%) of noble metal catalyst		$ 5,551	$ 264,848	H, J, K, L
	Utilities					
		Natural Gas		$ 10.34 /MCF	$ 2,513,986	B, C, D, E
		Electricity (75 Hp)		$ 0.0770 / kWhr	$ 29,751	B, E, F, M
Total DC					$ 2,856,135	
Indirect Annual Costs, IC						
	Overhead					
		60% of sum of Operating, supv., and maintenance labor and materials			$ 28,530	
	Administrative Charges	2% of Total Capital Investment			$ 44,693	
	Property Taxes	1% of Total Capital Investment			$ 22,346	
	Insurance	1% of Total Capital Investment			$ 22,346	
	Capital Recovery				$ 395,487	G
Total Indirect Costs					$ 513,403	
Total Annual Costs					$ 3,369,538	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					$ 27,044	E, I

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	38,400
C	Overall Temperature Rise Needed for 70% Heat Recovery (800 - 77) (°F/°R)	723
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	12.884

Annual Operating Costs

E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX , No Heat Recovery (in. of water column)	6
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	77
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2016 cost of noble metal catalyst, 1.85022 Inflation factor from 1988 to 2015	$5,551
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Occupation code	Occupation title (click on the occupation title to view an occupational profile)	Level	Employment	Employment RSE	Percent of total employment	Median hourly wage	Mean hourly wage	Annual mean wage	Mean wage RSE	NAICS 331300 - Alumina and Aluminum Production and Processing
51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	detail	1,870	16.20%	3.39%	$24.60	$24.70	########	2.50%	Bureau of Labor Statistics
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	broad	2,900	4.20%	5.26%	$29.20	$30.03	########	0.70%	Bureau of Labor Statistics

Annual Operating Costs

Total Capital Investment					**Comments**
Direct Costs					
	Purchased Equipment Costs (PEC)				
	$ 829,132	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1	EC = IA x (3623 $Q_{total}^{0.4189}$ + Hoods and Ductwork), HR = 35%	A, B, C, D, L
	$ 82,913	Instrumentation	0.1	EC	E
	$ 24,874	Taxes, Duties, VAT	0.03	EC	F
	$ 41,457	Freight	0.05	EC	
Purchased Equip. Total	**$ 978,376**		**1.18**	**EC = B**	
	Direct Installation Costs				
	$ 78,270	Foundations and supports	0.08	B	
	$ 205,459	Erecting and handling the equipment	0.21	B	G
	$ 39,135	Electrical work	0.04	B	
	$ 19,568	Piping	0.02	B	
	$ 9,784	Insulation	0.01	B	
	$ 9,784	Painting	0.01	B	
	$ 117,405	Fire suppression	0.12	B	H
	$ 275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$ 754,404**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,732,779**				
Indirect Costs (installation)					
	$ 97,838	Engineering	0.1	B	
	$ 48,919	Construction and field expenses	0.05	B	
	$ 97,838	Contractor fees	0.1	B	
	$ 19,568	Startup costs	0.02	B	
	$ 97,838	Performance test costs	0.1	B	
	$ 19,568	Contingencies	0.02	B	J
	$ 191,780	Plant Shutdown for Retrofit	Shutdown for retrofit		K
Total Indirect Costs, IC	**$ 573,346**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$ 2,306,126**				

Comments:

A	Design Air Flow (dscfm)	38,400
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M2 = 10.5 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost	Extended	Comments
Direct Annual Costs, DC						
	Operating Labor					
		Operator	0.5 hr/shift	$24.70	$ 13,276	A, E
		Supervisor	15% of operator		$ 1,991	
	Maintenance					
		Labor	0.5 hr/shift	$30.03	$ 16,141	A, E
		Materials	100% of Maintenance labor		$ 16,141	
	Replacement Parts, Catalysts (2-year life)					
		Material & freight (5%) of noble metal catalyst		$ 5,551	$ 264,848	H, J, K, L
	Utilities					
		Natural Gas		$ 10.34 /MCF	$ 1,625,213	B, C, D, E
		Electricity (125 Hp)		$ 0.0770 / kWhr	$ 49,586	B, E, F, M
Total DC					$ 1,987,196	
Indirect Annual Costs, IC						
	Overhead					
		60% of sum of Operating, supv., and maintenance labor and materials			$ 28,530	
	Administrative Charges	2% of Total Capital Investment			$ 46,123	
	Property Taxes	1% of Total Capital Investment			$ 23,061	
	Insurance	1% of Total Capital Investment			$ 23,061	
	Capital Recovery				$ 408,138	G
Total Indirect Costs					$ 528,913	
Total Annual Costs					$ 2,516,109	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					$ 20,195	E, I

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	38,400
C	Overall Temperature Rise Needed for 35% Heat Recovery (800 - 77) x 35% (°F/°R)	469.95
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	8.329

Annual Operating Costs

E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX plus 4", 35% Recovery (in. of water column)	10
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	77
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2016 cost of noble metal catalyst, 1.85022 Inflation factor from 1988 to 2015	$5,551
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Occupation code	Occupation title (click on the occupation title to view an occupational profile)	Level	Employment	Employment RSE	Percent of total employment	Median hourly wage	Mean hourly wage	Annual mean wage	Mean wage RSE	NAICS 331300 - Alumina and Aluminum Production and Processing
51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	detail	1,870	16.20%	3.39%	$24.60	$24.70	########	2.50%	Bureau of Labor Statistics
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	broad	2,900	4.20%	5.26%	$29.20	$30.03	########	0.70%	Bureau of Labor Statistics

					Comments
Total Capital Investment					
Direct Costs					
	Purchased Equipment Costs (PEC)				
	$	1,059,056	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1 EC = IA x (1215 $Q_{total}^{0.5575}$ + Hoods and Ductwork), HR = 50%	A, B, C, D, L
	$	105,906	Instrumentation	0.1 EC	E
	$	31,772	Taxes, Duties, VAT	0.03 EC	F
	$	52,953	Freight	0.05 EC	
Purchased Equip. Total	$	**1,249,686**		**1.18 EC = B**	
	Direct Installation Costs				
	$	99,975	Foundations and supports	0.08 B	
	$	262,434	Erecting and handling the equipment	0.21 B	G
	$	49,987	Electrical work	0.04 B	
	$	24,994	Piping	0.02 B	
	$	12,497	Insulation	0.01 B	
	$	12,497	Painting	0.01 B	
	$	149,962	Fire suppression	0.12 B	H
	$	275,000	Building and Site Preparation	Building	I
Direct Installation Total	$	**887,346**		**1.49 B + Building and Site Preparation**	
Total Direct Costs, DC	$	**2,137,032**			
Indirect Costs (installation)					
	$	124,969	Engineering	0.1 B	
	$	62,484	Construction and field expenses	0.05 B	
	$	124,969	Contractor fees	0.1 B	
	$	24,994	Startup costs	0.02 B	
	$	124,969	Performance test costs	0.1 B	
	$	24,994	Contingencies	0.02 B	J
	$	191,780	Plant Shutdown for Retrofit	Shutdown for retrofit	K
Total Indirect Costs, IC	$	**679,157**		**0.39 B + Shutdown**	
Total Capital Investment	$	**2,816,189**			

Comments:

A	Design Air Flow (dscfm)	38,400
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M2 = 10.5 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost	Extended	Comments
Direct Annual Costs, DC						
	Operating Labor					
		Operator	0.5 hr/shift	$24.70	$ 13,276	A, E
		Supervisor	15% of operator		$ 1,991	
	Maintenance					
		Labor	0.5 hr/shift	$30.03	$ 16,141	A, E
		Materials	100% of Maintenance labor		$ 16,141	
	Replacement Parts, Catalysts (2-year life)					
		Material & freight (5%) of noble metal catalyst		$ 5,551	$ 264,848	H, J, K, L
	Utilities					
		Natural Gas		$ 10.34 /MCF	$ 1,244,310	B, C, D, E
		Electricity (150 Hp)		$ 0.0770 / kWhr	$ 69,420	B, E, F, M
Total DC					$ 1,626,128	
Indirect Annual Costs, IC						
	Overhead					
		60% of sum of Operating, supv., and maintenance labor and materials			$ 28,530	
	Administrative Charges	2% of Total Capital Investment			$ 56,324	
	Property Taxes	1% of Total Capital Investment			$ 28,162	
	Insurance	1% of Total Capital Investment			$ 28,162	
	Capital Recovery				$ 498,409	G
Total Indirect Costs					$ 639,587	
Total Annual Costs					$ 2,265,714	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					$ 18,185	E, I

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	38,400
C	Overall Temperature Rise Needed for 70% Heat Recovery (800 - 77) x 50% (°F/°R)	361.5
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	6.377
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600

Annual Operating Costs

F	Pressure Drop = 6" CATOX plus 8", 50% Recovery (in. of water column)	14
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	77
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2016 cost of noble metal catalyst, 1.85022 Inflation factor from 1988 to 2015	$5,551
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

NAICS 331300 - Alumina and Aluminum Production and Processing

Occupation code	Occupation title (click on the occupation title to view an occupational profile)	Level	Employment	Employment RSE	Percent of total employment	Median hourly wage	Mean hourly wage	Annual mean wage	Mean wage RSE	
51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	detail	1,870	16.20%	3.39%	$24.60	$24.70	$51,370	2.50%	Bureau of Labor Statistics
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	broad	2,900	4.20%	5.26%	$29.20	$30.03	$62,460	0.70%	Bureau of Labor Statistics

Total Capital Investment					Comments
Direct Costs					
	Purchased Equipment Costs (PEC)				
	$	1,154,842	Primary Control Device, includes auxiliary equipment - interconnections, entry and exit hoods, and ductwork	1 EC = IA x (1443 $Q_{total}^{0.5527}$ + Hoods and Ductwork), HR = 70%	A, B, C, D, L
	$	115,484	Instrumentation	0.1 EC	E
	$	34,645	Taxes, Duties, VAT	0.03 EC	F
	$	57,742	Freight	0.05 EC	
Purchased Equip. Total	**$**	**1,362,714**		**1.18 EC = B**	
	Direct Installation Costs				
	$	109,017	Foundations and supports	0.08 B	
	$	286,170	Erecting and handling the equipment	0.21 B	G
	$	54,509	Electrical work	0.04 B	
	$	27,254	Piping	0.02 B	
	$	13,627	Insulation	0.01 B	
	$	13,627	Painting	0.01 B	
	$	163,526	Fire suppression	0.12 B	H
	$	275,000	Building and Site Preparation	Building	I
Direct Installation Total	**$**	**942,730**		**1.49 B + Building and Site Preparation**	
Total Direct Costs, DC	**$**	**2,305,443**			
Indirect Costs (installation)					
	$	136,271	Engineering	0.1 B	
	$	68,136	Construction and field expenses	0.05 B	
	$	136,271	Contractor fees	0.1 B	
	$	27,254	Startup costs	0.02 B	
	$	136,271	Performance test costs	0.1 B	
	$	27,254	Contingencies	0.02 B	J
	$	191,780	Plant Shutdown for Retrofit	Shutdown for retrofit	K
Total Indirect Costs, IC	**$**	**723,238**		**0.39 B + Shutdown**	
Total Capital Investment	**$**	**3,028,682**			

Comments:

A	Design Air Flow (dscfm)	38,400
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M2 = 10.5 shifts of full production downtime	
L	See Auxilliary Equipment sheet for derivation of Hoods and Ductwork	

	Cost Item		Suggested Factor	Unit Cost	Extended	Comments
Direct Annual Costs, DC						
	Operating Labor					
		Operator	0.5 hr/shift	$24.70	$ 13,276	A, E
		Supervisor	15% of operator		$ 1,991	
	Maintenance					
		Labor	0.5 hr/shift	$30.03	$ 16,141	A, E
		Materials	100% of Maintenance labor		$ 16,141	
	Replacement Parts, Catalysts (2-year life)					
		Material & freight (5%) of noble metal catalyst		$ 5,551	$ 264,848	H, J, K, L
	Utilities					
		Natural Gas		$ 10.34 /MCF	$ 736,440	B, C, D, E
		Electricity (225 Hp)		$ 0.0770 / kWhr	$ 104,130	B, E, F, M
Total DC					$ **1,152,967**	
Indirect Annual Costs, IC						
	Overhead					
		60% of sum of Operating, supv., and maintenance labor and materials			$ 28,530	
	Administrative Charges	2% of Total Capital Investment			$ 60,574	
	Property Taxes	1% of Total Capital Investment			$ 30,287	
	Insurance	1% of Total Capital Investment			$ 30,287	
	Capital Recovery				$ 536,016	G
Total Indirect Costs					$ 685,693	
Total Annual Costs					$ **1,838,660**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					$ **14,757**	E, I

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	38,400
C	Overall Temperature Rise Needed for 70% Heat Recovery (800 - 77) x 70% (°F/°R)	216.9
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	3.774
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX plus 15", 70% Recovery (in. of water column)	21
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	77
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2016 cost of noble metal catalyst, 1.85022 Inflation factor from 1988 to 2015	$5,551
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770

Auxilliary Equipment Costs

Includes Entry Hood - Rectangular canopy 11.3' x 9.7' = 109.6 ft^2 *	$	31,359.18
Includes Exit Hood - Rectangular canopy 8.3' x 9.7' = 80.6 ft^2 *	$	26,826.28
Includes six air curtains each a steel backdraft slotted, each an average of 9.8' x .17' = 1.67ft^2 [1]	$	58,930.17
1999 Entry Hood, Exit Hood, and Air Curtains	**$**	**117,116**

Duct diameter (Eq. 1.27) $D_d = 1.128(Q/u)^{1/2}$

Q =		41,472 acfm
u =		3,000 fpm
D_d =		4.2 ft.
D_d =		50.3 in.

1999 Cost of Duct per foot (Eq. 1.40)
Power cost model - circular,
longitudinal, plate steel, one coat paint
$C_{foot\ of\ pipe} = aD^b$

a = 2.49
b = 1.15

$C_{foot\ of\ pipe}$ =	$	225.57
Duct length from drawing		292.5 ft.
1999 Cost of Duct Pipe	**$**	**65,979**

Exponential cost model, single walled,
non-insulated elbow, a = 30.4
b= 0.0594

(Eq. **1.41**) and Tbl 1.10 $C_{elbow} = ae^{bD}$	$	604.20
Number of Elbows		5
1999 Cost of Elbows	**$**	**3,021**

Stack diameter (Eq. 1.27) $D_d = 1.128(Q_c/u_c)^{1/2}$

RTO temp. rise $_{max}$ 200 °R = (737/537), Q_c =		56,918	acfm
3,000 fpm (1.5 x wind speed, 34 mph), u_c =		3,000	fpm
Stack diamter, D_d =		4.9	ft.
D_d =		59.0	in.
$C_{foot\ of\ stack} = aD^b$			
a =	2.49		
b =	1.15		
$C_{foot\ of\ stack}$ =	$	270.61	
Stack height, from page 1-36, Section 2 Chapter 1		213	ft.
1999 Cost of Stack	$	**57,639**	
1999 Edition 6 of Control Cost Manual (most recent) does not include fan cost model - RTO only.	$	34,800	
125 Hp. Classs 3, backward inclined, 1,800 rpm TEFC, rated for 300 °F. Cost estimate is a lookup from the most recent (1978) EPA estimate, adjusted to 1999 by the CPI (2.56). **1999 Cost of Fan**	$	**89,088**	
	Totals		
Custom retrofitted	**$**	**117,116**	**Entry and Exit Hoods**
Custom retrofitted	**$**	**69,000**	**Duct and Elbows**
Only used with RTO, assumed to be part of other technology packages	**$**	**89,088**	**Backward inclined Fan**
Only used with RTO, assumed to be part of other technology packages	**$**	**57,639**	**Stack**

*Based on Eq (1.40) pg. 1-41 Sec. 2, Chptr. 1 EPA PCCM-6, upgraded by Table 1.12 multiplier for CRS from plastic (3.74/.393) per Table 1.8 steel for strength and to accommodate fire risk

Total Capital Investment

						Comments
Direct Costs						
	Purchased Equipment Costs (PEC)					
			Primary Control Device, includes auxiliary		EC = IA x 10,294 $Q_{total}^{0.2355}$ + Ductwork, HR =	
	$	241,972	equipment - interconnections and ductwork	1	None	**A, B, C, D, L**
	$	24,197	Instrumentation	0.1	EC	**E**
	$	7,259	Taxes, Duties, VAT	0.03	EC	**F**
	$	12,099	Freight	0.05	EC	
Purchased Equip. Total	$	**285,527**		**1.18**	**EC = B**	
	Direct Installation Costs					
	$	22,842	Foundations and supports	0.08	B	
	$	59,961	Erecting and handling the equipment	0.21	B	**G**
	$	11,421	Electrical work	0.04	B	
	$	5,711	Piping	0.02	B	
	$	2,855	Insulation	0.01	B	
	$	2,855	Painting	0.01	B	
	$	34,263	Fire suppression	0.12	B	**H**
	$	275,000	Building and Site Preparation		Building	**I**
Direct Installation Total	$	**414,908**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	$	**700,435**				
Indirect Costs (installation)						
	$	28,553	Engineering	0.1	B	
	$	14,276	Construction and field expenses	0.05	B	
	$	28,553	Contractor fees	0.1	B	
	$	5,711	Startup costs	0.02	B	
	$	28,553	Performance test costs	0.1	B	
	$	5,711	Contingencies	0.02	B	**J**
	$	191,780	Plant Shutdown for Retrofit		Shutdown for retrofit	**K**
Total Indirect Costs, IC	$	**303,136**		**0.39**	**B + Shutdown**	
Total Capital Investment	$	**1,003,571**				

Comments:

A	Design Air Flow (dscfm)	23,500
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M3 = 10.5 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 12,350	A, E
		Supervisor	15% of operator			$ 1,853	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 15,015	A, E
		Materials	100% of Maintenance labor			$ 15,015	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 2,630,846	B, C, D, E, J
		Electricity (100 Hp)		$ 0.0770	/ kWhr	$ 37,490	B, E, F, I
Total DC						$ **2,712,569**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 26,540	
	Administrative Charges	2% of Total Capital Investment				$ 20,071	
	Property Taxes	1% of Total Capital Investment				$ 10,036	
	Insurance	1% of Total Capital Investment				$ 10,036	
	Capital Recovery					$ 177,612	G
Total Indirect Costs						$ **244,294**	
Total Annual Costs						$ **2,956,863**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						$ **377,151**	E, H, K

Comments

Annual Operating Costs

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	23,500
C	Overall Temperature Rise Needed for No Heat Recovery (1,400 - 77) (°F/°R)	1323
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	23.684
E	Annual Operational Hours Assumes 2% Downtime for Maintenance	8000
F	Pressure Drop = 4" Thermal (in. of water column)	4
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
J	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
K	Current Hourly Potential-To-Emit VOC (lbs/hr)	2.0

Total Capital Investment					**Comments**
Direct Costs					
		Purchased Equipment Costs (PEC)			
		Primary Control Device, includes auxiliary		EC = IA x 13,149 $Q_{total}^{0.2609}$ + Ductwork, HR =	
	$ 363,577	equipment - interconnections and ductwork	1	35%	A, B, C, D, L
	$ 36,358	Instrumentation	0.1	EC	E
	$ 10,907	Taxes, Duties, VAT	0.03	EC	F
	$ 18,179	Freight	0.05	EC	
Purchased Equip. Total	**$ 429,021**		**1.18**	**EC = B**	
		Direct Installation Costs			
	$ 34,322	Foundations and supports	0.08	B	
	$ 90,094	Erecting and handling the equipment	0.21	B	G
	$ 17,161	Electrical work	0.04	B	
	$ 8,580	Piping	0.02	B	
	$ 4,290	Insulation	0.01	B	
	$ 4,290	Painting	0.01	B	
	$ 51,483	Fire suppression	0.12	B	H
	$ 275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$ 485,220**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 914,241**				
Indirect Costs (installation)					
	$ 42,902	Engineering	0.1	B	
	$ 21,451	Construction and field expenses	0.05	B	
	$ 42,902	Contractor fees	0.1	B	
	$ 8,580	Startup costs	0.02	B	
	$ 42,902	Performance test costs	0.1	B	
	$ 8,580	Contingencies	0.02	B	J
	$ 191,780	Plant Shutdown for Retrofit		Shutdown for retrofit	K
Total Indirect Costs, IC	**$ 359,098**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$ 1,273,339**				

Comments:

A	Design Air Flow (dscfm)	23,500
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M3 = 10.5 shifts of full production downtime	

Cost Item			Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 12,350	A, E
		Supervisor	15% of operator			$ 1,853	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 15,015	A, E
		Materials	100% of Maintenance labor			$ 15,015	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 1,704,996	B, C, D, E, J
		Electricity (125 Hp)		$ 0.0770	/ kWhr	$ 55,508	B, E, F, I
Total DC						**$ 1,804,736**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 26,540	
	Administrative Charges	2% of Total Capital Investment				$ 25,467	
	Property Taxes	1% of Total Capital Investment				$ 12,733	
	Insurance	1% of Total Capital Investment				$ 12,733	
	Capital Recovery					$ 225,356	G
Total Indirect Costs						**$ 302,829**	
Total Annual Costs						**$ 2,107,565**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 268,822**	**E, H, K**

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	23,500
C	Overall Temperature Rise Needed for 35% Heat Recovery (1,400 - 77) x 35% (°F/°R)	859.95
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	15.3491
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8000
F	Pressure Drop = 4" Thermal plus 8", 35% Recovery (in. of water column)	8
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
J	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
K	Current Hourly Potential-To-Emit VOC (lbs/hr)	2.0

Total Capital Investment					Comments
Direct Costs					
	Purchased Equipment Costs (PEC)				
	$	414,445	Primary Control Device, includes auxiliary equipment - interconnections and ductwork	1 EC = IA x 17,056 $Q_{total}^{0.2502}$ + Ductwork, HR = 50%	A, B, C, D, L
	$	41,445	Instrumentation	0.1 EC	E
	$	12,433	Taxes, Duties, VAT	0.03 EC	F
	$	20,722	Freight	0.05 EC	
Purchased Equip. Total	**$**	**489,045**		**1.18 EC = B**	
	Direct Installation Costs				
	$	39,124	Foundations and supports	0.08 B	
	$	102,700	Erecting and handling the equipment	0.21 B	G
	$	19,562	Electrical work	0.04 B	
	$	9,781	Piping	0.02 B	
	$	4,890	Insulation	0.01 B	
	$	4,890	Painting	0.01 B	
	$	58,685	Fire suppression	0.12 B	H
	$	275,000	Building and Site Preparation	Building	I
Direct Installation Total	**$**	**514,632**		**1.49 B + Building and Site Preparation**	
Total Direct Costs, DC	**$**	**1,003,678**			
Indirect Costs (installation)					
	$	48,905	Engineering	0.1 B	
	$	24,452	Construction and field expenses	0.05 B	
	$	48,905	Contractor fees	0.1 B	
	$	9,781	Startup costs	0.02 B	
	$	48,905	Performance test costs	0.1 B	
	$	9,781	Contingencies	0.02 B	J
	$	191,780	Plant Shutdown for Retrofit	Shutdown for retrofit	K
Total Indirect Costs, IC	**$**	**382,508**		**0.39 B + Shutdown**	
Total Capital Investment	**$**	**1,386,185**			

Comments:

A	Design Air Flow (dscfm)	23,500
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M3 = 10.5 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost			Extended	Comments
Direct Annual Costs, DC								
	Operating Labor							
		Operator	0.5 hr/shift		$24.70		$ 12,350	A, E
		Supervisor	15% of operator				$ 1,853	
	Maintenance							
		Labor	0.5 hr/shift		$30.03		$ 15,015	A, E
		Materials	100% of Maintenance labor				$ 15,015	
	Wear Item Replacement							
	Utilities							
		Natural Gas		$	10.34	/MCF	$ 1,308,203	B, C, D, E, J
		Electricity (175 Hp)		$	0.0770	/ kWhr	$ 70,744	B, E, F, I
Total DC							**$ 1,423,179**	
Indirect Annual Costs, IC								
	Overhead							
		60% of sum of Operating, supv., and maintenance labor and materials					$ 26,540	
	Administrative Charges	2% of Total Capital Investment					$ 27,724	
	Property Taxes	1% of Total Capital Investment					$ 13,862	
	Insurance	1% of Total Capital Investment					$ 13,862	
	Capital Recovery						$ 245,327	G
Total Indirect Costs							**$ 327,314**	
Total Annual Costs							**$ 1,750,493**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)							**$ 223,277**	E, H, K

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	23,500
C	Overall Temperature Rise Needed for 50% Heat Recovery (1,400 - 77) x 50% (°F/°R)	661.5
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	11.777
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8000
F	Pressure Drop = 4" Thermal plus 8", 50% Recovery (in. of water column)	12
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
J	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
K	Current Hourly Potential-To-Emit VOC (lbs/hr)	2.0

Total Capital Investment					**Comments**
Direct Costs					
Purchased Equipment Costs (PEC)					
	$ 503,935	Primary Control Device, includes auxiliary equipment - interconnections and ductwork	1	$EC = IA \times 21{,}342\ Q_{total}^{0.2500}$ + Ductwork, HR = 70%	A, B, C, D, L
	$ 50,393	Instrumentation	0.1	EC	E
	$ 15,118	Taxes, Duties, VAT	0.03	EC	F
	$ 25,197	Freight	0.05	EC	
Purchased Equip. Total	**$ 594,643**		**1.18**	**EC = B**	
Direct Installation Costs					
	$ 47,571	Foundations and supports	0.08	B	
	$ 124,875	Erecting and handling the equipment	0.21	B	G
	$ 23,786	Electrical work	0.04	B	
	$ 11,893	Piping	0.02	B	
	$ 5,946	Insulation	0.01	B	
	$ 5,946	Painting	0.01	B	
	$ 71,357	Fire suppression	0.12	B	H
	$ 275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$ 566,375**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,161,018**				
Indirect Costs (installation)					
	$ 59,464	Engineering	0.1	B	
	$ 29,732	Construction and field expenses	0.05	B	
	$ 59,464	Contractor fees	0.1	B	
	$ 11,893	Startup costs	0.02	B	
	$ 59,464	Performance test costs	0.1	B	
	$ 11,893	Contingencies	0.02	B	J
	$ 191,780	Plant Shutdown for Retrofit		Shutdown for retrofit	K
Total Indirect Costs, IC	**$ 423,691**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$ 1,584,709**				

Comments:

A	Design Air Flow (dscfm)	23,500
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M3 = 10.5 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 12,350	A, E
		Supervisor	15% of operator			$ 1,853	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 15,015	A, E
		Materials	100% of Maintenance labor			$ 15,015	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 779,145	B, C, D, E, J
		Electricity (200 Hp)		$ 0.0770	/ kWhr	$ 85,584	B, E, F, I
Total DC						**$ 908,962**	
Indirect Annual Costs, IC							
	Overhead	60% of sum of Operating, supv., and maintenance labor and materials				$ 26,540	
	Administrative Charges	2% of Total Capital Investment				$ 31,694	
	Property Taxes	1% of Total Capital Investment				$ 15,847	
	Insurance	1% of Total Capital Investment				$ 15,847	
	Capital Recovery					$ 280,462	G
Total Indirect Costs						**$ 370,390**	
Total Annual Costs						**$ 1,279,351**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 163,183**	E, H, K

Comments

Annual Operating Costs

A	Inflation 1999 - 2022	1.7	
B	Air Flow (dscfm)	23,500	
C	Overall Temperature Rise Needed for 70% Heat Recovery (1,400 - 77) x 70% (°F/°R)	396.9	
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	7.0142	
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8000	
F	Pressure Drop = 4" Thermal plus 15", 70% Recovery (in. of water column)	19	
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980	
H	DRE	98%	
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.077	
J	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34	www.eia.gov
K	Current Hourly Potential-To-Emit VOC (lbs/hr)	2.0	www.eia.gov

Total Capital Investment						**Comments**
Direct Costs						
Purchased Equipment Costs (PEC)						
	$	1,116,956	Primary Control Device, includes auxiliary equipment - interconnections, ductwork, fan, and stack	1	EC = IA x ((2.204 x 10^5 + 11.57 Q_{total}) + Ductwork, Fan, and Stack)	A, B, C, D, L
	$	111,696	Instrumentation	0.1	EC	E
	$	33,509	Taxes, Duties, VAT	0.03	EC	F
	$	55,848	Freight	0.05	EC	
Purchased Equip. Total	$	**1,318,008**		**1.18**	**EC = B**	
Direct Installation Costs						
	$	105,441	Foundations and supports	0.08	B	
	$	276,782	Erecting and handling the equipment	0.21	B	G
	$	52,720	Electrical work	0.04	B	
	$	26,360	Piping	0.02	B	
	$	13,180	Insulation	0.01	B	
	$	13,180	Painting	0.01	B	
	$	158,161	Fire suppression	0.12	B	H
	$	275,000	Building and Site Preparation		Building	I
Direct Installation Total	$	**920,824**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	$	**2,238,832**				
Indirect Costs (installation)						
	$	131,801	Engineering	0.1	B	
	$	65,900	Construction and field expenses	0.05	B	
	$	131,801	Contractor fees	0.1	B	
	$	26,360	Startup costs	0.02	B	
	$	131,801	Performance test costs	0.1	B	
	$	26,360	Contingencies	0.02	B	J
	$	191,780	Plant Shutdown for Retrofit		Shutdown for retrofit	K
Total Indirect Costs, IC	$	**705,803**		**0.39**	**B + Shutdown**	
Total Capital Investment	$	**2,944,635**				

Comments:

A	Design Air Flow (dscfm)	23,500
B	Btus in Exhaust (Btus/dscf)	0.130
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M3 = 10.5 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 12,350	A, E
		Supervisor	15% of operator			$ 1,853	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 15,015	A, E
		Materials	100% of Maintenance labor			$ 15,015	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 385,452	B, C, D, E, J
		Electricity (100 Hp)		$ 0.0770	/ kWhr	$ 41,633	B, E, F, I
Total DC						**$ 471,317**	
Indirect Annual Costs, IC							
	Overhead	60% of sum of Operating, supv., and maintenance labor and materials				$ 26,540	
	Administrative Charges	2% of Total Capital Investment				$ 58,893	
	Property Taxes	1% of Total Capital Investment				$ 29,446	
	Insurance	1% of Total Capital Investment				$ 29,446	
	Capital Recovery					$ 521,142	G
Total Indirect Costs						**$ 665,467**	
Total Annual Costs						**$ 1,136,783**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 144,998**	E, H, K

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	23,500

C	Overall Temperature Rise Assumed per Existing Pollution Control Device (°F above ambient)	200
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	3.47
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8000
F	Pressure Drop = 4" Thermal plus 8" (in. of water column)	12
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
J	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
K	Current Hourly Potential-To-Emit VOC (lbs/hr)	2.0

Auxilliary Equipment Costs

Duct diameter (Eq. 1.27) $D_d = 1.128(Q/u)^{1/2}$			
dscfm offset to acfm by 8% (greatest seen in stack tests) Q =		25,380	acfm
u =		3,000	fpm
D_d =		3.3	ft.
D_d =		39.4	in.
1999 Cost of Duct per foot (Eq. 1.40)			
Power cost model - circular,			
longitudinal, plate steel, one coat paint			
$C_{foot\ of\ pipe} = aD^b$			
a =	2.49		
b =	1.15		
$C_{foot\ of\ pipe}$ =	$	170.08	
Duct length from drawing		180	ft.
1999 Cost of Duct Pipe	**$**	**30,614**	
Exponential cost model, single walled,			
non-insulated elbow, a =	30.4		
b=	0.0594		
(Eq. 1.41) and Tbl 1.10 $C_{elbow} = ae^{bD}$	$	315.16	
Number of Elbows		5	
1999 Cost of Elbows	**$**	**1,576**	
Duct diameter (Eq. 1.27) $D_d = 1.128(Q_c/u_c)^{1/2}$			
RTO temp. rise $_{max}$ 200 °R = (737/537), Q_c =		34,833	acfm
3,000 fpm (1.5 x wind speed, 34 mph), u_c =		3,000	fpm
Stack diamter, D_d =		3.8	ft.
D_d =		46.1	in.
$C_{foot\ of\ stack} = aD^b$			
a =	2.49		
b =	1.15		
$C_{foot\ of\ stack}$ =	$	204.04	
Stack height, from page 1-36, Section 2 Chapter 1		213	ft.

1999 Cost of Stack	**$**	**43,460**	
1999 Edition 6 of Control Cost Manual (most recent) does not include fan cost model - RTO only.	$	34,800	
125 Hp. Classs 3, backward inclined, 1,800 rpm TEFC, rated for 300 °F. Cost estimate is a lookup from the most recent (1978) EPA estimate, adjusted to 1999 by the CPI (2.56). **1999 Cost of Fan**	**$**	**89,088**	
	Totals		
State of the Art Hoods are Installed	**$**	**-**	**Entry and Exit Hoods**
Custom retrofitted	**$**	**32,190**	**Duct and Elbows**
Only used with RTO, assumed to be part of other technology packages	**$**	**89,088**	**Backward inclined Fan**
Only used with RTO, assumed to be part of other technology packages	**$**	**43,460**	**Stack**

[1]Based on Eq (1.40) pg. 1-41 Sec. 2, Chptr. 1 EPA PCCM-6, upgraded by Table 1.12 multiplier for CRS from plastic (3.74/.393) per Table 1.8 steel for strength and to accommodate fire risk

Total Capital Investment					
	Direct Costs				
		Purchased Equipment Costs (PEC)			
		$ 1,598,564	Primary Control Device (includes auxiliary equipment - desorbing thermal oxidizer, interconnections, and ductwork)	1 EC = See derivation on Page 2 - Background and Calculations	
		$ 159,856	Instrumentation	0.1 EC	Fire damper(s), integration/interlocks with existing controls
		$ 47,957	Taxes, Duties, VAT	0.03 EC	
		$ 79,928	Freight	0.05 EC	
Purchased Equip. Total		**$ 1,886,305**		**1.18 EC = B**	
		Direct Installation Costs			
		$ 226,357	Foundations and supports	0.12 B	Retrofit penalty (50% above model) Landlocked - must move or avoid electric service, water service, sewer service, CO2 Service, Nitrogen service, Waste removal service
		$ 330,103	Equipment erection and handling	0.18 B	Retrofit penalty (25% above model). See previous comment
		$ 75,452	Electrical work	0.04 B	
		$ 18,863	Piping	0.01 B	Desorption to be accomplished using thermal destruction (50% reduction)
		$ 37,726	Insulation	0.02 B	Increased by 100% because of length, height, weather exposure, desire to minimize condensation, and hi-temperatures needed for desorption
		$ 18,863	Painting	0.01 B	
		$ 264,083	Fire suppression	0.14 B	Increased by 75% above standard to accommodate long duct at ceiling height and adsorption bed protection
		$ 275,000	Building and Site Preparation	Building	5,000 ft^2 assumed at $55/$ft^2$. Required because rolling oil freezes at 45 °F.
Direct Installation Total		**$ 1,246,447**		**1.52 B + Building and Site Preparation**	
Total Direct Costs, DC		**$ 3,132,752**			
	Indirect Costs (installation)				
		$ 188,630	Engineering	0.1 B	
		$ 94,315	Construction and field expenses	0.05 B	
		$ 188,630	Contractor fees	0.1 B	
		$ 37,726	Startup costs	0.02 B	
		$ 62,248	Performance test costs	0.033 B	
		$ 37,726	Contingencies	0.02 B	Redesign/modification of equipment, startup delays
		$ 343,380	Plant Shutdown for Retrofit	Shutdown for retrofit	7 days of 2016 EBITDA ($43M) = $824,658
Total Indirect Costs, IC		**$ 952,657**		**0.32 B + Shutdown**	
Total Capital Investment		**$ 4,085,409**			

Background and Calculations

		Design
Air Flow (dscfm)		21,466
Air Flow (acfm) = dscfm +8%, maximum variability in stack tests		23,183
Btus in Exhaust (Btus/dscf)		0.116
(IA) Inflation Adjustment for EC		1.700
Mill 4 currently has state-of-the-art hoods and air curtains	$	-
Cost of Ductwork	$	46,627

Each operational bed consists of round vessels 12' in diameter, to maximize road transportation
Each vessel is .06 feet long with 3 feet of transition/access on each end (L)
To achieve 60 fpm face velocity, four vessels are required accommodate 21,466 acfm,
The surface area of each vessel is $S = \pi D((L + 2\text{Transitions}) + D/2)$
$S = \pi 12(6.06+6)$, $S = 454.65\ ft^2$.
The cost of each vessel is given by the relationship $C_{vessel} = 271S^{0.778}$
The 1999 cost, C_{vessel} of a single vessel is $31,670
Each operational bed consists of four vessels. To accommodate 24/7 operation, two sets of beds are required for a total of eight vessels.
1999 cost of the combined vessels, C_{Vessel}, is $253,360
Amount of Zeolite needed per hour - 6.0 #/hr VOC / .225 (adsorbency factor)
Amount of Zeolite needed per 12-hour operational shift - 6.0#/hr VOC / .225 (adsorbency factor) x 12 = 320 pounds
Amount of Zeolite needed per day (shift x 2) = 640 pounds
1999 cost of system Zeolite charge, $C_{Adsorbent}$ (Zeolite lbs x $40/lb) = $25,600
To desorb the high MW VOCs, while avoiding thermal degradation of the zeolite, a 1,000 dscfm thermal oxidizer with 70% heat recovery would maintain 1,000 °F desorb/preheat temperature, destruction temperature of 1,500 °F and 18% of the LEL (assuming uniform bed desorption).
1999 thermal recuperative desorber equipment costs, $C_{Thermal} = 21{,}342 \times Q_{total}^{0.2500}$, where Q = 1,000 scfm., EC = $120,015.
Total Purchase Cost of Equipment (1999), based on EPA's survey of equipment suppliers must be factored to include piping, controls, compressors, pumps, fans, etc.
It is assumed that auxiliary equipment, other direct costs, and the indirect costs for the thermal desorption system are similar percentages for the adsorption system.
Per page 1-20 Section 3.1 Chapter 1 of EPA PCCM, total purchased cost of the four sampled adsorber/desorber systems varied from 1.14 to 2.24 times the carbon and vessel cost.
The low concentration of the high MW VOCs puts the vessel size ***beyond the parameters of the standard equipment models***. Similarly, ***desorbing with 1,000 °F air is beyond the norm*** and switching hardware must be included to desorb multiple beds or provide a moving bed.
The ***high end of the cost range for auxiliary is used to acknowledge that we are extrapolating costs beyond four known systems*** to include the above variations
Therefore, the factor to accommodate piping, controls, compressors, pumps, etc, ***R = 2.24***
The estimated costs in 1999 for the adsorber/desorber control system is $C_{equip} = R(C_{Vessel} + C_{Adsorbent} + C_{Thermal})$

1999 C_{equip} =	$	940,331
1999 C_{equip} x IA = **2022** C_{equip} =	$	**1,598,564**

Total Capital Investment

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70	$	13,276	A
		Supervisor	15% of operator		$	1,991	A
	Maintenance						
		Labor	0.5 hr/shift	$30.03	$	16,141	A
		Materials	100% of maintenance labor		$	16,141	A
	Replacement Parts, Zeolite (3-year life)						
		Labor			$	167	A, C, D, E
		Materials + freight	0.300245 (640 lbs. x $59.35/lb x 1.05)		$	11,975	D, E, Q
	Utilities						
		Natural Gas		$ 10.34 /MCF	$	15,469	A, F, I, J, K, L, S
		Electricity (50 Hp)		$ 0.0770 / kWhr	$	20,408	A, B, G, M, N, T
		Sewer and Water		0			
Total DC					**$**	**95,568**	
Indirect Annual Costs, IC							
	Overhead	60% of sum of Operating, supv., and maintenance labor and materials			$	28,530	A
	Administrative Charges	2% of Total Capital Investment			$	81,708	
	Property Taxes	1% of Total Capital Investment			$	40,854	
	Insurance	1% of Total Capital Investment			$	40,854	
	Capital Recovery				$	723,036	O
Total Indirect Costs					**$**	**914,982**	
Total Annual Costs					**$**	**1,010,550**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					**$**	**42,072**	A, H, U

Comments

A	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
B	Mill Exhaust Air Flow (acfm)	23,183
C	Based on EPA APCCM Ed. 6 Example (labor hours/changeout)	4
D	Anticipated adsorbent life (years)	3
E	Capital Recovery Factor, CRF for zeolite replacement = 0.41635, 3-years at 12% - JWA Internal Opportunity Cost	0.41635
F	Offline Thermal Desorption System. 18% LEL assuming uniform desorption (scfm)	1,000
G	Fan capacity required for thermal desorber- oxidizer with 67% R.H., at 1,500 F. (acfm)	3,650
H	Combined System Destruction Removal Efficiency (DRE) , pg. 16 of EPA 456/F-99-004, CATC Technical Bulletin Choosing An Adsorption System for VOC: Carbon, Zeolite, or Polymers?	93%
I	Overall Temperature Rise Needed Thermal Desorption and Destruction with 70 Heat Recovery (1,500 - 77) x (100% - 70%) (°F)	426.9
J	Btus in Mill Exhaust (Btus/dscf)	0.116

Comments (cont'd,)

K	Btus in Mill Exhaust (Btus/dscf), Concentrated by Factor of 40 in Desorption Air Stream	4.640
L	Btus Required to Heat one dscf of desorb air to Required Net Temperature includes contribution from Exhaust VOC	3.0442
M	Mill Exhaust pressure drop assumed for ductwork, pressure changes, and carbon beds (in. w.c.)	4.0
N	Thermal desorber with 70% heat recovery pressure drop (in. w.c.)	19.0
O	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
P	1999 cost of zeolite ($/lb)	40.00
Q	2015 cost of zeolite ($/lb.)	68.00
R	Inflation Factor 1999 - 2022	1.7
S	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
T	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.077
U	Current Hourly Potential-To-Emit VOC (lbs/hr)	6.0

				Comments
Total Capital Investment				
Direct Costs				
	Purchased Equipment Costs (PEC)			
		Primary Control Device, includes auxiliary	EC = IA x (10,294 $Q_{total}^{0.2355}$ + Ductwork), HR =	
	$ 262,566	equipment - interconnections and stacks	1 None	A, B, C, D, L
	$ 26,257	Instrumentation	0.1 EC	E
	$ 7,877	Taxes, Duties, VAT	0.03 EC	F
	$ 13,128	Freight	0.05 EC	
Purchased Equip. Total	**$ 309,828**		**1.18 EC = B**	
	Direct Installation Costs			
	$ 24,786	Foundations and supports	0.08 B	
	$ 65,064	Erecting and handling the equipment	0.21 B	G
	$ 12,393	Electrical work	0.04 B	
	$ 6,197	Piping	0.02 B	
	$ 3,098	Insulation	0.01 B	
	$ 3,098	Painting	0.01 B	
	$ 37,179	Fire suppression	0.12 B	H
	$ 275,000	Building and Site Preparation	Building	I
Direct Installation Total	**$ 426,816**		**1.49 B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 736,643**			
Indirect Costs (installation)				
	$ 30,983	Engineering	0.1 B	
	$ 15,491	Construction and field expenses	0.05 B	
	$ 30,983	Contractor fees	0.1 B	
	$ 6,197	Startup costs	0.02 B	
	$ 30,983	Performance test costs	0.1 B	
	$ 6,197	Contingencies	0.02 B	J
	$ 343,380	Plant Shutdown for Retrofit	Shutdown for retrofit	K
Total Indirect Costs, IC	**$ 464,213**		**0.39 B + Shutdown**	
Total Capital Investment	**$ 1,200,856**			

Comments:

A	Design Air Flow (dscfm)	21,466
B	Btus in Exhaust (Btus/dscf)	0.116
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M4 = 18 shifts of full production downtime	

Cost Item			Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 2,584,900	B, C, D, E, J
		Electricity (75 Hp)		$ 0.0770	/ kWhr	$ 36,814	B, E, F, I
Total DC						**$ 2,669,264**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 24,017	
	Property Taxes	1% of Total Capital Investment				$ 12,009	
	Insurance	1% of Total Capital Investment				$ 12,009	
	Capital Recovery					$ 212,528	G
Total Indirect Costs						**$ 289,092**	
Total Annual Costs						**$ 2,958,356**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 117,005**	E, H, K

Comments

Annual Operating Costs

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	21,466
C	Overall Temperature Rise Needed for No Heat Recovery (1,400 - 77) (°F/°R)	1323
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	23.698
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal (in. of water column)	4
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
J	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
K	Current Hourly Potential-To-Emit VOC (lbs/hr)	6.0

Total Capital Investment							Comments
	Direct Costs						
		Purchased Equipment Costs (PEC)					
		$	380,911	Primary Control Device, includes auxiliary equipment - interconnections and stacks	1	EC = IA x (13,149 $Q_{total}^{0.2609}$ + Ductwork), HR = 35%	A, B, C, D, L
		$	38,091	Instrumentation	0.1	EC	E
		$	11,427	Taxes, Duties, VAT	0.03	EC	F
		$	19,046	Freight	0.05	EC	
Purchased Equip. Total		**$**	**449,475**		**1.18**	**EC = B**	
		Direct Installation Costs					
		$	35,958	Foundations and supports	0.08	B	
		$	94,390	Erecting and handling the equipment	0.21	B	G
		$	17,979	Electrical work	0.04	B	
		$	8,990	Piping	0.02	B	
		$	4,495	Insulation	0.01	B	
		$	4,495	Painting	0.01	B	
		$	53,937	Fire suppression	0.12	B	H
		$	275,000	Building and Site Preparation		Building	I
Direct Installation Total		**$**	**495,243**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC		**$**	**944,718**				
	Indirect Costs (installation)						
		$	44,948	Engineering	0.1	B	
		$	22,474	Construction and field expenses	0.05	B	
		$	44,948	Contractor fees	0.1	B	
		$	8,990	Startup costs	0.02	B	
		$	44,948	Performance test costs	0.1	B	
		$	8,990	Contingencies	0.02	B	J
		$	343,380	Plant Shutdown for Retrofit	Shutdown for retrofit		K
Total Indirect Costs, IC		**$**	**518,675**		**0.39**	**B + Shutdown**	
Total Capital Investment		**$**	**1,463,394**				

Comments:

A	Design Air Flow (dscfm)	21,466
B	Btus in Exhaust (Btus/dscf)	0.116
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M4 = 18 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	**A, E**
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	**A, E**
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 1,675,757	**B, C, D, E, J**
		Electricity (125 Hp)		$ 0.0770	/ kWhr	$ 54,506	**B, E, F, I**
Total DC						**$ 1,777,813**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 29,268	
	Property Taxes	1% of Total Capital Investment				$ 14,634	
	Insurance	1% of Total Capital Investment				$ 14,634	
	Capital Recovery					$ 258,991	**G**
Total Indirect Costs						**$ 346,057**	
Total Annual Costs						**$ 2,123,870**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 84,001**	**E, H, K**

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	21,466
C	Overall Temperature Rise Needed for 35% Heat Recovery (1,400 - 77) x 35% (°F/°R)	859.95
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	15.3631
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 8", 35% Recovery (in. of water column)	8
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
J	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
K	Current Hourly Potential-To-Emit VOC (lbs/hr)	6.0

Total Capital Investment					**Comments**
Direct Costs					
Purchased Equipment Costs (PEC)					
	$ 430,933	Primary Control Device, includes auxiliary equipment - interconnections and stacks	1	EC = IA x (17,056 $Q_{total}^{0.2502}$ + Ductwork), HR = 50%	**A, B, C, D, L**
	$ 43,093	Instrumentation	0.1	EC	**E**
	$ 12,928	Taxes, Duties, VAT	0.03	EC	**F**
	$ 21,547	Freight	0.05	EC	
Purchased Equip. Total	**$ 508,500**		**1.18**	**EC = B**	
Direct Installation Costs					
	$ 40,680	Foundations and supports	0.08	B	
	$ 106,785	Erecting and handling the equipment	0.21	B	**G**
	$ 20,340	Electrical work	0.04	B	
	$ 10,170	Piping	0.02	B	
	$ 5,085	Insulation	0.01	B	
	$ 5,085	Painting	0.01	B	
	$ 61,020	Fire suppression	0.12	B	**H**
	$ 275,000	Building and Site Preparation		Building	**I**
Direct Installation Total	**$ 524,165**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,032,666**				
Indirect Costs (installation)					
	$ 50,850	Engineering	0.1	B	
	$ 25,425	Construction and field expenses	0.05	B	
	$ 50,850	Contractor fees	0.1	B	
	$ 10,170	Startup costs	0.02	B	
	$ 50,850	Performance test costs	0.1	B	
	$ 10,170	Contingencies	0.02	B	**J**
	$ 343,380	Plant Shutdown for Retrofit		Shutdown for retrofit	**K**
Total Indirect Costs, IC	**$ 541,695**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$ 1,574,361**				

Comments:

A	Design Air Flow (dscfm)	21,466
B	Btus in Exhaust (Btus/dscf)	0.116
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M4 = 18 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 1,286,124	B, C, D, E, J
		Electricity (150 Hp)		$ 0.0770	/ kWhr	$ 69,467	B, E, F, I
Total DC						**$ 1,403,141**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 31,487	
	Property Taxes	1% of Total Capital Investment				$ 15,744	
	Insurance	1% of Total Capital Investment				$ 15,744	
	Capital Recovery					$ 278,630	G
Total Indirect Costs						**$ 370,135**	
Total Annual Costs						**$ 1,773,276**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 70,134**	E, H, K

Comments

Annual Operating Costs

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	21,466
C	Overall Temperature Rise Needed for 50% Heat Recovery (1,400 - 77) x 50% (°F/°R)	661.5
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	11.791
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 8", 50% Recovery (in. of water column)	12
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
J	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
K	Current Hourly Potential-To-Emit VOC (lbs/hr)	6.0

Total Capital Investment					**Comments**
Direct Costs					
Purchased Equipment Costs (PEC)					
		Primary Control Device, includes auxiliary		EC = IA x (21,342 $Q_{total}^{0.2500}$ + Ductwork), HR =	
	$ 518,426	equipment - interconnections and stacks	1	70%	A, B, C, D, L
	$ 51,843	Instrumentation	0.1	EC	E
	$ 15,553	Taxes, Duties, VAT	0.03	EC	F
	$ 25,921	Freight	0.05	EC	
Purchased Equip. Total	**$ 611,742**		**1.18**	**EC = B**	
Direct Installation Costs					
	$ 48,939	Foundations and supports	0.08	B	
	$ 128,466	Erecting and handling the equipment	0.21	B	G
	$ 24,470	Electrical work	0.04	B	
	$ 12,235	Piping	0.02	B	
	$ 6,117	Insulation	0.01	B	
	$ 6,117	Painting	0.01	B	
	$ 73,409	Fire suppression	0.12	B	H
	$ 275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$ 574,754**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,186,496**				
Indirect Costs (installation)					
	$ 61,174	Engineering	0.1	B	
	$ 30,587	Construction and field expenses	0.05	B	
	$ 61,174	Contractor fees	0.1	B	
	$ 12,235	Startup costs	0.02	B	
	$ 61,174	Performance test costs	0.1	B	
	$ 12,235	Contingencies	0.02	B	J
	$ 343,380	Plant Shutdown for Retrofit		Shutdown for retrofit	K
Total Indirect Costs, IC	**$ 581,960**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$ 1,768,456**				

Comments:

A	Design Air Flow (dscfm)	21,466
B	Btus in Exhaust (Btus/dscf)	0.116
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M4 = 18 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 766,613	B, C, D, E, J
		Electricity (200 Hp)		$ 0.0770	/ kWhr	$ 84,040	B, E, F, I
Total DC						**$ 898,203**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 35,369	
	Property Taxes	1% of Total Capital Investment				$ 17,685	
	Insurance	1% of Total Capital Investment				$ 17,685	
	Capital Recovery					$ 312,981	G
Total Indirect Costs						**$ 412,249**	
Total Annual Costs						**$ 1,310,452**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						**$ 51,829**	E, H, K

Annual Operating Costs

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	21,466
C	Overall Temperature Rise Needed for 70% Heat Recovery (1,400 - 77) x 70% (°F/°R)	396.9
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	7.0282
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 15", 70% Recovery (in. of water column)	19
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.077
J	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
K	Current Hourly Potential-To-Emit VOC (lbs/hr)	6.0

Total Capital Investment						Comments
Direct Costs						
	Purchased Equipment Costs (PEC)					
	$	1,097,745	Primary Control Device, includes auxiliary equipment - interconnections and stack	1	$EC = IA \times ((2.204 \times 10^5 + 11.57\, Q_{total})$ + Ductwork, Fan, and Stack)	A, B, C, D, L
	$	109,775	Instrumentation	0.1	EC	E
	$	32,932	Taxes, Duties, VAT	0.03	EC	F
	$	54,887	Freight	0.05	EC	
Purchased Equip. Total	$	**1,295,340**		**1.18**	**EC = B**	
	Direct Installation Costs					
	$	103,627	Foundations and supports	0.08	B	
	$	272,021	Erecting and handling the equipment	0.21	B	G
	$	51,814	Electrical work	0.04	B	
	$	25,907	Piping	0.02	B	
	$	12,953	Insulation	0.01	B	
	$	12,953	Painting	0.01	B	
	$	155,441	Fire suppression	0.12	B	H
	$	275,000	Building and Site Preparation		Building	I
Direct Installation Total	$	**909,716**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	$	**2,205,056**				
Indirect Costs (installation)						
	$	129,534	Engineering	0.1	B	
	$	64,767	Construction and field expenses	0.05	B	
	$	129,534	Contractor fees	0.1	B	
	$	25,907	Startup costs	0.02	B	
	$	129,534	Performance test costs	0.1	B	
	$	25,907	Contingencies	0.02	B	J
	$	343,380	Plant Shutdown for Retrofit		Shutdown for retrofit	K
Total Indirect Costs, IC	$	**848,562**		**0.39**	**B + Shutdown**	
Total Capital Investment	$	**3,053,619**				

Comments:

A	Design Air Flow (dscfm)	21,466
B	Btus in Exhaust (Btus/dscf)	0.116
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M4 = 18 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Wear Item Replacement						
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 380,023	B, C, D, E, J
		Electricity (100 Hp)		$ 0.0770	/ kWhr	$ 40,881	B, E, F, I
Total DC						**$ 468,455**	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 61,072	
	Property Taxes	1% of Total Capital Investment				$ 30,536	
	Insurance	1% of Total Capital Investment				$ 30,536	
	Capital Recovery					$ 540,429	G
Total Indirect Costs						**$ 691,104**	
Total Annual Costs						**$ 1,159,559**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						$ 45,861	E, H, K

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	21,466

Annual Operating Costs

C	Overall Temperature Rise Assumed per Existing Pollution Control Device (°F above ambient)	200
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	3.484
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 4" Thermal plus 8" (in. of water column)	12
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.176980
H	DRE	98%
I	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
J	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
K	Current Hourly Potential-To-Emit VOC (lbs/hr)	6.0

						Comments
Total Capital Investment						
Direct Costs						
			Purchased Equipment Costs (PEC)			
	$	519,530	Primary Control Device, includes auxiliary equipment - interconnections and stack	1	$EC = IA \times (1105\ Q_{total}^{0.5471} + Ductwork)$, No HR	**A, B, C, D, L**
	$	51,953	Instrumentation	0.1	EC	**E**
	$	15,586	Taxes, Duties, VAT	0.03	EC	**F**
	$	25,976	Freight	0.05	EC	
Purchased Equip. Total	**$**	**613,045**		**1.18**	**EC = B**	
			Direct Installation Costs			
	$	49,044	Foundations and supports	0.08	B	
	$	128,739	Erecting and handling the equipment	0.21	B	**G**
	$	24,522	Electrical work	0.04	B	
	$	12,261	Piping	0.02	B	
	$	6,130	Insulation	0.01	B	
	$	6,130	Painting	0.01	B	
	$	73,565	Fire suppression	0.12	B	**H**
	$	275,000	Building and Site Preparation		Building	**I**
Direct Installation Total	**$**	**575,392**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	$	**1,188,437**				
Indirect Costs (installation)						
	$	61,305	Engineering	0.1	B	
	$	30,652	Construction and field expenses	0.05	B	
	$	61,305	Contractor fees	0.1	B	
	$	12,261	Startup costs	0.02	B	
	$	61,305	Performance test costs	0.1	B	
	$	12,261	Contingencies	0.02	B	**J**
	$	343,380	Plant Shutdown for Retrofit		Shutdown for retrofit	**K**
Total Indirect Costs, IC	**$**	**582,468**		**0.39**	**B + Shutdown**	
Total Capital Investment	$	**1,770,905**				

Comments:

A	Design Air Flow (dscfm)	21,466
B	Btus in Exhaust (Btus/dscf)	0.116
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M4 = 18 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost	Extended	Comments
Direct Annual Costs, DC						
	Operating Labor					
		Operator	0.5 hr/shift	$24.70	$ 13,276	A, E
		Supervisor	15% of operator		$ 1,991	
	Maintenance					
		Labor	0.5 hr/shift	$30.03	$ 16,141	A, E
		Materials	100% of Maintenance labor		$ 16,141	
	Replacement Parts, Catalysts (2-year life)					
		Material & freight (5%) of noble metal catalyst		$ 7,290	$ 194,446	H, J, K, L
	Utilities					
		Natural Gas		$ 10.34 /MCF	$ 1,406,872	B, C, D, E, N
		Electricity (50 Hp)		$ 0.0770 / kWhr	$ 16,631	B, E, F, M
Total DC					**$ 1,665,499**	
Indirect Annual Costs, IC						
	Overhead					
		60% of sum of Operating, supv., and maintenance labor and materials			$ 28,530	
	Administrative Charges	2% of Total Capital Investment			$ 35,418	
	Property Taxes	1% of Total Capital Investment			$ 17,709	
	Insurance	1% of Total Capital Investment			$ 17,709	
	Capital Recovery				$ 313,415	G
Total Indirect Costs					**$ 412,781**	
Total Annual Costs					**$ 2,078,280**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					**$ 84,793**	E, I, O

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	21,466
C	Overall Temperature Rise Needed for 70% Heat Recovery (800 - 77) (°F/°R)	723
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	12.898
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX , No Heat Recovery (in. of water column)	6
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	43
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2022 cost of noble metal catalyst, 2.43 Inflation factor from 1988 to 2022	$7,290
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
N	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
O	Current Hourly Potential-To-Emit VOC (lbs/hr)	6.0

Total Capital Investment						**Comments**
Direct Costs						
			Purchased Equipment Costs (PEC)			
			Primary Control Device, includes auxiliary		EC = IA x (3623 $Q_{total}^{0.4189}$ + Ductwork), HR =	
	$	481,139	equipment - interconnections and stack	1	35%	**A, B, C, D, L**
	$	48,114	Instrumentation	0.1	EC	**E**
	$	14,434	Taxes, Duties, VAT	0.03	EC	**F**
	$	24,057	Freight	0.05	EC	
Purchased Equip. Total	**$**	**567,744**		**1.18**	**EC = B**	
			Direct Installation Costs			
	$	45,420	Foundations and supports	0.08	B	
	$	119,226	Erecting and handling the equipment	0.21	B	**G**
	$	22,710	Electrical work	0.04	B	
	$	11,355	Piping	0.02	B	
	$	5,677	Insulation	0.01	B	
	$	5,677	Painting	0.01	B	
	$	68,129	Fire suppression	0.12	B	**H**
	$	275,000	Building and Site Preparation		Building	**I**
Direct Installation Total	**$**	**553,194**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$**	**1,120,938**				
Indirect Costs (installation)						
	$	56,774	Engineering	0.1	B	
	$	28,387	Construction and field expenses	0.05	B	
	$	56,774	Contractor fees	0.1	B	
	$	11,355	Startup costs	0.02	B	
	$	56,774	Performance test costs	0.1	B	
	$	11,355	Contingencies	0.02	B	**J**
	$	343,380	Plant Shutdown for Retrofit	Shutdown for retrofit		**K**
Total Indirect Costs, IC	**$**	**564,800**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$**	**1,685,738**				

Comments:

A	Design Air Flow (dscfm)	21,466
B	Btus in Exhaust (Btus/dscf)	0.116
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M4 = 18 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost		Extended	Comments
Direct Annual Costs, DC							
	Operating Labor						
		Operator	0.5 hr/shift	$24.70		$ 13,276	A, E
		Supervisor	15% of operator			$ 1,991	
	Maintenance						
		Labor	0.5 hr/shift	$30.03		$ 16,141	A, E
		Materials	100% of Maintenance labor			$ 16,141	
	Replacement Parts, Catalysts (2-year life)						
		Material & freight (5%) of noble metal catalyst		$ 7,290		$ 194,446	H, J, K, L
	Utilities						
		Natural Gas		$ 10.34	/MCF	$ 910,038	B, C, D, E, N
		Electricity (75 Hp)		$ 0.0770	/ kWhr	$ 27,719	B, E, F, M
Total DC						$ 1,179,753	
Indirect Annual Costs, IC							
	Overhead						
		60% of sum of Operating, supv., and maintenance labor and materials				$ 28,530	
	Administrative Charges	2% of Total Capital Investment				$ 33,715	
	Property Taxes	1% of Total Capital Investment				$ 16,857	
	Insurance	1% of Total Capital Investment				$ 16,857	
	Capital Recovery					$ 298,342	G
Total Indirect Costs						$ 394,301	
Total Annual Costs						$ 1,574,054	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)						$ 64,221	E, I, O

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	21,466
C	Overall Temperature Rise Needed for 35% Heat Recovery (800 - 77) x 35% (°F/°R)	469.95
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	8.343
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX plus 4", 35% Recovery (in. of water column)	10
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	43
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2022 cost of noble metal catalyst, 2.43 Inflation factor from 1988 to 2022	$7,290
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
N	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
O	Current Hourly Potential-To-Emit VOC (lbs/hr)	6.0

Total Capital Investment				Comments
Direct Costs				
		Purchased Equipment Costs (PEC)		
		Primary Control Device, includes auxiliary	EC = IA x (1215 $Q_{total}^{0.5575}$ + Ductwork), HR =	
	$ 616,269	equipment - interconnections and stack	1 50%	A, B, C, D, L
	$ 61,627	Instrumentation	0.1 EC	E
	$ 18,488	Taxes, Duties, VAT	0.03 EC	F
	$ 30,813	Freight	0.05 EC	
Purchased Equip. Total	**$ 727,198**		**1.18 EC = B**	
		Direct Installation Costs		
	$ 58,176	Foundations and supports	0.08 B	
	$ 152,712	Erecting and handling the equipment	0.21 B	G
	$ 29,088	Electrical work	0.04 B	
	$ 14,544	Piping	0.02 B	
	$ 7,272	Insulation	0.01 B	
	$ 7,272	Painting	0.01 B	
	$ 87,264	Fire suppression	0.12 B	H
	$ 275,000	Building and Site Preparation	Building	I
Direct Installation Total	**$ 631,327**		**1.49 B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,358,525**			
Indirect Costs (installation)				
	$ 72,720	Engineering	0.1 B	
	$ 36,360	Construction and field expenses	0.05 B	
	$ 72,720	Contractor fees	0.1 B	
	$ 14,544	Startup costs	0.02 B	
	$ 72,720	Performance test costs	0.1 B	
	$ 14,544	Contingencies	0.02 B	J
	$ 343,380	Plant Shutdown for Retrofit	Shutdown for retrofit	K
Total Indirect Costs, IC	**$ 626,987**		**0.39 B + Shutdown**	
Total Capital Investment	**$ 1,985,512**			

Comments:

A	Design Air Flow (dscfm)	21,466
B	Btus in Exhaust (Btus/dscf)	0.116
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M4 = 18 shifts of full production downtime	

	Cost Item		Suggested Factor		Unit Cost			Extended	Comments
Direct Annual Costs, DC									
	Operating Labor								
		Operator	0.5 hr/shift		$24.70		$	13,276	A, E
		Supervisor	15% of operator				$	1,991	
	Maintenance								
		Labor	0.5 hr/shift		$30.03		$	16,141	A, E
		Materials	100% of Maintenance labor				$	16,141	
	Replacement Parts, Catalysts (2-year life)								
		Material & freight (5%) of noble metal catalyst		$	7,290		$	194,446	H, J, K, L
	Utilities								
		Natural Gas		$	10.34	/MCF	$	697,109	B, C, D, E, N
		Electricity (100 Hp)		$	0.0723	/ kWhr	$	36,438	B, E, F, M
Total DC							$	**975,543**	
Indirect Annual Costs, IC									
	Overhead								
		60% of sum of Operating, supv., and maintenance labor and materials					$	28,530	
	Administrative Charges	2% of Total Capital Investment					$	39,710	
	Property Taxes	1% of Total Capital Investment					$	19,855	
	Insurance	1% of Total Capital Investment					$	19,855	
	Capital Recovery						$	351,396	G
Total Indirect Costs							$	**459,346**	
Total Annual Costs							$	**1,434,890**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)							$	**58,543**	E, I, O

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	21,466
C	Overall Temperature Rise Needed for 70% Heat Recovery (800 - 77) x 50% (°F/°R)	361.5
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	6.391
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX plus 8", 50% Recovery (in. of water column)	14
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	43
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2022 cost of noble metal catalyst, 2.43 Inflation factor from 1988 to 2022	$7,290
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
N	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
O	Current Hourly Potential-To-Emit VOC (lbs/hr)	6.0

Total Capital Investment					Comments
Direct Costs					
		Purchased Equipment Costs (PEC)			
	$ 687,225	Primary Control Device, includes auxiliary equipment - interconnections and stack	1	EC = IA x (1443 $Q_{total}^{0.5527}$ + Ductwork), HR = 70%	A, B, C, D, L
	$ 68,723	Instrumentation	0.1	EC	E
	$ 20,617	Taxes, Duties, VAT	0.03	EC	F
	$ 34,361	Freight	0.05	EC	
Purchased Equip. Total	**$ 810,926**		**1.18**	**EC = B**	
		Direct Installation Costs			
	$ 64,874	Foundations and supports	0.08	B	
	$ 170,294	Erecting and handling the equipment	0.21	B	G
	$ 32,437	Electrical work	0.04	B	
	$ 16,219	Piping	0.02	B	
	$ 8,109	Insulation	0.01	B	
	$ 8,109	Painting	0.01	B	
	$ 97,311	Fire suppression	0.12	B	H
	$ 275,000	Building and Site Preparation		Building	I
Direct Installation Total	**$ 672,354**		**1.49**	**B + Building and Site Preparation**	
Total Direct Costs, DC	**$ 1,483,280**				
Indirect Costs (installation)					
	$ 81,093	Engineering	0.1	B	
	$ 40,546	Construction and field expenses	0.05	B	
	$ 81,093	Contractor fees	0.1	B	
	$ 16,219	Startup costs	0.02	B	
	$ 81,093	Performance test costs	0.1	B	
	$ 16,219	Contingencies	0.02	B	J
	$ 343,380	Plant Shutdown for Retrofit		Shutdown for retrofit	K
Total Indirect Costs, IC	**$ 659,641**		**0.39**	**B + Shutdown**	
Total Capital Investment	**$ 2,142,921**				

Comments:

A	Design Air Flow (dscfm)	21,466
B	Btus in Exhaust (Btus/dscf)	0.116
C	*(IA)* Inflation Adjustment for EC	1.700
D	from 6th Edition EPA APCC Manual	
E	Fire damper, integration/interlocks with existing controls	
F	For manufacturing, exempt from sales tax	
G	Retrofit penalty (50% above recommendation) Against building, near high voltage	
H	Increased 50% above standard to accommodate long duct at ceiling height	
I	A heated building (5,000 ft^2 assumed at $55/$ft^2$)is necessary because Linpar 1416V becomes a solid at 45 °F.	
J	Redesign/modification of equipment, startup delays	
K	M4 = 18 shifts of full production downtime	

	Cost Item		Suggested Factor	Unit Cost	Extended	Comments
Direct Annual Costs, DC						
	Operating Labor					
		Operator	0.5 hr/shift	$24.70	$ 13,276	A, E
		Supervisor	15% of operator		$ 1,991	
	Maintenance					
		Labor	0.5 hr/shift	$30.03	$ 16,141	A, E
		Materials	100% of Maintenance labor		$ 16,141	
	Replacement Parts, Catalysts (2-year life)					
		Material & freight (5%) of noble metal catalyst		$ 7,290	$ 194,446	H, J, K, L
	Utilities					
		Natural Gas		$ 10.34 /MCF	$ 413,204	B, C, D, E, N
		Electricity (125 Hp)		$ 0.0770 / kWhr	$ 58,210	B, E, F, M
Total DC					**$ 713,410**	
Indirect Annual Costs, IC						
	Overhead					
		60% of sum of Operating, supv., and maintenance labor and materials			$ 28,530	
	Administrative Charges	2% of Total Capital Investment			$ 42,858	
	Property Taxes	1% of Total Capital Investment			$ 21,429	
	Insurance	1% of Total Capital Investment			$ 21,429	
	Capital Recovery				$ 379,254	G
Total Indirect Costs					**$ 493,501**	
Total Annual Costs					**$ 1,206,911**	
Total Costs for Removing One Ton of VOC ($/ton of VOC removed)					**$ 49,242**	E, I, O

Comments

A	Inflation 1999 - 2022	1.7
B	Air Flow (dscfm)	21,466
C	Overall Temperature Rise Needed for 70% Heat Recovery (800 - 77) x 70% (°F/°R)	216.9
D	Btus Required to Heat one dscf of air to Required Net Temperature includes contribution from Exhaust VOC	3.788
E	Annual Operational Hours - Assumes 2% Downtime for Maintenance	8600
F	Pressure Drop = 6" CATOX plus 15", 70% Recovery (in. of water column)	21
G	CRF - Capital Recovery Factor, based on 10-year equipment life, 12% interest rate - JWA Internal Opportunity Cost	0.17698
H	CRF - Capital Recovery Factor, 2-year catalyst life (per Table 2.10, Sec. 3.2 of APCCM), 12% interest rate - JWA Internal Opportunity Cost	0.5917
I	DRE, from page 2-30 APCCM, Section 3.2	95%
J	From Vatavuk, page 149, assume 2 ft^3 noble metal catalyst per 1,000 scfm	43
K	1988 Cost of noble metal catalyst per ft^3, not repeated in 2002 edition of APCCM	$3,000
L	2022 cost of noble metal catalyst, 2.43 inflation factor from 1988 to 2022	$7,290
M	PA Industrial Electricity Cost 2021/2022 Average ($/kWhr)	0.0770
N	PA Natural Gas Industry Cost 2921/2022 ($/mcf)	10.34
O	Current Hourly Potential-To-Emit VOC (lbs/hr)	6.0

Auxilliary Equipment Costs

Duct diameter (Eq. 1.27) $D_d = 1.128(Q/u)^{1/2}$			
Q =		23,183	acfm
u =		3,000	fpm
D_d =		3.1	ft.
D_d =		37.6	in.
1999 Cost of Duct per foot (Eq. 1.40)			
Power cost model - circular,			
longitudinal, plate steel, one coat paint			
$C_{foot\ of\ pipe} = aD^b$			
a =	2.49		
b =	1.15		
$C_{foot\ of\ pipe}$ =	$	161.45	
Duct length from drawing		280	ft.
1999 Cost of Duct Pipe	**$**	**45,207**	
Exponential cost model, single walled,			
non-insulated elbow, a =	30.4		
b=	0.0594		
(Eq. 1.41) and Tbl 1.10 $C_{elbow} = ae^{bD}$	$	284.17	
Number of Elbows		5	
1999 Cost of Elbows	**$**	**1,421**	
Duct diameter (Eq. 1.27) $D_d = 1.128(Q_c/u_c)^{1/2}$			
RTO temp. rise $_{max}$ 200 °R = (737/537), Q_c =		31,818	acfm
3,000 fpm (1.5 x wind speed, 34 mph), u_c =		3,000	fpm
Stack diamter, D_d =		3.7	ft.
D_d =		44.1	in.
$C_{foot\ of\ stack} = aD^b$			
a =	2.49		
b =	1.15		
$C_{foot\ of\ stack}$ =	$	193.69	
Stack height, from page 1-36, Section 2 Chapter 1		213	ft.

1999 Cost of Stack	**$**	**41,256**	
1999 Edition 6 of Control Cost Manual (most recent) does not include fan cost model - RTO only.	$	34,800.00	
125 Hp. Classs 3, backward inclined, 1,800 rpm TEFC, rated for 300 °F. Cost estimate is a lookup from the most recent (1978) EPA estimate, adjusted to 1999 by the CPI (2.56). **1999 Cost of Fan**	**$**	**89,088.00**	
	Totals		
State of the Art Hoods are Installed	**$**	**-**	**Entry and Exit Hoods**
Custom retrofitted	**$**	**46,627**	**Duct and Elbows**
Only used with RTO, assumed to be part of other technology packages	$	**89,088**	**Backward inclined Fan**
Only used with RTO, assumed to be part of other technology packages	$	**41,256**	**Stack**

[1]Based on Eq (1.40) pg. 1-41 Sec. 2, Chptr. 1 EPA PCCM-6, upgraded by Table 1.12 multiplier for CRS from plastic (3.74/.393) per Table 1.8 steel for strength and to accommodate fire risk