Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Tinting Process total throughput pounds for the year	Line B Year-end Yield Loss Report (found on site webpage in Butacite section under "Yield Loss Report")
Annual production run time for each bandwidth (hours for year)	

Point Source Emissions Determination:

Point source emissions for individual components are given in the following pages. A detailed explanation of the calculations is attached.

Equipment Emissions and Fugitive Emissions Determination:

The Butacite Tinting Process is contained in a Total Permanent Enclosure, and as such there are no non-point source (fugitive) emissions associated with this process.

Point Source Emission Determination

Dimethylformamide **CAS No. 68-12-2**
DMF

Emissions of dimethylformamide (DMF) from the Butacite® Tinting Process are reported as both a Volatile Organic Compound (VOC) and as a Hazardous Air Pollutant (HAP). All emissions of DMF are from the multi-stage horizontal spray water scrubber (BCD-D1) that has a documented DMF control efficiency of 97%.

DMF Before-Control Emissions:

The before-control DMF emission rate is determined by the hours that each of the various tinted bandwidths are produced during the year. The hours of production for a specific bandwidth is then multiplied by the DMF emission factor for that bandwidth to determine the before-contol quantity of DMF that would have been emitted from the tinting process. The emitted DMF quantities for each bandwidth is then summed to obtain the total before-control DMF emission quantity. That determination is shown in the preceeding Butacite® Tinting Process DMF Emissions Report.

For 2004 , the before-control DMF emission to the scrubber was 30,557.9 pounds.

DMF After-Control Emissions:

Before-control DMF emissions = **30,557.9** pounds

DMF control efficiency of the Tinting water scrubber (BCD-D1) = **97%**

After-control emissions utilizing the 97% control efficient water scrubber (BCD-D1):

After-control DMF emissions would be: 100% – 97% = **3%** of the incoming DMF

Therefore, after-control emissions = **30,557.9** pounds
X **3%**
916.7 pounds DMF

Fugitive and Equipment Emissions Determination (Non-point Source):

The Butacite Tinting Process is wholly contained in a Permanent Total Enclosure. As such, all emissions are ultimately discharged to and through the horizontal spray water scrubber (BCD-D1). Therefore, there are no non-point source emissions from this process.

Accidental Releases to Atmosphere

For 2004 there were no accidental releases from the Tinting Process.

Emission Summary

A. VOC Emissions by Compound and Source

Butacite® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lbs)	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total VOC Emissions (lbs)
DMF	Dimethylformamide	68-12-2	916.7	0	0	0	916.7
	Total VOC Emissions in 2004		**916.7**	**0**	**0**	**0**	**916.7**
					Total VOC (Tons)		**0.46**

B. Hazardous Air Pollutant Summary

Butacite® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lbs)	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total Emissions (lbs)
DMF	Dimethylformamide	68-12-2	917	0.0	0	0	916.7

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DAQ Region : FRO

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Division of Air Quality
Air Pollutant Point Source Emissions Inventory – Calendar Year 2004

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1. **Emission Source ID (from permit) or Emission Source Group ID** U–Insig–B1

2. **Emission Source Description:** Butacite(R) PVA Storage Silos

3. **Operating Scenario ID/Description:** OS – 32/Butacite(R) PVA Storage Silos

4. **SCC Number/Description:** 30199999/*Other Organic Chemica Manufacture Not Listed

5. **Throughput/units in 2004:**
(e.g. production or fuel use):

6. **Fuel Information** (If fuel is used)

% Sulfur		% Ash		Heat Content (Btu/units)	

7. **Capture Efficiency**
(% of Emissions from this Process Vented to Control Device or Stack): 100

8. **Control Device Information :None**

Order	CS–ID	CD ID (as listed in permit)	Control Device Description

9. **Emission Release Point (ERP) Information:** (Sources vented to more than one ERP use additional entry lines):

ERP ID	ERP Type	Height (in feet)	Diameter Circle (enter #): Rectangle (L x W) (in 0.1 feet)	Temperature (F)	Velocity (Feet/sec)	Volume Flow Rate (Acfm)	ERP Description
EP–Insig–B1	VERTICAL STACK	85	2	78	40	7539.82	Butacite(R) PVA Storage Silo

Operating Scenario: OS – 32 **Emission Source/Group ID:** U–Insig–B1

10. Operating Schedule: (Source/Operating Scenario that best characterizes Calendar Year 2004)
Hours per Day (24) **Days per Week** (7) **Weeks per Year** (52)

11. Typical Start & End Times For Operating Scenario: **Start:** 0 **End:** 2359

12. Seasonal Periods Percent Annual Throughput:

Jan–Feb + Dec 2004	25%	March–May 2004	25%	June–Aug. 2004	25%	Sept.–Nov. 2004	25%

13. Actual Emissions per Pollutant Listed :
Attach calculations and documentation of emission factors or other estimation methods used.

Criteria (NAAQS) Pollutants	Pollutant Code	Emissions– Criteria Pollutants (Tons/Year)	Emission Estimation Method Code (See Instructions)	Control Efficiency (Net after all controls)
		2004		
VOC	VOC	2.9	02	
HAP/TAP Pollutants (In Alphabetical Order)	**CAS** (see instructions)	**Emissions HAP/TAPS** (Pounds/Year)	**Emission Estimation Method Code** (See Instructions)	**Control Efficiency** (Net after all controls)
		2004		
Methanol	67–56–1	5814	02	

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Division of Air Quality
Air Pollutant Point Source Emissions Inventory – Calendar Year 2004

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1. **Emission Source ID (from permit) or Emission Source Group ID** U–Insig–B2
2. **Emission Source Description:** Butacite(R) PVA Dissolver Tank System
3. **Operating Scenario ID/Description:** OS – 34/Butacite(R) PVA Dissolver Tank System
4. **SCC Number/Description:** 30199999/*Other Organic Chemica Manufacture Not Listed

5. **Throughput/units in 2004:**
(e.g. production or fuel use):

6. **Fuel Information** (If fuel is used)

% Sulfur		% Ash		Heat Content (Btu/units)	

7. **Capture Efficiency**
(% of Emissions from this Process Vented to Control Device or Stack): 100

. **Control Device Information :None**

Order	CS–ID	CD ID (as listed in permit)	Control Device Description

9. **Emission Release Point (ERP) Information: (Sources vented to more than one ERP use additional entry lines):**

ERP ID	ERP Type	Height (in feet)	Diameter Circle (enter #): Rectangle (L x W) (in 0.1 feet)	Temperature (F)	Velocity (Feet/sec)	Volume Flow Rate (Acfm)	ERP Description
EP–Insig–B2	VERTICAL STACK	85	1	78	40	1884.95	Butacite(R) PVA Dissolving Tank System

Operating Scenario: OS – 34 **Emission Source/Group ID:** U–Insig–B2

10. Operating Schedule: (Source/Operating Scenario that best characterizes Calendar Year 2004)
Hours per Day (24) **Days per Week** (7) **Weeks per Year** (52)

11. Typical Start & End Times For Operating Scenario: **Start:** 0 **End:** 2359

12. Seasonal Periods Percent Annual Throughput:

Jan–Feb + Dec 2004	**25%**	**March–May 2004**	**25%**	**June–Aug. 2004**	**25%**	**Sept.–Nov. 2004**	**25%**

13. Actual Emissions per Pollutant Listed :
Attach calculations and documentation of emission factors or other estimation methods used.

Criteria (NAAQS) Pollutants	**Pollutant Code**	**Emissions– Criteria Pollutants (Tons/Year)**	**Emission Estimation Method Code** (See Instructions)	**Control Efficiency** (Net after all controls)
		2004		
VOC	**VOC**	0.55	02	
HAP/TAP Pollutants (In Alphabetical Order)	**CAS** (see instructions)	**Emissions HAP/TAPS** (Pounds/Year)	**Emission Estimation Method Code** (See Instructions)	**Control Efficiency** (Net after all controls)
		2004		
Methanol	**67–56–1**	1090	02	

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2004 AIR EMISSIONS INVENTORY

PVA DISSOLVER TANK

EMISSIONS DETERMINATION

Vapor Displaced per Batch

Dissolver Tank Volume = 7500 gallons   Tank Temperature = 91°C

Displaced vapor associated with filing dissolver tank and reactor feed tank:

= 15000 gallons

Displaced vapor associated with heating the dissolver tank:

$$= \frac{(\text{PH}_2\text{O at } 91°\text{C} - \text{Ph}_2\text{O at } 20°\text{C}) \times \text{Vapor Space Volume}}{\text{Atmospheric Pressure}} = \frac{(546 - 17.5)(7500)}{760} = 5216 \text{ gallons}$$

Where: PH_2O at 91°C = Vapor pressure of water at 91°C = 546 mmHg
PH_2O at 20°C = Vapor pressure of water at 20°C = 17.5 mmHg
Vapor Space Volume = Tank Volume = 7500 gallons

Total displaced vapor per batch = 15000 gallons + 5216 gallons = 20216 gallons = 2703 ft^3

Methanol (VOC) Emissions per Batch

Methanol emissions per batch are calculated based on the total moles in the displaced vapor multiplied by the methanol concentration measure in the tank vent (1200 ppm).

Methanol concentration = 1200 ppm by volume

Mole fraction of water in the air over the dissolver tank
= 546 mmHg ÷ 760 mmHg = 0.718 mole H2O per mole of air

Calculate the molar density in the air over the tank (assume air is at 91°C)
= Dmole = P / RT where: P = 1 atm; R = 0.082 atm-L / mole-°K; T = 551°K
= 0.0335 g-mole / L
= 0.0021 lb-mole / ft3

Total pound-moles emitted per batch are calculated as:
= 2703 ft3 / batch x 0.0021 lb-moles / ft3 = 5.65 lb-moles per batch

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Division of Air Quality
Air Pollutant Point Source Emissions Inventory – Calendar Year 2004

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1. Emission Source ID (from permit) or Emission Source Group ID INSIG–B8.1

2. Emission Source Description: Butacite extruder system – line no. 3

3. Operating Scenario ID/Description: OS – 9/Butacite extruder system – line no. 3

4. SCC Number/Description: 30199998/*Other Organic Chemica Manufacture Not Listed

5. Throughput/units in 2004:
(e.g. production or fuel use):

6. Fuel Information (If fuel is used)

% Sulfur		% Ash		Heat Content (Btu/units)	

7. Capture Efficiency
(% of Emissions from this Process Vented to Control Device or Stack): 100

Control Device Information :None

Order	CS–ID	CD ID (as listed in permit)	Control Device Description

9. Emission Release Point (ERP) Information: (Sources vented to more than one ERP use additional entry lines):

ERP ID	ERP Type	Height (in feet)	Diameter Circle (enter #): Rectangle (L x W) (in 0.1 feet)	Temperature (F)	Velocity (Feet/sec)	Volume Flow Rate (Acfm)	ERP Description
EP–EXT	VERTICAL STACK	50	1	100	0.98	46.18	Butacite extruder systems

Operating Scenario: OS – 9 **Emission Source/Group ID:** INSIG–B8.1

10. Operating Schedule: (Source/Operating Scenario that best characterizes Calendar Year 2004)
Hours per Day (24) **Days per Week** (7) **Weeks per Year** (52)

11. Typical Start & End Times For Operating Scenario: **Start:** 0 **End:** 2359

12. Seasonal Periods Percent Annual Throughput:

Jan–Feb + Dec 2004	**25%**	**March–May 2004**	**25%**	**June–Aug. 2004**	**25%**	**Sept.–Nov. 2004**	**25%**

13. Actual Emissions per Pollutant Listed :
Attach calculations and documentation of emission factors or other estimation methods used.

Criteria (NAAQS) Pollutants	**Pollutant Code**	**Emissions– Criteria Pollutants (Tons/Year)**	**Emission Estimation Method Code** (See Instructions)	**Control Efficiency** (Net after all controls)
		2004		
VOC	**VOC**	1.11	02	
HAP/TAP Pollutants (In Alphabetical Order)	**CAS** (see instructions)	**Emissions HAP/TAPS** (Pounds/Year)	**Emission Estimation Method Code** (See Instructions)	**Control Efficiency** (Net after all controls)
		2004		

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2004 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: BS-Insig B8.1

Emission Source Description: Butacite Extrusion Process - Line 3

Process and Emission Description:

The Butacite Line 3 Extrusion Process is a continuous process in which polyvinyl butyral (PVB) resin is extruded into a plastic sheet using three separate mechanical extruders. To remove the resin's entrained water, a vacuum is pulled on the extruders using a series of steam venturi jets. Following each steam jet, the exhaust stream passes through water-cooled condensers to remove the water vapor so that the following steam jet can achieve the necessary secondary vacuum to achieve the required overall vacuum at the extruder so as to produce saleable product.

Air emissions from the Butacite Line 3 Extrusion Process are assumed to be completely (100%) captured. The emissions of Volatile Organic Compounds (VOC) are assumed to be totally the 3GO plasticizer used to manufacture Butacite PVB sheeting. Because the potential VOC emissions are well less than the 40 ton per year NSR/PSD significant emission rate, the final condenser, which exists to remove water and other condensable compounds from the atmospheric discharge, can be treated as having a control efficiency of 0%.

Basis and Assumptions:

The assumption is that all VOC emissions from the Line 3 extrusion process are comprised of the 3GO plasticizer.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Butacite Line 3 Extrusion Process total throughput pounds for the year	Butacite Production Support (BPS) System annual report.

Point Source Emissions Determination:

Determination of point source VOC emissions are given in the following pages.

Equipment Emissions and Fugitive Emissions Determination:

Since the Butacite extruders operate under a vacuum, there are no non-point source (fugitive) emissions nor equipment emissions associated with this process.

Point Source Emission Determination - Line 3 Extrusion Process

Triethylene glycol di-2-ethylhexanoate (3GO) **CAS No. 94-28-0**

Emission Estimation Approach:

Emissions from the Butacite® extruders are calculated using a mass balance approach. Based on the vapor pressure exerted by organic material in the extruder and the flow rate out of the extruder, material flowrates throughout the entire extruder process are calculated. There are a total of 3 extruders in the Line 3 extruder operation.

The extruder process consists of the extruder unit followed by a knock-out pot, and the steam jet vacuum system. Material flowrates into and out of each of these process steps are calculated below.

General Steps for Quantifying Emissions:

The primary purpose of the extruders is to remove water from the extruder feed material. This is accomplished by heating the feed material and operating the extruders under vacuum conditions. A vacuum is pulled on each extruder via a 2-stage steam jet vacuum system. The vacuum jet system consists of a 1st condenser followed by the 1st vacuum jet, 2nd condenser, 2nd vacuum jet, and lastly a final condenser. The purpose of the first condenser is to remove condensable substances so as to maximize efficiency of the steam jet. The purpose of the 2nd condenser is to condense steam injected into the 1st vacuum jet in order to maximize efficiency of the 2nd vacuum jet. The purpose of the final condenser is to condense the steam that is injected into the 2nd vacuum jet. The general steps for quantifying emissions are as follows:

STEP 1: Estimate the VOC's vented from the extruder unit based on the water and noncondensables that are vented, the total system pressure, and the approximate vapor pressure of organics.

STEP 2: Calculate the amount of VOC that passes through the first condenser based on the temperature out of the first condenser, the noncondensable flow, and the system pressure.

STEP 3: Calculate the amount of VOC that passes through the second condenser based on the temperature of the second condenser, the noncondensable flow, and the system pressure.

STEP 4: Calculate the amount of VOC that passes through the final condenser based on the temperature of the final condenser, the noncondensable flow, and the atmospheric pressure.

For Steps 1 and 2, the VOC flowrates are calculated on a per extruder basis. For Steps 3 and 4, the VOC flowrates are calculated per extruder and for all three extruders combined.

Moles of VOC emitted from the extruder are determined by subtracting the non-organic moles in the off-gas (10.46 lb-mole/hr/extruder) from the total moles in the off-gas (10.85 lb-mole/hr/extruder).

$$\frac{10.85\ \text{lb-mole}}{\text{hr - extruder}} - \frac{10.46\ \text{lb-mole}}{\text{hr - extruder}} = \frac{0.39\ \text{lb-mole VOC}}{\text{hr - extruder}}$$

The mass of VOC emitted from each extruder is determined by number of moles emitted from an extruder per hour (0.39 lb-mole VOC) by the molecular weight of the organic, which is assumed to be 3GO with a molecular weight of 402.6 lb / lb-mole.

$$\frac{0.39\ \text{lb-mole VOC}}{\text{hr - extruder}} \times \frac{402.6\ \text{lb}}{\text{lb-mole}} = \frac{156.3\ \text{lb VOC}}{\text{hr - extruder}}$$

STEP 2: VOC's passing through the first condenser:

Note: Much of the VOC in the extruder off-gas is expected to be captured in the knock-out pot. However, for the purposes of these calculations, it is assumed that all of the VOC enters into the 1st condenser.

All of the noncondensables pass through the first condenser. Most of the water and most of the VOC are condensed. The vapor pressure of water and VOC at the condenser outlet are used to calculate their overall mole fraction. Based on this and the known moles of noncondensables passing through the condenser, the mass of VOC and water passing through the condenser is calculated.

Mole fraction of Water

Calculated as the vapor pressure of water (42.2 mmHg at 35 deg. C) divided by the system pressure (90 mmHg).

$$\frac{42.2\ \text{mmHg}}{90\ \text{mmHg}} = 46.9\%\ \text{water}$$

Mole fraction of VOC

Calculated as the vapor pressure of the VOC (0.26 mmHg at 35 deg. C) divided by the system pressure (90 mmHg).

$$\frac{0.26\ \text{mmHg}}{90\ \text{mmHg}} = 0.29\%\ \text{VOC as 3GO}$$

Mole fraction of noncondensables

Calculated as 100% minus the mole fraction of the water and VOC.

100% minus 46.9% water minus 0.29% VOC = 52.8% noncondensable gases

Total Moles

Calculated as the lb-moles of noncondensables (0.71 lb-moles per hour per extruder) divided by the noncondensable mole fraction (52.8% noncondensables).

$$\frac{0.71 \text{ lb-moles per hour per extruder}}{52.8\%} = 1.352 \frac{\text{lb-moles}}{\text{hour - extruder}}$$

Mass of VOC in condenser outlet

Calculated as the mole fraction of VOC (0.29%) times the total moles of gas (1.352 lb-moles per hour per extruder) times the VOC molecular weight o: 402.6 .

$$1.352 \frac{\text{lb-moles}}{\text{hour - extruder}} \times 0.29\% \text{ VOC} \times 402.6 \frac{\text{lb}}{\text{lb-mole}} = 1.57 \frac{\text{lb VOC}}{\text{hour - extruder}}$$

STEP 3: VOC's passing through the second condenser:

In general the same approach used in Step 2 is applied here with the only difference being that the system pressure is slightly higher which results in a slightly lower VOC mole fraction.

Mole fraction of Water

Calculated as the vapor pressure of water (42.2 mmHg at 35 deg. C) divided by the system pressure (225 mmHg).

$$\frac{42.2 \text{ mmHg}}{225 \text{ mmHg}} = 18.8\% \text{ water}$$

Mole fraction of VOC

Calculated as the vapor pressure of the VOC (0.26 mmHg at 35 deg. C) divided by the system pressure (225 mmHg).

$$\frac{0.3 \text{ mmHg}}{225 \text{ mmHg}} = 0.12\% \text{ VOC as 3GO}$$

Mole fraction of noncondensables

Calculated as 100% minus mole fraction of water and VOC

100% minus 18.8% water minus 0.12% VOC = 81.1% noncondensable gases

Total Moles

Calculated as the lb-mole of noncondensables (0.71 lb-moles per hour per extruder) divided by the noncondensable mole fraction (81.1% noncondensables).

$$\frac{0.71 \text{ lb-moles per hour per extruder}}{81.1\%} = 0.88 \frac{\text{lb-moles}}{\text{hour - extruder}}$$

Mass of VOC in condenser outlet

Calculated as the mole fraction of VOC (0.12%) times the total moles of gas (0.88 lb-moles per hour per extruder) times the VOC molecular weight of 402.6 .

$$0.88 \frac{\text{lb-moles}}{\text{hour - extruder}} \times 0.12\% \text{ VOC} \times 402.6 \frac{\text{lb}}{\text{lb-mole}} = 0.41 \frac{\text{lb VOC}}{\text{hour - extruder}}$$

Total Potential Emissions before the final condenser

Calculated by using the VOC emission rate of 0.41 lb. VOC per hour per extruder multiplied by 3 extruders and multiplied by 8,760 hours per year.

$$0.41 \frac{\text{lb VOC}}{\text{hour - extruder}} \times 3 \text{ extruders} \times \frac{8{,}760 \text{ hours}}{\text{year}} = \mathbf{10{,}764} \frac{\textbf{lb VOC}}{\textbf{year}}$$

STEP 4: VOC's passing through the final condenser:

In general the same approach used in Steps 2 and 3 is applied here with the only difference being that the system pressure is atmospheric at the condenser outlet which results in a lower VOC mole fraction.

Mole fraction of Water

Calculated as the vapor pressure of water (42.2 mmHg at 35 deg. C) divided by condenser's atmospheric pressure (760 mmHg).

$$\frac{42.2 \text{ mmHg}}{760 \text{ mmHg}} = 5.6\% \text{ water}$$

Mole fraction of VOC

Calculated as the vapor pressure of the VOC (0.26 mmHg at 35 deg. C) divided by the system pressure (760 mmHg).

$$\frac{0.26 \text{ mmHg}}{760 \text{ mmHg}} = 0.03\% \text{ VOC as 3GO}$$

Mole fraction of noncondensables

Calculated as 100% minus the mole fractions of water and VOC

100% minus 5.6% water minus 0.03% VOC = 94.4% noncondensable

Total Moles

Calculated as the lb-mole of noncondensables (0.71 lb-moles per hour per extruder) divided by the noncondensable mole fraction (94.4% noncondensables).

$$\frac{0.71 \text{ lb-moles per hour per extruder}}{94.4\%} = 0.76 \frac{\text{lb-moles}}{\text{hour - extruder}}$$

Butacite Extrusion Process (Line 3) - Emission Summary

A. VOC Emissions by Compound and Source

Butacite® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lbs)	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total VOC Emissions (lbs)
3GO	Triethylene glycol di-2-ethylhexanoate	94-28-0	2,211.8	0	0	0	2,211.8
	Total VOC Emissions in 2004		**2,211.8**	**0**	**0**	**0**	**2,211.8**
					Total VOC (Tons)		**1.11**

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Division of Air Quality
Air Pollutant Point Source Emissions Inventory – Calendar Year 2004

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1. Emission Source ID (from permit) or Emission Source Group ID INSIG–B8.2

2. Emission Source Description: Butacite extruder system – line no. 4

3. Operating Scenario ID/Description: OS – 10/Butacite extruder system – line no. 4

4. SCC Number/Description: 30199998/*Other Organic Chemica Manufacture Not Listed

5. Throughput/units in 2004:
(e.g. production or fuel use):

6. Fuel Information (If fuel is used)

% Sulfur		% Ash		Heat Content (Btu/units)	

7. Capture Efficiency
(% of Emissions from this Process Vented to Control Device or Stack): 100

. Control Device Information :None

Order	CS–ID	CD ID (as listed in permit)	Control Device Description

9. Emission Release Point (ERP) Information: (Sources vented to more than one ERP use additional entry lines):

ERP ID	ERP Type	Height (in feet)	Diameter Circle (enter #): Rectangle (L x W) (in 0.1 feet)	Temperature (F)	Velocity (Feet/sec)	Volume Flow Rate (Acfm)	ERP Description
EP–EXT	VERTICAL STACK	50	1	100	0.98	46.18	Butacite extruder systems

Operating Scenario: OS – 10 **Emission Source/Group ID:** INSIG–B8.2

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10. Operating Schedule: (Source/Operating Scenario that best characterizes Calendar Year 2004)
Hours per Day (24) Days per Week (7) Weeks per Year (52)

11. Typical Start & End Times For Operating Scenario: Start: 0 End: 2359

12. Seasonal Periods Percent Annual Throughput:

Jan–Feb + Dec 2004	**25%**	**March–May 2004**	**25%**	**June–Aug. 2004**	**25%**	**Sept.–Nov. 2004**	**25%**

13. Actual Emissions per Pollutant Listed :
Attach calculations and documentation of emission factors or other estimation methods used.

Criteria (NAAQS) Pollutants	**Pollutant Code**	**Emissions– Criteria Pollutants (Tons/Year)**	**Emission Estimation Method Code** (See Instructions)	**Control Efficiency** (Net after all controls)
		2004		
VOC	**VOC**	1.21	02	
HAP/TAP Pollutants (In Alphabetical Order)	**CAS** (see instructions)	**Emissions HAP/TAPS** (Pounds/Year)	**Emission Estimation Method Code** (See Instructions)	**Control Efficiency** (Net after all controls)
		2004		

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2004 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: BS-Insig B8.2

Emission Source Description: Butacite Extrusion Process - Line 4

Process and Emission Description:

The Butacite Line 4 Extrusion Process is a continuous process in which polyvinyl butyral (PVB) resin is extruded into a plastic sheet using three separate mechanical extruders. To remove the resin's entrained water, a vacuum is pulled on the extruders using a series of steam venturi jets. Following each steam jet, the exhaust stream passes through water-cooled condensers to remove the water vapor so that the following steam jet can achieve the necessary secondary vacuum to achieve the required overall vacuum at the extruder so as to produce saleable product.

Air emissions from the Butacite Line 4 Extrusion Process are assumed to be completely (100%) captured. The emissions of Volatile Organic Compounds (VOC) are assumed to be totally the 3GO plasticizer used to manufacture Butacite PVB sheeting. Because the potential VOC emissions are well less than the 40 ton per year NSR/PSD significant emission rate, the final condenser, which exists to remove water and other condensable compounds from the atmospheric discharge, can be treated as having a control efficiency of 0%.

Basis and Assumptions:

The assumption is that all VOC emissions from the Line 4 extrusion process are comprised of the 3GO plasticizer.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Butacite Line 4 Extrusion Process total throughput pounds for the year	Butacite Production Support (BPS) System annual report.

Point Source Emissions Determination:

Determination of point source VOC emissions are given in the following pages.

Equipment Emissions and Fugitive Emissions Determination:

Since the Butacite extruders operate under a vacuum, there are no non-point source (fugitive) emissions nor equipment emissions associated with this process.

Point Source Emission Determination - Line 4 Extrusion Process

Triethylene glycol di-2-ethylhexanoate (3GO) **CAS No. 94-28-0**

Emission Estimation Approach:

Emissions from the Butacite® extruders are calculated using a mass balance approach. Based on the vapor pressure exerted by organic material in the extruder and the flow rate out of the extruder, material flowrates throughout the entire extruder process are calculated. There are a total of 3 extruders in the Line 4 extruder operation.

The extruder process consists of the extruder unit followed by a knock-out pot, and the steam jet vacuum system. Material flowrates into and out of each of these process steps are calculated below.

General Steps for Quantifying Emissions:

The primary purpose of the extruders is to remove water from the extruder feed material. This is accomplished by heating the feed material and operating the extruders under vacuum conditions. A vacuum is pulled on each extruder via a 2-stage steam jet vacuum system. The vacuum jet system consists of a 1st condenser followed by the 1st vacuum jet, 2nd condenser, 2nd vacuum jet, and lastly a final condenser. The purpose of the first condenser is to remove condensable substances so as to maximize efficiency of the steam jet. The purpose of the 2nd condenser is to condense steam injected into the 1st vacuum jet in order to maximize efficiency of the 2nd vacuum jet. The purpose of the final condenser is to condense the steam that is injected into the 2nd vacuum jet. The general steps for quantifying emissions are as follows:

STEP 1: Estimate the VOC's vented from the extruder unit based on the water and noncondensables that are vented, the total system pressure, and the approximate vapor pressure of organics.

STEP 2: Calculate the amount of VOC that passes through the first condenser based on the temperature out of the first condenser, the noncondensable flow, and the system pressure.

STEP 3: Calculate the amount of VOC that passes through the second condenser based on the temperature of the second condenser, the noncondensable flow, and the system pressure.

STEP 4: Calculate the amount of VOC that passes through the final condenser based on the temperature of the final condenser, the noncondensable flow, and the atmospheric pressure.

For Steps 1 and 2, the VOC flowrates are calculated on a per extruder basis. For Steps 3 and 4, the VOC flowrates are calculated per extruder and for all three extruders combined.

Moles of VOC emitted from the extruder are determined by subtracting the non-organic moles in the off-gas (10.46 lb-mole/hr/extruder) from the total moles in the off-gas (10.85 lb-mole/hr/extruder).

$$\frac{10.85\ \text{lb-mole}}{\text{hr - extruder}} - \frac{10.46\ \text{lb-mole}}{\text{hr - extruder}} = \frac{0.39\ \text{lb-mole VOC}}{\text{hr - extruder}}$$

The mass of VOC emitted from each extruder is determined by number of moles emitted from an extruder per hour (0.39 lb-mole VOC) by the molecular weight of the organic, which is assumed to be 3GO with a molecular weight of 402.6 lb / lb-mole.

$$\frac{0.39\ \text{lb-mole VOC}}{\text{hr - extruder}} \times \frac{402.6\ \text{lb}}{\text{lb-mole}} = \frac{156.3\ \text{lb VOC}}{\text{hr - extruder}}$$

STEP 2: VOC's passing through the first condenser:

Note: Much of the VOC in the extruder off-gas is expected to be captured in the knock-out pot. However, for the purposes of these calculations, it is assumed that all of the VOC enters into the 1st condenser.

All of the noncondensables pass through the first condenser. Most of the water and most of the VOC are condensed. The vapor pressure of water and VOC at the condenser outlet are used to calculate their overall mole fraction. Based on this and the known moles of noncondensables passing through the condenser, the mass of VOC and water passing through the condenser is calculated.

Mole fraction of Water

Calculated as the vapor pressure of water (42.2 mmHg at 35 deg. C) divided by the system pressure (90 mmHg).

$$\frac{42.2\ \text{mmHg}}{90\ \text{mmHg}} = 46.9\%\ \text{water}$$

Mole fraction of VOC

Calculated as the vapor pressure of the VOC (0.26 mmHg at 35 deg. C) divided by the system pressure (90 mmHg).

$$\frac{0.26\ \text{mmHg}}{90\ \text{mmHg}} = 0.29\%\ \text{VOC as 3GO}$$

Mole fraction of noncondensables

Calculated as 100% minus the mole fraction of the water and VOC.

100% minus 46.9% water minus 0.29% VOC = 52.8% noncondensable gases

Total Moles

Calculated as the lb-moles of noncondensables (0.71 lb-moles per hour per extruder) divided by the noncondensable mole fraction (52.8% noncondensables).

$$\frac{0.71 \text{ lb-moles per hour per extruder}}{52.8\%} = 1.352 \frac{\text{lb-moles}}{\text{hour - extruder}}$$

Mass of VOC in condenser outlet

Calculated as the mole fraction of VOC (0.29%) times the total moles of gas (1.352 lb-moles per hour per extruder) times the VOC molecular weight o: 402.6 .

$$1.352 \frac{\text{lb-moles}}{\text{hour - extruder}} \times 0.29\% \text{ VOC} \times 402.6 \frac{\text{lb}}{\text{lb-mole}} = 1.57 \frac{\text{lb VOC}}{\text{hour - extruder}}$$

STEP 3: VOC's passing through the second condenser:

In general the same approach used in Step 2 is applied here with the only difference being that the system pressure is slightly higher which results in a slightly lower VOC mole fraction.

Mole fraction of Water

Calculated as the vapor pressure of water (42.2 mmHg at 35 deg. C) divided by the system pressure (225 mmHg).

$$\frac{42.2 \text{ mmHg}}{225 \text{ mmHg}} = 18.8\% \text{ water}$$

Mole fraction of VOC

Calculated as the vapor pressure of the VOC (0.26 mmHg at 35 deg. C) divided by the system pressure (225 mmHg).

$$\frac{0.3 \text{ mmHg}}{225 \text{ mmHg}} = 0.12\% \text{ VOC as 3GO}$$

Mole fraction of noncondensables

Calculated as 100% minus mole fraction of water and VOC

100% minus 18.8% water minus 0.12% VOC = 81.1% noncondensable gases

Total Moles

Calculated as the lb-mole of noncondensables (0.71 lb-moles per hour per extruder) divided by the noncondensable mole fraction (81.1% noncondensables).

$$\frac{0.71 \text{ lb-moles per hour per extruder}}{81.1\%} = 0.88 \frac{\text{lb-moles}}{\text{hour - extruder}}$$

Mass of VOC in condenser outlet

Calculated as the mole fraction of VOC (0.12%) times the total moles of gas (0.88 lb-moles per hour per extruder) times the VOC molecular weight of 402.6 .

$$0.88 \frac{\text{lb-moles}}{\text{hour - extruder}} \times 0.12\% \text{ VOC} \times 402.6 \frac{\text{lb}}{\text{lb-mole}} = 0.41 \frac{\text{lb VOC}}{\text{hour - extruder}}$$

Total Potential Emissions before the final condenser

Calculated by using the VOC emission rate of 0.41 lb. VOC per hour per extruder multiplied by 3 extruders and multiplied by 8,760 hours per year.

$$0.41 \frac{\text{lb VOC}}{\text{hour - extruder}} \times 3 \text{ extruders} \times \frac{8{,}760 \text{ hours}}{\text{year}} = \mathbf{10{,}764} \frac{\textbf{lb VOC}}{\textbf{year}}$$

STEP 4: VOC's passing through the final condenser:

In general the same approach used in Steps 2 and 3 is applied here with the only difference being that the system pressure is atmospheric at the condenser outlet which results in a lower VOC mole fraction.

Mole fraction of Water

Calculated as the vapor pressure of water (42.2 mmHg at 35 deg. C) divided by condenser's atmospheric pressure (760 mmHg).

$$\frac{42.2 \text{ mmHg}}{760 \text{ mmHg}} = 5.6\% \text{ water}$$

Mole fraction of VOC

Calculated as the vapor pressure of the VOC (0.26 mmHg at 35 deg. C) divided by the system pressure (760 mmHg).

$$\frac{0.26 \text{ mmHg}}{760 \text{ mmHg}} = 0.03\% \text{ VOC as 3GO}$$

Mole fraction of noncondensables

Calculated as 100% minus the mole fractions of water and VOC

100% minus 5.6% water minus 0.03% VOC = 94.4% noncondensable

Total Moles

Calculated as the lb-mole of noncondensables (0.71 lb-moles per hour per extruder) divided by the noncondensable mole fraction (94.4% noncondensables).

$$\frac{0.71 \text{ lb-moles per hour per extruder}}{94.4\%} = 0.76 \frac{\text{lb-moles}}{\text{hour - extruder}}$$

Butacite Extrusion Process (Line 4) - Emission Summary

A. VOC Emissions by Compound and Source

Butacite® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lbs)	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total VOC Emissions (lbs)
3GO	Triethylene glycol di-2-ethylhexanoate	94-28-0	2,412.3	0	0	0	2,412.3
	Total VOC Emissions in 2004		**2,412.3**	**0**	**0**	**0**	**2,412.3**
					Total VOC (Tons)		**1.21**

Facility Name: DuPont Company – Fayetteville Works
22828 NC Highway 87 West
Fayetteville, NC 28302

Facility ID : 0900009
Permit : 03735
County : Bladen
DAQ Region : FRO

North Carolina Department of Environment and Natural Resources
Division of Air Quality
Air Pollutant Point Source Emissions Inventory – Calendar Year 2004

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1. **Emission Source ID (from permit) or Emission Source Group ID** NS–A
2. **Emission Source Description:** Nafion HFPO process
3. **Operating Scenario ID/Description:** OS – 11/Nafion HFPO process
4. **SCC Number/Description:** 30199998/*Other Organic Chemica Manufacture Not Listed
5. **Throughput/units in 2004:** (e.g. production or fuel use):
6. **Fuel Information** (If fuel is used)

% Sulfur		% Ash		Heat Content (Btu/units)	

7. **Capture Efficiency** (% of Emissions from this Process Vented to Control Device or Stack): 100

. **Control Device Information :**

Order	CS–ID	CD ID (as listed in permit)	Control Device Description
1	CS–6	NCD–Hdr–1	Baffle plate–type tower waste gas scrubber

9. **Emission Release Point (ERP) Information: (Sources vented to more than one ERP use additional entry lines):**

ERP ID	ERP Type	Height (in feet)	Diameter Circle (enter #): Rectangle (L x W) (in 0.1 feet)	Temperature (F)	Velocity (Feet/sec)	Volume Flow Rate (Acfm)	ERP Description
EP–NEP–Hdr1	VERTICAL STACK	85	3	75	58	24598.67	Nafion scrubber Hdr1

Operating Scenario: OS – 11 **Emission Source/Group ID:** NS–A

10. Operating Schedule: (Source/Operating Scenario that best characterizes Calendar Year 2004)
Hours per Day (24) Days per Week (7) Weeks per Year (52)

11. Typical Start & End Times For Operating Scenario: Start: 0 End: 2359

12. Seasonal Periods Percent Annual Throughput:

Jan–Feb + Dec 2004	25%	March–May 2004	25%	June–Aug. 2004	25%	Sept.–Nov. 2004	25%

13. Actual Emissions per Pollutant Listed :
Attach calculations and documentation of emission factors or other estimation methods used.

Criteria (NAAQS) Pollutants	Pollutant Code	Emissions– Criteria Pollutants (Tons/Year)	Emission Estimation Method Code (See Instructions)	Control Efficiency (Net after all controls)
		2004		
VOC	VOC	41.01	02	90.5
HAP/TAP Pollutants (In Alphabetical Order)	**CAS** (see instructions)	**Emissions HAP/TAPS** (Pounds/Year)	**Emission Estimation Method Code** (See Instructions)	**Control Efficiency** (Net after all controls)
		2004		
Benzene	71–43–2	1.6	02	0
Hydrogen fluoride (hydrofluoric acid as mass of HF– Component of Fluorides)	7664–39–3	934.1	02	99.6
Toluene	108–88–3	8922	02	0

CONFIDENTIAL INFORMATION

Supporting documentation for the determination of air emissions from this emission source contains DuPont Confidential Business Information, which if made public would divulge the manufacturing method, process, and/or capacity, and has therefore been intentionally excluded from the Public Copy of this Air Emissions Inventory as allowed by North Carolina General Statutes §132-1.2, §143-215.3C(a), and §143-215.65.

$= 349\ \text{kg}\ COF_2 = 349\ \text{kg VOC}$

$=$ **769 lb. VOC**

HF Equivalent Emissions

$$\begin{array}{ll} & 349\ \text{kg}\ COF_2 \\ \times & 0.606\ \text{kg HF/kg}\ COF_2 \\ \hline = & 211\ \text{kg HF} \end{array}$$

$=$ **466 lb. HF**

F. Perfluoromethylcyclopropane (PMCP) CAS No. 379-16-8
Oxygen (O_2) **CAS No. 7782-44-7**
Fluoroform (CF_3H) **CAS No. 75-46-7**
Carbon Dioxide (CO_2) **CAS No. 124-38-9**

PMCP, O_2, CF_3H, and CO_2 are not VOCs nor do they have potential to make HF. Since they are not reportable emissions, the calculations are not shown here.

G. Point Source Summary

		Before Control		After Control		After Control	
		VOC Generated		Stack Emissions		Stack Emissions	
Nafion Compound Name		**kg/yr VOC**	**lb/yr VOC**	**lb/yr VOC**	**lb/yr HF**	**ton/yr VOC**	**Ton/yr HF**
A.	COF2	87,184	192,205	769	466	0	0
B.	PAF	65,088	143,492	574	99	0	0
C.	Acid Fluoride Solvent (TFF)	30,840	67,990	272	164.8	0	0
	Acid Fluoride Solvent (TAF)	30,840	67,990	272		0	
D.	HFP	10,261	22,621	22,621		11	
E.	HFPO	10,319	22,748	22,748		11	
	Total	234,531	517,046	**47,256**	**729**	**24**	**0**

Non-point Source Emission Determination:

Non-point source emissions include equipment emissions and maintenance emissions. Equipment emissions are due to leaks in valves, flanges, and pumps. If these leaks occur outside of a building, they are considered fugitive emissions. Maintenance emissions are due to opening up vessels for maintenance and though some of this equipment is located indoors, to be conservative it will be assumed that all maintenance emissions are fugitive emissions.

I. Equipment Emissions

Equipment Emissions are a function of the number of emission points in the plant (valves, flanges, pump seals). For the equipment emission calculations the inventory shown below is conservative and based on plant and process diagrams. Note that the calculations below include equipment emissions (EE) inside buildings (which become stack emissions or SE) as well as equipment emissions outside buildings (fugitive emissions or FE).

A. Equipment Emissions Inside Buildings (Stack Emissions)

1. Equipment Emissions from Reactor, Distillation Column, #1 Recycle Tank:

Emissions are vented from equipment located in the barricade and are vented through the barricade scrubber. Barricade scrubber is 95% efficient for control of acid fluorides. From W1208078 HFPO Flowsheet:

Material	VOC	HF	Average Vessel Contents (kg/hr)				% of contents	% VOC	% HF	HF Potential	% overall HF Potential			
			Line 6	Line 6	Line 4	Total					0.606	0.172	0.11	0.081
O2			2.4	2.4		4.8	0.1%							
COF2	x	x	33.7	33.7		67.4	1.4%	1.4%	1.4%	0.606	1.4%			
PAF	x	x	25.5	25.5		51	1.0%	1.0%	1.0%	0.172		1.0%		
HFP	x		76.4	76.4		152.8	3.1%	3.1%						
HFPO	x		100.1	100.1		200.2	4.1%	4.1%						
HFA	x		1	1		2	0.0%	0.0%						
PMFF	x	x	9.6	9.6		19.2	0.4%	0.4%	0.4%	0.606	0.4%			
PMAF	x	x	18.4	18.4	14.5	51.3	1.1%	1.1%	1.1%	0.11			1.1%	
PMCP			86.6	86.6	80.5	253.7	5.2%							
TFF	x	x	50.3	50.3	50	150.6	3.1%	3.1%	3.1%	0.081				3.1%
TAF	x	x	500	500	495.9	1495.9	30.6%	30.6%	30.6%	0.606	30.6%			
TAF	x	x	335	335	332	1002	20.5%	20.5%	20.5%	0.606	20.5%			
TAF	x	x	479	479	476.3	1434.3	29.4%	29.4%	29.4%	0.606	29.4%			
Total						4885.2		94.7%	87.4%		82.3%	1.0%	1.1%	3.1%

Average HF Potential **0.504**

Assume that: 95% of process materials are VOCs;
88% are acid fluorides with 95% controlled in the barricade scrubber;
7% are non-acid fluorides with 0% controlled in the barricade scrubber.
100% of the liquid is 0.504 weight fraction HF.

Barricade:

Valve emissions:	119 valves x 0.00039 lb/hr/valve	=	0.046 lb/hr EE
Flange emissions:	248 flanges x 0.00018 lb/hr/flange	=	0.045 lb/hr EE
Pump emissions:	1 pump x 0.00115 lb/hr/pump	=	0.001 lb/hr EE
Total equipment emission rate		=	0.092 lb/hr EE

Barricade VOC:

From acid fluorides: 0.092 lb. EE/hr
x 8760 hr/year
x 0.880 lb. A/F VOC/lb. EE
= 710.751 lb/yr VOC generated

710.751 lb VOC generated
x (100%-95%) scrubber efficiency
= 35.538 lb/yr VOC emitted

From non-acid fluorides: 0.092 lb. EE/hr
x 8760 hr/year
x 0.070 lb. Non-A/F VOC/lb. EE
= 56.537 lb/yr VOC

Total Barricade VOC Emissions:
35.538 lb/yr VOC
+ 56.537 lb/yr VOC
= **92.075 lb/yr VOC**

Barricade HF: 0.092 lb. EE/hr
x 8760 hr/year
x 0.504 lb. HF/lb. EE
x (100%-95%) scrubber efficiency
= **20.353 lb/yr HF**

2. Fugitive Emissions From Distillation System #1

issions are vented from equipment located in tower and are vented through stack.
n W1208078 HFPO Flowsheet:

Material	VOC	HF	Average Vessel Contents	% of contents	% VOC	% HF	HF Potential	% overall HF Potential		
			Line 8 (kg/hr)					0.606	0.172	0.11
O2			2.4	0.93%						
COF2	x	x	33.7	13.09%	13.1%	13.1%	0.606	13.1%		
PAF	x	x	25.5	9.91%	9.9%	9.9%	0.172		9.9%	
HFP	x		76.4	29.68%	29.7%					
HFPO	x		99.9	38.81%	38.8%					
HFA	x		1	0.39%	0.4%					
PMFF	x	x	9.6	3.73%	3.7%	3.7%	0.606	3.7%		
PMAF	x	x	3.8	1.48%	1.5%	1.5%	0.110			1.5%
PMCP			5.1	1.98%						
TFF	x	x								
TAF	x	x								
TAF	x	x								
TAF	x	x								
Total			257.4		94.7%	87.4%		82.3%	1.0%	1.5%

Average HF Potential **0.121**

Assume that : 95 wt. % of the process material are VOCs;
100% of the liquid is 0.121 weight fraction HF.

Valve emissions:	60 valves x 0.00039 lb/hr/valve	=	0.023 lb/hr EE
Flange emissions:	120 flanges x 0.00018 lb/hr/flange	=	0.022 lb/hr EE
Total equipment emission rate		=	0.045 lb/hr EE

VOC:	0.045 lb. EE/hr	HF:	0.045 lb. EE/hr
x	8760 hr/year	x	8760 hr/year
x	0.950 lb. VOC/lb. EE	x	0.121 lb. HF/lb. EE
=	**374.490 lb/yr VOC**	=	**47.698 lb/yr HF**

3. Equipment Emissions From Scrubber, Dryers, and Stripper Column

Emissions are vented from equipment located in tower and are vented through stack.
From W1208078 HFPO Flowsheet:

Material	VOC	HF	Average Vessel Contents (kg/hr)				% of contents	% VOC	% HF	HF Potential	% overall HF Potential		
			Line 6	Line 11	Line 12	Total					0.606	0.172	0.11
O2													
COF2													
PAF	x	x	6.5			6.5	0.68%	0.68%	0.68%	0.172	0.68%		
HFP	x		75.8	75.8	75.8	227.4	23.90%	23.90%					
HFPO	x		99.6	96.7	96.7	293	30.79%	30.79%					
HFA	x		1			1	0.11%	0.11%					
PMFF	x	x	9.6			9.6	1.01%	1.01%	1.01%	0.606		1.01%	
PMAF	x	x	3.8			3.8	0.40%	0.40%	0.40%	0.11			0.40%
PMCP			5.1		5.1	10.2	1.07%						
Water			360			360							
KOH			40			40							
Total						951.5		56.9%	2.1%		0.7%	1.0%	0.4%

Average HF Potential **0.008**

Assume that : 57 wt. % of the process material are VOCs;
100% of the liquid is 0.008 weight fraction HF.

Valve emissions:	171 valves x 0.00039 lb/hr/valve	=	0.067 lb/hr EE
Flange emissions:	312 flanges x 0.00018 lb/hr/flange	=	0.056 lb/hr EE
Pump emissions:	2 pumps x 0.00115 lb/hr/pump	=	0.002 lb/hr EE
Total equipment emission rate		=	0.125 lb/hr EE

VOC:	0.125 lb. EE/hr	HF:	0.125 lb. EE/hr
x	8760 hr/year	x	8760 hr/year
x	0.570 lb. VOC/lb. EE	x	0.008 lb. HF/lb. EE
	624.899 lb/yr VOC	=	**8.771 lb/yr HF**

4. Fugitive Emissions From Toluene

is: Fugitive emissions are determined via mass balance, i.e. any mass of toluene unaccounted for in the mass balance will be assumed to be air emissions.

Assume that: 95% of raw ingredient becomes waste

Mass Balance:

Toluene inventory in process as of January 1:	+	2628 lb		
Toluene added to process:	+	26819 lb		
Toluene inventory in process as of December 31:	-	3632 lb		
Toluene destroyed in process:	-	0 lb		
Toluene shipped off with product:	-	119 lb injected into product		
Toluene removed from process as a solid waste:	-	16774 lb		
Toluene released to air via permitted stack:	-	0 lb		
Toluene released to process wastewater:	-	0 lb		
Toluene released to the ground (spill):	-	0 lb		
Unaccounted for difference in mass:	=	8922 lb toluene	=	8922 lb VOC

In section B-1, fugitive emissions from distillation system #2, the assumption was made that all of the fugitive emissions were toluene. As the mass balance above shows the unaccounted for toluene, the amount calculated in section 3 is extremely conservative. Therefore, for the purpose of toluene and VOC emissions, the amount actually vented will be reported based on the mass balance calculation.

5. Total Equipment Emissions

		Inside Emissions (Stack Emissions)		Outside Emissions (Fugitive Emissions)	
Emission Source		**lb VOC**	**lb HF**	**lb VOC**	**lb HF**
A-1	Reactor, Distillation Columns, #1 Recycle Tank	92.07	20.35		
A-2	Distillation System #1	374.49	47.70		
A-3	Scrubbing, Dryers, Stripper Column	624.90	8.771		
B-1	Distillation System #2			1013	
B-2	HFP Storage and Feed			622.84	
B-4	Toluene System			8922.00	
	Total	1091.46	76.82	10557.49	0.00

In order to be conservative, the calculated values will be multiplied by a factor of 2.

	Inside Emissions (Stack Emissions)		Outside Emissions (Fugitive Emissions)	
	lb/yr VOC	**lb/yr HF**	**lb/yr VOC**	**lb/yr HF**
Conservative amount (total x 2)	2,183	154	21,115	0

Total HF emissions:
154 lbs HF from outside building
\+ 0 lbs HF from inside building
= **154 lbs HF**

Total VOCs generated inside building:
710.75 lb VOC from Reactor, Distillation Column, #1 Recycle Tank
\+ 374.49 lb VOC from Scrubber, Dryers, Stripper Column
\+ 624.90 lb VOC from Scrubber, Dryers, Stripper Column
= 1710.14 lb VOC generated (before control device)

Conservative amount (total x 2) 3420 lb VOC generated (before control device)

II. Maintenance Emissions

ckground

During preparation of equipment for maintenance, a vessel is first de-inventoried of liquid (to another process vessel), then de-pressurized (to a vacuum), then nitrogen is used for a series of pressurize/vent-down cycles until a vessel is fume free. For the purpose of estimating emissions from vessel preparation, the plant can be broken down into three sections: HFP Storage and Feed, HFPO Distillation system #2, and everything else. Below are the definitions, assumptions, and calculations of maintenance emissions for each section.

A. HFP Storage and Feed

The HFP Storage section consists of the two HFP Storage Tanks and the associated equipment to transfer HFP into the tanks. When maintenance clearing is required for these tanks (scheduled once per year), the liquid inventory is transferred to the other tank, the vapors are compressed into the tank (down to 10 psig), and then the residue is evacuated to the Nafion® Division Waste Gas Scrubber. The emissions to the atmosphere, therefore, are the HFP vapors remaining at 10 psig.

Calculations:

PV = nRT
Tank Volume = 3000 gal = 401 ft^3
Contents = 100 % HFP (MW=150 lb/lbmol)
Tank pressure = 10 psig = 24.7 psia
Tank temperature = ambient = 77 deg F = 537 R
R = 10.73 psia-ft^3/lbmol/R

PV/RT

$$n = \frac{24.7 \text{ psia}}{10.7 \text{ psia-ft}^3\text{/lbmol/R}} \times \frac{401 \text{ ft}^3}{537 \text{ R}} = 1.72 \text{ lbmol HFP}$$

$$1.72 \text{ lbmol HFP} \times \frac{150 \text{ lb HFP}}{\text{lbmol HFP}} = 258 \text{ lb HFP} = 258 \text{ lb VOC per cleaning}$$

Clearings/year: Each tank scheduled once per year; two tanks is two clearings/year scheduled; to be conservative, assume one extra clearing a year, so three clearings performed per year.

$$\begin{array}{rl} & 258 \text{ lb HFP} \\ \times & \underline{\quad 3 \text{ clearings/year}} \\ = & 774 \text{ lb/yr HFP} \end{array}$$

VOC from HFP Storage Tank =

$$\begin{array}{rl} & 258 \text{ lb VOC per cleaning} \\ \times & \underline{\quad 3 \text{ clearings/year}} \\ = & \mathbf{774 \text{ lb/yr VOC}} \end{array}$$

B. Distillation System #2

en maintenance clearing is required for the column and tanks (scheduled once per year), the liquid inventory is sferred to the other tank, the vapors are compressed into the tank (down to 10 psig), and then the residue is evacuated to the Nafion® Division Waste Gas Scrubber. For the purposes of these calculations, the average operating pressure and total volume are used.

Calculations:

PV = nRT
Tank Volume = 3300 gal = 441 ft^3
Contents = 50 % HFP (MW=150 lb/lbmol)
40 % HFPO (MW=166 lb/lbmol)
(Conservative approximation based off of vessel contents and volatility of compounds) 10 % Toluene (MW=92 lb/lbmol)
Average system pressure = 20 psig = 34.7 psia
Average system temperature = 30 deg F = 490 R
R = 10.73 psia-ft^3/lbmol/R

n = PV/RT

$$n = \frac{34.7 \text{ psia}}{10.7 \text{ psia-ft}^3\text{/lbmol/R}} \times \frac{441 \text{ ft}^3}{490 \text{ R}} = 2.91 \text{ lbmol material}$$

$$2.91 \text{ lbmol material} \times 50 \text{ \% HFP} \times \frac{150 \text{ lb HFP}}{\text{lbmol HFP}} = 218 \text{ lb HFP}$$

$$2.91 \text{ lbmol material} \times 40 \text{ \% HFPO} \times \frac{166 \text{ lb HFPO}}{\text{lbmol HFPO}} = 193 \text{ lb HFPO}$$

$$2.91 \text{ lbmol material} \times 10 \text{ \% Toluene} \times \frac{92 \text{ lb Toluene}}{\text{lbmol Toluene}} = 27 \text{ lb Toluene}$$

As stated previously, toluene amounts are calculated by mass balance. The amount vented calculated by mass balance will be used for toluene and VOC emisssions.

Total VOC per cleaning:
218 lb HFP
\+ 193 lb HFPO
= 412 lb VOC

Clearings/year: Each tank scheduled once per year; to be conservative, assume one extra clearing a year, so two clearings per year.

218 lb HFP
x 2 clearings/year
= 437 lb/yr HFP

193 lb HFPO
x 2 clearings/year
= 387 lb/yr HFPO

VOC from Distillation system #2 = 412 lb VOC
x 2 clearings/year
= **823 lb/yr VOC**

C. "Rest of the Process"

The rest of the HFPO process contains HFP, HFPO, and both low and high vapor pressure acid fluorides (acid ides are organic compounds which release HF when exposed to the atmosphere). The calculations below do not include the low-pressure acid fluorides because at temperatures at which the vessels are prepared for maintenance the concentration of the low vapor pressure acid fluorides is very low. The high vapor pressure acid fluorides are not included because they are assumed to go to the WGS during decontamination. Though some of the process is located inside buildings, to be conservative it will be assumed that all emissions are fugitive emissions.

Assume that: Pressure is vapor pressure of HFP/HFPO at ambient temperature (HFP and HFPO have the same vapor pressures)
Composition HFP to HFPO of vapor space in equipment is equivilant to ratio in line 11 of HFPO Flowsheet W130878 :
44 wt% HFP
56 wt% HFPO

Calculations:

PV = nRT
Tank Volume = 1100 gal = 147 ft^3
Contents = 44 wt% HFP (MW=150 lb/lbmol) = 47 mol% HFP
56 wt% HFPO (MW=166 lb/lbmol) = 53 mol% HFPO

Average system pressure 100 psia
Average system temperature = 77 deg F = 537 R
R = 10.73 psia-ft^3/lbmol/R

n = PV/RT

$$n = \frac{100 \text{ psia}}{10.7 \text{ psia-ft}^3\text{/lbmol/R}} \times \frac{147 \text{ ft}^3}{537 \text{ R}} = 2.55 \text{ lbmol material}$$

$$2.55 \text{ lbmol material} \times 47 \text{ \% HFP} \times \frac{150 \text{ lb HFP}}{\text{lbmol HFP}} = 180 \text{ lb HFP}$$

$$2.55 \text{ lbmol material} \times 53 \text{ \% HFPO} \times \frac{166 \text{ lb HFPO}}{\text{lbmol HFPO}} = 224.5 \text{ lb HFPO}$$

Total VOC per cleaning:
179.9 lb HFP
\+ 224.5 lb HFPO
= 404.3 lb VOC

Clearings/year: Each tank scheduled once per year; to be conservative, assume one extra clearing per year, so two clearings per year.

180 lb HFP
x 2 clearings/year
= **360 lb/yr HFP**

224.5 lb HFPO
x 2 clearings/year
= **449 lb/yr HFPO**

VOC from "Rest of the Process" =
404.3 lb VOC
x 2 clearings/year
= **808.6 lb/yr VOC**

D. Total fugitive Emissions from Maintenance Work

Source		lb/yr HFP	lb/yr HFPO	lb/yr VOC
II-A	HFP Storage and Feed	774		774
II-B	Distillation System #2	437	387	823
II-C	"Rest of the System"	360	449	809
	Total	**1,570**	**835**	**2,406**

III. Non-Point Source VOC Emission Summary

Nafion® Compound	Point-Source Emissions lbs	Stack Emissions	Fugitive Emissions		Total
		Inside Emissions (lbs)	Outside Emissions (lbs)	Maintenance Emissions (lbs)	lbs
COF2	769	36	344		1,148
PAF	574	27	256		857
TFF	272	13	122		406
TAF	272	13	122		406
HFP	22,621	1045	10107	1570	35,343
HFPO	22,748	1051	10165	835	34,799
Benzene			1.60		2
Toluene			8922		8,922
Total	47,256	2,183	30,039	2,406	**81,883**

Note: Speciated emissions (except for benzene, toluene, and maintenance emissions) were estimated by assuming that each compound's emission concentration was equal to the compound's stack emissions fraction of the total stack emissions.

example: the stack emission of PAF was 574 lbs
with the total stack emission of VOCs being 47,256 lbs
The total outside fugitive emission (minus benzene & toluene) was 21,114.98 lbs VOC

$$\frac{574 \text{ lbs PAF}}{47{,}256 \text{ lbs VOC}} \times 21{,}114.98 \text{ fugitive VOC} = 256 \text{ lb fugitive PAF emissions}$$

Accidental Releases to Atmosphere

A. IR-2004-033 Date: 3/21/2003

Material Released: Toluene CAS No. 108-88-3
Quantity Released: 8922 lb

Quantity VOC Released:

0.0 lbs HFPO
= **0.0 lb VOC**

NOTE: This release was already accounted for in the SARA 313, item B. It is included here only for documentation.

B. IR-2004-065 Date: 6/30/2004

Material Released: Hexafluoroproplyene (HFP) CAS No. 116-15-4
Quantity Released: 1 lbs

HFP is a VOC without the potential to form HF.

Quantity VOC Released:

1.0 lbs HFP
= **1.0 lb VOC**

C. IR-2004-120 Date: 9/30/2004

Material Released: Hexafluoroproplyene (HFP) CAS No. 116-15-4
Quantity Released: 3 lbs

Material Released: Hexafluoroproplyene Epoxide (HFPO) CAS No. 428-59-1
Quantity Released: 1.8 lbs

Material Released: Trifluoroacetyl Fluoride (PAF) CAS No. 354-34-7
Quantity Released: 43.4 lbs

Material Released: Carbonyl Fluoride (COF2) CAS No. 353-50-4
Quantity Released: 72.4 lbs

HFP and HFPO are VOC's without the potential to form HF.

	Quantity VOC Released:	HF Potential		
	1.8 lbs HFPO	n/a		
	3.0 lbs HFP	n/a		
	43.4 lbs PAF	0.172 lb HF/lb PAF		7.5 lb HF from PAF
	72.4 lbs COF2	0.606 lb HF/lb COF2		43.9 lb HF from COF2
=	**120.6 lb VOC**		=	**51.3 lb HF**

D. IR-2004-065 Date: 6/30/2004

Material Released: Hexafluoroproplyene Epoxide (HFPO) CAS No. 428-59-1
Quantity Released: 18.3 lbs

HFPO is a VOC without the potential to form HF.

Quantity VOC Released:

18.3 lbs HFPO
= **18.3 lb VOC**

E. Total Emissions from Accidental Releases

Source		lb DCM	lb HFP	lb HFPO	lb COF2	lb PAF	lb HFA	lb/yr VOC	lb/yr HF
A.	IR-2004-033	0.0	0	0.0	0	0	0	0.0	0
B.	IR-2004-065	0.0	1.0	0.0	0	0	0	1.0	0
C.	IR-2004-120	0.0	3	1.8	72.4	43.4	0	120.6	51.3
D.	IR-2004-065	0	0	18.300	0	0	0	18.30	0
	Total	**0**	**4**	**20**	**72**	**43**	**0**	**140**	**51**

Emission Summary

A. VOC Compound Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source and Non-point Source Emissions (lbs)	Accidental Emissions	Total Emissions (lbs)
COF2	Carbonyl Fluoride	353-50-4	1,148	72	1,220.26
PAF	Trifluoroacetyl Fluoride	354-34-7	857	43	900.34
A/F Solvent (TFF)	Perfluoro-3,5,7,9,11-pentaoxadodecanoyl fluoride	690-43	406		406.04
A/F Solvent (TAF)	Trifluoromethyl ester of carbonofluoridic acid	3299-24-9	406		406.04
HFP	Hexafluoroproplyene	116-15-4	35,343	4	35,347.35
HFPO	Hexafluoroproplyene Epoxide	428-59-1	34,799	20	34,819.39
Benzene	Benzene	71-43-2	2		1.60
Toluene	Methylbenzene	108-88-3	8,922		8,922.00
				Total VOC Emissions (lbs)	**82,023**
				Total VOC Emissions (tons)	**41.01**

B. VOC Control Efficiency

VOCs Generated			VOCs Emitted from Stack		
Point Source Generated (lbs)	Equipment Emissions Inside Buildings (lbs)	Total VOC Generated	Point Source Emissions (lbs)	Non-point Source Emissions (lbs)	Total VOC Emitted (lbs)
517,046	3,420	520,467	47,256	2,183	49,439

520,467 lb VOC generated
\- 49,439 lb VOC emitted
471,028 lb VOC removed in control device

$$\frac{471{,}028 \text{ lb VOC removed in control device}}{520{,}467 \text{ lb VOC generated}} = \textbf{90.50\% VOC control efficiency}$$

C. Toxic Air Pollutant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lbs)	Non-point Source Emissions (lbs)	Accidental Emissions	Total Emissions (lbs)
HF	Hydrogen Fluoride	7664-39-3	729.45	153.64	51	934.10
Benzene	Benzene	71-43-2		1.60		1.60
Toluene	Methylbenzene	108-88-3		8,922.00		8,922.00

D. HF Control Efficiency

Total Emissions (tons) **45.94**

$$\frac{729 \text{ lb HF emitted from Point Sources}}{(100\%-99.6\%) \text{ Stack Efficiency}} = 182{,}363 \text{ lb HF sent to control device from Point Sources}$$

182,363 lb HF sent to control device from Point Sources
\- 934 lb HF emitted
= 181,429 lb HF removed in control device

182,363 lb HF sent to control device from Point Sources
\+ 154 lb HF from Non-point Sources inside buildings
= 182,517 lb HF generated

$$\frac{181{,}429 \text{ lb HF removed in control device}}{182{,}517 \text{ lb HF generated}} = \mathbf{99.40\% \text{ HF control efficiency}}$$

Facility Name: DuPont Company – Fayetteville Works
22828 NC Highway 87 West
Fayetteville, NC 28302

Facility ID : 0900009
Permit : 03735
County : Bladen
DAQ Region : FRO

North Carolina Department of Environment and Natural Resources
Division of Air Quality
Air Pollutant Point Source Emissions Inventory – Calendar Year 2004

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1. **Emission Source ID (from permit) or Emission Source Group ID** NS–B
2. **Emission Source Description:** Nafion vinyl ethers north process
3. **Operating Scenario ID/Description:** OS – 12/Nafion vinyl ethers north process
4. **SCC Number/Description:** 30199998/*Other Organic Chemica Manufacture Not Listed
5. **Throughput/units in 2004:** (e.g. production or fuel use):
6. **Fuel Information** (If fuel is used)

% Sulfur		% Ash		Heat Content (Btu/units)	

7. **Capture Efficiency** (% of Emissions from this Process Vented to Control Device or Stack): 100

Control Device Information :

Order	CS–ID	CD ID (as listed in permit)	Control Device Description
1	CS–6	NCD–Hdr–1	Baffle plate–type tower waste gas scrubber

9. Emission Release Point (ERP) Information: (Sources vented to more than one ERP use additional entry lines):

ERP ID	ERP Type	Height (in feet)	Diameter Circle (enter #): Rectangle (L x W) (in 0.1 feet)	Temperature (F)	Velocity (Feet/sec)	Volume Flow Rate (Acfm)	ERP Description
EP–NEP–Hdr1	VERTICAL STACK	85	3	75	58	24598.67	Nafion scrubber Hdr1

Operating Scenario: OS – 12 **Emission Source/Group ID:** NS–B

10. Operating Schedule: (Source/Operating Scenario that best characterizes Calendar Year 2004)
Hours per Day (24) **Days per Week** (7) **Weeks per Year** (52)

11. Typical Start & End Times For Operating Scenario: **Start:** 0 **End:** 2359

12. Seasonal Periods Percent Annual Throughput:

Jan–Feb + Dec 2004	25%	**March–May 2004**	25%	**June–Aug. 2004**	25%	**Sept.–Nov. 2004**	25%

13. Actual Emissions per Pollutant Listed :
Attach calculations and documentation of emission factors or other estimation methods used.

Criteria (NAAQS) Pollutants	Pollutant Code	Emissions– Criteria Pollutants (Tons/Year)	Emission Estimation Method Code (See Instructions)	Control Efficiency (Net after all controls)
		2004		
CO	CO	4	02	0
VOC	VOC	24.9	02	22
HAP/TAP Pollutants (In Alphabetical Order)	**CAS** (see instructions)	**Emissions HAP/TAPS** (Pounds/Year)	**Emission Estimation Method Code** (See Instructions)	**Control Efficiency** (Net after all controls)
		2004		
Acetonitrile	75–05–8	1214	02	0
Glycol Ethers, Unlisted (Specify Component of GLYET) (See http://daq.state.nc.us/toxics/glycol/)	GLYET–Other	321	02	0
Hydrogen fluoride (hydrofluoric acid as mass of HF– Component of Fluorides)	7664–39–3	20.13	02	99.6
Methylene chloride	75–09–2	0	02	0

CONFIDENTIAL INFORMATION

Supporting documentation for the determination of air emissions from this emission source contains DuPont Confidential Business Information, which if made public would divulge the manufacturing method, process, and/or capacity, and has therefore been intentionally excluded from the Public Copy of this Air Emissions Inventory as allowed by North Carolina General Statutes §132-1.2, §143-215.3C(a), and §143-215.65.

2004 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No: NS-B

Emission Source Description: VE-North EVE Manufacturing Process

Process & Emission Description: The VE-North EVE manufacturing process is a continuous chemical reaction. All emissions from the process are vented through the Nafion Division Waste Gas Scrubber (Control Device ID No. NCD-Hdr) which has a documented control efficiency of 99.6% for all acid fluoride compounds. Some emitted compounds are assumed to pass completely through the scrubber, so the control efficiency for those compounds is assumed to be 0%. The control of emissions of specific compounds will be addressed and detailed in the following pages.

The EVE process in VE-North emits compounds in the acid fluoride family. In the presence of water (such as in atmospheric moisture), these acid fluorides can eventually hydrolyze to hydrogen fluoride. For the purpose of this emissions inventory, a conservative approach will be taken and the acid fluorides will be reported both as a VOC and as the equivalent quantity of hydrogen fluoride.

Basis and Assumptions:

- The EVE process flowsheet is the basis for relative concentrations of before-control emissions of gaseous wastes.

- Calculations of point source emissions are based on actual vent flow totals taken from the IP21 Historian.

- All emission determination calculations are available on the EXCEL spreadsheet found at : S:/Everyone/cecilkd/VEN 2002 Emissions.xls.

Point Source Emission Determination

A. Hexafluoropropylene (HFP) CAS No. 116-15-4

HF Potential:

HFP is a VOC without the potential to form HF

Quantity Released

HFP is a byproduct present in the HFPO feed. It is an inert in VE-North that is vented to the WGS.

HFP vented per the process flowsheet

Vented from the Condensation Reactor: $\frac{0.17\,kg\,HFP}{0.50\,kg\,CondRxVentFlo}$

Vented from the Crude Receiver $\frac{0\ kg\ HFP}{15.91\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0\ kg\ HFP}{0.14\ kg\ Foreshots\ Receiver\ Vent}$

HFP vented based on 865 kg in the Condensation Reactor vent stream.
HFP vented based on 17,476 kg in the Crude Receiver vent stream.
HFP vented based on 2 kg in the Foreshots Receiver vent stream.

HFP vented from Condensation Reactor:

$$\frac{0.17\text{ kg HFP}}{0.50\text{ kg CndRx}} \times 865\text{ kg CndRx} = 302\text{ kg HFP}$$

HFP vented from Crude Receiver

$$\frac{0.00\text{ kg HFP}}{15.91\text{ kg CrRec}} \times 17{,}476\text{ kg CrRec} = 0\text{ kg HFP}$$

HFP vented from Foreshots Receiver

$$\frac{0.00\text{ kg HFP}}{0.14\text{ kg FsRec}} \times 2\text{ kg FsRec} = 0\text{ kg HFP}$$

VOC Emissions

	302 kg from Condensation Reactor	
+	0 kg from Crude Receiver	
+	0 kg from Foreshots Receiver	
=	302 kg HFP	= 302 kg VOC
		663 lb VOC

B. Hexafluoropropylene oxide (HFPO)

CAS No. 428-59-1

HF Potential:

HFPO is a VOC without the potential to form HF

Quantity Released

HFPO is a byproduct present in the HFPO feed. It is an inert in VE-North that is vented to the WGS.

HFPO vented per the process flowsheet

Vented from the Condensation Reactor: $\boxed{\frac{0.13\ kg\ HFPO}{0.50\ kg\ Cond\ Rx\ Vent\ Flow}}$

Vented from the Crude Receiver $\boxed{\frac{0\ kg\ HFPO}{15.91\ kg\ Crude\ Receiver\ Vent}}$

Vented from the Foreshots Receiver $\boxed{\frac{0\ kg\ HFPO}{0.14\ kg\ ForeshotsReceiverVent}}$

HFPO vented based on 865 kg in the Condensation Reactor vent stream.
HFPO vented based on 17,476 kg in the Crude Receiver vent stream.
HFPO vented based on 2 kg in the Foreshots Receiver vent stream.

HFPO vented from Condensation Reactor:

$$\frac{0.13 \text{ kg HFPO}}{0.50 \text{ kg CndRx}} \times 865 \text{ kg CndRx} = 222 \text{ kg HFPO}$$

HFPO vented from Crude Receiver

$$\frac{0.00 \text{ kg HFPO}}{15.91 \text{ kg CrRec}} \times 17{,}476 \text{ kg CrRec} = 0 \text{ kg HFPO}$$

HFPO vented from Foreshots Receiver

$$\frac{0.00 \text{ kg HFPO}}{0.14 \text{ kg FsRec}} \times 2 \text{ kg FsRec} = 0 \text{ kg HFPO}$$

VOC Emissions

222 kg from Condensation Reactor
\+ 0 kg from Crude Receiver
\+ 0 kg from Foreshots Receiver
= 222 kg HFPO = 222 kg VOC
489 lb VOC

C. Perfluoro-2-Propoxy Propionyl Fluoride (HFPO Dimer)

CAS No. 2062-98-8

HF Potential:

Each mole of HFPO Dimer (MW = 332) can generate 1 mole of HF (MW = 20).

$$1\,kg\,Dimer\,\frac{1\,mole Dimer}{332g\,Dimer}\cdot\frac{20g\,HF}{1\,mole HF}\cdot\frac{1\,mole HF}{1\,mole Dimer}=0.06kg\,HF$$

Therefore, each 1 kg of PAF generates 0.060 kg of HF

Quantity Released

Before-control HFPO Dimer vented per the process flowsheet

Vented from the Condensation Reactor: $\frac{0.05\ kg\ HFPODimer}{0.50\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0\ kg\ HFPO\,Dimer}{15.91\ kg\ Crude\,Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0\ kg\ HFPODimer}{0.14\ kg\ ForeshotsReceiverVent}$

HFPO Dimer vented based on 865 kg in the Condensation Reactor vent stream.
HFPO Dimer vented based on 17,476 kg in the Crude Receiver vent stream.
HFPO Dimer vented based on 2 kg in the Foreshots Receiver vent stream.

Before control HFPO Dimer vented from Condensation Reactor:

$\frac{0.05\ \text{kg HFPO Dimer}}{0.50\ \text{kg CndRx}}$ x 865 kg CndRx = 87 kg HFPO Dimer

HFPO Dimer vented from Crude Receiver

$\frac{0.00\ \text{kg HFPO Dimer}}{15.91\ \text{kg CrRec}}$ x 17,476 kg CrRec = 0 kg HFPO Dimer

HFPO Dimer vented from Foreshots Receiver

$\frac{0.00\ \text{kg HFPO Dimer}}{0.14\ \text{kg FsRec}}$ x 2 kg FsRec = 0 kg HFPO Dimer

Total before-control HFPO Dimer vented 87 kg HFPO Dimer

After-control emissions utilizing the 99.6% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

Waste Gas Scrubber

87 kg Dimer
x (100%-99.6%)
= 0.35 kg Dimer = 0.35 kg VOC
0.77 lb. VOC

HF Equivalent Emissions

0 kg Dimer
x 0.060 kg HF/kg Dimer
= 0.02 kg HF **0.05 lb. HF**

D. Tetrafluoroethylene (TFE)

CAS No. 116-14-3

HF Potential:

TFE is a VOC without the potential to form HF

Quantity Released

TFE is a byproduct present in the TFE feed. It is an inert in VE-North that is vented to the WGS.

TFE vented per the process flowsheet

Vented from the Condensation Reactor: $\dfrac{0\ kg\ TFE}{0.50\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\dfrac{0.18\ kg\ TFE}{15.91\ kg\ Crude\,Receiver\ Vent}$

Vented from the Foreshots Receiver $\dfrac{0\ kg\ TFE}{0.14\ kg\ ForeshotsReceiverVent}$

TFE vented based on 865 kg in the Condensation Reactor vent stream.
TFE vented based on 17,476 kg in the Crude Receiver vent stream.
TFE vented based on 2 kg in the Foreshots Receiver vent stream.

TFE vented from Condensation Reactor:

$$\frac{0.00}{0.50}\ \frac{kg\ TFE}{kg\ CndRx} \times 865\ kg\ CndRx = 0\ kg\ TFE$$

TFE vented from Crude Receiver

$$\frac{0.18}{15.91}\ \frac{kg\ TFE}{kg\ CrRec} \times 17{,}476\ kg\ CrRec = 192\ kg\ TFE$$

TFE vented from Foreshots Receiver

$$\frac{0.00}{0.14}\ \frac{kg\ TFE}{kg\ FsRec} \times 2\ kg\ FsRec = 0\ kg\ TFE$$

VOC Emissions

	0 kg from Condensation Reactor		
+	192 kg from Crude Receiver		
+	0 kg from Foreshots Receiver		
=	192 kg TFE	=	192 kg VOC **423 lb VOC**

CAS No. 69116-72-9

E. Methyl Perfluoro (5-(Fluoroformyl) -4-Oxahexanoate) (MAE)

HF Potential:

Each mole of MAE (MW = 322) can generate 1 mole of HF (MW = 20).

$$\boxed{1\,kg\,PPF \cdot \frac{1\,moleMAE}{322g\,MAE} \cdot \frac{20g\,HF}{1\,moleHF} \cdot \frac{1\,moleHF}{1\,moleMAE} = 0.062kg\,HF}$$

Therefore, each 1 kg of PAF generates 0.062 kg of HF

Quantity Released

Before-control MAE vented per the process flowsheet

Vented from the Condensation Reactor: $$\boxed{\frac{0\ kg\ MAE}{0.50\ kg\ Cond\ Rx\ Vent\ Flow}}$$

Vented from the Crude Receiver $$\boxed{\frac{0\ kg\ MAE}{15.91\ kg\ Crude\,Receiver\ Vent}}$$

Vented from the Foreshots Receiver $$\boxed{\frac{0.04\ kg\ MAE}{0.14\ kg\ ForeshotsReceiverVent}}$$

MAE vented based on 865 kg in the Condensation Reactor vent stream.
MAE vented based on 17,476 kg in the Crude Receiver vent stream.
MAE vented based on 2 kg in the Foreshots Receiver vent stream.

Before control MAE vented from Condensation Reactor:

$$\frac{0.00\ kg\ MAE}{0.50\ kg\ CndRx} \times 865\ kg\ CndRx = 0\ kg\ MAE$$

MAE vented from Crude Receiver

$$\frac{0.00\ kg\ MAE}{15.91\ kg\ CrRec} \times 17{,}476\ kg\ CrRec = 0\ kg\ MAE$$

MAE vented from Foreshots Receiver

$$\frac{0.04\ kg\ MAE}{0.14\ kg\ FsRec} \times 2\ kg\ FsRec = 0\ kg\ MAE$$

Total before-control MAE vented = 0 kg MAE

After-control emissions utilizing the 99.6% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

Waste Gas Scrubber

0 kg MAE
x (100%-99.6%)
= 0 kg MAE = 0 kg VOC
0 lb. VOC

HF Equivalent Emissions

0 kg MAE
x 0.062 kg HF/kg MAE
= 0.00 kg HF 0.00 lb. HF

F. Propanoic Acid, 3-[1-[Difluoro [(Trifluoroethenyl) oxy] Methyl]-1,2,2,2-Tetrafluoroethoxy]-2,2,3,3 -Tetrafluoro-, Methyl Ester (EVE)

CAS No. 63863-43-4

HF Potential:

EVE is a VOC without the potential to form HF

Quantity Released

EVE is a byproduct present in the EVE feed. It is an inert in VE-North that is vented to the WGS.

EVE vented per the process flowsheet

Vented from the Condensation Reactor:

$$\frac{0\ kg\ EVE}{0.50\ kg\ Cond\ Rx\ Vent\ Flow}$$

Vented from the Crude Receiver

$$\frac{0\ kg\ EVE}{15.91\ kg\ Crude Receiver\ Vent}$$

Vented from the Foreshots Receiver

$$\frac{0.0 kg\ EVE}{0.14\ kg\ ForeshotsReceiverVent}$$

EVE vented based on	865	kg in the Condensation Reactor vent stream.
EVE vented based on	17,476	kg in the Crude Receiver vent stream.
EVE vented based on	2	kg in the Foreshots Receiver vent stream.

EVE vented from Condensation Reactor:

$$\frac{0.00}{0.50}\ \frac{kg\ EVE}{kg\ CndRx} \times 865\ kg\ CndRx = 0\ kg\ EVE$$

EVE vented from Crude Receiver

$$\frac{0.00}{15.91}\ \frac{kg\ EVE}{kg\ CrRec} \times 17{,}476\ kg\ CrRec = 0\ kg\ EVE$$

EVE vented from Foreshots Receiver

$$\frac{0.00}{0.14}\ \frac{kg\ EVE}{kg\ FsRec} \times 2\ kg\ FsRec = 0\ kg\ EVE$$

VOC Emissions

	0 kg from Condensation Reactor			
+	0 kg from Crude Receiver			
+	0 kg from Foreshots Receiver			
=	0 kg EVE	=	0 kg VOC	
			0 lb VOC	

G. Glycol Ethers (GE) GLYET-Other

The emissions of glycol ethers is based on a mass balance of glycol ethers consumed in the process.

The only GE emissions in EVE is TetraGlyme

Quantity Released

=	240	kg GE introduced into processes
=	227	kg GE transferred to H/C waste tank
=	13	kg GE unaccounted for and assumed emitted
=	**29**	**lb. Glycol Ethers**

Assume that the emissions of glycol ethers is split evenly between the three processes of Vinyl Ethers North.

Therefore:

Emissions of glycol ether from EVE = **29** **lb. Glycol Ethers**

H. Carbon Monoxide (CO)

CAS No. 630-08-0

HF Potential:

CO can not form HF

Quantity Released

CO is a byproduct from the Agitated Bed Reactor system.
They are inerts in VE-North that are vented to the WGS.

CO vented per the process flowsheet

Vented from the Condensation Reactor: $\boxed{\frac{0\ kg\ CO}{0.50\ kg\ Cond\ Rx\ Vent\ Flow}}$

Vented from the Crude Receiver $\boxed{\frac{0.59\ kg\ CO}{14.91\ kg\ Crude\,\mathrm{Re}\,ceiver\ Vent}}$

Vented from the Foreshots Receiver $\boxed{\frac{0\ kg\ CO}{0.14\ kg\ Foreshots\mathrm{R}eceiver\,Vent}}$

CO vented based on 865 kg in the Condensation Reactor vent stream.
CO vented based on 17,476 kg in the Crude Receiver vent stream.
CO vented based on 2 kg in the Foreshots Receiver vent stream.

CO vented from Condensation Reactor:

$$\frac{0.00\text{ kg CO}}{0.50\text{ kg CndRx}} \quad \text{x} \quad 865\text{ kg CndRx} \quad = \quad 0\text{ kg CO}$$

CO vented from Crude Receiver

$$\frac{0.59\text{ kg CO}}{15.91\text{ kg CrRec}} \quad \text{x} \quad 17{,}476\text{ kg CrRec} \quad = \quad 647\text{ kg CO}$$

CO vented from Foreshots Receiver

$$\frac{0.00\text{ kg CO}}{0.14\text{ kg FsRec}} \quad \text{x} \quad 2\text{ kg FsRec} \quad = \quad 0\text{ kg CO}$$

CO Emissions

0 kg from Condensation Reactor
\+ 647 kg from Crude Receiver
\+ 0 kg from Foreshots Receiver
= 647 kg CO = **1,426 lb CO**

I. VOC Summary

Nafion Compound Name		Before Control Generated		After Control Stack Emissions	
		kg/yr	lb/yr	VOC lb/yr	HF lb/yr
A.	HFP	302	665	663	
B.	HFPO	222	490	489	
C.	HFPO-Dimer	87	192	0.77	0.05
D.	TFE	192	424	423	
E.	MAE	0	1	0.00	0.00
F.	EVE	0	0	0	
G.	Glycol Ethers	13	29	29	
	Total	**817**	**1,801**	**1,605**	**0.05**

J. Point Source Summary

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions[1] lb/yr	Maintenance Emissions[2] lb/yr	Total Emissions lb/yr
A.	HFP	663	49.2	12.6	725
B.	HFPO	489	36.3	9.3	534
C.	HFPO-Dimer	1	0.1	0.0	0.8
D.	TFE	423	31.4	8.0	462
E.	MAE	0	0.0	0.0	0.0
F.	EVE	0	0.0	0.0	0.1
G.	Glycol Ethers	29	2.1	0.5	31.5
H.	CO	1,426	0.0	0.0	1,426
K.	ADN	0	287.4		287.4
	Total	**3,030**	**119.1**	**30.5**	**3,179.8**

Note 1 - See section titled "Equipment Emissions" for details
Note 2 - See section titled "Maintenance Emissions" for details

HF Equivalent Emissions

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
C.	HFPO-Dimer	0.05	0.003	0.001	0.05
E.	MAE	0	0.000	0.000	0
	Total	**0.05**	**0.003**	**0.001**	**0.00**

The estimated HF equivalent emissions from Equipment Emissions were determined by multiplying the HFPO-Dimer HF Potential (0.06 lb. HF/lb. HFPO-Dimer) by the HFPO-Dimer Equipment Emissions for the Compound

$$\frac{0.06\ \text{lb/yr HF}}{\text{lb/yr HFPO-Dimer}} \times 0.06\ \text{lb/yr Equipment HFPO-Dimer} = 0.003\ \text{lb/yr HF}$$

The estimated HF equivalent emissions from Maintenance Emissions were determined by multiplying the HFPO-Dimer HF Potential (0.06 lb. HF/lb. HFPO-Dimer) by the HFPO-Dimer Maintenance Emissions for the Compound

$$\frac{0.06\ \text{lb/yr HF}}{\text{lb/yr HFPO-Dimer}} \times 0.01\ \text{lb/yr Maintenance HFPO-Dimer} = 0.001\ \text{lb/yr HF}$$

K. Adiponitrile CAS No. 111-69-3

HF Potential

ADN is a VOC and Hazardous Air Polluntant without the potential to form HF.

Quantity Released

ADN emissions based on 2,399 kg ADN fed

VE North ADN Sent to waste Hydrocarbon tank = 2,268 kgs H/C waste
*Note ADN does not get released to the stack and only has the potential to be released through equipment and maintenance emissions

VOC Emission

2,399 kg ADN fed
\- 2,268 kg ADN to H/C waste
131 kg ADN lost = 131 **kg VOC**
287 lb VOC

ADN only used during an EVE Campaign

2004 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No: NS-B

Emission Source Description: VE-North PPVE Manufacturing Process

Process & Emission Description: The VE-North PPVE manufacturing process is a continuous chemical reaction. All emissions from the process are vented through the Nafion Division Waste Gas Scrubber (Control Device ID No. NCD-Hdr) which has a documented control efficiency of 99.6% for all acid fluoride compounds. Some emitted compounds are assumed to pass completely through the scrubber, so the control efficiency for those compounds is assumed to be 0%. The control of emissions of specific compounds will be addressed and detailed in the following pages.

The PPVE process in VE-North emits compounds in the acid fluoride family. In the presence of water (such as in atmospheric moisture), these acid fluorides can eventually hydrolyze to hydrogen fluoride. For the purpose of this emissions inventory, a conservative approach will be taken and the acid fluorides will be reported both as a VOC and as the equivalent quantity of hydrogen fluoride.

Basis and Assumptions:

- The PPVE process flowsheet is the basis for relative concentrations of before-control emissions of gaseous wastes.

- Calculations of point source emissions are based on actual vent flow totals taken from the IP21 Historian.

- All emission determination calculations are available on the EXCEL spreadsheet found at S:/Everyone/cecilkd/VEN 2003 Emissions.xls.

Point Source Emission Determination

A. Hexafluoropropylene (HFP) CAS No. 116-15-4

HF Potential:

HFP is a VOC without the potential to form HF

Quantity Released

HFP is a byproduct present in the HFPO feed. It is an inert in VE-North that is vented to the WGS.

HFP vented per the process flowsheet

Vented from the Condensation Reactor: $\boxed{\frac{0.05\ kg\ HFP}{2.35\ kg\ CondRxVentFlo}}$

Vented from the Crude Receiver $\boxed{\frac{0.01\ kg\ HFP}{3.97\ kg\ Crude\ Receiver\ Vent}}$

Vented from the Foreshots Receiver $\boxed{\frac{0.01\ kg\ HFP}{1.06\ kg\ ForeshotsReceiverVent}}$

Vented from the Stripper $\boxed{\frac{30\ kg\ HFP}{100\ kg\ Stripper\ Vent}}$

HFP vented based on 4,925 kg in the Condensation Reactor vent stream.
HFP vented based on 3,283 kg in the Crude Receiver vent stream.
HFP vented based on 1,032 kg in the Foreshots Receiver vent stream.
HFP vented based on 10,209 kg in the Stripper vent stream.

HFP vented from Condensation Reactor:

$$\frac{0.05\text{ kg HFP}}{2.35\text{ kg CndRx}} \quad x \quad 4{,}925\text{ kg CndRx} \quad = \quad 114\text{ kg HFP}$$

HFP vented from Crude Receiver

$$\frac{0.01\text{ kg HFP}}{3.97\text{ kg CrRec}} \quad x \quad 3{,}283\text{ kg CrRec} \quad = \quad 11\text{ kg HFP}$$

HFP vented from Foreshots Receiver

$$\frac{0.01\text{ kg HFP}}{1.06\text{ kg FsRec}} \quad x \quad 1{,}032\text{ kg FsRec} \quad = \quad 9\text{ kg HFP}$$

HFP vented from Stripper

$$\frac{30\text{ kg HFP}}{100\text{ kg Strpr}} \quad x \quad 10{,}209\text{ kg Strpr} \quad = \quad 3{,}063\text{ kg HFP}$$

VOC Emissions

114 kg from Condensation Reactor
\+ 11 kg from Crude Receiver
\+ 9 kg from Foreshots Receiver
3,063 kg from Stripper
= 3,197 kg HFP = 3,197 kg VOC
7,048 lb VOC

B. Hexafluoropropylene oxide (HFPO) CAS No. 428-59-1

HF Potential:

HFPO is a VOC without the potential to form HF

Quantity Released

HFPO is a byproduct present in the HFPO feed. It is an inert in VE-North that is vented to the WGS.

HFPO vented per the process flowsheet

Vented from the Condensation Reactor:

$$\boxed{\frac{0.11\ kg\ HFPO}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}}$$

Vented from the Crude Receiver

$$\boxed{\frac{0\ kg\ HFPO}{3.97\ kg\ Crude\ Receiver\ Vent}}$$

Vented from the Foreshots Receiver

$$\boxed{\frac{0\ kg\ HFPO}{1.06\ kg\ ForeshotsReceiver\ Vent}}$$

Vented from the Stripper

$$\boxed{\frac{60\ kg\ HFPO}{100\ kg\ Stripper\ Vent}}$$

HFPO vented based on 4,925 kg in the Condensation Reactor vent stream.
HFPO vented based on 3,283 kg in the Crude Receiver vent stream.
HFPO vented based on 1,032 kg in the Foreshots Receiver vent stream.
HFP vented based on 10,209 kg in the Stripper vent stream.

HFPO vented from Condensation Reactor:

$$\frac{0.11\ \text{kg HFPO}}{2.35\ \text{kg CndRx}} \times 4{,}925\ \text{kg CndRx} = 238\ \text{kg HFPO}$$

HFPO vented from Crude Receiver

$$\frac{0.00\ \text{kg HFPO}}{3.97\ \text{kg CrRec}} \times 3{,}283\ \text{kg CrRec} = 0\ \text{kg HFPO}$$

HFPO vented from Foreshots Receiver

$$\frac{0.00\ \text{kg HFPO}}{1.06\ \text{kg FsRec}} \times 1{,}032\ \text{kg FsRec} = 0\ \text{kg HFPO}$$

HFP vented from Stripper

$$\frac{60\ \text{kg HFPO}}{100\ \text{kg Strpr}} \times 10{,}209\ \text{kg Strpr} = 6{,}125\ \text{kg HFPO}$$

VOC Emissions

238 kg from Condensation Reactor
\+ 0 kg from Crude Receiver
\+ 0 kg from Foreshots Receiver
\+ 6,125 kg from Stripper
= 6,363 kg HFPO = 6,363 kg VOC

14,028 lb VOC

C. Perfluoropropionyl fluoride (PPF) CAS No. 422-61-7

HF Potential:

Each mole of PPF (MW = 166) can generate 1 mole of HF (MW = 20).

$$\boxed{1\,kg\,PPF \cdot \frac{1\,molePPF}{166\,g\,PPF} \cdot \frac{20\,g\,HF}{1\,moleHF} \cdot \frac{1\,moleHF}{1\,molePPF} = 0.120\,kg\,HF}$$

Therefore, each 1 kg of PAF generates 0.120 kg of HF

Quantity Released

Before-control PPF vented per the process flowsheet

Vented from the Condensation Reactor: $\boxed{\frac{2.14\ kg\ PPF}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}}$

Vented from the Crude Receiver $\boxed{\frac{0\ kg\ PPF}{3.97\ kg\ Crude\ Receiver\ Vent}}$

Vented from the Foreshots Receiver $\boxed{\frac{0\ kg\ PPF}{1.06\ kg\ ForeshotsReceiver\ Vent}}$

Vented from the Stripper $\boxed{\frac{10\ kg\ PPF}{100\ kg\ Stripper\ Vent}}$

PPF vented based on 4,925 kg in the Condensation Reactor vent stream.
PPF vented based on 3,283 kg in the Crude Receiver vent stream.
PPF vented based on 1,032 kg in the Foreshots Receiver vent stream.
PPF vented based on 10,209 kg in the Stripper vent stream.

Before control PPF vented from Condensation Reactor:

$$\frac{2.14\text{ kg PPF}}{2.35\text{ kg CndRx}} \times 4{,}925\text{ kg CndRx} = 4{,}477\text{ kg PPF}$$

PPF vented from Crude Receiver

$$\frac{0.00\text{ kg PPF}}{3.97\text{ kg CrRec}} \times 3{,}283\text{ kg CrRec} = 0\text{ kg PPF}$$

PPF vented from Foreshots Receiver

$$\frac{0.00\text{ kg PPF}}{1.06\text{ kg FsRec}} \times 1{,}032\text{ kg FsRec} = 0\text{ kg PPF}$$

PPF vented from Stripper

$$\frac{10\text{ kg PPF}}{100\text{ kg Strpr}} \times 10{,}209\text{ kg Strpr} = 1{,}021\text{ kg PPF}$$

Total before-control PPF vented = 5,498 kg PPF

After-control emissions utilizing the 99.6% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

Waste Gas Scrubber 5,498 kg PAF
x (100%-99.6%)
= 22 kg PAF = 22 kg VOC
48 lb. VOC

C. Perfluoropropionyl fluoride (PPF) CAS No. 422-61-7

(continued)

HF Equivalent Emissions		22 kg PAF		
	x	0.120 kg HF/kg PAF		
	=	3 kg HF	=	**5.8 lb. HF**

D. Tetrafluoroethylene (TFE)

CAS No. 116-14-3

HF Potential:

TFE is a VOC without the potential to form HF

Quantity Released

TFE is a byproduct present in the TFE feed. It is an inert in VE-North that is vented to the WGS.

TFE vented per the process flowsheet

Vented from the Condensation Reactor: $\boxed{\dfrac{0\ kg\ TFE}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}}$

Vented from the Crude Receiver $\boxed{\dfrac{2.17\ kg\ TFE}{3.97\ kg\ Crude\ Receiver\ Vent}}$

Vented from the Foreshots Receiver $\boxed{\dfrac{0.0045\ kg\ TFE}{1.06\ kg\ Foreshots\ Receiver\ Vent}}$

Vented from the Stripper $\boxed{\dfrac{0\ kg\ TFE}{100\ kg\ Stripper\ Vent}}$

TFE vented based on 4,925 kg in the Condensation Reactor vent stream.
TFE vented based on 3,283 kg in the Crude Receiver vent stream.
TFE vented based on 1,032 kg in the Foreshots Receiver vent stream.
TFE vented based on 10,209 kg in the Stripper vent stream.

TFE vented from Condensation Reactor:
0.00 / 2.35 kg TFE / kg CndRx x 4,925 kg CndRx = 0 kg TFE

TFE vented from Crude Receiver
2.17 / 3.97 kg TFE / kg CrRec x 3,283 kg CrRec = 1,794 kg TFE

TFE vented from Foreshots Receiver
0.0045 / 1.06 kg TFE / kg FsRec x 1,032 kg FsRec = 4 kg TFE

TFE vented from Stripper
0 kg TFE / 100 kg Strpr x 10,209 kg Strpr = 0 kg TFE

VOC Emissions
0 kg from Condensation Reactor
\+ 1,794 kg from Crude Receiver
\+ 4 kg from Foreshots Receiver
\+ 0 kg from Stripper
= 1,798 kg TFE = 1,798 kg VOC
3,964 lb VOC

E. Perfluoropropyl vinyl ether (PPVE)

CAS No. 1623-5-8

HF Potential:

PPVE is a VOC without the potential to form HF

Quantity Released

PPVE vented per the process flowsheet

Vented from the Condensation Reactor:

$$\boxed{\frac{0\ kg\ PPVE}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}}$$

Vented from the Crude Receiver

$$\boxed{\frac{0.50\ kg\ PPVE}{3.97\ kg\ Crude\ Receiver\ Vent}}$$

Vented from the Foreshots Receiver

$$\boxed{\frac{0.88\ kg\ PPVE}{1.06\ kg\ ForeshotsReceiverVent}}$$

Vented from the Stripper

$$\boxed{\frac{0\ kg\ PPVE}{100\ kg\ Stripper\ Vent}}$$

PPVE vented based on 4,925 kg in the Condensation Reactor vent stream.
PPVE vented based on 3,283 kg in the Crude Receiver vent stream.
PPVE vented based on 1,032 kg in the Foreshots Receiver vent stream.
PPVE vented based on 10,209 kg in the Stripper vent stream.

PPVE vented from Condensation Reactor:

$$\frac{0.00\ kg\ PPVE}{2.35\ kg\ CndRx} \quad x \quad 4{,}925\ kg\ CndRx \quad = \quad 0\ kg\ PPVE$$

PPVE vented from Crude Receiver

$$\frac{0.50\ kg\ PPVE}{3.97\ kg\ CrRec} \quad x \quad 3{,}283\ kg\ CrRec \quad = \quad 417\ kg\ PPVE$$

PPVE vented from Foreshots Receiver

$$\frac{0.88\ kg\ PPVE}{1.06\ kg\ FsRec} \quad x \quad 1{,}032\ kg\ FsRec \quad = \quad 855\ kg\ PPVE$$

PPVE vented from Stripper

$$\frac{0\ kg\ PPVE}{100\ kg\ Strpr} \quad x \quad 10{,}209\ kg\ Strpr \quad = \quad 0\ kg\ PPVE$$

VOC Emissions

0 kg from Condensation Reactor
\+ 417 kg from Crude Receiver
\+ 855 kg from Foreshots Receiver
\+ 0 kg from Stripper
= 1,273 kg PPVE = 1,273 kg VOC
2,806 lb VOC