

2014 Emissions Inventory Review / Data Tracking Form

Facility Name: Chemours Company - Fayetteville Works		Facility ID: 0900009	
Facility Classification: Title V	Assigned to: Gregory Reeves		Bladen County Confidential Copy Submitted? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO

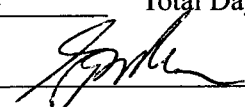
Initial Review / Data Entry

- ☒ Enter date received into ED. Date Received: 6/2/15
- ☒ Assigned to appropriate individual. Date Assigned: 6/3/15 Date Due: 7/3/15
- ☐ Paper copy submitted: One copy received with supporting documentation, certification form signed by responsible official, and appears generally complete; OR
- ☒ Electronic copy submitted: All supporting documentation and certification form (with time/date stamp) signed by responsible official has been received.

Comments: SO₂ EMISSIONS REPORTED INCORRECTLY FOR 05-14. REPORTED AS 3.7 TONS, BUT SHOULD HAVE BEEN 3.7 LBS. ALSO ENTRY CHANGED 06/04/15 PER MIKE JOHNSON. GWR

Inventory Review

- ☒ All forms and supporting documentation appear to be complete if paper submission (check ED OS data if electronic).
- ☒ Contact, address, phone number changes entered into I-Beam/Facilities if necessary.
- ☒ All known operating scenarios, control devices, and emission release points have been entered for each emission source (permitted, insignificant, and unpermitted) or note that the emission source was not operated or not required to report.
- ☒ Check if SCC codes for each OS are accurate and update if needed.
- N/A ☒ Evaluate "U" sources for significance and address according to policy.
- ☒ Calculations / forms appear to add up correctly.
- V/A ☒ All compliance issues are being addressed (e.g. Toxics limits, above TV thresholds, large emissions increase/decrease, installation without a permit).
- ☒ All volatile HAPs/TAPs were included in the VOC total.
- ☒ Calculations and control efficiencies appear correct. Emission factors are the best available and most current factors appropriate for the reporting facility (e.g. stack testing, AP-42, etc.).
- N/A ☒ Review facility comments and address any issues.
- ☒ Update ED (Data Entry Main) if additional information is required (corrections due date and date received).
- ☒ Check all ED QA/QC reports.
- ☒ Comparison with previous emission inventory must be made and outliers (> 10%) must be investigated and explained.
- ☒ Put inventory review comments and summarize any changes in ED - Data Entry Main "DAQ internal comments".
- ☒ Print and attach the facility total report.

Date Info Requested: <u>N/A</u>	Date Info Received: <u>N/A</u>	Total Days on Hold: <u>N/A</u>
Date Review Complete: <u>06/04/2015</u>	Signature: <u></u>	
Date Submitted to EI Coordinator: <u>06/04/2015</u>		
Date Approved: <u>8/26/15</u>	Initials: <u>HSC</u>	

Facility Total CY 2014 Emission Summary Recorded in ED
Facility ID #: 0900009

Facility Name: Chemours Company - Fayetteville Works

Permit #(s): 03735T39

Green House Gases Pollutants (GHG)		Actual Emissions Tons/Yr			% Change
<u>Pollutant</u>	<u>CAS</u>	CY 2014 from ED	CY 2013 from Fees	Demini- mus	
Hydrofluorocarbons (HFCs)		7.23			
	HFC	Not Reported	Not Reported		N/A
<i>HFC-23 (Trifluoromethane)</i>	75467	7.23	7.23	0.05	0.0%
Carbon Dioxide (CO2)	124389	38,348.44	38,214.17	5,000.0	0.4%
Methane (CH4)	74-82-8	0.734300	2.64	10.0	-72.1%
Nitrous Oxide (N2O)	10024972	0.075700	3.04	1.0	-97.5%
CO2 equivalent (sum of individual GHG pollutant emission times their 1995 IPCC Global Warming Potential (GWP), converted to metric tons)		111,565.94	metric tons		

Criteria Pollutants		Actual Emissions (Tons/Year)			% Change
<u>Pollutant</u>	<u>CAS</u>	CY 2014 from ED	CY 2013 from Fees	Demini- mus	
CO	CO	38.10	30.45	0.5	25.1%
NOx	NOx	76.26	80.13	0.5	-4.8%
PM(TSP)	TSP	8.60	9.47	0.5	-9.2%
PM10	PM10	8.60	9.47	0.5	-9.2%
PM2.5	PM2.5	8.60	9.47	0.5	-9.2%
SO2	SO2	1.95	0.210000	0.5	828.6%
VOC	VOC	332.17	312.90	0.5	6.2%

Hazardous Air Pollutants (HAPs) and/or Toxic Air Pollutants (TAPs)		Actual Emissions (Pounds/Year)			% Change
<u>Pollutant</u>	<u>CAS</u>	CY 2014 from ED	CY 2013 from Fees	Demini- mus	
Antimony & Compounds (total mass, inc elemental SB)		Not Reported	0.000000	10.0	N/A
<i>Antimony Unlisted Compounds - Specify Compound (Component of SBC)</i>	SBC-Other	Not Reported	Not Reported	10.0	N/A

Hazardous Air Pollutants (HAPs) and/or Toxic Air Pollutants (TAPs)		Actual Emissions (Pounds/Year)			% Change
<u>Pollutant</u>	<u>CAS</u>	CY 2014 from ED	CY 2013 from Fees	Demini- mus	
Arsenic & Compounds (total mass of elemental AS, arsine and all inorganic compounds)		0.152730	0.129360	0.01	18.1%
Arsenic Unlisted Compounds - Specify Compound (Component of ASC)	ASC-Other	0.152730	0.129360	0.01	18.1%
Beryllium & compounds (Total mass)		0.023240	0.009960	1.0	133.3%
Beryllium Metal (unreacted) (Component of BEC)	7440-41-7	0.023240	0.009960	1.0	133.3%
Beryllium Unlisted Compounds - Specify Compound (Component of BEC)	BEC-Other	Not Reported	Not Reported	1.0	N/A
Cadmium & compounds (total mass includes elemental metal)		0.712020	0.696370	0.1	2.2%
Cadmium Metal, elemental, unreacted (Component of CDC)	7440-43-9	0.712020	0.696370	0.1	2.2%
Cadmium Unlisted Compounds - Specify Compound (Component of CDC)	CDC-Other	Not Reported	Not Reported	0.1	N/A
Chromium - All/Total (includes Chromium (VI) categories, metal and others)		0.901020	0.885640	0.1	1.7%
Chromic acid (VI) (Component of SolCR6 & CRC)	7738-94-5	0.901020	0.885640	0.01	1.7%
Chromium Unlisted Compounds - Specify Compound (Component of CRC)	CRC-Other	Not Reported	Not Reported	0.1	N/A
Chromium (VI) Soluble Chromate Compounds (Component of CRC)		0.901020	0.885640	0.01	1.7%
Chromic acid (VI) (Component of SolCR6 & CRC)	7738-94-5	0.901020	0.885640	0.01	1.7%
Cobalt & compounds		0.052800	0.053270	1.0	-0.9%
Cobalt Unlisted Compounds - Specify Compound (Component of COC)	COC-Other	0.052800	0.053270	1.0	-0.9%
Glycol ethers (total all individual glycol ethers-See http://daq.state.nc.us/toxics/glycol/)		Not Reported	0.000000	100.0	N/A
Glycol Ethers, Unlisted - Specify Compound (component of GLYET) (See http://daq.state.nc.us/toxics)	GLYET-Other	Not Reported	Not Reported	100.0	N/A
Lead & compounds		0.129860	0.055650	1.0	133.4%

Facility Total CY 2014 Emission Summary Recorded in ED
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Permit #(s): 03735T39

Hazardous Air Pollutants (HAPs) and/or Toxic Air Pollutants (TAPs) Pollutant	CAS	Actual Emissions (Pounds/Year)			% Change
		CY 2014 from ED	CY 2013 from Fees	Demini- mus	
Lead Unlisted Compounds - Specify Compound (Component of PBC)	PBC-Other	0.129860	0.055650	10.0	133.4%
Manganese & compounds		0.279520	0.244520	10.0	14.3%
Manganese Unlisted Compounds - Specify Compound (Component of MNC)	MNC-Other	0.279520	0.244520	10.0	14.3%
Mercury & Compounds - all total mass includes Hg Vapor		0.184220	0.166420	0.001	10.7%
Mercury Unlisted Compounds - Specify Compound (Component of HGC)	HGC-Other	Not Reported	Not Reported	0.001	N/A
Mercury, vapor (Component of HGC)	7439-97-6	0.184220	0.166420	0.001	10.7%
Nickel & Compounds, sum total mass includes elemental		1.34	1.33	1.0	0.8%
Nickel metal (Component of NIC)	7440-02-0	1.34	1.33	1.0	0.7%
Nickel Unlisted Compounds (Component of NIC - Specify)	NIC-Other	Not Reported	Not Reported	1.0	N/A
Nickel, soluble compounds as nickel (Component of NIC)	NICKSOLCPDS	Not Reported	Not Reported	1.0	N/A
Polycyclic Organic Matter (7 PAH Compounds for NIF)		0.000750	0.000750	1.0	N/A
Benzo(a)pyrene (Component of 83329/POMTV & 56553/7PAH)	50-32-8	0.000750	0.000750	1.0	N/A
Polycyclic Organic Matter (Specific Compounds from OAQPS for TV)		0.400470	0.389520	1.0	2.8%
Benzo(a)pyrene (Component of 83329/POMTV & 56553/7PAH)	50-32-8	0.000750	0.000750	1.0	N/A
Naphthalene (Component of 83329/POMTV)	91-20-3	0.399720	0.388770	1.0	2.8%
Total Reduced Sulfur (TRS as total mass)		180.60	180.60		0.0%
Dimethyl sulfide	75-18-3	37.50	37.50	1.0	0.0%
Hydrogen sulfide	7783-06-4	140.00	140.00	1.0	0.0%
Methyl mercaptan	74-93-1	3.10	3.10	1.0	0.0%
Acetaldehyde	75-07-0	0.002060	0.001420	10.0	N/A

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<u>Pollutant</u>	<u>CAS</u>	CY 2014 from ED	CY 2013 from Fees	Demini- mus	
Acetic acid	64-19-7	950.00	923.90	100.0	2.8%
Acetonitrile	75-05-8	1,859.00	2,103.00	100.0	-11.6%
Acrolein	107-02-8	1.00	1.00	10.0	0.1%
Ammonia (as NH3)	7664-41-7	1,862.80	1,920.18	100.0	-3.0%
Benzene	71-43-2	9.45	9.35	1.0	1.0%
Bromine	7726-95-6	26.00	26.00	10.0	0.0%
CFC- 113 (1,1,2-trichloro-1,2,2-trifluoroethane)	76-13-1	1,354.70	1,120.00	100.0	21.0%
CFC-12 (Dichlorodifluoromethane)	75-71-8	Not Reported	Not Reported	100.0	N/A
Chlorine	7782-50-5	1,244.00	1,244.00	100.0	0.0%
Chloroform	67-66-3	1.00	1.00	100.0	0.0%
Dimethyl formamide	68-12-2	Not Reported	Not Reported	1.0	N/A
Dioxane, 1,4-	123-91-1	Not Reported	Not Reported	0.01	N/A
Ethyl acetate	141-78-6	17.00	17.00	10.0	0.0%
Ethyl benzene	100-41-4	1,446.04	1,206.00	100.0	19.9%
Ethylene dichloride (1,2-dichloroethane)	107-06-2	541.00	541.00	1.0	0.0%
Ethylene glycol	107-21-1	134.00	114.00	100.0	17.5%
Fluorides (sum of all fluoride compounds as mass of F ion)	16984-48-8	2,445.95	0.212280	10.0	1,152,129.1%
Formaldehyde	50-00-0	12.87	47.84	10.0	-73.1%
Hexane, n-	110-54-3	1,226.00	1,236.59	100.0	-0.9%
Hydrogen chloride (hydrochloric acid)	7647-01-0	11.49	11.00	100.0	4.5%
Hydrogen fluoride (hydrofluoric acid as mass of HF) (Component of 16984488/Fluorides)	7664-39-3	2,444.15	2,140.45	100.0	14.2%
MEK (methyl ethyl ketone, 2-butanone)	78-93-3	586.00	489.00	100.0	19.8%
Methanol (methyl alcohol)	67-56-1	39,138.00	39,856.00	1,000.0	-1.8%

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Pollutant	CAS	CY 2014 from ED	CY 2013 from Fees	Demini- mus	
Methyl chloroform	71-55-6	0.012010	0.001340	100.0	N/A
Methylene chloride	75-09-2	13,938.00	12,873.00	1.0	8.3%
Nitric acid	7697-37-2	109.00	109.00	100.0	0.0%
Phosphorus Metal, Yellow or White	7723-14-0	Not Reported	Not Reported	1.0	N/A
Polycyclic Organic Matter (Inc PAH, dioxins, etc. NCPOM & AP 42 historic)		0.160170	0.018780	1.0	752.9%
Selenium Compounds	SEC	0.115160	0.027170	10.0	323.8%
Sulfur trioxide	7446-11-9	0.000000	67.40	100.0	-100.0%
Sulfuric acid	7664-93-9	227.40	228.80	100.0	-0.6%
Toluene	108-88-3	2,656.05	3,816.61	100.0	-30.4%
Vinylidene chloride	75-35-4	Not Reported	Not Reported	0.1	N/A
Xylene (mixed isomers)	1330-20-7	2,500.07	2,208.01	100.0	13.2%
Largest Individual HAP	Methanol (methyl alcohol)	39,138.00 lbs			
Total HAP Emissions		67,166.58 lbs			

DAQ's Comments Regarding Inventory

SO2 emissions increased by 828.6% (1.74 tons) due to firing 65,000 gallons of #6 fuel oil. CO emissions increased by 25.1% (7.6 tons) due to firing of #6 fuel oil. Emissions of heavy metals and POM increased due to firing of #6 fuel oil as follows: Arsenic 18.1% (0.23 lbs), Lead 133.4% (0.07 lbs), Manganese 14.3% (0.03 lbs), Mercury 10.7% (0.02 lbs), Polycyclic Organic Matter 752.9% (0.14 lbs) and Selenium 323.8% (0.09 lbs). All were very small increases in actual amounts. Various organic HAPs and TAPs emissions increased (or decreased) due to the mix of products produced in the facility. Fluorides emissions appear to have increased due to the reporting of HF as a fluoride. However, according to materials submitted by DuPont representatives, it appears that HF should not be reported as a fluoride in AERO, as EPA guidance suggests that these reported fluoride emissions should be only the metal fluorides, not HF. Sulfur Trioxide emissions decreased by 100% due to a change in the chemistry of the APFO process. Sulfur Trioxide is no longer used in this process. An entry error was corrected for Operating Scenario OS-14. SO2 emissions for this process were reported as 3.7 tons, but the actual emissions were only 3.7 pounds. This entry change was approved by Mike Johnson of Chemours on 06/04/15.



DuPont Fluoroproducts

RECEIVED
JUN - 2 2015
DENR-FAYETTEVILLE REGIONAL OFFICE

VIA COURIER

June 1, 2015

Mr. Steven F. Vozzo
Air Quality Supervisor
NCDENR – Division of Air Quality
225 Green Street – Suite 714
Fayetteville, NC 28301

SUBJECT: 2014 Air Emissions Inventory Report
DuPont Company – Fayetteville Works
Bladen County, North Carolina
Air Permit No. 03735T39
Facility ID: 06/09-0900009

Dear Mr. Vozzo,

As required by Section 3.D of the subject Title V Air Permit, enclosed are a photocopy of this letter, an original and one photocopy of the 2014 Air Emissions Inventory Report, an original and one photocopy of the required Inventory Certification Form, and an original and one photocopy of the required Confidential Information Submission.

If you have any questions regarding this report, please call me at (910) 678-1155.

Sincerely,

A handwritten signature in black ink, appearing to read "Michael E. Johnson", written over a large, stylized, and somewhat abstract scribble or flourish.

Michael E. Johnson, PE
Environmental Manager

Enclosures



RECEIVED
JUN -2 2015
DENR-FAYETTEVILLE REGIONAL OFFICE

**DUPONT COMPANY
FAYETTEVILLE WORKS**

**AIR PERMIT NUMBER 03735T39
FACILITY ID 0900009**

**2014
AIR
EMISSIONS
INVENTORY
REPORT**

Inventory Certification Form(Title V)

Facility Name: DuPont Company – Fayetteville Works
22828 NC Highway 87 West
Fayetteville, NC 28306

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

RECEIVED
JUN 2 2015
DENR-FAYETTEVILLE REGION

**North Carolina Department of Environment and Natural Resources
Division of Air Quality
Air Pollutant Point Source Emissions Inventory – Calendar Year 2014**

These forms must be completed and returned even if the facility did not operate or emissions were zero

**The legally defined "Responsible Official" of record for your facility is Ellis McGaughy
This person or one that meets the definition below must sign this certification form.**

The official submitting the information must certify that he/she complies with the requirements as specified in Title 15A NCAC 2Q.0520(b) which references and follows the federal definition. 40 CFR Part 70.2 defines a responsible as meaning one of the following:

1. For a corporation: a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision making functions for the overall operation of one or more manufacturing, production, or operating facilities applying for a or subject to a permit and either
 - i. the facilities employ more than 250 persons or have gross annual sales or expenditures exceeding \$25 million(in second quarter 1980 dollars); or
 - ii. the delegation of authority to such representatives is approved in advance by the permitting authority;
2. For partnership or sole proprietorship; a general partner or the proprietor, respectively;
3. for a municipality, state, federal, or other public agency includes the chief executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., a Regional Administrator of EPA).

CERTIFICATION STATEMENT:

(Important: Legally Responsible Official, read and sign after all submissions are final.)

I certify that I am the responsible official for this facility, as described above, and hereby certify that the information contained in this air emissions report, including attached calculations and documentation, is true, accurate and complete. (Subject to legal penalties of up to \$25,000 per occurrence and possible imprisonment as outlined in G.S.§143-215.3(a)(2))

Responsible Official's Signature Below (use blue ink): **Date Signed:**

Printed Name: Ellis McGaughy

Signature:

Ellis H. McGaughy

5/28/2015

This form applies to Title V facilities. If this facility is not classified as Title V, please telephone your regional office Emission Inventory contact at once for proper forms.

Email address of Responsible Official: Ellis.H.McGaughy@dupont.com

Information on this Form cannot be held confidential

2014 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No.: BS- B1.1 through 1.4 and BS-B2.1 through 2.4

Emission Source Description: Butacite® Flake Reactors

Process & Emission Description:

The Butacite® Flake Reactors receive raw materials and react them to create a polyvinyl butyral ("PVB") polymer dispersion. Polyvinyl alcohol ("PVA"), one of the two major reactants, contains up to 1% by weight of methanol. Butyraldehyde ("BA"), a VOC, is the other major reactant. After the reaction step, the reactor contents are sparged with nitrogen to remove unreacted BA. The PVB dispersion mix is then pumped from the reactors for draining, washing with water, re-slurry and storage. Each reactor has a reflux condenser, which in turn vent to one of two water scrubbers (control devices BCD-B1 and BCD-B2). The residual methanol and unreacted BA which exit the reactor through the vent line are either condensed back to the reactor or enter the water scrubber. That which is not removed in the scrubber is vented to the atmosphere.

Basis and Assumptions:

Estimated uncontrolled methanol emissions from this operation are based on modeling of the individual steps of the reactor batch process using commercial software called "Emission Master". This software incorporates the equations in the National Emission Standards for Pharmaceutical Production (40 CFR 63.1257) as required by the MON rule. Emissions results from this modeling were presented to the NCDENR in our MON Notification of Compliance Status Report dated 10/2/2008.

Estimated uncontrolled butyraldehyde emissions from this operation are based on modeling of the Butacite® PVB polymer production process using ASPEN Tech process modeling software. This process model was developed by the DuPont Engineering Technology group in Wilmington, Delaware in May 2008.

Uncontrolled methanol emissions from the Butacite® reactors were calculated to be 1.448×10^{-4} lb. per PVB polymer production unit ("PPU"). Uncontrolled butyraldehyde emissions from the Butacite® reactors were calculated to be 2.279×10^{-2} lb. per PPU. These emissions are reduced by 99% through the scrubbers.

Fugitive emissions are calculated using the EPA SOCMF factors. Butyraldehyde is classified as a light liquid.

Due to the small fraction of methanol in the vapor space, fugitive emissions are nil.

Information Inputs and Source Inputs:

Information Input	Source of Inputs
PVB Polymer Production	Butacite® Production Clerk

Point Source Emissions Determination:

Shown on the following page.

Fugitive Emissions Determination:

Shown on the following page.

2014 AIR EMISSIONS INVENTORY

BUTACITE® FLAKE REACTORS

(BS-B1.1 thru 1.4 and BS-B2.1 thru 2.4)

EMISSIONS SUMMARY

95-41

	VOC EMISSIONS (lb./year)	VOC EMISSIONS (TPY)
POINT SOURCE EMISSIONS:		
Packed Bed Scrubbers (BCD-B1 and BCD-B2)	1,619	0.81
FUGITIVE EMISSIONS:		
Reactor and Vent System	801	0.40
Charging System	10,923	5.46
Recirculation System	3,522	1.76
TOTAL EMISSIONS	16,865	8.43

Point Source Emission Determination**Flake Reactors (BS-B1.1 thru 1.4 and BS-B2.1 thru 2.4)****Butyraldehyde (BA)**
Methanol (MeOH)**CAS No. 00123-72-8**
CAS No. 67-56-1

Annual Production for the PVB Flake Reactors in 2014 equaled 7,059,841 Polymer Production Units (PPU)

Uncontrolled methanol emissions for the PVB Flake Reactors are 0.0001448 pounds per Polymer Production Units (PPU). Therefore annual uncontrolled methanol emissions for this source are:

$$1.448\text{E-}04 \frac{\text{lb. MeOH}}{\text{PPU PVB}} \times 7,059,841 \frac{\text{PPU PVB}}{\text{year}} = 1,022 \frac{\text{lb. MeOH}}{\text{year}}$$

Uncontrolled butyraldehyde emissions for the PVB Flake Reactors are 0.02279 pounds per Polymer Production Units (PPU). Therefore annual uncontrolled butyraldehyde emissions for this source are:

$$2.279\text{E-}02 \frac{\text{lb. BA}}{\text{PPU PVB}} \times 7,059,841 \frac{\text{PPU PVB}}{\text{year}} = 160,894 \frac{\text{lb. BA}}{\text{year}}$$

The packed bed scrubbers have an efficiency of 99%. Therefore the actual emissions to the atmosphere of methanol and butyraldehyde are:

$$\text{Annual methanol emissions} = 1,022 \frac{\text{lb. MeOH}}{\text{year}} \times (1-0.99) = 10 \frac{\text{lb. MeOH}}{\text{year}}$$

$$\text{Annual butyraldehyde emissions} = 160,894 \frac{\text{lb. BA}}{\text{year}} \times (1-0.99) = 1,609 \frac{\text{lb. BA}}{\text{year}}$$

Total VOC point source emissions of Methanol and Butyraldehyde from the Packed Bed Scrubbers (BCD-B1 and BCD-B2) in 2014 was:

$$\begin{aligned} 10 \text{ lb. MeOH} + 1,609 \text{ lb. BA} &= 1,619 \text{ lb. VOC} \\ &= 0.81 \text{ ton VOC} \end{aligned}$$

Fugitive Emission Determination

Flake Reactors (BS-B1.1 thru 1.4 and BS-B2.1 thru 2.4)

Butyraldehyde (BA)

CAS No. 00123-72-8

Fugitive Loss Assumptions and Data

1. The Reactor/Vent system emissions are production dependent. All reactors/vent systems are treated as one source.
2. Due to the low methanol concentration in the reactor, only butyraldehyde fugitive emissions are considered.
3. Weight fraction of butyraldehyde in the vapor phase 0.140
4. Reaction hours are the sum of all reactors' time spent in reaction and sparging steps.
5. The Reactor/Vent system is essentially a vapor system. The charging and recirculation systems are liquid systems.

A. Reactor/Vent System

$$\begin{aligned}\text{Leak Rate} &= (\text{gas valve loss} + \text{liquid valve loss} + \text{open-ended line} + \text{flange loss}) \times \text{wt. fraction BA} \times \text{reaction hours} \\ &= [(16) (0.012) + (1) (0.016) + (1) (0.0037) + (48) (0.0018)] \times 0.14 \times 19,156 \\ &= 801 \text{ lbs./year}\end{aligned}$$

B. Charging System

$$\begin{aligned}\text{Leak rate} &= (\text{pump loss} + \text{liquid valve loss} + \text{flange loss}) \times \text{operating hours} \\ &= [() (0.109) + (84) (0.016) + (177) (0.0018)] \times 5,808 \\ &= 10,923 \text{ lbs./year}\end{aligned}$$

C. Recirculation System

$$\begin{aligned}\text{Leak rate} &= (\text{liquid valve loss} + \text{flange loss} + \text{pressure relief loss}) \times \text{operating hours} \\ &= [(6) (0.016) + (28) (0.0018) + (2) (0.23)] \times 5,808 \\ &= 3,522 \text{ lbs./year}\end{aligned}$$

05-21

Supporting Documentation for WWTP Sludge Dryers (WTS-B and WTS-C)

The Specific Conditions for the Impingement Type Wet Scrubber (ID No. WTCD-1) is discussed in Part 1 Section 2.1(E) of the site's Title V Air Permit. The Permit states that the scrubber is to control the "odorous emissions from the wastewater treatment sludge dryers (Nos. WTC-B and WTS-C)."

Major categories of offensive odors from the drying of activated sludge could generally be grouped into the following:

Odor Category	Common Chemical in Odor Category	Odor Threshold of Common Chemical (ppmv)
Amines	Methyl amine	0.021
Ammonia	Ammonia	1.5
Hydrogen sulfide	Hydrogen sulfide	0.13
Mercaptans	Methyl mercaptan	0.002
Organic sulfides	Dimethyl sulfide	0.001
Skatole	3-Methyl-1H-indole	0.019

Based on the lack of odors coming from the discharge of the WWTP Sludge Dryer scrubber, and the low odor threshold of the possible odorous compounds coming from the scrubber, it is believed that only an insignificant amount of VOCs could be emitted from this source.

To quantify the worst-case scenario, it will be assumed that the scrubber is running continuously for the entire year with the above compounds being vented at their odor threshold concentration. This is an obvious overstatement of actual emissions since the WWTP Scrubber normally operates with no detectable odors.

Conversion of concentration expressed as ppmv to mg/m³ is via the following equation:

$$\frac{\text{mg}}{\text{m}^3} = \frac{\text{ppmv} \times 12.187 \times \text{Molecular Weight}}{(273.15 + \text{Temperature})^{\circ}\text{C}}$$

For the purpose of this concentration conversion, it will be assumed that the actual scrubber discharge temperature is a constant 27 °C. Therefore, the above equation reduces to:

$$\frac{\text{mg}}{\text{m}^3} = 0.0406 \times \text{ppmv} \times \text{Molecular Weight}$$

For example, converting 0.021 ppmv of methyl amine (MW = 31) to mg/m³ follows:

$$0.0406 \times 0.021 \text{ ppmv} \times 31 \frac{\text{grams}}{\text{mole}} = 0.026 \frac{\text{mg}}{\text{m}^3}$$

Conversion of concentration from ppmv to mg/m³

Compound	Molecular Weight (grams per mole)	Odor Threshold (ppmv)	Odor Threshold (mg/m ³)
Methyl amine	31	0.021	0.026
Ammonia	17	1.5	1.035
Hydrogen sulfide	34	0.13	0.179
Methyl mercaptan	48	0.002	0.004
Dimethyl sulfide	62	0.001	0.048
3-Methyl-1H-indole	131	0.019	0.101

Scrubber (ID No. WTCD-3) design air flow rate is 23,850 cubic feet per minute.

This flow rate is converted to cubic meters per year by the following:

$$23,850 \frac{\text{ft}^3}{\text{min}} \times 0.0283 \frac{\text{m}^3}{\text{ft}^3} \times 60 \frac{\text{min}}{\text{hr}} \times 8,760 \frac{\text{hr}}{\text{yr}} = 354,756,350 \frac{\text{m}^3}{\text{yr}}$$

Emissions Determination:

Compound	Odor Threshold (mg/m ³)	Multiplied by:		Equals:
		Scrubber Flow Rate (m ³ /yr)	Mass Conversion (lb/mg)	Emission Rate (lb/yr)
Methyl amine	0.026	354,756,350	2.2046×10^{-6}	20.3
Ammonia (Note 1)	1.035	354,756,350	2.2046×10^{-6}	809.5
Hydrogen sulfide (Note 1)	0.179	354,756,350	2.2046×10^{-6}	140.0
Methyl mercaptan (Note 1)	0.004	354,756,350	2.2046×10^{-6}	3.1
Dimethyl sulfide (Note 1)	0.048	354,756,350	2.2046×10^{-6}	37.5
3-Methyl-1H-indole	0.101	354,756,350	2.2046×10^{-6}	79.0

Note 1: These compounds are listed as HAPs and/or TAPs

VOC Emissions Determination:

Methyl amine	20.3 lb/yr
Methyl mercaptan	3.1 lb/yr
Dimethyl sulfide	37.5 lb/yr
3-Methyl-1H-indole	79.0 lb/yr
Total VOC	139.9 lb/yr
Total VOC	0.07 TPY

**2014 AIR EMISSIONS SUMMARY
POLYMER PROCESSING AID PROCESS**

05/12

VOC Emissions		lb/yr
FRD901		0.5
Dimer		33.9
Dimer Acid		4.6
Total VOC emissions (lb/yr)		39.0
Total VOC emissions (ton/yr)		0.02

Particulate (PM) Emissions		lb/yr
FRD902		2.8
Total PM emissions (lb/yr)		2.8
Total PM emissions (ton/yr)		0.001

Toxic Air Pollutant (TAP) Emissions		lb/yr
Ammonia		53.3
HF		3.6
H2SO4		47.5

Ammonia (NH₃)

Definitions

PT = Total Pressure
VP_i = Vapor Pressure of Component i
P_i = Partial Pressure of Component i
X_i = Mole Fraction of Component i in the Liquid
Y_i = Mole Fraction of Component i in the Vapor
K_i = Henry's Law Constant

Assumptions

Ideal Gas Laws apply and all solutions are considered Ideal Solutions
Vapor Pressure is constant over temperature range. Value used is for worst case ie. max ambient temp (90 F) from Tanner Industries table for Aqua Ammonia

Constants

Molecular Weight of NH ₃	17
Molecular Weight of Water	18
Molecular Weight of pure APFO	431.1
VP of 19% solution [mm Hg]	382
Specific Gravity of 19% solution	0.94
Specific Gravity of 20% APFO	1.2
Density of Water [g/cm ³]	0.995
K _{NH3} [atm]	0.95

Conversions

1 gallon = 3.785 liters = 3,785 cm³ = 231 in³
1 atm = 760 mm Hg = 14.7 psi
1 lb = 454 grams
1 ft³ = 28.3 liters

Leak Rates [lb/hour] (using "Good" factor for DuPont facilities)

Pump Seals	0.00750
Valves	0.00352
Flanges	0.00031

Equations

$P_i = X_i \cdot K_i$ Henry's Law (used for dilute solutions)
 $P_i = X_i \cdot V_{pi}$ Raoult's Law
 $Y_i = P_i / PT$

Assumptions & Notes

Tote is filled from 55 gallon drums and displaced vapors exit into atmosphere

Tote Filling

Number of drums added to tote during fill	4
Total vapor displaced during fill [liters]	832.7
Number of fills per year	92
Total vapor displaced during year [liters]	76,608
P _{NH3} [mm Hg]	64.097
Y _{NH3}	0.08434
Total NH ₃ vapor displaced during year [liters]	6461.0
Total NH ₃ vapor displaced during year [lbs]	10.8005

Reactor Charging

Number of batches per year	472
Average pump run time per batch (min)	30
Number of flanges in line	15
Number of open valves in line	4
Number of pump seals (air diaphragm)	0
Total pump time for year [hours]	236
Total fugitive emissions [lbs]	4.4203

Line is liquid-filled during entire charging time and empty during non-charging time

905 Reactor Charging

Number of batches per year	31
Average drop time per batch (min)	360
Number of flanges in line	15
Number of open valves in line	10
Number of pump seals (air diaphragm)	0
Total drop time for year [hours]	186
Total fugitive emissions [lbs]	23.7708

APFO Reactor Emissions

Vessel Capacity [gal]	1,000
Avg. Heel [lbs]	1,500
Water Charge [lbs]	2,500
19% Ammonia Charge [lbs]	210
Vapor space of APFO Reactor minus	523.57
% Ammonia after Dilution	0.01571
VP after dilution [mm Hg]	90
Moles of APFO	315.94
Moles of Water	93,322
Moles of NH ₃	1,066
X _{NH3}	0.01125
P _{NH3} [mm Hg]	8.1236
Y _{NH3}	0.01069
Total NH ₃ vapor to scrubber [lb mol/batch]	0.00179
Total NH ₃ vapor to scrubber [lbs/batch]	0.03035
Total NH ₃ vapor to Scrubber [lbs/year]	14.3249
Assumed Efficiency of Scrubber	0
Ammonia exiting Stack [lbs/year]	14.3249

Ammonia gas, through vapor pressure, fills entire available vapor space of Reactor. This entire volume is then vented to the Scrubber before PFOA is charged and reaction to APFO instantly occurs.

Ammonia VP is reduced after dilution. Value used is from table for 2% at

0.019 psi / mm Hg

10.73 - gas constant in ft³ psi / °R lb mole
7.48 gal / ft³

Total Ammonia Emissions [lbs/year]

53.3

Sulfuric Acid (H₂SO₄)

Constants

Molecular Weight of H ₂ SO ₄	98.1
Molecular Weight of Water	18
VP of Sulfuric [mm Hg]	0.01
K _{H2SO4} [atm] -> 0 [atm] therefore Raoult's Law will only be used	

Leak Rates [lb/hour]	Good	Excellent
Pump Seals	0.0075	0.00115
Valves	0.00352	0.00036
Flanges	0.00031	0.00018

Assumptions & Notes

Oleum Storage Tank contains no flanges/valves below liquid line and because the VP of H₂SO₄ is so low, any vapor leaks out of flanges above liquid line are negligible as well as vapor losses to Scrubber during Oleum Storage Tank filling and hose blow-down.

Sulfuric Acid Storage Tank Filling

Average fill size [gallons]	3000
Number of fills per year	9
Total vapor displaced during year [liters]	102195
P _{H2SO4} [mm Hg]	0.00986
Y _{H2SO4}	1.298E-05
Total H ₂ SO ₄ vapor displaced during year [liters]	1.32635
Total H ₂ SO ₄ vapor displaced during year [lbs]	0.01279

H₂SO₄ Storage Tank Emissions

Avg time vessel is inventoried [days/yr]	335
Number of vessel flanges (below inventory line)	4
Number of open valves (below inventory line)	1
Fugitive H ₂ SO ₄ emissions [lbs/year]	38.2704

Because Sulfuric has such a low VP, leaks out of vessel above the liquid line are negligible

Hydrolysis Reactor Charging

Number of acid charges per year	472
Average pump run time per batch (min)	15
Number of flanges in line	25
Number of open valves in line	9
Number of pump seals	1
Total pump time for year [hours]	118
Total fugitive emissions [lbs]	5.53774

Line is liquid-filled during entire charging time and empty during non-charging time

Hydrolysis Reactor Emissions

Vessel capacity [gal]	600
Hydro Reactor Charge of water [lbs]	2000
Hydro Reactor Charge of H ₂ SO ₄ [lbs]	590
Batches per year	1416
Avg Level of Vessel at Vent [gallons]	490
X _{H2SO4}	0.59431
P _{H2SO4} [mm Hg]	0.00594
Y _{H2SO4}	7.820E-06
H ₂ SO ₄ vapor vented to Scrubber [lb mol/batch]	2.744E-07
H ₂ SO ₄ vapor vented to Scrubber [lbs/year]	0.038117
Assumed Efficiency of Scrubber	0.95
H ₂ SO ₄ exiting Stack [lbs/year]	0.001906

Worst Case - liquid molar ratio of H₂SO₄ at time of venting is same as initial charge
Avg pressure at time of vent = atmosphere
Entire available head space is vented to the Scrubber

0.019 psi / mm Hg

10.73 - gas constant in ft³ psi / °R lb mole

7.48 gal / ft³

Avg time vessel is inventoried [days/yr]	335
Number of vessel flanges (below inventory line)	7
Number of open valves (below inventory line)	0
Fugitive H ₂ SO ₄ emissions [lbs/year]	3.66383

Closed valves and instruments connections considered flanges

Because Sulfuric has such a low VP, leaks out of vessel above the liquid line are negligible

Dilution Tank Emissions (Mix and Settle)

Vessel capacity [gal]	1,963
Avg Level of Vessel at Vent [gallons]	800
Batches per year	0
Mass fraction of H ₂ SO ₄	0.2
Pressure of Vessel at Vent [mm Hg]	760
X _{H2SO4}	0.57672
P _{H2SO4} [mm Hg]	0.00577
Y _{H2SO4}	7.588E-06
H ₂ SO ₄ vapor vented to Scrubber [liters/batch]	0.03340
H ₂ SO ₄ vapor vented to Scrubber [lbs/year]	0.00000
Assumed Efficiency of Scrubber	0.95
H ₂ SO ₄ exiting Stack [lbs/year]	0.00000

Entire available head space is vented to the Scrubber

Dilution Trailer Loadout Emissions

Number of transfers per year	0
Average pump run time per transfer (min)	60
Number of flanges in line	30
Number of open valves in line	11
Number of pump seals	1
Total pump time for year [hours]	0
Total fugitive emissions [lbs]	0.00000

Line is liquid-filled during entire charging time and empty during non-charging time

Total H₂SO₄ Emissions [lbs/year]	47.5
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Hydrofluoric Acid (HF)

		Leak Rates [lb/hour]	Good	Excellent
Molecular Weight of HF	20	Pump Seals	0.0075	0.00115
Molecular Weight of DAF	332	Valves	0.00352	0.00036
Molecular Weight of H ₂ SO ₄	98.1	Flanges	0.00031	0.00018
Molecular Weight of Dimer Acid	330			
Molecular Weight of Water	18			
VP at 60°C [mm Hg]	2			
K _{HF}	0.006			

Hydrolysis Reactor Emissions

Vessel capacity [gal]	600
Water Charge [lbs]	2660
93% Sulfuric Charge [lbs]	782
DAF Charge [lbs]	1400
HF (post reaction) [lbs]	84.34
Dimer Acid (post reaction) [lbs]	1391.57
Water (post reaction) [lbs]	2584.10
Sulfuric (post reaction) [lbs]	782
Avg Level of Vessel at Vent [gal]	490
Mass Fraction of HF	0.017418
X _{HF}	0.026361
P _{HF} [mm Hg]	0.120206
Y _{HF}	0.0001582
HF vapor vented to Scrubber [lb mol/batch]	5.55E-06
HF vapor vented to Scrubber [lbs/year]	0.0468420
Assumed Efficiency of Scrubber	0.95
HF exiting Stack [lbs/year]	0.00234210
Avg time vessel contains Virgin material [days/yr]	150
Number of vessel flanges (below inventory line)	7
Number of open valves (below inventory line)	0
Fugitive HF emissions [lbs/year]	1.54504

Trailer Loadout Emissions

Number of transfers per year	0
Average pump run time per transfer (min)	60
Number of flanges in line	30
Number of open valves in line	11
Number of pump seals	1
Total pump time for year [hours]	0
Total fugitive emissions [lbs]	0.00000

Emissions based on DAF

2.04022

Total HF Emissions [lbs/year]

3.6

Assumptions & Notes

Worst Case - 100% conversion resulting in maximum HF generation

VP listed is for 10% solution which is an over-estimation.

0.019 psi / mm Hg

10.73 gas constant in ft³ psi / °R lb mol

7.48 gal / ft³

Because HF has a low VP, leaks out of vessel above the liquid line are negligible

Emissions from Dilution Tank are negligible based on the concentration, time in vessel, and VP of HF

Accounting for Hydrolysis of DAF in the atmosphere into FRD903 which releases HF on a one mole to one mole basis

Perfluoro-2-Propoxy Propionyl Fluoride (C₆F₁₂O₂) (Dimer)

Emissions based on data collected during stack testing in 2006.

Note 1

Virgin Campaign Emission Rate [lbs/hr]

0.008

Note 2

Amount of Annual Time dedicated to FRD Production [fraction]

0.56

Fraction of Emissions that are Dimer

0.85626

Note 3

Total DAF Emissions [lbs/year]

33.9

Assumptions & Notes

Note 1 Calculations will be based on the air emissions conducted for the combined PFOF, PFOA, and APFO molecules noting that this **Dimer molecule will be modeled as the PFOF molecule.**

Note 2 Emission Rates are based on previously conducted stack testing and represent the combined output of PFOF, PFOA, and APFO.

Note 3 Based on 2006 analysis.

Perfluoro-2-Propoxy Propionic Acid (C₆F₁₁O₃H) (Dimer Acid GX903)

Emissions based on data collected during stack testing in 2006.

Virgin Campaign Emission Rate [lbs/hr]

0.008

Note 1

Purified Campaign Emission Rate [lbs/hr]

0.0024

Note 2

Amount of Annual Time dedicated to GX Virgin Production [fraction]

0.56

Amount of Annual Time dedicated to GX Purified Production [fraction]

0.07

Fraction of Emissions that are Dimer Acid

0.0896

Note 3

Total Dimer Acid Emissions [lbs/year]

4.6

Assumptions & Notes

Note 1 Calculations will be based on the air emissions conducted for the combined PFOF, PFOA, and APFO molecules noting that this **Dimer molecule will be modeled as the PFOF molecule.**

Note 2 Emission Rates are based on previously conducted stack testing and represent the

Note 3 Based on 2006 analysis.

FRD901

Definitions

PT= Total Pressure
VP_i = Vapor Pressure of Component i
P_i = Partial Pressure of Component i
X_i = Mole Fraction of Component i in the Liquid
Y_i = Mole Fraction of Component i in the Vapor
K_i = Henry's Law Constant

Assumptions

Ideal Gas Laws apply and all solutions are considered Ideal Solutions
Vapor Pressure is constant over temperature range.
Value used is for worst case ie. max ambient temp (90 F)

Constants

Molecular Weight of 901	1533
Leak Rates [lb/hour] (using "Good" factor for DuPont facilities)	
Pump Seals	0.00750
Valves	0.00352
Flanges	0.00031

Conversions

1 gallon = 3.785 liters = 3,785 cm³ = 231 in³
1 atm = 760 mm Hg = 14.7 psi
1 lb = 454 grams
1 ft³ = 28.3 liters

Equations

$P_i = X_i \cdot K_i$ Henry's Law (used for dilute solutions)
 $P_i = X_i \cdot V_{pi}$ Raoult's Law
 $Y_i = P_i / PT$

901 Tank Filling

Number of drums added to tote during fill	2
Total vapor displaced during fill [liters]	105.98
Number of fills per year	22
Total vapor displaced during year [liters]	2,332
P ₉₀₁ [mm Hg]	0.004
Y ₉₀₁	0.00000
Total 901 vapor displaced during year [liters]	0.0112
Total 901 vapor displaced during year [lbs]	0.0017
Average pump run time per batch (min)	10
Number of flanges in line	10
Number of open valves in line	2
Number of pump seals (air diaphragm)	1
Total pump time for year [hours]	7.3
Total fugitive emissions [lbs]	0.1311

Assumptions & Notes

Tote is filled from 14 gallon drums and displaced vapors exit into atmosphere

901 Reactor Charging

Number of batches per year	31
Average drop time per batch (min)	45
Number of flanges in line	6
Number of open valves in line	4
Number of pump seals (air diaphragm)	0
Total drop time for year [hours]	23.25
Total fugitive emissions [lbs]	0.3706



Total FRD901 Emissions [lbs/year]

0.5

Line is liquid-filled during entire charging time and empty during non-charging time

Propanoic acid, 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-, ammoniumsalt (GX902)

Emissions based on data collected during stack testing in 2006.

Virgin Campaign Emission Rate [lbs/hr]

0.008

Note 1

Purified Campaign Emission Rate [lbs/hr]

0.0024

Note 2

Amount of Annual Time dedicated to GX Virgin Production [fraction]

0.56

Amount of Annual Time dedicated to GX Purified Production [fraction]

0.07

Fraction of Emissions that are GX902

0.05413

Note 3

Total GX902 Emissions [lbs/year]

2.8

Assumptions & Notes

Note 1 Calculations will be based on the air emissions conducted for the combined PFOF, PFOA, and APFO molecules noting that this **Dimer molecule will be modeled as the PFOF molecule.**

Note 2 Emission Rates are based on previously conducted stack testing and represent the

Note 3 Based on 2006 analysis.

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2014 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION (see Note 1)

Note 1: Exclusively for the time period from January 1, 2014, through August 31, 2014

Emission Source ID No.: BS- A

Emission Source Description: Butyraldehyde Storage Tank

Process & Emission Description:

The Butyraldehyde (BA) Storage Tank is a vertical fixed dome roof storage tank. It is maintained at a working level by re-filling from tank trucks or rail cars. The storage tank is vented through a brine-cooled condenser (control device BCD-A) and a conservation vent to the atmosphere.

Basis and Assumptions:

Estimated uncontrolled emissions from this unit (breathing and working losses) are calculated using EPA-developed Tanks 4.0 software. Actual working losses are zero because when being loaded, the tank is vented back to the tank truck or railcar. Actual breathing losses are reduced by the brine cooled condenser. Thus control on working losses is 100% and control on breathing losses is 68%.

As shown by the calculations attached, this gives an overall control efficiency of approximately 90%.

Fugitive emissions are calculated using the EPA SOCMF factors. Butyraldehyde is classified as a light liquid.

Information Inputs and Source Inputs:

Information Input	Source of Inputs
BA Storage Tank Throughput	Butacite® Production Clerk

Point Source Emissions Determination:

Shown on the following page.

Fugitive Emissions Determination:

Shown on the following page.

2014 AIR EMISSIONS INVENTORY
BUTYRALDEHYDE (BA) STORAGE TANK
(BS-A)

EMISSIONS SUMMARY

	VOC EMISSIONS (lb./year)	VOC EMISSIONS (TPY)
POINT SOURCE EMISSIONS:		
BA Condenser (BCD-A)	444	0.22
FUGITIVE EMISSIONS:		
Unloading System	1,752	0.88
Vapor Return Syste	68	0.03
BA Storage Tank	1,118	0.56
TOTAL EMISSIONS	3,381	1.69

Point Source Emission Determination**Butyraldehyde Storage Tank (BS-A)****Butyraldehyde (BA)****CAS No. 00123-72-8**

Throughput for the BA Storage Tank in 2014 equals 1,433,306 Storage Units ("SU").

Using the actual throughput and the working volume of the BA Storage Tank, there were 41 turnovers of this tank during the year.

Entering this data into the TANKS 4.0 software, the following quantities of uncontrolled BA emissions were returned:

Annual uncontrolled breathing loss	=	1,383	pounds
Annual uncontrolled working loss	=	4,301	pounds
Annual total uncontrolled emissions	=	5,684	pounds
Average BA vapor pressure in tank	=	1.737	psia

The condenser efficiency calculation assumes the condenser exit temperature is equal to the coolant temperature of 32 °F. The BA vapor pressure at 32 °F equals 0.558 psia.

$$\begin{aligned}\text{The condenser efficiency} &= 1 - (\text{BA vapor pressure at } 32^{\circ}\text{F} / \text{average BA vapor pressure in tank}) \times 100 \\ &= 1 - (0.558 \text{ psia} / 1.737 \text{ psia}) \times 100 \\ &= 68\%\end{aligned}$$

Therefore, the actual breathing loss emissions through the condenser would be 32% of the uncontrolled breathing loss coming into the condenser:

$$1,383 \frac{\text{lb. BA}}{\text{year}} \times 32\% = 444 \frac{\text{lb. BA}}{\text{year}}$$

Since the BA Storage Tank is vented to the rail car or tank truck during unloading operations, there are zero (0) actual working loss emissions, since 100% of the potential working losses are controlled.

$$\begin{aligned}\text{Overall control efficiency} &= 1 - \frac{\text{actual breathing loss emissions from condenser} + \text{actual working loss emission}}{\text{total uncontrolled emissions}} \\ &= 1 - \frac{444 + 0}{5,684} \\ &= 92.2\%\end{aligned}$$

Total emissions of Butyraldehyde (VOC) from the Storage Tank Condenser (BCD-A) in 2014 was:

$$= 444 \text{ lb of Butyraldehyde}$$

Fugitive Emission Determination

Butyraldehyde Storage Tank (BS-A)

Butyraldehyde (BA)

CAS No. 00123-72-8

Fugitive Loss Assumptions and Data

1. Tank in service year-round (100% utility) = 8760 hours
2. Average area temperature = 75 °F
3. BA Vapor pressure at 75 °F = 110 mm Hg = 2.128 psia
4. Vapor space is nitrogen, saturated with BA
5. Molecular Weights: BA = 72; N₂ = 28

A. Unloading System

$$\begin{aligned}\text{Leak Rate} &= (\text{pump loss} + \text{liquid valve loss} + \text{flange loss}) \times \text{operating hours} \\ &= [(1) (0.109) + (9) (0.016) + (27) (0.0018)] \times 5,808 \\ &= 1,752 \text{ lbs./year}\end{aligned}$$

B. Vapor Return System

$$\begin{aligned}\text{BA Mole fraction in vapor} &= \frac{\text{Vapor pressure of BA}}{\text{Total pressure}} \\ &= \frac{2.128 \text{ psia}}{14.7 \text{ psia}} = 0.145 \\ \text{BA Weight fraction in vapor} &= \frac{\text{Mole fraction BA} \times \text{M.W. BA}}{(\text{Mole fraction BA} \times \text{M.W. BA}) + (\text{Mole fraction N}_2 \times \text{M.W. N}_2)} \\ &= \frac{0.145 \times 72}{(0.145 \times 72) + (0.855 \times 28)} = 0.303\end{aligned}$$

$$\begin{aligned}\text{Leak rate} &= (\text{gas valve loss} + \text{flange loss}) \times \text{weight fraction BA} \times \text{operating hours} \\ &= [(2) (0.012) + (5) (0.0018)] \times 0.303 \times 8760 \\ &= 68 \text{ lbs./year}\end{aligned}$$

C. Storage Tank

1. Liquid Flanges/Valves

$$\begin{aligned}\text{Leak rate} &= (\text{liquid valve loss} + \text{flange loss}) \times \text{operating hours} \\ &= [(2) (0.012) + (8) (0.0018)] \times 8760 \\ &= 269 \text{ lbs./year}\end{aligned}$$

Fugitive Emission Determination

Butyraldehyde Storage Tank (BS-A)

Butyraldehyde (BA)

CAS No. 00123-72-8

C. Storage Tank (Continued)

2. Vapor Flanges/Conservation Vents

$$\begin{aligned}\text{Leak rate} &= (\text{C/V loss} + \text{flange loss}) \times \text{weight fraction BA} \times \text{operating hours} \\ &= [(2) (0.23) + (12) (0.0018)] \times 0.303 \times 5,808 \\ &= 848 \text{ lbs./year}\end{aligned}$$

3. Total Storage Tank Leak Rate

$$\begin{aligned}&= 269 + 848 \\ &= 1,118 \text{ lbs./year}\end{aligned}$$

05-7

2014 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No.: BS-C

Emission Source Description: Butacite® Flake Dryer

Process & Emission Description:

The Butacite® Flake Dryer is a fluidized bed dryer which dries water from the wet polyvinyl butyral ("PVB") flake. During normal operation of the Flake Dryer, some of the solid PVB particles are entrained in the exit of the heated air stream of the dryer. The PVB exiting the Flake Dryer is controlled by a cyclone separator that in turn discharges the air stream to a fabric filter baghouse which vents to the atmosphere.

The wet PVB feed to the Dryer contains a small amount of methanol. Methanol is an impurity in the polyvinyl alcohol ("PVA"), one of the major raw materials for the PVB. The methanol entering with the wet PVB feed to the Dryer is that which remains following the previous process steps of PVA dissolving, PVB reaction, PVB washing and re-slurry and centrifuging. This methanol is vented from the Flake Dryer with the water during drying of the PVB.

Basis and Assumptions:

The Butacite® Flake Dryer air exhaust vents to a cyclone separator with a 90% removal efficiency for Total Suspended Particulates (TSP) which in turn vents to a bag filter house with a 99% removal efficiency for TSP. The above stated control efficiencies are based on efficiency test with the Flake Dryer running at full capacity. There are no fugitive emissions.

All methanol entering the system is listed as point source emissions; therefore, there are no fugitive emissions.

Information Inputs and Source Inputs:

Information Input	Source of Inputs
Flake Dryer Throughput	Butacite® Production Clerk
Flake Dryer Hours of Operation	Butacite® Production Clerk

Point Source Emissions Determination:

Shown on the following page.

Fugitive Emissions Determination:

None; all emissions are point source emissions.

Point Source Emission Determination

PVB Flake Dryer (BS-C)

Polyvinyl butyral (PVB) resin (flake)
Methanol (MeOH)

CAS No. 63148-65-2

CAS No. 67-56-1

1. PVB Flake (TSP) emissions

During normal operation of the Flake Dryer, polyvinyl butyral ("PVB") flake is entrained in the exit of the heated air stream of the dryer. The PVB exiting the Flake Dryer is controlled by a cyclone separator that in turn discharges to a fabric filter baghouse.

Product throughput for the Flake Dryer in 2014 equaled 1,836,022 Dryer Units ("DU").

At full design capacity rate, 2.589 lb. of PVB per Dryer Unit ("DU") is vented from the dryer to the cyclone.

Therefore, the quantity of TSP vented to the cyclone in 2014 was equal to:

$$1,836,022 \frac{\text{DU}}{\text{year}} \times 2.589 \frac{\text{lb. PVB}}{\text{DU}} = 4,753,460 \frac{\text{lb. PVB}}{\text{year}}$$

The cyclone efficiency has been determined to be 90% for the removal of TSP.

Therefore, the quantity of PVB exiting the cyclone would be 10% of the incoming PVB:

$$4,753,460 \frac{\text{lb. PVB}}{\text{year}} \times 10\% = 475,346 \frac{\text{lb. PVB vented from cyclone}}{\text{year}}$$

The bag filter efficiency has been determined to be 99% for the removal of TSP.

Therefore, the quantity of PVB exiting the bag filter would be 1% of the incoming PVB:

$$475,346 \frac{\text{lb. PVB}}{\text{year}} \times 1\% = 4,753 \frac{\text{lb. PVB vented from bag filter}}{\text{year}}$$

Total emissions of PVB flake (TSP) to the atmosphere in 2014 was:

$$\begin{aligned} &= 4,753 \text{ lb of PVB flake (TSP)} \\ &= 2.38 \text{ tons of TSP} \end{aligned}$$

2. Methanol (VOC/HAP) Emissions

The methanol remaining in the wet PVB feed to the Flake Dryer has been calculated to be 0.000012 pounds of methanol per Dryer Units ("DU").

Product throughput for the Flake Dryer in 2014 equaled 1,836,022 Dryer Units ("DU").

Therefore, the quantity of methanol vented to the atmosphere in 2014 was equal to:

$$1,836,022 \frac{\text{DU}}{\text{year}} \times 0.000012 \frac{\text{lb. MeOH}}{\text{DU}} = 21 \frac{\text{lb. MeOH}}{\text{year}}$$

Total emissions of methanol (VOC/HAP) to the atmosphere in 2014 was:

$$\begin{aligned} &= 21 \text{ lb methanol (VOC/HAP)} \\ &= 0.01 \text{ tons of VOC} \end{aligned}$$

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AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Point Source Emission Determination - Line 3 Extrusion Process Via Steam Jet Vacuum

**Triethylene glycol di-2-ethylhexanoate
(3GO)**

CAS No. 94-28-0

Emission Estimation Approach:

Emissions from the Butacite® Line 3 Sheeting Extrusion Process (ID No. BS-E1) 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 four (4) extruders in the Line 3 extruder operation. The final condenser (BCD-E2) vents to the atmosphere through its vent stack (BEP-E2).

The current Line 3 sheeting extrusion 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 four extruders combined.

Process Parameters Used in the Calculations:

Total PVB feed to extruder :	176 lb / TU / extruder
Fraction of water in extruder feed:	11.7%
Fraction of water in output stream:	0.30%
System pressure up to the first vacuum jet:	90 mm Hg absolute
Average extruder vapor space temperature	150 degrees Celsius (°C)
Organic vapor pressure @ 150 °C ¹	3.22 mm Hg absolute
Condenser outlet temperatures	35 degrees Celsius (°C)
Organic vapor pressure @ 35 °C ¹	0.26 mm Hg absolute
System pressure between 1st and 2nd jets:	225 mm Hg absolute
Noncondensable flow through system:	2.34 lb / TU
Water vapor pressure @ 35 °C	42.2 mm Hg absolute
Molecular weight of plasticizer	402.6 lb / lb-mole
Molecular weight of water	18.0 lb / lb-mole
Molecular weight of non-condensables	28.0 lb / lb-mole

¹ The organic vapor pressure is based on a plasticizer which is added to the polyvinyl butyral (PVB) product. This plasticizer is called "3GO" and is Triethylene Glycol di-2-ethylhexanoate which has a molecular weight of 402.6 lb/lb-mole. The Butacite® product contains approximately 28% 3GO. As is normally the case for compounds with high molecular weights, 3GO has an extremely low vapor pressure. Other materials are added to PVB to give it various properties; however all of these materials have negligible vapor pressures and are added in very small amounts (0.1% or less). Therefore, all organic emissions are assumed to be 3GO. According to EPA literature, the vapor pressure of 3GO is 0.00000422 mmHg at 25 °C and 5 mmHg at 219 °C. Extrapolating, the vapor pressures of 3GO would be 0.26 mmHg at 35 °C and 3.22 mmHg at 150 °C.

These vapor pressure values are conservative because it is expected that they overestimate actual vapor pressures primarily because they do not account for mole fractions in the extruder feed (i.e. Raoult's Law), and furthermore, they do not account for molecular level interactions that resist volatilization (this is why all of the water is not removed even though the extruders operate in excess of the atmospheric boiling point temperature of water and under vacuum).

STEP 1: VOC's vented from extruder:

Non-organic mass in extruder off-gas:

Water

$$\begin{array}{rcl} \text{Total PVB feed to extruder :} & & 176 \text{ lb / TU / extruder} \\ \text{Fraction of water in extruder feed:} & \times & 11.7\% \\ \hline \text{Water removed from PVB feed:} & & 20.6 \text{ lb / TU / extruder} \end{array}$$

$$\begin{array}{rcl} \text{Noncondensable gases:} & & 2.34 \text{ lb / TU / extruder} \\ \text{(Basis: Vacuum jet performance curves)} & & \end{array}$$

Non-organic moles in extruder off-gas:

Water

$$\begin{array}{rcl} \text{Water removed from PVB feed:} & & 20.6 \text{ lb / TU / extruder} \\ \text{Molecular weight of water:} & \text{divided by} & 18.0 \text{ lb / lb-mole} \\ \hline \text{Moles of water in off-gas:} & & 1.14 \text{ lb-mole / TU / extruder} \end{array}$$

Noncondensable gas (assumed as nitrogen)

$$\begin{array}{rcl} \text{Noncondensables mass in off-gas:} & & 2.34 \text{ lb / TU / extruder} \\ \text{Molecular weight of noncondensable:} & \text{divided by} & 28.0 \text{ lb / lb-mole} \\ \hline \text{Moles of noncondensables in off-gas:} & & 0.08 \text{ lb-mole / TU / extruder} \end{array}$$

$$\text{Total: } 1.14 \text{ lb-mole / TU} + 0.08 \text{ lb-mole / TU} = 1.23 \text{ lb-mole / TU / extruder}$$

Mole fraction of organics:

Calculated as the vapor pressure of organics (3.22 mmHg at 150 °C) divided by the system pressure (90 mmHg absolute).

$$\frac{3.22 \text{ mmHg}}{90 \text{ mmHg}} = 3.6\% \text{ VOC}$$

Thus, total moles are calculated as non-organic moles in off-gas divided by the fraction of non-organic moles in off-gas (i.e. 100% minus the VOC mole fraction of organics, or or 3.6% VOC, which equals 96.4%).

$$\begin{array}{rcl} \text{Non-organic moles in off-gas} & = & 1.23 \text{ lb-mole non-VOC / TU / extruder} \\ \text{100\% minus 3.6\% VOC} & = & 96.4\% \text{ non-organic (non-VOC) gases} \end{array}$$

$$\text{Total moles} = \frac{1.23 \text{ lb-mole non-VOC}}{\text{TU - extruder}} \div 96.4\% = \frac{1.27 \text{ lb-mole}}{\text{TU - extruder}}$$

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Moles of VOC emitted from the extruder are determined by subtracting the non-organic (non-VOC) moles in the off-gas (1.23 lb-mole / TU / extruder) from the total moles in the off-gas (1.27 lb-mole / TU / extruder).

$$\frac{1.27 \text{ lb-mole}}{\text{TU - extruder}} - \frac{1.23 \text{ lb-mole non-VOC}}{\text{TU - extruder}} = \frac{0.05 \text{ lb-mole VOC}}{\text{TU - extruder}}$$

The mass of VOC emitted from each extruder is determined by multiplying the number of moles emitted from an extruder per TU (0.05 lb-mole VOC) by the molecular weight of the organic, which is assumed to be 3GO with a molecular weight of 402.6.

$$\frac{0.05 \text{ lb-mole VOC}}{\text{TU - extruder}} \times \frac{402.6 \text{ lb}}{\text{lb-mole}} = \frac{18 \text{ lb VOC}}{\text{TU - extruder}}$$

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 °C) divided by the system pressure (90 mmHg absolute).

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

Mole fraction of VOC

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

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

Mole fraction of noncondensables

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

$$100\% - 46.9\% \text{ water} - 0.29\% \text{ VOC} = 52.8\% \text{ noncondensable gases}$$

Total Moles

Calculated as the lb-moles of noncondensables (0.08 lb-moles per TU per extruder) divided by the noncondensable mole fraction (52.8% noncondensables).

$$\frac{0.08 \text{ lb-moles non-VOC per TU per extruder}}{52.8\%} = 0.16 \frac{\text{lb-moles}}{\text{TU - extruder}}$$

Mass of VOC in condenser outlet

Calculated as the mole fraction of VOC (0.29%) times the total moles of gas (0.16 lb-moles per TU per extruder) times the VOC molecular weight of 402.6.

$$0.16 \frac{\text{lb-moles}}{\text{TU - extruder}} \times 0.29\% \text{ VOC} \times 402.6 \frac{\text{lb}}{\text{lb-mole}} = 0.18 \frac{\text{lb VOC}}{\text{TU - extruder}}$$

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

$$\frac{0.26 \text{ mmHg}}{225 \text{ mmHg}} = 0.12\% \text{ VOC as 3GO}$$

Mole fraction of noncondensables

Calculated as 100% minus mole fraction of water and VOC

$$100\% - 18.8\% - 0.12\% = 81.1\% \text{ noncondensable gases}$$

Total Moles

Calculated as the lb-mole of noncondensables (0.084 lb-moles per TU per extruder) divided by the noncondensable mole fraction (0.0% noncondensables).

$$\frac{0.08 \text{ lb-moles per TU per extruder}}{81.1\%} = 0.103 \frac{\text{lb-moles}}{\text{TU - extruder}}$$

Mass of VOC in condenser outlet

Calculated as the mole fraction of VOC (0.12%) times the total moles of emitted gas (0.103 lb-moles per TU per extruder) times the VOC molecular weight of 402.6.

$$0.10 \frac{\text{lb-moles}}{\text{TU - extruder}} \times 0.12\% \text{ VOC} \times 402.6 \frac{\text{lb}}{\text{lb-mole}} = 0.05 \frac{\text{lb VOC}}{\text{TU - extruder}}$$

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 the 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's atmospheric 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

$$100\% - 5.6\% \text{ water} - 0.03\% \text{ VOC} = 94.4\% \text{ noncondensable gases}$$

Total Moles

Calculated as the lb-mole of noncondensables (0.08 lb-moles per TU per extruder) divided by the noncondensable mole fraction (94.4% noncondensable gases).

Calculated as the lb-mole of noncondensables (0.08 lb-moles per TU per extruder)

$$\frac{0.08 \text{ lb-mole gas per TU per extruder}}{0.94 \text{ lb-mole noncondensable per lb-mole gas}} = 0.09 \frac{\text{lb-moles}}{\text{TU - extruder}}$$

Mass of VOC in condenser outlet

Calculated as the mole fraction of VOC (0.03%) multiplied by the total moles of gas (0.09 lb-moles per TU per extruder) multiplied by the VOC molecular weight of 402.6 lb/lb-mole.

$$0.09 \frac{\text{lb-moles}}{\text{TU - extruder}} \times 0.03\% \text{ VOC} \times 402.6 \frac{\text{lb}}{\text{lb-mole}} = 0.012 \frac{\text{lb VOC}}{\text{TU - extruder}}$$

Total Line 3 Extrusion Actual Emissions

Calculated as 0.012 lb. VOC per TU per extruder multiplied by 4 extruders multiplied by the 12,297 TUs that Line 3 operated in 2014.

$$\begin{aligned} 0.012 \frac{\text{lb VOC}}{\text{TU - extruder}} \times 4 \text{ extruders} \times \frac{12,297 \text{ TU}}{\text{year}} &= 600 \frac{\text{lb VOC}}{\text{year}} \\ &= 0.30 \frac{\text{ton VOC}}{\text{year}} \end{aligned}$$

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Point Source Emission Determination - Line 4 Extrusion Process Via Steam Jet Vacuum

**Triethylene glycol di-2-ethylhexanoate
(3GO)**

CAS No. 94-28-0

Emission Estimation Approach:

Emissions from the Butacite® Line 4 Sheeting Extrusion Process (ID No. BS-E2) 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 four (4) extruders in the Line 4 extruder operation. The final condenser (BCD-E2) vents to the atmosphere through its vent stack (BEP-E2).

The current Line 4 sheeting extrusion 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.

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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 four extruders combined.

Process Parameters Used in the Calculations:

Total PVB feed to extruder :	176 lb / TU / extruder
Maximum number of concurrent extruders :	4 lb / TU / extruder
Fraction of water in extruder feed:	11.7%
Fraction of water in output stream:	0.30%
System pressure up to the first vacuum jet:	90 mm Hg absolute
Average extruder vapor space temperature	150 degrees Celsius (°C)
Organic vapor pressure @ 150 °C ¹	3.22 mm Hg absolute
Condenser outlet temperatures	35 degrees Celsius (°C)
Organic vapor pressure @ 35 °C ¹	0.26 mm Hg absolute
System pressure between 1st and 2nd jets:	225 mm Hg absolute
Noncondensable flow through system:	2.34 lb / TU
Water vapor pressure @ 35 °C	42.2 mm Hg absolute
Molecular weight of plasticizer	402.6 lb / lb-mole
Molecular weight of water	18.0 lb / lb-mole
Molecular weight of non-condensables	28.0 lb / lb-mole

¹ The organic vapor pressure is based on a plasticizer which is added to the polyvinyl butyral (PVB) product. This plasticizer is called "3GO" and is Triethylene Glycol di-2-ethylhexanoate which has a molecular weight of 402.6 lb/lb-mole. The Butacite® product contains approximately 28% 3GO. As is normally the case for compounds with high molecular weights, 3GO has an extremely low vapor pressure. Other materials are added to PVB to give it various properties; however all of these materials have negligible vapor pressures and are added in very small amounts (0.1% or less). Therefore, all organic emissions are assumed to be 3GO. According to EPA literature, the vapor pressure of 3GO is 0.00000422 mmHg at 25 °C and 5 mmHg at 219 °C. Extrapolating, the vapor pressures of 3GO would be 0.26 mmHg at 35 °C and 3.22 mmHg at 150 °C.

These vapor pressure values are conservative because it is expected that they overestimate actual vapor pressures primarily because they do not account for mole fractions in the extruder feed (i.e. Raoult's Law), and furthermore, they do not account for molecular level interactions that resist volatilization (this is why all of the water is not removed even though the extruders operate in excess of the atmospheric boiling point temperature of water and under vacuum).

STEP 1: VOC's vented from extruder:

Non-organic mass in extruder off-gas:

Water

$$\begin{array}{rcl} \text{Total PVB feed to extruder :} & & 176 \text{ lb / TU / extruder} \\ \text{Fraction of water in extruder feed:} & \times & 11.7\% \\ \hline \text{Water removed from PVB feed:} & & 20.6 \text{ lb / TU / extruder} \end{array}$$

$$\begin{array}{rcl} \text{Noncondensable gases:} & & 2.34 \text{ lb / TU / extruder} \\ \text{(Basis: Vacuum jet performance curves)} & & \end{array}$$

Non-organic moles in extruder off-gas:

Water

$$\begin{array}{rcl} \text{Water removed from PVB feed:} & & 20.6 \text{ lb / TU / extruder} \\ \text{Molecular weight of water:} & \text{divided by} & 18.0 \text{ lb / lb-mole} \\ \hline \text{Moles of water in off-gas:} & & 1.14 \text{ lb-mole / TU / extruder} \end{array}$$

Noncondensable gas (assumed as nitrogen)

$$\begin{array}{rcl} \text{Noncondensables mass in off-gas:} & & 2.34 \text{ lb / TU / extruder} \\ \text{Molecular weight of noncondensable:} & \text{divided by} & 28.0 \text{ lb / lb-mole} \\ \hline \text{Moles of noncondensables in off-gas:} & & 0.08 \text{ lb-mole / TU / extruder} \end{array}$$

$$\text{Total: } 1.14 \text{ lb-mole / TU} + 0.08 \text{ lb-mole / TU} = 1.23 \text{ lb-mole / TU / extruder}$$

Mole fraction of organics:

Calculated as the vapor pressure of organics (3.22 mmHg at 150 °C) divided by the system pressure (90 mmHg absolute).

$$\frac{3.22 \text{ mmHg}}{90 \text{ mmHg}} = 3.6\% \text{ VOC}$$

Thus, total moles are calculated as non-organic moles in off-gas divided by the fraction of non-organic moles in off-gas (i.e. 100% minus the VOC mole fraction of organics, or 96.4% VOC, which equals 96.4%).

$$\begin{array}{rcl} \text{Non-organic moles in off-gas} & = & 1.23 \text{ lb-mole non-VOC / TU / extruder} \\ \text{100\% minus 3.6\% VOC} & = & 96.4\% \text{ non-organic (non-VOC) gases} \end{array}$$

$$\text{Total moles} = \frac{1.23 \text{ lb-mole non-VOC}}{\text{TU - extruder}} \div 96.4\% = \frac{1.27 \text{ lb-mole}}{\text{TU - extruder}}$$

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Moles of VOC emitted from the extruder are determined by subtracting the non-organic (non-VOC) moles in the off-gas (1.23 lb-mole / TU / extruder) from the total moles in the off-gas (1.27 lb-mole / TU / extruder).

$$\frac{1.27 \text{ lb-mole}}{\text{TU - extruder}} - \frac{1.23 \text{ lb-mole non-VOC}}{\text{TU - extruder}} = \frac{0.05 \text{ lb-mole VOC}}{\text{TU - extruder}}$$

The mass of VOC emitted from each extruder is determined by multiplying the number of moles emitted from an extruder per TU (0.05 lb-mole VOC) by the molecular weight of the organic, which is assumed to be 3GO with a molecular weight of 402.6.

$$\frac{0.05 \text{ lb-mole VOC}}{\text{TU - extruder}} \times \frac{402.6 \text{ lb}}{\text{lb-mole}} = \frac{18 \text{ lb VOC}}{\text{TU - extruder}}$$

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 °C) divided by the system pressure (90 mmHg absolute).

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

Mole fraction of VOC

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

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

Mole fraction of noncondensables

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

$$100\% - 46.9\% \text{ water} - 0.29\% \text{ VOC} = 52.8\% \text{ noncondensable gases}$$

Total Moles

Calculated as the lb-moles of noncondensables (0.08 lb-moles per TU per extruder) divided by the noncondensable mole fraction (52.8% noncondensables).

$$\frac{0.08 \text{ lb-moles non-VOC per TU per extruder}}{52.8\%} = 0.16 \frac{\text{lb-moles}}{\text{TU - extruder}}$$

Mass of VOC in condenser outlet

Calculated as the mole fraction of VOC (0.29%) times the total moles of gas (0.16 lb-moles per TU per extruder) times the VOC molecular weight of 402.6.

$$0.16 \frac{\text{lb-moles}}{\text{TU - extruder}} \times 0.29\% \text{ VOC} \times 402.6 \frac{\text{lb}}{\text{lb-mole}} = 0.18 \frac{\text{lb VOC}}{\text{TU - extruder}}$$

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

$$\frac{0.26 \text{ mmHg}}{225 \text{ mmHg}} = 0.12\% \text{ VOC as 3GO}$$

Mole fraction of noncondensables

Calculated as 100% minus mole fraction of water and VOC

$$100\% - 18.8\% \text{ water} - 0.12\% \text{ VOC} = 81.1\% \text{ noncondensable gases}$$

Total Moles

Calculated as the lb-mole of noncondensables (0.084 lb-moles per TU per extruder) divided by the noncondensable mole fraction (0.0% noncondensables).

$$\frac{0.08 \text{ lb-moles per TU per extruder}}{81.1\%} = 0.103 \frac{\text{lb-moles}}{\text{TU - extruder}}$$

Mass of VOC in condenser outlet

Calculated as the mole fraction of VOC (0.12%) times the total moles of emitted gas (0.103 lb-moles per TU per extruder) times the VOC molecular weight of 402.6.

$$0.10 \frac{\text{lb-moles}}{\text{TU - extruder}} \times 0.12\% \text{ VOC} \times 402.6 \frac{\text{lb}}{\text{lb-mole}} = 0.05 \frac{\text{lb VOC}}{\text{TU - extruder}}$$

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 the 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's atmospheric 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

$$100\% - 5.6\% - 0.03\% = 94.4\% \text{ noncondensable gases}$$

Total Moles

Calculated as the lb-mole of noncondensables (0.08 lb-moles per TU per extruder) divided by the noncondensable mole fraction (94.4% noncondensable gases).

Calculated as the lb-mole of noncondensables (0.08 lb-moles per TU per extruder)

$$\frac{0.08 \text{ lb-mole gas per TU per extruder}}{0.94 \text{ lb-mole noncondensable per lb-mole gas}} = 0.09 \frac{\text{lb-moles}}{\text{TU - extruder}}$$

Mass of VOC in condenser outlet

Calculated as the mole fraction of VOC (0.03%) multiplied by the total moles of gas (0.09 lb-moles per TU per extruder) multiplied by the VOC molecular weight of 402.6 lb/lb-mole.

$$0.09 \frac{\text{lb-moles}}{\text{TU - extruder}} \times 0.03\% \text{ VOC} \times 402.6 \frac{\text{lb}}{\text{lb-mole}} = 0.012 \frac{\text{lb VOC}}{\text{TU - extruder}}$$

Total Line 4 Extrusion Actual Emissions

Calculated as 0.012 lb. VOC per TU per extruder multiplied by 4 extruders multiplied by the 42,178 TUs that Line 4 operated in 2014.

$$\begin{aligned} 0.012 \frac{\text{lb VOC}}{\text{TU - extruder}} \times 4 \text{ extruders} \times \frac{42,178 \text{ TU}}{\text{year}} &= 2,059 \frac{\text{lb VOC}}{\text{year}} \\ &= 1.03 \frac{\text{ton VOC}}{\text{year}} \end{aligned}$$

AIR EMISSIONS INVENTORY

SUPPORTING DOCUMENTATION

05-46

Point Source Emission Determination - Butacite® Line 3 Back-End Process

The Butacite® Line 3 Back-End Process (ID No. BS-E3) consists of the Quench Tank, the Dryer/Relaxer, and the Wind-Up Area. All air emissions associated with this equipment are vented uncontrolled through the Butacite® Manufacturing Building main stack (BEP-3).

The estimation of VOC emissions from the Butacite® Line 3 Back-End Process is based on the conservative engineering calculations shown in the May 7, 2002 addendum to the Title V Air Permit application. The worst-case conservative assumption, which results in the highest potential emissions, is that all of the emissions from the sheeting process are the plasticizer (triethylene glycol di-2-ethylhexanoate or 3GO, CAS Number 94-28-0). Those calculations are reproduced below:

Basis and Assumptions:

Line 3 Quench Tank Average OVA Reading:	0.9 ppmv
Line 3 Quench Tank Total Vent Flow:	15,808 ft ³ per TU at ambient temperature
Line 3 Dryer/Relaxer Average OVA Reading:	26.7 ppmv
Line 3 Dryer/Relaxer Total Vent Flow:	10,539 ft ³ per TU at 212 degrees F
Molecular Weight of 3GO	402.6 lb. per lb-mole
Ideal Gas Volume of 1 pound-mole:	388 ft ³ at 72 deg F and 1 atmosphere
Ideal Gas Volume of 1 pound-mole:	490 ft ³ at 212 deg F and 1 atmosphere

Line 3 Quench Tank Emissions (3GO only)

$$\frac{15,808 \text{ ft}^3}{\text{TU}} \times \frac{1 \text{ lb-mole}}{388 \text{ ft}^3} \times \frac{0.9 \text{ ft}^3 \text{ 3GO}}{1,000,000 \text{ ft}^3 \text{ gas}} = \frac{0.0000367 \text{ lb-mole 3GO}}{\text{TU}}$$
$$\frac{0.0000367 \text{ lb-mole 3GO}}{\text{TU}} \times \frac{402.6 \text{ lb.}}{\text{lb-mole}} = \frac{0.0148 \text{ lb. 3GO}}{\text{TU}}$$

Line 3 Dryer/Relaxer Emissions (3GO only)

$$\frac{10,539 \text{ ft}^3}{\text{TU}} \times \frac{1 \text{ lb-mole}}{490 \text{ ft}^3} \times \frac{26.7 \text{ parts}}{1,000,000 \text{ parts}} = \frac{0.000574 \text{ lb-mole}}{\text{TU}}$$
$$\frac{0.000574 \text{ lb-mole}}{\text{TU}} \times \frac{402.6 \text{ lb.}}{\text{lb-mole}} = \frac{0.2312 \text{ lb. 3GO}}{\text{TU}}$$

Line 3 Back-End Process Total VOC Emissions (3GO only)

$$\frac{0.0148 \text{ lb. 3GO}}{\text{TU}} + \frac{0.2312 \text{ lb. 3GO}}{\text{TU}} = \frac{0.246 \text{ lb. 3GO}}{\text{TU}} = \frac{0.246 \text{ lb. VOC}}{\text{TU}}$$

2014 Actual VOC Emissions from Line 3 Back-End Process

$$\frac{0.246 \text{ lb. VOC}}{\text{TU}} \times 11,956 \frac{\text{TU}}{\text{year}} = \frac{2,941 \text{ lb. VOC}}{\text{year}}$$
$$= \frac{1.470 \text{ ton VOC}}{\text{year}}$$

AIR EMISSIONS INVENTORY

SUPPORTING DOCUMENTATION

05-17

Point Source Emission Determination - Butacite® Line 4 Back-End Process

The Butacite® Line 4 Back-End Process (ID No. BS-E4) consists of the Quench Tank, the Dryer/Relaxer, and the Wind-Up Area. All air emissions associated with this equipment are vented uncontrolled through the Butacite® Manufacturing Building main stack (BEP-3).

The estimation of VOC emissions from the Butacite® Line 4 Back-End Process is based on the conservative engineering calculations shown in the May 7, 2002 addendum to the Title V Air Permit application. The worst-case conservative assumption, which results in the highest potential emissions, is that all of the emissions from the sheeting process are the plasticizer (triethylene glycol di-2-ethylhexanoate or 3GO, CAS Number 94-28-0). Those calculations are reproduced below:

Basis and Assumptions:

Line 4 Quench Tank Average OVA Reading:	0.9 ppmv
Line 4 Quench Tank Total Vent Flow:	15,808 ft ³ per TU at ambient temperature
Line 4 Dryer/Relaxer Average OVA Reading:	26.7 ppmv
Line 4 Dryer/Relaxer Total Vent Flow:	10,539 ft ³ per TU at 212 degrees F
Molecular Weight of 3GO	402.6 lb. per lb-mole
Ideal Gas Volume of 1 pound-mole:	388 ft ³ at 72 deg F and 1 atmosphere
Ideal Gas Volume of 1 pound-mole:	490 ft ³ at 212 deg F and 1 atmosphere

Line 4 Quench Tank Emissions (3GO only)

$$\frac{15,808 \text{ ft}^3}{\text{TU}} \times \frac{1 \text{ lb-mole}}{388 \text{ ft}^3} \times \frac{0.9 \text{ ft}^3 \text{ 3GO}}{1,000,000 \text{ ft}^3 \text{ gas}} = \frac{0.0000367 \text{ lb-mole 3GO}}{\text{TU}}$$
$$\frac{0.0000367 \text{ lb-mole 3GO}}{\text{TU}} \times \frac{402.6 \text{ lb.}}{\text{lb-mole}} = \frac{0.0148 \text{ lb. 3GO}}{\text{TU}}$$

Line 4 Dryer/Relaxer Emissions (3GO only)

$$\frac{10,539 \text{ ft}^3}{\text{TU}} \times \frac{1 \text{ lb-mole}}{490 \text{ ft}^3} \times \frac{26.7 \text{ parts}}{1,000,000 \text{ parts}} = \frac{0.000574 \text{ lb-mole}}{\text{TU}}$$
$$\frac{0.000574 \text{ lb-mole}}{\text{TU}} \times \frac{402.6 \text{ lb.}}{\text{lb-mole}} = \frac{0.2312 \text{ lb. 3GO}}{\text{TU}}$$

Line 4 Back-End Process Total VOC Emissions (3GO only)

$$\frac{0.0148 \text{ lb. 3GO}}{\text{TU}} + \frac{0.2312 \text{ lb. 3GO}}{\text{TU}} = \frac{0.246 \text{ lb. 3GO}}{\text{TU}} = \frac{0.246 \text{ lb. VOC}}{\text{TU}}$$

2014 Actual VOC Emissions from Line 4 Back-End Process

$$\frac{0.246 \text{ lb. VOC}}{\text{TU}} \times 41,836 \frac{\text{TU}}{\text{year}} = \frac{10,290 \text{ lb. VOC}}{\text{year}}$$
$$= \frac{5.15 \text{ ton VOC}}{\text{year}}$$

2014 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No.: BS- F

Emission Source Description: PVA Unloading System and Storage Silos

Process & Emission Description:

Polyvinyl alcohol (PVA) is unloaded from rail cars into one of two storage silos using a pneumatic conveying system. The PVA contains up to 1 percent methanol. During unloading and storage, some of the methanol is emitted due to outgassing from the PVA. A portion of the methanol is emitted at the unloading blower discharge and the remainder is emitted through the conservation vents on the PVA silos, as the PVA displaces the vapor in the silos.

Basis and Assumptions:

Estimated uncontrolled emissions from this operation are based on sampling of the methanol concentration in the vapor space during unloading operations. Calculations supporting these emissions were presented to the NCDENR in our MON Precompliance Report dated 11/8/2005 and in our MON Notification of Compliance Status Report dated 10/2/2008.

An engineering analysis was conducted in 2005 to determine the concentration of methanol in the PVA unloading conveying air. Sampling of the unloading blower exhaust showed methanol emissions to be 1.27 lbs per 1000 conveying units of PVA. In 2008, the methanol weight fraction in the PVA was reduced from 1.2% to 1.0%. Therefore, assuming a linear reduction in outgassing with the reduction in methanol concentration in the PVA, the methanol emissions at the unloading blower exhaust were reduced to 1.059 lbs per 1000 conveying units of PVA.

In 2008, sampling of the vapor space above the stored PVA at equilibrium, as exists in the PVA silos, showed the methanol emissions to be 0.138 lbs per 1000 conveying units of PVA.

Fugitive emissions of methanol are assumed to be nil and are not calculated.

Information Inputs and Source Inputs:

Information Input	Source of Inputs
PVA Consumption	Butacite® Production Clerk

Point Source Emissions Determination:

Shown on the following page.

Fugitive Emissions Determination:

None

Point Source Emission Determination

PVA Unloading System and Storage Silos (BS-F)

Methanol (MeOH)

CAS No. 67-56-1

Throughput for the PVA Unloading System and Storage Silos in 2014 equaled 1,196,986 Conveying Units (CU) of PVA.

Methanol emissions for the PVA Unloading Blower are 1.059 pounds per 1000 PVA conveying units. Therefore annual methanol emissions for this source are:

$$1.059 \frac{\text{lb. MeOH}}{1000 \text{ CU PVA}} \times 1,196,986 \frac{\text{CU PVA}}{\text{year}} = 1,268 \frac{\text{lb. MeOH}}{\text{year}}$$

Methanol emissions for the PVA Silos are 0.138 pounds per 1000 PVA conveying units. Therefore annual methanol emissions for this source are:

$$0.138 \frac{\text{lb. MeOH}}{1000 \text{ CU PVA}} \times 1,196,986 \frac{\text{CU PVA}}{\text{year}} = 165 \frac{\text{lb. MeOH}}{\text{year}}$$

Total emissions of Methanol (VOC) from the PVA Unloading System and Storage Silos (BS-F) in 2014 was:

$$\begin{aligned} &= 1,268 + 165 = 1,433 \text{ lb of Methanol} \\ &= 0.72 \text{ tons of VOC} \end{aligned}$$

2014 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

05-34

Emission Source ID No.: BS- G

Emission Source Description: PVA Dissolver Tank System

Process & Emission Description:

Polyvinyl alcohol (PVA) is dissolved in a batch cycle, which begins by adding a weighed amount of PVA powder and cold water into a small Pre-dissolver tank in the correct ratio. This slurry is transferred to one of two Dissolver tanks where the mix is heated with live steam in order to dissolve the PVA in the water. The solution is heated to 90°C and is then transferred to a Holdup tank while awaiting transfer to the subsequent reaction step. Both Dissolvers and the Holdup tank are vented to atmosphere and have reflux condensers on their vents. The PVA powder feed contains up to 1.0% methanol by weight. During the Dissolver process, a fraction of the methanol is emitted through the tank's vents.

Basis and Assumptions:

Estimated uncontrolled emissions from this operation are based on modeling of the individual steps of the Dissolver process using commercial software called "Emission Master". This software incorporates the equations in the National Emission Standards for Pharmaceutical Production (40 CFR 63.1257) as required by the MON rule. Emissions results from this modeling were presented to the NCDENR in our MON Notification of Compliance Status Report dated 10/2/2008.

Methanol emissions from the Dissolver process were calculated to be 1.123 lb./operating time unit ("TU") based on continuous operation of all Dissolver process steps. This is a conservative approach since the Dissolver process is a batch operation. In determining actual operating time for this system, the system is considered to be operating unless both Dissolver Tanks have been empty for greater than 8 hours.

Fugitive emissions of methanol are assumed to be nil and are not calculated.

Information Inputs and Source Inputs:

Information Input	Source of Inputs
Dissolver System Operating Hours	Butacite® Flake Day Coordinator

Point Source Emissions Determination:

Shown on the following page.

Fugitive Emissions Determination:

None

Point Source Emission Determination**PVA Dissolver Tank System (BS-G)****Methanol (MeOH)****CAS No. 67-56-1**

Operating time for the PVA Dissolver Tank System in 2014 equaled 557 Dissolver Time Units (TU).

Methanol emissions for the PVA Dissolver Tank system are 1.123 pounds per Dissolver time unit (TU). Therefore annual methanol emissions for this source are:

$$1.123 \frac{\text{lb. MeOH}}{\text{Dissolver TU}} \times 557 \frac{\text{Dissolver TU}}{\text{year}} = 626 \frac{\text{lb. MeOH}}{\text{year}}$$

Total emissions of Methanol from the PVA Dissolver Tank System (BS-G) in 2014 were:

$$\begin{aligned} &= 626 \text{ lb of Methanol (HAP)} \\ &= 0.31 \text{ tons of VOC} \end{aligned}$$

05-48 ✓

AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No.: FS-B

Emission Source Description: Polyvinyl Fluoride Process No. 1

Process and Emission Description:

The PVF process is a continuous manufacturing process. All emissions from this process vent to the atmosphere, some via a vertical stack. The calculation of emissions of VOCs will be addressed in the attached spreadsheet.

Basis and Assumptions:

FEP-B1 (Analytical Equipment) emissions are calculated using the flowmeters feeding the analyzers and the rotometers in the GC bypass loops (which are not routinely valved to the stack).

FEP-B2 (Maintenance Header) is only in operation when equipment is vented for maintenance. A flowmeter is installed immediately upstream of the VF Dispersion Stack. Procedure requires the line to be purged with N₂, then vent VF and then purged with N₂ at least 3 times to remove low concentrations of VF. After maintenance air is removed by purging the equipment with N₂ an additional 3 times (min). In July of 2011, a densitometer was installed, calibrated and verified. The densitometer accurately measures the percent of VF in the gas leaving via the maintenance vent header, giving an accurate emission total for that source. The year's Maintenance Header emissions are calculated using data from the densitometer.

FEP-B3 (Flash Tank) emissions are based on the operating pressure, temperature, and flow through the Low Pressure Slurry Separator. It is assumed that if VF Flow to the PVF reactor is less than 1000 pph, then there is no VF leaving the Flash Tank.

FEP-B4 (Product Collection System) emissions are based on the operating time and production rate of the baghouse and the bag efficiency. According to the manufacturer, W.L. Gore, the Baghouse bags have a 99.97% efficiency rating on 0.3 micron particulate. We don't expect to have any particles smaller than that, so emissions will be 0.488 lb. PVF particulate emission per Polymer Production Unit (PPU).

Information Inputs and Source of Info.: IP.21 and rotometers.

Point Source Emissions Determination:

Point source emissions for individual components are given in the attached spreadsheet.

Equipment Emissions and Fugitive Emissions Determination:

Emissions from equipment leaks will be individually identified. True fugitive (non-point source) emissions have been determined using equipment component emission factors established by DuPont. The determination of those emissions are shown in a separate section of this supporting documentation.

PVF-1 Process VOC Determination (Emission Source ID Nos. FS-B)

Year 2014

Analytical Equipment Vent Flow Rates

Vent No. FEP-B1 flow rate (Q_{FEP-B1})	4,959	pounds
Analytical Equipment VOC emissions (E_{FEP-B1})	4,959	pounds

Maintenance Header Vent Flow Rates

Vent No. FEP-B2 flow rate (Q_{FEP-B2})	15,003	pounds
Maintenance Headers VOC emissions (E_{FEP-B2})	15,003	pounds

Flash Tank Vent Flow Rates

Emissions from Vent No. FEP-B3 flow rate (Q_{FEP-B3})	4,266	pounds
Flash Tanks VOC emissions (E_{FEP-B3})	4,266	pounds

Fugitive Emissions

Fugitive emissions from FS-B (E_{F-B})	1,886	pounds
Total fugitive emissions (E_F)	1,886	pounds

Accidental Releases

Accidental releases from FS-B (Q_{A-B})	80	pounds
Total accidental releases (E_A)	80	pounds

VOC emissions (E) from the PVF-1 facility

Analytical Equipment VOC emissions (E_{FEP-B1})	4,959	pounds
Maintenance Headers VOC emissions (E_{FEP-B2})	15,003	pounds
Flash Tanks VOC emissions (E_{FEP-B3})	4,266	pounds
Total fugitive emissions (E_F)	1,886	pounds
Total accidental releases (E_A)	80	pounds

Total VOC emissions (E) from the PVF-1 facility

* Note: VOC emissions are exclusively vinyl fluoride

	26,194	pounds
	13.10	tons

PVF-1 Process PM Determination (Emission Source ID Nos. FS-B)

Year 2014

Basis and Assumptions:

FEP-B4 (Product Collection System) emissions are based on the operating time and production rate of the baghouse and the bag efficiency. According to the manufacturer, W.L. Gore, the Baghouse bags efficiency rating on 0.3 micron particulate indicates the potential particulate emissions would be 0.488 lb. particulate matter ("PM") per Polymer Production Unit ("PPU"). It is not expected that any particles would be smaller than 0.3 micron.

Determination of Particulate Matter Emissions

Production during reporting year
PM Emission Factor

Total PM emissions from the PVF-1 facility

3,251	PPU
0.488	lb-PM / PPU
1,588	pounds
0.79	tons

AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

05-66

Emission Source ID No.: FS-C

Emission Source Description: Polyvinyl Fluoride Process No. 2

Process and Emission Description:

The PVF process is a continuous manufacturing process. All emissions from this process vent to the atmosphere, some via a vertical stack. The calculation of emissions of VOCs will be addressed in the attached spreadsheet.

Basis and Assumptions:

FEP-C1 (Analytical Equipment) emissions are calculated using the flowmeters feeding the analyzers and the rotometers in the GC bypass loops (which are not routinely valved to the stack).

FEP-C2 (Maintenance Header) is only in operation when equipment is vented for maintenance. A flowmeter is installed immediately upstream of the VF Dispersion Stack. Procedure requires the line to be purged with N₂, then vent VF and then purged with N₂ at least 3 times to remove low concentrations of VF. After maintenance air is removed by purging the equipment with N₂ an additional 3 times (min). It is therefore conservatively assumed that 50% of the flow is VOC (VF or Propylene) when densitometer data is not available (January-April). In May of 2012, a densitometer was installed, calibrated and verified. The densitometer accurately measures the percent of VF in the gas leaving via the maintenance vent header, giving an accurate emission total for that source. The year's Maintenance Header emissions are calculated using data from the densitometer from May through December and in January through April, 50% of the flow was assumed to be VOC.

FEP-C3 (Flash Tank) emissions are based on the operating pressure, temperature, and flow through the Low Pressure Slurry Separator. It is assumed that if VF Flow to the PVF reactor is less than 1000 pph, then there is no VF leaving the Flash Tank.

FEP-C4 (Product Collection System) emissions are based on the operating time and production rate of the baghouse and the bag efficiency. According to the manufacturer, W.L. Gore, the Baghouse bags have a 99.97% efficiency rating on 0.3 micron particulate. We don't expect to have any particles smaller than that, so emissions will be 0.488 lb. PVF particulate emission per Polymer Production Unit (PPU).

Information Inputs and Source of Info.: IP.21 and rotometers.

Point Source Emissions Determination:

Point source emissions for individual components are given in the attached spreadsheet.

Equipment Emissions and Fugitive Emissions Determination:

Emissions from equipment leaks will be individually identified. True fugitive (non-point source) emissions have been determined using equipment component emission factors established by DuPont. The determination of those emissions are shown in a separate section of this supporting documentation.

PVF-2 Process VOC Determination (Emission Source ID Nos. FS-C)

Year 2014

Analytical Equipment Vent Flow Rates

Vent No. FEP-C1 flow rate (Q_{FEP-C1})	2,886	pounds
Analytical Equipment VOC emissions (E_{FEP-C1})	2,886	pounds

Maintenance Header Vent Flow Rates

Vent No. FEP-C2 flow rate (Q_{FEP-C2})	18,225	pounds
Maintenance Headers VOC emissions (E_{FEP-C2})	18,225	pounds

Flash Tank Vent Flow Rates

Emissions from Vent No. FEP-C3 flow rate (Q_{FEP-C3})	3,748	pounds
Flash Tanks VOC emissions (E_{FEP-C3})	3,748	pounds

Fugitive Emissions

Fugitive emissions from FS-C (E_{F-C})	1,886	pounds
Total fugitive emissions (E_F)	1,886	pounds

Accidental Releases

Accidental releases from FS-C (Q_{A-C})	52	pounds
Total accidental releases (E_A)	52	pounds

VOC emissions (E) from the PVF-2 facility

Analytical Equipment VOC emissions (E_{FEP-C1})	2,886	pounds
Maintenance Headers VOC emissions (E_{FEP-C2})	18,225	pounds
Flash Tanks VOC emissions (E_{FEP-C3})	3,748	pounds
Total fugitive emissions (E_F)	1,886	pounds
Total accidental releases (E_A)	52	pounds

Total VOC emissions (E) from the PVF-2 facility

* Note: VOC emissions are exclusively vinyl fluoride

	26,797	pounds
	13.40	tons

PVF-2 Process PM Determination (Emission Source ID Nos. FS-C)

Year 2014

Basis and Assumptions:

FEP-C4 (Product Collection System) emissions are based on the operating time and production rate of the baghouse and the bag efficiency. According to the manufacturer, W.L. Gore, the Baghouse bags efficiency rating on 0.3 micron particulate indicates the potential particulate emissions would be 0.488 lb. particulate matter ("PM") per Polymer Production Unit ("PPU"). It is not expected that any particles would be smaller than 0.3 micron.

Determination of Particulate Matter Emissions

Production during reporting year

2,689 PPU

PM Emission Factor

0.488 lb-PM / PPU

Total PM emissions from the PVF-2 facility

1,313 pounds

0.66 tons

Completed By:

Christopher A. Chanelli

Date Completed:

January 15, 2015

2014 Air Emissions Inventory Supporting Documentation

05-53

Emission Source ID No.: GHG-HDR

Emission Source Description: HFA-Hydrate Destruction Reactor System

Process and Emission Description:

The HFA-Hydrate Destruction Reactor System (HDR) consists of a thermal-alkaline reactor that decomposes HFA-hydrate to trifluoromethane (HFC-23 or fluoroform) and trifluoroacetate. The trifluoroacetate is water soluble and leaves the HDR system in the wastewater stream. The HFC-23 is vented to the atmosphere via the Nafion® Process' main vent stack (NEP-1).

HFC-23 is not a VOC, HAP, or North Carolina TAP. As such, HFC-23 is not a regulated air pollutant. Because of this, the HDR is not listed on the site's Title V Air Permit. Therefore, for the purpose of this report, HFC-23 is reported as a greenhouse gas emission.

Basis and Assumptions:

The basis of the HFC-23 emissions is the formation of HFA-hydrate in the HFPO Process. In the HDR system, the HFA-hydrate is chemically decomposed to HFC-23. Per the HFPO Process flowsheet (W1208078), 0.4 kg of HFC-23 is formed and emitted for every 30.48 HFP Units fed into the HFPO Process. Therefore, the emission of HFC-23 is proportional to the quantity of HFP make-up fed to the HFPO Process. It is assumed that 10% of the HFC-23 formed in the HFPO Process is ultimately vented from the HDR system, and 90% is vented from the HFPO Process itself.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
HFPO Process' fresh HFP make-up quantity	SAP financial records

Point Source Emissions Determination:

All air emissions from the HDR system are point source. The estimate of the emission of fluoroform (HFC-23) is given on the following page.

A. Trifluoromethane (CF₃H; fluoroform; HFC-23; R-23)**CAS No. 75-46-7**Quantity Generated:Before-control CF₃H generation per the process flowsheet (W1208078):

$$\frac{0.4 \text{ kg CF}_3\text{H}}{30.48 \text{ HFP Units}}$$

Before-control CF₃H generation based on 499,992 HFP Units

$$\begin{aligned} \frac{0.4 \text{ kg CF}_3\text{H}}{30.48 \text{ HFP Units}} \times 499,992 \text{ HFP Units} &= 6,561 \text{ kg CF}_3\text{H} \\ &= 14,464 \text{ lb. CF}_3\text{H} \end{aligned}$$

Assume that 10% of the generated trifluoromethane is emitted from the HFA-hydrate Destruction Reactor System (GHG-HDR) and 90% is emitted from the HFPO Process (NS-A).

$$\begin{aligned} 14,464 \text{ lb. CF}_3\text{H} \times 10\% &= 1,446 \text{ lb. CF}_3\text{H} \\ &= 0.72 \text{ ton CF}_3\text{H} \end{aligned}$$

2014 Air Emissions Inventory Supporting Documentation

OS-68

Emission Source ID No.: I-01A

Emission Source Description: PVF-1 House Vacuum System

Process and Emission Description:

For general good housekeeping purposes, the DuPont Company - Fayetteville Works' PVF-1 Process uses a vacuum system to remove the PVF powder from the building's floor and equipment. The emission of particulate matter from the vacuum system is controlled by a two-stage fabric filter.

Basis and Assumptions:

The first stage fabric filter or pre-separator is a TDC Filter QX blended cellulosic / synthetic fiber paper filter. Its efficiency for capturing / controlling particles is 48% for 0.3 - 1.0 micron size, 88% for 1.0 - 3.0 micron size, and 99% for 3.0 - 10.0 micron size.

The second stage fabric filter or pre-separator is a TDC Filter SB-TX heavy-duty spunbond 100% synthetic filter media with high efficiency ePTFE membrane applied. Its MERV Test results show the filter's efficiency for capturing / controlling particles is 99.99% for 0.3 - 1.0 micron size, 100% for 1.0 - 3.0 micron size, and 100% for 3.0 - 10.0 micron size.

The amount of PVF powder captured from the pre-separator is typically no more than two 340-lb. bags per month. To be conservative, it will be assumed that 680 lb. of PVF is collected every month for a total of 8,160 lb. of solids per year.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Control efficiency of the two fabric filters	Vendor information

Point Source Emissions Determination:

For the purpose of this report, it is assumed that all emissions are point source.

Equipment Emissions and Fugitive Emissions Determination:

For the purpose of this report, it is assumed that all emissions are point source.

Point Source Emissions Determination**Emission Source ID No.: I-01A****Particulate Matter Emissions Determination**

Determination of before-control particulate matter is based on the conservative estimate of 8,160 lb/yr collected from the 1st-stage filter (pre-separator), the capture efficiencies of that filter, and the particle size distribution of the PVF powder.

Results of particle size distribution testing of size batches of PVF powder during August through October 2013 showed the worst-case situation of 68% being less than 1.0 μm . To be conservative, assume 70% is less than 1.0 μm and 30% is greater than 1.0 μm .

Vendor literature from TDC Filter states the capture / control efficiency of their QX Filter is 48% for particles less than 1.0 μm and 88% for particles greater than 1.0 μm .

The quantity of particulate emissions that is captured / controlled by the 1st-stage filter is 8,160 lb. per year and is equal to the following:

$$\begin{array}{|c|} \hline \text{Uncontrolled} \\ \hline \text{Emissions} \\ \hline \end{array} \begin{array}{|c|} \hline \text{Fraction} \\ \hline < 1 \mu\text{m} \\ \hline \end{array} \begin{array}{|c|} \hline \text{Efficiency} \\ \hline < 1 \mu\text{m} \\ \hline \end{array} + \begin{array}{|c|} \hline \text{Uncontrolled} \\ \hline \text{Emissions} \\ \hline \end{array} \begin{array}{|c|} \hline \text{Fraction} \\ \hline > 1 \mu\text{m} \\ \hline \end{array} \begin{array}{|c|} \hline \text{Efficiency} \\ \hline > 1 \mu\text{m} \\ \hline \end{array}$$

$$\begin{array}{c} \text{Uncontrolled} \\ \text{Emissions} \end{array} \times 70\% \times 48\% + \begin{array}{c} \text{Uncontrolled} \\ \text{Emissions} \end{array} \times 30\% \times 88\% = 8,160 \text{ lb.}$$

$$\begin{array}{c} \text{Uncontrolled} \\ \text{Emissions} \end{array} = \frac{8,160 \text{ lb.}}{70\% \times 48\% + 30\% \times 88\%} = 13,600 \text{ lb.}$$

The quantity of the 1st-stage filter's after-control particulate matter that passes through the 1st-stage filter and enters the 2nd-stage filter as the uncontrolled particulate matter for the 2nd-stage filter is:

$$13,600 \text{ lb.} - 8,160 \text{ lb.} = 5,440 \text{ lb.}$$

Vendor literature from TDC Filter states the capture / control efficiency of their SB-TX Filter Media is 99.99% for particles less than 1.0 μm and 100% for particles greater than 1.0 μm . To be conservative, it will be assumed the efficiency is 99.99% for all particles.

The quantity of particulate emissions that is captured / controlled by the 2nd-stage filter is:

$$\left| \begin{array}{c} \text{Uncontrolled} \\ \text{Emissions} \end{array} \right| \left| \begin{array}{c} \text{Fraction} \\ < 1 \mu\text{m} \end{array} \right| \left| \begin{array}{c} \text{Efficiency} \\ < 1 \mu\text{m} \end{array} \right| + \left| \begin{array}{c} \text{Uncontrolled} \\ \text{Emissions} \end{array} \right| \left| \begin{array}{c} \text{Fraction} \\ > 1 \mu\text{m} \end{array} \right| \left| \begin{array}{c} \text{Efficiency} \\ > 1 \mu\text{m} \end{array} \right|$$

$$5,440 \text{ lb.} \quad \times \quad 99.99\% \quad = \quad 5,439.5 \text{ lb.}$$

The annualized quantity of the 2nd-stage filter's after-control particulate matter that passes through the 2nd-stage filter to the atmosphere is:

$$5,440 \text{ lb.} \quad - \quad 5,439.5 \text{ lb.} \quad = \quad \begin{array}{l} 0.54 \text{ lb/yr Particulate Matter} \\ 0.0003 \text{ ton/yr Particulate Matter} \end{array}$$

The annualized quantity of the particulate matter emissions will be reported as 0.01 tons per year as that is the lowest value that is shown on the NC-DAQ AERO database system.

Pollutant	Emissions (ton/year)
Particulate Matter (TSP)	0.01
PM ₁₀ (< 10 micron)	0.01
PM _{2.5} (< 2.5 micron)	0.01

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2014 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-01B

Emission Source Description: PVF-2 House Vacuum System

Process and Emission Description:

For general good housekeeping purposes, the DuPont Company - Fayetteville Works' PVF-2 Process uses a vacuum system to remove the PVF powder from the building's floor and equipment. The emission of particulate matter from the vacuum system is controlled by a two-stage fabric filter.

Basis and Assumptions:

The first stage fabric filter or pre-separator is a TDC Filter QX blended cellulosic / synthetic fiber paper filter. Its efficiency for capturing / controlling particles is 48% for 0.3 - 1.0 micron size, 88% for 1.0 - 3.0 micron size, and 99% for 3.0 - 10.0 micron size.

The second stage fabric filter or pre-separator is a TDC Filter SB-TX heavy-duty spunbond 100% synthetic filter media with high efficiency ePTFE membrane applied. Its MERV Test results show the filter's efficiency for capturing / controlling particles is 99.99% for 0.3 - 1.0 micron size, 100% for 1.0 - 3.0 micron size, and 100% for 3.0 - 10.0 micron size.

The amount of PVF powder captured from the pre-separator is typically no more than two 340-lb. bags per month. To be conservative, it will be assumed that 680 lb. of PVF is collected every month for a total of 8,160 lb. of solids per year.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Control efficiency of the two fabric filters	Vendor information

Point Source Emissions Determination:

For the purpose of this report, it is assumed that all emissions are point source.

Equipment Emissions and Fugitive Emissions Determination:

For the purpose of this report, it is assumed that all emissions are point source.

Point Source Emissions Determination**Emission Source ID No.: I-01B****Particulate Matter Emissions Determination**

Determination of before-control particulate matter is based on the conservative estimate of 8,160 lb/yr collected from the 1st-stage filter (pre-separator), the capture efficiencies of that filter, and the particle size distribution of the PVF powder.

Results of particle size distribution testing of size batches of PVF powder during August through October 2013 showed the worst-case situation of 68% being less than 1.0 μm . To be conservative, assume 70% is less than 1.0 μm and 30% is greater than 1.0 μm .

Vendor literature from TDC Filter states the capture / control efficiency of their QX Filter is 48% for particles less than 1.0 μm and 88% for particles greater than 1.0 μm .

The quantity of particulate emissions that is captured / controlled by the 1st-stage filter is 8,160 lb. per year and is equal to the following:

$$\left| \begin{array}{c} \text{Uncontrolled} \\ \text{Emissions} \end{array} \right| \left| \begin{array}{c} \text{Fraction} \\ < 1 \mu\text{m} \end{array} \right| \left| \begin{array}{c} \text{Efficiency} \\ < 1 \mu\text{m} \end{array} \right| + \left| \begin{array}{c} \text{Uncontrolled} \\ \text{Emissions} \end{array} \right| \left| \begin{array}{c} \text{Fraction} \\ > 1 \mu\text{m} \end{array} \right| \left| \begin{array}{c} \text{Efficiency} \\ > 1 \mu\text{m} \end{array} \right|$$

$$\text{Uncontrolled Emissions} \times 70\% \times 48\% + \text{Uncontrolled Emissions} \times 30\% \times 88\% = 8,160 \text{ lb.}$$

$$\text{Uncontrolled Emissions} = \frac{8,160 \text{ lb.}}{70\% \times 48\% + 30\% \times 88\%} = 13,600 \text{ lb.}$$

The quantity of the 1st-stage filter's after-control particulate matter that passes through the 1st-stage filter and enters the 2nd-stage filter as the uncontrolled particulate matter for the 2nd-stage filter is:

$$13,600 \text{ lb.} - 8,160 \text{ lb.} = 5,440 \text{ lb.}$$

Vendor literature from TDC Filter states the capture / control efficiency of their SB-TX Filter Media is 99.99% for particles less than 1.0 μm and 100% for particles greater than 1.0 μm . To be conservative, it will be assumed the efficiency is 99.99% for all particles.

The quantity of particulate emissions that is captured / controlled by the 2nd-stage filter is:

$$\left| \begin{array}{c} \text{Uncontrolled} \\ \text{Emissions} \end{array} \right| \left| \begin{array}{c} \text{Fraction} \\ < 1 \mu\text{m} \end{array} \right| \left| \begin{array}{c} \text{Efficiency} \\ < 1 \mu\text{m} \end{array} \right| + \left| \begin{array}{c} \text{Uncontrolled} \\ \text{Emissions} \end{array} \right| \left| \begin{array}{c} \text{Fraction} \\ > 1 \mu\text{m} \end{array} \right| \left| \begin{array}{c} \text{Efficiency} \\ > 1 \mu\text{m} \end{array} \right|$$

$$5,440 \text{ lb.} \quad \times \quad 99.99\% \quad = \quad 5,439.5 \text{ lb.}$$

The annualized quantity of the 2nd-stage filter's after-control particulate matter that passes through the 2nd-stage filter to the atmosphere is:

$$5,440 \text{ lb.} \quad - \quad 5,439.5 \text{ lb.} \quad = \quad \begin{array}{l} 0.54 \text{ lb/yr Particulate Matter} \\ 0.0003 \text{ ton/yr Particulate Matter} \end{array}$$

The annualized quantity of the particulate matter emissions will be reported as 0.01 tons per year as that is the lowest value that is shown on the NC-DAQ AERO database system.

Pollutant	Emissions (ton/year)
Particulate Matter (TSP)	0.01
PM ₁₀ (< 10 micron)	0.01
PM _{2.5} (< 2.5 micron)	0.01

AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

05-37

Emission Source ID No.: I-02

Emission Source Description: Waste DMSO Storage Tank

Process Description:

This tank is used as an intermediate storage space for disposal of DMSO (dimethyl sulfoxide) offsite. DMSO is used in the Hydrolysis process and can not currently be disposed of onsite. When the material in Hydrolysis can no longer be used for the process, the chemical is transferred to the Waste DMSO Storage Tank. From this tank, a truck comes and disposes of the DMSO solution. The tank is open to the atmosphere with a gooseneck pipe coming off the top that ends 12" above the diked area.

Basis and Assumptions:

- Direct vent to atmosphere
- Tank volume = 6000 gallons or 802 ft³
- DMSO vapor pressure = 0.46 mm Hg @ 20°C
- Molar volume of an Ideal Gas @ 0°C and 1 atm = 359 ft³/(lb-mole)
- Molecular Weight of DMSO = 78 (78 lb DMSO / lb-mole DMSO)
- Assume one complete tank volume turnover per day for point source emissions.
- Assume DuPont Good Emission Factor on Equipment Leaks for fugitive emissions (See Appendix A).
- Flange emissions were used for all equipment except valves and pumps.

Information Inputs and Source of Inputs:

Information	Source
Total shipped DMSO (lb/yr) (#5 on State Inventory Form)	Waste Shipping Specialist, Global Supply Support
Vapor pressure	MSDS #22310402, CAS #67-68-5
Tank volume	Procedure PR-70, W1535321, or NBPf000351
Number of Each Type of Equipment	W1535321 and verifying at source
% Production/Quarter (#12 on State Inventory Form)	Master Production Scheduler via SAP BW Reporting

Dimethyl sulfoxide (DMSO)

CAS No. 67-68-5

Point Source Emissions Determination:

Vapor pressure of DMSO = 0.46 mm Hg at 20°C

Mole fraction DMSO in vapor (using Dalton's law):

$$\text{Mole fraction DMSO} = \frac{\text{Vapor pressure DMSO}}{\text{Total pressure in tank}} = \frac{0.46 \text{ mm Hg}}{760 \text{ mm Hg}} = \frac{0.000605 \text{ mole DMSO}}{\text{mole gas in tank}}$$

Molar volume at 0°C and 1 atm = 359 ft³ \Rightarrow Molar volume at 20°C and 1 atm = 385 ft³

Pounds of DMSO per tank volume:

$$\frac{802 \text{ ft}^3}{\text{tank volume}} * \frac{\text{lb-mole}}{385 \text{ ft}^3} * \frac{0.000605 \text{ mole DMSO}}{\text{lb-mole gas in tank}} * \frac{78 \text{ lb DMSO}}{\text{mole DMSO}} = \frac{0.098 \text{ lb DMSO}}{\text{tank volume}}$$

Total DMSO emissions per year from tank volume:

$$\frac{0.098 \text{ lb DMSO}}{\text{tank volume}} * \frac{1 \text{ tank volume}}{\text{day}} * \frac{365 \text{ days}}{\text{year}} * \frac{1 \text{ ton}}{2000 \text{ lbs}} = \mathbf{0.018 \text{ ton DMSO / yr}}$$

Fugitive Emissions Determination:

Equipment Component	Number of Components	Good Factor (lb/hr/component)	Emissions (lb/hr)	Emissions (ton/yr)
Pump Seal	1	0.0075	0.0075	0.033
Heavy Liquid Valve	20	0.00352	0.0704	0.308
Open-ended Line	1	0.0215	0.0215	0.094
Flange/Connection	9	0.00031	0.00279	0.012
			Total	0.447

Good factor (lb/hr/component) \times Number of Components = Emissions (lb/hr)

Emissions (lb/hr) \times 1 ton / 2000 lbs \times 24 hr/day \times 365 days/year = Emissions (ton/yr)

Total fugitive DMSO emissions per year = **0.447 ton DMSO / year**

Emissions Summary:

Point Source Emissions + Fugitive Emissions = Total Emissions

$$0.018 \text{ ton DMSO / year} + 0.447 \text{ ton DMSO / year} = \mathbf{0.47 \text{ ton DMSO / year}}$$

APPENDIX A: FUGITIVE EMISSION LEAK RATES FOR PROCESS EQUIPMENT

Fugitive emission studies have been done on a number of DuPont facilities and the measurements were considerable lower than emission factors recommended by the EPA for SOCOMI chemical processes. These screening and bagging data have been used to establish "typical" emission factors from DuPont facilities. The data separated into three categories of emission levels for "as found" emissions from plants who were not involved in LDAR programs.

As a result of this effort, three sets of DuPont factors were developed: "superior", "excellent", and "good." The superior factors are typical of processes that contain extremely hazardous materials, i.e. phosgene (COCl_2), chlorine (Cl_2), and hydrogen fluoride (HF). A set of example questions to help guide DuPont sites as to when to use the different categories was also developed and is discussed in the next section. The three categories represent the range found at DuPont facilities, but still are much lower than EPA SOCOMI factors. All three sets of factors are listed below.

COMPONENT	SERVICE	EMMISSION FACTORS (lb/hr/component)			
		SUPERIOR	EXCELLENT	GOOD	EPA SOCOMI
Pump Seals	Light Liquid	.xxxxxx	0.00115	0.0075	0.109
Pump Seals	Heavy Liquid	.xxxxxx	0.00115	0.0075	0.047
Valves	Gas	.xxxxxx	0.00039	0.00549	0.012
Valves	Light Liquid	.xxxxxx	0.00036	0.00352	0.016
Valves	Heavy Liquid	.xxxxxx	0.00036	0.00352	0.00051
Pressure Relief Seals	Gas/Vapor	.xxxxxx	0.00012	0.00013	0.23
Open Ended Lines	All	.xxxxxx	0.001	0.0215	0.0037
Flanges	All	.xxxxxx	0.00018	0.00031	0.0018
Sampling Connections	All	.xxxxxx	0.00018	0.00031	0.033
Compressor Seals	Gas/Vapor	N/A	N/A	N/A	0.50
Overall Emission Factor		1/10,000	1/20	1/3	1/1

Heavy liquid means a liquid with a true vapor pressure of less than 0.3 kPa (0.04 psia) at a temperature of 294.3 °K (70 °F); or which has 0.1 Reid Vapor Pressure; or which when distilled requires a temperature of 421.95 °K (300 °F); or greater to recover 10 percent of the liquid as determined by ASTM method D86-82.

Light liquid means a liquid that is not a **heavy liquid**.

05-31

2014 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION**Emission Source ID No.:** I-03**Emission Source Description:** Fugitive emissions of Methylene Chloride**Process & Emission Description:**

Methylene Chloride is used as a heat exchanging fluid in many of the processes in Nafion. It is a closed loop system. All emissions from this system are a result of equipment leaks or spills.

Basis and Assumptions:

A material balance is used for calculating fugitive emissions.

Information Inputs and Source Inputs:

Information Input	Source of Inputs
Methylene Chloride Emissions	SARA 313 Report from Nafion Waste Shipment Clerk

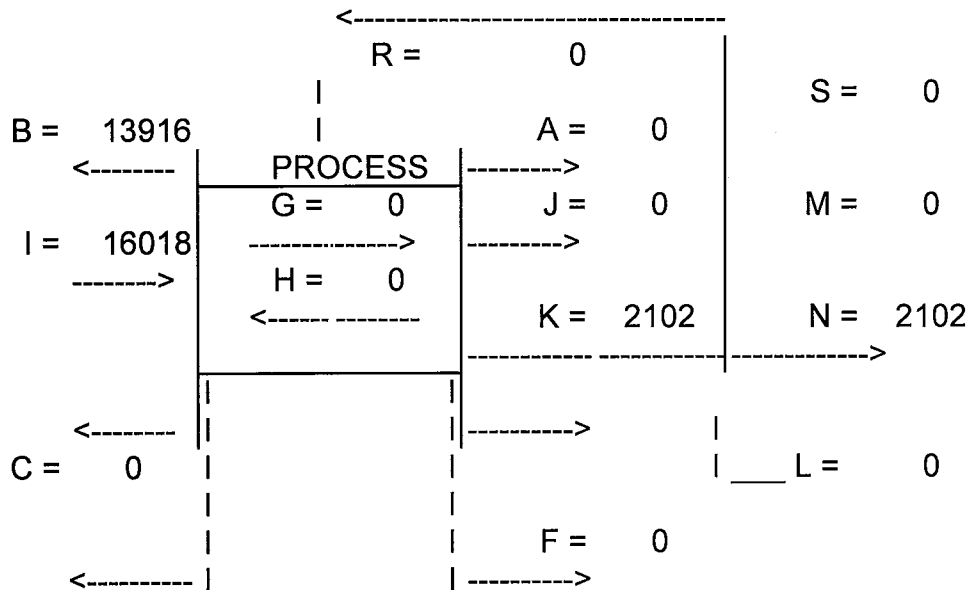
Point Source Emissions Determination:

None

Fugitive Emissions Determination:

Shown on the following page.

SARA 313 2014
All units in Lbs.
Material Balance For: Methylene Chloride



A = Emitted to Air - Permitted Point Source	0
B = Emitted to Air - Fugitive & Releases	13916
C = Emitted to Ground - (Release)	0
F = Rework inventory on pad	0
G = Generated In Process - (Specify How)	0
H = Destroyed or Transformed in Process - (Specify How)	0
I = Introduced into Process - (Raw Ingredients Consumed)	16018
J = Shipped off with Product	0
K = Generated as Waste in Current Year	2102
L = Waste Stored from Previous Year	0
M = Waste Stored at End of Current Year	0
N = Total Waste Shipped During Current Year	2102
R = Returned to System w/o Recycling Step (From Prev Year)	0
S = Diallylamine & Propylene Oxide added to adjust pH.	0

NOTES: All this waste was shipped to Heritage WTI - If generated

+Beg. Inv.	38946
+Purchas	2400
-End Inv.	25328
Total	16018

Riverwater Sodium Hypochlorite^a (as Chlorine) Fugitive Emissions Basis

Equipment Component	Total Components	EPA SOCM ^b (kg / hr / component)	Service (hr / yr)	Emissions (kg / yr)	Emissions (lb / yr)
Valves in light liquid service	1	0.00403	8760	35.3	77.8
Connections including fusible plugs in light liquid service	33	0.00183	8760	529.0	1166.3
Total Emissions as Chlorine				564	1244

Note a : Sodium hypochlorite has a vapor pressure of 17 mmHg (2.26 Kpa) at 20 degrees C. Per 40 CFR 63 Subpart H, "light liquid service" means equipment whose contents have a vapor pressure of greater than 0.3 kilopascals at 20 degrees C. Therefore, for the purpose of determining fugitive emissions from the river water chlorination system, the sodium hypochlorite equipment is considered to be in "light liquid service" even though sodium hypochlorite is not an organic compound.

Note b : Source: EPA, November 1995, Table 2-1.

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2014 Air Emissions Inventory Supporting Documentation

05-39

Emission Source ID No.: I-05

Emission Source Description: Sitewide Laboratory Emissions

Process and Emission Description:

The DuPont Company - Fayetteville Works has several laboratories located throughout the site. The use of normal laboratory chemicals result in assumed emissions of these compounds.

Basis and Assumptions:

The amount of the laboratory chemicals used in the various laboratories is not easily quantified due to the current procurement procedures. In previous years these quantities could and were determined. During those years, it was assumed that 100% of the laboratory chemicals purchased were emitted as air emissions.

To be conservative, it will be assumed that the annual emission of laboratory chemicals is the summation of the emissions that occurred in the four (4) year period from 2003 to 2006.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Total pounds of laboratory chemicals reported from 2003 through 2006.	Assumed conservative high estimates

Point Source Emissions Determination:

For the purpose of this report, it is assumed that all emissions are point source via the lab hoods.

Equipment Emissions and Fugitive Emissions Determination:

For the purpose of this report, it is assumed that all emissions are point source via the lab hoods.

Point Source Emission Determination

Emission Source ID No.: I-05

VOC Emissions Determination

The emission of VOC is determined by summing the total laboratory emissions reported in the air emissions inventories from 2003 to 2006.

The DuPont Company - Fayetteville Works has several laboratories located throughout the site. The use of normal laboratory chemicals result in assumed emissions of these compounds.

2003-2006 Summation Sitewide Laboratory Chemicals

Compounds	2003	2004	2005	2006	48-month Total
Acetic Acid	252	258		403	913
Acrolein		1			1
Benzene	1	2		2	5
Bromine		17	9		26
Chloroform			1		1
Ethyl Acetate	5		12		17
Ethylene Dichloride	262	132		147	541
Hydrogen Chloride		80	15		95
n-Hexane			3		3
Nitric Acid	22	87			109
Toluene		31			31
					1,742

Total VOC emissions would be the sum of the above compounds except for bromine, hydrogen chloride, and nitric acid.

Total VOC emissions	1,512 lb. VOC
	0.756 tons VOC

2014 Air Emissions Inventory Supporting Documentation

05-51

Emission Source ID No.: I-06

Emission Source Description: Outdoor Abrasive Blasting Operation

Process and Emission Description:

The DuPont Company - Fayetteville Works has a free-standing structure that is used to abrasive blast large metal parts prior to painting.

Basis and Assumptions:

The abrasive blasting activity in this structure is infrequent. Purchasing records of the abrasive media used in this operation is the basis of the abrasive media consumption.

Per the AP-42 Section 13.2.6 particulate emission factors for abrasive blasting of mild steel panels with a five mile per hour wind speed, total particulate matter emissions would be 27 pounds per 1,000 pounds of abrasive. The choice of this low wind speed is appropriate since the blasting operation is conducted inside an enclosure.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Total pounds of abrasive media	Fluor Daniels personnel responsible for the abrasive blasting operation.

Point Source Emissions Determination:

For the purpose of this report, it is assumed that all emissions are fugitive.

Equipment Emissions and Fugitive Emissions Determination:

For the purpose of this report, it is assumed that all emissions are fugitive.

Fugitive Emission Determination**Emission Source ID No.: I-06****PM Emissions Determination**

The emission of particulate matter is determined by multiplying the total estimate of abrasive media consumed by the AP-42 Section 13.2.6 particulate emission factors.

AP-42 Section 13.2.6 particulate emission factors for abrasive blasting of mild steel panels with a five mile per hour wind speed	27 pounds total particulate matter (PM) emissions per 1,000 pounds of abrasive
---	--

Input:

Abrasive media consumed during reporting year	8,000 pounds
---	--------------

$$\begin{aligned}
 \frac{8,000 \text{ lb. abrasive}}{\text{year}} & \times \frac{27 \text{ lb. PM}}{1,000 \text{ lb. abrasive}} = \frac{216 \text{ lb. PM}}{\text{year}} \\
 & = \frac{0.11 \text{ ton PM}}{\text{year}}
 \end{aligned}$$

Pollutant	Emissions (ton/year)
Particulate Matter (TSP)	0.11
PM ₁₀ (< 10 micron)	0.11
PM _{2.5} (< 2.5 micron)	0.11

2014 Air Emissions Inventory Supporting Documentation

05-52

Emission Source ID No.: I-07**Emission Source Description:** Paint Shop**Process and Emission Description:**

The DuPont Company -Fayetteville Works operates a Paint Shop in which product cylinders and assorted metal parts are painted.

Basis and Assumptions:

The painting activity in these spray booths is fairly frequent. Most of the painting is of the the Fluoromonomer product cylinders. The basis of the emissions determination is the actual consumption records of paints and primers used at this source.

This activity results in very low overall emissions of both VOC and HAP/TAP emissions. In addition, the type and brand of paints consumed varies dramatically each year. As such, the effort to accurately quantify and qualify the emissions from this activity is much greater than the relative scale of the emissions.

Therefore, a conservative approach will be used to determine the air emissions, in which it will be assumed that all the paint consumed was 100% VOC by mass, that all of the paints' density is 12.71 lb/gal which is the greatest known density of a previously used paint, and that each paint has the highest concentration of HAP/TAP of any previously used paint.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Total gallons of paint consumed	KBR personnel responsible for the Paint Shop

Point Source Emissions Determination:

For the purpose of this report, it is assumed that all emissions are fugitive.

Equipment Emissions and Fugitive Emissions Determination:

For the purpose of this report, it is assumed that all emissions are fugitive.

Emission Source ID No.: I-07**VOC Emissions Determination**

Worst-case Density of Paint 12.71 lb/gal
 Worst-case VOC Content 100%
 Paint Consumed in Year 400 gallons (assumed)

$$400 \text{ gal. paint} \times \frac{12.7 \text{ lb. paint}}{\text{gal. paint}} \times \frac{1.0 \text{ lb. VOC}}{\text{lb. paint}} = 5,084 \text{ lb. VOC}$$

$$= 2.54 \text{ ton VOC}$$

HAP / TAP Emissions Determination

HAP / TAP	Worst-case Conc.	Volume of Paint Consumed (gal)	Worst-case * Density (lb/gal)	Mass of HAP/TAP Emitted (lb)
Ethyl benzene	24.6%	400	12.71	1,251
Methyl ethyl ketone	10.0%	400	12.71	508
Toluene	17.0%	400	12.71	864
Xylene	30.0%	400	12.71	1,525
Hexamethylene-diisocyanate	0.2%	400	12.71	10
Ethylene glycol	2.0%	400	12.71	102

* Worst-case HAP / TAP concentration is based on the following paints:

- DuPont T-8805 Thinner contains 24.6% ethyl benzene
- Krylon Orange contains 10.0% methyl ethyl ketone
- Krylon Acrylic Spray contains 17.0% toluene
- Krylon Orange contains 30.0% xylene
- DuPont Imron Accelerator 389-S contains 0.2% hexamethylene diisocyanate
- Latex Exterior Paint contains 2.0% ethylene glycol

2014 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-08

Emission Source Description: Abrasive Blasting Cabinets

Process and Emission Description:

The DuPont Company - Fayetteville Works has several self-contained abrasive blasting cabinets located throughout the site. The function of these cabinets is to perform occasional abrasive blasting of metal parts prior to painting.

Basis and Assumptions:

The abrasive blasting activity in these cabinets is very infrequent. Some cabinets are used once or twice a year. However, for the purposes of this air emissions inventory, it will be assumed that a extremely conservative high estimate exists where one ton of abrasive media is consumed in each cabinet each month.

Per the AP-42 Section 13.2.6 particulate emission factors for abrasive blasting of mild steel panels with a five mile per hour wind speed, total particulate matter emissions would be 27 pounds per 1,000 pounds of abrasive. The choice of this low wind speed is appropriate since the blasting operation is conducted inside a cabinet.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Total pounds of abrasive media	Assumed conservative high estimates

Point Source Emissions Determination:

For the purpose of this report, it is assumed that all emissions are fugitive.

Equipment Emissions and Fugitive Emissions Determination:

For the purpose of this report, it is assumed that all emissions are fugitive.

Fugitive Emission Determination**PM Emissions Determination**

The emission of particulate matter is determined by multiplying the total estimate of abrasive media consumed by the AP-42 Section 13.2.6 particulate emission factors.

AP-42 Section 13.2.6 particulate emission factors for abrasive blasting of mild steel panels with a five mile per hour wind speed	27 pounds total particulate matter emissions per 1,000 pounds of abrasive
---	---

Assumptions:

Abrasive Blasting Cabinets on-site	4 cabinets
Abrasive consumed per cabinet	1 ton / month
Abrasive consumed per cabinet	12 ton / year
Sitewide abrasive consumed	48 ton / year

$$\frac{48 \text{ tons abrasive}}{\text{year}} \times \frac{27 \text{ ton PM}}{1,000 \text{ ton abrasive}} = \frac{1.3 \text{ ton PM}}{\text{year}}$$

Pollutant	Emissions (ton/year)
Particulate Matter (TSP)	1.3
PM ₁₀ (< 10 micron)	1.3
PM _{2.5} (< 2.5 micron)	1.3

2014 Air Emissions Inventory Supporting Documentation

05-19

Emission Source ID No.: I-09

Emission Source Description: Spray Paint Booths

Process and Emission Description:

The DuPont Company -Fayetteville Works has several small paint booths located throughout the site. The function of these spray booths is to perform occasional painting of metal parts using aerosol spray cans.

Basis and Assumptions:

The painting activity in these spray booths is very infrequent. Some spray paint booths are used once or twice a year. However, for the purposes of this air emissions inventory, it will be assumed that a extremely conservative high estimate exists:

- (1) While most if not all of the paint spray booths are used less than one day per month, it will be assumed that each spray booth has five (5) aerosol cans of paint emptied into it each day, five days per week.
- (2) Most commercial spray paints contain 60% to 65% VOC. However, for the purpose of this report, it will be assumed that the paint is 100% VOC by weight.
- (3) To account for the emission of hazardous air pollutants, it will be assumed that the paint contains the highest concentration of the individual HAPs per the Material Safety Data Sheets for Krylon and Rust-oleum paints.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Total pounds of paint, VOC content, and HAP content	Assumed conservative high estimates

Point Source Emissions Determination:

For the purpose of this report, it is assumed that all emissions are fugitive.

Equipment Emissions and Fugitive Emissions Determination:

For the purpose of this report, it is assumed that all emissions are fugitive.

Fugitive Emission Determination**VOC Emissions Determination**

Spraybooths on-site	4 spraybooths
Cans of paint per day per booth	5 cans / day / booth
Cans of paint per day	20 cans / day
Net weight of contents per can	0.75 pounds
Weight of paint per day	15 lb. paint / day
Days per week spraybooth is used	5 days / week
Days per year spraybooth is used	260 days / year
Weight of paint per year	3,900 lb. paint / year
VOC content of paint	100% VOC content
Weight of VOC per year (lb.)	3,900 lb. VOC / year
Weight of VOC per year (ton)	1.95 tons VOC / year

HAP Emissions Determination

The emission of hazardous air pollutants is determined by multiplying the total estimate of paint consumed by the HAP content of the paint.

Example: Determination of the emission of ethyl benzene

$$\frac{3,900 \text{ lb. paint}}{\text{year}} \times \frac{5 \text{ lb. ethyl benzene}}{100 \text{ lb. paint}} = 195 \text{ lb. ethyl benzene}$$

Hazardous Air Pollutant	CAS Number	HAP Content	Total Emissions (lb)
Ethyl benzene	100-41-4	5%	195
Methyl ethyl ketone	78-93-3	2%	78
Toluene	108-88-3	45%	1,755
Xylene	1330-20-7	25%	975

AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

05-115

Emission Source ID No.: I-11

Emission Source Description: Butacite® Plasticizer Storage Tank

Process Description:

This tank is used to store triethylene glycol bis (2-ethylhexanoate) or 3GO. Emissions from this tank would be exclusively from the diurnal temperature change. Because the delivery railcar is closed-loop vented with the tank, the displaced headspace associated with the unloading of the railcar is vented back to the railcar, thereby resulting in no emissions to the atmosphere. The tank vents to the atmosphere through a conservation vent, so there are normally no emissions from the tank unless the tank is heating up from the sun.

Basis and Assumptions:

- Venting to atmosphere occurs only from daytime heating.
- Tank volume = 60,000 gallons or 8021 ft³
- 3GO vapor pressure = <0.0075 mm Hg @ 20°C (see Note 1)
5 mm Hg @ 219°C (see Note 2)
- Molar volume of an Ideal Gas @ 0°C and 1 atm = 359 ft³/(lb-mole)
- Molecular Weight of 3GO = 403 (403 lb 3GO / lb-mole 3GO)
- Assume one complete tank volume turnover per day for point source emissions.
- Assume DuPont Good Emission Factor on Equipment Leaks for fugitive emissions (See Appendix A).
- Flange emissions were used for all equipment except valves and pumps.

Note 1: Vapor pressure reference from Celenese EC Safety Data Sheet
2001/58/EG revised on February 16, 2007.

Note 2: Vapor pressure reference from March 6, 1991, Federal Register Volume
56, Number 44, Page 9571

**Triethylene glycol bis (2-ethylhexanoate)
3GO**

CAS No. 94-28-0

Point Source Emissions Determination:

Assume a diurnal temperature change from a nighttime low of 50°F (10°C or 283°K) to a daytime high of 113°F (45°C or 318°K).

Assume the entire tank volume (8021 ft³) is nitrogen saturated with 3GO.

Assume the ideal gas law applies:

$$\text{Pressure} \times \text{Volume} = \text{lb-moles} \times \text{Gas Constant} \times \text{Temperature}$$

At a temperature of 10°C (510°R):

$$(1 \text{ atm}) \times (8021 \text{ ft}^3) = (n \text{ lb-moles}) \times (0.73 \text{ atm ft}^3 \text{ } ^\circ\text{R}^{-1} \text{ lb-mole}^{-1}) \times (510^\circ\text{R})$$

$$n \text{ lb-moles} = 21.55 \text{ lb-moles of gas inside the tank}$$

At a temperature of 45°C (573°R):

$$(1 \text{ atm}) \times (8021 \text{ ft}^3) = (n \text{ lb-moles}) \times (0.73 \text{ atm ft}^3 \text{ } ^\circ\text{R}^{-1} \text{ lb-mole}^{-1}) \times (573^\circ\text{R})$$

$$n \text{ lb-moles} = 19.18 \text{ lb-moles of gas inside the tank}$$

Therefore, if the tank heats from 10°C to 45°C, then **2.37 lb-mole** (21.55 minus 19.18) of gas per day is lost through the conservation vent.

Vapor pressure of 3GO = <0.0075 mm Hg at 20°C

Mole fraction 3GO in vapor (using Dalton's law):

$$\text{Mole fraction 3GO} = \frac{\text{Vapor pressure 3GO}}{\text{Total pressure in tank}} = \frac{0.0075 \text{ mm Hg}}{760 \text{ mm Hg}} = \frac{0.0000099 \text{ mole 3GO}}{\text{mole gas in tank}}$$

Pounds of 3GO emissions from tank from diurnal temperature change:

$$\frac{2.37 \text{ lb-mole}}{\text{day}} \times \frac{0.0000099 \text{ lb-mole 3GO}}{\text{lb-mole gas in tank}} \times \frac{403 \text{ lb 3GO}}{\text{lb-mole 3GO}} = \frac{0.0095 \text{ lb 3GO}}{\text{day}}$$

Total 3GO emissions per year from the diurnal temperature change:

$$\frac{0.0095 \text{ lb 3GO}}{\text{day}} \times \frac{365 \text{ days}}{\text{year}} \times \frac{1 \text{ ton}}{2000 \text{ lbs}} = \frac{0.002 \text{ ton 3GO}}{\text{year}}$$

Fugitive Emissions Determination:

Equipment Component	Number of Components	Good Factor (lb/hr/component)	Emissions (lb/hr)	Emissions (ton/yr)
Pump Seal	1	0.0075	0.0075	0.033
Heavy Liquid Valve	20	0.00352	0.0704	0.308
Open-ended Line	1	0.0215	0.0215	0.094
Flange/Connection	9	0.00031	0.00279	0.012
			Total	0.447

Good factor (lb/hr/component) \times Number of Components = Emissions (lb/hr)

Emissions (lb/hr) \times 1 ton / 2000 lbs \times 24 hr/day \times 365 days/year = Emissions (ton/yr)

Total fugitive 3GO emissions per year = **0.447 ton 3GO / year**

Total Emissions Summary:

Point Source Emissions + Fugitive Emissions = Total Emissions

0.002 ton 3GO / year + 0.447 ton 3GO / year = **0.449 ton 3GO / year**

= **0.449 ton VOC / year**

The DuPont Company sold the Butacite® manufacturing facility, including the 3GO Storage Tank, to Kuraray America, Inc. on June 1, 2014. Therefore, DuPont is reporting the emissions for only the first five (5) months of 2014.

0.449 ton VOC / year \times 5/12 = **0.187 ton VOC / year**

APPENDIX A: FUGITIVE EMISSION LEAK RATES FOR PROCESS EQUIPMENT

Fugitive emission studies have been done on a number of DuPont facilities and the measurements were considerable lower than emission factors recommended by the EPA for SOCM I chemical processes. These screening and bagging data have been used to establish "typical" emission factors from DuPont facilities. The data separated into three categories of emission levels for "as found" emissions from plants who were not involved in LDAR programs.

As a result of this effort, three sets of DuPont factors were developed: "superior", "excellent", and "good." The superior factors are typical of processes that contain extremely hazardous materials, i.e. phosgene (COCl_2), chlorine (Cl_2), and hydrogen fluoride (HF). A set of example questions to help guide DuPont sites as to when to use the different categories was also developed and is discussed in the next section. The three categories represent the range found at DuPont facilities, but still are much lower than EPA SOCM I factors. All three sets of factors are listed below.

COMPONENT	SERVICE	EMMISSION FACTORS (lb/hr/component)			
		SUPERIOR	EXCELLENT	GOOD	EPA SOCMI
Pump Seals	Light Liquid	.xxxxxx	0.00115	0.0075	0.109
Pump Seals	Heavy Liquid	.xxxxxx	0.00115	0.0075	0.047
Valves	Gas	.xxxxxx	0.00039	0.00549	0.012
Valves	Light Liquid	.xxxxxx	0.00036	0.00352	0.016
Valves	Heavy Liquid	.xxxxxx	0.00036	0.00352	0.00051
Pressure Relief Seals	Gas/Vapor	.xxxxxx	0.00012	0.00013	0.23
Open Ended Lines	All	.xxxxxx	0.001	0.0215	0.0037
Flanges	All	.xxxxxx	0.00018	0.00031	0.0018
Sampling Connections	All	.xxxxxx	0.00018	0.00031	0.033
Compressor Seals	Gas/Vapor	N/A	N/A	N/A	0.50
Overall Emission Factor		1/10,000	1/20	1/3	1/1

Heavy liquid means a liquid with a true vapor pressure of less than 0.3 kPa (0.04 psia) at a temperature of 294.3 °K (70 °F); or which has 0.1 Reid Vapor Pressure; or which when distilled requires a temperature of 421.95 °K (300 °F); or greater to recover 10 percent of the liquid as determined by ASTM method D86-82.

Nafion Dispersions Process (I-12)

Product	Amount (L)
D0521	0
D520	336
D521	804
D1020	8
D1021	916
D1031	0
D2020	1,272
D2021	80
D2029	1
D2820	0

TOTAL	3,417
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0562

Vapor density of n-propanol = 2.46 g/l

Assume containers are filled with 100% n-propanol vapor at start of filling.

The emissions are the displaced headspace of the containers as a result of their filling.

$$\begin{aligned} \frac{3,417 \text{ Liters}}{\text{year}} &\times \frac{2.46 \text{ grams NPA}}{\text{Liter}} = \frac{8,394 \text{ grams}}{\text{year}} \\ &= \frac{19 \text{ lb. VOC}}{\text{year}} \\ &= \frac{0.01 \text{ ton VOC}}{\text{year}} \end{aligned}$$

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	1,547	1	1,548
PAF	Trifluoroacetyl Fluoride	354-34-7	1,418	0	1,418
AVF Solvent (TFF)	Perfluoro-3,5,7,9,11-pentaaxadodecanoyl fluoride	690-43	289	1	290
AVF Solvent (TAF)	Trifluoromethyl ester of carbonofluoridic acid	3299-24-9	614	2	616
HFP	Hexafluoropropylene	116-15-4	51,205	44	51,248
HFPO	Hexafluoropropylene Epoxide	428-59-1	20,444	46	20,490
Benzene	Benzene	71-43-2	3	0	3
Toluene	Methylbenzene	108-88-3	0	0	0
			Total VOC Emissions (lbs)		75,612
			Total VOC Emissions (tons)		37.81

B. 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	1,634	94	2	1,731
Benzene	Benzene	71-43-2		3	0	3
Methylene Chloride	Methylene Chloride	75-09-2	0	0	22	22
Toluene	Methylbenzene	108-88-3		0	0	0

05-11

Point Source Emission Determination**A. Carbonyl Fluoride (COF₂)**

CAS No. 353-50-4

HF Potential:Each mole of COF₂ (MW = 66) can generate 2 moles of HF (MW = 20).

$$1 \text{ lb COF}_2 \cdot \frac{1 \text{ mole COF}_2}{66 \text{ lb COF}_2} \cdot \frac{20 \text{ lb HF}}{1 \text{ mole HF}} \cdot \frac{2 \text{ moles HF}}{1 \text{ mole COF}_2} = 0.606 \text{ lb HF}$$

Therefore, each 1 lb of COF₂ generates

0.606 lb of HF

Quantity Generated:Before-control COF₂ generation :

Vented from A/F Column:	Total AF column vent flow [lb] * Average COF ₂ mass fraction in AF column vent [lb COF ₂ /lb]
From "Vent Flows" Tab =	684,993.54 X 0.5018 = 343,730 lb COF ₂

Vented from Stripper Column:	Total Stripper col vent flow [lb] * Average COF ₂ mass fraction in Stripper column vent [lb COF ₂ /lb]
From "Vent Flows" Tab =	203,711.74 X 0 = 0 lb COF ₂

Vented from Solvent Recycle Tank:	Total Solvent tank vent flow [lb] * Average COF ₂ mass fraction in Solvent tank vent [lb COF ₂ /lb]
From "Vent Flows" Tab =	246,095.69 X 0 = 0 lb COF ₂

COF ₂ sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab):	= 21,170 lb COF ₂
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Total COF ₂ Emitted from Process =	343,730 lb COF ₂ from A/F Column
(sent to WGS)	+ 0 lb COF ₂ from Stripper Column
	+ 0 lb COF ₂ from Solvent Recycle Tank
	+ 21,170 lb COF ₂ sent to VE-South Process when VE-S shutdown
	= 364,900 lb COF ₂ sent to WGS

After-control emissions utilizing the Waste Gas Scrubber (WGS):	Efficiency= 99.10%
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<u>VOC Emissions</u>	364,900 lb COF ₂
Waste Gas Scrubber	x 0.90%
	= 1,460 lb COF ₂ (VOC)

<u>HF Equivalent Emissions</u>	1460 lb COF ₂
	x 0.606 lb HF/lb COF ₂
	= 885 lb HF (Equivalent HF)

**B. Perfluoroacetyl Fluoride (PAF)
Trifluoroacetyl Fluoride (CF₃COF)**

CAS No. 354-34-7

HF Potential:

Each mole of PAF (MW = 116) can generate 1 mole of HF (MW = 20).

$$1 \text{ lb PAF} \cdot \frac{1 \text{ mole PAF}}{116 \text{ lb PAF}} \cdot \frac{20 \text{ lb HF}}{1 \text{ mole HF}} \cdot \frac{1 \text{ mole HF}}{1 \text{ mole PAF}} = 0.172 \text{ lb HF}$$

Therefore, each 1 lb of PAF generates

0.172 lb of HF

Quantity Generated:

Before-control PAF vented

Vented from A/F Column: From "Vent Flows" Tab =	Total AF column vent flow [lb] * Average PAF mass fraction in AF column vent [lb PAF/lb]	
	684,993.54 X 0.4653 =	318,727 lb PAF
Vented from Stripper Column: From "Vent Flows" Tab =	Total Stripper column vent flow [lb] * Average PAF mass fraction in Stripper column vent [lb PAF/lb]	
	203,711.74 X 0.0038 =	774 lb PAF
Vented from Solvent Recycle From "Vent Flows" Tab =	Total Solvent tank vent flow [lb] * Average PAF mass fraction in Solvent tank vent [lb PAF/lb]	
	246,095.69 X 0 =	0 lb PAF
PAF sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab):	=	16,778 lb PAF

Total COF ₂ Emitted from Process = (sent to WGS)	318,727 lb PAF from A/F Column
	+ 774 lb PAF from Stripper Column
	+ 0 lb PAF from Solvent Recycle Tank
	+ 16,778 lb PAF sent to VE-South Process when VE-S shutdown
	= 336,280 lb PAF sent to WGS

After-control emissions utilizing the Waste Gas Scrubber (WGS): Efficiency= 99.10%

<u>VOC Emissions</u>	336,280 lb PAF
Waste Gas Scrubber	x 0.90%
	= 1,345 lb PAF (VOC)

<u>HF Equivalent Emissions</u>	1345 lb PAF
	x 0.172 lb HF/lb PAF
	= 231 lb HF (Equivalent HF)

C. Acid Fluoride Solvent - mixture of TAF and TFF**Perfluoro-3,5,7,9,11-pentaoxadodecanoyl fluoride (TFF)
Trifluoromethyl ester of carbonofluoridic acid (TAF)****CAS Nos. 690-43-7
3299-24-9**HF Potential:

The acid fluoride solvent is a mixture of telomeric acid fluorides (TAF) and telomeric fluoroformates (TFF).
TAF behaves as typical acid fluorides, however an average molecular weight must be used since chain length varies.

Each mole of TAF (avg MW = 330) can generate one mole of HF (MW = 20).

$$1 \text{ lb TAF} \cdot \frac{1 \text{ mole TAF}}{330 \text{ lb TAF}} \cdot \frac{20 \text{ lb HF}}{1 \text{ mole HF}} \cdot \frac{1 \text{ mole HF}}{1 \text{ mole TAF}} = 0.0606 \text{ lb HF}$$

Therefore, each 1 lb of TAF generates 0.061 kg of HF

Telomeric Fluoroformates break down into multiples of COF_2 (MW = 66), which in turn generate 2 moles of HF (MW = 20).
Using n=4 would mean for every mole of TFF, 6 moles of COF_2 can be generated. MW of n=4 TFF is 396.
Most TFF is believed to be of chain length less than n=4 based on recent analysis.

$$1 \text{ lb TFF} \cdot \frac{1 \text{ mole TFF}}{396 \text{ lb TFF}} \cdot \frac{6 \text{ mole COF}_2}{1 \text{ mole TFF}} \cdot \frac{20 \text{ lb HF}}{1 \text{ mole HF}} \cdot \frac{2 \text{ moles HF}}{1 \text{ mole COF}_2} = 0.606 \text{ lb HF}$$

Therefore, each 1 lb of TFF generates 0.606 lb of HF

For the purpose of HF Potential, it will be conservatively assumed that all of the Acid Fluoride Solvent is TFF, since the potential HF is greater.

Quantity Generated:

The only process vent where TAF/TFF may be vented to atmosphere is the solvent recycle tank vent.

Before-control Acid Fluoride solvent (AF) vented

Vented from Solvent Recycle	Total Solvent tank vent flow [lb] * Average AF mass fraction in Solvent tank vent [lb AF/lb]
From "Vent Flows" Tab =	246,095.69 X 0.8691 = 213,882 lb TAF/TFF

Total AF Emitted from Process = 213,882 lb AF sent to WGS
(sent to WGS)

After-control emissions utilizing the Waste Gas Scrubber (WGS): Efficiency= 99.10%

VOC Emissions

Waste Gas Scrubber	x	213,882 lb AF	
	=	0.90%	
		856 lb total AF	(VOC)
			69% TAF and 31% TFF, based on May 2012 estimate

VOC Emissions

For TFF:

	x	66,303 lb TFF 31% TFF	
	=	0.90% Waste Gas Scrubber	
		265 lb TFF	265 lb VOC

For TAF:

	x	147,578 lb TAF 69% TAF	
	=	0.90% Waste Gas Scrubber	
		590 lb TAF	590 lb VOC

HF Equivalent Emissions As explained above, assume all solvent is TFF for conservative calculation of HF generation.

=	856 lb AF solvent, assumed all TFF	X	0.606 lb HF/lb TFF	=	519 lb. HF
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D. Hexafluoropropylene (HFP)**CAS No. 116-15-4**HF Potential:

HFP is a VOC without the potential to form HF.

Quantity Released:

Vented from A/F Column: From "Vent Flows" Tab =	Total AF column vent flow [lb] * Average HFP mass fraction in AF column vent [lb HFP/lb]	
	684,993.54 X 0.0193 =	13,220 lb HFP
Vented from Stripper Column: From "Vent Flows" Tab =	Total Stripper column vent flow [lb] * Average HFP mass fraction in Stripper column vent [lb HFP/lb]	
	203,711.74 X 0.1112 =	22,653 lb HFP
Vented from Solvent Recycle From "Vent Flows" Tab =	Total Solvent tank vent flow [lb] * Average HFP mass fraction in Solvent tank vent [lb HFP/lb]	
	246,095.69 X 0.0079 =	1,944 lb HFP
HFP sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab):	=	735 lb HFP

Additional HFP is emitted from the unloading of HFP, specifically the decontamination of hoses and compressor after each trailer is unloaded. The decontamination involves venting the contents of the two hoses and compressor piping to the WGS. Each hose is 2" diameter x 20 feet long.

$$\text{Volume of each hose} = 753.98 \text{ in}^3 = 12.36 \text{ L}$$

The density of HFP liquid at 16C is 1.42 kg/L
The density of HFP vapor at 16C is 0.0281 kg/L

Determined from physical property data
Determined by ideal gas law @ 16C and vapor press of 450 kPa abs.
(pressure from H27457PG on iso container, after H27451HV closes)

HFP vented from Liquid Hose: (assumes hose volume is filled with liquid)

$$\text{Volume of hose X liquid density} = 17.54 \text{ kg from Liquid Hose}$$

HFP vented from Vapor Hose: (assumes hose volume is filled with vapor)

$$\text{Volume of hose X vapor density} = 0.35 \text{ kg from Vapor Hose}$$

There is an additional estimated 20' of 1 1/2" piping between the hose and 27460HV, also decontaminated, volume = 7 L

$$\text{HFP vented from vapor piping} = 7 \text{ L X vapor density} = 0.20 \text{ kg from Vapor Piping}$$

HFP vapor vented from compressor & associated piping

Suction bottle volume is 30.2 L, typical temperature is 27C and pressure is 270 kPa(g) at time of decontamination.

$$\text{Vapor density of HFP} = 0.0223 \text{ kg/L}$$

Determined by ideal gas law @ 27C and 371.3 kPa (a)
Reference H27454TG & H27453PG

Additional vapor in 10' of 1" diameter pipe, estimated volume is 1.5 L. Total volume is 31.7 L

$$\text{Suction side volume X vapor density} = 0.71 \text{ kg}$$

Discharge bottle volume is 30.2 L, typical temperature is 37C, 370 kPa (g) at time of decontamination.

$$\text{Vapor density of HFP} = 0.0274 \text{ kg/L}$$

Determined by ideal gas law @ 37C and 471.3 kPa (a)
Reference H27456TG & H27455PG

$$\text{Discharge side volume x vapor density} = 0.83 \text{ kg}$$

$$\text{Total volume form compressor & piping} = 1.54 \text{ kg from Compressor & Piping}$$

The number of decontamination events required is based on the HFP consumed divided by the typical transfer amount, rounded up.

$$2,598,034 / 13,500 = 193$$

Total HFP from decontamination of unloading hoses = Number of events * (vented from liquid hose + vapor hose + compressor + piping)

$$= 193 \text{ X } 20 = 3,778 \text{ kg HFP}$$

$$8,329 \text{ lb HFP from hose decon}$$

HFP is also vented from the Crude Dryers each time a dryer is changed. The basis for this calculation assumes the composition of vapor in the dryer is 50 %HFP and 50 %HFPO,
and the vapor density is 3.3 lb/ft3 (reference ASPEN model)

The molecular sieves have a bulk density of 47 lb per ft3 of bed volume
The density of the sieves themselves is 57 lb per ft3 according to a recent Certificate of Analysis.
Therefore the void fraction of a bed of sieves would be 0.175 ft3 void volume per ft3 total bed volume

From BPF dimensions of the dryer, it is estimated that 10' height of 10" diameter space is filled with sieves, plus 2' of a 6" diameter section. The remaining space at the top containing no sieves consists of 6" high x 10" diameter section plus a 8" high x 6" dia. section.

$$\begin{aligned} \text{Vapor volume in dryer} &= 1.429 \text{ ft}^3 \text{ of vapor} \\ \text{X vapor density of} &= 3.3 \text{ lb/ft}^3 \\ &= 4.72 \text{ lb VOC vapor released per dryer change} \end{aligned}$$

Dryer changes occur every 48 hours. The number of dryer changes is estimated to be
HFP vented = %HFP x lb of VOC per dryer change x number of dryer changes in the year =

$$\begin{aligned} &138 \\ &326 \text{ lb HFP} \end{aligned}$$

After-control emissions from the Waste Gas Scrubber with an assumed efficiency of zero percent (0%) (HFP is not scrubbed out)

VOC Emissions

	13,220 lb HFP from A/F Column	
+	22,653 lb HFP from Stripper Column	
+	1,944 lb HFP from Solvent Recycle Tank	
+	8,329 lb HFP from Unloading Hoses	
+	326 lb HFP from crude dryer changes	
+	735 lb HFP sent to VE-South Process when VE-S shutdown	
=	47,207 lb HFP	47,207 lb VOC

E. Hexafluoropropylene Epoxide (HFPO)

CAS No. 428-59-1

HF Potential:

HFPO is a VOC without the potential to form HF.

Quantity Released:

Vented from A/F Column: From "Vent Flows" Tab =	Total AF column vent flow [lb] * Average HFPO mass fraction in AF column vent [lb HFPO/lb]	
	684,993.54 X 0.0019 =	1,301 lb HFPO
Vented from Stripper Column: From "Vent Flows" Tab =	Total Stripper col vent flow [lb] * Average HFPO mass fraction in Stripper column vent [lb HFPO/lb]	
	203,711.74 X 0.0496 =	10,104 lb HFPO
Vented from Solvent Recycle From "Vent Flows" Tab =	Total Solvent tank vent flow [lb] * Average HFPO mass fraction in Solvent tank vent [lb HFPO/lb]	
	246,095.69 X 0.0216 =	5,316 lb HFPO
HFPO sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab):	=	70 lb HFPO

Additional HFPO is emitted from the decontamination of hoses after each HFPO ISO is loaded.
The decontamination involves venting the contents of the two hoses to the WGS via a service manifold.
The liquid hose is 1" diameter x 20 feet long. The vapor hose is 0.5" diameter x 20 feet long. (BPF 346333).

$$\text{Volume of liquid hose} = 188.5 \text{ in}^3 = 3.09 \text{ L}$$

$$\text{Volume of vapor hose} = 47.124 \text{ in}^3 = 0.77 \text{ L}$$

The density of HFPO liquid at -25C is 1.58 kg/L Determined from physical property data

The density of HFPO vapor at -25C is 0.0563 kg/L Determined by ideal gas law @ -25C and max press of 700 kPa abs.
(max pressure observed H10765PG on iso container, after filling)

HFPO vented from Liquid Hose: (assumes hose volume is filled with liquid)

$$\text{Volume of hose X liquid density} = 4.88 \text{ kg from Liquid Hose}$$

HFPO vented from Vapor Hose: (assumes hose volume is filled with vapor)

$$\text{Volume of hose X vapor density} = 0.04 \text{ kg from Vapor Hose}$$

The amount of piping involved in the decontamination is negligible (isolation valves are in close proximity to hoses).

$$\begin{aligned} \text{Total HFPO from decontamination of loading hoses} &= \text{Number of events} * (\text{vented from liquid hose} + \text{vapor hose}) \\ &= 49 \times 4.92 = 241 \text{ kg HFPO} \\ &= 532 \text{ lb HFPO} \end{aligned}$$

As in the HFP section above, HFPO is vented from the crude dryers during each dryer change.

$$\text{HFPO vented} = \% \text{HFPO} \times \text{lb of VOC per dryer change} \times \text{number of dryer changes in the year} = 326 \text{ lb HFPO from dryers}$$

After-control emissions from the Waste Gas Scrubber with an assumed efficiency of zero percent (0%) (HFPO is not scrubbed out)

VOC Emissions

	1,301 lb HFPO from A/F Column	
+	10,104 lb HFPO from Stripper Column	
+	5,316 lb HFPO from Solvent Recycle Tank	
+	532 lb HFPO from Unloading Hoses	
+	326 lb HFPO from dryer changes	
+	70 lb HFPO sent to VE-South Process when VE-S shutdown	
=	17,650 lb HFP	17,650 lb VOC

F. Perfluoromethylcyclopropane (PMCP)Oxygen (O₂)Fluoroform (CF₃H)Carbon Dioxide (CO₂)

CAS No. 379-16-8

CAS No. 7782-44-7

CAS No. 75-46-7

CAS No. 124-38-9

PMCP, O₂, CF₃H, and CO₂ are not VOCs nor do they have potential to make HF. Since they are not reportable emissions, the calculations are not shown here.

G. Annual Point source emissions summary - Process Vents (after control)

		VOC (lb)	Equiv HF (lb)
A.	COF2	1,460	885
B.	PAF	1,345	231
C.	Acid Fluoride Solvent (TFF)	265	519
	Acid Fluoride Solvent (TAF)	590	
D.	HFP	47,207	0
E.	HFPO	17,650	0
Total for year (lb)		68,517	1,634

Equiv HF represents conservative estimate total for TFF+TAF

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 emission types are as follows: Equipment Emissions (EE) inside buildings = Stack Emissions (SE)

Equipment Emissions (EE) outside buildings = Equipment Fugitive Emissions (FE)

Maintenance Fugitive Emissions (ME)

A. Equipment Emissions Inside Buildings (Stack Emissions)

1. Equipment Emissions (EE) from Barricade:

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 ASPEN Model:

Material	VOC	HFA	Avg. Contents (kg/hr)				% of contents	% VOC	% HF	HF Potential	% Overall HF Potential			
			Line 207B	Line 255	Line 305	Total					0.606	0.172	0.11	0.081
HFPO	x		1491.169	10.38736	277.0774	1778.634	6.02	6.02						
COF ₂	x	x	223.8143	0	43.16596	266.9803	0.90	0.90	0.90	0.606	0.90			
PAF	x	x	206.9447	0.069376	39.84183	246.8559	0.84	0.84	0.84	0.172		0.84		
HFP	x		1916.528	3.505045	366.0799	2286.113	7.74	7.74						
F23			5.084826	0	0.980683	6.065509	0.02							
O ₂			26.42446	0	5.096328	31.52079	0.11							
CO ₂			0	0	0	0	0.00							
PMAP	x	x	17.91142	0.074824	3.378695	21.36494	0.07	0.07	0.07	0.11			0.07	
TAF _{N=1}	x	x	5230.229	1005.205	0	6235.434	21.11	21.11	21.11	0.606	21.11			
TAF _{N=2}	x	x	11378.11	2192.731	0	13570.84	45.94	45.94	45.94	0.606	45.94			
TAF _{N=2+}	x	x	3753.989	723.9967	0	4477.986	15.16	15.16	15.16	0.606	15.16			
Dimer	x	x	7.260958	0	0	7.260958	0.02	0.02	0.02	0.606	0.02			
Trimer	x	x	9.359539	0	0	9.359539	0.03	0.03	0.03	0.081				0.03
PMCP			476.0362	79.94006	0.015	555.9913	1.88							
HFA	x		6.427688	0	1.233058	7.660746	0.03	0.03						
Benzene			14.78905	2.867976	0	17.65703	0.06							
Toluene			14.88	2.87	0	17.75035	0.06							
Total						29537.47	100.00	97.87	84.08		83.1	0.8	0.1	0.0

Assume that: 96% of process materials are VOCs,

84% are acid fluorides with 95% controlled in the barricade scrubber;

16% are non-acid fluorides with 0% controlled in the barricade scrubber.

100% of the liquid is 0.505 weight fraction HF.

Barricade:

Valve emissions:	219 valves x 0.00039 lb/hr/valve	=	0.085 lb/hr EE
Flange emissions:	438 flanges x 0.00018 lb/hr/flange	=	0.079 lb/hr EE
Pump emissions:	2 pump x 0.00115 lb/hr/pump	=	0.002 lb/hr EE
Total equipment emission rate		=	0.167 lb/hr EE

Barricade VOC:

From acid fluorides:	0.167 lb. EE/hr		929.263 lb VOC generated
x	6642.2 operating hr/year	x	(100%-95%) scrubber efficiency
x	0.840 lb. A/F VOC/lb. EE	=	46.463 lb VOC emitted
	= 929.263 lb VOC generated		

From non-acid fluorides:	0.167 lb. EE/hr
x	6642.2 operating hr/year
x	0.160 lb. Non-A/F VOC/lb. EE
=	177.002 lb VOC

Total Barricade VOC Emissions:

	46.463 lb VOC
+	177.002 lb VOC
=	223.466 lb VOC

Barricade HF:

	0.167 lb. EE/hr
x	6642 operating hr/year
x	0.505 lb. HF/lb. EE
x	(100%-95%) scrubber efficiency
=	27.933 lb HF

2. Equipment Emissions (EE) From HFPO Tower

Emissions are vented from equipment located in tower and are vented through stack.
From ASPEN Model:

A/F Column, Scrubbers, Dryers, Stripper Column & Associated Equipment															
Material	VOC	HFA	Avg. Contents (kg/hr)					% of contents	% VOC	% HF	HF Potential	% Overall HF Potential			
			Line 405	Line 572	Line 605	Line 652	Total					0.606	0.172	0.11	0.081
HFPO	x		0.089511	0	0.117529	271.2223	271.4293	37.18	37.18						
COF ₂	x	x	43.11259	0	0	0	43.11259	5.91	5.91	5.91	0.606	5.91			
PAF	x	x	33.16642	0	0	0	33.16642	4.54	4.54	4.54	0.172		4.54		
HFP	x		0.327155	0	0.265321	361.8233	362.4158	49.64	49.64						
F23			0.978137	0	0.489234	0.033179	1.50055	0.21							
O ₂			5.096328	0	0	0	5.096328	0.70							
CO ₂			0	0	1.448218	0.035243	1.483461	0.20							
PMAF	x	x	0	0	0	0	0	0.00	0.00	0.00	0.11			0.00	
TAF _{N=1}	x	x	0	0	0	0	0	0.00	0.00	0.00	0.606	0.00			
TAF _{N=2}	x	x	0	0	0	0	0	0.00	0.00	0.00	0.606	0.00			
TAF _{N=2+}	x	x	0	0	0	0	0	0.00	0.00	0.00	0.606	0.00			
Dimer	x	x	0.585265	0	0	0	0.585265	0.08	0.08	0.08	0.606	0.08			
Trimer	x	x	0	0	0	0	0	0.00	0.00	0.00	0.081			0.00	
PMCP			0	0	0	11.2638	11.2638	1.54							
HFA	x		0	0	0	0	0	0.00	0.00						
Water			0	129.8095	0										
Benzene			0	0	0	0	0	0.00							
Toluene			0	0	0	0	0	0.00							
Total							730.0535	100.00	97.35	10.53		6.0	4.5	0.0	
Assume that : 97 wt. % of the process material are VOCs:												Average HF Potential		0.044087	

Valve emissions:	298 valves x 0.00039 lb/hr/valve	=	0.116 lb/hr EE
Flange emissions:	596 flanges x 0.00018 lb/hr/flange	=	0.107 lb/hr EE
Pump emissions:	2 pumps x 0.00115 lb/hr/pump	=	0.002 lb/hr EE
Total equipment emission rate		=	0.226 lb/hr EE

VOC:	0.226 lb. EE/hr	HF:	0.226 lb. EE/hr
x	6642 operating hr/year	x	6642 operating hr/year
x	0.970 lb. VOC/lb. EE	x	0.044 lb. HF/lb. EE
	1454.823 lb VOC	=	65.992 lb HF

B. Equipment Emissions Outside Buildings (Fugitive Emissions)**1. Fugitive Emissions (FE) From Outside Unit Operations**

From ASPEN Model:

Reactor/Solvent Recycle/Solvent Column & Associated Equipment														
Material	VOC	HFA	Avg. Contents (kg/hr)				% of contents	% VOC	% HF	HF Potential	% Overall HF Potential			
			Line 706	Line 805	Line 812	Total					0.606	0.172	0.11	0.081
HFPO	x		238.6887	32.53355	0.014913	271.2372	3.97	3.97						
COF ₂	x	x	0	0	0	0	0.00	0.00	0.00	0.606	0.00			
PAF	x	x	0	0	0	0	0.00	0.00	0.00	0.172		0.00		
HFP	x		0.08421	361.7391	0.181291	362.0046	5.30	5.30						
F23			0	0.033124	0	0.033124	0.00							
O ₂			0	0	0	0	0.00							
CO ₂			0.035184	0	0	0.035184	0.00							
PMAF	x	x	0	0	0	0	0.00	0.00	0.00	0.11			0.00	
TAF _{N=1}	x	x	0	0	0	0	0.00	0.00	0.00	0.606	0.00			
TAF _{N=2}	x	x	0	0	0	0	0.00	0.00	0.00	0.606	0.00			
TAF _{N=2+}	x	x	0	0	0	0	0.00	0.00	0.00	0.606	0.00			
Dimer	x	x	0	0	0	0	0.00	0.00	0.00	0.606	0.00			
Trimer	x	x	0	0	0	0	0.00	0.00	0.00	0.081				0.00
PMCP			0	11.2536	6.755249	18.00885	0.26							
HFA	x		0	0	0	0	0.00	0.00						
Benzene	x		0	0	0	0	0.00	0.00						
Toluene	x		0	0.016223	6180.06	6180.076	90.47	90.47						
Total						6831.395	100.00	99.74	0.00		0.0	0.0	0.0	0.0
Assume that : 100 wt. % of the process material are VOCs											Average HF Potential			
0 wt. % of the liquid is HF.											0			

Valve emissions: 317 valves x 0.00039 lb/hr/valve = 0.124 lb/hr FE
 Flange emissions: 634 flanges x 0.00018 lb/hr/flange = 0.114 lb/hr FE
 Pump emissions: 3 pump x 0.00115 lb/hr/pump = 0.003 lb/hr FE
 Total fugitive emission rate = 0.241 lb/hr FE

VOC: 0.241 lb. FE/hr HF: 0.241 lb. FE/hr
 x 6642 operating hr/year x 6642 operating hr/year
 x 1.00 lb. VOC/lb. FE x 0.0 lb. HF/lb. FE
 = 1602 lb VOC = 0.00 lb HF
 1602 lb VOC excluding toluene, which is calculated below by mass balance

2. Fugitive Emissions From HFP Storage and Feed

Assume that : This system contains only HFP, so 100 wt. % of the process material are VOCs
 HFP has no potential to form HF, so 0 wt. % of the liquid is HF.

Valve emissions: 120 valves x 0.00039 lb/hr/valve = 0.047 lb/hr FE
 Flange emissions: 135 flanges x 0.00018 lb/hr/flange = 0.024 lb/hr FE
 Total fugitive emission rate = 0.071 lb/hr FE

VOC: 0.071 lb. FE/hr HF: 0.071 lb. FE/hr
 x 6642 operating hr/year x 6642.24 operating hr/year
 x 1.00 lb. VOC/lb. FE x 0.0 lb. HF/lb. FE
 = 472 lb VOC = 0.00 lb HF

3. Fugitive Emissions From Benzene

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

Assume that: Benzene introduced into the process is mostly destroyed by reaction.
Ratio of emissions to benzene used = 1.9 lb emission/368 lb benzene used

Calculations:

Benzene introduced to process: 527.16 lbs

Benzene emissions:

$$527.161905 \text{ lbs} \times \frac{1.90 \text{ lb emission}}{368 \text{ lb benzene}} = 2.72 \text{ lb benzene emission}$$

4. Fugitive Emissions of Toluene by Mass Balance

Basis: 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 first day of month ('User E	+	4068.60 lb	1-Jan
Toluene added to process:	+	10471 lb	
Toluene inventory in process as of last day of month ('Use	-	3935.20 lb	1-Jan
Toluene destroyed in process:	-	0 lb	
Toluene shipped off with product:	-	0 lb injected into product	
Toluene removed from process as a solid waste:	-	13438 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:	=	-2834 lb toluene	= 0 lb VOC

5. Total Equipment Emissions (Fugitive)

Emission Source	Inside Emissions (Stack Emissions)		Outside Emissions (Fugitive Emissions)	
	lb VOC	lb HF	lb VOC	lb HF
A-1 Barricade	223.47	27.93		
A-2 HFPO Tower	1454.82	65.99		
B-1 Outside operations(excluding toluene system)			1602	
B-2 HFP Storage and Feed			472.26	
B-3 Benzene system			2.72	
B-4 Toluene mass balance			0	
Total	1678.29	93.93	2077.09	0.00

6. Speciated Equipment and Fugitive Emissions for annual reporting

For speciated reporting, the following assumptions are made:

- A1 AF VOCs from the barricade (J43) are reported as 50% TAF and 50% TFF
- A1 Non-AF VOCs from the barricade (E49) are reported as 50% HFP and 50% HFPO
- A2 Tower VOCs (H184) are reported as 38% HFPO, 51% HFP, 6% COF2, and 5% PAF.
- B1 Toluene emissions are included in B-4. The remaining VOC (J185) is reported as 60% HFP and 40% HFPO.
- B2 HFP system VOCs are 100% HFP
- B3 VOCs calculated in B3 are 100% benzene
- B4 Toluene system emissions are 100% toluene

Compound	lb VOC
COF2	87.29
PAF	72.74
A/F Solvent (TFF)	23.23
A/F Solvent (TAF)	23.23
HFP	2263.99
HFPO	1282.18
Benzene	2.72
Toluene	0
Total VOC	3755.38

Equipment Cleaned/ Decontaminated	HFP (lb/yr)	HFPO (lb/yr)	TAF (lb/yr)	TFF (lb/yr)	COF2 (lb/yr)	PAF (lb/yr)
TOTAL	1733.46	1512.57	0.46	0.46	0.10	0.10

Total VOC (lb/yr) 3247.15

Data summed from monthly report worksheets. Calculations based on vessel volumes and compositions at time of decontamination.

Accidental Releases to Atmosphere

There were 9 accidental releases to the atmosphere recorded in 2014. Refer to incident reports for more information

I. Total Emissions from Accidental Releases

	Source (Incident date)	TAF (lb)	TFF (lb)	HFP (lb)	HFPO (lb)	COF2 (lb)	PAF (lb)	HFA (lb)	MeCl (lb)	Toluene (lb)	VOC (lb)	HF (lb)
A.	14-003-RCI 1/3/2014			20	20						40.00	0.00
B.	14-0063-RCI 2/20/2014	0.5	0.5								1.00	0.606
C.	3/3/2014				20.00						20.0	0
D.	3/12/2014	1.0	0.0								1.00	0.606
E.	14-0155-RCI 7/4/2014					0.6	0.4				1.0	0.4324
F.	14-0156-RCI 7/7/2014			6	6						11.0	0
G.	14-0200-RCI 9/30/2014								22		22.0	0
H.	14-0213-RCI 10/21/2014			18							18.0	0.00
I.	15-0007-RCI 12/23/2014	0.5	0.5								1.0	0.606
J.												
K.												
L.												
M.												
	Total	2	1	44	46	1	0	0	22	0	115.0	2

05-12

2011 Emissions Summary**A. VOC Emissions Summary**

Nafion® Compound	CAS Chemical Name	CAS No.	EVE Process Emissions (lbs)	PPVE Process Emissions (lbs)	PSEPVE Process Emissions (lbs)	Accidental Releases (lbs)	Total Vinyl Ethers North Emissions (lbs)
HFP	Hexafluoropropylene	116-15-4	132	7,898	11,079		19,109
HFPO	Hexafluoropropylene oxide	428-59-1	126	15,663	793		16,583
HFPO-Dimer	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	1	38	0		39
EVE	Propanoic Acid, 3-[1-[Difluoro [(Trifluoroethenyl oxy) Methyl]-1,2,2,2-Tetrafluoroethoxy] -2,2,3,3-Tetrafluoro-, Methyl Ester	63863-43-4	56	0	0		56
PPVE	Perfluoropropyl vinyl ether	1623-05-8	0	9,576	0		9,576
PSEPVE	Perfluoro-2-(2-Fluorosulfonylethoxy) Propyl Vinyl Ether	16090-14-5	0	0	199		199
PPF	Perfluoropropionyl fluoride	422-61-7	0	77	0		78
TFE	Tetrafluoroethylene	116-14-3	104	30,713	32		30,849
C4	Perfluoro-2-butene	360-89-4	0	494	1,659		2,153
C5	Perfluoropentene	376-87-4	0	32	0		32
Diglyme	Diethylene Glycol Dimethyl Ether	111-96-6	0	0	0		0
AN	Acetonitrile	75-05-8	0	493	0		493
ADN	Adiponitrile	111-69-3	0	0	0		0
TTG	Tetraglyme	143-24-8	1	0	0		1
DA	Tetrafluoro-2[Hexafluoro-2-(Tetrafluoro-2-(Fluorosulfonyl)Ethoxy) Propoxy Propionyl Fluoride	4089-58-1	0	0	12		12
Hydro-PSEPVE	Tetrafluoro-2-[Trifluoro-2-(1,2,2,2-Tetra-fluoroethoxy)-1-(Trifluoromethyl) Ethoxy]-Ethane Sulfonyl Fluoride	755-02-9	0	0	0		0
MA	Tetrafluoro-2-[Tetrafluoro-2-(Fluorosulfonyl)Ethoxy]-Propanoyl Fluoride	4089-57-0	0	0	5		5
MAE	Methyl Perfluoro (5-(Fluoroformyl)-4-Oxahexanoate)	69116-72-9	2	0	0		2
DAE	Methyl Perfluoro (8-(Fluoroformyl)-5-methyl-4,7-Dioxanonanoate)	69116-73-0	3	0	0		3
TAE	Methyl Perfluoro (11-(Fluoroformyl)-5,8-Dimethyl-4,7,10-Trioxadodecanoate)	69116-67-2	0	0	0		0
hydro-EVE	Methyl Perfluoro-5-methyl-4,7-dioxanon-8-hydroxanoate	87483-34-9	6	0	0		6
iso-EVE	Methyl Perfluoro-6-Methyl-4,7-Dioxanon-8 Eneate	73122-14-2	9	0	0		9
MMF	Methyl-2,2-Difluoromalonyl Fluoride	69116-71-8	0	0	0		0
HFPO Trimer	Perfluoro-2,5-Dimethyl-3,6-Dioxanonanoyl	2641-34-1	0	1	0		1
Iso-PSEPVE	Perfluoro-1-Methyl-2-(2 Fluorosulfonyl Ethoxy) Ethyl	34805-58-8	0	0	1		1
Total VOC Emissions (lbs)			439	64,985	13,782	0	79,206
Total VOC Emissions (tons)			0.2	32.5	6.9	0.0	39.6

B. VOC Control Device Efficiency

VOCs Generated Before Control (lbs)					VOCs After Control (lbs)
Process Emissions	Equipment Emissions (lbs)	Maintenance Emissions	Accidental Releases	Total VOC Generated	Total VOC Emitted (lbs)
85,858	2,222	1,292	0	89,372	79,206

89,372 lb VOC generated

79,206 lb VOC emitted

10,165 lb VOC removed in control device

10,165 lb VOC removed in control device

89,372 lb VOC generated

= 11.37% VOC control efficiency

C. Toxic Air Pollutant and Hazardous Air Pollutant Summary (TAPS/HAPS)

Nafion® Compound	CAS Chemical Name	CAS No.	EVE Emissions (lbs)	PPVE Emissions (lbs)	PSEPVE Emissions (lbs)	Accidental Releases (lbs)	Total Emissions (lbs)
HF	Hydrogen Fluoride	7664-39-3	0.27	11.6	31.0	0	42.9
Diglyme	Diethylene Glycol Dimethyl Ether	111-96-6			0		0
Acetonitrile	Acetonitrile	75-05-8		493			493

D. Carbon Monoxide (CO) Emissions Summary

Nafion® Compound	CAS Chemical Name	CAS No.	EVE Emissions (lbs)	PPVE Emissions (lbs)	PSEPVE Emissions (lbs)	Total Emissions (lbs)	Total Emissions (tons)
CO	Carbon Monoxide	630-08-0	350	18,024	4,603	22,976	11.5

Report Created By: Broderick Locklear
Report Created: 7/15/2011

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 99.1% 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.

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:

0.17 kg HFP
0.50 kg CondRx Vent Flow

Vented from the Crude Receiver

0 kg HFP
15.91 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg HFP
0.14 kg Foreshots Receiver Vent

HFP vented based on

170 kg total Condensation Reactor vent stream (22266FG).

HFP vented based on

4,288 kg total Crude Receiver vent stream (22701FG).

HFP vented based on

2 kg total Foreshots Receiver vent stream (22826FG).

HFP vented from Condensation Reactor:

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

$$170 \text{ kg CndRx} = 59 \text{ kg HFP}$$

HFP vented from Crude Receiver

$$\frac{0.00 \text{ kg HFP}}{15.91 \text{ kg CrRec}} \times$$

$$4,288 \text{ kg CrRec} = 0 \text{ kg HFP}$$

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

+	59 kg from Condensation Reactor	
+	0 kg from Crude Receiver	
+	0 kg from Foreshots Receiver	
=	59 kg HFP	= 59 kg VOC
		131 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 unreacted in condensation is vented to the WGS.

HFPO vented per the process flowsheet

Vented from the Condensation Reactor:

0.13 kg HFPO
0.50 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg HFPO
15.91 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg HFPO
0.14 kg Foreshots Receiver Vent

HFPO vented based on
 HFPO vented based on
 HFPO vented based on

170 kg total Condensation Reactor vent stream (22266FG).
 4,288 kg total Crude Receiver vent stream (22701FG).
 2 kg total Foreshots Receiver vent stream (22826FG).

HFPO vented from Condensation Reactor:

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

$$170 \text{ kg CndRx} = 44 \text{ kg HFPO}$$

HFPO vented from Crude Receiver

$$\frac{0.00 \text{ kg HFPO}}{15.91 \text{ kg CrRec}} \times$$

$$4,288 \text{ kg CrRec} = 0 \text{ kg HFPO}$$

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

+	44 kg from Condensation Reactor	
+	0 kg from Crude Receiver	
+	0 kg from Foreshots Receiver	
=	44 kg HFPO	= 44 kg VOC
		96 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).

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

Therefore, each 1 kg of HFPO Dimer generates

0.060 kg of HF

Quantity Released

Before-control HFPO Dimer vented per the process flowsheet

Vented from the Condensation Reactor:

0.05 kg HFPO Dimer
0.50 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg HFPO Dimer
15.91 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg HFPO Dimer
0.14 kg Foreshots Receiver Vent

HFPO Dimer vented based on

170 kg total Condensation Reactor vent stream (22266FG).

HFPO Dimer vented based on

4,288 kg total Crude Receiver vent stream (22701FG).

HFPO Dimer vented based on

2 kg total Foreshots Receiver vent stream (22826FG).

Before control HFPO Dimer vented from Condensation Reactor:

<u>0.05 kg HFPO Dimer</u>	x	170 kg CndRx	=	17 kg HFPO Dimer
0.50 kg CndRx				

HFPO Dimer vented from Crude Receiver

<u>0.00 kg HFPO Dimer</u>	x	4,288 kg CrRec	=	0 kg HFPO Dimer
15.91 kg CrRec				

HFPO Dimer vented from Foreshots Receiver

<u>0.00 kg HFPO Dimer</u>	x	2 kg FsRec	=	0 kg HFPO Dimer
0.14 kg FsRec				

Total before-control HFPO Dimer vented

= 17 kg HFPO Dimer

After-control emissions utilizing the 99.1% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

Waste Gas Scrubber

17 kg Dimer		
x (100%-99.1%)		
= 0.15 kg Dimer		0.15 kg VOC
	=	0.34 lb. VOC

HF Equivalent Emissions

0.15 kg Dimer		
x 0.060 kg HF/kg Dimer		
= 0.01 kg HF		0.02 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 that can be formed in the ABR system. It is an inert in VE-North that is vented to the WGS.

TFE vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg TFE
0.50 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0.18 kg TFE
15.91 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg TFE
0.14 kg Foreshots Receiver Vent

TFE vented based on 170 kg total Condensation Reactor vent stream (22266FG).
 TFE vented based on 4,288 kg total Crude Receiver vent stream (22701FG).
 TFE vented based on 2 kg total Foreshots Receiver vent stream (22826FG).

TFE vented from Condensation Reactor:

0.00	x	170 kg CndRx	=	0 kg TFE
0.50 kg TFE				
kg CndRx				

TFE vented from Crude Receiver

0.18	x	4,288 kg CrRec	=	47 kg TFE
15.91 kg TFE				
kg CrRec				

TFE vented from Foreshots Receiver

0.00	x	2 kg FsRec	=	0 kg TFE
0.14 kg TFE				
kg FsRec				

VOC Emissions

+	0 kg from Condensation Reactor	
+	47 kg from Crude Receiver	
+	0 kg from Foreshots Receiver	
=	47 kg TFE	= 47 kg VOC
		104 lb VOC

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

CAS No. 69116-72-9

HF Potential:

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

$$1 \text{ kg MAE} \cdot \frac{1 \text{ mole MAE}}{322 \text{ g MAE}} \cdot \frac{20 \text{ g HF}}{1 \text{ mole HF}} \cdot \frac{1 \text{ mole HF}}{1 \text{ mole MAE}} = 0.062 \text{ kg HF}$$

Therefore, each 1 kg of MAE generates

0.062 kg of HF

Quantity Released

Before-control MAE vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg MAE
0.50 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg MAE
15.91 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.04 kg MAE
0.14 kg Foreshots Receiver Vent

MAE vented based on

MAE vented based on

MAE vented based on

170 kg total Condensation Reactor vent stream (22266FG).

4,288 kg total Crude Receiver vent stream (22701FG).

2 kg total Foreshots Receiver vent stream (22826FG).

Before control MAE vented from Condensation Reactor:

0.00 kg MAE	x	170 kg CndRx	=	0 kg MAE
0.50 kg CndRx				

MAE vented from Crude Receiver

0.00 kg MAE	x	4,288 kg CrRec	=	0 kg MAE
15.91 kg CrRec				

MAE vented from Foreshots Receiver

0.04 kg MAE	x	2 kg FsRec	=	1 kg MAE
0.14 kg FsRec				

Total before-control MAE vented

= 1 kg MAE

After-control emissions utilizing the 99.1% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

Waste Gas Scrubber

1 kg MAE		
x (100%-99.1%)		
= 0.01 kg MAE		0.01 kg VOC
		0.01 lb. VOC

HF Equivalent Emissions

0.01 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 vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg EVE
0.50 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg EVE
15.91 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.005kg EVE
0.14 kg ForeshotsReceiverVent

EVE vented based on 170 kg total Condensation Reactor vent stream (22266FG).

EVE vented based on 4,288 kg total Crude Receiver vent stream (22701FG).

EVE vented based on 2 kg total Foreshots Receiver vent stream (22826FG).

EVE vented from Condensation Reactor:

0.00	x	170 kg CndRx	=	0 kg EVE
0.50 kg EVE				
kg CndRx				

EVE vented from Crude Receiver

0.00	x	4,288 kg CrRec	=	0 kg EVE
15.91 kg EVE				
kg CrRec				

EVE vented from Foreshots Receiver

0.005	x	2 kg FsRec	=	0 kg EVE
0.14 kg EVE				
kg FsRec				

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. Tetraglyme (TTG)**CAS No. 143-24-8**

The emissions of Tetraglyme is based on a mass balance.

Quantity Released

=	108	kg TTG introduced into processes
=	108	kg TTG transferred to H/C waste tank
=	0	kg TTG unaccounted for and assumed emitted
=	0	lb. Tetraglyme

Emissions of TTG from EVE = **0 lb. Tetraglyme**

H. Carbon Monoxide (CO)

CAS No. 630-08-0

HF Potential:

CO can not form HF

Quantity ReleasedCO is a byproduct from the Agitated Bed Reactor system.
vented to the WGS.

CO vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg CO
0.50 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0.59 kg CO
14.91 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg CO
0.14 kg Foreshots Receiver Vent

CO vented based on 170 kg total Condensation Reactor vent stream (22266FG).
 CO vented based on 4,288 kg total Crude Receiver vent stream (22701FG).
 CO vented based on 2 kg total Foreshots Receiver vent stream (22826FG).

CO vented from Condensation Reactor:

0.00 kg CO	x	170 kg CndRx	=	0 kg CO
0.50 kg CndRx				

CO vented from Crude Receiver

0.59 kg CO	x	4,288 kg CrRec	=	159 kg CO
15.91 kg CrRec				

CO vented from Foreshots Receiver

0.00 kg CO	x	2 kg FsRec	=	0 kg CO
0.14 kg FsRec				

CO Emissions

+	0 kg from Condensation Reactor	
+	159 kg from Crude Receiver	
+	0 kg from Foreshots Receiver	
=	159 kg CO	= 350 lb CO (not a VOC)

I. Adiponitrile

CAS No. 111-69-3

HF Potential

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

Quantity Released

ADN emissions based on 1,083 kg ADN fed

VE North ADN Sent to waste Hydrocarbon tank = 1,083 kgs H/C waste

VOC Emission

$$\begin{array}{rcl} & 1,083 \text{ kg ADN fed} & \\ - & 1,083 \text{ kg ADN to H/C waste} & \\ \hline & 0 \text{ kg ADN lost} & = \end{array} \quad \begin{array}{l} 0 \text{ kg VOC} \\ 0 \text{ lb VOC} \end{array}$$

ADN only used during an EVE Campaign

J. VOC Summary

Nafion Compound Name		Before Control Generated		After Control Stack Emissions
		kg/yr	lb/yr	VOC lb/yr
A.	HFP	59	131	131
B.	HFPO	44	97	97
C.	HFPO-Dimer	17	38	0
D.	TFE	47	104	104
E.	MAE	1	1	0.0
F.	EVE	0	0	0.2
G.	TTG	0	0	0
K.	ADN	0	0	0
	Total	168	371	332.0

K. Total Emission Summary**

** All Emissions in this table represent "After Control" emissions.

Nafion Compound Name	Process Emissions lb/yr	Equipment Emissions ^(Note 1) lb/yr	Maintenance Emissions ^(Note 2) lb/yr	Total Emissions lb/yr
A. HFP	131	1	0	132
B. HFPO	97	28	2	126
C. HFPO-Dimer	0	0	0	1
D. TFE	104	0	0	104
E. MAE	0	0	2	2
F. EVE	0	56	0	56
G. TTG	0	1	0	1
H. CO (not a VOC)				350
I. ADN		12	1	0
* DAE		0	2	3
* TAE		0	0	0
* MMF		0	0	0
* hydro-EVE		3	3	6
* iso-EVE		4	4	9
Total	332	106	14	789

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

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

H. CO not realistically expected through equipment or maintenance emissions. Not a VOC

I. ADN total based on material balance, see section I.

* Not normally emitted from the process as a routine stack emission

Total Non AF ##

Total AF 0

L. HF Equivalent Emissions

Nafion Compound Name	Process Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
C. HFPO-Dimer	0.000	0.001	0.014	0.015
E. MAE	0.000	0.006	0.095	0.101
* DAE		0.015	0.096	0.111
* TAE		0.000	0.003	0.003
* MMF		0.003	0.039	0.041
Total	0.00	0.03	0.25	0.27

* Not normally emitted from the process as a routine stack emission

The estimated HF equivalent emissions were determined by multiplying the total emission quantity of an acid fluoride by the ratio of the molecular weight of HF divided by the molecular weight of the specific acid fluoride. This is based on the fact that one mole of an acid fluoride will generate one mole of HF.

For example, if 100 lb. of MAE was emitted:

$$\frac{20 \text{ lb/mol HF}}{332 \text{ lb/mol MAE}} \times 100 \text{ lb/yr Equipment MAE} = 6.0 \text{ lb/yr HF}$$

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 99.1% 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.

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:

0.05 kg HFP
2.35 kg CondRx Vent Flow

Vented from the Crude Receiver

0.01 kg HFP
3.97 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.01 kg HFP
1.06 kg Foreshots Receiver Vent

Vented from the Stripper

30 kg HFP
100 kg Stripper Vent

HFP vented based on 2,967 kg total Condensation Reactor vent stream (22266FG).

HFP vented based on 25,490 kg total Crude Receiver vent stream (22701FG).

HFP vented based on 844 kg total Foreshots Receiver vent stream (22826FG).

HFP vented based on 11,390 kg in the Stripper vent stream (22231FC).

HFP vented from Condensation Reactor:

0.05 kg HFP	x	2,967 kg CndRx	=	69 kg HFP
2.35 kg CndRx				

HFP vented from Crude Receiver

0.01 kg HFP	x	25,490 kg CrRec	=	88 kg HFP
3.97 kg CrRec				

HFP vented from Foreshots Receiver

0.01 kg HFP	x	844 kg FsRec	=	7 kg HFP
1.06 kg FsRec				

HFP vented from Stripper

30 kg HFP	x	11,390 kg Strpr	=	3,417 kg HFP
100 kg Strpr				

VOC Emissions

	+	69 kg from Condensation Reactor	
	+	88 kg from Crude Receiver	
	+	7 kg from Foreshots Receiver	
		3,417 kg from Stripper	
=		3,581 kg HFP	= 3,581 kg VOC
			7,894 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 unreacted in condensation is vented to the WGS.

HFPO vented per the process flowsheet

Vented from the Condensation Reactor:

0.11 kg HFPO
2.35 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg HFPO
3.97 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg HFPO
1.06 kg Foreshots Receiver Vent

Vented from the Stripper

60 kg HFPO
100 kg Stripper Vent

HFPO vented based on 2,967 kg total Condensation Reactor vent stream (22266FG).

HFPO vented based on 25,490 kg total Crude Receiver vent stream (22701FG).

HFPO vented based on 844 kg total Foreshots Receiver vent stream (22826FG).

HFP vented based on 11,390 kg in the Stripper vent stream (22231FC).

HFPO vented from Condensation Reactor:

0.11 kg HFPO	x	2,967 kg CndRx	=	143 kg HFPO
2.35 kg CndRx				

HFPO vented from Crude Receiver

0.00 kg HFPO	x	25,490 kg CrRec	=	0 kg HFPO
3.97 kg CrRec				

HFPO vented from Foreshots Receiver

0.00 kg HFPO	x	844 kg FsRec	=	0 kg HFPO
1.06 kg FsRec				

HFP vented from Stripper

60 kg HFPO	x	11,390 kg Strpr	=	6,834 kg HFPO
100 kg Strpr				

VOC Emissions

		143 kg from Condensation Reactor		
+		0 kg from Crude Receiver		
+		0 kg from Foreshots Receiver		
+		6,834 kg from Stripper		
=		6,978 kg HFPO	=	6,978 kg VOC
				15,383 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).

$$1 \text{ kg PPF} \cdot \frac{1 \text{ mole PPF}}{166 \text{ g PPF}} \cdot \frac{20 \text{ g HF}}{1 \text{ mole HF}} \cdot \frac{1 \text{ mole HF}}{1 \text{ mole PPF}} = 0.120 \text{ kg HF}$$

Therefore, each 1 kg of PPF generates

0.120 kg of HF

Quantity Released

Before-control PPF vented per the process flowsheet

Vented from the Condensation Reactor:

2.14 kg PPF

2.35 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg PPF

3.97 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg PPF

1.06 kg Foreshots Receiver Vent

Vented from the Stripper

10 kg PPF

100 kg Stripper Vent

PPF vented based on 2,967 kg total Condensation Reactor vent stream (22266FG).
 PPF vented based on 25,490 kg total Crude Receiver vent stream (22701FG).
 PPF vented based on 844 kg total Foreshots Receiver vent stream (22826FG).
 PPF vented based on 11,390 kg in the Stripper vent stream (22231FC).

Before control PPF vented from Condensation Reactor:

2.14 kg PPF	x	2,967 kg CndRx	=	2,697 kg PPF
2.35 kg CndRx				

PPF vented from Crude Receiver

0.00 kg PPF	x	25,490 kg CrRec	=	0 kg PPF
3.97 kg CrRec				

PPF vented from Foreshots Receiver

0.00 kg PPF	x	844 kg FsRec	=	0 kg PPF
1.06 kg FsRec				

PPF vented from Stripper

10 kg PPF	x	11,390 kg Strpr	=	1,139 kg PPF
100 kg Strpr				

Total before-control PPF vented

	=	3,836 kg PPF
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After-control emissions utilizing the 99.1% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

		3,836 kg PAF		
Waste Gas Scrubber	x	(100%-99.1%)		
	=	35 kg PAF	=	35 kg VOC
			=	76 lb. VOC

HF Equivalent Emissions

		35 kg PAF		
	x	0.120 kg HF/kg PAF		
	=	4 kg HF	=	9.2 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 that can be formed in the ABR system. It is an inert in VE-North that is vented to the WGS.

TFE vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg TFE

2.35 kg Cond Rx Vent Flow

Vented from the Crude Receiver

2.17 kg TFE

3.97 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.0045 kg TFE

1.06 kg Foreshots Receiver Vent

Vented from the Stripper

0 kg TFE

100 kg Stripper Vent

TFE vented based on 2,967 kg total Condensation Reactor vent stream (22266FG).

TFE vented based on 25,490 kg total Crude Receiver vent stream (22701FG).

TFE vented based on 844 kg total Foreshots Receiver vent stream (22826FG).

TFE vented based on 11,390 kg in the Stripper vent stream (22231FC).

TFE vented from Condensation Reactor:

0.00 kg TFE	x	2,967 kg CndRx	=	0 kg TFE
2.35 kg CndRx				

TFE vented from Crude Receiver

2.17 kg TFE	x	25,490 kg CrRec	=	13,928 kg TFE
3.97 kg CrRec				

TFE vented from Foreshots Receiver

0.0045 kg TFE	x	844 kg FsRec	=	4 kg TFE
1.06 kg FsRec				

TFE vented from Stripper

0 kg TFE	x	11,390 kg Strpr	=	0 kg TFE
100 kg Strpr				

VOC Emissions

	+	0 kg from Condensation Reactor	
	+	13,928 kg from Crude Receiver	
	+	4 kg from Foreshots Receiver	
	+	0 kg from Stripper	
=		13,931 kg TFE	= 13,931 kg VOC
			30,713 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:

0 kg PPVE
2.35 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0.50 kg PPVE
3.97 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.88 kg PPVE
1.06 kg Foreshots Receiver Vent

Vented from the Stripper

0 kg PPVE
100 kg Stripper Vent

PPVE vented based on 2,967 kg total Condensation Reactor vent stream (22266FG).

PPVE vented based on 25,490 kg total Crude Receiver vent stream (22701FG).

PPVE vented based on 844 kg total Foreshots Receiver vent stream (22826FG).

PPVE vented based on 11,390 kg in the Stripper vent stream (22231FC).

PPVE vented from Condensation Reactor:

0.00 kg PPVE	x	2,967 kg CndRx	=	0 kg PPVE
2.35 kg CndRx				

PPVE vented from Crude Receiver

0.50 kg PPVE	x	25,490 kg CrRec	=	3,241 kg PPVE
3.97 kg CrRec				

PPVE vented from Foreshots Receiver

0.88 kg PPVE	x	844 kg FsRec	=	699 kg PPVE
1.06 kg FsRec				

PPVE vented from Stripper

0 kg PPVE	x	11,390 kg Strpr	=	0 kg PPVE
100 kg Strpr				

VOC Emissions

	+	0 kg from Condensation Reactor	
	+	3,241 kg from Crude Receiver	
	+	699 kg from Foreshots Receiver	
	+	0 kg from Stripper	
=		3,940 kg PPVE	= 3,940 kg VOC
			8,687 lb VOC

F. Perfluoro-2-butene (C4)**CAS No. 360-89-4**HF Potential:

C4s are VOCs without the potential to form HF

Quantity Released

C4s are perfluorobutenes that are byproducts from the Agitated Bed Reactor system.
They are inert in VE-North that are vented to the WGS.

C4s vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg C4s

2.35 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0.01 kg C4s

3.97 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.15 kg C4s

1.06 kg Foreshots Receiver Vent

Vented from the Stripper

0 kg C4s

100 kg Stripper Vent

C4s vented based on 2,967 kg total Condensation Reactor vent stream (22266FG).

C4s vented based on 25,490 kg total Crude Receiver vent stream (22701FG).

C4s vented based on 844 kg total Foreshots Receiver vent stream (22826FG).

C4s vented based on 11,390 kg in the Stripper vent stream (22231FC).

C4s vented from Condensation Reactor:

0.00 kg C4s	x	2,967 kg CndRx	=	0 kg C4s
2.35 kg CndRx				

C4s vented from Crude Receiver

0.01 kg C4s	x	25,490 kg CrRec	=	58 kg C4s
3.97 kg CrRec				

C4s vented from Foreshots Receiver

0.15 kg C4s	x	844 kg FsRec	=	119 kg C4s
1.06 kg FsRec				

C4s vented from Stripper

0 kg C4s	x	11,390 kg Strpr	=	0 kg C4s
100 kg Strpr				

VOC Emissions

	+	0 kg from Condensation Reactor	
	+	58 kg from Crude Receiver	
	+	119 kg from Foreshots Receiver	
	+	0 kg from Stripper	
=		177 kg C4s	= 177 kg VOC 391 lb VOC

G. Perfluoropentene (C5)

CAS No. 376-87-4

HF Potential:

C5s are VOCs without the potential to form HF

Quantity Released

C5s are perfluoropentenes that are byproducts from the Agitated Bed Reactor system.
They are inert in VE-North that are vented to the WGS.

C5s vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg C5s

2.35 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg C5s

3.97 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.02 kg C5s

1.06 kg Foreshots Receiver Vent

Vented from the Stripper

0 kg C5s

100 kg Stripper Vent

C5s vented based on	2,967	kg total Condensation Reactor vent stream (22266FG).
C5s vented based on	25,490	kg total Crude Receiver vent stream (22701FG).
C5s vented based on	844	kg total Foreshots Receiver vent stream (22826FG).
C5s vented based on	11,390	kg in the Stripper vent stream (22231FC).

C5s vented from Condensation Reactor:

0.00 kg C5s	x	2,967 kg CndRx	=	0 kg C5s
2.35 kg CndRx				

C5s vented from Crude Receiver

0.00 kg C5s	x	25,490 kg CrRec	=	0 kg C5s
3.97 kg CrRec				

C5s vented from Foreshots Receiver

0.02 kg C5s	x	844 kg FsRec	=	14 kg C5s
1.06 kg FsRec				

C4s vented from Stripper

0 kg C5s	x	11,390 kg Strpr	=	0 kg C5s
100 kg Strpr				

VOC Emissions

	+	0 kg from Condensation Reactor	
	+	0 kg from Crude Receiver	
	+	14 kg from Foreshots Receiver	
	+	0 kg from Stripper	
=		14 kg C5s	= 14 kg VOC
			32 lb VOC

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.
This inert in VE-North that are vented to the WGS.

CO vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg CO
2.35 kg Cond Rx Vent Flow

Vented from the Crude Receiver

1.27 kg CO
3.97 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg CO
1.06 kg Foreshots Receiver Vent

Vented from the Stripper

0 kg CO
100 kg Stripper Vent

CO vented based on 2,967 kg total Condensation Reactor vent stream (22266FG).

CO vented based on 25,490 kg total Crude Receiver vent stream (22701FG).

CO vented based on 844 kg total Foreshots Receiver vent stream (22826FG).

CO vented based on 11,390 kg in the Stripper vent stream (22231FC).

CO vented from Condensation Reactor:

0.00 kg CO	x	2,967 kg CndRx	=	0 kg CO
2.35 kg CndRx				

CO vented from Crude Receiver

1.27 kg CO	x	25,490 kg CrRec	=	8,176 kg CO
3.97 kg CrRec				

CO vented from Foreshots Receiver

0.00 kg CO	x	844 kg FsRec	=	0 kg CO
1.06 kg FsRec				

CO vented from Stripper

0 kg CO	x	11,390 kg Strpr	=	0 kg CO
100 kg Strpr				

CO Emissions

	0 kg from Condensation Reactor	
+	8,176 kg from Crude Receiver	
+	0 kg from Foreshots Receiver	
+	0 kg from Stripper	
=	8,176 kg CO	= 18,024 lb CO (not a VOC)

I. Acetonitrile (AN)**CAS No. 75-05-8**HF Potential

AN is a VOC and Hazardous Air Pollutant without the potential to form HF.

Quantity Released

AN emissions based on 12,313 kg AN fed

Hydrocarbon waste sent to Hydrocarbon waste tank = 12,313 kgs H/C waste

PPVE generated during the year 164,705 kg PPVE

Assume that: **5%** of spent acetonitrile are fluorocarbons.

AN portion of hydrocarbon waste stream:

$$\begin{array}{r}
 12,313 \text{ kg to H/C waste} \\
 \times (1-(.1)) \\
 \hline
 = 11,697 \text{ kg AN to H/C waste}
 \end{array}$$

Material Balance

Based on total Vinyl ether produced 164,705 kg PPVE

Assume 90% Crude is needed to generate that amount of PPVE

70% of AF going to ABR is needed to create the Crude

$$\begin{array}{r}
 \text{Feed going to ABR is } \frac{1,500 \text{ ppm AN}}{1,000,000}
 \end{array}$$

$$\begin{array}{r}
 \text{Therefore:} \\
 \begin{array}{r}
 164,705 \text{ kg PPVE} \\
 \backslash 0.90 \text{ Crude} \\
 \backslash 0.70 \text{ AF} \\
 \times 0.0015 \text{ ppm AN} \\
 \hline
 = 392 \text{ kg AN in Feed to ABR}
 \end{array}
 \end{array}$$

VOC Emission

$$\begin{array}{r}
 12,313 \text{ kg AN fed} \\
 11,697 \text{ kg AN to H/C waste} \\
 - 392 \text{ kg AN to ABR} \\
 \hline
 223 \text{ kg AN}
 \end{array}$$

223 kg VOC
493 lb VOC

AN only used during a PPVE Campaign

Total AN **493 lb VOC**

J. VOC Summary

Nafion Compound Name		Before Control Generated		After Control Stack Emissions
		kg/yr	lb/yr	VOC lb/yr
A.	HFP	3,581	7,894	7,894
B.	HFPO	6,978	15,383	15,383
C.	PPF	3,836	8,458	76
D.	TFE	13,931	30,713	30,713
E.	PPVE	3,940	8,687	8,687
F.	C4	177	391	391
G.	C5	14	32	32
I.	AN	223	493	493
	Total	32,682	72,051	63,669

K. Total Emission Summary**

** All Emissions in this table represent "After Control" emissions.

Nafion Compound Name		Process Emissions lb/yr	Equipment Emissions ^(Note 1) lb/yr	Maintenance Emissions ^(Note 2) lb/yr	Total Emissions lb/yr
A.	HFP	7,894	4	0	7,898
B.	HFPO	15,383	265	16	15,663
C.	PPF	76	0	1	77
D.	TFE	30,713	0	0	30,713
E.	PPVE	8,687	434	455	9,576
F.	C4	391	42	61	494
G.	C5	32	0	0	32
H.	CO (not a VOC)		0	0	18,024
I.	AN	493	109	6	493
*	HFPO-Dimer		5	32	38
*	HFPO Trimer		0	1	1
Total		63,669	858	573	83,009

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

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

CO not realistically expected through equipment or maintenance emissions

AN total based on material balance, see section K.

* Not normally emitted from the process as a routine stack emission

L. HF Equivalent Emissions

Nafion Compound Name		Process Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
C.	PPF	9.2	0.0	0.13	9.31
*	HFPO-Dimer		0.3	1.94	2.27
*	HFPO Trimer		0.0	0.03	0.03
	Total	9.2	0	2.10	11.61

* Not normally emitted from the process as a routine stack emission

The estimated HF equivalent emissions were determined by multiplying the total emission quantity of an acid fluoride by the ratio of the molecular weight of HF divided by the molecular weight of the specific acid fluoride. This is based on the fact that one mole of an acid fluoride will generate one mole of HF.

For example, if 100 lb. of PPF was emitted:

$$\frac{20 \text{ lb/mol HF}}{166 \text{ lb/mol PPF}} \times 100 \text{ lb/yr Equipment PPF} = 12.0 \text{ lb/yr HF}$$

AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No: NS-B

Emission Source Description: VE-North PSEPVE Manufacturing Process

Process & Emission Description: The VE-North PSEPVE 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 99.1% 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 PSEPVE 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 PSEPVE 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.

Point Source Emission Determination**A. HFP**

CAS No. 116-15-4

Hexafluoropropylene**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:

<i>0.15 kg HFP</i>
<i>3.66 kg CondRx Vent Flow</i>

Vented from the Crude Receiver

<i>3.12 kg HFP</i>
<i>18.76 kg Crude Receiver Vent</i>

Vented from the Foreshots Receiver

<i>0 kg HFP</i>
<i>0.33 kg Foreshots Receiver Vent</i>

HFP vented based on

HFP vented based on

HFP vented based on

348 kg total Condensation Reactor vent stream (22266FG).

30,029 kg total Crude Receiver vent stream (22701FG).

10 kg total Foreshots Receiver vent stream (22826FG).

HFP vented from Condensation Reactor:

<u>0.15 kg HFP</u>	x	348 kg CndRx	=	14 kg HFP
3.66 kg CndRx				

HFP vented from Crude Receiver

<u>3.12 kg HFP</u>	x	30,029 kg CrRec	=	4,990 kg HFP
18.76 kg CrRec				

HFP vented from Foreshots Receiver

<u>0.00 kg HFP</u>	x	10 kg FsRec	=	0 kg HFP
0.33 kg FsRec				

VOC Emissions

+	14 kg from Condensation Reactor	
+	4,990 kg from Crude Receiver	
+	0 kg from Foreshots Receiver	
=	<u>5,004 kg HFP</u>	= 5,004 kg VOC
		11,009 lb VOC

B. HFPO
Hexafluoropropylene oxide

CAS No. 428-59-1

HF Potential:

HFPO is a VOC without the potential to form HF

Quantity Released

HFPO unreacted in condensation is vented to the WGS.

HFPO vented per the process flowsheet

Vented from the Condensation Reactor:

<i>3.28 kg HFPO</i>
<i>3.66 kg Cond Rx Vent Flow</i>

Vented from the Crude Receiver

<i>0 kg HFPO</i>
<i>18.76 kg Crude Receiver Vent</i>

Vented from the Foreshots Receiver

<i>0 kg HFPO</i>
<i>0.33 kg Foreshots Receiver Vent</i>

HFPO vented based on

348 kg total Condensation Reactor vent stream (22266FG).

HFPO vented based on

30,029 kg total Crude Receiver vent stream (22701FG).

HFPO vented based on

10 kg total Foreshots Receiver vent stream (22826FG).

HFPO vented from Condensation Reactor:

<u>3.28 kg HFPO</u>	x	348 kg CndRx	=	312 kg HFPO
3.66 kg CndRx				

HFPO vented from Crude Receiver

<u>0.00 kg HFPO</u>	x	30,029 kg CrRec	=	0 kg HFPO
18.76 kg CrRec				

HFPO vented from Foreshots Receiver

<u>0.00 kg HFPO</u>	x	10 kg FsRec	=	0 kg HFPO
0.33 kg FsRec				

VOC Emissions

+	312 kg from Condensation Reactor		
+	0 kg from Crude Receiver		
+	0 kg from Foreshots Receiver		
=	<u>312 kg HFPO</u>	=	312 kg VOC
			686 lb VOC

C. PPF
Perfluoropropionyl fluoride

CAS No. 422-61-7

HF Potential:

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

$$1 \text{ kg PPF} \cdot \frac{1 \text{ mole PPF}}{166 \text{ g PPF}} \cdot \frac{20 \text{ g HF}}{1 \text{ mole HF}} \cdot \frac{1 \text{ mole HF}}{1 \text{ mole PPF}} = 0.120 \text{ kg HF}$$

Therefore, each 1 kg of PPF generates

0.120 kg of HF

Quantity Released

Before-control PPF vented per the process flowsheet

Vented from the Condensation Reactor:

0.20 kg PPF
3.66 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg PPF
18.76 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg PPF
0.33 kg Foreshots Receiver Vent

PPF vented based on

348 kg total Condensation Reactor vent stream (22266FG).

PPF vented based on

30,029 kg total Crude Receiver vent stream (22701FG).

PPF vented based on

10 kg total Foreshots Receiver vent stream (22826FG).

Before control PPF vented from Condensation Reactor:

0.20 kg PPF	x	348 kg CndRx	=	19 kg PPF
3.66 kg CndRx				

PPF vented from Crude Receiver

0.00 kg PPF	x	30,029 kg CrRec	=	0 kg PPF
18.76 kg CrRec				

PPF vented from Foreshots Receiver

0.00 kg PPF	x	10 kg FsRec	=	0 kg PPF
0.33 kg FsRec				

Total before-control PPF vented

= 19 kg PPF

After-control emissions utilizing the 99.1% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

Waste Gas Scrubber	x	19 kg PPF		
	x	(100%-99.1%) Control Efficiency		
	=	0.17 kg PAF	=	0.17 kg VOC
			=	0.39 lb. VOC

HF Equivalent Emissions

	x	0 kg PPF		
	x	0.120 kg HF/kg PPF		
	=	0.02 kg HF		0.05 lb. HF

D. TFE
Tetrafluoroethylene

CAS No. 116-14-3

HF Potential:

TFE is a VOC without the potential to form HF

Quantity Released

TFE is a byproduct that can be formed in the ABR system. It is an inert in VE-North that is vented to the WGS.

TFE vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg TFE
3.66 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0.01 kg TFE
18.76 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg TFE
0.33 kg Foreshots Receiver Vent

TFE vented based on

348 kg total Condensation Reactor vent stream (22266FG).

TFE vented based on

30,029 kg total Crude Receiver vent stream (22701FG).

TFE vented based on

10 kg total Foreshots Receiver vent stream (22826FG).

TFE vented from Condensation Reactor:

0.00	x	348 kg CndRx	=	0 kg TFE
3.66 kg TFE				
kg CndRx				

TFE vented from Crude Receiver

0.01	x	30,029 kg CrRec	=	15 kg TFE
18.76 kg TFE				
kg CrRec				

TFE vented from Foreshots Receiver

0.00	x	10 kg FsRec	=	0 kg TFE
0.33 kg TFE				
kg FsRec				

VOC Emissions

	+	0 kg from Condensation Reactor		
	+	15 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
=		15 kg TFE	=	15 kg VOC
				32 lb VOC

E. PSEPVE
Perfluoro-2-(2-Fluorosulfonylethoxy) Propyl Vinyl Ether

CAS No. 1623-5-8

HF Potential:

PSEPVE is a VOC without the potential to form HF

Quantity Released

PSEPVE vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg PSEPVE
3.66 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg PSEPVE
18.76 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.07 kg PSEPVE
0.33 kg Foreshots Receiver Vent

PSEPVE vented based on 348 kg total Condensation Reactor vent stream (22266FG).
PSEPVE vented based on 30,029 kg total Crude Receiver vent stream (22701FG).
PSEPVE vented based on 10 kg total Foreshots Receiver vent stream (22826FG).

PSEPVE vented from Condensation Reactor:

$$\frac{0.00}{3.66 \text{ kg PSEPVE}} \times 348 \text{ kg CndRx} = 0 \text{ kg PSEPVE}$$

PSEPVE vented from Crude Receiver

$$\frac{0.00}{18.76 \text{ kg PSEPVE}} \times 30,029 \text{ kg CrRec} = 0 \text{ kg PSEPVE}$$

PSEPVE vented from Foreshots Receiver

$$\frac{0.07}{0.33 \text{ kg PSEPVE}} \times 10 \text{ kg FsRec} = 2.07 \text{ kg PSEPVE}$$

VOC Emissions

$$\begin{array}{rcl}
 & + & 0 \text{ kg from Condensation Reactor} \\
 & + & 0 \text{ kg from Crude Receiver} \\
 & + & 2.07 \text{ kg from Foreshots Receiver} \\
 = & & 2.07 \text{ kg PSEPVE} = 2.07 \text{ kg VOC} \\
 & & 4.56 \text{ lb VOC}
 \end{array}$$

F. C4
Perfluoro-2-butene

CAS No. 360-89-4

HF Potential:

C4s are VOCs without the potential to form HF

Quantity Released

C4s are perfluorobutenes that are byproducts from the Agitated Bed Reactor system.
They are inerts in VE-North that is vented to the WGS.

C4s vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg C4
3.66 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0.46 kg C4
18.76 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.10 kg C4
0.33 kg Foreshots Receiver Vent

C4s vented based on 348 kg total Condensation Reactor vent stream (22266FG).
C4s vented based on 30,029 kg total Crude Receiver vent stream (22701FG).
C4s vented based on 10 kg total Foreshots Receiver vent stream (22826FG).

C4s vented from Condensation Reactor:

0.00	x	348 kg CndRx	=	0 kg C4s
3.66 kg C4s				
kg CndRx				

C4s vented from Crude Receiver

0.46	x	30,029 kg CrRec	=	735 kg C4s
18.76 kg C4s				
kg CrRec				

C4s vented from Foreshots Receiver

0.10	x	10 kg FsRec	=	3 kg C4s
0.33 kg C4s				
kg FsRec				

VOC Emissions

	+	0 kg from Condensation Reactor		
	+	735 kg from Crude Receiver		
	+	3 kg from Foreshots Receiver		
=		738 kg C4s	=	738 kg VOC
				1,623 lb VOC

G. HFPO Trimer
Perfluoro-2,5-Dimethyl-3,6-Dioxanonanoyl

CAS No. 2641-34-1

HF Potential:

Each mole of HFPO Trimer (MW = 498) can generate 1 mole of HF (MW = 20).

$$1 \text{ kg MA} \cdot \frac{1 \text{ mole Trimer}}{498 \text{ g Trimer}} \cdot \frac{20 \text{ g HF}}{1 \text{ mole HF}} \cdot \frac{1 \text{ mole HF}}{1 \text{ mole Trimer}} = 0.0402 \text{ kg HF}$$

Therefore, each 1 kg of HFPO Trimer generates

0.040 kg of HF

Quantity Released

HFPO Trimer is a byproduct formed in the Condensation Reactor system.

HFPO Trimer vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg HFPO Trimer
3.66 kg Cond Rx Vent Flow

Vented from the Crude Receiver:

0 kg HFPO Trimer
18.76 kg Crude Receiver Vent

Vented from the Foreshots Receiver:

0.01 kg HFPO Trimer
0.33 kg Foreshots Receiver Vent

HFPO Trimer vented based on

348 kg total Condensation Reactor vent stream (22266FG).

HFPO Trimer vented based on

30,029 kg total Crude Receiver vent stream (22701FG).

HFPO Trimer vented based on

10 kg total Foreshots Receiver vent stream (22826FG).

Before control HFPO Trimer vented from Condensation Reactor:

0.00	x	348 kg CndRx	=	0 kg HFPO Trimer
<hr/>				
3.66 kg HFPO Trimer				
kg CndRx				

HFPO Trimer vented from Crude Receiver

0.00	x	30,029 kg CrRec	=	0 kg HFPO Trimer
<hr/>				
18.76 kg HFPO Trimer				
kg CrRec				

HFPO Trimer vented from Foreshots Receiver

0.01	x	10 kg FsRec	=	0.41 kg HFPO Trimer
<hr/>				
0.33 kg HFPO Trimer				
kg FsRec				

Total before-control HFPO Trimer vented

0.41 kg VOC

After-control emissions utilizing the 99.1% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

Waste Gas Scrubber	x	0.41 kg HFPO Trimer		
		(100%-99.1%) Control Efficiency		
	=	0.0037 kg HFPO Trimer	=	0.0037 kg VOC
			=	0.008 lb. VOC

HF Equivalent Emissions

	x	0.0037 kg HFPO Trimer		
		0.040 kg HF/kg HFPO Trimer		
	=	0.00015 kg HF		0.00033 lb. HF

H. Monoadduct (MA)

CAS No. 4089-57-0

Tetrafluoro-2-[Tetrafluoro-2-(Fluorosulfonyl)Ethoxy]-Propanoyl FluorideHF Potential:

Each mole of MA (MW = 346) can generate 1 mole of HF (MW = 20).

$$1 \text{ kg MA} \cdot \frac{1 \text{ mole MA}}{346 \text{ g MA}} \cdot \frac{20 \text{ g HF}}{1 \text{ mole HF}} \cdot \frac{1 \text{ mole HF}}{1 \text{ mole MA}} = 0.058 \text{ kg HF}$$

Therefore, each 1 kg of MA generates

0.058 kg of HF

Quantity Released

Before-control MA vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg MA
3.66 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg MA
18.76 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.0045 kg MA
0.33 kg Foreshots Receiver Vent

MA vented based on

348 kg total Condensation Reactor vent stream (22266FG).

MA vented based on

30,029 kg total Crude Receiver vent stream (22701FG).

MA vented based on

10 kg total Foreshots Receiver vent stream (22826FG).

Before control MA vented from Condensation Reactor:

0.00 kg MA	x	348 kg CndRx	=	0 kg MA
3.66 kg CndRx				

MA vented from Crude Receiver

0.00 kg MA	x	30,029 kg CrRec	=	0 kg MA
18.76 kg CrRec				

MA vented from Foreshots Receiver

0.0045 kg MA	x	10 kg FsRec	=	0.138 kg MA
0.33 kg FsRec				

Total before-control MA vented

= 0.138 kg MA

After-control emissions utilizing the 99.1% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

		0.138 kg MA	
Waste Gas Scrubber	x	(100%-99.1%) Control Efficiency	
	=	0.00124 kg MA	= 0.00124 kg VOC
			= 0.003 lb. VOC

HF Equivalent Emissions

		0.00124 kg MA	
	x	0.058 kg HF/kg MA	
	=	0.00 kg HF	0.00 lb. HF

I. Diadduct (DA)

CAS No. 4089-58-1

Tetrafluoro-2-[Hexafluoro-2-(Tetrafluoro-2-(Fluorosulfonyl)Ethoxy) Propoxy Propionyl FluorideHF Potential:

Each mole of DA (MW = 512) can generate 1 mole of HF (MW = 20).

$$1 \text{ kg DA} \cdot \frac{1 \text{ mole DA}}{512 \text{ g DA}} \cdot \frac{20 \text{ g HF}}{1 \text{ mole HF}} \cdot \frac{1 \text{ mole HF}}{1 \text{ mole DA}} = 0.039 \text{ kg HF}$$

Therefore, each 1 kg of DA generates

0.039 kg of HF

Quantity Released

Before-control DA vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg DA
3.66 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg DA
18.76 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.13 kg DA
0.33 kg Foreshots Receiver Vent

DA vented based on

348 kg total Condensation Reactor vent stream (22266FG).

DA vented based on

30,029 kg total Crude Receiver vent stream (22701FG).

DA vented based on

10 kg total Foreshots Receiver vent stream (22826FG).

Before control DA vented from Condensation Reactor:

0.00 kg DA	x	348 kg CndRx	=	0 kg DA
3.66 kg CndRx				

DA vented from Crude Receiver

0.00 kg DA	x	30,029 kg CrRec	=	0 kg DA
18.76 kg CrRec				

DA vented from Foreshots Receiver

0.13 kg DA	x	10 kg FsRec	=	4.00 kg DA
0.33 kg FsRec				

Total before-control DA vented

= 4.00 kg DA

After-control emissions utilizing the 99.1% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

		4.00 kg DA		
Waste Gas Scrubber	x	(100%-99.1%) Control Efficiency		
	=	0.0360 kg DA	=	0.036 kg VOC
			=	0.079 lb. VOC

HF Equivalent Emissions

		0.0360 kg DA		
	x	0.039 kg HF/kg DA		
	=	0.00141 kg HF	=	0.00 lb. HF

J. Hydro PSEPVE**CAS No. 755-02-9****Tetrafluoro-2-[Trifluoro-2-(1,2,2,2-Tetra-fluoroethoxy)-1-(Trifluoromethyl) Ethoxy]-
Ethane Sulfonyl Fluoride**HF Potential:

Hydro-PSEPVE is a VOC without the potential to form HF

Quantity Released

Hydro-PSEPVE vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg Hydro – PSEPVE
3.66 kg Cond Rx Vent Flow

Vented from the Crude Receiver

0 kg Hydro– PSEPVE
18.76 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0.0045 kg Hydro– PSEPVE
0.33 kg Foreshots Receiver Vent

Hydro-PSEPVE vented based on

348 kg total Condensation Reactor vent stream (22266FG).

Hydro-PSEPVE vented based on

30,029 kg total Crude Receiver vent stream (22701FG).

Hydro-PSEPVE vented based on

10 kg total Foreshots Receiver vent stream (22826FG).

Hydro-PSEPVE vented from Condensation Reactor:

0.00 kg Hydro-PSEPVE	x	348 kg CndRx	=	0 kg Hydro-PSEPVE
3.66 kg CndRx				

Hydro-PSEPVE vented from Crude Receiver

0.00 kg Hydro-PSEPVE	x	30,029 kg CrRec	=	0 kg Hydro-PSEPVE
18.76 kg CrRec				

Hydro-PSEPVE vented from Foreshots Receiver

0.0045 kg Hydro-PSEPVE	x	10 kg FsRec	=	0.138 kg Hydro-PSEPVE
0.33 kg FsRec				

VOC Emissions

+	0 kg from Condensation Reactor	
+	0 kg from Crude Receiver	
+	0.138 kg from Foreshots Receiver	
=	0.138 kg Hydro-PSEPVE	= 0.138 kg VOC
		0.304 lb VOC

K. Iso-PSEPVE**CAS No. 34805-58-8****Perfluoro-1-Methyl-2-(2 Fluorosulfonyl Ethoxy) Ethyl Vinyl Ether**HF Potential:

Iso-PSEPVE is a VOC without the potential to form HF

Quantity Released

Iso-PSEPVE vented per the process flowsheet

Vented from the Condensation Reactor:

<i>0 kg Iso – PSEPVE</i>
<i>3.66 kg Cond Rx Vent Flow</i>

Vented from the Crude Receiver

<i>0 kg Iso – PSEPVE</i>
<i>18.76 kg Crude Receiver Vent</i>

Vented from the Foreshots Receiver

<i>0.014 kg Iso – PSEPVE</i>
<i>0.014 kg Foreshots Receiver Vent</i>

Iso-PSEPVE vented based on 348 kg total Condensation Reactor vent stream (22266FG).

Iso-PSEPVE vented based on 30,029 kg total Crude Receiver vent stream (22701FG).

Iso-PSEPVE vented based on 10 kg total Foreshots Receiver vent stream (22826FG).

Iso-PSEPVE vented from Condensation Reactor:

<u>0.00 kg Iso-PSEPVE</u>	x	348 kg CndRx	=	0 kg Iso-PSEPVE
3.66 kg CndRx				

Iso-PSEPVE vented from Crude Receiver

<u>0.00 kg Iso-PSEPVE</u>	x	30,029 kg CrRec	=	0 kg Iso-PSEPVE
18.76 kg CrRec				

Iso-PSEPVE vented from Foreshots Receiver

<u>0.014 kg Iso-PSEPVE</u>	x	10 kg FsRec	=	0.414 kg Iso-PSEPVE
0.33 kg FsRec				

VOC Emissions

+	0 kg from Condensation Reactor	
+	0 kg from Crude Receiver	
+	0.414 kg from Foreshots Receiver	
=	0.414 kg Iso-PSEPVE	=
		0.414 kg VOC
		0.911 lb VOC

L. Diglyme**CAS No. 111-96-6**

The emissions of diglyme is based on a mass balance

Quantity Released

=	2,098	kg diglyme introduced into processes
=	2,098	kg diglyme transferred to H/C waste tank
=	0	kg diglyme unaccounted for and assumed emitted
=	0	lb. Diglyme

Emissions of diglyme from PSEPVE =

0 lb. Diglyme

M. Sulfonyl Fluoride (SOF2)

CAS No. 7783-42-8

HF Potential:

Each mole of SOF2 (MW = 86) can generate 2 mole of HF (MW = 20).

$$1 \text{ kg SOF2} \cdot \frac{1 \text{ mole SOF2}}{86 \text{ g SOF2}} \cdot \frac{20 \text{ g HF}}{1 \text{ mole HF}} \cdot \frac{2 \text{ mole HF}}{1 \text{ mole SOF2}} = 0.465 \text{ kg HF}$$

Therefore, each 1 kg of SOF2 generates

0.465 kg of HF

Quantity Released

Before-control SOF2 vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg SOF2
3.66 kg Cond Rx Vent Flow

Vented from the Crude Receiver

2.04 kg SOF2
18.76 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg SOF2
0.33 kg Foreshots Receiver Vent

SOF2 vented based on

348 kg total Condensation Reactor vent stream (22266FG).

SOF2 vented based on

30,029 kg total Crude Receiver vent stream (22701FG).

SOF2 vented based on

10 kg total Foreshots Receiver vent stream (22826FG).

Before control SOF2 vented from Condensation Reactor:

0.00 kg SOF2	x	348 kg CndRx	=	0 kg SOF2
3.66 kg CndRx				

SOF2 vented from Crude Receiver

2.04 kg SOF2	x	30,029 kg CrRec	=	3,266 kg SOF2
18.76 kg CrRec				

SOF2 vented from Foreshots Receiver

0.00 kg SOF2	x	10 kg FsRec	=	0 kg SOF2
0.33 kg FsRec				

Total before-control SOF2 vented

= 3,266 kg SOF2

After-control emissions utilizing the 99.1% control efficient Waste Gas Scrubber (WGS):

SOF2 Emissions

		3,266 kg SOF2	
Waste Gas Scrubber	x	(100%-99.1%) Control Efficiency	
	=	29 kg SOF2	65 lb. SOF2

HF Equivalent Emissions

		29 kg SOF2	
	x	0.465 kg HF/kg SOF2	
	=	13.67 kg HF	30.14 lb. HF

SOF2 is not a VOC (no carbon)

N. Carbon Monoxide (CO)

CAS No. 630-08-0

CO is a criteria pollutant

Quantity Released

CO are perfluorobutenes that are byproducts 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:

0 kg CO
3.66 kg Cond Rx Vent Flow

Vented from the Crude Receiver

1.30 kg CO
18.76 kg Crude Receiver Vent

Vented from the Foreshots Receiver

0 kg CO
0.33 kg Foreshots Receiver Vent

CO vented based on

348 kg total Condensation Reactor vent stream (22266FG).

CO vented based on

30,029 kg total Crude Receiver vent stream (22701FG).

CO vented based on

10 kg total Foreshots Receiver vent stream (22826FG).

CO vented from Condensation Reactor:

0.00	x	348 kg CndRx	=	0 kg CO
3.66 kg CO				
kg CndRx				

CO vented from Crude Receiver

1.30	x	30,029 kg CrRec	=	2,088 kg CO
18.76 kg CO				
kg CrRec				

CO vented from Foreshots Receiver

0.00	x	10 kg FsRec	=	0 kg CO
0.33 kg CO				
kg FsRec				

CO Emissions

	0 kg from Condensation Reactor	
+	2,088 kg from Crude Receiver	
+	0 kg from Foreshots Receiver	
=	2,088 kg CO	= 4,603 lb CO (not a VOC)

O. VOC Summary

Nafion Compound Name	Before Control Generated		After Control Stack Emissions	
			VOC	HF
	kg/yr	lb/yr	lb/yr	lb/yr
A. HFP	5,004	11032	11,032	
B. HFPO	312	687	687	
C. PPF	19	43	0.39	0.05
D. TFE	15	32	32	
E. PSEPVE	2	5	5	
F. C4	738	1626	1,626	
G. HFPO Trimer	0.41	1	0.01	0.00
H. MA	0.14	0	0.003	0.00
I. DA	4.00	9	0.08	0.01
J. Hydro PSEPVE	0.14	0.3	0.3	
K. Iso PSEPVE	0.41	1	1	
L. Diglyme	0	0	0	
M. SOF2 (not a VOC)				
N. CO (not a VOC)				
Total	6,095	13,436	13,384	0.1

P. Total Emission Summary**

** All Emissions in this table represent "After Control" emissions.

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions ^(Note 1) lb/yr	Maintenance Emissions ^(Note 2) lb/yr	Total Emissions lb/yr
A.	HFP	11,032	22	25	11,079
B.	HFPO	687	100	6	793
C.	PPF	0.39	0	0	0
D.	TFE	32	0	0	32
E.	PSEPVE	5	195	0	199
F.	C4	1,626	15	18	1,659
G.	HFPO Trimer	0.01	0	0	0
H.	MA	0.00	0	5	5
I.	DA	0.08	2	11	12
J.	Hydro-PSEPVE	0.3	0	0	0
K.	Iso-PSEPVE	0.9	0	0	1
L.	Diglyme		50	3	0
M.	SOF2 (not a VOC)	64.8			65
N.	CO (not a VOC)				4,603
*	TA		0	0	0
*	RSU		0	0	0
*	HFPO-Dimer		0	0	0
Total		13,449	382	69	18,450

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

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

N CO not realistically expected through equipment or maintenance emissions

L. Diglyme total based on material balance, see section L

* Not normally emitted from the process as a routine stack emission

HF Equivalent Emissions

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
C.	PPF	0.05	0.00	0.01	0.05
G.	HFPO Trimer	0.00	0.00	0.01	0.01
H.	MA	0.00	0.02	0.28	0.30
I.	DA	0.00	0.06	0.42	0.48
M.	SOF2	30.14			30.14
*	TA		0.00	0.01	0.01
*	RSU		0.00	0.00	0.00
*	HFPO-Dimer		0.00	0.02	0.02
	Total	30.19	0.08	0.72	30.99

The estimated HF equivalent emissions were determined by multiplying the total emission quantity of an acid fluoride by the ratio of the molecular weight of HF divided by the molecular weight of the specific acid fluoride. This is based on the fact that one mole of an acid fluoride will generate one mole of HF.

For example, if 100 lb. of PPF was emitted:

$$\frac{20 \text{ lb/mol HF}}{166 \text{ lb/mol PPF}} \times 100 \text{ lb/yr Equipment PPF} = 12.0 \text{ lb/yr HF}$$

2014 Equipment Emissions Determination

Equipment Emissions (EE) 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 division scrubber efficiency is 99.6% for control of acid fluorides.

A. Equipment Emissions from Condensation Reactor SystemCondensation Tower (vents to stack)

* Emission Factors found on Fugitive Emission Leak rates worksheet

Valve emissions:	462 valves	X	0.00039	lb/hr/valve	=	0.180	lb/hr VOC from EE
Flange emissions:	924 flanges	X	0.00018	lb/hr/flange	=	0.166	lb/hr VOC from EE
Pump emissions:	0 pumps	X	0.00115	lb/hr/pump	=	0.000	lb/hr VOC from EE
Total fugitive emission rate					=	0.347	lb/hr VOC from EE

Condensation Tower VOC by campaign

Campaign	EVE	PPVE	PSEPVE
Operating Hours	343	2,588	1,247
Total VOC generated per campaign	119	897	432

Component	EVE	After control**	PPVE	After control**	PSEPVE	After control**
	lb	lb		lb		lb
HFP	1	1	4	4	1	1
HFPO	28	28	265	265	100	100
HFPO-Dimer	4	0	490	2	6	0
PPF	1	0	18	0	1	0
Diglyme	0	0	0	0	50	50
AN	0	0	109	109	0	0
ADN	12	12	0	0	0	0
TTG	1	1	0	0	0	0
DA	0	0	0	0	182	1
MA	0	0	0	0	82	0
TA	0	0	0	0	7	0
RSU	0	0	0	0	1	0
MAE	26	0	0	0	0	0
MMF	5	0	0	0	0	0
DAE	39	0	0	0	0	0
TAE	2	0	0	0	0	0
HFPO Trimer	0	0	12	0	4	0
Total	119	42	897	379	432	151

Note: Speciated equipment emissions were estimated by assuming typical volumes of each component in the system, and applying the fraction of each component to the total estimated emissions. The worksheet "vessel compositions" shows the factors used in this calculation.

B. Equipment Emissions from Agitated Bed Reactor System

Valve emissions:	85 valves	X	0.00039 lb/hr/valve	=	0.033 lb/hr VOC from EE
Flange emissions:	170 flanges	X	0.00018 lb/hr/flange	=	0.031 lb/hr VOC from EE
Pump emissions:	0 pumps	X	0.00115 lb/hr/pump	=	0.000 lb/hr VOC from EE
Total fugitive emission rate				=	0.064 lb/hr VOC from EE

ABR/crude VOC by campaign

Campaign	EVE	PPVE	PSEPVE
Operating Hours	342.9981	2,588	1,247
Total VOC per campaign	21.86613	165	80

Component	EVE	PPVE	PSEPVE
	lb	lb	lb
HFP	0	0	6
HFPO-Dimer	0	2	0
EVE	19	0	0
PPVE	0	158	0
DA	0	0	1
DAE	0	0	0
PSEPVE	0	0	69
hydro-EVE	1	0	0
iso-EVE	2	0	0
C4	0	5	4
Total	22	165	80

Worst case, assume all acid fluorides are released in the portion of the feed line outside the ABR room and are not removed by the WGS.

C. Equipment Emissions from Refining System

Valve emissions:	162 valves	X	0.00039	lb/hr/valve	=	0.063	lb/hr VOC from EE
Flange emissions:	324 flanges	X	0.00018	lb/hr/flange	=	0.058	lb/hr VOC from EE
Pump emissions:	0 pumps	X	0.00115	lb/hr/pump	=	0.000	lb/hr VOC from EE
Total fugitive emission rate					=	0.122	lb/hr VOC from EE

Refining System VOC by campaign

Campaign	EVE	PPVE	PSEPVE
Operating Hours	342.9981	2,588	1,247
Total VOC per campaign	41.67426	314	152

Component	EVE	PPVE	PSEPVE
	lb	lb	lb
HFP	0	0	15
HFPO-Dimer	0	2	0
EVE	38	0	0
PPVE	0	275	0
PSEPVE	0	0	125
hydro-EVE	2	0	0
iso-EVE	3	0	0
C4	0	37	11
Total	42	314	152

All Refining equipment is located outside of the tower so releases will be directly to atmosphere.

D. Component Summary - All equipment emissions

Component	EVE	PPVE	PSEPVE	Total	Total AF
	lb	lb	lb		
HFP	1	4	22	26	8
HFPO	28	265	100	393	
HFPO-Dimer	0	5	0	6	Total Non AF 1339
PPF	0	0	0	0	
Diglyme	0	0	50	50	
AN	0	109	0	109	
ADN	12	0	0	12	
TTG	1	0	0	1	
DA	0	0	2	2	
MA	0	0	0	0	
TA	0	0	0	0	
RSU	0	0	0	0	
MAE	0	0	0	0	
MMF	0	0	0	0	
DAE	0	0	0	0	
TAE	0	0	0	0	
HFPO Trimer	0	0	0	0	
EVE	56	0	0	56	
PPVE	0	434	0	434	
PSEPVE	0	0	195	195	
hydro-EVE	3	0	0	3	
iso-EVE	4	0	0	4	
C4	0	42	15	57	
				1347	

2014 Maintenance Emission Determination**A. Background**

Periodically, the process vessels in the VE-North plant are emptied for campaign switches and for maintenance. During the deinventory process, the liquid is transferred to another process vessel and then the gases are evacuated to the division waste gas scrubber. The amount of gasses from the condensation reactor, crude receiver and foreshots receiver are already included in the vent flowmeter readings used to calculate emissions in previous sections. This section estimates maintenance emissions for the rest of the major process vessels.

B. Condensation Tower

Assume the following:

- (a) void fraction in distillation columns is 40%
- (b) ideal gas behavior
- (c) vessels are at atmospheric pressure
- (d) ambient temperature (25 deg C)
- (e) gases are 67% acid fluorides and 33% non-acid fluorides
- (f) average molecular weight (MW) for acid fluoride component based on the average computed from composite composition as shown on "Vessel Compositions" worksheet.
Therefore the average molecular weight for condensation is 351
- (g) average MW for non-acid fluoride component = 166 (average of HFPO & HFP)
- (h) number of deinventory events = 7

List of Process Vessels

Condensation Tower	Volume (ft ³)	Volume (gallons)
Reactor Decanter	5	41
Stripper Feed Decanter	7	51
Stripper Overhead Receiver	5	40
A/F Column	27	203
A/F Overhead Receiver	14	106
A/F Tails Decanter	1	10
ABR Feed Tank	27	202
Total Volume	87	654

VOC Emissions

$$n = PV/RT, \quad \text{where} \quad \begin{array}{ll} P = 14.7 \text{ psia} & R = 10.73 \text{ psia-ft}^3/\text{lb-mol degR} \\ V = 87 \text{ ft}^3 & T = 537 \text{ degrees R} \end{array}$$

$$n = \frac{PV}{RT} = \frac{14.7 \text{ psia} \times 87 \text{ ft}^3}{10.73 \frac{\text{psia-ft}^3}{\text{lb-mol degR}} \times 537 \text{ deg R}} = 0.22 \frac{\text{lb-mol gas}}{\text{deinventory event}}$$

$$0.22 \frac{\text{lb-mol gas}}{\text{deinventory event}} \times 7 \frac{\text{deinventory events}}{\text{year}} = 1.56 \frac{\text{lb-mol gas}}{\text{year}}$$

$$1.56 \frac{\text{lb-mol gas}}{\text{year}} \times 33\% \text{ non-acid fluorides} \times 166 \frac{\text{lb non-A/F}}{\text{lb-mol gas}} = 84.4 \frac{\text{lb non-A/F}}{\text{year}}$$

Before-control A/F vented from Condensation:

$$1.56 \frac{\text{lb-mol gas}}{\text{year}} \times 67\% \text{ acid fluorides} \times 351 \frac{\text{lb A/F}}{\text{lb-mol gas}} = 369 \frac{\text{lb A/F}}{\text{year}}$$

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

$$\begin{array}{ll} \times \frac{369 \text{ lb/yr A/F VOC}}{(100\%-99.6\%) \text{ control efficiency}} & \text{Total VOC: } \frac{84.4 \text{ lb/yr non-A/F VOC}}{1.5 \text{ lb/yr A/F VOC}} \\ & + \frac{84.4 \text{ lb/yr non-A/F VOC}}{1.5 \text{ lb/yr A/F VOC}} \\ & \underline{\hspace{1cm}} \\ & 85.9 \text{ lb/yr VOC} \end{array}$$

C. Refining

Assume the following:

- (a) void fraction in distillation columns is 40%
- (b) ideal gas behavior
- (c) vessels are at atmospheric pressure
- (d) ambient temperature (25 deg C)
- (e) gases are 100% vinyl ethers which are 100% VOC
- (f) average molecular weight (MW) for vinyl ether component based on the average computed from composite composition as shown on "Vessel Compositions" worksheet.
Therefore the average molecular weight for refining is 288
- (g) number of deinventory events = 7

HF Potential

Vinyl ethers are VOCs without the potential to form HF

List of Process Vessels

Refining	Volume (ft ³)	Volume (gallons)
Ether Still	107	803
Ether Still Overhead Receiver	9	69
Product Receiver	46	348
Total Volume	163	1220

VOC Emissions

$$n = PV/RT, \quad \text{where} \quad \begin{array}{ll} P = 14.7 \text{ psia} & R = 10.73 \text{ psia-ft}^3/\text{lb-mol degR} \\ V = 163 \text{ ft}^3 & T = 537 \text{ degrees R} \end{array}$$

$$n = \frac{PV}{RT} = \frac{14.7 \text{ psia} \times 163 \text{ ft}^3}{10.73 \frac{\text{psia-ft}^3}{\text{lb-mol degR}} \times 537 \text{ deg R}} = 0.42 \frac{\text{lb-mol gas}}{\text{deinventory event}}$$

$$0.42 \frac{\text{lb-mol gas}}{\text{deinventory event}} \times 7 \frac{\text{deinventory events}}{\text{year}} = 2.91 \frac{\text{lb-mol gas}}{\text{year}}$$

$$2.91 \frac{\text{lb-mol gas}}{\text{year}} \times 288 \frac{\text{lb VOC}}{\text{lb-mol gas}} = 838.7 \frac{\text{lb VOC}}{\text{year}}$$

D. Component Summary - All maintenance emissions

Component	EVE	PPVE	PSEPVE
	lb	lb	lb
HFP	0	0	25
HFPO	2	16	6
HFPO-Dimer	0	32	0
PPF	0	1	0
Diglyme	0	0	3
AN	0	6	0
ADN	1	0	0
TTG	0	0	0
DA	0	0	11
MA	0	0	5
TA	0	0	0
RSU	0	0	0
MAE	2	0	0
MMF	0	0	0
DAE	2	0	0
TAE	0	0	0
HFPO Trimer	0	1	0
EVE *	0	0	0
PPVE	0	455	0
PSEPVE **	0	0	0
hydro-EVE	3	0	0
iso-EVE	4	0	0
C4	0	61	18

Composite compositions for each area, Condensation, ABR, and Refining, were determined on the Vessel Composition worksheet, taking into account run hours on each campaign and approximate compositions. The mass fraction for each component was then multiplied by the VOC from these areas.

Campaign	EVE	PPVE	PSEPVE
Campaign Fract'n	0.08	0.62	0.30
Cond VOC	7	53	26
Refining VOC	69	519	250

Pre-control VOC	106	800	386
-----------------	-----	-----	-----

Total before control VOC (lb.)	1292
Total after control VOC	923

* this is very conservative, since EVE will be liquid at ambient temp

** this is very conservative, since PSEPVE will be liquid at ambient temp

2014 Emission Summary

Report date

1/21/2015

Prepared by

Broderick Locklear

A. VOC Emissions Summary

Nafion® Compound	CAS Chemical Name	CAS No.	PE/PM Emissions (lb.)	PPVE Emissions (lb.)	Accidental Releases (lb.)	Total Emissions (lb.)
COF2	Carbonyl Fluoride	353-50-4	319	0	0	319
PAF	Perfluoroacetyl Fluoride	354-34-7	379	0	0	379
PMPF	Perfluoromethoxypropionyl fluoride	2927-83-5	790	0	0	790
PEPF	Perfluoroethoxypropionyl fluoride	1682-78-6	309	0	0	309
PMVE	Perfluoromethyl vinyl ether	1187-93-5	13,819	0	0	13,819
PEVE	Perfluoroethyl vinyl ether	10493-43-3	941	0	0	941
HFP	Hexafluoropropylene	116-15-4	2,378	364	0	2,742
HFPO	Hexafluoropropylene Epoxide	428-59-1	2,648	712	0	3,360
AN	Acetonitrile	75-05-8	1,246	120	0	1,366
HFPO Dimer	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	5	0	0	5
MD			44	0	0	44
HydroPEVE			9	0	0	9
PPVE	Perfluoropropyl vinyl ether	1623-05-8	9	605	0	614
PPF	Perfluoropropionyl fluoride	422-61-7	0	6	0	6
TFE	Tetrafluoroethylene	116-14-3	0	966	0	966
C4	Perfluoro-2-butene	360-89-4	0	69	0	69
C5	Perfluoropentene	376-87-4	0	8	0	8
Total VOC Emissions (lb.)						25,746
Total VOC Emissions (tons)						12.9

B. Criteria Pollutant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Process Emissions (lb.)	Accidental Releases (lb.)	Total Emissions (lb.)
CO	Carbon Monoxide	630-08-0	265	0	265
Total CO Emissions (lb.)					265
Total CO Emissions (tons)					0.1

C. Toxic Air Pollutant and Hazardous Air Pollutant Summary (TAPS/HAPS)

Nafion® Compound	CAS Chemical Name	CAS No.	Process Emissions (lb.)	Accidental Releases (lb.)	Total Emissions (lb.)
HF	Hydrogen Fluoride	7664-39-3	351	0	351
Acetonitrile	Acetonitrile	75-05-8	1,366	0	1,366

2014 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION**Emission Source ID No:** NS-C**Emission Source Description:** VE-South PEPM Manufacturing Process

Process & Emission Description: The VE-South PEPM manufacturing process is a continuous chemical reaction. All emissions from the process are vented through the VE-South Waste Gas Scrubber (Control Device ID No. NCD-Hdr2) 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 PEPM process in VE-South 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:

- A process flowsheet, developed from operating data during a typical month, May 2005, is the basis for relative concentrations of before-control emissions of gaseous wastes.
- The flowsheet is available under the "flowsheet" tab for reference and includes the basis for ratios used in this calculation.
- Because an overall material balance for the year is used for calculation of emissions, "maintenance emissions" related to turnarounds are assumed to be included with the calculated emissions. The usual practice is to deinventory liquids and then vent vessels to the Waste Gas Scrubber.
- All emission determination calculations are available on the EXCEL spreadsheet found at:
P:/Emissions/VE-S Emissions

Point Source Emissions Determination

A. Carbonyl Fluoride (COF₂)

CAS No. 353-50-4

HF Potential:

Each mole of COF_2 (MW = 66) can generate 2 moles of HF (MW = 20).

$$1 \text{ kg COF}_2 \cdot \frac{1 \text{ mole COF}_2}{66 \text{ g COF}_2} \cdot \frac{20 \text{ g HF}}{1 \text{ mole HF}} \cdot \frac{2 \text{ moles HF}}{1 \text{ mole COF}_2} = 0.606 \text{ kg HF}$$

Therefore, each kg of COF_2 generates 0.606 kg HF

Quantity Generated

COF₂ is vented from the PAF column and condensation process. Because amount vented depends on the product split, the composition exit the PAF column is calculated using the following relationship from the flowsheet, which relates COF₂ in feed to condensation to the overall amount of PMVE produced:

kg COF ₂ in Condensation feed	=	3.827 kg COF ₂ / PMVE Unit
PMVE Unit produced	X	<u>25,475 PMVE Units produced</u>
		97,493 kg COF ₂ fed to condensation

COF₂ vented from PAF column is determined from a material balance on the column:
COF₂ vented from PAF column = COF₂ fed to PAF column - COF₂ fed to condensation

COF ₂ fed to PAF column	=	45 kg/h average precursor feed, (1066FC)
	X	4787 hours of operation (from uptime data)
	X	<u>55%</u> typical COF ₂ in precursor feed to PAF column
		118,478 kg COF ₂ fed to PAF column

$$\text{COF}_2 \text{ vented from PAF column} = 118,478 - 97,493 = 20,985 \text{ kg}$$

COF₂ vented from condensation (primarily the reactor vent) will also vary with product split, and is therefore estimated using a relationship from the flowsheet:

$\frac{\text{kg COF}_2 \text{ vented}}{\text{PMVE Unit produced}}$	=	0.408 kg COF₂ / PMVE Unit
	X	<u>25,475 PMVE Units produced</u>
COF ₂ vented from condensation =		10,392

Total COF ₂ vented from process vents to WGS =	20,985	+	10,392	=	31,377 kg
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After-control emissions utilizing the 99.6% control efficient Waste Gas Scrubber (WGS)

VOC emissions:

$$31,377 \text{ kg COF}_2 \text{ emitted to WGS}$$

$$\times \frac{(100\% - 99.6\%)}{126 \text{ kg VOC}} = 126 \text{ kg VOC}$$

$$= 276 \text{ lb VOC}$$

HF Equivalent Emissions

$$\begin{array}{rcl} & 126 \text{ kg COF}_2 & \\ \times & 0.606 \text{ kg HF/kg COF}_2 & \\ = & \hline & 76 \text{ kg HF} & = 167 \text{ lb HF} \end{array}$$

B. Perfluoroacetyl Fluoride (PAF)**CAS No. 354-34-7**HF Potential:

Each mole of PAF (MW = 116) can generate 1 mole of HF (MW = 20).

$$1 \text{ kg PAF} \cdot \frac{1 \text{ mole PAF}}{116 \text{ g PAF}} \cdot \frac{20 \text{ g HF}}{1 \text{ mole HF}} \cdot \frac{1 \text{ mole HF}}{1 \text{ mole PAF}} = 0.172 \text{ kg HF}$$

Therefore, each kg of PAF generates

0.172 kg HF

Quantity Generated

PAF is vented from the PAF column and condensation process. Because amount vented depends on the product split, the composition exit the PAF column is calculated using the following relationship from the flowsheet, which relates PAF in feed to condensation to the overall amount of PEVE produced:

$$\begin{aligned} \frac{\text{kg PAF in Condensation feed}}{\text{PEVE Unit produced}} &= 4.935 \text{ kg PAF / PEVE Unit} \\ &\times 12,192 \text{ PEVE Units produced} \\ &= 60,164 \text{ kg PAF fed to condensation} \end{aligned}$$

PAF vented from PAF column is determined from a material balance on the column:
PAF vented from PAF column = PAF fed to PAF column - PAF fed to condensation

$$\begin{aligned} \text{PAF fed to PAF column} &= 45 \text{ kg/h average precursor feed, (1066FC)} \\ &\times 4787 \text{ hours of operation (from uptime data)} \\ &\times 44\% \text{ typical PAF in precursor feed to PAF column} \\ &= 94,783 \text{ kg PAF fed to PAF column} \end{aligned}$$

$$\text{PAF vented from PAF column} = 94,783 - 60,164 = 34,619$$

PAF vented from condensation (primarily the reactor vent) will also vary with product split, and is therefore estimated using a relationship from the flowsheet:

$$\begin{aligned} \frac{\text{kg PAF vented}}{\text{PEVE Unit produced}} &= 0.303 \text{ kg PAF / PEVE Unit} \\ &\times 12,192 \text{ PEVE Units produced} \\ \text{PAF vented from condensation} &= 3,699 \end{aligned}$$

$$\text{Total PAF vented from process vents to WGS} = 34,619 + 3,699 = 38,318 \text{ kg}$$

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

$$\begin{aligned} \text{VOC emissions} &= 38,318 \text{ kg PAF} \\ &\times (100\% - 99.6\%) \\ &= 153 \text{ kg PAF} \\ &= 153 \text{ kg VOC} \\ &= 337 \text{ lb VOC} \end{aligned}$$

HF Equivalent Emissions

$$\begin{aligned} &\times 153 \text{ kg PAF} \\ &= \frac{0.172 \text{ kg HF/kg PAF}}{26 \text{ kg HF}} = 58 \text{ lb HF} \end{aligned}$$

C. Perfluoromethoxypropionyl fluoride (PMPF)

CAS No. 2927-83-5

HF Potential:

Each mole of PMPF (MW = 232) can generate 1 mole of HF (MW = 20).

$$1\text{ kg PMPF} \cdot \frac{1\text{ mole PMPF}}{232\text{ g PMPF}} \cdot \frac{20\text{ g HF}}{1\text{ mole HF}} \cdot \frac{1\text{ mole HF}}{1\text{ mole PMPF}} = 0.086\text{ kg HF}$$

Therefore, each kg of PMPF generates

0.086 kg HF

Quantity Generated

PMPF is emitted from the Agitated Bed Reactor system. Because amount vented depends on the product split, the composition of the waste gas is estimated using the following relationship from the flowsheet, which relates PMPF in the vent stream to the overall amount of PMVE produced:

$\frac{\text{kg PMPF vented}}{\text{PMVE Unit produced}}$	=	1.42 kg PMPF / PMVE Unit
	X	<u>25,475 PMVE Units produced</u>
PMPF vented from ABR system =		36,238 kg

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

VOC emissions		36,238 kg PMPF		
	x	(100% - 99.6%)		
	=	145 kg PMPF	=	145 kg VOC
				319 lb VOC

HF Equivalent Emissions	x	145 kg PMPF	
		0.086 kg HF/kg PMPF	
	=	12 kg HF	= 27 lb HF

D. Perfluoroethoxypropionyl fluoride (PEPF)**CAS No. 1682-78-6**HF Potential:

Each mole of PEPF (MW = 282) can generate 1 mole of HF (MW = 20).

$$1 \text{ kg PEPF} \cdot \frac{1 \text{ mole PEPF}}{282 \text{ g PEPF}} \cdot \frac{20 \text{ g HF}}{1 \text{ mole HF}} \cdot \frac{1 \text{ mole HF}}{1 \text{ mole PEPF}} = 0.071 \text{ kg HF}$$

Therefore, each kg of PEPF generates

0.071 kg HF

Quantity Generated

PEPF is emitted from the Agitated Bed Reactor system. Because amount vented depends on the product split, the composition of the waste gas is estimated using the following relationship from the flowsheet, which relates PEPF in the vent stream to the overall amount of PEVE produced:

$$\frac{\text{kg PEPF vented}}{\text{PEVE Unit produced}} = \frac{1.04 \text{ kg PEPF / PEVE Unit}}{1} \times 12,192 \text{ PEVE Units produced} = 12,724 \text{ kg}$$

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

$$\text{VOC emissions: } 12,724 \text{ kg PEPF} \times \frac{(100\% - 99.6\%)}{51 \text{ kg PEPF}} = 51 \text{ kg VOC} \quad 112 \text{ lb VOC}$$

$$\text{HF Equivalent Emissions: } 51 \text{ kg PEPF} \times \frac{0.071 \text{ kg HF/kg PEPF}}{4 \text{ kg HF}} = 8 \text{ lb HF}$$

E. Perfluoromethyl vinyl ether (PMVE)**CAS No. 1187-93-5**HF Potential:

PMVE is a VOC without the potential to form HF.

Quantity Released

PMVE is a component in the vent from the Low Boiler Column. Composition of this vent stream is based on the flow sheet.

$$\text{The low boiler column vented at a rate of } 2,450 \text{ kg/h vent rate, (1830FG)} \times 4,787 \text{ hours of operation (from uptime data)} = 11,728 \text{ kg vented from low boiler column}$$

$$\text{PMVE in the low boiler column vent stream} = 49\% \times 11,728 = 5,782 \text{ kg}$$

$$\text{After-control emissions from the Waste Gas Scrubber with an assumed efficiency of zero percent (0\%)} \\ \text{VOC Emissions} = 5,782 \text{ kg VOC} \quad 12,720 \text{ lb VOC}$$

F. Perfluoroethyl vinyl ether (PEVE)**CAS No. 10493-43-3**HF Potential:

PEVE is a VOC without the potential to form HF.

Quantity Released

There are no point source emissions identified which contain PEVE.

VOC Emissions	=	0 kg VOC
		0 lb VOC

G. Hexafluoropropylene (HFP)**CAS No. 116-15-4**HF Potential:

HFP is a VOC without the potential to form HF.

Quantity Released

HFP is an inert in the process that is vented from the PAF column and from the low boiler column.

HFP in the LBC vent stream is based on the flow sheet and estimated total vented.

The low boiler column vented at a rate of	2.450 kg/h vent rate, (1830FG)
X	4,787 hours of operation (from uptime data)
	11,728 kg vented from low boiler column

HFP in the low boiler column vent stream =	9%	X	11,728	=	1,020 kg
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The HFP vented from the PAF column is estimated from a material balance on the PAF column.

HFP vented from PAF column = HFP fed to PAF column - HFP left in system (later removed in LBC)

HFP fed to PAF column	=	45 kg/h average precursor feed, (1066FC)
	X	4787 hours of operation (from uptime data)
	X	0.5% typical HFP in precursor feed to PAF column
		1,077 kg HFP fed to PAF column
HFP vented from PAF column =	1,077	- 1,020 = 57 kg

After-control emissions from the Waste Gas Scrubber with an assumed efficiency of zero percent (0%)

VOC Emissions

	1,020 kg HFP from PAF Vent	
+	57 kg HFP from LBC Vent	
	1,077 kg HFP	=
		1,077 kg VOC
		2,370 lb VOC

H. Hexafluoropropylene oxide (HFPO)**CAS No. 428-59-1**HF Potential:

HFPO is a VOC without the potential to form HF.

Quantity Released

HFPO is an inert in the process that is vented from the PAF column. It is assumed that all HFPO fed to the PAF column is vented.

$$\begin{aligned}
 &\text{HFPO fed to PAF column} = 45 \text{ kg/h average precursor feed, (1066FC)} \\
 &\quad \times 4787 \text{ hours of operation (from uptime data)} \\
 &\quad \times 0.5\% \text{ typical HFPO in precursor feed to PAF column} \\
 &= 1,077 \text{ kg HFPO fed to PAF column} \\
 &= 1,077 \text{ kg HFPO vented from PAF column}
 \end{aligned}$$

After-control emissions from the Waste Gas Scrubber with an assumed efficiency of zero percent (0%)

VOC Emissions

$$\begin{aligned}
 1,077 \text{ kg HFPO} &= 1,077 \text{ kg VOC} \\
 &= 2,370 \text{ lb VOC}
 \end{aligned}$$

I. VOC Summary - Point Source Emissions

Nafion Compound Name		Before Control		After Control	
		VOC Generated		Stack Emissions	
		kg/yr VOC	lb/yr VOC	lb/yr VOC	lb/yr HF
A.	COF2	31,377	69,029	276	167
B.	PAF	38,318	84,299	337	58
C.	PMPF	36,238	79,725	319	27
D.	PEPF	12,724	27,993	112	8
E.	PMVE	5,782	12,720	12,720	0
F.	PEVE	0	0	0	0
G.	HFP	1,077	2,370	2,370	0
H.	HFPO	1,077	2,370	2,370	0
Total		126,593	278,504	18,504	261

J. VOC Summary - All sources

Nafion Compound		After Control		Equipment Emissions ^(Note 1)		Total Emissions	
		Stack Emissions		lb/yr VOC	lb/yr HF	lb/yr VOC	lb/yr HF
		lb/yr VOC	lb/yr HF				
A.	COF2	276	167	43	26	319	193
B.	PAF	337	58	42	7	379	65
C.	PMPF	319	27	471	40	790	67
D.	PEPF	112	8	197	13	309	21
E.	PMVE	12,720	0	1099	0	13819	0
F.	PEVE	0	0	941	0	941	0
G.	HFP	2,370	0	8	0	2378	0
H.	HFPO	2,370	0	278	0	2648	0
	HFPO Dimer			5	0	5	0
	MD			44	2	44	2
	HydroPEVE			9	0	9	0
	PPVE			9	0	9	0
	AN			1246	0	1246	0
Total		18,504	261	4,392	89	22,895	350

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

2014 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION**Emission Source ID No:** NS-C**Emission Source Description:** VE-South PPVE Manufacturing Process

Process & Emission Description: The VE-South PPVE manufacturing process is a continuous chemical reaction. All emissions from the process are vented through the VES Waste Gas Scrubber (Control Device ID No. NCD-Hdr2) 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-South 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 VE South's PPVE process emissions are based on the calculated emissions from the VE North's PPVE Process, since both processes produce the identical product with the identical process steps. Hence the VE South's PPVE emissions are determined using the calculated emission factor for each speciated compound per kilogram of PPVE produced.

Process Emission Determination**

** All Emissions in this table represent "After Control" emissions.

Nafion Compound Name	VE North PPVE Emission Factor lb / PPVE Unit	VE South PPVE Production PPVE Units / yr	Process Emissions lb / yr
HFP	0.1304	2,794	364
HFPO	0.2548	2,794	712
PPF	0.0021	2,794	6
TFE	0.3458	2,794	966
PPVE	0.2167	2,794	605
C4	0.0246	2,794	69
C5	0.0028	2,794	8
AN	0.0430	2,794	120
CO (not a VOC)	0.0947	2,794	265
HFPO-Dimer	0	2,794	0
HFPO Trimer	0	2,794	0

CO not realistically expected through equipment or maintenance emissions

AN total based on material balance, see section K.

* Not normally emitted from the process as a routine stack emission

HF Equivalent Emissions

Nafion Compound Name	Total Emissions lb/yr	Molecular Weight lb/mole	HF Wt. Fraction lb HF / lb	HF Equiv. Emissions lb/yr
PPF	6.0	166.02	0.121	0.7
HFPO-Dimer	0.0	332.04	0.060	0.0
HFPO Trimer	0.0	498.07	0.040	0.0
			Total	0.7

* Not normally emitted from the process as a routine stack emission

The estimated HF equivalent emissions were determined by multiplying the total emission quantity of an acid fluoride by the ratio of the molecular weight of HF divided by the molecular weight of the specific acid fluoride. This is based on the fact that one mole of an acid fluoride will generate one mole of HF.

For example:

$$\frac{6.0 \text{ lb. PPF}}{\text{year}} \times \frac{20.006 \text{ lb. HF per mole HF}}{166.02 \text{ lb. PPF per mole PPF}} = \frac{0.7 \text{ lb. HF}}{\text{year}}$$

2014 Fugitive Emissions Determination

Fugitive Emissions (FE) are a function of the number of emission points in the plant (valves, flanges, pump seals). For the fugitive emission calculations the inventory shown below is conservative and based on plant and process diagrams.

Note that the division scrubber efficiency is 99.6% for control of acid fluorides.

A. Fugitive Emissions from Condensation Reactor SystemCondensation Tower (vents to stack)

Valve emissions:	322 valves x	0.00039 lb/hr/valve	=	0.126 lb/hr VOC from FE
Flange emissions:	644 flanges x	0.00018 lb/hr/flange	=	0.116 lb/hr VOC from FE
Pump emissions:	6 pump x	0.00115 lb/hr/pump	=	0.007 lb/hr VOC from FE
Total fugitive emission rate			=	0.248 lb/hr VOC from FE

Condensation Tower VOC

Total Condensation Fugitive Emissions:	
VOC	0.248 lb/hr FE
x	4787 Operating hr/yr
=	1189 lb FE

Composition of Condensation Tower Fugitive Emissions is estimated based on typical process inventory:

PAF column:

Inventoried with	30 gal fluorocarbon
Equivalent mass FC	375.75 lb fluorocarbon

Component	Mass fraction	lb
COF2	0.45	169
PAF	0.54	203
HFP	0.005	2
HFPO	0.005	2

Reactor loop

Inventoried with	51 gal hydrocarbon	assumes 60 gallons, 85% hydrocarbon, 15% fluorocarbon
Equivalent mass HC	383.265 lb hydrocarbon	
Inventoried with	9 gal fluorocarbon	
Equivalent mass FC	112.725 lb fluorocarbon	

Component	Mass fraction	lb	
COF2	0.09	10	
PAF	0.04	5	
HFP	0.03	3	
PMPF	0.59	67	
PEPF	0.23	26	
Dimer	0.01	1	
MD	0.01	1	
AN		383	Hydrocarbon

Reactor decanter

Inventoried with	25 gal hydrocarbon	assumes 50 gal, 50% HC, 50% FC
Equivalent mass HC	187.875 lb hydrocarbon	
Inventoried with	25 gal fluorocarbon	
Equivalent mass FC	313.125 lb fluorocarbon	

Component	Mass fraction	lb	
COF2	0.09	28	
PAF	0.04	13	
HFP	0.03	9	
PMPF	0.59	185	
PEPF	0.23	72	
Dimer	0.01	3	
MD	0.01	3	
AN		188	Hydrocarbon

Stripper columnInventoried with
Equivalent mass FC30 gal fluorocarbon
375.75 lb fluorocarbon

Component	Mass fraction	lb
COF2	0.09	34
PAF	0.04	15
HFP	0.03	11
PMPF	0.59	222
PEPF	0.23	86
Dimer	0.01	4
MD	0.01	4

AF columnInventoried with
Equivalent mass FCall FC (70% PMPF, 27% PEPF, 1.5% dimer, 1.5% MD)
30 gal fluorocarbon
375.75 lb fluorocarbon

Component	Mass fraction	lb
PMPF	0.7	263
PEPF	0.27	101
Dimer	0.015	6
MD	0.015	6

AF overhead

Inventoried with

1000 kg FC
2200 lb FC

Component	Mass fraction	lb
PMPF	0.72	1,584
PEPF	0.28	616

AF decanterInventoried with
Equivalent mass FC30 gal fluorocarbon
375.75 lb fluorocarbon

Component	Mass fraction	lb
PMPF	0.72	271
PEPF	0.28	105

HFPO tank135 gal HFPO
1555.605 lb HFPO 1.38 SGWaste FC tankInventoried with
Equivalent mass FC40 gal fluorocarbon
501 30% refining waste (?), 70% is condensation waste (4% dimer, 67% MD, 29% ED)

Component	Mass fraction	lb
Dimer	0.028	14.028 assumes 70% is condensation waste (4% dimer, 67% MD, 29% ED)
MD	0.469	234.969
ED	0.203	101.703
PEPF	0.099	49.599 assumes 30% is waste from refining purges, high boilers PEPF, hydro PEVE, ar
Hydro PEVE	0.099	49.599
PPVE	0.099	49.599

Average system composition - Condensation

	lb	%	VOC emissions (lb)	Equivalent HF (lb)
COF2	241	3.63%	43	26
PAF	235	3.53%	42	7
HFP	26	0.39%	5	0
HFPO	1,557	23.41%	278	0
PMPF	2,591	38.94%	463	40
PEPF	1,057	15.88%	189	13
Dimer	28	0.42%	5	0.3
MD	249	3.74%	44	2
AN	571	8.58%	102	0
HydroPEVE	50	0.75%	9	0
PPVE	50	0.75%	9	0
total	6,653		1189	89

B. Fugitive Emissions from Agitated Bed Reactor System & Refining

Valve emissions:	555 valves x	0.00039 lb/hr/valve	=	0.216 lb/hr FE
Flange emissions:	1110 flanges x	0.00018 lb/hr/flange	=	0.200 lb/hr FE
Pump emissions:	12 pump x	0.00115 lb/hr/pump	=	0.014 lb/hr FE
Total fugitive emission rate			=	0.430 lb/hr FE

ABR & Refining VOC

Total ABR & Refining Fugitive Emissions:	0.43 lb/hr FE
x	4,787 Operating hr/yr
=	2,059 lb FE

ABR/Crude system

Inventoried with 1500 kg FC
3300 lb FC

Component	Mass fraction	lb	
CO2	0.33	1,089	Not a VOC
PMPF	0.01	33	
PEPF	0.01	33	
HFP	0.005	17	
PEVE	0.22	726	
PMVE	0.425	1,403	

Refining

Inventoried with 3000 kg FC
6600 lb FC

Component	Mass fraction	lb
PMVE	0.5	3300
PEVE	0.5	3300

Average System Composition - ABR/Refining

	lb	%	VOC emissions (lb)	Equivalent HF (lb)
PMPF	33	0.37%	8	1
PEPF	33	0.37%	8	1
HFP	17	0.19%	4	0
PEVE	4,026	45.69%	941	0
PMVE	4,703	53.37%	1099	0
total	8,811		2,059	1

C. Acetonitrile fugitive emissions

No normal process vents of AN to stack. Equipment emissions are estimated above for normal process composition and leaks. A material balance is also done to ensure all AN losses are accounted for. When material balance shows negative loss, only the estimated equipment emissions are included.

VOC Emission

AN to hydrocarbon waste from VE-S = 10,400

Assume that: 5% of spent acetonitrile are fluorocarbons.

AN portion of hydrocarbon waste stream:

$$\begin{array}{rcl}
 & 10,400 \text{ kg to H/C waste} & \\
 \times & (1 - (.05)) & \\
 \hline
 = & 9,880 \text{ kg AN to H/C waste} & \\
 \\
 & 10,400 \text{ kg AN fed} & \\
 - & 9,880 \text{ kg AN to waste} & \\
 \hline
 & 520 \text{ kg AN lost} & = \quad 520 \text{ kg VOC} \\
 & & \quad 1,144 \text{ lb VOC additional AN loss}
 \end{array}$$

Note: Based on this material balance, it is assumed that no AN is emitted to atmosphere from fugitive emissions, other than what is determined above.

The amount of hydrocarbon sent to waste is probably overestimated due to inaccuracies in calculation of VE-N portion of the waste.

D. Total Fugitive Emissions

Emission Source	Total Emissions lb VOC
Condensation Tower	1,087
Agitated Bed Reactor & Refining	2,059
AN	1,246
Total	4,392

E. Speciated Equipment Emissions Summary

Nafion® Compound	Equipment Emissions	
	lb VOC	lb HF
COF2	43	26
PAF	42	7
HFP	8	0
HFPO	278	0
PMPF	471	40
PEPF	197	13
HFPO Dimer	5	0.3
MD	44	2
HydroPEVE	9	0
PPVE	9	0
PEVE	941	0
PMVE	1,099	0
AN	1,246	0
TOTAL	4,392	89

Emission Summary 2014

A. VOC Emissions by Compound and Source

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lbs)	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total VOC Emissions (lbs)
TFE	Tetrafluoroethylene	116-14-3	2465.4	0	295.4	0	2760.7
PAF	Trifluoroacetyl Fluoride	354-34-7	6.8	0	0.8	0	7.6
RSU	Difluoro(Fluorosulfonyl)Acetyl Fluoride	677-67-8	2.3	0	0.3	0.0	2.6
SU	2-Hydroxytetrafluoroethane Sulfonic Acid Sultone	697-18-7	6.8	0	0.8	0	7.6
EDC	1,2-Dichloroethane	107-06-2	0	19.9	0	0	19.9
Total for 2014			2481.3	19.9	297.3	0.0	2798.5
						Tons	1.40

B. Toxic Air Pollutant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lbs)	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total TAP Emissions (lbs)
HF	Hydrogen Fluoride	7664-39-3	2.19	0	38.6	0.0	38.65
H2SO4	Sulfuric Acid	7664-93-9	9.5	170.4	0	0	179.9

C. Criteria Air Pollutant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lbs)	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total VOC Emissions (lbs)
SO2	Sulfur dioxide	7446-09-5	3.7	0	0	0	3.7

CORRECTED ENTRY IN AERO
PER MIKE JOHNSON 06/04/15

WAT ORIGINALLY REPORTED AS 3.7 TONS - GUL

05-14

Point Source Emission Determination**A. Tetrafluoroethylene (TFE)****CAS No. 116-14-3****HF Potential:**

TFE is a VOC without the potential to form HF.

TFE Quantity Generated:

Before-control TFE generation per the Process Flowsheet #4 (W1207831):

Source	TFE Vent Rate
Reactor	0.05171 kg TFE vented per RSU unit
Rearranger	0.19559 kg TFE vented per RSU unit
Still	0.02206 kg TFE vented per RSU unit
Total	0.26936 kg TFE vented per RSU unit

The before-control TFE generation is based on **4,151.6** RSU units in 2014

TFE vented from the RSU Process in the reporting year:

$$\frac{0.2694 \text{ kg TFE}}{\text{RSU unit}} \times 4,151.6 \text{ RSU units} = \mathbf{1,118 \text{ kg TFE}}$$

After-control emissions utilizing the 0% control efficient Waste Gas Scrubber (WGS):

$$\begin{array}{rcll} \text{VOC Emissions} & & 1,118 \text{ kg TFE} & \\ \text{Waste Gas Scrubber} & \times & (100\% - 0\%) \text{ control efficiency} & \\ & = & \frac{1,118 \text{ kg TFE}}{1} & = 1,118 \text{ kg VOC} \\ & & & = \mathbf{2465.4 \text{ lb. VOC}} \end{array}$$

B. Perfluoroacetyl Fluoride (PAF)**CAS No. 354-34-7**HF Potential:

Each mole of PAF (MW = 116) can generate 1 mole of HF (MW = 20).

$$1 \text{ kg PAF} \times \frac{1 \text{ mole PAF}}{116 \text{ g PAF}} \times \frac{20 \text{ g HF}}{1 \text{ mole HF}} \times \frac{1 \text{ mole HF}}{1 \text{ mole PAF}} = 0.172 \text{ kg HF}$$

Therefore, each 1 kg of PAF generates 0.172 kg of HF

PAF Quantity Generated:

Before-control PAF generation per the Process Flowsheet #4 (W1207831):

Source	PAF Vent Rate
Reactor	0 kg PAF vented per RSU unit
Rearranger	0.16755 kg PAF vented per RSU unit
Still	0.01862 kg PAF vented per RSU unit
Total	0.186 kg PAF vented per RSU unit

The before-control PAF generation is based on **4,151.6** RSU units in 2014

PAF vented from the RSU Process in the reporting year:

$$\frac{0.186 \text{ kg PAF}}{\text{RSU unit}} \times 4,151.6 \text{ RSU units} = 773 \text{ kg PAF}$$

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

$$\begin{array}{lcl} \text{VOC Emissions} & & 773 \text{ kg PAF} \\ \text{Waste Gas Scrubber} & \times & (100\% - 99.6\%) \text{ control efficiency} \\ & = & \frac{3.09 \text{ kg PAF}}{= 6.8 \text{ lb. VOC}} \end{array}$$

$$\begin{array}{lcl} \text{HF Equivalent Emissions} & & 3.09 \text{ kg PAF} \\ & \times & 0.172 \text{ kg HF/kg PAF} \\ & = & \frac{0.53 \text{ kg HF}}{= 1.17 \text{ lb. HF}} \end{array}$$

C. Rearranged Sultone (RSU)
Difluoro(Fluorosulfonyl) Acetyl Fluoride

CAS No. 677-67-8

HF Potential:

Each mole of RSU (MW = 180) can generate 1 moles of HF (MW = 20).

$$1 \text{ kg RSU} \times \frac{1 \text{ mole RSU}}{180 \text{ g RSU}} \times \frac{20 \text{ g HF}}{1 \text{ mole HF}} \times \frac{1 \text{ mole HF}}{1 \text{ mole RSU}} = 0.111 \text{ kg HF}$$

Therefore, each 1 kg of RSU generates 0.111 kg of HF

RSU Quantity Generated:

Before-control RSU generation per the Process Flowsheet #4 (W1207831):

Source	RSU Vent Rate
Reactor	0 kg RSU vented per RSU unit
Rearranger	0.05677 kg RSU vented per RSU unit
Still	0.00644 kg RSU vented per RSU unit
Total	0.063 kg RSU vented per RSU unit

The before-control RSU generation is based on **4,151.6** RSU units in 2014

RSU vented from the RSU Process in the reporting year:

$$\frac{0.063 \text{ kg RSU}}{\text{RSU unit}} \times 4,151.6 \text{ RSU units} = 262 \text{ kg RSU}$$

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

$$\begin{aligned} \text{VOC Emissions} &= \frac{262 \text{ kg RSU}}{(100\%-99.6\%) \text{ control efficiency}} \\ \text{Waste Gas Scrubber} &= \frac{1.05 \text{ kg RSU}}{1.05 \text{ kg RSU}} = 1.05 \text{ kg VOC} \\ &= 2.3 \text{ lb. VOC} \end{aligned}$$

$$\begin{aligned} \text{HF Equivalent Emissions} &= \frac{1.05 \text{ kg RSU}}{0.111 \text{ kg HF/kg RSU}} \\ &= 0.12 \text{ kg HF} = 0.26 \text{ lb. HF} \end{aligned}$$

D. Sultone (SU)**CAS No. 697-18-7****TFE Sultone (2-Hydroxytetrafluoroethane Sulfonic Acid)**HF Potential:

Each mole of SU (MW = 180) can generate 1 mole of HF (MW = 20).

$$1 \text{ kg SU} \times \frac{1 \text{ mole SU}}{180 \text{ g SU}} \times \frac{20 \text{ g HF}}{1 \text{ mole HF}} \times \frac{1 \text{ mole HF}}{1 \text{ mole SU}} = 0.111 \text{ kg HF}$$

Therefore, each 1 kg of SU generates 0.111 kg of HF

SU Quantity Generated:

Before-control SU generation per the Process Flowsheet #4 (W1207831):

Source	SU Vent Rate
Reactor	0 kg SU vented per RSU unit
Rearranger	0.16755 kg SU vented per RSU unit
Still	0.01862 kg SU vented per RSU unit
Total	0.186 kg SU vented per RSU unit

The before-control SU generation is based on **4,151.6** RSU units in 2014

SU vented from the RSU Process in the reporting year:

$$\frac{0.186 \text{ kg SU}}{\text{RSU unit}} \times 4,151.6 \text{ RSU units} = 773 \text{ kg SU}$$

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

$$\begin{array}{lcl} \text{VOC Emissions} & & 773 \text{ kg SU} \\ \text{Waste Gas Scrubber} & \times & (100\%-99.6\%) \text{ control efficiency} \\ & = & \frac{3.09 \text{ SU}}{3.09 \text{ SU}} = 3.09 \text{ kg VOC} \\ & & = \mathbf{6.8 \text{ lb. VOC}} \end{array}$$

$$\begin{array}{lcl} \text{HF Equivalent Emissions} & & 3.09 \text{ kg SU} \\ & \times & 0.111 \text{ kg HF/kg SU} \\ & = & \frac{0.3 \text{ kg HF}}{0.3 \text{ kg HF}} = \mathbf{0.76 \text{ lb. HF}} \end{array}$$

E. Sulfur dioxide (SO₂)**CAS No. 354-34-7**Air Pollutant Description:

Sulfur dioxide is a criteria pollutant and will be reported as such on the NC DAQ forms.

SO₂ Quantity Generated:

Before-control SO₂ generation per the Process Flowsheet #4 (W1207831):

Source	SO ₂ Vent Rate
Reactor	0 kg SO ₂ vented per RSU unit
Rearranger	0.09124 kg SO ₂ vented per RSU unit
Still	0.00988 kg SO ₂ vented per RSU unit
Total	0.101 kg SO₂ vented per RSU unit

The before-control SO₂ generation is based on **4,151.6** RSU units in 2014

SO₂ vented from the RSU Process in the reporting year:

$$\frac{0.101 \text{ kg SO}_2}{\text{RSU unit}} \times 4,151.6 \text{ RSU units} = 420 \text{ kg SO}_2$$

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

$$\begin{array}{l} \text{SO}_2 \text{ Emissions} \\ \text{Waste Gas Scrubber} \end{array} \times \frac{420 \text{ kg SO}_2}{(100\% - 99.6\%) \text{ control efficiency}} = \frac{1.68 \text{ kg SO}_2}{\text{kg SO}_2} = 3.7 \text{ lb. SO}_2$$

F. Sulfur trioxide (SO₃)**CAS No. 7446-11-9**H₂SO₄ Potential:

Each mole of SO₃ (MW = 80) can generate 1 mole of H₂SO₄ (MW = 98).

$$1 \text{ kg SO}_3 \times \frac{1 \text{ mole SO}_3}{80 \text{ g SO}_3} \times \frac{98 \text{ g H}_2\text{SO}_4}{1 \text{ mole H}_2\text{SO}_4} \times \frac{1 \text{ mole H}_2\text{SO}_4}{1 \text{ mole SO}_3} = 1.225 \text{ kg H}_2\text{SO}_4$$

Therefore, each 1 kg of SO₃ generates 1.225 kg of H₂SO₄

SO₃ Quantity Generated:

Before-control SO₃ generation per the Process Flowsheet #4 (W1207831):

Source	SO ₃ Vent Rate
Reactor	0.00115 kg SO ₃ vented per RSU unit
Rearranger	0.188 kg SO ₃ vented per RSU unit
Still	0.02114 kg SO ₃ vented per RSU unit
Total	0.211 kg SO₃ vented per RSU unit

The before-control SO₃ generation is based on **4,151.6** RSU units in 2014

SO₃ vented from the RSU Process in the reporting year:

$$\frac{0.211 \text{ kg SO}_3}{\text{RSU unit}} \times 4,151.6 \text{ RSU units} = \mathbf{875 \text{ kg SO}_3}$$

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

$$\begin{array}{l} \text{SO}_3 \text{ Emissions} \\ \text{Waste Gas Scrubber} \end{array} \times \frac{875 \text{ kg SO}_3}{(100\% - 99.6\%) \text{ control efficiency}} = \frac{3.50 \text{ kg SO}_3}{7.7} = \mathbf{7.7 \text{ lb. SO}_3}$$

$$\begin{array}{l} \text{H}_2\text{SO}_4 \text{ Equivalent Emissions} \\ \text{Waste Gas Scrubber} \end{array} \times \frac{3.50 \text{ kg SO}_3}{1.225 \text{ kg H}_2\text{SO}_4 / \text{kg SO}_3} = \frac{4.29 \text{ kg H}_2\text{SO}_4}{9.5} = \mathbf{9.5 \text{ lb. H}_2\text{SO}_4}$$

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

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

A. Equipment emissions from SU Reactor, Rearranger, RSU Still and RSU Hold Tank:

Emissions are vented from equipment located inside the RSU barricade and are vented to a vent stack.

Barricade:

Valve emissions:	250 valves x 0.00036 lb/hr/valve	=	0.090 lb/hr EE
Flange emissions:	550 flanges x 0.00018 lb/hr/flange	=	0.045 lb/hr EE
Total equipment emission rate		=	0.135 lb/hr EE

Days of operation = 92

On average 0.13 lbs of HF are produced for every 1 lb of RSU, SU or PAF.

VOC:	0.135 lb/hr EE	HF:	0.135 lb/hr EE
x	24 hours/day	x	24 hours/day
x	92 days/year	x	92 days/year
=	297.3 lb/yr VOC from EE	x	0.13 lb HF per lb VOC
		=	38.6 lb/yr HF from EE

B. Fugitive Emissions From SO₃ Storage Tank and Vaporizer

This equipment is not inside a building, therefore emissions are true Fugitive Emissions

Valve emissions:	85 valves x 0.00036 lb/hr/valve	=	0.031 lb/hr FE
Flange emissions:	180 flanges x 0.00018 lb/hr/flange	=	0.032 lb/hr FE
Total fugitive emission rate		=	0.063 lb/hr FE

SO₃:	0.063 lb. FE/hr	H₂SO₄:	0.063 lb. FE/hr
x	24 hours/day	x	24 hours/day
x	92 days/year	x	92 days/year
=	139.1 lb/yr SO₃ from EE	x	1.225 lb H ₂ SO ₄ per lb SO ₃
		=	170.4 lb/yr H₂SO₄ from FE

C. Fugitive Emissions From EDC Tank

This equipment is not inside a building, therefore emissions are true Fugitive Emissions

Valve emissions:	20 valves x 0.00036 lb/hr/valve	=	0.007 lb/hr FE
Flange emissions:	10 flanges x 0.00018 lb/hr/flange	=	0.002 lb/hr FE
Total fugitive emission rate		=	0.009 lb/hr FE

VOC:	0.009 lb/hr FE	HF:	0
x	24 hours/day		
x	92 days/year		
=	19.9 lb/yr VOC from FE		

D. Total RSU Plant Non-Point Source Emissions

Emission Source	Equipment Emissions		Fugitive Emissions		
	VOC lb/yr	HF lb/yr	VOC lb/yr	SO3 lb/yr	H2SO4 lb/yr
A. Equipment Emissions from SU Reactor, Rearranger, Still and Hold Tank	297.3	38.6	0	0	0
B. Fugitive Emissions From SO3 Storage Tank and Vaporizer	0	0	0	139.1	170.4
C. Fugitive Emissions From EDC Tank	0	0	19.9	0	0
Total for 2014	297.3	38.6	19.9	139.1	170.4

E. VOC Emission by Source Type

Nafion® Compound	Emissions from Stack (lb)	Equipment Emissions (lb)	Fugitive Emissions (lb)	Accidental Releases (lb)	Total Emissions (lb)
TFE	2465.4	295.4	0	0	2760.7
PAF	6.8	0.8	0	0	7.6
RSU	2.3	0.3	0	0.0	2.6
SU	6.8	0.8	0	0	7.6
EDC	0	0	19.9	0	19.9
Total	2481.3	297.3	19.9	0.0	2798.5

Note: Speciated equipment emissions were estimated by assuming that each compound's equipment emission concentration was equal to that compound's stack emission fraction of the total stack emission.

Example: The TFE equipment emissions were determined by the ratio of the TFE stack emission (1,997.9 lb) divided by the total stack emission (2,010.8 lb), multiplied by the total equipment emissions (229.4 lb).

Specifically:

$$\frac{2465.4}{2481.3} \times 297.3 = 295.4 \text{ lb. TFE}$$

2014

Emission Source ID No.:

NS-E

Emission Source Description:

Nafion Liquid Waste Stabilization

Process & Emission Description:

The Nafion liquid waste stabilization is a continuous system of storage with batch neutralization. To comply with the regulatory requirements of RCRA SubPart CC, neither the storage tank nor the reactor vent during normal operating conditions. All venting from this system occurs as a non-routine maintenance activity, which is detailed in the following pages. All emissions from this system are vented through the Nafion Division Waste Gas Scrubber (Control Device ID No. NCD-Hdr1) which has a documented control efficiency of 99.6% for acid fluoride compounds. The control of emissions of specific compounds will be addressed and detailed in the following pages.

The Nafion liquid waste stabilization process emits compounds in the acid fluoride family. In the presence of water, these acid fluorides will eventually hydrolyse to hydrogen fluoride. For the purpose of this emissions inventory, a conservative approach will be take and the acid fluorides will be reported both as a VOC and as the equivalent quantity of hydrogen fluoride.

Basis and Assumptions:

- For the HF emissions the entire gas flow is assumed to be HF
- The VOC emissions are assumed to be 30% COF2 and 70% TAF for the Reactor
- The VOC emissions are calculated based on Trimer and RSU for the Storage Tank
- The ideal gas law is used.

Information Inputs and Source Inputs:

Information Input	Source of Inputs
Weight of Tank	IP21 (W03450WG and W03606WG)
Category and Reason for Emission	Waste Mechanical Facilitator

Point Source Emissions Determination:

Shown on the following pages

Fugitive Emissions Determination:

Shown on the following pages.

Stack Emissions from Maintenance Activity or Emergency Activity for the Reactor

Background

Before performing maintenance on the reactor or storage tank, the pressure from the system is vented to the Division WGS. Each vent is recorded in IP21 by the weight before and after the vent. There can be times when the pressure in either the reactor or storage tank rises rapidly due to reaction. During these times if the pressure rises above 700 kpa in either tank, a pressure control valve can be opened to vent the tank to avoid the relief valve opening. See chart below.

Date	Tank	Category	Reason	Tank Weight	
				Initial (kg)	Final (kg)
10/7/14	Reactor	Maintenance	Annual Shutdwon	310	8

Sample calculation using maintenance activity dated 10/7/14

Initial Weight minus Final Weight equals kg vented to Division WGS

310 kg minus 8 kg equals 302 kg vented to WGS

Assume that all of the above is VOC emissions This assumption also overstates the true emissions as inerts, such as nitrogen are not counted.

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

Percentage of acid fluoride VOCs removed by the WGS = 99.6%

Percentage of acid fluoride VOCs vented from the WGS = 100% minus 99.6%

Percentage of acid fluoride VOCs vented from the WGS = 0.4%

Therefore, VOCs vented to the atmosphere from the 10/7/14 maintenance activity is equal to:

Amount of VOCs vented to WGS: 302 kg of VOC

Percentage of VOCs vented from the WGS: x 0.4%

Quantity of VOCs vented from the WGS: = 1.208 kg VOC

= 2.66316 lb VOC

**Stack Emissions from Maintenance Activity (cont.)
for the Reactor****VOC Emissions by Compound**

Assume that the vapor is 30% COF2 and 70% TAF. This assumption is based on process knowledge of the system.

Quantity of VOCs vented from the WGS (see previous page) = **2.6632 lb VOC**

COF2 (carbonyl fluoride)**CAS No. 353-50-4**

Sample calculation using maintenance activity dated 10/7/14

VOC emissions would be equal to:

$$\frac{2.663 \text{ lb VOC}}{1 \text{ lb VOC}} \times \frac{0.30 \text{ lb COF}_2}{1 \text{ lb VOC}} = 0.7989 \text{ lb COF}_2$$

**TAF (telomeric acid fluoride)
(perfluoro-3,5,7, 9,11-pentaoxadodecanoyl fluoride)****CAS No. 690-43-7**

Sample calculation using maintenance activity dated 10/7/14

VOC emissions would be equal to:

$$\frac{2.663 \text{ lb VOC}}{1 \text{ lb VOC}} \times \frac{0.70 \text{ lb TAF}}{1 \text{ lb VOC}} = 1.8642 \text{ lb VOC}$$

**Stack Emissions from Maintenance Activity (cont.)
for the Reactor
HF Potential**

Assume that the vapor is 30% COF₂ and 70% TAF. This assumption is based on process knowledge of the system.

COF₂ (carbonyl fluoride)

CAS No. 353-50-4

Each mole of COF₂ (MW = 66) can generate 2 moles of HF (MW =20)

$$\frac{1 \text{ lb COF}_2}{66 \text{ lb COF}_2} \times \frac{1 \text{ mole COF}_2}{1 \text{ mole COF}_2} \times \frac{20 \text{ lb HF}}{1 \text{ mole HF}} \times \frac{2 \text{ moles HF}}{1 \text{ mole COF}_2} = 0.606 \text{ lb of HF}$$

Therefore, each 1 lb of COF₂ generates 0.606 lb of HF

**TAF (telomeric acid fluoride)
(perfluoro-3,5,7, 9,11-pentaoxadodecanoyl fluoride)**

CAS No. 690-43-7

Each mole of TAF (MW = 330) can generate 1 mole of HF (MW =20)

$$\frac{1 \text{ lb TAF}}{330 \text{ lb TAF}} \times \frac{1 \text{ mole TAF}}{1 \text{ mole TAF}} \times \frac{20 \text{ lb HF}}{1 \text{ mole HF}} \times \frac{1 \text{ moles HF}}{1 \text{ mole TAF}} = 0.061 \text{ lb of HF}$$

Therefore, each 1 lb of TAF generates 0.061 lb of HF

Sample calculation using maintenance activity dated 10/7/14

Quantity of VOCs vented from the WGS (see Page 2) = **2.6632 lb VOC**

HF equivalent emissions would be equal to:

$$\begin{array}{l} \frac{2.663 \text{ lb VOC}}{0.30 \text{ lb COF}_2} \times \frac{0.30 \text{ lb COF}_2}{1 \text{ lb VOC}} \times \frac{0.606 \text{ lb HF}}{1 \text{ lb COF}_2} = 0.4842 \text{ lb HF} \\ \frac{2.663 \text{ lb VOC}}{0.70 \text{ lb TAF}} \times \frac{0.70 \text{ lb TAF}}{1 \text{ lb VOC}} \times \frac{0.061 \text{ lb HF}}{1 \text{ lb TAF}} = 0.113 \text{ lb HF} \end{array}$$

Therefore, HF vented to the atmosphere from the 10/7/14 maintenance activity is equal to:

$$0.4842 \text{ lb HF} + 0.113 \text{ lb HF} = 0.5972 \text{ lb HF}$$

**Stack Emissions from Maintenance Activity (cont.)
for the Reactor
Calculation page**

Date	Tank	Category	Reason	Weight of Tank		Emitted VOC (lb)	Emitted HF (lb)
				Initial (kg)	Final (kg)		
10/7/14	Reactor	Maintenance	Annual Shutdwon	310	8	2.663	0.597
							0.000

Total Emissions	2.66	0.60
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Total VOC = 2.66 lb
 VOC = 0.0013 ton STACK EMISSIONS

Total HF = 0.60 lb STACK EMISSIONS

Speciated VOC Stack Emissions

The VOC emissions from the Waste Liquid Stabilization process is assumed to be comprised of 30% by weight of COF2 and 70% by weight of TAF. The emission of these compounds from each of the following events is determined simply by multiplying the total emitted VOC by 30% to determine the COF2 emission and 70% to determine the TAF emission.

Date	Tank	Category	Reason	Emitted VOC (lb)	Emitted COF2 (lb)	Emitted TAF (lb)
10/7/14	Reactor	Maintenance	Annual Shutdwon	2.663	0.799	1.864
1/0/00	1/0/00	1/0/00	1/0/00	0.000	0.000	0.000

Total Emissions	2.66	0.80	1.86
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Fugitive Emissions Leak Rates for Process Equipment for the Reactor

Using the following table, the Fugitive Emissions Rates will be calculated:

Component	Service	Emission Factors (lb/hr/component)
Pump Seals	Light Liquid	0.00115
Valves	Light Liquid	0.00036
Flanges	All	0.00018

VOC Fugitive Emissions from Equipment Components

1	Pump Seals	x	0.00115	lb/hr/pumpseal	=	0.00115	lb/hr VOC
96	Valves	x	0.00036	lb/hr/valve	=	0.0346	lb/hr VOC
55	Flanges	x	0.00018	lb/hr/flange	=	0.0099	lb/hr VOC
Total VOC Emissions from Equipment Leaks					=	0.0456	lb/hr VOC

Total Annual Fugitive VOC Emissions:

$$0.0456 \text{ lb/hr VOC} \times 8760 \text{ hr/year} = 399.54 \text{ lb VOC}$$

$$0.1998 \text{ tons VOC}$$

Speciated Fugitive VOC Emissions by Compound:

Assume that the emissions are 30% COF2 and 70% TAF. This assumption is based on process knowledge of the system.

$$\frac{399.5 \text{ lb VOC}}{\text{lb VOC}} \times \frac{0.30 \text{ lb COF2}}{\text{lb VOC}} = 119.86 \text{ lb COF2}$$

$$\frac{399.5 \text{ lb VOC}}{\text{lb VOC}} \times \frac{0.70 \text{ lb TAF}}{\text{lb VOC}} = 279.68 \text{ lb TAF}$$

See Page 3 for HF equivalents calculation:

$$\frac{399.5 \text{ lb VOC}}{\text{lb VOC}} \times \frac{0.30 \text{ lb COF2}}{\text{lb VOC}} \times \frac{0.606 \text{ lb HF}}{\text{lb COF2}} = 72.644 \text{ lb HF}$$

$$\frac{399.5 \text{ lb VOC}}{\text{lb VOC}} \times \frac{0.70 \text{ lb TAF}}{\text{lb VOC}} \times \frac{0.061 \text{ lb HF}}{\text{lb TAF}} = 16.95 \text{ lb HF}$$

$$72.644 \text{ lb HF} + 16.95 \text{ lb HF} = 89.6 \text{ lb HF}$$

Stack Emissions from Maintenance Activity or Emergency Activity for the Storage Tank

Background

Before performing maintenance on the reactor or storage tank, the pressure from the system is vented to the Division WGS. Each vent is recorded in IP21 by the weight before and after the vent. There can be times when the pressure in either the reactor or storage tank rises rapidly due to reaction. During these times if the pressure rises above 700 kpa in either tank, a pressure control valve can be opened to vent the tank to avoid the relief valve opening. See chart below.

Date	Tank	Category	Reason	Tank Weight	
				Initial (kg)	Final (kg)
10/8/14	Storage	Maintenance	Annual Shutdown	190	172

Sample calculation using maintenance activity dated 10/8/14

Initial Weight minus Final Weight equals kg vented to Division WGS
 190 kg minus 172 kg equals 18 kg vented to WGS

Assume that all of the above is VOC emissions This assumption also overstates the true emissions as inerts, such as nitrogen are not counted.

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

Percentage of acid fluoride VOCs removed by the WGS = 99.6%
 Percentage of acid fluoride VOCs vented from the WGS = 100% minus 99.6%
 Percentage of acid fluoride VOCs vented from the WGS = 0.4%

Therefore, VOCs vented to the atmosphere from the 10/8/14 maintenance activity is equal to:

Amount of VOCs vented to WGS: 18 kg of VOC
 Percentage of VOCs vented from the WGS: x 0.4%
 Quantity of VOCs vented from the WGS: = $\frac{0.072}{0.072}$ kg VOC
 = 0.158731 lb VOC

**Stack Emissions from Maintenance Activity (cont.)
for the Storage Tank
VOC Emissions by Compound**

Assume that the vapor is 100% Trimer. This assumption is based on process knowledge of the system.

Quantity of VOCs vented from the WGS (see previous page) = **0.16 lb VOC**

HFPO Trimer (perfluoro-2,5-dimethyl-3,6-dioxanonanoyl fluoride) **CAS No. 2641-34-1**

Sample calculation using maintenance activity dated 10/8/14

VOC emissions would be equal to:

$$\frac{0.159 \text{ lb VOC}}{1.00 \text{ lb Trimer}} = 0.1587 \text{ lb HFPO Trimer}$$

**Stack Emissions from Maintenance Activity (cont.)
for the Storage Tank
HF Potential**

Assume that the vapor is 100% Trimer. This assumption is based on process knowledge of the system.

HFPO Trimer (perfluoro-2,5-dimethyl-3,6-dioxanonanoyl fluoride)

$$2490 \text{ lb HFPO Trimer} = 100 \text{ lb of HF}$$

$$1 \text{ lb HFPO Trimer} = 0.0402 \text{ lb of HF}$$

Therefore, each 1 lb of Trimer generates 0.04 lb of HF

Sample calculation using maintenance activity dated 10/8/14

$$\text{Quantity of VOCs vented from the WGS (see Page 2)} = \mathbf{0.16 \text{ lb VOC}}$$

HF equivalent emissions would be equal to:

$$\frac{0.159 \text{ lb VOC}}{1.00 \text{ lb Trimer}} \times \frac{1.00 \text{ lb Trimer}}{0.040 \text{ lb HF}} = 0.006 \text{ lb HF}$$

**Stack Emissions from Maintenance Activity (cont.)
for the Storage Tank
Calculation page**

Date	Tank	Category	Reason	Weight of Tank		Emitted VOC (lb)	Emitted HF (lb)
				Initial (kg)	Final (kg)		
10/8/14	Storage	Maintenance	Annual Shutd	190	172	0.159	0.006

Total Emissions	0.16	0.01
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Total VOC = 0.16 lb
 VOC = 0.0001 ton STACK EMISSIONS

Total HF = 0.01 lb STACK EMISSIONS

Speciated VOC Stack Emissions

The VOC emissions from the Waste Liquid Stabilization Storage Tank is assumed to be comprised of 100% by weight of HFPO Trimer.

Date	Tank	Category	Reason	Emitted	Emitted	
				VOC (lb)	Trimer (lb)	
10/8/14	Storage	Maintenance	Annual Shutdown	0.159	0.159	

Total Emissions	0.16	0.16	0.00
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Fugitive Emissions Leak Rates for Process Equipment for the Storage Tank

Using the following table, the Fugitive Emissions Rates will be calculated:

Component	Service	Emission Factors (lb/hr/component)
Pump Seals	Light Liquid	0.00115
Valves	Light Liquid	0.00036
Flanges	All	0.00018

VOC Fugitive Emissions from Equipment Components

1	Pump Seals	x	0.00115	lb/hr/pumpseal	=	0.00115	lb/hr VOC
60	Valves	x	0.00036	lb/hr/valve	=	0.0216	lb/hr VOC
35	Flanges	x	0.00018	lb/hr/flange	=	0.0063	lb/hr VOC
Total VOC Emissions from Equipment Leaks					=	0.0291	lb/hr VOC

Total Annual Fugitive VOC Emissions:

$$0.0291 \text{ lb/hr VOC} \times 8760 \text{ hr/year} = 254.48 \text{ lb VOC}$$

$$0.1272 \text{ tons VOC}$$

Speciated Fugitive VOC Emissions by Compound:

Assume that the emissions are 100% Trimer. This assumption is based on process knowledge of the system.

$$\frac{254.5 \text{ lb VOC}}{1 \text{ lb VOC}} \times \frac{1.00 \text{ lb COF2}}{1 \text{ lb VOC}} = 254 \text{ lb HFPO Trimer}$$

See Page 3 for HF equivalents calculation:

$$\frac{399.5 \text{ lb VOC}}{1 \text{ lb VOC}} \times \frac{1.00 \text{ lb Trimer}}{1 \text{ lb VOC}} \times \frac{0.040 \text{ lb HF}}{1 \text{ lb Trimer}} = 16.0 \text{ lb HF}$$

Emission Summary**A. VOC Emissions by Compound and Source**

Nafion® Compound	CAS Chemical Name	CAS No.	Stack Emissions (lbs)	Fugitive Emissions (lbs)	Total Emissions (lbs)
COF2	Carbonyl fluoride	116-14-3	0.80	119.9	120.7
TAF	Perfluoro-3,5,7, 9,11- pentaoxidodecanoyl fluoride	690-43-7	1.86	279.7	281.5
HFPO Trimer	(perfluoro-2,5-dimethyl-3,6- dioxanonanoyl fluoride)	2641-34-1	0.16	254.5	254.6
Total VOC (lb)					402.2
Total VOC (ton)					0.20

B. Toxic Air Pollutant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Stack Emissions (lbs)	Fugitive Emissions (lbs)	Total Emissions (lbs)
HF	Hydrogen fluoride	7664-39-3	16.64	89.6	106.2

Emission Summary

A. VOC Emissions by Compound and Source

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lbs)	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total VOC Emissions (lbs)
DMC	Carbonic Acid, Dimethyl Ester	616-38-6	244.0	216.0	0	0	460.0
DME	Dimethyl ether	115-10-6	0.1	0.1	0	0	0.1
MTVE	Methyl Trifluorovinyl Ether	3823-94-7	0.01	0.01	0	0	0.0
MTFE	1-methoxy-1,1,2,2-tetrafluoroethane	425-88-7	0.02	0.02	0	0	0.0
MTP	Methyl-3-methoxy-	755-73-7	0.02	0.01	0	0	0.0
BMTK	Bis(2-methoxytetrafluoroethyl)ketone	1422-71-5	0.00	0.001	0	0	0.0
MTP Acid	MTP Acid	93449-21-9	0.00	0.000	0	0	0.0
TFE	Tetrafluoroethylene	116-14-3	37.3	33.0	0	0	70.3
CH3F	Methyl Fluoride	593-53-3	12.4	11.0	8.8	0	32.3
MMF	Propanoic Acid, 2,2,3-Trifluoro-3-oxo,methyl ester	69116-71-8	0	0.0	31.3	0	31.3
Total VOC for 2014			293.9	260.1	40.2	0	594.1
						VOC (Tons)	0.30

B. Toxic Air Pollutant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lbs)	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total Emissions (lbs)
HF	Hydrogen Fluoride	7664-39-3	0	33.8	5	0	39.0

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Point Source Emission Determination**A. TFE**
Tetrafluoroethylene**CAS No. 116-14-3****HF Potential:**

TFE is a VOC without the potential to form HF.

TFE Quantity Generated:

Before-control TFE emission rate per the Process Flowsheet #5600:

Source	TFE Vent Rate	
MTP Rx	0.0182	kg TFE vented per MMF unit
Neutralizer	0	kg TFE vented per MMF unit
Wash Tk	0	kg TFE vented per MMF unit
Crude MTP Tk	0	kg TFE vented per MMF unit
Crude DMC Tk	0	kg TFE vented per MMF unit
DMC Still	0	kg TFE vented per MMF unit
Total	0.0182	kg TFE vented per MMF unit

The before-control TFE emission is based on **928.9** MMF units in 2014

TFE vented from the MMF Process in the reporting year:

$$\frac{0.0182 \text{ kg TFE}}{\text{MMF unit}} \times 928.9 \text{ MMF unit} = 16.91 \text{ kg TFE}$$

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

VOC Emissions

$$\begin{array}{rclclcl} \text{Waste Gas Scrubber} & \times & \frac{16.91 \text{ kg TFE}}{(100\%-0\%) \text{ control efficiency}} & & & \\ = & & 16.91 \text{ kg TFE} & = & 37.27 & \text{lb. THF} \\ & & & & = & 37.27 \text{ lb. VOC} \end{array}$$

B. DMC**CAS No. 616-38-6****Carbonic acid, dimethyl ester**HF Potential:

DMC is a VOC without the potential to form HF

DMC Quantity Generated:

Before-control DMC emission rate per the Process Flowsheet #5600:

Source	DMC Vent Rate	
MTP Rx	0.0249	kg DMC vented per MMF unit
Neutralizer	0.0315	kg DMC vented per MMF unit
Wash Tk	0.0057	kg DMC vented per MMF unit
Crude MTP Tk	0.0075	kg DMC vented per MMF unit
Crude DMC Tk	0.0099	kg DMC vented per MMF unit
DMC Still	0.0396	kg DMC vented per MMF unit
Total	0.1192	kg DMC vented per MMF unit

The before-control DMC emission is based on **928.9** MMF units in 2014

DMC vented from the MMF Process in the reporting year:

$$\frac{0.1192 \text{ kg DMC}}{\text{MMF unit}} \times 928.9 \text{ MMF unit} = 110.70 \text{ kg DMC}$$

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

VOC Emissions

$$\begin{array}{rcll} \text{Waste Gas Scrubber} & \times & \frac{110.70 \text{ kg DMC}}{(100\%-0\%) \text{ control efficiency}} & \\ & = & \frac{110.70 \text{ kg DMC}}{1} & = 244.04 \text{ lb. DMC} \\ & & & = \mathbf{244.04 \text{ lb. VOC}} \end{array}$$

C. DME
Dimethyl ether**CAS No. 115-10-6**HF Potential:

DME is a VOC without the potential to form HF

DME Quantity Generated:

Before-control DME emission rate per the Process Flowsheet #5600:

Source	DME Vent Rate	
MTP Rx	0	kg DME vented per MMF unit
Neutralizer	0.000214	kg DME vented per MMF unit
Wash Tk	0.000138	kg DME vented per MMF unit
Crude MTP Tk	0.000221	kg DME vented per MMF unit
Crude DMC Tk	0	kg DME vented per MMF unit
DMC Still	0.00860	kg DME vented per MMF unit
Total	0.00917	kg DME vented per MMF unit

The before-control RSU emission is based on **928.9** MMF units in 2014

DME vented from the MMF Process in the reporting year:

$$\frac{0.00917 \text{ kg DME}}{\text{MMF unit}} \times 928.9 \text{ MMF unit} = \mathbf{8.52} \text{ kg DME}$$

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

VOC Emissions

$$\begin{array}{rcl} \text{Waste Gas Scrubber} & \times \frac{8.52 \text{ kg DME}}{(100\% - 99.6\%) \text{ control efficiency}} & \\ & = \frac{0.03 \text{ kg DME}}{0.03} & = 0.08 \text{ lb. DME} \\ & & = \mathbf{0.08} \text{ lb. VOC} \end{array}$$

D. MTVE
Methyl Trifluorovinyl Ether**CAS No. 3823-94-7**HF Potential:

MTVE is a VOC without the potential to form HF

MTVE Quantity Generated:

Before-control MTVE emission rate per the Process Flowsheet #5600:

Source	MTVE Vent Rate	
MTP Rx	0.00057	kg MTVE vented per MMF unit
Neutralizer	0.00049	kg MTVE vented per MMF unit
Wash Tk	0.00019	kg MTVE vented per MMF unit
Crude MTP Tk	0.00042	kg MTVE vented per MMF unit
Crude DMC Tk	0	kg MTVE vented per MMF unit
DMC Still	0	kg MTVE vented per MMF unit
Total	0.00166	kg MTVE vented per MMF unit

The before-control MTVE emission is based on **928.9** MMF units in 2014

MTVE vented from the MMF Process in the reporting year:

$$\frac{0.00166 \text{ kg MTVE}}{\text{MMF unit}} \times 928.9 \text{ MMF unit} = 1.54 \text{ kg MTVE}$$

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

VOC Emissions

$$\begin{array}{rclclcl} & & 1.5447 & \text{kg MTVE} & & & \\ \text{Waste Gas Scrubber} & \times & \frac{(100\%-99.6\%) \text{ control efficiency}}{0.0062} & & & & \\ & = & 0.0062 & \text{kg MTVE} & = & 0.014 & \text{lb. MTVE} \\ & & & & = & 0.014 & \text{lb. VOC} \end{array}$$

**E. MTFE (Methyl tetrafluoroethyl ether)
1-methoxy-1,1,2,2-tetrafluoroethane****CAS No. 425-88-7**HF Potential:

MTFE is a VOC without the potential to form HF.

MTFE Quantity Generated:

Before-control MTFE emission rate per the Process Flowsheet #5600:

Source	MTFE Vent Rate	
MTP Rx	0.001269	kg MTFE vented per MMF unit
Neutralizer	0.000489545	kg MTFE vented per MMF unit
Wash Tk	0.00019306	kg MTFE vented per MMF unit
Crude MTP Tk	0.000420595	kg MTFE vented per MMF unit
Crude DMC Tk	0	kg MTFE vented per MMF unit
DMC Still	0	kg MTFE vented per MMF unit
Total	0.00237	kg MTFE vented per MMF unit

The before-control MTFE emission is based on **928.9** MMF units in 2014

MTFE vented from the MMF Process in the reporting year:

$$\frac{0.00237 \text{ kg MTFE}}{\text{MMF unit}} \times 928.9 \text{ MMF unit} = 2.20 \text{ kg MTFE}$$

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

VOC Emissions

$$\begin{array}{rclclcl} \text{Waste Gas Scrubber} & \times & \frac{2.203 \text{ kg MTFE}}{(100\% - 99.6\%) \text{ control efficiency}} & & & \\ & = & \frac{0.009}{\text{kg MTFE}} & = & 0.019 & \text{lb. MTFE} \\ & & & & = & \mathbf{0.019 \text{ lb. VOC}} \end{array}$$

F. MTP**CAS No. 755-73-7****Methyl-3-methoxy-tetrafluoropropionate**HF Potential:

MTP is a VOC without the potential to form HF

MTP Quantity Generated:

Before-control MTP emission rate per the Process Flowsheet #5600:

Source	MTP Vent Rate	
MTP Rx	0.0000028	kg MTP vented per MMF unit
Neutralizer	0.001041	kg MTP vented per MMF unit
Wash Tk	0.000365	kg MTP vented per MMF unit
Crude MTP Tk	0.000503	kg MTP vented per MMF unit
Crude DMC Tk	0.0000007	kg MTP vented per MMF unit
DMC Still	0	kg MTP vented per MMF unit
Total	0.00191	kg MTP vented per MMF unit

The before-control MTP emission is based on **928.9** MMF units in 2014

MTP vented from the MMF Process in the reporting year:

$$\frac{0.00191 \text{ kg MTP}}{\text{MMF unit}} \times 928.9 \text{ MMF unit} = 1.78 \text{ kg MTP}$$

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

MTP Emissions

$$\begin{array}{rclcl} \text{Waste Gas Scrubber} & \times & \frac{1.777 \text{ kg MTP}}{(100\%-99.6\%) \text{ control efficiency}} & & \\ & = & \frac{0.007}{\text{kg MTP}} & = & 0.016 \text{ lb. MTP} \\ & & & = & \mathbf{0.016 \text{ lb. VOC}} \end{array}$$

G. BMTK**CAS No. 1422-71-5****Bis(2-methoxytetrafluoroethyl)ketone**HF Potential:

BMTK is a VOC without the potential to form HF.

BMTK Quantity Generated:

Before-control BMTK emission rate per the Process Flowsheet #5600:

Source	BMTK Vent Rate	
MTP Rx	0	kg BMTK vented per MMF unit
Neutralizer	0.000089635	kg BMTK vented per MMF unit
Wash Tk	0.000034475	kg BMTK vented per MMF unit
Crude MTP Tk	0.00004137	kg BMTK vented per MMF unit
Crude DMC Tk	0	kg BMTK vented per MMF unit
DMC Still	0	kg BMTK vented per MMF unit
Total	0.00016548	kg BMTK vented per MMF unit

The before-control BMTK emission is based on **928.9** MMF units in 2014

BMTK vented from the MMF Process in the reporting year:

$$\frac{0.000165 \text{ kg BMTK}}{\text{MMF unit}} \times 928.9 \text{ MMF unit} = 0.15 \text{ kg BMTK}$$

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

BMTK Emissions

$$\begin{array}{rclcl} \text{Waste Gas Scrubber} & \times & \frac{0.15372 \text{ kg BMTK}}{(100\%-99.6\%) \text{ control efficiency}} & & \\ & = & \frac{0.00061}{\text{kg BMTK}} & = & 0.001 \text{ lb. BMTK} \\ & & & = & \mathbf{0.001 \text{ lb. VOC}} \end{array}$$

H. MTP Acid**CAS No. 93449-21-9**HF Potential:

MTP Acid is a VOC without the potential to form HF.

MTP Acid Quantity Generated:

Before-control MTP Acid emission rate per the Process Flowsheet #5600:

Source	MTP Acid Vent Rate	
MTP Rx	0.000000	kg MTP Acid vented per MMF unit
Neutralizer	0	kg MTP Acid vented per MMF unit
Wash Tk	0.000020685	kg MTP Acid vented per MMF unit
Crude MTP Tk	0.000034475	kg MTP Acid vented per MMF unit
Crude DMC Tk	0	kg MTP Acid vented per MMF unit
DMC Still	0	kg MTP Acid vented per MMF unit
Total	0.00005516	kg MTP Acid vented per MMF unit

The MTP Acid emission* is based on **928.9** MMF units in 2014
 * before-control emissions

MTP Acid vented from the MMF Process in the reporting year:

$$\frac{0.000055 \text{ kg MTP Acid}}{\text{MMF unit}} \times 928.9 \text{ MMF unit} = \mathbf{0.051 \text{ kg MTP Acid}}$$

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

MTP Acid Emissions

$$\begin{array}{rclcl} \text{Waste Gas Scrubber} & \times & \frac{0.051 \text{ kg MTP Acid}}{(100\% - 99.6\%) \text{ control efficiency}} & & \\ & = & \frac{0.00020}{\text{kg MTP Acid}} & = & 0.0005 \text{ lb. MTP Acid} \\ & & & = & \mathbf{0.0005 \text{ lb. VOC}} \end{array}$$

I. CH₃F
Methyl fluoride

CAS No. 593-53-3

HF Potential:CH₃F is a VOC without the potential to form HF.CH₃F Quantity Generated:Before-control CH₃F emission rate per the Process Flowsheet #9599:

Source	CH ₃ F Vent Rate	
MTP Reactor	0	kg CH ₃ F vented per MMF unit
Neutralizer	0	kg CH ₃ F vented per MMF unit
Wash Tk	0	kg CH ₃ F vented per MMF unit
Crude MTP Tk	0	kg CH ₃ F vented per MMF unit
Crude DMC Tk	0	kg CH ₃ F vented per MMF unit
DMC Still	0	kg CH ₃ F vented per MMF unit
MMF Reactor	1.52	kg CH ₃ F vented per MMF unit
Total	1.52	kg CH₃F vented per MMF unit

The before-control CH₃F emission is based on **928.9** MMF units in 2014CH₃F vented from the MMF Process in the reporting year:

$$\frac{1.52 \text{ kg CH}_3\text{F}}{\text{MMF unit}} \times 928.9 \text{ MMF unit} = 1,409.1 \text{ kg CH}_3\text{F}$$

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

CH₃F Emissions

$$\begin{array}{rclcl} \text{Waste Gas Scrubber} & \times & \frac{1,409.1 \text{ kg CH}_3\text{F}}{(100\%-99.6\%) \text{ control efficiency}} & & \\ & = & \frac{5.6}{\text{kg CH}_3\text{F}} & = & 12.4 \text{ lb. CH}_3\text{F} \\ & & & = & \mathbf{12.4 \text{ lb. VOC}} \end{array}$$

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

Fugitive (FE) and Equipment Emissions (EE) are a function of the number of emission points in the plant (valves, flanges, pump seals). The inventory shown below is conservative and based on plant and process diagrams. Note that the calculations below include the following: (1) equipment emissions not inside buildings, which are "fugitive" in nature and will be reported as such, and (2) equipment emission in side buildings, which are not "fugitive" in nature and will be reported as equipment emissions only.

A. Fugitive emissions from MMF equipment outside of the barricade:

Emissions from this equipment are not inside a building and are therefore "fugitive" in nature.

Valve emissions:	552 valves x 0.00036 lb/hr/valve	=	0.199 lb/hr EE
Flange emissions:	100 flanges x 0.00018 lb/hr/flange	=	0.018 lb/hr EE
Total equipment emission rate		=	<u>0.217 lb/hr EE</u>

Days of operation = 50

On average 0.13 lbs of HF are produced for every 1 pound of process material released

VOC:	0.217 lb/hr EE	HF:	0.217 lb/hr EE
x	24 hours/day	x	24 hours/day
x	50 days/year	x	50 days/year
=	260.1 lb/yr VOC from EE	x	0.13 lb HF per lb VOC
		=	33.8 lb/yr HF from EE

B. Equipment Emissions From MMF Reactor and Transfer Tank

This equipment is inside a building, therefore emissions are not true Fugitive Emissions

Valve emissions:	88 valves x 0.00036 lb/hr/valve	=	0.032 lb/hr FE
Flange emissions:	10 flanges x 0.00018 lb/hr/flange	=	0.002 lb/hr FE
Total fugitive emission rate		=	<u>0.033 lb/hr FE</u>

VOC:	0.033 lb. FE/hr	HF:	0.033 lb. FE/hr
x	24 hours/day	x	24 hours/day
x	50 days/year	x	50 days/year
=	40.2 lb/yr VOC from EE	x	0.13 lb HF per lb VOC
		=	5.2 lb/yr HF from EE

C. Total MMF Plant Non-Point Source Emissions

Emission Source	Fugitive Emissions		Equipment Emissions	
	VOC lb/yr	HF lb/yr	VOC lb/yr	HF lb/yr
A. Fugitive emissions from MMF equipment outside of the barricade:	260.1	33.8	0	0
B. Equipment Emissions From MMF Reactor and Transfer Tank	0	0	40.2	5.2
Total for 2014	260.1	33.8	40.2	5.2

E. VOC Emission by Source Type

Nafion® Compound	Emissions from Stack (lb)	Fugitive Emissions (lb)	Equipment Emissions (lb)	Accidental Releases (lb)	Total Emissions (lb)
DMC	244.0	216.0	0	0	460.0
DME	0.1	0.1	0	0	0.1
MTVE	0.01	0.01	0	0	0.03
MTFE	0.02	0.02	0	0	0.04
MTP	0.02	0.01	0	0	0.03
BMTK	0.001	0.001	0	0	0.003
MTP Acid	0.0005	0.000	0	0	0.001
TFE	37.3	33.0	0	0	70.3
CH3F	12.4	11.0	8.8	0	32.3
MMF	0	0	31.3	0	31.3
Total	293.9	260.1	40.2	0.0	594.1

Note: Speciated equipment emissions were estimated by assuming that each compound's equipment emission concentration was equal to that compound's stack emission fraction of the total stack emission.

Example: The DMC equipment emissions were determined by the ratio of the DMC stack emission (244.7 lb) divided by the total stack emission (306.7 lb), multiplied by the total equipment emissions (358.9 lb).

Specifically:
$$\frac{244.0}{293.9} \times 260.1 = 216.0 \text{ lb. DMC}$$

Yearly Emission Summary**A. VOC Compound Summary**

NS-G SR/CR Resins Manufacturing Process			
Nafion® Compound	CAS Chemical Name	CAS No.	Emission (lbs)
PSEPVE	Perfluoro-2-(2-Fluorosulfonylethoxy) Propyl Vinyl Ether	16090-14-5	9,943
EVE	Propanoic Acid, 3-[1-[Difluoro[(Trifluoroethenyl)oxy]Methyl]-1,2,2,2-Tetrafluoroethoxy]-2,2,3,3-Tetrafluoro-Methyl Ester	63863-43-4	1,983
TFE	Tetrafluoroethylene	116-14-3	15,279
E-2	2H-Perfluoro(5-Methyl-3,6-Dioxanonane)	3330-14-1	3,816
MeOH	Methanol	67-56-1	244
Total VOC Emissions (lbs)			31,264
Total VOC Emissions (tons)			15.6

B. Toxic Air Pollutant Summary

NS-G SR/CR Resins Manufacturing Process			
Nafion® Compound	CAS Chemical Name	CAS No.	Emission (lbs)
F-113	Trichloro-1,2,2-trifluoro-1,1,2 Ethane	76-13-1	0
HF	Hydrogen Fluoride	7664-39-3	0.7
MeOH	Methanol	67-56-1	244

Total raw materials fed (M) , kgs											
Month		E-2 Solution Addition	PSEPVE Solution Addition	Totalized PSEPVE Feed	EVE Solution Addition	Totalized EVE Feed	Totalized TFE Make- up	Totalized DP Addition	SR Consumpti on	CR Consumpti on	"M"
1	Jan-14	566	658	4,752	0	0	4,953	364	6,913	1,728	19,934
2	Feb-14	5,444	3,348	3,717	0	0	3,982	263	6,544	1,670	24,968
3	Mar-14	1,327	164	5,621	0	0	6,326	438	9,249	2,195	25,320
4	Apr-14	378	1,569	4,996	0	0	5,582	391	7,470	444	20,830
5	May-14	1,593	405	6,354	0	0	6,918	476	12,172	1,815	29,733
6	Jun-14	203	1,523	3,903	0	0	4,279	325	11,351	2,553	24,137
7	Jul-14	232	279	3,696	0	0	3,822	288	6,852	2,512	17,681
8	Aug-14	1,835	757	4,861	0	0	5,731	416	6,973	906	21,479
9	Sep-14	1,869	1,962	2,686	0	0	2,917	234	4,892	0	14,560
10	Oct-14	0	0	0	0	0	0	0	1,733	0	1,733
11	Nov-14	8,665	2,312	2,007	1,894	3,126	7,920	599	3,823	917	31,263
12	Dec-14	1,381	1,471	5,724	0	0	6,307	424	12,461	1,923	29,691
Total raw materials fed (M) , kgs											261,329

Total transformed materials collected (P) , kgs						
Month		Polymer	N/S Polymer	Purge & Adhesions	Purge	Vent Port Juice
1	Jan-14	8,096	43	0	556	36
2	Feb-14	5,858	133	353	207	34
3	Mar-14	9,979	22	551	289	49
4	Apr-14	9,425	122	0	200	39
5	May-14	11,102	316	302	111	720
6	Jun-14	7,606	70	0	111	99
7	Jul-14	6,554	56	400	275	59
8	Aug-14	8,870	750	158	212	62
9	Sep-14	5,139	0	0	43	130
10	Oct-14	0	0	0	15	46
11	Nov-14	10,939	659	0	42	102
12	Dec-14	9,884	0	278	127	0
Total transformed materials collected (P) , kgs						101,229

Total untransformed materials collected (W)						
Month		SR Issued	CR Issued	Solution Increase	VE to Filters/Siev es	E2 to Filters/Siev es
1	Jan-14	6,429	1,607	790	533	459
2	Feb-14	6,196	1,607	7,597	674	583
3	Mar-14	8,787	2,121	895	704	647
4	Apr-14	7,097	427	1,148	695	648
5	May-14	11,442	1,721	1,616	643	558
6	Jun-14	10,923	2,476	1,349	567	493
7	Jul-14	6,509	2,404	467	246	213
8	Aug-14	6,768	844	1,614	488	493
9	Sep-14	4,694	0	2,658	347	302
10	Oct-14	1,661	0	0	0	0
11	Nov-14	3,808	858	12,068	269	408
12	Dec-14	12,344	1,695	890	1,418	1,229
Total untransformed materials collected (W), kg						146,126

VOC emissions from the filling of storage tanks (S)					
Month		Total PSEPVE loss from Tank	Total EVE loss from Tank	Total E-2 loss from Tank	Total MeOH Emissions (kg)
1	Jan-14	0.45	0.05	0.71	22.24
2	Feb-14	0.45	0.04	0.67	16.45
3	Mar-14	0.43	0.05	0.73	23.65
4	Apr-14	0.43	0.05	0.75	22.61
5	May-14	0.48	0.05	0.71	29.08
6	Jun-14	0.43	0.05	0.62	29.92
7	Jul-14	0.42	0.06	0.64	17.44
8	Aug-14	0.42	0.05	0.67	22.98
9	Sep-14	0.46	0.05	0.69	14.46
10	Oct-14	0.42	0.05	0.64	0.00
11	Nov-14	0.41	0.05	0.75	20.68
12	Dec-14	0.42	0.05	0.64	24.33
Filling of storage tanks (S), kg					258

Nafion® Resins Process VOC Determination (Emission Source ID No. NS-G)Year

2014

Total raw materials fed (M)

261,329

 kgTotal transformed materials collected (P)

101,229

 kgTotal untransformed materials collected (W)

146,126

 kgVOC emissions from the filling of storage tanks (S)

258

 kg**Total process VOC emissions (E)**Total raw materials fed (M)

261,329

 kgTotal transformed materials collected (P)

101,229

 kgTotal untransformed materials collected (W)

146,126

 kgVOC emissions from the filling of storage tanks (S)

258

 kg**TOTAL PROCESS VOC EMISSIONS (E)**

$$E = (M - P - W + S) \times 2.2$$

31,310

 lb

05-18

Emission source/Operating Scenario Data

1. Emission Source ID No. **NS-H**

Actual emissions per pollutant listed for source/process identified on page 1:

Criteria (NAAQS) pollutants	Pollutant code	Emissions- Criteria pollutants (tons/yr)	Emission estimation method code	control efficiency
		2014		
Carbon Monoxide	CO	0	2	
NOx	NOx	0	2	
TSP	TSP	0	2	
PM 2.5	PM-2.5	0	2	
PM 10	PM-10	0	2	
SO2	SO2	0	2	
VOC	VOC	11.7	2	0%

Criteria (NAAQS) pollutants	Pollutant code	Emissions- Criteria pollutants (lb/yr)	Emission estimation method code	control efficiency
		2014		
HAP/TAP pollutants	CAS #		2	0%
Acetic Acid	64-19-7	37	2	0%
Hydrogen Fluoride	7664-39-03	108	2	0%

NS-H Membrane treatment (extrusion & hydrolysis) summary report.

<u>DMSO Emissions yr</u>	<u>Units</u>	<u>2014</u>
Waste Shipped	lbs/yr	102540
Waste in storage tk yr end	gallons	1194
Waste in storage tk yr end	lbs	12179
Waste % in storage tk yr end	%	20%
DMSO Waste Content	wt%	11%
DMSO in Waste liquid	lbs/yr	12619
DMSO Shipped as Waste liquid	lbs/yr	11279.4
treatment	gal/yr	28093
	lbs/yr	286552
DMSO pumped to waste treatment	lbs/yr	31521

DMSO Inventory

inv. Begin year	drums	16.224
inv. End year	drums	12.224
DMSO Drums Rec	drums	131
Wt/Drum	lb/drum	500
total DMSO consumed	lbs	67500

DMSO Emissions into air	lbs/yr	23360
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<u>DMSO Emissions into air</u>	<u>tons/yr</u>	<u>11.7</u>
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Acetic Acid Emissions air

1st Quarter	hrs	5.4
2nd Quarter	hrs	4.8
3rd Quarter	hrs	34.63
4th Quarter	hrs	5.9
Total	hrs	<u>50.7</u>

Acetic Acid Emissions Rate	lbs/hr	0.727
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Acetic Acid HAP/TAP Emissions	lbs/yr	36.9
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<u>Acetic Acid HAP/TAP Emissions</u>	<u>tons/yr</u>	<u>0.02</u>
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Total VOC Emissions	lbs/yr	23397
Total VOC Emissions	tons/yr	11.70

HF Emissions

SR Resin extruded in Resin Units ("RU")	RU/yr	22,800
CR Resin extruded in Resin Units ("RU")	RU/yr	2,253
Total polymer extruded in Resin Units ("RU")	RU/yr	25,053

kg HF / SR Resin Unit @ 275 deg C	0.00212
kg HF / CR Resin Unit @ 275 deg C	0.00024

SR Resin extruded per year (Resin Units)	22,800
kg HF / SR Resin Unit @ 275 deg C	0.00212
kg HF emitted per year	48.3

CR Resin extruded per year (Resin Units)	2,253
kg HF / CR Resin Unit @ 275 deg C	0.00024
kg HF emitted per year	0.5

Total HF Formed	kg/yr	48.9
Total HF HAP/TAP Emissions	lbs/yr	107.54

1. Emission Source ID No.

NS-I

05-19

Actual emissions per pollutant listed for source/process identified on page 1:

Criteria (NAAQS) pollutants	Pollutant code	Emissions-Criteria pollutants (tons/yr)	Emission estimation	control efficiency
		2014		
Carbon Monoxide	CO	0	8	
NOx	NOx	0	8	
TSP	TSP	0.24	2	0%
PM 2.5	PM-2.5	0.24	2	0%
PM 10	PM-10	0.24	2	0%
SO2	SO2	0	8	
VOC	VOC	20.6	2	0%

Coating Process_yr 2014

Max Spray Coat Rate	cc/min (2 guns)	400
Max Process Rate	gal/hr	6.3

Paint Batches	batch	133
Gallons/batch	gals	50
Gallons from Original batches	gals	6650
Remade batches	batchs	0
Gallons added/batch	gals	5
Gallons added to remake batches	gals	0

Annual Process Throughput	gals/yr	6650
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Coating Density	lb/gal	7.928
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Coating Consumed	lbs/yr	52721
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VOC Emissions

Ethanol	wt %	69%
Methanol	wt %	1%
1-Propanol	wt %	8%

Annual VOC Emissions	lbs/yr	41123
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tons/yr	20.56
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TSP Emissions

Coating Solids	wt %	18%
Paint Arrestor Effic	%	95%
Solids Produced	lb/yr	9490

Annual TSP Emissions	lbs/yr	474.5
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total suspended particles	tons/yr	0.24
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2014 Emission Summary

05-54

A. VOC Emissions by Compound

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lb)	Fugitive Emissions (lb)	Accidental Emissions (lb)	Total VOC Emissions (lb)
TFE	Tetrafluoroethylene	116-14-3	63543.0	39.0	0	63582.0
Total VOC Emissions (lb)						63582.0
Total VOC Emissions (tons)						31.79

B. Additional Emissions by Compound

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lb)	Fugitive Emissions (lb)	Accidental Emissions (lb)	Total Emissions (lb)
CO2	Carbon dioxide	124-38-9	127.0	39.0	0	166.0
Total Emissions (lb)						166.0
Total Emissions (tons)						0.08

Point Source Emission Determination**A. Tetrafluoroethylene (TFE)****CAS No. 116-14-3****HF Potential:**

TFE is a VOC without the potential to form HF.

TFE Quantity Generated:

From Precursor area facilitator (mixture is 50% TFE and 50% CO2):

Source	Quantity
TFE/CO2 fed to area	230,399 kg TFE/CO2
Total	115,200 kg TFE fed to area

From area facilitators:

Source	Quantity Consumed
Polymers consumption	59,280 kg TFE
Semiworks consumption	411 kg TFE
MMF consumption	7,494 kg TFE
RSU consumption	19,192 kg TFE
Total	86,377 kg TFE consumed

TFE vented from the TFE/CO2 area in the reporting year:

$$\begin{array}{r} 115200 \text{ kg TFE fed} \\ - 86376.6 \text{ kg TFE consumed} \\ \hline 28822.9 \text{ kg TFE vented} \end{array}$$

VOC Emissions

28822.9 kg VOC
63543.0 lb. VOC

B. Carbon dioxide (CO2)**CAS No. 124-38-9**CO2 Quantity Generated:

From Precursor area facilitator (mixture is 50% TFE and 50% CO2):

Source	Quantity
TFE/CO2 fed to area	230,399 kg TFE/CO2
Total	115,200 kg CO2 sent to Separator

The separator is assumed to remove 99.95% of the CO2. Therefore, the CO2 in the exit stream

Source	Quantity
CO2 in Product	57.6 kg CO2 exiting separator

Assume all CO2 in exit stream is vented.

CO2 Emissions

57.6 kg CO2
127.0 lb. CO2

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

Fugitive emissions (FE) are a function of the number of emission points in the plant (valves, flanges, pump seals). The inventory shown below is conservative and based on plant and process diagrams. Note that the calculations below include only the equipment upstream of the TFE/CO2 mass meter. All other fugitive emissions are included in the system mass balance.

A. Fugitive emissions from TFE/CO2 truck unloading area to vaporizer:

This equipment is not inside a building, therefore emissions are true Fugitive Emissions

Valve emissions:	15 valves x 0.00036 lb/hr/valve	=	0.005 lb/hr FE
Flange emissions:	24 flanges x 0.00018 lb/hr/flange	=	0.004 lb/hr FE
Total TFE/CO2 emission rate		=	0.010 lb/hr FE

Days of operation = 258

VOC:	0.005 lb/hr TFE FE	
x	24 hours/day	
x	258 days/year	
=	30.1 lb/yr VOC from EE	

CO2:	0.005 lb/hr CO2 FE	
x	24 hours/day	
x	258 days/year	
=	30.1 lb/yr CO2 from EE	

B. Fugitive Emissions From TFE/CO2 Vaporizer to TFE/CO2 mass meter:

This equipment is not inside a building, therefore emissions are true Fugitive Emissions

Valve emissions:	2 valves x 0.00036 lb/hr/valve	=	0.001 lb/hr FE
Flange emissions:	12 flanges x 0.00018 lb/hr/flange	=	0.002 lb/hr FE
Total TFE/CO2 emission rate		=	0.003 lb/hr FE

Days of operation = 258

VOC:	0.0014 lb/hr TFE FE	
x	24 hours/day	
x	258 days/year	
=	8.9 lb/yr VOC from EE	

CO2:	0.0014 lb/hr CO2 FE	
x	24 hours/day	
x	258 days/year	
=	8.9 lb/yr CO2 from EE	

D. Total Non-Point Source Fugative Emissions

Emission Source	VOC lb/yr
A. Fugative emissions from TFE/CO2 Truck Unloading area:	30.1
B. Fugitive Emissions From TFE/CO2 Vaporizer	8.9
Total for 2014	39.0

Note: All VOC emissions are TFE. There are no other VOC's used in the TFE/CO2 area.

Emission Source	CO2 lb/yr
A. Fugative emissions from TFE/CO2 Truck Unloading area:	30.1
B. Fugitive Emissions From TFE/CO2 Vaporizer	8.9
Total for 2014	39.0

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2014 Annual VOC Emissions Summary

HFPO Product Container Decontamination Process

Nafion® Compound	CAS Chemical Name	CAS No.	VOC Emissions (lbs)
HFPO	Hexafluoropropylene oxide	428-59-1	13,290
HFA	Hexafluoroacetone	684-16-2	0
Total VOC Emissions (lb)			13,290
Total VOC Emissions (tons)			6.65

Emission Unit ID: NS-N

Emission Source Description: HFPO Product Container Decontamination Process

Emission Calculation Basis:

HFPO product containers returned from customers are decontaminated by venting residual hexafluoropropylene oxide ("HFPO") to the Nafion Division Waste Gas Scrubber (WGS). To determine the amount emitted from this process, the vapor density of HFPO is used along with the volume of the container.

Vapor density is based on Aspen process simulation data at 13°C, which is **0.0377** kg/L.

13°C was chosen based on the average 24 hour temperature for Audubon, NJ, which is located 30 miles northeast of Deepwater, NJ, the location of the primary customer of ISO containers and ton cylinders, i.e. where containers are emptied. (determined from www.worldclimate.com).

The mass of vapor in a container emptied of liquid is equal to the volume of the container multiplied by the vapor density.

$$M_{\text{vap}} = V * \rho_{\text{vap}}$$

Volumes of the containers currently in use are as follows:

<u>Container</u>	<u>Volume (L)</u>	<u>Reference</u>
ISO Container	17,000	NBPF-0460 p. 10
UNT Cylinder	1,000	BPF 353454
1-Ton cylinder	760	Columbiana Boiler Co. Literature
3AA Cylinder	50	222.c-f-c.com/gaslink/cyl/hp3AAcyl.htm

Estimated mass of HFPO vapor emitted from the decontamination of each container is estimated to be:

ISO Container	17,000 L	X	0.0377 kg/L	=	641 kg	=	1,413 lb
UNT Cylinder	1,000 L	X	0.0377 kg/L	=	38 kg	=	83 lb
1-Ton cylinder	760 L	X	0.0377 kg/L	=	29 kg	=	63 lb
3AA cylinder	50 L	X	0.0377 kg/L	=	2 kg	=	4 lb

All containers are assumed to contain HFPO vapor. Occasionally some containers may contain rearranged HFPO in the form of hexafluoroacetone ("HFA"), however this should not affect vapor density since HFA has the same molecular weight as HFPO.

Emission Calculation for 2014

Container Type	Quantity of Containers	VOC per container (lb)	VOC Emissions (lb)
ISO Container	5	1,413	7,065
UNT Cylinder	4	83	332
1-Ton cylinder	13	63	821
3AA Cylinder	32	4	133
Total VOC Emission for All Containers			8,351

Total Containers Decontaminated	54
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Year 2014

05-59

VE-North Product Container Decontamination Process Emission Summary:

Nafion® Compound	CAS Chemical Name	CAS No.	Total Emissions (lb.)
DIMER	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	0.0
PSEPVE	Perfluorinated Sulfonyl Vinyl Ether	16090-14-5	0.0
PPVE	Perfluoropropyl Vinyl Ether	1623-05-8	280.5
EVE	Ester Vinyl Ether	63863-43-4	2.3

Total VOC Emissions (lb.) 283
Total VOC Emissions (tons) 0.14

Prepared by: Broderick Locklear

Emission Unit IDs: NS-O

Emission Source Description: Vinyl Ethers North (VE-N) Product Container
Decontamination Process

Container Emission Estimation Basis:

Dimer, PPVE, PSPEVE and EVE are the products that are produced in the VEN facility. Usually only PPVE is shipped to customers in 1-ton cylinders from the VE Nouth Manufacturing Process. Prior to filling the containers, they are decontaminated by pressurizing with Nitrogen, venting to the Waste Gas Scrubber (WGS) and evacuating for numerous cycles. TA NF-11-1821 has been written to fill on top of heels in cylinders without the need to decontaminate. This will greatly reduce the emissions as a result of decontaminating product shipping containers.

To determine the amount emitted from this process, the vapor density of each component is used along with the volume of the container.

Approximately 50°F (10°C) average year round temperature for Parkersburg, WV where containters are emptied (use this temperature as worse case for all products). Assume when containers are emptied they remain full of vapors.

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. Dimer is an acid fluoride.

Vapor density is based on data from PM Report #231, PM Report PM-E-487 extrapolated to 10°C and the ideal gas equation.

<u>Product</u>	<u>Vapor Density (lb/gal) @ 10°C</u>
Dimer	0.020
PSEPVE	0.001
PPVE	0.034
EVE	0.010

The mass of vapor ("M_{vap}") in a container emptied of liquid is equal to the volume of the container ("V") multiplied by the vapor density ("ρ_{vap}").

$$M_{vap} = V * \rho_{vap}$$

Volumes of the containers currently in use are as follows:

<u>Container</u>	<u>Volume (gal)</u>
ISO	3828
UNT	264
1 ton cylinder	200
4BW cylinder	57
4BA/3AA cylinder	15

**Estimated emissions:****Dimer**

					Before Control	After Control
ISO	### gal	X	0.020 lb/gal	=	76.56 lb	0.30624 lb
UNT	264 gal	X	0.020 lb/gal	=	5.28 lb	0.02112 lb
1 ton cylinder	200 gal	X	0.020 lb/gal	=	4 lb	0.016 lb
4BW cylinder	57 gal	X	0.020 lb/gal	=	1.14 lb	0.0046 lb
4BA/3AA cylinder	15 gal	X	0.020 lb/gal	=	0.3 lb	0.0012 lb

PSEPVE

1 ton cylinder	200 gal	X	0.001 lb/gal	=	0.2 lb	0.2 lb
4BW cylinder	57 gal	X	0.001 lb/gal	=	0.057 lb	0.057 lb
4BA/3AA cylinder	15 gal	X	0.001 lb/gal	=	0.015 lb	0.015 lb

PPVE

1 ton cylinder	200 gal	X	0.034 lb/gal	=	6.8 lb	6.8 lb
4BW cylinder	57 gal	X	0.034 lb/gal	=	1.938 lb	1.938 lb
4BA/3AA cylinder	15 gal	X	0.034 lb/gal	=	0.51 lb	0.51 lb

EVE

1 ton cylinder	200 gal	X	0.010 lb/gal	=	2 lb	2 lb
4BW cylinder	57 gal	X	0.010 lb/gal	=	0.57 lb	0.57 lb
4BA/3AA cylinder	15 gal	X	0.010 lb/gal	=	0.15 lb	0.15 lb

Emission Calculation:

Dimer	Quantity of Containers		VOC per container		VOC Emissions
ISO	0	X	0.306 lb	=	0 lb
UNT	0	X	0.021 lb	=	0 lb
1 ton cylinder	0	X	0.016 lb	=	0 lb
4BW cylinder	0	X	0.005 lb	=	0 lb
4BA/3AA cylinder	0	X	0.001 lb	=	0 lb
PSEPVE					
1 ton cylinder	0	X	0.2 lb	=	0 lb
4BW cylinder	0	X	0.1 lb	=	0 lb
4BA/3AA cylinder	0	X	0.0 lb	=	0 lb
PPVE					
1 ton cylinder	17	X	6.8 lb	=	115.6 lb
4BW cylinder	73	X	1.9 lb	=	141.5 lb
4BA/3AA cylinder	46	X	0.5 lb	=	23.46 lb
EVE					
1 ton cylinder	0	X	2.0 lb	=	0 lb
4BW cylinder	0	X	0.6 lb	=	0 lb
4BA/3AA cylinder	15	X	0.2 lb	=	2.25 lb

NS-P VE South Container Decontamination

0560

Year 2014

VE-South VOC Container Emission Summary:

Nafion® Compound	CAS Chemical Name	CAS No.	Total Emissions (TPY)
PMVE	Perfluoromethyl vinyl ether	1187-93-5	1.32
PEVE	Perfluoroethyl vinyl ether	10493-43-3	0.21
PPVE	Perfluoropropyl vinyl ether	1623-05-8	0.00

Actual TPY Emitted from Containers 1.53

NS-P VE South Container Decontamination

Actual Container Emission Calculations for 2014

Containers used to ship PMVE, PEVE and PPVE from the VE-S process

Container	Container Capacity (gal)
Iso container	4,480
1 ton cylinder	200
4BW cylinder	57
4BA/3AA cylinder	15

Product	Vapor Density @10°C (lb/gal)
PMVE	0.2258
PEVE	0.0901
PPVE	0.0342

Product & Container Type	No. of containers	VOC emitted (lb.)	VOC emitted (ton)
PMVE ISO	2	2,023.2	1.01
PMVE 1 ton	10	451.6	0.23
PMVE 4BW	0	0.0	0.00
PMVE 4BA/3AA	51	172.7	0.09
Total PMVE emitted		2,648.8	1.32

PEVE 1 ton	0	0.0	0.00
PEVE 4BW	81	416.0	0.21
PEVE 4BA/3AA	3	4.1	0.00
Total PEVE emitted		420.3	0.21

PPVE 1 ton	0	0.0	0.00
PPVE 4BW	0	0.0	0.00
PPVE 4BA/3AA	0	0.0	0.00
Total PPVE emitted		0.0	0.00

Total VOC emitted	3,069.1	1.53
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**NATURAL GAS COMBUSTION EMISSIONS CALCULATOR REVISION L 10/08/2013 - OUTPUT SCREEN**

Instructions: Enter emission source / facility data on the "INPUT" tab/screen. The air emission results and summary of input data are viewed / printed on the "OUTPUT" tab/screen. The different tabs are on the bottom of this screen.

This spreadsheet is for your use only and should be used with caution. DENR does not guarantee the accuracy of the information contained. This spreadsheet is subject to continual revision and updating. It is your responsibility to be aware of the most current information available. DENR is not responsible for errors or omissions that may be contained herein.

05-65

SOURCE / FACILITY / USER INPUT SUMMARY (FROM INPUT SCREEN)

COMPANY: DuPont Company - Fayetteville Works				FACILITY ID NO.: 03 / 09 / 00009	
EMISSION SOURCE DESCRIPTION: 139.4 MMBTU/HR NATURAL GAS-FIRED BOILER				PERMIT NUMBER: 03735T39	
EMISSION SOURCE ID NO.: PS-A				FACILITY CITY: Fayetteville	
CONTROL DEVICE: NO CONTROL				FACILITY COUNTY: Bladen	
SPREADSHEET PREPARED BY: Michael E. Johnson				POLLUTANT CONTROL EFF.	
ACTUAL FUEL THROUGHPUT: 492.81		10 ⁶ SCF/YR		FUEL HEAT VALUE: 1,020 BTU/SCF	
POTENTIAL FUEL THROUGHPUT: 1,197.20		10 ⁶ SCF/YR		BOILER TYPE: LARGE WALL-FIRED BOILER (> 100 mmBTU/HR)	
REQUESTED MAX. FUEL THRPT: 1,197.20		10 ⁶ SCF/YR		HOURS OF OPERATIONS: 24	
NO SNCR APPLIED					

CRITERIA AIR POLLUTANT EMISSIONS INFORMATION

AIR POLLUTANT EMITTED	ACTUAL EMISSIONS		POTENTIAL EMISSIONS				EMISSION FACTOR	
	(AFTER CONTROLS / LIMITS)		(BEFORE CONTROLS / LIMITS)		(AFTER CONTROLS / LIMITS)		lb/mmBtu	
	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	uncontrolled	controlled
PARTICULATE MATTER (Total)	1.04	1.87	1.04	4.55	1.04	4.55	0.007	0.007
PARTICULATE MATTER (Condensable)	0.78	1.40	0.78	3.41	0.78	3.41	0.006	0.006
PARTICULATE MATTER (Filterable)	0.26	0.47	0.26	1.14	0.26	1.14	0.002	0.002
SULFUR DIOXIDE (SO ₂)	0.08	0.15	0.08	0.36	0.08	0.36	0.001	0.001
NITROGEN OXIDES (NO _x)	38.27	68.99	38.27	167.61	38.27	167.61	0.275	0.275
CARBON MONOXIDE (CO)	11.48	20.70	11.48	50.28	11.48	50.28	0.082	0.082
VOLATILE ORGANIC COMPOUNDS (VOC)	0.75	1.36	0.75	3.29	0.75	3.29	0.005	0.005

TOXIC / HAZARDOUS AIR POLLUTANT EMISSIONS INFORMATION

TOXIC / HAZARDOUS AIR POLLUTANT	CAS NUMBER	ACTUAL EMISSIONS		POTENTIAL EMISSIONS				EMISSION FACTOR	
		(AFTER CONTROLS / LIMITS)		(BEFORE CONTROLS / LIMITS)		(AFTER CONTROLS / LIMITS)		lb/mmBtu	
		lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	uncontrolled	controlled
Acetaldehyde (TH)	75070	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acrolein (TH)	107028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ammonia (T)	7664417	4.37E-01	1.58E+03	4.37E-01	3.83E+03	4.37E-01	3.83E+03	3.14E-03	3.14E-03
Arsenic unlisted compounds (TH)	ASC-other	2.73E-05	9.86E-02	2.73E-05	2.39E-01	2.73E-05	2.39E-01	1.96E-07	1.96E-07
Benzene (TH)	71432	2.87E-04	1.03E+00	2.87E-04	2.51E+00	2.87E-04	2.51E+00	2.06E-06	2.06E-06
Benzo(a)pyrene (TH)	50328	1.64E-07	5.91E-04	1.64E-07	1.44E-03	1.64E-07	1.44E-03	1.18E-09	1.18E-09
Beryllium metal (unreacted) (TH)	7440417	1.64E-06	5.91E-03	1.64E-06	1.44E-02	1.64E-06	1.44E-02	1.18E-08	1.18E-08
Cadmium metal (elemental unreacted) (TH)	7440439	1.50E-04	5.42E-01	1.50E-04	1.32E+00	1.50E-04	1.32E+00	1.08E-06	1.08E-06
Chromic acid (VI) (TH)	7738945	1.91E-04	6.90E-01	1.91E-04	1.68E+00	1.91E-04	1.68E+00	1.37E-06	1.37E-06
Cobalt unlisted compounds (H)	COC-other	1.15E-05	4.14E-02	1.15E-05	1.01E-01	1.15E-05	1.01E-01	8.24E-08	8.24E-08
Formaldehyde (TH)	50000	1.03E-02	3.70E+01	1.03E-02	8.98E+01	1.03E-02	8.98E+01	7.35E-05	7.35E-05
Hexane, n- (TH)	110543	2.46E-01	8.87E+02	2.46E-01	2.15E+03	2.46E-01	2.15E+03	1.76E-03	1.76E-03
Lead unlisted compounds (H)	PBC-other	6.83E-05	2.46E-01	6.83E-05	5.99E-01	6.83E-05	5.99E-01	4.90E-07	4.90E-07
Manganese unlisted compounds (TH)	MNC-other	5.19E-05	1.87E-01	5.19E-05	4.55E-01	5.19E-05	4.55E-01	3.73E-07	3.73E-07
Mercury vapor (TH)	7439976	3.55E-05	1.28E-01	3.55E-05	3.11E-01	3.55E-05	3.11E-01	2.55E-07	2.55E-07
Naphthalene (H)	91203	8.34E-05	3.01E-01	8.34E-05	7.30E-01	8.34E-05	7.30E-01	5.98E-07	5.98E-07
Nickel metal (TH)	7440020	2.87E-04	1.03E+00	2.87E-04	2.51E+00	2.87E-04	2.51E+00	2.06E-06	2.06E-06
Selenium compounds (H)	SEC	3.28E-06	1.18E-02	3.28E-06	2.87E-02	3.28E-06	2.87E-02	2.35E-08	2.35E-08
Toluene (TH)	108883	4.65E-04	1.68E+00	4.65E-04	4.07E+00	4.65E-04	4.07E+00	3.33E-06	3.33E-06
Total HAPs		2.58E-01	9.30E+02	2.58E-01	2.26E+03	2.58E-01	2.26E+03	1.85E-03	1.85E-03
Highest HAP	Hexane	2.46E-01	8.87E+02	2.46E-01	2.15E+03	2.46E-01	2.15E+03	1.76E-03	1.76E-03

TOXIC AIR POLLUTANT EMISSIONS INFORMATION (FOR PERMITTING PURPOSES)

EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS					EMISSION FACTOR	
TOXIC AIR POLLUTANT	CAS Num.	lb/hr	lb/day	lb/yr	uncontrolled	controlled
Acetaldehyde (TH)	75070	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acrolein (TH)	107028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ammonia (T)	7664417	4.37E-01	1.05E+01	1.58E+03	3.14E-03	3.14E-03
Arsenic unlisted compounds (TH)	ASC-other	2.73E-05	6.56E-04	9.86E-02	1.96E-07	1.96E-07
Benzene (TH)	71432	2.87E-04	6.89E-03	1.03E+00	2.06E-06	2.06E-06
Benzo(a)pyrene (TH)	50328	1.64E-07	3.94E-06	5.91E-04	1.18E-09	1.18E-09
Beryllium metal (unreacted) (TH)	7440417	1.64E-06	3.94E-05	5.91E-03	1.18E-08	1.18E-08
Cadmium metal (elemental unreacted) (TH)	7440439	1.50E-04	3.61E-03	5.42E-01	1.08E-06	1.08E-06
Soluble chromate compounds, as chromium (VI) equivalent	SoICR6	1.91E-04	4.59E-03	6.90E-01	1.37E-06	1.37E-06
Formaldehyde (TH)	50000	1.03E-02	2.46E-01	3.70E+01	7.35E-05	7.35E-05
Hexane, n- (TH)	110543	2.46E-01	5.90E+00	8.87E+02	1.76E-03	1.76E-03
Manganese unlisted compounds (TH)	MNC-other	5.19E-05	1.25E-03	1.87E-01	3.73E-07	3.73E-07
Mercury vapor (TH)	7439976	3.55E-05	8.53E-04	1.28E-01	2.55E-07	2.55E-07
Nickel metal (TH)	7440020	2.87E-04	6.89E-03	1.03E+00	2.06E-06	2.06E-06
Toluene (TH)	108883	4.65E-04	1.12E-02	1.68E+00	3.33E-06	3.33E-06

GREENHOUSE GAS EMISSIONS INFORMATION (FOR EMISSIONS INVENTORY PURPOSES) - CONSISTENT WITH EPA MANDATORY REPORTING RULE (MRR) METHOD**GHG - POTENTIAL TO EMIT NOT BASED ON EPA MRR METHOD**

GREENHOUSE GAS POLLUTANT	ACTUAL EMISSIONS			POTENTIAL EMISSIONS	
	EPA MRR CALCULATION METHOD: TIER 1				
	metric tons/yr	metric tons/yr, CO ₂ e	short tons/yr	short tons/yr	short tons/yr, CO ₂ e
CARBON DIOXIDE (CO ₂)	26860.39		29,608.48	71,369.12	71369.12
METHANE (CH ₄)	5.07E-01	1.06E+01	5.58E-01	1.35E+00	2.83E+01
NITROUS OXIDE (N ₂ O)	5.07E-02	1.57E+01	5.58E-02	1.35E-01	4.17E+01
TOTAL CO ₂ e (metric tons)			26,866.74		TOTAL CO ₂ e (short tons)
					71,439.12

NOTE: CO₂e means CO₂ equivalent

The DAQ Air Emissions Reporting Online (AERO) system requires short tons be reported. The EPA MRR requires metric tons be reported. Do not use greenhouse gas emission estimates from this spreadsheet for PSD (Prevention of Significant Deterioration) purposes.

FUEL OIL COMBUSTION EMISSIONS CALCULATOR REVISION G 11/5/2012 - OUTPUT SCREEN



Instructions: Enter emission source / facility data on the "INPUT" tab/screen. The air emission results and summary of input data are viewed / printed on the "OUTPUT" tab/screen. The different tabs are on the bottom of this screen.

This spreadsheet is for your use only and should be used with caution. DENR does not guarantee the accuracy of the information contained. This spreadsheet is subject to continual revision and updating. It is your responsibility to be aware of the most current information available. DENR is not responsible for errors or omissions that may be contained herein.

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SOURCE / FACILITY / USER INPUT SUMMARY (FROM INPUT SCREEN)

COMPANY:	DuPont Company - Fayetteville Works	MAX HEAT INPUT:	139.40	MMBTU/HR
FACILITY ID NO.:	03 / 09 / 0009	FUEL HEAT VALUE:	140,000	BTU/GAL
PERMIT NUMBER:	03735T39	HHV for GHG CALCULATIONS:	0.138	mm BTU/GAL
FACILITY CITY:	Fayetteville	ACTUAL ANNUAL FUEL USAGE:	50	GAL/YR
FACILITY COUNTY:	Bladen	MAXIMUM ANNUAL FUEL USAGE:	8,722,457	GAL/YR
USER NAME:	Michael E. Johnson	MAXIMUM SULFUR CONTENT:	0.5	%
EMISSION SOURCE DESCRIPTION:	No. 2 oil-fired Boiler	REQUESTED PERMIT LIMITATIONS		
EMISSION SOURCE ID NO.:	PS-A	MAX. FUEL USAGE:	8,722,457	GAL/YR
		MAX. SULFUR CONTENT:	0.5	%
TYPE OF CONTROL DEVICES		POLLUTANT	CONTROL EFF.	
NONE/OTHER		PM	0	
NONE/OTHER		SO2	0	
NONE/OTHER		NOx	0	

METHOD USED TO COMPUTE ACTUAL GHG EMISSIONS: TIER 1: DEFAULT HIGH HEAT VALUE AND DEFAULT EF
CARBON CONTENT USED FOR GHGS (kg C/gal): CARBON CONTENT NOT USED FOR CALCULATION TIER CHOSEN

CRITERIA AIR POLLUTANT EMISSIONS INFORMATION

AIR POLLUTANT EMITTED	ACTUAL EMISSIONS		POTENTIAL EMISSIONS		EMISSION FACTOR	
	(AFTER CONTROLS / LIMITS)	(BEFORE CONTROLS / LIMITS)	(AFTER CONTROLS / LIMITS)	(BEFORE CONTROLS / LIMITS)	uncontrolled	controlled
TOTAL PARTICULATE MATTER (PM) (FPM+CPM)	3.29	0.00	3.29	14.39	3.30E+00	3.30E+00
FILTERABLE PM (FPM)	1.99	0.00	1.99	8.72	2.00E+00	2.00E+00
CONDENSABLE PM (CPM)	1.29	0.00	1.29	5.67	1.30E+00	1.30E+00
FILTERABLE PM<10 MICRONS (PM ₁₀)	1.00	0.00	1.00	4.36	1.00E+00	1.00E+00
FILTERABLE PM<2.5 MICRONS (PM _{2.5})	0.25	0.00	0.25	1.09	2.50E-01	2.50E-01
SULFUR DIOXIDE (SO ₂)	70.70	0.00	70.70	309.65	7.10E+01	7.10E+01
NITROGEN OXIDES (NO _x)	23.90	0.00	23.90	104.67	2.40E+01	2.40E+01
CARBON MONOXIDE (CO)	4.98	0.00	4.98	21.81	5.00E+00	5.00E+00
VOLATILE ORGANIC COMPOUNDS (VOC)	0.20	0.00	0.20	0.87	2.00E-01	2.00E-01
LEAD	0.00	0.00	0.00	0.01	1.26E-03	1.26E-03

TOXIC / HAZARDOUS AIR POLLUTANT EMISSIONS INFORMATION

TOXIC / HAZARDOUS AIR POLLUTANT	CAS NUMBER	ACTUAL EMISSIONS		POTENTIAL EMISSIONS		EMISSION FACTOR	
		(AFTER CONTROLS / LIMITS)	(BEFORE CONTROLS / LIMITS)	(AFTER CONTROLS / LIMITS)	(BEFORE CONTROLS / LIMITS)	uncontrolled	controlled
Antimony Unlisted Compounds	(H) SBC-Other	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
Arsenic Unlisted Compounds	(TH) ASC-Other	5.6E-04	2.8E-05	5.6E-04	4.9E+00	5.60E-04	5.60E-04
Benzene	(TH) 71432	2.7E-03	1.4E-04	2.7E-03	2.4E+01	2.75E-03	2.75E-03
Beryllium Metal (unreacted)	(TH) 7440417	4.2E-04	2.1E-05	4.2E-04	3.7E+00	4.20E-04	4.20E-04
Cadmium Metal (elemental unreacted)	(TH) 7440439	4.2E-04	2.1E-05	4.2E-04	3.7E+00	4.20E-04	4.20E-04
Chromic Acid (VI)	(TH) 7738945	4.2E-04	2.1E-05	4.2E-04	3.7E+00	4.20E-04	4.20E-04
Cobalt Unlisted Compounds	(H) COC-Other	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
Ethylbenzene	(H) 100414	8.1E-04	4.1E-05	8.1E-04	7.1E+00	8.17E-04	8.17E-04
Fluorides (sum fluoride compounds)	(T) 16984488	3.7E-02	1.9E-03	3.7E-02	3.3E+02	3.73E-02	3.73E-02
Formaldehyde	(TH) 50000	4.8E-02	2.4E-03	4.8E-02	4.2E+02	4.80E-02	4.80E-02
Lead Unlisted Compounds	(H) PBC-Other	1.3E-03	6.3E-05	1.3E-03	1.1E+01	1.26E-03	1.26E-03
Manganese Unlisted Compounds	(TH) MNC-Other	8.4E-04	4.2E-05	8.4E-04	7.3E+00	8.40E-04	8.40E-04
Mercury, vapor	(TH) 7439976	4.2E-04	2.1E-05	4.2E-04	3.7E+00	4.20E-04	4.20E-04
Methyl chloroform	(TH) 71566	2.3E-04	1.2E-05	2.3E-04	2.1E+00	2.36E-04	2.36E-04
Naphthalene	(H) 91203	3.3E-04	1.7E-05	3.3E-04	2.9E+00	3.33E-04	3.33E-04
Nickel Metal	(TH) 7440020	4.2E-04	2.1E-05	4.2E-04	3.7E+00	4.20E-04	4.20E-04
Phosphorus Metal, Yellow or White	(H) 7723140	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
POM rates uncontrolled	(H) POM	3.3E-03	1.7E-04	3.3E-03	2.9E+01	3.30E-03	3.30E-03
Selenium compounds	(H) SEC	2.1E-03	1.1E-04	2.1E-03	1.8E+01	2.10E-03	2.10E-03
Toluene	(TH) 108883	7.9E-02	4.0E-03	7.9E-02	6.9E+02	7.97E-02	7.97E-02
Xylene	(TH) 1330207	1.4E-03	7.0E-05	1.4E-03	1.2E+01	1.40E-03	1.40E-03
Total HAP	(H)	1.4E-01	7.2E-03	1.4E-01	1.3E+03	1.4E-01	1.4E-01
Largest HAP	(H)	7.93E-02	3.98E-03	7.93E-02	6.95E+02	7.97E-02	7.97E-02

EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS

TOXIC AIR POLLUTANT	CAS Num.	EMISSION FACTOR	
		uncontrolled	controlled
Arsenic Unlisted Compounds	(TH) ASC-Other	5.60E-04	5.60E-04
Benzene	(TH) 71432	2.75E-03	2.75E-03
Beryllium Metal (unreacted)	(TH) 7440417	4.20E-04	4.20E-04
Cadmium Metal (elemental unreacted)	(TH) 7440439	4.20E-04	4.20E-04
Soluble chromate compounds, as chromium (VI)	(TH) SolCr6	4.20E-04	4.20E-04
Fluorides (sum fluoride compounds)	(T) 16984488	3.73E-02	3.73E-02
Formaldehyde	(TH) 50000	4.80E-02	4.80E-02
Manganese Unlisted Compounds	(TH) MNC-Other	8.40E-04	8.40E-04
Mercury, vapor	(TH) 7439976	4.20E-04	4.20E-04
Methyl chloroform	(TH) 71566	2.36E-04	2.36E-04
Nickel Metal	(TH) 7440020	4.20E-04	4.20E-04
Toluene	(TH) 108883	7.97E-02	7.97E-02
Xylene	(TH) 1330207	1.40E-03	1.40E-03

GREENHOUSE GAS EMISSIONS INFORMATION (FOR EMISSIONS INVENTORY PURPOSES) - CONSISTENT WITH EPA MANDATORY REPORTING RULE (MRR) METHOD

GHG - POTENTIAL TO EMIT NOT BASED ON EPA MRR METHOD

GREENHOUSE GAS POLLUTANT	ACTUAL EMISSIONS			POTENTIAL EMISSIONS - utilize max heat input capacity and EPA MRR Emission Factors		POTENTIAL EMISSIONS With Requested Emission Limitation - utilize requested fuel limit and EPA MRR Emission Factors	
	EPA MRR CALCULATION METHOD: TIER 1			short tons/yr, CO2e		short tons/yr, CO2e	
CARBON DIOXIDE (CO ₂)	metric tons/yr	metric tons/yr, CO2e	short tons/yr	short tons/yr	short tons/yr, CO2e	short tons/yr	short tons/yr, CO2e
	0.51	0.51	0.56	99,556.02	99,556.02	99,556.02	99,556.02
METHANE (CH ₄)	2.07E-05	4.35E-04	2.28E-05	4.04E+00	8.48E+01	4.04E+00	8.48E+01
NITROUS OXIDE (N ₂ O)	4.14E-06	1.28E-03	4.56E-06	8.08E-01	2.50E+02	8.08E-01	2.50E+02
TOTAL		0.51		TOTAL	99,891.19	TOTAL	99,891.19

NOTES: 1) CO2e means CO2 equivalent
2) The DAQ Air Emissions Reporting Online (AERO) system requires short tons and the EPA MRR requires metric tons

Boiler PS-A

Hydrogen Chloride (HCl)

CAS No. 7647-01-0

The EPA Industrial Boiler MACT rulemaking emission factor for uncontrolled residual and distillate oil firing is given as 7.1E-5 lb/MMBtu in Docket Document Number II-B-8, Development of Average Emission Factors and Baseline Emission Estimates for the Industrial, Commercial, and Institutional Boilers and Process Heaters NESHAP, October 2002; so that figure is used as the latest information from EPA.

EPA emission factor = **7.1E-05** pounds of HCl per million BTUs generated in the boiler.

From the memo from Christy Burlew and Roy Oommen, Eastern Research Group to Jim Eddinger, U.S. EPA, OAQPS, October, 2002, Development of Average Emission Factors and Baseline Emission Estimates for the Industrial, Commercial, and Institutional Boilers and Process Heaters National Emission Standard for Hazardous Air Pollutants, Appendix A, the HCl emission factor for natural gas combustion is 1.24 x 10⁻⁵ lb. per MM-BTU.

Emission factor = **1.24E-05** pounds of HCl per million BTUs generated in the boiler.

PS-A emissions of HCl:

50 gallons of No. 2 fuel oil were burned in 2014

$$50 \text{ gal. No. 2 F.O.} \times \frac{0.140 \text{ MM-BTU}}{\text{gal. No. 2 F.O.}} = 7.00\text{E}+00 \text{ MM-BTU}$$

$$7.00\text{E}+00 \text{ MM-BTU} \times \frac{7.1\text{E}-05 \text{ lb HCl}}{\text{MM-BTU}} = \mathbf{0.0 \text{ lb HCl}}$$

492.81 MM-scf of Natural Gas were burned in 2014

$$492.810 \text{ MM-scf Natural Gas} \times \frac{1,028 \text{ BTU}}{\text{scf Natural Gas}} = 506,609 \text{ MM-BTU}$$

$$506,609 \text{ MM-BTU} \times \frac{1.2\text{E}-05 \text{ lb HCl}}{\text{MM-BTU}} = \mathbf{6.3 \text{ lb HCl}}$$

Total HCl emissions:

$$\begin{array}{r} 0.0 \text{ lb HCl from No. 2 F.O.} \\ + \quad 6.3 \text{ lb HCl from Natural Gas} \\ \hline \mathbf{6.3 \text{ lb. HCl emissions}} \end{array}$$

**NATURAL GAS COMBUSTION EMISSIONS CALCULATOR REVISION L 10/08/2013 - OUTPUT SCREEN**

Instructions: Enter emission source / facility data on the "INPUT" tab/screen. The air emission results and summary of input data are viewed / printed on the "OUTPUT" tab/screen. The different tabs are on the bottom of this screen.

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SOURCE / FACILITY / USER INPUT SUMMARY (FROM INPUT SCREEN)

COMPANY: DuPont Company - Fayetteville Works				FACILITY ID NO.: 03 / 09 / 00009	
EMISSION SOURCE DESCRIPTION: 88.4 MMBTU/HR NATURAL GAS-FIRED BOILER				PERMIT NUMBER: 03735739	
EMISSION SOURCE ID NO.: PS-B				FACILITY CITY: Fayetteville	
CONTROL DEVICE: NO CONTROL				FACILITY COUNTY: Bladen	
SPREADSHEET PREPARED BY: Michael E. Johnson				POLLUTANT	
ACTUAL FUEL THROUGHPUT: 135.54 10 ⁶ SCF/YR				NOX	
FUEL HEAT VALUE: 1,020 BTU/SCF				CONTROL EFF. CALC'D AS 0%	
POTENTIAL FUEL THROUGHPUT: 759.20 10 ⁶ SCF/YR		BOILER TYPE: SMALL BOILER (<100 mmBTU/HR)		NO SNCR APPLIED	
REQUESTED MAX. FUEL THRPT: 759.20 10 ⁶ SCF/YR		HOURS OF OPERATIONS: 24			

CRITERIA AIR POLLUTANT EMISSIONS INFORMATION

AIR POLLUTANT EMITTED	ACTUAL EMISSIONS		POTENTIAL EMISSIONS				EMISSION FACTOR	
	(AFTER CONTROLS / LIMITS)		(BEFORE CONTROLS / LIMITS)		(AFTER CONTROLS / LIMITS)		lb/mmBtu	
	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	uncontrolled	controlled
PARTICULATE MATTER (Total)	0.66	0.52	0.66	2.88	0.66	2.88	0.007	0.007
PARTICULATE MATTER (Condensable)	0.49	0.39	0.49	2.16	0.49	2.16	0.006	0.006
PARTICULATE MATTER (Filterable)	0.16	0.13	0.16	0.72	0.16	0.72	0.002	0.002
SULFUR DIOXIDE (SO ₂)	0.05	0.04	0.05	0.23	0.05	0.23	0.001	0.001
NITROGEN OXIDES (NO _x)	8.67	6.78	8.67	37.96	8.67	37.96	0.098	0.098
CARBON MONOXIDE (CO)	7.28	5.69	7.28	31.89	7.28	31.89	0.082	0.082
VOLATILE ORGANIC COMPOUNDS (VOC)	0.48	0.37	0.48	2.09	0.48	2.09	0.005	0.005

TOXIC / HAZARDOUS AIR POLLUTANT EMISSIONS INFORMATION

TOXIC / HAZARDOUS AIR POLLUTANT	CAS NUMBER	ACTUAL EMISSIONS		POTENTIAL EMISSIONS				EMISSION FACTOR	
		(AFTER CONTROLS / LIMITS)		(BEFORE CONTROLS / LIMITS)		(AFTER CONTROLS / LIMITS)		lb/mmBtu	
		lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	uncontrolled	controlled
Acetaldehyde (TH)	75070	1.32E-06	2.06E-03	1.32E-06	1.15E-02	1.32E-06	1.15E-02	1.49E-08	1.49E-08
Acrolein (TH)	107028	1.56E-06	2.44E-03	1.56E-06	1.37E-02	1.56E-06	1.37E-02	1.76E-08	1.76E-08
Ammonia (T)	7664417	2.77E-01	4.34E+02	2.77E-01	2.43E+03	2.77E-01	2.43E+03	3.14E-03	3.14E-03
Arsenic unlisted compounds (TH)	ASC-other	1.73E-05	2.71E-02	1.73E-05	1.52E-01	1.73E-05	1.52E-01	1.96E-07	1.96E-07
Benzene (TH)	71432	1.82E-04	2.85E-01	1.82E-04	1.59E+00	1.82E-04	1.59E+00	2.06E-06	2.06E-06
Benzo(a)pyrene (TH)	50328	1.04E-07	1.63E-04	1.04E-07	9.11E-04	1.04E-07	9.11E-04	1.18E-09	1.18E-09
Beryllium metal (unreacted) (TH)	7440417	1.04E-06	1.63E-03	1.04E-06	9.11E-03	1.04E-06	9.11E-03	1.18E-08	1.18E-08
Cadmium metal (elemental unreacted) (TH)	7440439	9.53E-05	1.49E-01	9.53E-05	8.35E-01	9.53E-05	8.35E-01	1.08E-06	1.08E-06
Chromic acid (VI) (TH)	7738945	1.21E-04	1.90E-01	1.21E-04	1.06E+00	1.21E-04	1.06E+00	1.37E-06	1.37E-06
Cobalt unlisted compounds (H)	COC-other	7.28E-06	1.14E-02	7.28E-06	6.38E-02	7.28E-06	6.38E-02	8.24E-08	8.24E-08
Formaldehyde (TH)	50000	6.50E-03	1.02E+01	6.50E-03	5.69E+01	6.50E-03	5.69E+01	7.35E-05	7.35E-05
Hexane, n- (TH)	110543	1.56E-01	2.44E+02	1.56E-01	1.37E+03	1.56E-01	1.37E+03	1.76E-03	1.76E-03
Lead unlisted compounds (H)	PBC-other	4.33E-05	6.78E-02	4.33E-05	3.80E-01	4.33E-05	3.80E-01	4.90E-07	4.90E-07
Manganese unlisted compounds (TH)	MNC-other	3.29E-05	5.15E-02	3.29E-05	2.88E-01	3.29E-05	2.88E-01	3.73E-07	3.73E-07
Mercury vapor (TH)	7439976	2.25E-05	3.52E-02	2.25E-05	1.97E-01	2.25E-05	1.97E-01	2.55E-07	2.55E-07
Naphthalene (H)	91203	5.29E-05	8.27E-02	5.29E-05	4.63E-01	5.29E-05	4.63E-01	5.98E-07	5.98E-07
Nickel metal (TH)	7440020	1.82E-04	2.85E-01	1.82E-04	1.59E+00	1.82E-04	1.59E+00	2.06E-06	2.06E-06
Selenium compounds (H)	SEC	2.08E-06	3.25E-03	2.08E-06	1.82E-02	2.08E-06	1.82E-02	2.35E-08	2.35E-08
Toluene (TH)	108883	2.95E-04	4.61E-01	2.95E-04	2.58E+00	2.95E-04	2.58E+00	3.33E-06	3.33E-06
Total HAPs		1.64E-01	2.56E+02	1.64E-01	1.43E+03	1.64E-01	1.43E+03	1.85E-03	1.85E-03
Highest HAP	Hexane	1.56E-01	2.44E+02	1.56E-01	1.37E+03	1.56E-01	1.37E+03	1.76E-03	1.76E-03

TOXIC AIR POLLUTANT EMISSIONS INFORMATION (FOR PERMITTING PURPOSES)

EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS					EMISSION FACTOR	
TOXIC AIR POLLUTANT	CAS Num.	lb/hr	lb/day	lb/yr	uncontrolled	controlled
Acetaldehyde (TH)	75070	1.32E-06	3.16E-05	2.06E-03	1.49E-08	1.49E-08
Acrolein (TH)	107028	1.56E-06	3.74E-05	2.44E-03	1.76E-08	1.76E-08
Ammonia (T)	7664417	2.77E-01	6.66E+00	4.34E+02	3.14E-03	3.14E-03
Arsenic unlisted compounds (TH)	ASC-other	1.73E-05	4.16E-04	2.71E-02	1.96E-07	1.96E-07
Benzene (TH)	71432	1.82E-04	4.37E-03	2.85E-01	2.06E-06	2.06E-06
Benzo(a)pyrene (TH)	50328	1.04E-07	2.50E-06	1.63E-04	1.18E-09	1.18E-09
Beryllium metal (unreacted) (TH)	7440417	1.04E-06	2.50E-05	1.63E-03	1.18E-08	1.18E-08
Cadmium metal (elemental unreacted) (TH)	7440439	9.53E-05	2.29E-03	1.49E-01	1.08E-06	1.08E-06
Soluble chromate compounds, as chromium (VI) equivalent	SoICR6	1.21E-04	2.91E-03	1.90E-01	1.37E-06	1.37E-06
Formaldehyde (TH)	50000	6.50E-03	1.56E-01	1.02E+01	7.35E-05	7.35E-05
Hexane, n- (TH)	110543	1.56E-01	3.74E+00	2.44E+02	1.76E-03	1.76E-03
Manganese unlisted compounds (TH)	MNC-other	3.29E-05	7.90E-04	5.15E-02	3.73E-07	3.73E-07
Mercury vapor (TH)	7439976	2.25E-05	5.41E-04	3.52E-02	2.55E-07	2.55E-07
Nickel metal (TH)	7440020	1.82E-04	4.37E-03	2.85E-01	2.06E-06	2.06E-06
Toluene (TH)	108883	2.95E-04	7.07E-03	4.61E-01	3.33E-06	3.33E-06

GREENHOUSE GAS EMISSIONS INFORMATION (FOR EMISSIONS INVENTORY PURPOSES) - CONSISTENT WITH EPA MANDATORY REPORTING RULE (MRR) METHOD**GHG - POTENTIAL TO EMIT NOT BASED ON EPA MRR METHOD**

GREENHOUSE GAS POLLUTANT	ACTUAL EMISSIONS			POTENTIAL EMISSIONS	
	EPA MRR CALCULATION METHOD: TIER 1				
	metric tons/yr	metric tons/yr, CO ₂ e	short tons/yr	short tons/yr	short tons/yr, CO ₂ e
CARBON DIOXIDE (CO ₂)	7387.55	7,387.55	8,143.37	45,258.47	45258.47
METHANE (CH ₄)	1.39E-01	2.93E+00	1.54E-01	8.54E-01	1.79E+01
NITROUS OXIDE (N ₂ O)	1.39E-02	4.32E+00	1.54E-02	8.54E-02	2.65E+01
TOTAL CO ₂ e (metric tons)			7,394.79	TOTAL CO ₂ e (short tons)	
				45,302.86	

NOTE: CO₂e means CO₂ equivalent

The DAQ Air Emissions Reporting Online (AERO) system requires short tons be reported. The EPA MRR requires metric tons be reported. Do not use greenhouse gas emission estimates from this spreadsheet for PSD (Prevention of Significant Deterioration) purposes.

FUEL OIL COMBUSTION EMISSIONS CALCULATOR REVISION G 11/5/2012 - OUTPUT SCREEN



Instructions: Enter emission source / facility data on the "INPUT" tab/screen. The air emission results and summary of input data are viewed / printed on the "OUTPUT" tab/screen. The different tabs are on the bottom of this screen.

This spreadsheet is for your use only and should be used with caution. DENR does not guarantee the accuracy of the information contained. This spreadsheet is subject to continual revision and updating. It is your responsibility to be aware of the most current information available. DENR is not responsible for errors or omissions that may be contained herein.

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SOURCE / FACILITY / USER INPUT SUMMARY (FROM INPUT SCREEN)

COMPANY:	DuPont Company - Fayetteville Works	MAX HEAT INPUT:	88.40	MMBTU/HR
FACILITY ID NO.:	03 / 09 / 0009	FUEL HEAT VALUE:	140,000	BTU/GAL
PERMIT NUMBER:	03735T39	HHV for GHG CALCULATIONS:	0.138	mm BTU/GAL
FACILITY CITY:	Fayetteville	ACTUAL ANNUAL FUEL USAGE:	48,922	GAL/YR
FACILITY COUNTY:	Bladen	MAXIMUM ANNUAL FUEL USAGE:	5,531,314	GAL/YR
USER NAME:	Michael E. Johnson	MAXIMUM SULFUR CONTENT:	0.5	%
EMISSION SOURCE DESCRIPTION:	No. 2 oil-fired Boiler	REQUESTED PERMIT LIMITATIONS		
EMISSION SOURCE ID NO.:	PS-B	MAX. FUEL USAGE:	5,531,314	GAL/YR
		MAX. SULFUR CONTENT:	0.5	%

TYPE OF CONTROL DEVICES	POLLUTANT	CONTROL EFF.
NONE/OTHER	PM	0
NONE/OTHER	SO2	0
NONE/OTHER	NOx	0

METHOD USED TO COMPUTE ACTUAL GHG EMISSIONS: TIER 1: DEFAULT HIGH HEAT VALUE AND DEFAULT EF
CARBON CONTENT USED FOR GHGS (kg C/gal): CARBON CONTENT NOT USED FOR CALCULATION TIER CHOSEN

CRITERIA AIR POLLUTANT EMISSIONS INFORMATION

AIR POLLUTANT EMITTED	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS)		POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS)		POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS)		EMISSION FACTOR (lb/10 ³ gal)	
	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	uncontrolled	controlled
TOTAL PARTICULATE MATTER (PM) (FPM+CPM)	2.08	0.08	2.08	9.13	2.08	9.13	3.30E+00	3.30E+00
FILTERABLE PM (FPM)	1.26	0.05	1.26	5.53	1.26	5.53	2.00E+00	2.00E+00
CONDENSABLE PM (CPM)	0.82	0.03	0.82	3.60	0.82	3.60	1.30E+00	1.30E+00
FILTERABLE PM<10 MICRONS (PM ₁₀)	0.63	0.02	0.63	2.77	0.63	2.77	1.00E+00	1.00E+00
FILTERABLE PM<2.5 MICRONS (PM _{2.5})	0.16	0.01	0.16	0.69	0.16	0.69	2.50E-01	2.50E-01
SULFUR DIOXIDE (SO ₂)	44.83	1.74	44.83	196.36	44.83	196.36	7.10E+01	7.10E+01
NITROGEN OXIDES (NO _x)	12.63	0.49	12.63	55.31	12.63	55.31	2.00E+01	2.00E+01
CARBON MONOXIDE (CO)	3.16	0.12	3.16	13.83	3.16	13.83	5.00E+00	5.00E+00
VOLATILE ORGANIC COMPOUNDS (VOC)	0.13	0.00	0.13	0.55	0.13	0.55	2.00E-01	2.00E-01
LEAD	0.00	0.00	0.00	0.00	0.00	0.00	1.26E-03	1.26E-03

TOXIC / HAZARDOUS AIR POLLUTANT EMISSIONS INFORMATION

TOXIC / HAZARDOUS AIR POLLUTANT	CAS NUMBER	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS)		POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS)		POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS)		EMISSION FACTOR (lb/10 ³ gal)	
		lb/hr	lb/yr	lb/hr	lb/yr	lb/hr	lb/yr	uncontrolled	controlled
Antimony Unlisted Compounds	(H) SBC-Other	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
Arsenic Unlisted Compounds	(TH) ASC-Other	3.5E-04	2.7E-02	3.5E-04	3.1E+00	3.5E-04	3.1E+00	5.60E-04	5.60E-04
Benzene	(TH) 71432	1.7E-03	1.3E-01	1.7E-03	1.5E+01	1.7E-03	1.5E+01	2.75E-03	2.75E-03
Beryllium Metal (unreacted)	(TH) 7440417	2.7E-04	2.1E-02	2.7E-04	2.3E+00	2.7E-04	2.3E+00	4.20E-04	4.20E-04
Cadmium Metal (elemental unreacted)	(TH) 7440439	2.7E-04	2.1E-02	2.7E-04	2.3E+00	2.7E-04	2.3E+00	4.20E-04	4.20E-04
Chromium Acid (VI)	(TH) 7738945	2.7E-04	2.1E-02	2.7E-04	2.3E+00	2.7E-04	2.3E+00	4.20E-04	4.20E-04
Cobalt Unlisted Compounds	(H) COC-Other	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
Ethylbenzene	(H) 100414	5.2E-04	4.0E-02	5.2E-04	4.5E+00	5.2E-04	4.5E+00	8.17E-04	8.17E-04
Fluorides (sum fluoride compounds)	(T) 16984488	2.4E-02	1.8E+00	2.4E-02	2.1E+02	2.4E-02	2.1E+02	3.73E-02	3.73E-02
Formaldehyde	(TH) 50000	3.0E-02	2.3E+00	3.0E-02	2.7E+02	3.0E-02	2.7E+02	4.80E-02	4.80E-02
Lead Unlisted Compounds	(H) PBC-Other	8.0E-04	6.2E-02	8.0E-04	7.0E+00	8.0E-04	7.0E+00	1.26E-03	1.26E-03
Manganese Unlisted Compounds	(TH) MNC-Other	5.3E-04	4.1E-02	5.3E-04	4.6E+00	5.3E-04	4.6E+00	8.40E-04	8.40E-04
Mercury, vapor	(TH) 7439976	2.7E-04	2.1E-02	2.7E-04	2.3E+00	2.7E-04	2.3E+00	4.20E-04	4.20E-04
Methyl chloroform	(TH) 71566	1.5E-04	1.2E-02	1.5E-04	1.3E+00	1.5E-04	1.3E+00	2.36E-04	2.36E-04
Naphthalene	(H) 91203	2.1E-04	1.6E-02	2.1E-04	1.8E+00	2.1E-04	1.8E+00	3.33E-04	3.33E-04
Nickel Metal	(TH) 7440020	2.7E-04	2.1E-02	2.7E-04	2.3E+00	2.7E-04	2.3E+00	4.20E-04	4.20E-04
Phosphorus Metal, Yellow or White	(H) 7723140	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
POM rates uncontrolled	(H) POM	2.1E-03	1.6E-01	2.1E-03	1.8E+01	2.1E-03	1.8E+01	3.30E-03	3.30E-03
Selenium compounds	(H) SEC	1.3E-03	1.0E-01	1.3E-03	1.2E+01	1.3E-03	1.2E+01	2.10E-03	2.10E-03
Toluene	(TH) 108883	5.0E-02	3.9E+00	5.0E-02	4.4E+02	5.0E-02	4.4E+02	7.97E-02	7.97E-02
Xylene	(TH) 1330207	8.8E-04	6.9E-02	8.8E-04	7.7E+00	8.8E-04	7.7E+00	1.40E-03	1.40E-03
Total HAP	(H)	9.1E-02	7.0E+00	9.1E-02	7.9E+02	9.1E-02	7.9E+02	1.4E-01	1.4E-01
Largest HAP	(H)	5.03E-02	3.90E+00	5.03E-02	4.41E+02	5.03E-02	4.41E+02	7.97E-02	7.97E-02

TOXIC AIR POLLUTANT EMISSIONS INFORMATION (FOR PERMITTING PURPOSES)

EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS					EMISSION FACTOR (lb/10 ³ gal)	
TOXIC AIR POLLUTANT	CAS Num.	lb/hr	lb/day	lb/yr	uncontrolled	controlled
Arsenic Unlisted Compounds	(TH) ASC-Other	3.54E-04	8.49E-03	3.10E+00	5.60E-04	5.60E-04
Benzene	(TH) 71432	1.74E-03	4.17E-02	1.52E+01	2.75E-03	2.75E-03
Beryllium Metal (unreacted)	(TH) 7440417	2.65E-04	6.36E-03	2.32E+00	4.20E-04	4.20E-04
Cadmium Metal (elemental unreacted)	(TH) 7440439	2.65E-04	6.36E-03	2.32E+00	4.20E-04	4.20E-04
Soluble chromate compounds, as chromium (VI)	(TH) SolCR6	2.65E-04	6.36E-03	2.32E+00	4.20E-04	4.20E-04
Fluorides (sum fluoride compounds)	(T) 16984488	2.36E-02	5.65E-01	2.06E+02	3.73E-02	3.73E-02
Formaldehyde	(TH) 50000	3.03E-02	7.27E-01	2.66E+02	4.80E-02	4.80E-02
Manganese Unlisted Compounds	(TH) MNC-Other	5.30E-04	1.27E-02	4.65E+00	8.40E-04	8.40E-04
Mercury, vapor	(TH) 7439976	2.65E-04	6.36E-03	2.32E+00	4.20E-04	4.20E-04
Methyl chloroform	(TH) 71566	1.49E-04	3.58E-03	1.31E+00	2.36E-04	2.36E-04
Nickel Metal	(TH) 7440020	2.65E-04	6.36E-03	2.32E+00	4.20E-04	4.20E-04
Toluene	(TH) 108883	5.03E-02	1.21E+00	4.41E+02	7.97E-02	7.97E-02
Xylene	(TH) 1330207	8.84E-04	2.12E-02	7.75E+00	1.40E-03	1.40E-03

**GREENHOUSE GAS EMISSIONS INFORMATION (FOR EMISSIONS INVENTORY PURPOSES) -
CONSISTENT WITH EPA MANDATORY REPORTING RULE (MRR) METHOD**

**GHG - POTENTIAL TO EMIT
NOT BASED ON EPA MRR METHOD**

GREENHOUSE GAS POLLUTANT	ACTUAL EMISSIONS			POTENTIAL EMISSIONS - utilize max heat input capacity and EPA MRR Emission Factors		POTENTIAL EMISSIONS With Requested Emission Limitation - utilize requested fuel limit and EPA MRR Emission Factors	
	EPA MRR CALCULATION METHOD: TIER 1			Factors		Factors	
	metric tons/yr	metric tons/yr, CO2e	short tons/yr	short tons/yr	CO2e	short tons/yr	CO2e
CARBON DIOXIDE (CO ₂)	499.32	499.32	550.41	63,133.09	63,133.09	63,133.09	63,133.09
METHANE (CH ₄)	2.03E-02	4.25E-01	2.23E-02	2.56E+00	5.38E+01	2.58E+00	5.38E+01
NITROUS OXIDE (N ₂ O)	4.05E-03	1.26E+00	4.47E-03	5.12E-01	1.59E+02	5.12E-01	1.59E+02
TOTAL		501.00		TOTAL	63,345.64	TOTAL	63,345.64

NOTES: 1) CO2e means CO2 equivalent
2) The DAQ Air Emissions Reporting Online (AERO) system requires short tons and the EPA MRR requires metric tons

Boiler PS-B

Hydrogen Chloride (HCl)

CAS No. 7647-01-0

The EPA Industrial Boiler MACT rulemaking emission factor for uncontrolled residual and distillate oil firing is given as 7.1E-5 lb/MMBtu in Docket Document Number II-B-8, Development of Average Emission Factors and Baseline Emission Estimates for the Industrial, Commercial, and Institutional Boilers and Process Heaters NESHAP, October 2002; so that figure is used as the latest information from EPA.

EPA emission factor = **7.1E-05** pounds of HCl per million BTUs generated in the boiler.

From the memo from Christy Burlew and Roy Oommen, Eastern Research Group to Jim Eddinger, U.S. EPA, OAQPS, October, 2002, Development of Average Emission Factors and Baseline Emission Estimates for the Industrial, Commercial, and Institutional Boilers and Process Heaters National Emission Standard for Hazardous Air Pollutants, Appendix A, the HCl emission factor for natural gas combustion is 1.24 x 10⁻⁵ lb. per MM-BTU.

Emission factor = **1.24E-05** pounds of HCl per million BTUs generated in the boiler.

PS-B emissions of HCl:

48,922 gallons of No. 2 fuel oil were burned in 2014

$$48,922 \text{ gal. No. 2 F.O.} \times \frac{0.140 \text{ MM-BTU}}{\text{gal. No. 2 F.O.}} = 6.85\text{E}+03 \text{ MM-BTU}$$

$$6.85\text{E}+03 \text{ MM-BTU} \times \frac{7.1\text{E}-05 \text{ lb HCl}}{\text{MM-BTU}} = \mathbf{0.49 \text{ lb HCl}}$$

135.54 MM-scf of Natural Gas were burned in 2014

$$135.540 \text{ MM-scf Natural Gas} \times \frac{1,028 \text{ BTU}}{\text{scf Natural Gas}} = 139,335 \text{ MM-BTU}$$

$$139,335 \text{ MM-BTU} \times \frac{1.2\text{E}-05 \text{ lb HCl}}{\text{MM-BTU}} = \mathbf{1.7 \text{ lb HCl}}$$

Total HCl emissions:

$$\begin{array}{r} 0.5 \text{ lb HCl from No. 2 F.O.} \\ + \quad 1.7 \text{ lb HCl from Natural Gas} \\ \hline \mathbf{2.2 \text{ lb. HCl emissions}} \end{array}$$

Emission Summary

05-44

A. VOC Emissions by Compound and Source

SentryGlas® Compound	CAS Chemical Number	Point Source Emissions (lb.)	Total Emissions (lb.)
Ethylene	74-85-1	1,147	1,147
Methacrylic acid	79-41-4	3,728	3,728
Methanol	67-56-1	574	574
Mineral Spirits	8052-41-3	9,006	9,006
Total VOC Emissions in 2014 (lb.)			14,455
Total VOC Emissions in 2014 (ton)			7.23

B. Particulate Matter Emissions by Compound and Source

SentryGlas® Compound	CAS Chemical Name	Point Source Emissions (lb.)	Total Emissions (lb.)
Tinuvin 328	25973-55-1	1,262	1,262
Total PM Emissions in 2014 (lb.)			1,262
Total TSP Emissions in 2014 (ton)			0.63
Total PM10 Emissions in 2014 (ton)			0.63
Total PM2.5 Emissions in 2014 (ton)			0.63

C. Hazardous Air Pollutant Summary

SentryGlas® Compound	CAS Chemical Name	Point Source Emissions (lb.)	Total Emissions (lb.)
Methanol	67-56-1	574	574

Point Source Emission Determination

Emissions from the SentryGlas® Process are reported as Volatile Organic Compounds ("VOC"), Particulate Matter ("PM" and "TSP"), and in the case of methanol as a Hazardous Air Pollutant ("HAP"). All emissions are based on the emissions at full design rates.

Emissions of particulates from the SentryGlas® Process are discharged inside the manufacturing building, thus there should be no emissions of particulate matter. However, to be conservative, the emission of Tinuvin 328, a solid, will be reported as PM emissions.

The emission rates from the SentryGlas® Process are based on the emissions from a sister manufacturing facility. The reported emissions are based on the emissions from the process at full production design rates, and are expressed as pounds of pollutant per Time Unit ("TU").

SentryGlas® Compound	CAS Number	VOC Emissions (lb/TU)	Annual Operation (TU)	Total Emissions (lb)
Ethylene	74-85-1	0.63	1,826	1,147
Methacrylic acid	79-41-4	2.04	1,826	3,728
Methanol	67-56-1	0.31	1,826	574
Mineral Spirits	8052-41-3	4.93	1,826	9,006
Tinuvin 328	25973-55-1	0.69	1,826	1,262

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Material Balance Summary

Compound	Added	Remaining	Used	Production	VOC Emitted (kg)
E2	195.0	83.4	111.6	0.0	111.6
PSEPVE	302.6	36.4	266.2	154.4	111.7
TFE	410.6	0.0	410.6	369.5	41.1
F113	1048.4	432.7	615.8	0.0	0.0
Initiator	4.5	0.0	4.5	0.0	4.5
					Total (kg) 268.9
					Total (lb) 591.7
					Total (ton) 0.30
VE Yield					
Vinyl Ether =	PSEPVE	MW = 446			
VE in polymer	154.4	% in polymer = 58.0%			
VE used	266.2				

Lbs of Emissions

SW-1	
VOC's	591.7 lbs
F-113	1354.7 lbs
TFE	90.5 lbs
AF's	23.1 lbs

2014 Air Emissions Summary

WTS-A Central Wastewater Treatment Plant

05-43

A. VOC Compound Summary

Compound	CAS Chemical Name	CAS No.	Emission (lb.)
BA	Butyraldehyde	123-72-8	145,962
EtGly	Ethylene Glycol	107-21-1	32
MeOH	Methanol	67-56-1	36,230
Total VOC Emissions (lb.)			182,223
Total VOC Emissions (tons)			91.11

B. Hazardous / Toxic Air Pollutant Summary

Compound	CAS Chemical Name	CAS No.	Emission (lbs)
EtGly	Ethylene Glycol	107-21-1	32
MeOH	Methanol	67-56-1	36,230
NH3	Ammonia	7664-41-7	566

2014 Emissions from Wastewater Treatment Plant (WTS-A)

	BA	EtGly	MeOH
To WWTP from Kuraray Butacite (lb)	488,355	8,144	199,115
To WWTP from DuPont Nafion Resins (lb)	-	-	35,506
To WWTP from Dupont PVF (lb)	-	-	-
To WWTP from Kuraray SentryGlas (lb)	-	-	-
To WWTP from Other Sources (lb)	-	-	-
Total to WWTP (lb)	488,355	8,144	234,621
Quantity entering EQB (lb)	488,355	8,144	234,621
Percent of compound volatilized	23.42%	0.29%	11.71%
Quantity volatilized from EQB (lb)	114,373	24	27,474
Quantity leaving EQB (lb)	373,982	8,120	207,147
Quantity entering Predigester (lb)	373,982	8,120	207,147
Percent of compound volatilized	8.30%	0.10%	4.15%
Quantity volatilized from Predigester (lb)	31,041	8	8,597
Quantity leaving Predigester (lb)	342,942	8,112	198,550
Quantity entering Aeration Tank (lb)	342,942	8,112	198,550
Percent of compound volatilized	0.16%	0.002%	0.08%
Quantity volatilized from Aeration Tank (lb)	549	0	159
Percent of compound biodegraded	85.00%	85.00%	85.00%
Quantity biodegraded in Aeration Tank (lb)	291,500	6,895	168,768
Quantity leaving to Cape Fear River (lb)	50,893	1,217	29,624
Butacite Quantity to Cape Fear River (lb)	50,893	1,217	25,141
Nafion Quantity to Cape Fear River (lb)	-	-	4,483
PMDF Quantity to Cape Fear River (lb)			
SentryGlas Quantity to Cape Fear River (lb)			
Nafion Quantity to Cape Fear River (lb)			
Total Quantity to Cape Fear River (lb)	50,893	1,217	29,624
Butacite Fraction Volatilized to Air (lb)	145,962	32	30,747
Nafion Fraction Volatilized to Air (lb)	-	-	5,483
PMDF Fraction Volatilized to Air (lb)	-	-	-
SentryGlas Fraction Volatilized to Air (lb)	-	-	-
Nafion Fraction Volatilized to Air (lb)	-	-	-
Total Volatilized to Air (lb)	145,962	32	36,230

See Note 1

Source of Reduction Factors: EPA WATER8 computer model

BA = Butyraldehyde

EtGly = Ethylene Glycol

MeOH = Methanol

Note 1: Based on best professional judgement of Ken W. Cook (DuET Wastewater Consultant) the "Percent of compound biodegraded" was reduced from 94+% to 85% for the reports beginning calendar year 2012. It is believed that an acclimated biological system would be able to biodegrade 85% these simple organic compounds during the 18-hour residence period.

2014 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: WTS-A

Emission Source Description: Central Wastewater Treatment Plant

Ammonia (NH₃) Emissions

The wastewater treatment plant ("WWTP") is fed aqueous ammonia (30% NH₃) as a nutrient for the biological microbes.

In 2014, the WWTP consumed 49,313 pounds of 30% aqueous ammonia, which equates to 14,794 pounds of 100% ammonia (100% NH₃).

The aqueous ammonia is fed directly into the WWTP Aeration Tank that is aerated via 2,000 cubic feet per minute of diffused air injected into the bottom of the tank.

The aqueous ammonia is fed directly into the WWTP Aeration Tank that is aerated via 2,000 cubic feet per minute of diffused air injected into the bottom of the tank. To be conservative, the emissions of ammonia from the WWTP will assume that none of the NH₃ is utilized by the microbes, who would convert the ammonia into nonvolatile nitrate.

The WWTP influent averages approximately one (1) million gallons of water per day, which is equal to 3,044,100,000 lb. of water per year.

Concentration of NH₃ in the Aeration Tank

$$\frac{14,794 \text{ lb. NH}_3}{\text{year}} \times \frac{\text{year}}{3,044,100,000 \text{ lb. water}} = \frac{0.00000486 \text{ lb. NH}_3}{\text{lb. water}}$$

$$\frac{0.00000486 \text{ lb. NH}_3}{\text{lb. water}} \times \frac{453.6 \text{ g NH}_3}{\text{lb. NH}_3} \times \frac{2,204.6 \text{ lb. water}}{\text{m}^3 \text{ water}} = \frac{4.86 \text{ g NH}_3}{\text{m}^3 \text{ water}}$$

Henry's Law Constant for Ammonia in water at 30 deg C (see Note 1)

$$K_h = (0.2138/T) 10^{6.123 - 1825/T}$$

$$K_h = \frac{0.000888 \text{ g NH}_3 / \text{m}^3 \text{ air}}{\text{g NH}_3 / \text{m}^3 \text{ water}}$$

Note 1: Montes, F., C. A. Rotz, H. Chaoui. (2009). "Process Modeling of Ammonia Volatilization from Ammonium Solution and Manure Surfaces: A Review with Recommended Models." Transactions of the American Society of Agricultural and Biological Engineers (ASABE). 52(5): 1707-1720.

Concentration of NH₃ in the Aeration Tank's Diffused Air

$$\frac{0.000888 \text{ g NH}_3 / \text{m}^3 \text{ air}}{\text{g NH}_3 / \text{m}^3 \text{ water}} \times \frac{4.86 \text{ g NH}_3}{\text{m}^3 \text{ water}} = \frac{0.00432 \text{ g NH}_3}{\text{m}^3 \text{ air}}$$

Emission of NH₃ from the Aeration Tank's Diffused Air

Basis: Diffused air injection rate of 2,000 ft³ air per minute

$$\frac{2,000 \text{ ft}^3 \text{ air}}{\text{minute}} \times \frac{\text{m}^3}{35.315 \text{ ft}^3} \times \frac{525,600 \text{ min}}{\text{year}} = \frac{29,766,388 \text{ m}^3 \text{ air}}{\text{year}}$$

$$\frac{0.00432 \text{ g NH}_3}{\text{m}^3 \text{ air}} \times \frac{29,766,388 \text{ m}^3 \text{ air}}{\text{year}} \times \frac{\text{lb.}}{453.6 \text{ g}} = \frac{283 \text{ lb. NH}_3}{\text{year}}$$

Emission of NH₃ from the WWTP Clarifiers

The final wastewater treatment unit operation are the clarifiers in which the biomass is separated from the treated process wastewater through gravity settling. The clarifiers are quiescent tanks with no mixing or aeration. Any emissions of ammonia from the clarifiers would be a small fraction of the estimated ammonia emissions from the Aeration Tank. To be conservative, it will be assumed that the emissions of ammonia from the clarifiers are equal to the ammonia emissions from the Aeration Tank.

$$\text{Emission of NH}_3 \text{ from the WWTP Clarifiers} = 283 \text{ lb NH}_3 / \text{year}$$

Total Emission of NH₃ from the WWTP System (ID No. WT-A)

$$\text{Emission of NH}_3 \text{ from the WWTP Aeration Tank} = 283 \text{ lb. NH}_3 / \text{year}$$

$$\text{Emission of NH}_3 \text{ from the WWTP Clarifiers} = 283 \text{ lb. NH}_3 / \text{year}$$

$$\text{Emission of NH}_3 \text{ from the WWTP System} = 566 \text{ lb. NH}_3 / \text{year}$$