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Air Permits Section

CHEMOURS COMPANY

FAYETTEVILLE WORKS

AIR PERMIT NUMBER 03735T43

FACILITY ID 0900009

NOTE: THIS INVENTORY INCLUDED A CONFIDENTIAL INFORMATION SUBMITTAL, SEE THE CONFIDENTIAL INFO FILE FOR DETAILS

2017 AIR EMISSIONS INVENTORY REPORT

GREG REEVES
08/17/2018

Inventory Certification Form(Title V)

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

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

North Carolina Department of Environment and Natural Resources
Division of Air Quality
Air Pollutant Point Source Emissions Inventory – Calendar Year 2017

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 propietorship; a general partner or the proprietor, respectively;
3. for a muncipality, 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 penalities 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: Brian D Long 7/2/2018
Printed Name: ~~Ellis McGaughy~~ BRIAN D. LONG
Signature:

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: Brian.D.Long@Chemours.com ~~Ellis.H.McGaughy@chemours.com~~

Information on this Form cannot be held confidential

VIA COURIER

July 2, 2018

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

SUBJECT: 2017 Air Emissions Inventory Report
Chemours Company – Fayetteville Works
Bladen County, North Carolina
Air Permit No. 03735T43
Facility ID: 06/09-0900009

Dear Mr. Vozzo,

Pursuant to Section 3 of the subject Title V Air Permit, enclosed are the originals of the 2017 Air Emissions Inventory Report, the Inventory Certification Form, and the Confidential Information Submission, from the Chemours Company – Fayetteville Works.

Chemours prepared the 2017 Air Emissions Inventory Report with the assistance of ERM NC, Inc. The methods for calculating the emissions figures (e.g., stack testing results, engineering estimates, emissions factors) are provided alongside the emissions figures in the Report. Further, although the Permit does not require the quantification of VOC emissions by the specific VOC, Chemours is voluntarily providing emissions figures for specific VOCs as it has done for prior years. Chemours will submit updates to this Report if it determines (e.g., through additional testing) that any of the emissions figures provided herein have changed.

If you have any questions regarding this Report, please call me at (910) 678-1415.

Sincerely,

Brian D. Long,
Plant Manager

Enclosures

Facility Name: Chemours Company – Fayetteville Works
Facility ID: 0900009 **Permit:** 03735

North Carolina Department of Environment and Natural Resources
Division of Air Quality
General Information

If any information already provided to DAQ has changed or otherwise is incorrect, please provide corrections. You may leave blanks where the information is unchanged. (Except Facility ID and Name).

Physical (911) Address of Facility ______________________________

____

Name of Responsible Official: Brian D. Long
Title: Plant Manager **Telephone #** (910) 678 - 1415
E-Mail Address: Brian.D.Long@chemours.com
Mailing Address of Responsible Official
22828 NC Highway 87 W
Fayetteville, NC 28306

Name of Facility Technical/Permit Mailing Contact ____________
Title ____________ **Telephone #** (____) _____ - _______
E-Mail Address ____________
Mailing Address of Responsible Official ____________

____

Name of Inspection Contact ____________
Title ____________ **Telephone #** (____) _____ - _______
E-Mail Address ____________

Name of Billing/Invoice Contact ____________
Title ____________ **Telephone #** (____) _____ - _______
E-Mail Address ____________
Billing/Invoice Company ____________
Billing/Invoice Address ____________

____

Standard Industrial Classification (SIC) Code(s)			
North American Industry Classification System (NAICS – six digit) Code(s) – If known (see instructions)			

Report Prepared by ___Justin Spencer **Telephone #** (910) 678 - 1941
E-Mail Address: Justin.Spencer1@chemours.com

Provide to Appropriate DAQ Regional Office as needed.
Information on This Form cannot be held confidential.

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 during 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/m^3 is via the following equation:

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

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/m^3 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:

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

Emissions Determination:

		Multiplied by:	Multiplied by:	Equals:
Compound	**Odor Threshold (mg/m^3)**	**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**

2017 AIR EMISSIONS SUMMARY
POLYMER PROCESSING AID PROCESS

VOC Emisions					
Nickname	**Chemical Name**	**CAS No.**	**Stack Emissions[1] (lb/yr)**	**Fugitive Emissions (lb/yr)**	**Total Emissions (lb/yr)**
FRD-901	Poly[oxy[trifluoro(trifluoromethyl)-1,2-ethanediyl]], .alpha.-(1-carboxy-1,2,2,2-tetrafluoroethyl)-.omega.-[tetrafluoro(trifluoromethyl)ethoxy]-	51798-33-5	0.3	0.0	0.3
HFPO Dimer Acid	2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoic acid	13252-13-6	669.8	1.0	671
		Total VOC emissions (lb/yr)			671
		Total VOC emissions (ton/yr)			0.34

[1] Contains HFPO DA Indoor Equipment Emissions

Toxic Air Pollutant (TAP) Emisions			
Nickname	**Chemical Name**	**CAS No.**	**lb/yr**
Ammonia	Ammonia (NH3)	7664-41-7	71.5
HF	Hydrogen fluoride	7664-39-3	40.7
Fluorides*	Fluorides (sum of all fluoride compounds)	16984-48-8	40.7
H2SO4	Sulfuric acid	7664-93-9	441.1

** Note: NCDAQ requires that HF be reported as "Fluorides" as well as HF on the annual AERO database.*

Fugitive Emissions of Outdoor Equipment Components

2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoic acid
HFPO Dimer Acid (FRD-903 or GX903)
CAS No.: 13252-13-6

In April 2018, Team, Inc. (Team) conducted instrument monitoring of outdoor valves and connectors associated with the HFPO Dimer Acid Fluoride transfer piping. EPA Method 21 monitoring was conducted using flame ionization detectors (FIDs) to identify volatile organic compound (VOC) leaks from these specific fugitive piping components.

The details and results of this equipment emissions investigation are detailed in the ERM report titled "HFPO-DA Baseline Emission Estimates" dated May 18, 2018.

The source tests' analysis would have been performed for the dimer acid anion, therefore, results from testing would include emissions of the following three dimer acid compounds: HFPO Dimer Acid (HFPO-DA), HFPO Dimer Acid Fluoride (HFPO-DAF), and HFPO Dimer Acid Ammonium Salt. The ERM report reported all results as HFPO Dimer Acid (HFPO-DA).

The Method 21 monitoring indicated the outdoor equipment emissions from the PPA Process were approximately 1.04 lb. HFPO-DA in 2017. This quantity was derived using the assumption that the process was in continuous VOC service for 8,760 hours in 2017. This quantity is reported as 1.0 lb. HFPO-DA for the reporting year.

Outdoor Fugutive Emissions 1.0 lb.

2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoic acid

HFPO Dimer Acid (FRD-903 or GX903)

CAS No.: 13252-13-6

In early 2018, stack testing was performed on the PPA Process Stack (ID No. AEP-A1) for the HFPO Dimer anion. For the purpose of this report, it will be assumed that the measured compound was the HFPO Dimer Acid ("DA").

The stack testing results showed an average emission rate of 0.0255 lb/hr of DA during periods when the Hydrolysis Batch Step was not occurring. These emissions would be the combination of the after-control process emissions and the indoor equipment emissions from valves, connectors, pumps, and agitators.

A separate stack testing was performed that showed an average emission rate of 1.58 lb/hr of DA during periods when only the Hydrolysis Batch Step was occurring. These emissions would also be the combination of the after-control process emissions and the indoor equipment emissions.

Emissions are estimated by using the stack testing emission rates in lb. DA per hour and multiplying those emission rates by the hours that the particular activity occurred.

HFPO Dimer Acid Emissions Excluding the Hydrolysis Batch Step

Total hours of operation during the reporting year	5,381 hours
DA Emission Rate excluding Hydrolysis Batch Step	0.0255 lb/hr DA emissions
Estimated DA Emissions during the Reporting Year	137.2 lb. DA emissions

HFPO Dimer Acid Emissions Associated with the Hydrolysis Batch Step

Number of Hydrolysis Batches during the reporting year	316 batches
Hours of Hydrolysis Batches during the reporting year	1.07 hours / batch
DA Emission Rate from the Hydrolysis Batch Step	1.58 lb/hr DA emissions
Estimated DA Emissions during the Reporting Year	532.6 lb. DA emissions

Total HFPO Dimer Acid Stack Emissions

DA Emissions Excluding the Hydrolysis Batch Step	137.2 lb. DA emissions
DA Emissions from the Hydrolysis Batch Step	532.6 lb. DA emissions
	669.8 lb. DA emissions

HFPO Dimer Acid Emissions from Indoor Equipment Leaks

Total hours of operation during the reporting year	5,381 hours

DA Emission Rate from PPA Building Exhaust	0.0058 lb/hr DA emissions
Indoor Equipment Leaks during the Reporting Year	31.2 lb. DA emissions

HFPO Dimer Acid Emissions from Process Vents

Total HFPO Dimer Acid Stack Emissions	669.8 lb. DA emissions
Indoor Equipment Leaks during the Reporting Year	31.2 lb. DA emissions
Process Vent Emissions during the Reporting Year	638.6 lb. DA emissions

Ammonia (NH_3)

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 902	347
VP of 19% solution [mm Hg]	382
Specific Gravity of 19% solution	0.94
Specific Gravity of 70% 902	1.47
Density of Water [g/cm^3]	0.995
K_{NH3} [atm]	0.95

Conversions

1 gallon = 3.785 liters = 3,785 cm^3 = 231 in^3
1 atm = 760 mm Hg = 14.7 psi
1 lb = 454 grams
1 ft^3 =28.3 liters

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

Pump Seals	0.00750
Valves	0.00352
Flanges	0.00031

Equations

$P_i=X_i*K_i$	Henry's Law (used for dilute solutions)
$P_i=X_i*Vpi$	Raoult's Law
$Y_i = P_i/PT$	

Tote Filling

Number of drums added to tote during fill	4
Total vapor displaced during fill [liters]	832.7
Number of fills per year	83
Total vapor displaced during year [liters]	69,114
P_{NH3} [mm Hg]	64.097
Y_{NH3}	0.08434
Total NH_3 vapor displaced during year[liters	5828.9
Total NH_3 vapor displaced during year [lbs]	9.7439

Assumptions & Notes

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

902 Reactor Charging

Number of batches per year	482.3333
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]	241.1667
Total fugitive emmisions [lbs]	4.5171

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

905 Reactor Charging

Number of batches per year	27
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]	162
Total fugitive emmisions [lbs]	6.4557

902 Reactor Emissions

Vessel Capacity [gal]	1,000
Additions between fillout	3
Avg. 903 addition from Rec Tk [lbs]	1,800
% 903 in Addition	90%
Total 903 addition [lbs]	4,860
Water Charge from 903 [lbs]	486
19% Ammonia Charge [lbs]	1,215.00
Vapor space of 902 Reactor minus heel,	390.33
% Ammonia after Dilution	0.035
VP after dilution [mm Hg]	90
Moles of 902	1271.72
Moles of Water	110,322
Moles of NH_3	6,165
X_{NH3}	0.05235
P_{NH3} [mm Hg]	37.7990
Y_{NH3}	0.04974
Total NH_3 vapor to scrubber [lb mol/batch]	0.00619
Total NH_3 vapor to scrubber [lbs/batch]	0.10528
Total NH_3 vapor to Scrubber [lbs/year]	50.7783
Assumed Efficiency of Scrubber	0
Ammonia exiting Stack [lbs/year]	50.7783

Ammonia gas, through vapor pressure, fills entire available vapor space of Reactor. This entire volume is then vented to the Scrubber before 903 is charged and reaction to 902 instantly occurs.
Ammonia VP is reduced after dilution. Value used is from table for 2% at standard operating temp

0.019 psi / mm Hg

10.73 - gas constant in ft^3 psi / °R lb mole

7.48 gal / ft^3

Total Ammonia Emissions [lbs/year] **71.5**

Sulfuric Acid (H_2SO_4)

Constants

Molecular Weight of H_2SO_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

Sulfuric Acid Storage Tank Filling

Average fill size [gallons]	3000
Number of fills per year	13
Total vapor displaced during year [liters]	147615
P_{H2SO4} [mm Hg]	0.00986
Y_{H2SO4}	1.298E-05
Total H_2SO_4 vapor displaced during year [liters]	1.91584
Total H_2SO_4 vapor displaced during year [lbs]	0.01848

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.

H_2SO_4 Storage Tank Emmisions

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_2SO_4 emissions [lbs/year]	38.2704

Hydrolysis Reactor Charging

Number of acid charges per year	815
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	0
Total pump time for year [hours]	203.75
Total fugitive emmisions [lbs]	8.0338625

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

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

Hydrolysis Reactor Emissions

Vessel capacity [gal]	655
Hydro Reactor Charge of water [lbs]	2000
Hydro Reactor Charge of H_2SO_4 [lbs]	590
Batches per year	1447
Avg Level of Vessel at Vent [gallons]	537.1
X_{H2SO4}	0.59431
P_{H2SO4} [mm Hg]	0.00594
Y_{H2SO4}	7.820E-06
H_2SO_4 vapor vented to Scrubber [lb mol/batch]	2.941E-07
H_2SO_4 vapor vented to Scrubber [lbs/year]	0.041748
Assumed Efficiency of Scrubber	0.95
H_2SO_4 exiting Stack [lbs/year]	0.002087

Worst Case - liquid molar ratio of H_2SO_4 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

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_2SO_4 emissions [lbs/year]	17.44680

0.019 psi / mm Hg
10.73 - gas constant in ft^3 psi / °R lb mole
7.48 gal / ft^3

Dilution Tank Emissions (Mix and Settle)

Vessel capacity [gal]	1,963	
Avg Level of Vessel at Vent [gallons]	800	Closed valves and instruments connections considered flanges
Batches per year	48	
Mass fraction of H_2SO_4	0.2	Because Sulfuric has such a low VP, leaks out of vessel above the liquid line are negligible
Pressure of Vessel at Vent [mm Hg]	760	
X_{H2SO4}	0.57672	
P_{H2SO4} [mm Hg]	0.00577	Entire available head space is vented to the Scrubber
Y_{H2SO4}	7.588E-06	
H_2SO_4 vapor vented to Scrubber [liters/batch]	0.03340	
H_2SO_4 vapor vented to Scrubber [lbs/year]	0.01547	
Assumed Efficiency of Scrubber	0.95	
H_2SO_4 exiting Stack [lbs/year]	0.00077	

Dilution Trailer Loadout Emissions

Number of transfers per year	48	
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]	48	
Total fugitive emmisions [lbs]	0.53299	Line is liquid-filled during entire charging time and empty during non-charging time

Dilution Trailer Loading (Displacement) Emissions

Assume displaced vapor is pure H_2SO_4 gas.

Number of trailers loaded during year	48
Average quantity loaded into a trailer [lb/trailer]	43,000
Specific gravity of Waste Sulfuric Acid	1.2
Displaced vapor from loading of trailers [L]	780,527
Molar volume [L-gas/mole-gas]	22.4
Displaced vapor from loading of trailers [moles]	34,845
Molecular Weight of H_2SO_4	98.1
Before control H_2SO_4 in displaced vapor [lb]	7,536
Assumed control efficiency of Process Scrubber	95%
After control H_2SO_4 in displaced vapor [lb]	376.8

Total H_2SO_4 Emissions [lbs/year] **441.1**

Hydrofluoric Acid (HF) CAS No. 7664-39-3

It is assumed that HFPO Dimer Acid Fluoride hydrolyzes into HFPO Dimer Acid (GX903), which releases hydrogen fluoride (HF) on a one mole to one mole basis.

For the purpose of estimating the potential HF emissions through the hydrolysis of acid fluorides by moisture in the atmosphere, it will be conservatively assumed the reported emissions of HFPO Dimer Acid is HFPO Dimer Acid Fluoride.

HFPO Dimer Acid emissions	670.8 lb.
HFPO Dimer Acid Fluoride molecular weight	332.04 g/mole
HFPO Dimer Acid molecular weight	330.05 g/mole
HFPO Dimer Acid Fluoride (equivalent emissions)	674.9 lb.
HF molecular weight	20.01 g/mole
HFPO Dimer Acid Fluoride molecular weight	332.04 g/mole
HF (equivalent emissions)	40.7 lb.

Poly[oxy[trifluoro(trifluoromethyl)-1,2-ethanediyl]], .alpha.-(1-carboxy-1,2,2,2-tetrafluoroethyl)-.omega.-[tetrafluoro(trifluoromethyl)ethoxy]-

FRD-901 or Krytox 157FSH

CAS No. 51798-33-5

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

Constants

Molecular Weight of FRD901: 1533

Equipment Leak Rates [lb/hr] (using "Good" factor)

Pump Seals	0.00750
Valves	0.00352
Flanges	0.00031

Equations

$P_i=X_i*K_i$	Henry's Law (used for dilute solutions)
$P_i=X_i*Vpi$	Raoult's Law
$Y_i = P_i/PT$	

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)

Conversions

1 gallon = 3.785 liters = 3,785 cm^3 = 231 in^3
1 atm = 760 mm Hg = 14.7 psi
1 lb = 454 grams
1 ft^3 =28.3 liters

Assumptions & Notes

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

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

FRD901 Tank Filling

Number of drums added to tote during fill	2
Total vapor displaced during fill [liters]	105.98
Number of fills per year	26
Total vapor displaced during year [liters]	2,755
P_{901} [mm Hg]	0.004
Y_{901}	0.00000
Total 901 vapor displaced during year[liters]	0.0133
Total 901 vapor displaced during year [lbs]	0.0020
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]	8.7
Total fugitive emmisions [lbs]	0.15

901 Reactor Charging

Number of batches per year	27	
Average drop time per batch (min)	25	200 lb/batch and 8 lb/min feed rate
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]	11.25	
Total fugitive emmisions [lbs]	0.18	

Total FRD901 Emissions [lb/year] **0.33**

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: GHG-HDR

Emission Source Description: HFA-Hydrate Destruction Reactor System

Process and Emission Description:

The Hexafluoroacetone Hydrate ("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. Vent testing of the HFPO Process has established the HFC-23 emission factor for that process. Therefore the emissions of the HFC-23 from the HDR system is simply the difference between the total HFC-23 emissions and the HFPO Process' HFC-23 emissions.

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 (CHF_3; fluoroform; HFC-23; R-23) **CAS No. 75-46-7**

Quantity Generated:

Before-control CHF_3 generation per the process flowsheet (W1208078):

$$\frac{0.4\ \text{kg}\ CHF_3}{30.48\ \text{HFP Units}}$$

Before-control CHF_3 generation based on 269,866 HFP Units

$$\frac{0.4\ \text{kg}\ CHF_3}{30.48\ \text{HFP Units}} \times 269{,}866\ \text{HFP Units} = 3{,}541\ \text{kg}\ CHF_3$$

$$= 7{,}807\ \text{lb.}\ CHF_3$$

The amount of CF3H emitted from the HFPO Process is based on the before-control CHF_3 emissions factor documented in TA NF-11-1824 from the stripper column vent.

E_{CF3H}= 0.0114 kg CHF_3 / HFP Units fed to process

Therefore the amount emitted from the HFPO process is:

$$\frac{0.0114\ \text{kg}\ CHF_3}{1.00\ \text{HFP Units}} \times 269{,}866\ \text{HFP Units} = 3{,}085\ \text{kg}\ CHF_3$$

$$= 6{,}801\ \text{lb.}\ CHF_3$$

Therefore the quantity of trifluoromethane emitted from the HFA-hydrate Destruction Reactor System (GHG-HDR) would be the difference between the total CHF_3 emissions and the quantity emitted from the HFPO Process (NS-A).

7,807 lb. CHF_3 minus 6,801 lb. CHF_3 = 1,005 lb. CHF_3

= 0.50 ton CHF_3

AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

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 cannot 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, the waste DMSO solution is pumped to the facility's NPDES permitted wastewater treatment plant for disposal. The tank vents to the atmosphere through a gooseneck pipe with a conservation vent coming off the top that ends 12" above the diked area.

Basis and Assumptions:

- Direct vent to atmosphere
- Tank volume = 6000 gallons or 802 ft^3
- DMSO vapor pressure = 0.46 mm Hg @ 20°C
- Molar volume of an Ideal Gas @ 0°C and 1 atm = 359 ft^3/(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 "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
Waste DMSO generated (lb/yr)	Waste Shipping Specialist, Global Supply Support
Vapor pressure	CAS Number 67-68-5
Tank volume	Procedure PR-70, W1535321, or NBPF000351
Number of Each Type of Equipment	W1535321 and verifying at source
% Production / Quarter	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 ft^3 ⇒ Molar volume at 20°C and 1 atm = 385 ft^3

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) × Number of Components = Emissions (lb/hr)

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

Total fugitive DMSO emissions per year = **0.448 ton DMSO / year**

Emissions Summary:

Point Source Emissions + Fugitive Emissions = Total Emissions

0.018 ton DMSO / year + 0.448 ton DMSO / year = **0.47 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 SOCMI 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 form 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 SOCMI factors. All three sets of factors are listed below.

		EMMISION FACTORS (lb/hr/component)			
COMPONENT	**SERVICE**	**SUPERIOR**	**EXCELLENT**	**GOOD**	**EPA SOCMI**
Pump Seals	Light Liquid	.xxxxx	0.00115	0.0075	0.109
Pump Seals	Heavy Liquid	.xxxxx	0.00115	0.0075	0.047
Valves	Gas	.xxxxx	0.00039	0.00549	0.012
Valves	Light Liquid	.xxxxx	0.00036	0.00352	0.016
Valves	Heavy Liquid	.xxxxx	0.00036	0.00352	0.00051
Pressure Relief Seals	Gas/Vapor	.xxxxx	0.00012	0.00013	0.23
Open Ended Lines	All	.xxxxx	0.001	0.0215	0.0037
Flanges	All	.xxxxx	0.00018	0.00031	0.0018
Sampling Connections	All	.xxxxx	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***.

2017 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 FPS Fluoromonomers and IXM Resin/Membrane processes. 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	Sitewide TAP Report

Point Source Emissions Determination:

None

Fugitive Emissions Determination:

Shown on the following page.

Methylene Chloride Emissions Determination

MeCl Storage Tank Beginning Inventory (01-01-2017)	26,404 lb.
Methylene Chloride added to MeCl Storage Tank	3,600 lb.
MeCl Storage Tank Ending Inventory (12-31-2017)	23,071 lb.

Emissions (Losses) During Year	**6,933 lb.**

Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-04

Emission Source Description: Chlorination of Riverwater to Control Mussel Growth in Equipment

Sodium Hypochlorite[a] (as Chlorine) Fugitive Emissions (Equipment Leaks)

Equipment Component	Total Compo-nents	EPA SOCMI [b] (kg / hr / component)	Service (hr / yr)	Emissions (kg / yr)	Emissions (lb / yr)
Pump Seals in light liquid service	1	0.0199	8760	174.3	384
Valves in light liquid service	1	0.00403	8760	35.3	78
Connections in light liquid service	33	0.00183	8760	529.0	1,166
	Total Emissions as Chlorine			**564**	**1,628**

Note a : Sodium hypochorite 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 soduim 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.

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-05

Emission Source Description: Sitewide Laboratory Emissions

Process and Emission Description:

The Chemours 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.

Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-05

Emission Source Description: Sitewide Laboratory Emissions

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 Chemours 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

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-06

Emission Source Description: Outdoor abrasive blasting operation for items exceeding 8-feet in any dimension

Process and Emission Description:

The Chemours 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	Brown & Root 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.

Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-06

Emission Source Description: Outdoor abrasive blasting operation for items exceeding 8-feet in any dimension

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	2,500 pounds

$$\frac{2{,}500 \text{ lb. abrasive}}{\text{year}} \times \frac{27 \text{ lb. PM}}{1{,}000 \text{ lb. abrasive}} = \frac{68 \text{ lb. PM}}{\text{year}}$$

$$= \frac{0.03 \text{ ton PM}}{\text{year}}$$

Pollutant	Emissions (ton/year)
Particulate Matter (TSP)	0.03
PM_{10} (< 10 micron)	0.03
$PM_{2.5}$ (< 2.5 micron)	0.03

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-07

Emission Source Description: Paint Shop

Process and Emission Description:

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

Basis and Assumptions:

The painting activity at this souirce is fairly frequent. Most of the painting is of the Fluoromonomer product cylinders. The basis of the emissions determination is the historical 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.

During the period from 2008 through 2014, the Paint Shop averaged 681 gallons per year. Therefore, to be conservative it will be assumed that 750 gallons of the above described worst-case paint was consumed during the reporting year.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Historical consumption of paint	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 Desity of Paint	12.71	lb/gal
Worst-case VOC Content	100%	
Paint Consumed in Year	750	gallons (assumed)

$$750 \text{ gal. paint} \times \frac{12.7 \text{ lb. paint}}{\text{gal. paint}} \times \frac{1.0 \text{ lb. VOC}}{\text{lb. paint}} = 9{,}533 \text{ lb. VOC}$$

$$= 4.77 \text{ ton VOC}$$

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%	750	12.71	2,345
Methyl ethyl ketone	10.0%	750	12.71	953
Toluene	17.0%	750	12.71	1,621
Xylene	88.7%	750	12.71	8,455
Hexamethylene-diisocyanate	0.2%	750	12.71	19
Ethylene glycol	2.0%	750	12.71	191

* 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
- DuPont T-8805 Thinner contains 88.7% xylene
- DuPont Imron Accelerator 389-S contains 0.2% hexamethylene diioscyanate
- Latex Exterior Paint contains 2.0% ethylene glycol

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-08

Emission Source Description: Abrasive Blasting Cabinets

Process and Emission Description:

The Chemours Company - Fayetteville Works has several self-contained abrasive blasting cabinets located throughout the site. The function of these cabinets is to perform 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.

Abrasive Blasting Cabinets - 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

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-09

Emission Source Description: Spray Paint Booths

Process and Emission Description:

The Chemours Company - Fayetteville Works has several small spray 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.

Spray Paint Booths - 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

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-12

Emission Source Description: IXM Dispersions Repackaging Process

Process and Emission Description:

The IXM Dispersions Repackaging Process consists of the transloading of the IXM Dispersions solution from 55-gal drums to smaller containers.

The emissions from this process are the result of the displacement of gas/vapor compounds in the headspace in the smaller containers as they are filled with the liquid Dispersion product.

Basis and Assumptions:

It is assumed that the empty small container is completely full of 1-propanol (n-propanol or NPA) vapor at the start of the filling of the container. The volume of air emissions is then merely the volume of the container. The vapor density of NPA is 2.46 g NPA per liter of gas. The mass of NPA emissions is then determined by multiplying the volume of Dispersion in liters that was transloaded by 2.46 g NPA per L.

Information Inputs and Source of Inputs:

Information Inputs	Source of Inputs
Volume (liters) of Dispersion transloaded into small containers.	SAP financial records

Point Source Emissions Determination:

All air emissions from the IXM Dispersion Repackaging Process are point source. The estimate of the emission of NPA (as VOC) is given on the following page.

IXM Dispersions Process (I-12)

Product	Amount (L)
D0521	0
D520	680
D521	2,280
D521FP	460
D1020	0
D1021	2,204
D1031	0
D2020	2,780
D2021	192
D2029	4
D2820	0
D2821	0
[redacted]	
TOTAL	8,600

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

Vapor density of n-propanol = 2.46 g/l

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

$$\frac{8{,}600 \text{ Liters}}{\text{year}} \times \frac{2.46 \text{ grams NPA}}{\text{Liter}} = \frac{21{,}125 \text{ grams}}{\text{year}}$$

$$= \frac{47 \text{ lb. VOC}}{\text{year}}$$

$$= \frac{0.02 \text{ ton VOC}}{\text{year}}$$

GAS & DIESEL INTERNAL COMBUSTION ENGINES EMISSIONS CALCULATOR REVISION S 6/22/2015 - OUTPUT SCREEN

NCDENR

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.

SOURCE / FACILITY / USER INPUT SUMMARY (FROM INPUT SCREEN)

COMPANY:	**Chemours Company - Fayetteville Works**				FACILITY ID NO.:	0900009
					PERMIT NUMBER:	03735T43
EMISSION SOURCE DESCRIPTION:	181 HP POWER OUTPUT, DIESEL INTERNAL COMBUSTION ENGINE				FACILITY CITY:	Fayetteville
EMISSION SOURCE ID NO.:	I-RICE -01				FACILITY COUNTY:	Bladen
SPREADSHEET PREPARED BY:	Michael E. Johnson				POLLUTANT	CONTROL EFF.
ACTUAL THROUGHPUT	529 GALS COMBUSTED	FUEL HEATING VALUE:	140000	BTU/GAL	PM	0
REQUESTED ANNUAL LIMITATION	529 GALS COMBUSTED	CALCULATIONS:	0.138	mm BTU/GAL	PM10	0
SULFUR CONTENT OF DIESEL FUEL (%)	0				PM2.5	0
METHOD USED TO COMPUTE ACTUAL GHG EMISSIONS:	TIER 1: DEFAULT HIGH HEAT VALUE AND DEFAULT EF				SO2	0
CARBON CONTENT USED FOR GHGS (kg C/gal):	CARBON CONTENT NOT USED FOR CALCULATION TIER CHOSEN				NOX	0
					CO	0
					VOC	0

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/hp-hr
	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	uncontrolled
PARTICULATE MATTER (PM)	0.40	0.01	0.40	1.74	0.40	0.01	2.20E-03
PARTICULATE MATTER<10 MICRONS (PM_{10})	0.40	0.01	0.40	1.74	0.40	0.01	2.20E-03
PARTICULATE MATTER<2.5 MICRONS ($PM_{2.5}$)	0.40	0.01	0.40	1.74	0.40	0.01	2.20E-03
SULFUR DIOXIDE (SO2)	0.00	0.00	0.00	0.01	0.00	0.00	1.21E-05
NITROGEN OXIDES (NOx)	5.61	0.16	5.61	24.58	5.61	0.16	3.10E-02
CARBON MONOXIDE (CO)	1.21	0.04	1.21	5.30	1.21	0.04	6.68E-03
VOLATILE ORGANIC COMPOUNDS (VOC)	0.46	0.01	0.46	1.99	0.46	0.01	2.51E-03

TOXIC / HAZARDOUS AIR POLLUTANT EMISSIONS INFORMATION

TOXIC / HAZARDOUS AIR POLLUTANT	CAS NUMBER	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	ACTUAL lb/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	POTENTIAL (BEFORE) lb/yr	POTENTIAL (AFTER CONTROLS/LIMITS) lb/hr	POTENTIAL (AFTER) lb/yr	EMISSION FACTOR lb/hp-hr uncontrolled
Acetaldehyde (H,T)	75070	9.72E-04	5.68E-02	9.72E-04	8.51E+00	9.72E-04	5.68E-02	5.37E-06
Acrolein (H,T)	107028	1.17E-04	6.86E-03	1.17E-04	1.03E+00	1.17E-04	6.86E-03	6.48E-07
Arsenic unlisted compounds (H,T)	ASC-Other	5.07E-06	2.96E-04	5.07E-06	4.44E-02	5.07E-06	2.96E-04	2.80E-08
Benzene (H,T)	71432	1.18E-03	6.92E-02	1.18E-03	1.04E+01	1.18E-03	6.92E-02	6.53E-06
Benzo(a)pyrene (H,T)	50328	2.38E-07	1.39E-05	2.38E-07	2.09E-03	2.38E-07	1.39E-05	1.32E-09
Beryllium metal (unreacted) (H,T)	7440417	3.80E-06	2.22E-04	3.80E-06	3.33E-02	3.80E-06	2.22E-04	2.10E-08
1,3-Butadiene (H,T)	106990	4.95E-05	2.90E-03	4.95E-05	4.34E-01	4.95E-05	2.90E-03	2.74E-07
Cadmium metal (elemental unreacted) (H,T)	7440439	3.80E-06	2.22E-04	3.80E-06	3.33E-02	3.80E-06	2.22E-04	2.10E-08
Chromic Acid (VI) (H,T)	7738945	3.80E-06	2.22E-04	3.80E-06	3.33E-02	3.80E-06	2.22E-04	2.10E-08
Formaldehyde (H,T)	50000	1.50E-03	8.75E-02	1.50E-03	1.31E+01	1.50E-03	8.75E-02	8.26E-06
Lead unlisted compounds (H)	PBC-Other	1.14E-05	6.67E-04	1.14E-05	9.99E-02	1.14E-05	6.67E-04	6.30E-08
Manganese unlisted compounds (H,T)	MNC-Other	7.60E-06	4.45E-04	7.60E-06	6.66E-02	7.60E-06	4.45E-04	4.20E-08
Mercury vapor (H,T)	7439976	3.80E-06	2.22E-04	3.80E-06	3.33E-02	3.80E-06	2.22E-04	2.10E-08
Napthalene (H)	91203	1.07E-04	6.29E-03	1.07E-04	9.41E-01	1.07E-04	6.29E-03	5.94E-07
Nickel metal (H,T)	7440020	3.80E-06	2.22E-04	3.80E-06	3.33E-02	3.80E-06	2.22E-04	2.10E-08
Selenium compounds (H)	SEC	1.90E-05	1.11E-03	1.90E-05	1.66E-01	1.90E-05	1.11E-03	1.05E-07
Toluene (H,T)	108883	5.18E-04	3.03E-02	5.18E-04	4.54E+00	5.18E-04	3.03E-02	2.86E-06
Xylene (H,T)	1330207	3.61E-04	2.11E-02	3.61E-04	3.16E+00	3.61E-04	2.11E-02	2.00E-06
Highest HAP (Formaldehyde)	50000	1.50E-03	8.75E-02	1.50E-03	1.31E+01	1.50E-03	8.75E-02	8.26E-06
Total HAPs		4.86E-03	2.85E-01	4.86E-03	4.26E+01	4.86E-03	2.85E-01	

TOXIC AIR POLLUTANT EMISSIONS INFORMATION (FOR PERMITTING PURPOSES)

EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS					EMISSION FACTOR lb/hp-hr
TOXIC AIR POLLUTANT	CAS Num.	lb/hr	lb/day	lb/yr	uncontrolled
Acetaldehyde (H,T)	75070	9.72E-04	2.33E-02	5.68E-02	5.37E-06
Acrolein (H,T)	107028	1.17E-04	2.81E-03	6.86E-03	6.48E-07
Arsenic unlisted compounds (H,T)	ASC-Other	5.07E-06	1.22E-04	2.96E-04	2.80E-08
Benzene (H,T)	71432	1.18E-03	2.84E-02	6.92E-02	6.53E-06
Benzo(a)pyrene (H,T)	50328	2.38E-07	5.72E-06	1.39E-05	1.32E-09
Beryllium metal (unreacted) (H,T)	7440417	3.80E-06	9.12E-05	2.22E-04	2.10E-08
1,3-Butadiene (H,T)	106990	4.95E-05	1.19E-03	2.90E-03	2.74E-07
Cadmium metal (elemental unreacted) (H,T)	7440439	3.80E-06	9.12E-05	2.22E-04	2.10E-08
soluble chromate compounds, as chromium (VI) equivalent	SOLCR6	3.80E-06	9.12E-05	2.22E-04	2.10E-08
Formaldehyde (H,T)	50000	1.50E-03	3.59E-02	8.75E-02	8.26E-06
Manganese unlisted compounds (H,T)	MNC-Other	7.60E-06	1.82E-04	4.45E-04	4.20E-08
Mercury vapor (H,T)	7439976	3.80E-06	9.12E-05	2.22E-04	2.10E-08
Nickel metal (H,T)	7440020	3.80E-06	9.12E-05	2.22E-04	2.10E-08
Toluene (H,T)	108883	5.18E-04	1.24E-02	3.03E-02	2.86E-06
Xylene (H,T)	1330207	3.61E-04	8.67E-03	2.11E-02	2.00E-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

DISTILLATE #2	ACTUAL EMISSIONS			POTENTIAL EMISSIONS - utilize max heat input capacity or horsepower and EPA MRR Emission Factors		POTENTIAL EMISSIONS With Requested Emission Limitation - utilize requested fuel limit and EPA MRR Emission Factors	
GREENHOUSE GAS EMITTED	EPA MRR CALCULATION METHOD: TIER 1						
	metric tons/yr	metric tons/yr, CO2e	short tons/yr	short tons/yr	short tons/yr, CO2e	short tons/yr	short tons/yr, CO2e
CARBON DIOXIDE (CO_2)	5.40	5.40	5.96	904.86	904.86	6.04	6.04
METHANE (CH_4)	2.19E-04	5.48E-03	2.42E-04	3.67E-02	9.18E-01	2.42E-04	6.04E-03
NITROUS OXIDE (N_2O)	4.38E-05	1.31E-02	4.83E-05	7.34E-03	2.19E+00	4.83E-05	1.44E-02
	TOTAL	5.42		TOTAL	907.97	TOTAL	6.06

NOTE: CO2e means CO2 equivalent.

NOTE: The DAQ Air Emissions Reporting Online (AERO) system requires short tons be reported. The EPA MRR requires metric tons be reported.

NOTE: Do not use greenhouse gas emission estimates from this spreadsheet for PSD (Prevention of Significant Deterioration) purposes.

GAS & DIESEL INTERNAL COMBUSTION ENGINES EMISSIONS CALCULATOR REVISION S 6/22/2015 - OUTPUT SCREEN

NCDENR

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.

SOURCE / FACILITY / USER INPUT SUMMARY (FROM INPUT SCREEN)

COMPANY:	**Chemours Company - Fayetteville Works**				
EMISSION SOURCE DESCRIPTION:	370 HP POWER OUTPUT, DIESEL INTERNAL COMBUSTION ENGINE				
EMISSION SOURCE ID NO.:	I-RICE-02				
SPREADSHEET PREPARED BY:	Michael E. Johnson				
ACTUAL THROUGHPUT	594	GALS COMBUSTED	FUEL HEATING VALUE:	140000	BTU/GAL
REQUESTED ANNUAL LIMITATION	594	GALS COMBUSTED	CALCULATIONS:	0.138	mm BTU/GAL
SULFUR CONTENT OF DIESEL FUEL (%)	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				

FACILITY ID NO.:	0900009
PERMIT NUMBER:	03735T43
FACILITY CITY:	Fayetteville
FACILITY COUNTY:	Bladen

POLLUTANT	CONTROL EFF.
PM	0
PM10	0
PM2.5	0
SO2	0
NOX	0
CO	0
VOC	0

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/hp-hr
	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	uncontrolled
PARTICULATE MATTER (PM)	0.81	0.01	0.81	3.57	0.81	0.01	2.20E-03
PARTICULATE MATTER<10 MICRONS (PM_{10})	0.81	0.01	0.81	3.57	0.81	0.01	2.20E-03
PARTICULATE MATTER<2.5 MICRONS ($PM_{2.5}$)	0.81	0.01	0.81	3.57	0.81	0.01	2.20E-03
SULFUR DIOXIDE (SO2)	0.00	0.00	0.00	0.02	0.00	0.00	1.21E-05
NITROGEN OXIDES (NOx)	11.47	0.18	11.47	50.24	11.47	0.18	3.10E-02
CARBON MONOXIDE (CO)	2.47	0.04	2.47	10.83	2.47	0.04	6.68E-03
VOLATILE ORGANIC COMPOUNDS (VOC)	0.93	0.01	0.93	4.07	0.93	0.01	2.51E-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/hp-hr
		lb/hr	lb/yr	lb/hr	lb/yr	lb/hr	lb/yr	uncontrolled
Acetaldehyde (H,T)	75070	1.99E-03	6.38E-02	1.99E-03	1.74E+01	1.99E-03	6.38E-02	5.37E-06
Acrolein (H,T)	107028	2.40E-04	7.69E-03	2.40E-04	2.10E+00	2.40E-04	7.69E-03	6.48E-07
Arsenic unlisted compounds (H,T)	ASC-Other	1.04E-05	3.33E-04	1.04E-05	9.08E-02	1.04E-05	3.33E-04	2.80E-08
Benzene (H,T)	71432	2.42E-03	7.76E-02	2.42E-03	2.12E+01	2.42E-03	7.76E-02	6.53E-06
Benzo(a)pyrene (H,T)	50328	4.87E-07	1.56E-05	4.87E-07	4.27E-03	4.87E-07	1.56E-05	1.32E-09
Beryllium metal (unreacted) (H,T)	7440417	7.77E-06	2.49E-04	7.77E-06	6.81E-02	7.77E-06	2.49E-04	2.10E-08
1,3-Butadiene (H,T)	106990	1.01E-04	3.25E-03	1.01E-04	8.87E-01	1.01E-04	3.25E-03	2.74E-07
Cadmium metal (elemental unreacted) (H,T)	7440439	7.77E-06	2.49E-04	7.77E-06	6.81E-02	7.77E-06	2.49E-04	2.10E-08
Chromic Acid (VI) (H,T)	7738945	7.77E-06	2.49E-04	7.77E-06	6.81E-02	7.77E-06	2.49E-04	2.10E-08
Formaldehyde (H,T)	50000	3.06E-03	9.81E-02	3.06E-03	2.68E+01	3.06E-03	9.81E-02	8.26E-06
Lead unlisted compounds (H)	PBC-Other	2.33E-05	7.48E-04	2.33E-05	2.04E-01	2.33E-05	7.48E-04	6.30E-08
Manganese unlisted compounds (H,T)	MNC-Other	1.55E-05	4.99E-04	1.55E-05	1.36E-01	1.55E-05	4.99E-04	4.20E-08
Mercury vapor (H,T)	7439976	7.77E-06	2.49E-04	7.77E-06	6.81E-02	7.77E-06	2.49E-04	2.10E-08
Napthalene (H)	91203	2.20E-04	7.05E-03	2.20E-04	1.92E+00	2.20E-04	7.05E-03	5.94E-07
Nickel metal (H,T)	7440020	7.77E-06	2.49E-04	7.77E-06	6.81E-02	7.77E-06	2.49E-04	2.10E-08
Selenium compounds (H)	SEC	3.89E-05	1.25E-03	3.89E-05	3.40E-01	3.89E-05	1.25E-03	1.05E-07
Toluene (H,T)	108883	1.06E-03	3.40E-02	1.06E-03	9.28E+00	1.06E-03	3.40E-02	2.86E-06
Xylene (H,T)	1330207	7.38E-04	2.37E-02	7.38E-04	6.47E+00	7.38E-04	2.37E-02	2.00E-06
Highest HAP (Formaldehyde)	50000	3.06E-03	9.81E-02	3.06E-03	2.68E+01	3.06E-03	9.81E-02	8.26E-06
Total HAPs		9.94E-03	3.19E-01	9.94E-03	8.71E+01	9.94E-03	3.19E-01	

TOXIC AIR POLLUTANT EMISSIONS INFORMATION (FOR PERMITTING PURPOSES)

EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS					EMISSION FACTOR lb/hp-hr
TOXIC AIR POLLUTANT	CAS Num.	lb/hr	lb/day	lb/yr	uncontrolled
Acetaldehyde (H,T)	75070	1.99E-03	4.77E-02	6.38E-02	5.37E-06
Acrolein (H,T)	107028	2.40E-04	5.75E-03	7.69E-03	6.48E-07
Arsenic unlisted compounds (H,T)	ASC-Other	1.04E-05	2.49E-04	3.33E-04	2.80E-08
Benzene (H,T)	71432	2.42E-03	5.80E-02	7.76E-02	6.53E-06
Benzo(a)pyrene (H,T)	50328	4.87E-07	1.17E-05	1.56E-05	1.32E-09
Beryllium metal (unreacted) (H,T)	7440417	7.77E-06	1.86E-04	2.49E-04	2.10E-08
1,3-Butadiene (H,T)	106990	1.01E-04	2.43E-03	3.25E-03	2.74E-07
Cadmium metal (elemental unreacted) (H,T)	7440439	7.77E-06	1.86E-04	2.49E-04	2.10E-08
soluble chromate compounds, as chromium (VI) equivalent	SOLCR6	7.77E-06	1.86E-04	2.49E-04	2.10E-08
Formaldehyde (H,T)	50000	3.06E-03	7.33E-02	9.81E-02	8.26E-06
Manganese unlisted compounds (H,T)	MNC-Other	1.55E-05	3.73E-04	4.99E-04	4.20E-08
Mercury vapor (H,T)	7439976	7.77E-06	1.86E-04	2.49E-04	2.10E-08
Nickel metal (H,T)	7440020	7.77E-06	1.86E-04	2.49E-04	2.10E-08
Toluene (H,T)	108883	1.06E-03	2.54E-02	3.40E-02	2.86E-06
Xylene (H,T)	1330207	7.38E-04	1.77E-02	2.37E-02	2.00E-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

DISTILLATE #2	ACTUAL EMISSIONS			POTENTIAL EMISSIONS - utilize max heat input capacity or horsepower and EPA MRR Emission Factors		POTENTIAL EMISSIONS With Requested Emission Limitation - utilize requested fuel limit and EPA MRR Emission Factors	
GREENHOUSE GAS EMITTED	EPA MRR CALCULATION METHOD: TIER 1						
	metric tons/yr	metric tons/yr, CO2e	short tons/yr	short tons/yr	short tons/yr, CO2e	short tons/yr	short tons/yr, CO2e
CARBON DIOXIDE (CO_2)	6.06	6.06	6.68	1,849.71	1,849.71	6.78	6.78
METHANE (CH_4)	2.46E-04	6.15E-03	2.71E-04	7.50E-02	1.88E+00	2.71E-04	6.78E-03
NITROUS OXIDE (N_2O)	4.92E-05	1.47E-02	5.42E-05	1.50E-02	4.47E+00	5.42E-05	1.62E-02
	TOTAL	6.08		TOTAL	1,856.06	TOTAL	6.80

NOTE: CO2e means CO2 equivalent.

NOTE: The DAQ Air Emissions Reporting Online (AERO) system requires short tons be reported. The EPA MRR requires metric tons be reported.

NOTE: Do not use greenhouse gas emission estimates from this spreadsheet for PSD (Prevention of Significant Deterioration) purposes.

GAS & DIESEL INTERNAL COMBUSTION ENGINES EMISSIONS CALCULATOR REVISION S 6/22/2015 - OUTPUT SCREEN

NCDENR

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:	**Chemours Company - Fayetteville Works**				FACILITY ID NO.:	0900009
					PERMIT NUMBER:	03735T43
EMISSION SOURCE DESCRIPTION:	197 HP POWER OUTPUT, DIESEL INTERNAL COMBUSTION ENGINE				FACILITY CITY:	Fayetteville
EMISSION SOURCE ID NO.:	I-RICE-03				FACILITY COUNTY:	Bladen
SPREADSHEET PREPARED BY:	Michael E. Johnson				POLLUTANT	CONTROL EFF.
ACTUAL THROUGHPUT	690 GALS COMBUSTED	FUEL HEATING VALUE:	140000	BTU/GAL	PM	0
REQUESTED ANNUAL LIMITATION	690 GALS COMBUSTED	CALCULATIONS:	0.138	mm BTU/GAL	PM10	0
SULFUR CONTENT OF DIESEL FUEL (%)	0				PM2.5	0
METHOD USED TO COMPUTE ACTUAL GHG EMISSIONS:	TIER 1: DEFAULT HIGH HEAT VALUE AND DEFAULT EF				SO2	0
CARBON CONTENT USED FOR GHGS (kg C/gal):	CARBON CONTENT NOT USED FOR CALCULATION TIER CHOSEN				NOX	0
					CO	0
					VOC	0

CRITERIA AIR POLLUTANT EMISSIONS INFORMATION

AIR POLLUTANT EMITTED	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) tons/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS/LIMITS) lb/hr	POTENTIAL EMISSIONS (BEFORE CONTROLS/LIMITS) tons/yr	POTENTIAL EMISSIONS (AFTER CONTROLS/LIMITS) lb/hr	POTENTIAL EMISSIONS (AFTER CONTROLS/LIMITS) tons/yr	EMISSION FACTOR lb/hp-hr uncontrolled
PARTICULATE MATTER (PM)	0.43	0.02	0.43	1.90	0.43	0.02	2.20E-03
PARTICULATE MATTER<10 MICRONS (PM_{10})	0.43	0.02	0.43	1.90	0.43	0.02	2.20E-03
PARTICULATE MATTER<2.5 MICRONS ($PM_{2.5}$)	0.43	0.02	0.43	1.90	0.43	0.02	2.20E-03
SULFUR DIOXIDE (SO2)	0.00	0.00	0.00	0.01	0.00	0.00	1.21E-05
NITROGEN OXIDES (NOx)	6.11	0.21	6.11	26.75	6.11	0.21	3.10E-02
CARBON MONOXIDE (CO)	1.32	0.05	1.32	5.76	1.32	0.05	6.68E-03
VOLATILE ORGANIC COMPOUNDS (VOC)	0.50	0.02	0.50	2.17	0.50	0.02	2.51E-03

TOXIC / HAZARDOUS AIR POLLUTANT EMISSIONS INFORMATION

TOXIC / HAZARDOUS AIR POLLUTANT	CAS NUMBER	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/yr	POTENTIAL EMISSIONS (AFTER CONTROLS/LIMITS) lb/hr	POTENTIAL EMISSIONS (AFTER CONTROLS/LIMITS) lb/yr	EMISSION FACTOR lb/hp-hr uncontrolled
Acetaldehyde (H,T)	75070	1.06E-03	7.40E-02	1.06E-03	9.27E+00	1.06E-03	7.40E-02	5.37E-06
Acrolein (H,T)	107028	1.28E-04	8.93E-03	1.28E-04	1.12E+00	1.28E-04	8.93E-03	6.48E-07
Arsenic unlisted compounds (H,T)	ASC-Other	5.52E-06	3.86E-04	5.52E-06	4.83E-02	5.52E-06	3.86E-04	2.80E-08
Benzene (H,T)	71432	1.29E-03	9.01E-02	1.29E-03	1.13E+01	1.29E-03	9.01E-02	6.53E-06
Benzo(a)pyrene (H,T)	50328	2.59E-07	1.81E-05	2.59E-07	2.27E-03	2.59E-07	1.81E-05	1.32E-09
Beryllium metal (unreacted) (H,T)	7440417	4.14E-06	2.90E-04	4.14E-06	3.62E-02	4.14E-06	2.90E-04	2.10E-08
1,3-Butadiene (H,T)	106990	5.39E-05	3.77E-03	5.39E-05	4.72E-01	5.39E-05	3.77E-03	2.74E-07
Cadmium metal (elemental unreacted) (H,T)	7440439	4.14E-06	2.90E-04	4.14E-06	3.62E-02	4.14E-06	2.90E-04	2.10E-08
Chromic Acid (VI) (H,T)	7738945	4.14E-06	2.90E-04	4.14E-06	3.62E-02	4.14E-06	2.90E-04	2.10E-08
Formaldehyde (H,T)	50000	1.63E-03	1.14E-01	1.63E-03	1.43E+01	1.63E-03	1.14E-01	8.26E-06
Lead unlisted compounds (H)	PBC-Other	1.24E-05	8.69E-04	1.24E-05	1.09E-01	1.24E-05	8.69E-04	6.30E-08
Manganese unlisted compounds (H,T)	MNC-Other	8.27E-06	5.79E-04	8.27E-06	7.25E-02	8.27E-06	5.79E-04	4.20E-08
Mercury vapor (H,T)	7439976	4.14E-06	2.90E-04	4.14E-06	3.62E-02	4.14E-06	2.90E-04	2.10E-08
Napthalene (H)	91203	1.17E-04	8.19E-03	1.17E-04	1.02E+00	1.17E-04	8.19E-03	5.94E-07
Nickel metal (H,T)	7440020	4.14E-06	2.90E-04	4.14E-06	3.62E-02	4.14E-06	2.90E-04	2.10E-08
Selenium compounds (H)	SEC	2.07E-05	1.45E-03	2.07E-05	1.81E-01	2.07E-05	1.45E-03	1.05E-07
Toluene (H,T)	108883	5.64E-04	3.95E-02	5.64E-04	4.94E+00	5.64E-04	3.95E-02	2.86E-06
Xylene (H,T)	1330207	3.93E-04	2.75E-02	3.93E-04	3.44E+00	3.93E-04	2.75E-02	2.00E-06
Highest HAP (Formaldehyde)	50000	1.63E-03	1.14E-01	1.63E-03	1.43E+01	1.63E-03	1.14E-01	8.26E-06
Total HAPs		5.29E-03	3.71E-01	5.29E-03	4.64E+01	5.29E-03	3.71E-01	

TOXIC AIR POLLUTANT EMISSIONS INFORMATION (FOR PERMITTING PURPOSES)

EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS

TOXIC AIR POLLUTANT	CAS Num.	lb/hr	lb/day	lb/yr	EMISSION FACTOR lb/hp-hr uncontrolled
Acetaldehyde (H,T)	75070	1.06E-03	2.54E-02	7.40E-02	5.37E-06
Acrolein (H,T)	107028	1.28E-04	3.06E-03	8.93E-03	6.48E-07
Arsenic unlisted compounds (H,T)	ASC-Other	5.52E-06	1.32E-04	3.86E-04	2.80E-08
Benzene (H,T)	71432	1.29E-03	3.09E-02	9.01E-02	6.53E-06
Benzo(a)pyrene (H,T)	50328	2.59E-07	6.22E-06	1.81E-05	1.32E-09
Beryllium metal (unreacted) (H,T)	7440417	4.14E-06	9.93E-05	2.90E-04	2.10E-08
1,3-Butadiene (H,T)	106990	5.39E-05	1.29E-03	3.77E-03	2.74E-07
Cadmium metal (elemental unreacted) (H,T)	7440439	4.14E-06	9.93E-05	2.90E-04	2.10E-08
soluble chromate compounds, as chromium (VI) equivalent	SOLCR6	4.14E-06	9.93E-05	2.90E-04	2.10E-08
Formaldehyde (H,T)	50000	1.63E-03	3.91E-02	1.14E-01	8.26E-06
Manganese unlisted compounds (H,T)	MNC-Other	8.27E-06	1.99E-04	5.79E-04	4.20E-08
Mercury vapor (H,T)	7439976	4.14E-06	9.93E-05	2.90E-04	2.10E-08
Nickel metal (H,T)	7440020	4.14E-06	9.93E-05	2.90E-04	2.10E-08
Toluene (H,T)	108883	5.64E-04	1.35E-02	3.95E-02	2.86E-06
Xylene (H,T)	1330207	3.93E-04	9.43E-03	2.75E-02	2.00E-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

DISTILLATE #2	ACTUAL EMISSIONS			POTENTIAL EMISSIONS - utilize max heat input capacity or horsepower and EPA MRR Emission Factors		POTENTIAL EMISSIONS With Requested Emission Limitation - utilize requested fuel limit and EPA MRR Emission Factors	
GREENHOUSE GAS EMITTED	EPA MRR CALCULATION METHOD: TIER 1						
	metric tons/yr	metric tons/yr, **CO2e**	short tons/yr	short tons/yr	short tons/yr, **CO2e**	short tons/yr	short tons/yr, **CO2e**
CARBON DIOXIDE (CO_2)	7.04	7.04	7.76	984.85	984.85	7.87	7.87
METHANE (CH_4)	2.85E-04	7.14E-03	3.15E-04	3.99E-02	9.99E-01	3.15E-04	7.87E-03
NITROUS OXIDE (N_2O)	5.71E-05	1.70E-02	6.29E-05	7.99E-03	2.38E+00	6.29E-05	1.88E-02
	TOTAL	7.06		TOTAL	988.23	TOTAL	7.90

NOTE: CO2e means CO2 equivalent.

NOTE: The DAQ Air Emissions Reporting Online (AERO) system requires short tons be reported. The EPA MRR requires metric tons be reported.

NOTE: Do not use greenhouse gas emission estimates from this spreadsheet for PSD (Prevention of Significant Deterioration) purposes.

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	3,732	9	3,741
PAF	Trifluoroacetyl Fluoride	354-34-7	2,861	9	2,869
A/F Solvent (n=4 TFF)	Carbonofluoridic acid, 1,1,3,3,5,5,7,7,9,9,9-undecafluoro-2,4,6,8-	21703-48-0	867	2	868
A/F Solvent (n=1 TAF)	Perfluoro-3,5-dioxahexanoyl fluoride	21703-43-5	8	0	8
A/F Solvent (n=2 TAF)	Perfluoro-3,5,7-trioxaoctanoyl fluoride	21703-45-7	842	2	843
A/F Solvent (n=3 TAF)	1,1,1,3,3,5,5,7,7,9,9-undecafluoro-2,4,6,8-tetraoxadecan-10-oyl fluoride	21703-47-9	6	0	6
A/F Solvent (n=4 TAF)	Perfluoro-3,5,7,9,11-pentaoxadodecanoyl fluoride	21703-49-1	8	0	8
HFP	Hexafluoroproplyene	116-15-4	36,645	2	36,647
HFPO	Hexafluoroproplyene oxide	428-59-1	34,535	1	34,536
Benzene	Benzene	71-43-2	3	0	3
Toluene	Methylbenzene	108-88-3	1,246	0	1,246
				Total VOC Emissions (lbs)	**80,776**
				Total VOC Emissions (tons)	**40.39**

B. Toxic Air Polluntant 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	3,225	124	8	3,357
Benzene	Benzene	71-43-2	0	3	0	3
Methylene Chloride	Methylene Chloride	75-09-2	0	0	65	65
Toluene	Methylbenzene	108-88-3	0	1,246	0	1,246

Reported by: Amy Martin
Date: 6/25/2018

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 (2013, 0.07 O2, 4000 kg/h basis):

Reactor/Solvent Recycle/Solvent Column & Associated Equipment														
			Avg. Contents (kg/hr)				% of			HF	% Overall HF Potential			
Material	VOC	HFA	Line 207B	Line 255	Line 305	Total	contents	% VOC	% HF	Potential	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							
PMAF	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
											Average HF Potential			0.505393

Assume that: 98% 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
x 8760 operating hr/year
x 0.840 lb. A/F VOC/lb. EE
= 1225.542 lb VOC generated

1225.542 lb VOC generated
x (100%-95%) scrubber efficiency
= 61.277 lb VOC emitted

From non-acid fluorides:
0.167 lb. EE/hr
x 8760 operating hr/year
x 0.160 lb. Non-A/F VOC/lb. EE
= 233.436 lb VOC

Total Barricade VOC Emissions:
61.277 lb VOC
\+ 233.436 lb VOC
= 294.714 **lb VOC**

Barricade HF:
0.167 lb. EE/hr
x 8760 operating hr/year
x 0.505 lb. HF/lb. EE
x (100%-95%) scrubber efficiency
= **36.839 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 (2013, 0.07 O2, 4000 kg/h basis):

A/F Column, Scrubbers, Dryers, Stripper Column & Associated Equipment															
			Avg. Contents (kg/hr)					% of			HF	% Overall HF Potential			
Material	VOC	HFA	Line 405	Line 572	Line 605	Line 652	Total	contents	% VOC	% HF	Potential	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	0.0
												Average HF Potential			0.044087

Assume that : 97 wt. % of the process material are VOCs vented to stack (no scrubbing);
100% of the liquid is 0.044 weight fraction HF.

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:			HF:		
	0.226	lb. EE/hr			0.226 lb. EE/hr
x	8760	operating hr/year		x	8760 operating hr/year
x	0.970	lb. VOC/lb. EE		x	0.044 lb. HF/lb. EE
	1918.668	**lb VOC**		=	**87.032 lb HF**

B. Equipment Emissions Outside Buildings (Fugitive Emissions)

1. Fugitive Emissions (FE) From Outside Unit Operations

From ASPEN Model (2013, 0.07 O2, 4000 kg/h basis):

Refining Columns & Associated Equipment														
			Avg. Contents (kg/hr)				% of			HF	% Overall HF Potential			
Material	VOC	HFA	Line 706	Line 805	Line 812	Total	contents	% VOC	% HF	Potential	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
											Average HF Potential			0

Assume that : 100 wt. % of the process material are VOCs
0 wt. % of the liquid is HF.

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:			HF:		
	0.241	lb. FE/hr			0.241 lb. FE/hr
x	8760	opearting hr/year		x	8760 operating hr/year
x	1.00	lb. VOC/lb. FE		x	0.0 lb. HF/lb. FE
=	**2113**	**lb VOC total**		=	**0.00 lb HF**
	201	**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:			HF:		
	0.071	lb. FE/hr			0.071 lb. FE/hr
x	8760	operating hr/year		x	8760 operating hr/year
x	1.00	lb. VOC/lb. FE		x	0.0 lb. HF/lb. FE
=	**623**	**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: 541.39 lbs

Benzene emissions:

$$541.390476 \text{ lbs} \times \frac{1.90 \text{ lb emission}}{368 \text{ lb benzene}} = 2.80 \text{ lb benzene emission}$$

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 year ('User Entr	+	4759.00 lb		1-Jan
Toluene added to process:	+	12734.00 lb		
Toluene inventory in process as of last day of year ('User E	-	5493.00 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:	-	10754.00 lb		
Toluene released to air via permitted stack:	-	170.10 lb		
Toluene released to process wastewater:	-	0 lb		
Toluene released to the ground (spill):	-	0 lb		
Unaccounted for difference in mass:	=	1076 lb toluene	=	1076 lb VOC

5. Total Equipment Emissions (Fugitive)

		Inside Emissions (Stack Emissions)		Outside Emissions (Fugitive Emissions)	
Emission Source		lb VOC	lb HF	lb VOC	lb HF
A-1	Barricade	294.71	36.84		
A-2	HFPO Tower	1918.67	87.03		
B-1	Outside operations(excluding toluene system)			201	
B-2	HFP Storage and Feed			622.84	
B-3	Benzene system			2.80	
B-4	Toluene mass balance			1075.90	
	Total	2213.38	123.87	1902.26	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 (J42): 1%COF2, 1% PAF, 49% TFF, 13% n1 TAF, 13% n2 TAF, 10% n3 TAF, 13% n4TAF
A1 Non-AF VOCs from the barricade (E48) are reported as 57% HFP and 43% HFPO per table A1
A2 Tower VOCs (H177) are reported as 38% HFPO, 51% HFP, 6% COF2, and 5% PAF.
B1 Toluene emissions are included in B-4. The remaining VOC (J178) is reported as 57% HFP and 43% 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	115.73
PAF	96.55
TFF	30.03
n1 TAF	7.97
HFP	1848.83
HFPO	915.78
Benzene	2.80
Toluene	1075.90

Compound	lb VOC
n2 TAF	7.97
n3 TAF	6.13
n4 TAF	7.97
Total VOC	4115.64
PMCP	63.55

0.61

Point Source Emission Determination

A. Carbonyl Fluoride (COF_2) CAS No. 353-50-4

HF Potential:

Each mole of COF_2 (MW = 66) can generate 2 moles of HF (MW = 20).

$$1\,lb\,COF_2 \cdot \frac{1\,mole COF_2}{66\,lb\,COF_2} \cdot \frac{20\,lb\,HF}{1\,mole HF} \cdot \frac{2\,moles HF}{1\,mole COF_2} = 0.606\,lb\,HF$$

Therefore, each 1 lb of COF_2 generates 0.606 lb of HF

Quantity Generated:

Before-control COF_2 generation :

Vented from A/F Column:	Total AF column vent flow [lb] * Average COF2 mass fraction in AF column vent [lb COF2/lb]					
From "Vent Flows" Tab =	644,835.49	X	0.5308	=	342,279	lb COF2
Vented from Stripper Column:	Total Stripper col vent flow [lb] * Average COF2 mass fraction in Stripper column vent [lb COF2/lb]					
From "Vent Flows" Tab =	225,783.63	X	0	=	0	lb COF2
Vented from Solvent Recycle Tank:	Total Solvent tank vent flow [lb] * Average COF2 mass fraction in Solvent tank vent [lb COF2/lb]					
From "Vent Flows" Tab =	290,072.00	X	0.16225	=	47,064	lb COF2
COF_2 sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab):				=	12,493	lb COF2

Total COF_2 Emitted from Process =		342,279	lb COF_2 from A/F Column
(sent to WGS)	+	0	lb COF_2 from Stripper Column
	+	47,064	lb COF_2 from Solvent Recycle Tank
	+	12,493	lb COF_2 sent to VE-South Process when VE-S shutdown
	=	401,836	lb COF_2 sent to WGS

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

VOC Emissions		401,836	lb COF_2
Waste Gas Scrubber	x	0.90%	
	=	3,617	lb COF_2 (VOC)

HF Equivalent Emissions		3617	lb COF_2
	x	0.606	lb HF/lb COF_2
	=	2,192	lb HF (Equivalent HF)

B. Perfluoroacetyl Fluoride (PAF) **CAS No. 354-34-7**
Trifluoroacetyl Fluoride (CF3COF)

HF Potential:

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

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

Therefore, each 1 lb of PAF generates 0.172 lb of HF

Quantity Generated:

Before-control PAF vented

Vented from A/F Column:	Total AF column vent flow [lb] * Average PAF mass fraction in AF column vent [lb PAF/lb]				
From "Vent Flows" Tab =	644,835.49	X	0.4511	=	290,885 lb PAF
Vented from Stripper Column:	Total Stripper column vent flow [lb] * Average PAF mass fraction in Stripper column vent [lb PAF/lb]				
From "Vent Flows" Tab =	225,783.63	X	0.0015	=	339 lb PAF
Vented from Solvent Recycle	Total Solvent tank vent flow [lb] * Average PAF mass fraction in Solvent tank vent [lb PAF/lb]				
From "Vent Flows" Tab =	290,072.00	X	0.01815	=	5,265 lb PAF
PAF sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab):				=	10,617 lb PAF

Total COF_2 Emitted from Process =		290,885 lb PAF from A/F Column
(sent to WGS)	+	339 lb PAF from Stripper Column
	+	5,265 lb PAF from Solvent Recycle Tank
	+	10,617 lb PAF sent to VE-South Process when VE-S shutdown
	=	307,106 lb PAF sent to WGS

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

VOC Emissions		307,106 lb PAF	
Waste Gas Scrubber	x	0.90%	
	=	2,764 lb PAF	(VOC)

HF Equivalent Emissions		2764 lb PAF	
	x	0.172 lb HF/lb PAF	
	=	475 lb HF	(Equivalent HF)

C. Acid Fluoride Solvent - mixture of TAF and TFF
Carbonofluoridic acid, 1,1,3,3,5,5,7,7,9,9,9-undecafluoro-2,4,6,8-tetraoxanon-1-yl ester (n=4 TFF) **CAS Nos. 21703-48-0**
PERFLUORO-3,5,7-TRIOXAOCTANOYL FLUORIDE (n=2 TAF) **21703-45-7**

HF Potential:

The acid fluoride solvent is a mixture of telomeric acid fluorides (TAF) and telomeric fluoroformates (TFF).
TAF is present in multiple chain lengths in the process. In the process vent from the solvent recycle tank, models estimate the average chain length is n=2, which will be the basis for these calculations.
Each mole of n2 TAF (avg MW = 314) can generate one mole of HF (MW = 20).

$$1\ lb\ TAF \cdot \frac{1\ mole\ TAF}{314\ lb\ TAF} \cdot \frac{20\ lb\ HF}{1\ mole\ HF} \cdot \frac{1\ mole\ HF}{1\ mole\ TAF} = 0.0637 lb\ HF$$

Therefore, each 1 lb of TAF generates 0.0637 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 COF2 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, so this is a reasonable conservative estimate.

$$1\ lb\ TFF \cdot \frac{mole\ \ TFF}{396\ lb\ TFF} \cdot \frac{6\ mole\ \ COF_2}{1 mole\ \ TFF} \cdot \frac{20\ lb\ HF}{1\ mole\ \ HF} \cdot \frac{2\ moles\ \ HF}{1\ mole\ \ COF_2} = 0.606\ lb\ HF$$

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

Quantity Generated:

The only processs 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 =	290,072.00	X	0.63865	=	185,254 lb TAF/TFF

Total AF Emitted from Process = 185,254 lb AF sent to WGS
(sent to WGS)

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

VOC Emissions
185,254 lb AF
Waste Gas Scrubber x 0.90%
= 1,667 lb total AF (VOC)

VOC Emissions
For TFF: 92,627 lb TFF Assumed 50% TFF
x 0.90% Waste Gas Scrubber
= 834 lb TFF 834 lb VOC

For n2 TAF: 92,627 lb TAF Assumed 50% TAF
x 0.90% Waste Gas Scrubber
= 834 lb TAF 834 lb VOC

HF Equivalent Emissions

505.2 lb HF equivalent from TFF

53.1 lb HF equivalent from TAF

558 lb. HF

D. Hexafluoroproplyene (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:	Total AF column vent flow [lb] * Average HFP mass fraction in AF column vent [lb HFP/lb]				
From "Vent Flows" Tab =	644,835.49	X	0.0016	=	1,032 lb HFP
Vented from Stripper Column:	Total Stripper column vent flow [lb] * Average HFP mass fraction in Stripper column vent [lb HFP/lb]				
From "Vent Flows" Tab =	225,783.63	X	0.0865	=	19,530 lb HFP
Vented from Solvent Recycle	Total Solvent tank vent flow [lb] * Average HFP mass fraction in Solvent tank vent [lb HFP/lb]				
From "Vent Flows" Tab =	290,072.00	X	0.00045	=	131 lb HFP
HFP sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab):				=	38 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.

Volume of each hose = 753.98 in^3 = 12.36 L

The density of HFP liquid at 16C is 1.42 kg/L Determined from physical property data
The density of HFP vapor at 16C is 0.0281 kg/L 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)
Volume of hose X liquid density = 17.54 kg from Liquid Hose

HFP vented from Vapor Hose: (assumes hose volume is filled with vapor)
Volume of hose X vapor density = 0.35 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
HFP vented from vapor piping= 7 L X vapor density = 0.20 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.
Vapor density of HFP= 0.0223 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
Suction side volume X vapor density= 0.71 kg

Discharge bottle volume is 30.2 L, typical temperature is 37C, 370 kPa (g) at time of decontamination.
Vapor density of HFP= 0.0274 kg/L Determined by ideal gas law @ 37C and 471.3 kPa (a) Reference H27456TG & H27455PG

Discharge side volume x vapor density= 0.83 kg

Total volume form compressor & piping = 1.54 kg from Compressor & Piping

The number of decontamination events required is based on the HFP consumed divided by the typical transfer amount, rounded up.
2,841,194 / 13,500 = 211

Total HFP from decontamination of unloading hoses = Number of events * (vented from liquid hose + vapor hose + compressor + piping)
= 211 X 20 = 4,131 kg HFP
9,107 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.
Vapor volume in dryer= 1.429 ft3 of vapor
X vapor density of 3.3 lb/ft3
4.72 lb VOC vapor released per dryer change
Dryer changes occur every 48 hours. The number of dryer changes is estimated to be 142
HFP vented = %HFP x lb of VOC per dryer change x number of dryer changes in the year= **335** lb HFP

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

<u>VOC Emissions</u>		1,032	lb HFP from A/F Column
	+	19,530	lb HFP from Stripper Column
	+	131	lb HFP from Solvent Recycle Tank
	+	9,107	lb HFP from Unloading Hoses
	+	335	lb HFP from crude dryer changes
	+	38	lb HFP sent to VE-South Process when VE-S shutdown
	=	30,173	lb HFP 30,173 lb VOC

E. Hexafluoroproplyene Epoxide (HFPO) **CAS No. 428-59-1**

HF Potential:

HFPO is a VOC without the potential to form HF.

Quantity Released:

Chemours conducted various stack tests in April 2018 to determine the HFPO emission rates from the HFPO Process Unit, VE-North Process Unit, and VE-South Process Unit. This section summarizes the methodologies used to determine the 2017 process emissions of HFPO. Depending on the data available for each process unit, the most applicable (best available) data was utilized to estimate emissions by unit for calendar year 2017

On April 25-26, 2018, source testing was performed on the Division Stack while the HFPO Process unit was operating and the VE-North Process Unit was operating but the VE-North Stripper Column was not venting. During this operational period, HFPO emissions would be expected from the HFPO process and only minimal, if any, emissions, from the VE-North process. Therefore, it has been assumed that the emission rates represented in Table 2-1 are associated only with the HFPO process.

HFPO Source Test Results

Date	Test Run Number	HFPO Emission Rate (lb/hr)
04-25-2018	Division 1	6.30
04-26-2108	Division 2	3.03
	Average Emission Rate	**4.67**

Hours of Operation **6822 hours**

Process Vent Emissions

4.67 lb/hr X 6822 hours = **31,859 lb. HFPO**

HFPO sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab): **388 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).

Volume of liquid hose = 188.5 in^3 = 3.09 L
Volume of vapor hose= 47.124 in^3 = 0.77 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)
Volume of hose X liquid density = 4.88 kg from Liquid Hose

HFPO vented from Vapor Hose: (assumes hose volume is filled with vapor)
Volume of hose X vapor density = 0.04 kg from Vapor Hose

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

Total HFPO from decontamination of loading hoses = Number of events * (vented from liquid hose + vapor hose)
= 49 X 4.92 = 241 kg HFPO
532 lb HFPO

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

HFPO vented = %HFPO x lb of VOC per dryer change x number of dryer changes in the year= **335** 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

	31,859	lb HFPO from Process Vents	
+	532	lb HFPO from Unloading Hoses	
+	335	lb HFPO from dryer changes	
+	388	lb HFPO sent to VE-South Process when VE-S shutdown	
=	33,114	lb HFPO	33,114 lb VOC

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

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

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

		VOC (lb)	Equiv HF (lb)
A.	COF2	3,617	2,192
B.	PAF	2,764	475
C.	Acid Fluoride Solvent (TFF)	834	558
	Acid Fluoride Solvent (n=2 TAF)	834	
D.	HFP	30,173	0
E.	HFPO	33,114	0
	Total for year (lb)	**71,335**	**3,225**

Equiv HF represents conservative estimate total for TFF+TAF

2017 Emissions Summary

A. VOC Emissions Summary

Nafion® Compound	CAS Chemical Name	CAS No.	EVE Process Emissions (lb.)	PPVE Process Emissions (lb.)	PSEPVE Process Emissions (lb.)	Accidental Releases (lb.)	Total Vinyl Ethers North Emissions (lb.)
HFP	Hexafluoroproplyene	116-15-4	111	6,848	215		7,173
HFPO	Hexafluoropropylene oxide	428-59-1	122	12,355	1,046		13,523
HFPO Dimer Acid Fluoride	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	49	1,238	203	2	1,492
EVE	Propanoic Acid, 3-[1-[Difluoro [(Trifluoroethenyl oxy] Methyl]-1,2,2,2-Tetrafluoroethoxy] -2,2,3,3-Tetrafluoro-, Methyl Ester	63863-43-4	141	0	0		141
PPVE	Perfluoropropyl vinyl ether	1623-05-8	0	2,074	0		2,074
PSEPVE	Perfluoro-2-(2-Fluorosulfonylethoxy) Propyl Vinyl Ether	16090-14-5	0	0	550		550
PPF	Perfluoropropionyl fluoride	422-61-7	0	76	2		78
TFE	Tetrafluoroethylene	116-14-3	58	8	284		350
C4	Perfluoro-2-butene	360-89-4	0	286	680		966
C5	Perfluoropentene	376-87-4	0	17	0		17
Diglyme	Diethylene Glycol Dimethyl Ether	111-96-6	0	0	81		81
AN	Acetonitrile	75-05-8	0	1,445	0		1,445
ADN	Adiponitrile	111-69-3	17	0	0		17
TTG	Tetraglyme	143-24-8	2	0	0		2
DA	Tetrafluoro-2[Hexafluoro-2-(Tetrafluoro-2-{Fluorosulfonyl}Ethoxy) Propoxy Propionyl Fluoride	4089-58-1	0	0	289		289
Hydro-PSEPVE	Tetrafluoro-2-[Trifluoro-2-(1,2,2,2-Tetra-fluoroethoxy)-1-(Trifluoromethyl) Ethoxy]-Ethane Sulfonyl Fluoride	75549-02-9	0	0	1		1
MA	Tetrafluoro-2-[Tetrafluoro-2-(Fluorosulfonyl)Ethoxy]-Propanoyl Fluoride	4089-57-0	0	0	129		129
MAE	Methyl Perfluoro (5-(Fluoroformyl)-4-Oxahexanoate)	69116-72-9	36	0	0		36
DAE	Methyl Perfloro (8-(Fluoroformyl)-5-methyl-4,7-Dioxanonanoate)	69116-73-0	55	0	0		55
TAE	Methyl Perfluoro (11-(Fluoroformyl)-5,8-Dimethyl-4,7,10-Trioxadodecanoate)	69116-67-2	2	0	0		2
hydro-EVE	Methyl Perfloro-5-methyl-4,7-dioxanon-8-hydroaneoate	87483-34-9	7	0	0		7
iso-EVE	Methyl Perfluoro-6-Methyl-4,7-Dioxanon-8 Eneoate	73122-14-2	10	0	0		10
MMF	Methyl-2,2-Difluoromalonyl Fluoride	69116-71-8	7	0	0		7
HFPO Trimer	Perfluoro-2,5-Dimethyl-3,6-Dioxanonanoyl	2641-34-1	0	19	7		26
Iso-PSEPVE	Perfluoro-1-Methyl-2-(2 Fluorosulfonyl Ethoxy) Ethyl	34805-58-8	0	0	2		2
TA	2,3,3,3-tetrafluoro-2-[1,1,2,3,3,3-hexafluoro-2-[1,1,2,3,3,3-hexafluoro-2-[1,1,2,2-tetrafluoro-2-(fluorosulfonyl)ethoxy]propoxy]propoxy] propanoyl	4628-44-8	0	0	11		11
RSU	2,2-difluoro-2-(fluorosulfonyl) acetyl fluoride	677-67-8	0	0	1		1
	Total VOC Emissions (lb.)		**618**	**24,366**	**3,500**	**2**	**28,486**
	Total VOC Emissions (tons)		**0.3**	**12.2**	**1.7**	**0.0**	**14.2**

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

Nafion® Compound	CAS Chemical Name	CAS No.	EVE Emissions (lb.)	PPVE Emissions (lb.)	PSEPVE Emissions (lb.)	Accidental Releases (lb.)	Total Emissions (lb.)
HF	Hydrogen Fluoride	7664-39-3	8.48	84.5	19.3	0	112.3
Diglyme	Diethylene Glycol Dimethyl Ether	111-96-6			81		81
Acetonitrile	Acetonitrile	75-05-8		1,445			1,445

C. Carbon Monoxide (CO) Emissions Summary

Nafion® Compound	CAS Chemical Name	CAS No.	EVE Emissions (lb.)	PPVE Emissions (lb.)	PSEPVE Emissions (lb.)	Total Emissions (lb.)	Total Emissions (tons)
CO2	Carbon Dioxide	124-38-9	194	11,919	48	12,161	6.1

2017 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: $\frac{0.17\,kg\,HFP}{0.50\,kg\,CondRxVentFlo}$

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

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

HFP vented based on 143 kg total Condensation Reactor vent stream (22266FG).
HFP vented based on 2,378 kg total Crude Receiver vent stream (22701FG).
HFP vented based on 6 kg total Foreshots Receiver vent stream (22826FG).

HFP vented from Condensation Reactor:

$\frac{0.17\text{ kg HFP}}{0.50\text{ kg CndRx}}$ x 143 kg CndRx = 50 kg HFP

HFP vented from Crude Receiver

$\frac{0.00\text{ kg HFP}}{15.91\text{ kg CrRec}}$ x 2,378 kg CrRec = 0 kg HFP

HFP vented from Foreshots Receiver

$\frac{0.00\text{ kg HFP}}{0.14\text{ kg FsRec}}$ x 6 kg FsRec = 0 kg HFP

VOC Emissions				
		50 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
	=	**50** kg HFP	=	50 kg VOC
				110 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: $\frac{0.13\ kg\ HFPO}{0.50\ kg\ Cond\ Rx\ Vent\ Flow}$

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

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

HFPO vented based on 143 kg total Condensation Reactor vent stream (22266FG).
HFPO vented based on 2,378 kg total Crude Receiver vent stream (22701FG).
HFPO vented based on 6 kg total Foreshots Receiver vent stream (22826FG).

HFPO vented from Condensation Reactor:

$\frac{0.13\ kg\ HFPO}{0.50\ kg\ CndRx}$ x 143 kg CndRx = 37 kg HFPO

HFPO vented from Crude Receiver

$\frac{0.00\ kg\ HFPO}{15.91\ kg\ CrRec}$ x 2,378 kg CrRec = 0 kg HFPO

HFPO vented from Foreshots Receiver

$\frac{0.00\ kg\ HFPO}{0.14\ kg\ FsRec}$ x 6 kg FsRec = 0 kg HFPO

VOC Emissions

	37 kg from Condensation Reactor		
+	0 kg from Crude Receiver		
+	0 kg from Foreshots Receiver		
=	37 kg HFPO	=	37 kg VOC
			81 lb VOC

C. HFPO Dimer Acid Fluoride **CAS No. 2062-98-8**
2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoyl fluoride

HF Potential:

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

$$1\,kg\,DAF \cdot \frac{1\,moleDAF}{332g\,DAF} \cdot \frac{20\,g\,HF}{1\,moleHF} \cdot \frac{1\,moleHF}{1\,moleDAF} = 0.120 kg\,HF$$

Therefore, each 1 kg of HFPO Dimer Acid Fluoride generates 0.060 kg of HF

Quantity Released

In early 2018, stack testing was performed on the Division Stack (ID No. NEP-Hdr1) for the HFPO Dimer anion during the production of PSEPVE. For the purpose of this report, it will be assumed that the measured compound was the HFPO Dimer Acid Fluoride ("DAF") and that the emission rate measured during the production of PSEPVE is the same as during the production of EVE.

The stack testing results showed an emission rate of 0.103 lb/hr of DAF. These emissions would be the combination of the after-control process vent and maintenance activity emissions plus the uncontrolled indoor equipment emissions from valves and connectors.

Equipment emissions are determined and reported separately in this report. It has been determined that approximately 60% of the equipment is inside the VE North Tower and the emissions from that equipment would have been included in the stack test's measured emission rate of 0.103 lb/hr DAF. It has also been determined that approximately 40% of the equipment is outdoors and the emissions from that equipment would not have been included in the stack test.

For this report, the process emissions will be estimated by calculating the stack emissions by multiplying the hours of operation of the PSEPVE campaign and emission factor 0.103 lb/hr DAF, and then subtract from that product the estimated indoor equipment emissions.

480 hours of operation during reporting year

0.103 lb/hr DAF emission rate (from 2018 stack testing)

49.4 lb. DAF discharged from the Division Stack (ID No. NEP-Hdr1)

0.0 lb. DAF total equipment emissions during reporting year

0.0 lb. DAF indoor equipment emissions during reporting year (60% of total)

0.01 lb. DAF from maintenance activities

Process Vent Emissions = Stack Emissions – Indoor Equipment Leaks – Maintenance Emissions
Process Vent Emissions = 49.4 lb. DAF minus 0.0 lb. DAF minus 0.01 lb. DAF
Process Vent Emissions = 49.4 lb. DAF (after control)

Process Vent Emissions = 49.4 lb. DAF (after control)
Process Vent Emissions = 49.4 lb. VOC (after control)

HF Equivalent Emissions

	49.4 lb-DAF
x	0.060 lb-HF / lb-DAF
=	2.98 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: $\frac{0\ kg\ TFE}{0.50\ kg\ Cond\ Rx\ Vent\ Flow}$

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

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

TFE vented based on 143 kg total Condensation Reactor vent stream (22266FG).
TFE vented based on 2,378 kg total Crude Receiver vent stream (22701FG).
TFE vented based on 6 kg total Foreshots Receiver vent stream (22826FG).

TFE vented from Condensation Reactor:

$\frac{0.00\ kg\ TFE}{0.50\ kg\ CndRx}$ x 143 kg CndRx = 0 kg TFE

TFE vented from Crude Receiver

$\frac{0.18\ kg\ TFE}{15.91\ kg\ CrRec}$ x 2,378 kg CrRec = 26 kg TFE

TFE vented from Foreshots Receiver

$\frac{0.00\ kg\ TFE}{0.14\ kg\ FsRec}$ x 6 kg FsRec = 0 kg TFE

VOC Emissions

		0 kg from Condensation Reactor		
	+	26 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
	=	26 kg TFE	=	26 kg VOC
				58 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).

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

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

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

Vented from the Foreshots Receiver $\frac{0.04\ kg\ MAE}{0.14\ kg\ Foreshots Receiver\,Vent}$

MAE vented based on	143	kg total Condensation Reactor vent stream (22266FG).
MAE vented based on	2,378	kg total Crude Receiver vent stream (22701FG).
MAE vented based on	6	kg total Foreshots Receiver vent stream (22826FG).

Before control MAE vented from Condensation Reactor:

0.00 kg MAE / 0.50 kg CndRx	x	143 kg CndRx	=	0 kg MAE

MAE vented from Crude Receiver

0.00 kg MAE / 15.91 kg CrRec	x	2,378 kg CrRec	=	0 kg MAE

MAE vented from Foreshots Receiver

0.04 kg MAE / 0.14 kg FsRec	x	6 kg FsRec	=	1 kg MAE

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
		=	**0.03 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: $\frac{0\ kg\ EVE}{0.50\ kg\ Cond\ Rx\ Vent\ Flow}$

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

Vented from the Foreshots Receiver $\frac{0.005 kg\ EVE}{0.14\ kg\ Foreshots Receiver Vent}$

EVE vented based on	143	kg total Condensation Reactor vent stream (22266FG).
EVE vented based on	2,378	kg total Crude Receiver vent stream (22701FG).
EVE vented based on	6	kg total Foreshots Receiver vent stream (22826FG).

EVE vented from Condensation Reactor:

$\frac{0.00\ kg\ EVE}{0.50\ kg\ CndRx}$ x 143 kg CndRx = 0 kg EVE

EVE vented from Crude Receiver

$\frac{0.00\ kg\ EVE}{15.91\ kg\ CrRec}$ x 2,378 kg CrRec = 0 kg EVE

EVE vented from Foreshots Receiver

$\frac{0.005\ kg\ EVE}{0.14\ kg\ FsRec}$ x 6 kg FsRec = 0 kg EVE

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

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

The emissions of Tetraglyme is based on a mass balance.

Quantity Released

	=	289	kg TTG introduced into processes
	=	289	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 Dioxide (CO2) **CAS No. 124-38-9**

HF Potential:

CO2 can not form HF

Quantity Released

CO2 is a byproduct from the Agitated Bed Reactor system.
vented to the WGS.

CO2 vented per the process flowsheet

Vented from the Condensation Reactor:

0 kg CO2
0.50 kg Cond Rxr Vent Flow

Vented from the Crude Receiver

0.59 kg CO2
14.91 kg Crude Receiver Vent Flow

Vented from the Foreshots Receiver

0 kg CO2
0.14 kg Foreshots Receiv'r Vent Flow

CO2 vented based on 143 kg total Condensation Reactor vent stream (22266FG).
CO2 vented based on 2,378 kg total Crude Receiver vent stream (22701FG).
CO2 vented based on 6 kg total Foreshots Receiver vent stream (22826FG).

CO2 vented from Condensation Reactor:

$\frac{0.00 \text{ kg CO2}}{0.50 \text{ kg CndRx}}$ x 143 kg CndRx = 0 kg CO2

CO2 vented from Crude Receiver

$\frac{0.59 \text{ kg CO2}}{15.91 \text{ kg CrRec}}$ x 2,378 kg CrRec = 88 kg CO2

CO2 vented from Foreshots Receiver

$\frac{0.00 \text{ kg CO2}}{0.14 \text{ kg FsRec}}$ x 6 kg FsRec = 0 kg CO2

CO2 Emissions

	0 kg from Condensation Reactor		
+	88 kg from Crude Receiver		
+	0 kg from Foreshots Receiver		
=	88 kg CO2	=	**194 lb CO2**
			(not a VOC)

I. Adiponitrile

CAS No. 111-69-3

HF Potential

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

Quantity Released

ADN emissions based on 2,887 kg ADN fed

VE North ADN Sent to waste Hydrocarbon tank = 2,887 kgs H/C waste

VOC Emission

	2,887 kg ADN fed		
-	2,887 kg ADN to H/C waste		
	0 kg ADN lost	=	0 **kg VOC**
			0 lb VOC

ADN only used during an EVE Campaign

J. VOC Summary

Nafion Compound Name		Before Control Generated		After Control Stack Emissions VOC
		kg/yr	lb/yr	lb/yr
A.	HFP	49.7	110	110
B.	HFPO	37	81	81
C.	HFPO-Dimer	2,491	5,492	49
D.	TFE	26	58	58
E.	MAE	1	3	0.0
F.	EVE	0	0	0.4
G.	TTG	0	0	0
K.	ADN	0	0	0
	Total	**2,605**	**5,744**	**297.8**

K. Total Emission Summary**

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

	Nafion Compound Name	Process Emissions lb/yr	Equipment Emissions lb/yr (Note 1)	Maintenance Emissions lb/yr (Note 2)	Total Emissions lb/yr
A.	HFP	110	1	0	111
B.	HFPO	81	39	2	122
C.	HFPO Dimer Acid Fluoride	49	0	0	49
D.	TFE	58	0	0	58
E.	MAE	0	36	0	36
F.	EVE	0	78	62	141
G.	TTG	0	2	0	2
H.	CO2 (not a VOC)	194			194
I.	ADN	0	17	1	17
*	DAE		55	0	55
*	TAE		2	0	2
*	MMF		7	0	7
*	hydro-EVE		4	3	7
*	iso-EVE		6	4	10
	Total	**492**	**249**	**72**	**812**

Note 1 - See section titled "Equipment Emissions" for details
Note 2 - See section titled "Maintenance Emissions" for details
H. CO2 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

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	2.977	0.000	0.001	2.978
E.	MAE	0.002	2.234	0.004	2.240
*	DAE		2.270	0.004	2.274
*	TAE		0.074	0.000	0.075
*	MMF		0.916	0.002	0.918
	Total	**2.98**	**5.50**	**0.01**	**8.48**

* 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:

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

2017 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: $\frac{0.05\ kg\ HFP}{2.35\ kg\ CondRx\ VentFlow}$

Vented from the Crude Receiver $\frac{0.00\ kg\ HFP}{3.97\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0.01\ kg\ HFP}{1.06\ kg\ ForeshotsReceiver\ Vent}$

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

HFP vented based on 1,465 kg total Condensation Reactor vent stream (22266FG).
HFP vented based on 6,214 kg total Crude Receiver vent stream (22701FG).
HFP vented based on 459 kg total Foreshots Receiver vent stream (22826FG).
HFP vented based on 10,218 kg in the Stripper vent stream (22231FC).

HFP vented from Condensation Reactor:

$\frac{0.05\ kg\ HFP}{2.35\ kg\ CndRx}$ x 1,465 kg CndRx = 34 kg HFP

HFP vented from Crude Receiver

$\frac{0.00\ kg\ HFP}{3.97\ kg\ CrRec}$ x 6,214 kg CrRec = 0 kg HFP

HFP vented from Foreshots Receiver

$\frac{0.01\ kg\ HFP}{1.06\ kg\ FsRec}$ x 459 kg FsRec = 4 kg HFP

HFP vented from Stripper

$\frac{30\ kg\ HFP}{100\ kg\ Strpr}$ x 10,218 kg Strpr = 3,065 kg HFP

VOC Emissions

		34 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	4 kg from Foreshots Receiver		
		3,065 kg from Stripper		
	=	3,103 kg HFP	=	3,103 kg VOC
				6,841 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

On April 5, 2018 and April 25-26, 2018, source testing was performed on the Division Stack while the HFPO Process unit was operating and VE-North Process Unit was operating and producing PPVE. It was determined by review of process data (i.e., flow meter trends) that the source tests presented in the table below were conducted while the VE-North Stripper Column was being vented. The results of those source tests are also included in the below table.

HFPO/VE-North (With Stripper Column Vent) Source Test Results

Date	Test Run Number	HFPO Emission Rate (lb/hr)
04-05-2018	Division 1	14.67
04-05-2018	Division 2	22.97
04-05-2018	Division 3	18.31
04-26-2018	Division 3	8.53
04-26-2018	Division 4	12.36
	Avg Emission Rate	15.37

The source testing for the HFPO Process indicated emissions of 4.67 lb/hr; therefore to determine VE-North's contribution, 4.67 lb/hr was subtracted from the average emission rate shown in the above Table (15.37 lb/hr). The resulting emission rate, for VE-North during periods when the Stripper Column was venting, is 10.70 lb/hr.

VE North Stripper Column emission rate = 10.70 lb. HFPO / hour

Review of VE-North process data from the data historian indicates that the VE-North Stripper Column vented for 639 hours during 2017. The Stripper Column was assumed to be venting when the process was being fed and the manual and control valves on the vent line were open. Review of the data also indicated that there were 460 hours during which the data historian did not maintain the process data. To be conservative, the emission estimates here have assumed that the Stripper Column was venting during that entire period. Therefore, the Stripper Column was assumed to be venting for 1,099 hours during 2017.

VE North Stripper Column venting time = 1,099 hours

VE North Stripper Column emissions = 1,099 hr X 10.70 lb. HFPO / hour
VE North Stripper Column emissions = **11,759 lb. HFPO**

HFPO emissions would also be emitted from the VE-North Condensation Reactor on a routine, as-needed basis. HFPO emissions from the VE-North Condensation Reactor, while producing PPVE, were determined using the total mass flow from the Condensation Reactor vent along with the concentration of HFPO in the Condensation Reactor vent stream. Emissions were calculated as follows:

HFPO unreacted in condensation is vented to the WGS.

HFPO vented per the process flowsheet

Vented from the Condensation Reactor: $\frac{0.11\ kg\ HFPO}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}$

HFPO vented based on 1,465 kg total Condensation Reactor vent stream (22266FG).

HFPO vented from Condensation Reactor:

$\frac{0.11\text{ kg HFPO}}{2.35\text{ kg CndRx}}$ x 1,465 kg CndRx = 69 kg HFPO
151 lb. HFPO

VOC Emissions		151 lb. from Condensation Reactor		
	+	11,759 lb. from Stripper Column		
	=	11,910 lb. HFPO	=	**11,910 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).

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

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: $\frac{2.14\ kg\ PPF}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}$

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

Vented from the Foreshots Receiver $\frac{0\ kg\ PPF}{1.06\ kg\ Foreshots\text{Receiver}\,Vent}$

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

PPF vented based on 1,465 kg total Condensation Reactor vent stream (22266FG).
PPF vented based on 6,214 kg total Crude Receiver vent stream (22701FG).
PPF vented based on 459 kg total Foreshots Receiver vent stream (22826FG).
PPF vented based on 10,218 kg in the Stripper vent stream (22231FC).

Before control PPF vented from Condensation Reactor:

$\frac{2.14\ \text{kg PPF}}{2.35\ \text{kg CndRx}}$ x 1,465 kg CndRx = 1,332 kg PPF

PPF vented from Crude Receiver

$\frac{0.00\ \text{kg PPF}}{3.97\ \text{kg CrRec}}$ x 6,214 kg CrRec = 0 kg PPF

PPF vented from Foreshots Receiver

$\frac{0.00\ \text{kg PPF}}{1.06\ \text{kg FsRec}}$ x 459 kg FsRec = 0 kg PPF

PPF vented from Stripper

$\frac{10\ \text{kg PPF}}{100\ \text{kg Strpr}}$ x 10,218 kg Strpr = 1,022 kg PPF

Total before-control PPF vented = 2,353 kg PPF

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

VOC Emissions			2,353 kg PAF		
	Waste Gas Scrubber	x	(100%-99.1%)		
		=	21 kg PAF	=	21 kg VOC
				=	**47 lb. VOC**
HF Equivalent Emissions			21 kg PAF		
		x	0.120 kg HF/kg PAF		
		=	3 kg HF	=	**5.6 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: $\frac{0\ kg\ TFE}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0.0012\ kg\ TFE}{3.97\ kg\ Crude\ Receiver\ Vent}$

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

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

TFE vented based on	1,465 kg total Condensation Reactor vent stream (22266FG).
TFE vented based on	6,214 kg total Crude Receiver vent stream (22701FG).
TFE vented based on	459 kg total Foreshots Receiver vent stream (22826FG).
TFE vented based on	10,218 kg in the Stripper vent stream (22231FC).

TFE vented from Condensation Reactor:

$$\frac{0.00\ kg\ TFE}{2.35\ kg\ CndRx} \times 1{,}465\ kg\ CndRx = 0\ kg\ TFE$$

TFE vented from Crude Receiver

$$\frac{0.0012\ kg\ TFE}{3.97\ kg\ CrRec} \times 6{,}214\ kg\ CrRec = 2\ kg\ TFE$$

TFE vented from Foreshots Receiver

$$\frac{0.0045\ kg\ TFE}{1.06\ kg\ FsRec} \times 459\ kg\ FsRec = 2\ kg\ TFE$$

TFE vented from Stripper

$$\frac{0\ kg\ TFE}{100\ kg\ Strpr} \times 10{,}218\ kg\ Strpr = 0\ kg\ TFE$$

VOC Emissions

		0 kg from Condensation Reactor	
	+	2 kg from Crude Receiver	
	+	2 kg from Foreshots Receiver	
	+	0 kg from Stripper	
=		4 kg TFE	= 4 kg VOC
			8 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: $\frac{0 \ kg \ PPVE}{2.35 \ kg \ Cond \ Rx \ Vent \ Flow}$

Vented from the Crude Receiver $\frac{0.002 \ kg \ PPVE}{3.97 \ kg \ Crude \ Receiver \ Vent}$

Vented from the Foreshots Receiver $\frac{0.88 \ kg \ PPVE}{1.06 \ kg \ Foreshots Receiver Vent}$

Vented from the Stripper $\frac{0 \ kg \ PPVE}{100 \ kg \ Stripper \ Vent}$

PPVE vented based on	1,465	kg total Condensation Reactor vent stream (22266FG).
PPVE vented based on	6,214	kg total Crude Receiver vent stream (22701FG).
PPVE vented based on	459	kg total Foreshots Receiver vent stream (22826FG).
PPVE vented based on	10,218	kg in the Stripper vent stream (22231FC).

PPVE vented from Condensation Reactor:

$\frac{0.00 \text{ kg PPVE}}{2.35 \text{ kg CndRx}}$ x 1,465 kg CndRx = 0 kg PPVE

PPVE vented from Crude Receiver

$\frac{0.0020 \text{ kg PPVE}}{3.97 \text{ kg CrRec}}$ x 6,214 kg CrRec = 3 kg PPVE

PPVE vented from Foreshots Receiver

$\frac{0.88 \text{ kg PPVE}}{1.06 \text{ kg FsRec}}$ x 459 kg FsRec = 381 kg PPVE

PPVE vented from Stripper

$\frac{0 \text{ kg PPVE}}{100 \text{ kg Strpr}}$ x 10,218 kg Strpr = 0 kg PPVE

VOC Emissions				
		0 kg from Condensation Reactor		
	+	3 kg from Crude Receiver		
	+	381 kg from Foreshots Receiver		
	+	0 kg from Stripper		
=		384 kg PPVE	=	384 kg VOC
				846 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 inerts in VE-North that are vented to the WGS.

C4s vented per the process flowsheet

Vented from the Condensation Reactor: $\frac{0\ kg\ C4s}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0.0012\ kg\ C4s}{3.97\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0.15\ kg\ C4s}{1.06\ kg\ Foreshots Receiver Vent}$

Vented from the Stripper $\frac{0\ kg\ C4s}{100\ kg\ Stripper\ Vent}$

C4s vented based on	1,465 kg total Condensation Reactor vent stream (22266FG).
C4s vented based on	6,214 kg total Crude Receiver vent stream (22701FG).
C4s vented based on	459 kg total Foreshots Receiver vent stream (22826FG).
C4s vented based on	10,218 kg in the Stripper vent stream (22231FC).

C4s vented from Condensation Reactor:

$\frac{0.00\ kg\ C4s}{2.35\ kg\ CndRx}$ x 1,465 kg CndRx = 0 kg C4s

C4s vented from Crude Receiver

$\frac{0.0012\ kg\ C4s}{3.97\ kg\ CrRec}$ x 6,214 kg CrRec = 2 kg C4s

C4s vented from Foreshots Receiver

$\frac{0.15\ kg\ C4s}{1.06\ kg\ FsRec}$ x 459 kg FsRec = 65 kg C4s

C4s vented from Stripper

$\frac{0\ kg\ C4s}{100\ kg\ Strpr}$ x 10,218 kg Strpr = 0 kg C4s

VOC Emissions				
		0 kg from Condensation Reactor		
	+	2 kg from Crude Receiver		
	+	65 kg from Foreshots Receiver		
	+	0 kg from Stripper		
=		67 kg C4s	=	67 kg VOC
				147 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 inerts in VE-North that are vented to the WGS.

C5s vented per the process flowsheet

Vented from the Condensation Reactor: $\frac{0\ kg\ C5s}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0\ kg\ C5s}{3.97\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0.02\ kg\ C5s}{1.06\ kg\ Foreshots Receiver\ Vent}$

Vented from the Stripper $\frac{0\ kg\ C5s}{100\ kg\ Stripper\ Vent}$

C5s vented based on	1,465	kg total Condensation Reactor vent stream (22266FG).
C5s vented based on	6,214	kg total Crude Receiver vent stream (22701FG).
C5s vented based on	459	kg total Foreshots Receiver vent stream (22826FG).
C5s vented based on	10,218	kg in the Stripper vent stream (22231FC).

C5s vented from Condensation Reactor:

$\frac{0.00\ kg\ C5s}{2.35\ kg\ CndRx}$ x 1,465 kg CndRx = 0 kg C5s

C5s vented from Crude Receiver

$\frac{0.00\ kg\ C5s}{3.97\ kg\ CrRec}$ x 6,214 kg CrRec = 0 kg C5s

C5s vented from Foreshots Receiver

$\frac{0.02\ kg\ C5s}{1.06\ kg\ FsRec}$ x 459 kg FsRec = 8 kg C5s

C4s vented from Stripper

$\frac{0\ kg\ C5s}{100\ kg\ Strpr}$ x 10,218 kg Strpr = 0 kg C5s

VOC Emissions				
		0 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	8 kg from Foreshots Receiver		
	+	0 kg from Stripper		
=		8 kg C5s	=	8 kg VOC
				17 lb VOC

H. Carbon Dioxide (CO_2)

CAS No. 124-38-9

HF Potential:
CO2 can not form HF

Quantity Released

CO2 is a byproduct from the Agitated Bed Reactor system.
They are inerts in VE-North that are vented to the WGS.

CO2 vented per the process flowsheet

Vented from the Condensation Reactor:	0 kg CO2 / 2.35 kg Condensation Reactor Vent Flow
Vented from the Crude Receiver	1.27 kg CO2 / 3.97 kg Crude Receiver Vent Flow
Vented from the Foreshots Receiver	0 kg CO2 / 1.06 kg Foreshots Receiver Vent Flow
Vented from the Stripper	0 kg CO2 / 100.00 kg Stripper Vent Flow

CO2 vented based on	1,465	kg total Condensation Reactor vent stream (22266FG).
CO2 vented based on	6,214	kg total Crude Receiver vent stream (22701FG).
CO2 vented based on	459	kg total Foreshots Receiver vent stream (22826FG).
CO2 vented based on	10,218	kg in the Stripper vent stream (22231FC).

CO2 vented from Condensation Reactor:

$$\frac{0.00 \text{ kg CO2}}{2.35 \text{ kg CndRx}} \times 1{,}465 \text{ kg CndRx} = 0 \text{ kg CO2}$$

CO2 vented from Crude Receiver

$$\frac{3.45 \text{ kg CO2}}{3.97 \text{ kg CrRec}} \times 6{,}214 \text{ kg CrRec} = 5{,}406 \text{ kg CO2}$$

CO2 vented from Foreshots Receiver

$$\frac{0.00 \text{ kg CO2}}{1.06 \text{ kg FsRec}} \times 459 \text{ kg FsRec} = 0 \text{ kg CO2}$$

CO2 vented from Stripper

$$\frac{0 \text{ kg CO2}}{100 \text{ kg Strpr}} \times 10{,}218 \text{ kg Strpr} = 0 \text{ kg CO2}$$

CO2 Emissions

	0 kg from Condensation Reactor			
+	5,406 kg from Crude Receiver			
+	0 kg from Foreshots Receiver			
+	0 kg from Stripper			
=	5,406 kg CO2	=	**11,919 lb CO2**	**(not a VOC)**

I. Acetonitrile (AN)

CAS No. 75-05-8

HF Potential

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

Quantity Released

AN emissions based on	19,330 kg AN fed
Hydrocarbon waste sent to Hydrocarbon waste tank =	19,330 kgs H/C waste
PPVE generated during the year	165,472 kg PPVE

Assume that: **5%** of spent acetonitrile are fluorocarbons.

AN portion of hydrocarbon waste stream:

	19,330	kg to H/C waste
x	(1-(.1))	
=	18,364	kg AN to H/C waste

Material Balance

Based on total Vinyl ether produced 165,472 kg PPVE

Assume 90% Crude is needed to generage that amount of PPVE
70% of AF going to ABR is needed to create the Crude

Feed going to ABR is $\frac{1{,}500 \text{ ppm AN}}{1{,}000{,}000}$

Therefore:

	165,472	kg PPVE	
\	0.90	Crude	
\	0.70	AF	
x	0.0015	ppm AN	
=	394	kg AN	in Feed to ABR

VOC Emission

	19,330	kg AN fed
	18,364	kg AN to H/C waste
-	394	kg AN to ABR
	573	kg AN
	573	**kg VOC**
	1,262	**lb VOC**

AN only used during a PPVE Campaign

Total AN 1,262 **lb VOC**

J. HFPO Dimer Acid Fluoride **CAS No. 2062-98-8**
2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoyl fluoride

HF Potential:

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

$$1\,kg\,DAF \cdot \frac{1\,moleDAF}{332g\,DAF} \cdot \frac{20\,g\,HF}{1\,moleHF} \cdot \frac{1\,moleHF}{1\,moleDAF} = 0.120kg\,HF$$

Therefore, each 1 kg of HFPO Dimer Acid Fluoride generates 0.060 kg of HF

Quantity Released

In early 2018, stack testing was performed on the Division Stack (ID No. NEP-Hdr1) for the HFPO Dimer anion. For the purpose of this report, it will be assumed that the measured compound was the HFPO Dimer Acid Fluoride ("DAF").

The stack testing results showed an average emission rate of 0.296 lb/hr of DAF. These emissions would be the combination of the after-control process vent and maintenance activity emissions plus the uncontrolled indoor equipment emissions from valves and connectors.

Equipment emissions of DAF are determined and reported separately in this report. Because the emission factor was determined via Method 21 testing during the PPVE campaign and the equipment emissions were estimated with the assumption that the equipment was in continuous VOC service (8760 hours/year), the total equipment emissions of DAF from the VE North Process will be given to PPVE campaigns.

For this report, the process emissions will be estimated by calculating the stack emissions by multiplying the hours of operation of the PPVE campaign and emission factor 0.296 lb/hr DAF, and then subtract from that product the estimated indoor equipment emissions and maintenace emissions.

4,176 hours of operation during reporting year

0.296 lb/hr DA emission rate (from 2018 stack testing)

1,236.1 lb. DA discharged from the Division Stack (ID No. NEP-Hdr1)

2.5 lb. DA from indoor equipment emissions during reporting year

1.3 lb. DA from maintenance activities

Process Emissions = Stack Emissions – Indoor Equipment Leaks – Maintenance Emissions
Process Emissions = 1,236.1 lb. DA minus 2.5 lb. DA minus 1.3 lb. DA
Process Emissions = 1,232.3 lb. DA (after control)

Process Emissions = 1,232 lb. DA (after control)
Process Emissions = 1,232 lb. VOC (after control)

HF Equivalent Emissions

		1232.3 lb-DAF
	x	0.060 lb-HF / lb-DAF
	=	74.22 lb-HF

J. VOC Summary

Nafion Compound Name		Before Control Generated		After Control Stack Emissions
		kg/yr	lb/yr	VOC lb/yr
A.	HFP	3,103	6,841	6,841
B.	HFPO	5,403	11,910	11,910
C.	PPF	2,353	5,188	47
D.	TFE	4	8	8
E.	PPVE	384	846	846
F.	C4	67	147	147
G.	C5	8	17	17
I.	AN	573	1,262	1,262
J.	HFPO Dimer Acid Fluoride	62,106	136,919	1,232
	Total	11,894	26,221	**21,080**

K. Total Emission Summary**

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

	Nafion Compound Name	Process Emissions lb/yr	Equipment Emissions lb/yr (Note 1)	Maintenance Emissions lb/yr (Note 2)	Total Emissions lb/yr
A.	HFP	6,841	6	0	6,848
B.	HFPO	11,910	427	18	12,355
C.	PPF	47	30	0	76
D.	TFE	8	0	0	8
E.	PPVE	846	700	527	2,074
F.	C4	147	68	71	286
G.	C5	17	0	0	17
H.	CO2 (not a VOC)	11,919	0	0	11,919
I.	AN	1,262	175	7	1,445
J	HFPO Dimer Acid Fluoride	1,232	4	1	1,238
*	HFPO Trimer		19	0	19
	Total	**34,231**	**1,429**	**625**	**36,285**

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

Note 1 - All equipment emissions of HFPO Dimer Acid Fluoride will be reported as from PPVE

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

CO2 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	5.6	3.6	0.01	9.20
J.	HFPO-Dimer	74	0.3	0.08	74.56
*	HFPO Trimer		0.8	0.00	0.78
	Total	**79.8**	**5**	**0.09**	**84.53**

* 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:

$$\frac{20 \text{ lb/mol HF}}{166 \text{ lb/mol PPF}} \times 100 \text{ lb/yr Equipment PPF} = 12.0 \text{ lb/yr HF}$$

2017 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: $\frac{0.15 kgHFP}{3.66 kgCondRxVentFlow}$

Vented from the Crude Receiver $\frac{0.08\ kg\ HFP}{18.76\ kg\ Crude Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0\ kg\ HFP}{0.33\ kg\ Foreshots Receiver Vent}$

HFP vented based on	446 kg total Condensation Reactor vent stream (22266FG).
HFP vented based on	12,873 kg total Crude Receiver vent stream (22701FG).
HFP vented based on	18 kg total Foreshots Receiver vent stream (22826FG).

HFP vented from Condensation Reactor:
$\frac{0.15\ kg\ HFP}{3.66\ kg\ CndRx}$ x 446 kg CndRx = 18 kg HFP

HFP vented from Crude Receiver
$\frac{0.08\ kg\ HFP}{18.76\ kg\ CrRec}$ x 12,873 kg CrRec = 51 kg HFP

HFP vented from Foreshots Receiver
$\frac{0.00\ kg\ HFP}{0.33\ kg\ FsRec}$ x 18 kg FsRec = 0 kg HFP

VOC Emissions

		18 kg from Condensation Reactor		
	+	51 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
	=	69 kg HFP	=	69 kg VOC
				152 lb VOC

B. HFPO **CAS No. 428-59-1**
Hexafluoropropylene oxide

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: $\frac{3.28\ kg\ HFPO}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0\ kg\ HFPO}{18.76\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0\ kg\ HFPO}{0.33\ kg\ Foreshots Receiver Vent}$

HFPO vented based on 446 kg total Condensation Reactor vent stream (22266FG).
HFPO vented based on 12,873 kg total Crude Receiver vent stream (22701FG).
HFPO vented based on 18 kg total Foreshots Receiver vent stream (22826FG).

HFPO vented from Condensation Reactor:

$\frac{3.28\ \text{kg HFPO}}{3.66\ \text{kg CndRx}}$ x 446 kg CndRx = 400 kg HFPO

HFPO vented from Crude Receiver

$\frac{0.00\ \text{kg HFPO}}{18.76\ \text{kg CrRec}}$ x 12,873 kg CrRec = 0 kg HFPO

HFPO vented from Foreshots Receiver

$\frac{0.00\ \text{kg HFPO}}{0.33\ \text{kg FsRec}}$ x 18 kg FsRec = 0 kg HFPO

VOC Emissions

		400 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
	=	400 kg HFPO	=	400 kg VOC
				880 lb VOC

C. PPF **CAS No. 422-61-7**
Perfluoropropionyl fluoride

HF Potential:

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

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

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: $\frac{0.20\ kg\ PPF}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0\ kg\ PPF}{18.76\ kg\ Crude Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0\ kg\ PPF}{0.33\ kg\ Foreshots Receiver Vent}$

PPF vented based on 446 kg total Condensation Reactor vent stream (22266FG).
PPF vented based on 12,873 kg total Crude Receiver vent stream (22701FG).
PPF vented based on 18 kg total Foreshots Receiver vent stream (22826FG).

Before control PPF vented from Condensation Reactor:

$\frac{0.20\ kg\ PPF}{3.66\ kg\ CndRx}$ x 446 kg CndRx = 25 kg PPF

PPF vented from Crude Receiver

$\frac{0.00\ kg\ PPF}{18.76\ kg\ CrRec}$ x 12,873 kg CrRec = 0 kg PPF

PPF vented from Foreshots Receiver

$\frac{0.00\ kg\ PPF}{0.33\ kg\ FsRec}$ x 18 kg FsRec = 0 kg PPF

Total before-control PPF vented = 25 kg PPF

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

VOC Emissions

		25 kg PPF			
Waste Gas Scrubber	x	(100%-99.1%) Control Efficiency			
	=	0.22 kg PAF	=	**0.22**	kg VOC
			=	**0.49**	**lb. VOC**

HF Equivalent Emissions

	0 kg PPF	
x	0.120 kg HF/kg PPF	
=	0.03 kg HF	**0.06 lb. HF**

D. TFE **CAS No. 116-14-3**
Tetrafluoroethylene

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: $\frac{0\ kg\ TFE}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0.19\ kg\ TFE}{18.76\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0\ kg\ TFE}{0.33\ kg\ Foreshots\ Receiver\ Vent}$

TFE vented based on 446 kg total Condensation Reactor vent stream (22266FG).
TFE vented based on 12,873 kg total Crude Receiver vent stream (22701FG).
TFE vented based on 18 kg total Foreshots Receiver vent stream (22826FG).

TFE vented from Condensation Reactor:

0.00 / 3.66 kg TFE / kg CndRx	x	446 kg CndRx	=	0 kg TFE

TFE vented from Crude Receiver

0.19 / 18.76 kg TFE / kg CrRec	x	12,873 kg CrRec	=	129 kg TFE

TFE vented from Foreshots Receiver

0.00 / 0.33 kg TFE / kg FsRec	x	18 kg FsRec	=	0 kg TFE

VOC Emissions

		0 kg from Condensation Reactor		
	+	129 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
=		129 kg TFE	=	129 kg VOC
				283 lb VOC

E. PSEPVE **CAS No. 1623-5-8**
Perfluoro-2-(2-Fluorosulfonylethoxy) Propyl Vinyl Ether

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: $\frac{0\ kg\ PSEPVE}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0\ kg\ PSEPVE}{18.76\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0.07\ kg\ PSEPVE}{0.33\ kg\ Foreshots\ Receiver\ Vent}$

PSEPVE vented based on 446 kg total Condensation Reactor vent stream (22266FG).
PSEPVE vented based on 12,873 kg total Crude Receiver vent stream (22701FG).
PSEPVE vented based on 18 kg total Foreshots Receiver vent stream (22826FG).

PSEPVE vented from Condensation Reactor:

$\frac{0.00}{3.66}$ kg PSEPVE / kg CndRx x 446 kg CndRx = 0 kg PSEPVE

PSEPVE vented from Crude Receiver

$\frac{0.00}{18.76}$ kg PSEPVE / kg CrRec x 12,873 kg CrRec = 0 kg PSEPVE

PSEPVE vented from Foreshots Receiver

$\frac{0.07}{0.33}$ kg PSEPVE / kg FsRec x 18 kg FsRec = 3.80 kg PSEPVE

VOC Emissions

		0 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	3.80 kg from Foreshots Receiver		
=		3.80 kg PSEPVE	=	3.80 kg VOC
				8.35 lb VOC

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: $\frac{0\ kg\ C4}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0.41\ kg\ C4}{18.76\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0.10\ kg\ C4}{0.33\ kg\ Foreshots\ Receiver\ Vent}$

C4s vented based on 446 kg total Condensation Reactor vent stream (22266FG).
C4s vented based on 12,873 kg total Crude Receiver vent stream (22701FG).
C4s vented based on 18 kg total Foreshots Receiver vent stream (22826FG).

C4s vented from Condensation Reactor:

0.00 / 3.66 kg C4s / kg CndRx	x	446 kg CndRx	=	0 kg C4s

C4s vented from Crude Receiver

0.41 / 18.76 kg C4s / kg CrRec	x	12,873 kg CrRec	=	283 kg C4s

C4s vented from Foreshots Receiver

0.10 / 0.33 kg C4s / kg FsRec	x	18 kg FsRec	=	5 kg C4s

VOC Emissions

		0 kg from Condensation Reactor		
	+	283 kg from Crude Receiver		
	+	5 kg from Foreshots Receiver		
=		289 kg C4s	=	289 kg VOC
				635 lb VOC

G. HFPO Trimer **CAS No. 2641-34-1**
Perfluoro-2,5-Dimethyl-3,6-Dioxanonanoyl

HF Potential:

Each mole of HFPO Trimer (MW = 498) can generate 1 mole of HF (MW = 20).

$$1\,kg\,MA \cdot \frac{1\,mole Trimer}{498\,g\,Trimer} \cdot \frac{20\,g\,HF}{1\,mole HF} \cdot \frac{1\,mole HF}{1\,mole Trimer} = 0.0402 kg\,HF$$

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: $\frac{0\ kg\ HFPO\ Trimer}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver: $\frac{0\ kg\ HFPOTrimer}{18.76\ kg\ Crude Receiver\ Vent}$

Vented from the Foreshots Receiver: $\frac{0.01\,kg\ HFPO\,Trimer}{0.33\ kg\ ForeshotsReceiverVent}$

HFPO Trimer vented based on 446 kg total Condensation Reactor vent stream (22266FG).
HFPO Trimer vented based on 12,873 kg total Crude Receiver vent stream (22701FG).
HFPO Trimer vented based on 18 kg total Foreshots Receiver vent stream (22826FG).

Before control HFPO Trimer vented from Condensation Reactor:

$\frac{0.00}{3.66}$ kg HFPO Trimer / kg CndRx x 446 kg CndRx = 0 kg HFPO Trimer

HFPO Trimer vented from Crude Receiver

$\frac{0.00}{18.76}$ kg HFPO Trimer / kg CrRec x 12,873 kg CrRec = 0 kg HFPO Trimer

HFPO Trimer vented from Foreshots Receiver

$\frac{0.01}{0.33}$ kg HFPO Trimer / kg FsRec x 18 kg FsRec = 0.76 kg HFPO Trimer

Total before-control HFPO Trimer vented 0.76 kg VOC

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

VOC Emissions

Waste Gas Scrubber
0.76 kg HFPO Trimer
x (100%-99.1%) Control Efficiency
= 0.0068 kg HFPO Trimer = 0.0068 kg VOC
= **0.015 lb. VOC**

HF Equivalent Emissions

0.0068 kg HFPO Trimer
x 0.040 kg HF/kg HFPO Trimer
= 0.00027 kg HF **0.00061 lb. HF**

H. Monoadduct (MA) **CAS No. 4089-57-0**
Tetrafluoro-2-[Tetrafluoro-2-(Fluorosulfonyl)Ethoxy]-Propanoyl Fluoride

HF Potential:

Each mole of MA (MW = 346) can generate 1 mole of HF (MW = 20).

$$1\,kg\,MA \cdot \frac{1\,mole\,MA}{346\,g\,MA} \cdot \frac{20\,g\,HF}{1\,mole\,HF} \cdot \frac{1\,mole\,HF}{1\,mole\,MA} = 0.058\,kg\,HF$$

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: $\frac{0\ kg\ MA}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0\ kg\ MA}{18.76\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0.0045\ kg\ MA}{0.33\ kg\ Foreshots\ Receiver\ Vent}$

MA vented based on	446	kg total Condensation Reactor vent stream (22266FG).
MA vented based on	12,873	kg total Crude Receiver vent stream (22701FG).
MA vented based on	18	kg total Foreshots Receiver vent stream (22826FG).

Before control MA vented from Condensation Reactor:
$\frac{0.00\ kg\ MA}{3.66\ kg\ CndRx}$ x 446 kg CndRx = 0 kg MA

MA vented from Crude Receiver
$\frac{0.00\ kg\ MA}{18.76\ kg\ CrRec}$ x 12,873 kg CrRec = 0 kg MA

MA vented from Foreshots Receiver
$\frac{0.0045\ kg\ MA}{0.33\ kg\ FsRec}$ x 18 kg FsRec = 0.253 kg MA

Total before-control MA vented = 0.253 kg MA

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

VOC Emissions

Waste Gas Scrubber
0.253 kg MA
x (100%-99.1%) Control Efficiency
= 0.00228 kg MA = 0.00228 kg VOC
= **0.005 lb. VOC**

HF Equivalent Emissions

0.00228 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 Fluoride

HF Potential:

Each mole of DA (MW = 512) can generate 1 mole of HF (MW = 20).

$$1\,kg\,MA \cdot \frac{1\,mole\,DA}{512\,g\,DA} \cdot \frac{20\,g\,HF}{1\,mole\,HF} \cdot \frac{1\,mole\,HF}{1\,mole\,DA} = 0.039\,kg\,HF$$

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: $\frac{0\ kg\ DA}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0\ kg\ DA}{18.76\ kg\ Crude\,Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0.13\ kg\ DA}{0.33\ kg\ Foreshots\,Receiver\,Vent}$

DA vented based on	446 kg total Condensation Reactor vent stream (22266FG).
DA vented based on	12,873 kg total Crude Receiver vent stream (22701FG).
DA vented based on	18 kg total Foreshots Receiver vent stream (22826FG).

Before control DA vented from Condensation Reactor:

$$\frac{0.00\ kg\ DA}{3.66\ kg\ CndRx} \times 446\ kg\ CndRx = 0\ kg\ DA$$

DA vented from Crude Receiver

$$\frac{0.00\ kg\ DA}{18.76\ kg\ CrRec} \times 12{,}873\ kg\ CrRec = 0\ kg\ DA$$

DA vented from Foreshots Receiver

$$\frac{0.13\ kg\ DA}{0.33\ kg\ FsRec} \times 18\ kg\ FsRec = 7.34\ kg\ DA$$

Total before-control DA vented = 7.34 kg DA

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

VOC Emissions

		7.34 kg DA		
Waste Gas Scrubber	x	(100%-99.1%) Control Efficiency		
	=	0.0661 kg DA	=	0.066 kg VOC
			=	**0.146 lb. VOC**

HF Equivalent Emissions

	0.0661 kg DA		
x	0.039 kg HF/kg DA		
=	0.00258 kg HF	=	**0.01 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: $\frac{0\ kg\ Hydro-PSEPVE}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0\ kg\ Hydro-PSEPVE}{18.76\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0.0045\ kg\ Hydro-PSEPVE}{0.33\ kg\ Foreshots\ Receiver\ Vent}$

Hydro-PSEPVE vented based on 446 kg total Condensation Reactor vent stream (22266FG).
Hydro-PSEPVE vented based on 12,873 kg total Crude Receiver vent stream (22701FG).
Hydro-PSEPVE vented based on 18 kg total Foreshots Receiver vent stream (22826FG).

Hydro-PSEPVE vented from Condensation Reactor:

$\frac{0.00\ kg\ Hydro\text{-}PSEPVE}{3.66\ kg\ CndRx}$ x 446 kg CndRx = 0 kg Hydro-PSEPVE

Hydro-PSEPVE vented from Crude Receiver

$\frac{0.00\ kg\ Hydro\text{-}PSEPVE}{18.76\ kg\ CrRec}$ x 12,873 kg CrRec = 0 kg Hydro-PSEPVE

Hydro-PSEPVE vented from Foreshots Receiver

$\frac{0.0045\ kg\ Hydro\text{-}PSEPVE}{0.33\ kg\ FsRec}$ x 18 kg FsRec = 0.253 kg Hydro-PSEPVE

VOC Emissions

	0 kg from Condensation Reactor			
+	0 kg from Crude Receiver			
+	0.253 kg from Foreshots Receiver			
=	0.253 kg Hydro-PSEPV	=	0.253 kg VOC	
			0.557 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: $\frac{0\ kg\ Iso-PSEPVE}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0\ kg\ Iso-PSEPVE}{18.76\ kg\ Crude\,\mathrm{Re}ceiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0.014\ kg\ Iso-PSEPVE}{0.014\ kg\ Foreshots\,\mathrm{Re}ceiver\ Vent}$

Iso-PSEPVE vented based on	446	kg total Condensation Reactor vent stream (22266FG).
Iso-PSEPVE vented based on	12,873	kg total Crude Receiver vent stream (22701FG).
Iso-PSEPVE vented based on	18	kg total Foreshots Receiver vent stream (22826FG).

Iso-PSEPVE vented from Condensation Reactor:

$\frac{0.00\ \text{kg Iso-PSEPVE}}{3.66\ \text{kg CndRx}}$ x 446 kg CndRx = 0 kg Iso-PSEPVE

Iso-PSEPVE vented from Crude Receiver

$\frac{0.00\ \text{kg Iso-PSEPVE}}{18.76\ \text{kg CrRec}}$ x 12,873 kg CrRec = 0 kg Iso-PSEPVE

Iso-PSEPVE vented from Foreshots Receiver

$\frac{0.014\ \text{kg Iso-PSEPVE}}{0.33\ \text{kg FsRec}}$ x 18 kg FsRec = 0.759 kg Iso-PSEPVE

VOC Emissions

	0 kg from Condensation Reactor			
+	0 kg from Crude Receiver			
+	0.759 kg from Foreshots Receiver			
=	0.759 kg Iso-PSEPVE	=	0.759 kg VOC	
			1.671 lb VOC	

L. HFPO Dimer Acid Fluoride **CAS No. 2062-98-8**
2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoyl fluoride

HF Potential:

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

$$1\,kg\,DAF \cdot \frac{1\,moleDAF}{332g\,DAF} \cdot \frac{20\,g\,HF}{1\,moleHF} \cdot \frac{1\,moleHF}{1\,moleDAF} = 0.120kg\,HF$$

Therefore, each 1 kg of HFPO Dimer Acid Fluoride generates 0.060 kg of HF

Quantity Released

In early 2018, stack testing was performed on the Division Stack (ID No. NEP-Hdr1) for the HFPO Dimer anion during the production of PSEPVE. For the purpose of this report, it will be assumed that the measured compound was the HFPO Dimer Acid ("DA").

The stack testing results showed an emission rate of 0.103 lb/hr of DA. These emissions would be the combination of the after-control process vent and maintenance activity emissions plus the uncontrolled indoor equipment emissions from valves and connectors.

Equipment emissions are determined and reported separately in this report. The equipment emissions were determined via Method 21 testing during a PPVE campaign. The annual total of equipment emissions will be reported under the PPVE section.

For this report, the process emissions will be estimated by calculating the stack emissions by multiplying the hours of operation of the PSEPVE campaign and emission factor 0.103 lb/hr DAF, and then subtract from that product the estimated maintenance emissions.

1,968 hours of operation during reporting year

0.103 lb/hr DA emission rate (from 2018 stack testing)

202.7 lb. DA discharged from the Division Stack (ID No. NEP-Hdr1)

0.01 lb. DA from maintenance activities

Process Vent Emissions =	Stack Emissions -	Maintenance Emissions
Process Vent Emissions =	202.7 lb. DA -	0.01 lb. DA
Process Vent Emissions =	202.7 lb. DA (after control)	

Conversion from HFPO Dimer Acid (DA) to HFPO Dimer Acid Fluoride (DAF)

HFPO Dimer Acid Fluoride (DAF)	332.045 g-DAF / mole-DAF
HFPO Dimer Acid (DA)	330.053 g-DA / mole-DA
	1.00604 g-DAF / g-DA

Process Vent Emissions =	202.7 lb. DA (after control)
Process Vent Emissions =	203.9 lb. DAF (after control)
Process Vent Emissions =	203.9 lb. VOC (after control)

HF Equivalent Emissions

	202.7 lb-DAF
x	0.060 lb-HF / lb-DAF
=	12.21 lb-HF

M. Diglyme **CAS No. 111-96-6**

The emissions of diglyme is based on a mass balance

Quantity Released

=	2,400	kg diglyme introduced into processes
=	2,400	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**

N. Sulfonyl Fluoride (SOF2) — CAS No. 7783-42-8

HF Potential:

Each mole of SOF2 (MW = 86) can generate 2 mole of HF (MW = 20).

$$1\,kg\,MA \cdot \frac{1\,mole SOF2}{86\,g\,SOF2} \cdot \frac{20\,g\,HF}{1\,mole HF} \cdot \frac{2\,mole HF}{1\,mole SOF2} = 0.465 kg\,HF$$

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: $\frac{0\ kg\ SOF2}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0\ kg\ SOF2}{18.76\ kg\ Crude Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0\ kg\ SOF2}{0.33\ kg\ Foreshots Receiver Vent}$

SOF2 vented based on 446 kg total Condensation Reactor vent stream (22266FG).
SOF2 vented based on 12,873 kg total Crude Receiver vent stream (22701FG).
SOF2 vented based on 18 kg total Foreshots Receiver vent stream (22826FG).

Before control SOF2 vented from Condensation Reactor:

$\frac{0.00\ kg\ SOF2}{3.66\ kg\ CndRx}$ x 446 kg CndRx = 0 kg SOF2

SOF2 vented from Crude Receiver

$\frac{0.00\ kg\ SOF2}{18.76\ kg\ CrRec}$ x 12,873 kg CrRec = 0 kg SOF2

SOF2 vented from Foreshots Receiver

$\frac{0.00\ kg\ SOF2}{0.33\ kg\ FsRec}$ x 18 kg FsRec = 0 kg SOF2

Total before-control SOF2 vented = 0 kg SOF2

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

SOF2 Emissions

Waste Gas Scrubber		0 kg SOF2	
	x	(100%-99.1%) Control Efficiency	
	=	0 kg SOF2	0 lb. SOF2

HF Equivalent Emissions

	0 kg SOF2	
x	0.465 kg HF/kg SOF2	
=	0.00 kg HF	**0.00 lb. HF**

SOF2 is not a VOC (no carbon)

O. Carbon Dioxide (CO2) **CAS No. 124-38-9**

Quantity Released

CO2 is a byproduct from the Agitated Bed Reactor system.
They are inerts in VE-North that are vented to the WGS.

CO2 vented per the process flowsheet

Vented from the Condensation Reactor: $\frac{0\ kg\ CO2}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{17.45\ kg\ CO2}{18.76\ kg\ Crude\,Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0\ kg\ CO2}{0.33\ kg\ Foreshot\,Receiver\,Vent}$

CO2 vented based on 446 kg total Condensation Reactor vent stream (22266FG).
CO2 vented based on 12,873 kg total Crude Receiver vent stream (22701FG).
CO2 vented based on 18 kg total Foreshots Receiver vent stream (22826FG).

CO2 vented from Condensation Reactor: 0.00 / 3.66 kg CO2 / kg CndRx	x	446 kg CndRx	=	0 kg CO2
CO2 vented from Crude Receiver 17.45 / 18.76 kg CO2 / kg CrRec	x	12,873 kg CrRec	=	11,972 kg CO2
CO2 vented from Foreshots Receiver 0.00 / 0.33 kg CO2 / kg FsRec	x	18 kg FsRec	=	0 kg CO2

CO2 Emissions Exit WGS

	0 kg from Condensation Reactor			
+	48 kg from Crude Receiver			
+	0 kg from Foreshots Receiver			
=	48 kg CO2	=	**106 lb CO2**	

(not a VOC)

P. VOC Summary

	Nafion Compound Name	Before Control Generated		After Control Stack Emissions	
		VOC	VOC	VOC	HF
		kg/yr	lb/yr	lb/yr	lb/yr
A.	HFP	69	153	153	
B.	HFPO	400	882	882	
C.	PPF	25	55	0	0.1
D.	TFE	129	284	284	
E.	PSEPVE	4	8	8	
F.	C4	289	636	636	
G.	HFPO Trimer	1	2	0	0.0
H.	MA	0	1	0	0.0
I.	DA	7	16	0	0.0
J.	Hydro PSEPVE	0	1	1	
K.	Iso PSEPVE	1	2	2	
L.	HFPO Dimer Acid Fluoride	10,215	22,521	203	12.2
M	Diglyme	0	0	0	
N.	SOF2 (not a VOC)				
O.	CO2 (not a VOC)	48	106	48	
	Total	**11,188**	**24,665**	**2,216**	**12.3**

Q. 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	153	34	28	215
B.	HFPO	882	158	7	1,046
C.	PPF	0.49	1	0	2
D.	TFE	284	0	0	284
E.	PSEPVE	8	307	235	550
F.	C4	636	23	20	680
G.	HFPO Trimer	0.02	7	0	7
H.	MA	0.01	129	0	129
I.	DA	0.15	289	0	289
J.	Hydro-PSEPVE	0.6	0	0	1
K.	Iso-PSEPVE	1.7	0	0	2
L.	HFPO Dimer Acid Fluoride	202.7	0	0	203
M	Diglyme	0	78	3	81
N.	SOF2 (not a VOC)	0.0	0	0	0
O.	CO2 (not a VOC)	106	0	0	106
*	TA		11	0	11
*	RSU		1	0	1
	Total	2,274	1,038	294	**3,606**

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	0.06	0.17	0.00	0.23
G.	HFPO Trimer	0.00	0.26	0.00	0.26
H.	MA	0.00	7.46	0.01	7.47
I.	DA	0.01	11.27	0.02	11.30
M	SOF2	0.00			0.00
*	TA		0.31	0.00	0.31
*	RSU		0.12	0.00	0.12
L.	HFPO-Dimer	12.21	0.00	0.00	12.21
	Total	**0.07**	**19.17**	**0.03**	**19.27**

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:

$$\frac{20 \text{ lb/mol HF}}{166 \text{ lb/mol PPF}} \times 100 \text{ lb/yr Equipment PPF} = 12.0 \text{ lb/yr HF}$$

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.

A. Equipment Emissions from Condensation Reactor System

Condensation 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	480	4,176	1,968
Total VOC generated per campaign	166	1447	682

Component	EVE	After control**	PPVE	After control**	PSEPVE	After control**
	lb	lb	lb	lb	lb	lb
HFP	1	1	6	6	1	1
HFPO	39	39	427	427	158	158
PPF	1	1	30	30	1	1
Diglyme	0	0	0	0	78	78
AN	0	0	175	175	0	0
ADN	17	17	0	0	0	0
TTG	2	2	0	0	0	0
DA	0	0	0	0	287	287
MA	0	0	0	0	129	129
TA	0	0	0	0	11	11
RSU	0	0	0	0	1	1
MAE	36	36	0	0	0	0
MMF	7	7	0	0	0	0
DAE	55	55	0	0	0	0
TAE	2	2	0	0	0	0
HFPO Trimer	0	0	19	19	7	7
Total	**161**	**161**	**657**	**657**	**673**	**673**

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	480	4,176	1,968
Total VOC per campaign	30.6	266	125

Component	EVE	PPVE	PSEPVE
	lb	lb	lb
HFP	0	0	9
EVE	26	0	0
PPVE	0	256	0
DA	0	0	1
DAE	0	0	0
PSEPVE	0	0	109
hydro-EVE	2	0	0
iso-EVE	3	0	0
C4	0	8	6
Total	**31**	**264**	**125**

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 campiagn

Campaign	EVE	PPVE	PSEPVE
Operating Hours	480	4,176	1,968
Total VOC per campaign	58.32	507	239

Component	EVE	PPVE	PSEPVE
	lb	lb	lb
HFP	0	0	24
EVE	52	0	0
PPVE	0	444	0
PSEPVE	0	0	198
hydro-EVE	2	0	0
iso-EVE	3	0	0
C4	0	60	17
Total	**58**	**504**	**239**

All Refining equipment is located outside of the tower so releases will be directly to atmosphere.

D. Equipment Emissions of HFPO Dimer Acid Fluoride (HFPO Dimer)

In April 2018, Team, Inc. (Team) conducted instrument monitoring on valves and connectors for specified streams containing at least 1% by weight or greater HFPO Dimer Acid or HFPO Dimer Acid Fluoride. EPA Method 21 monitoring was conducted using flame ionization detectors (FIDs) to identify volatile organic compound (VOC) leaks from these specific fugitive piping components. The VE North Process' outdoor components were monitored during a perfluoropropyl vinyl ether (PPVE) campaign.

The details and results of this equipment emissions investigation are detailed in the ERM report titled "HFPO-DA Baseline Emission Estimates" dated May 18, 2018.

The source tests' analysis would have been performed for the dimer acid anion, therefore, results from testing would include emissions of the following three dimer acid compounds: HFPO Dimer Acid (HFPO-DA), HFPO Dimer Acid Fluoride (HFPO-DAF), and HFPO Dimer Acid Ammonium Salt. The ERM report reported all results as HFPO Dimer Acid (HFPO-DA).

The Method 21 monitoring indicated the outdoor equipment emissions from the VE North Process were approximately 1.65 lb. HFPO-DA in 2017. This quantity was derived using the assumption that the process was in continuous VOC service for 8,760 hours in 2017. This quantity is reported as 1.7 lb. HFPO-DA for the reporting year.

The VE North Process indoor equipment emissions were estimated using the estimated split of 60% of the equipment being indoors and 40% of the equipment being outdoors. Using this ratio, the indoor equipment emissions was estimated to be 2.5 lb. HFPO-DA for the reporting year. Therefore the total equipment emissions for the process is estimated to be 4.2 lb. HFPO-DA for the reporting year.

Total equipment emissions =	4.2 lb. HFPO-DA 4.2 lb. HFPO-DAF or HFPO-Dimer
Indoor equipment emissions =	2.5 lb. HFPO-DAF or HFPO-Dimer
Outdoor equipment emissions =	1.7 lb. HFPO-DAF or HFPO-Dimer

D. Component Summary - All equipment emissions

Component	EVE	PPVE	PSEPVE	Total
	lb	lb	lb	lb
HFP	1	6	34	41
HFPO	39	427	158	624
HFPO-Dimer				4
PPF	1	30	1	32
Diglyme	0	0	78	78
AN	0	175	0	175
ADN	17	0	0	17
TTG	2	0	0	2
DA	0	0	289	289
MA	0	0	129	129
TA	0	0	11	11
RSU	0	0	1	1
MAE	36	0	0	36
MMF	7	0	0	7
DAE	55	0	0	55
TAE	2	0	0	2
HFPO Trimer	0	19	7	26
EVE	78	0	0	78
PPVE	0	700	0	700
PSEPVE	0	0	307	307
hydro-EVE	4	0	0	4
iso-EVE	6	0	0	6
C4	0	68	23	91
				2716

2017 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. Therfore the average molecular weight for condensation is 350
(g) average MW for non-acid fluoride component = 166 (average of HFPO & HFP)
(h) number of deinventory events = 8

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, where P = 14.7 psia, R = 10.73 psia-ft^3/lb-mol degR
V = 87 ft^3, T = 537 degrees R

$$n = \frac{PV}{RT} = \frac{14.7\ \text{psia} \times 87\ \text{ft}^3}{10.73\ \frac{\text{psia-ft}^3}{\text{lb-mol degR}} \times 537\ \text{deg R}} = 0.22\ \frac{\text{lb-mol gas}}{\text{deinventory event}}$$

$$0.22\ \frac{\text{lb-mol gas}}{\text{deinventory event}} \times 8\ \frac{\text{deinventory events}}{\text{year}} = 1.78\ \frac{\text{lb-mol gas}}{\text{year}}$$

$$1.78\ \frac{\text{lb-mol gas}}{\text{year}} \times 33\%\ \text{non-acid fluorides} \times 166\ \frac{\text{lb non-A/F}}{\text{lb-mol gas}} = 96.7\ \frac{\text{lb non-A/F}}{\text{year}}$$

Before-control A/F vented from Condensation:

$$1.78\ \frac{\text{lb-mol gas}}{\text{year}} \times 67\%\ \text{acid fluorides} \times 350\ \frac{\text{lb A/F}}{\text{lb-mol gas}} = 420\ \frac{\text{lb A/F}}{\text{year}}$$

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

	420	lb/yr A/F VOC
×	(100%-99.1%)	control efficiency
	3.8	lb/yr A/F VOC

Total VOC:

	96.7	lb/yr non-A/F VOC
+	3.8	lb/yr A/F VOC
	100.5	**lb/yr VOC**

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. Therfore the average molecular weight for refining is 287
(g) number of deinventory events = 8

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, where P = 14.7 psia, R = 10.73 psia-ft^3/lb-mol degR
V = 163 ft^3, T = 537 degrees R

$$n = \frac{PV}{RT} = \frac{14.7 \text{ psia} \times 163 \text{ ft}^3}{10.73 \frac{\text{psia-ft}^3}{\text{lb-mol degR}} \times 537 \text{ deg R}} = 0.42 \frac{\text{lb-mol gas}}{\text{deinventory event}}$$

$$0.42 \frac{\text{lb-mol gas}}{\text{deinventory event}} \times \frac{8 \text{ deinventory events}}{\text{year}} = 3.33 \frac{\text{lb-mol gas}}{\text{year}}$$

$$3.33 \frac{\text{lb-mol gas}}{\text{year}} \times \frac{287 \text{ lb VOC}}{\text{lb-mol gas}} = \mathbf{954.3} \frac{\textbf{lb VOC}}{\textbf{year}}$$

D. Component Summary - All maintenance emissions

Component	EVE	PPVE	PSEPVE
	lb	lb	lb
HFP	0.047	0.249	28.413
HFPO	1.662	17.987	6.640
HFPO-Dimer	0.009	1.334	0.014
PPF	0.002	0.049	0.002
Diglyme	0.000	0.000	3.294
AN	0.000	7.388	0.000
ADN	0.705	0.000	0.000
TTG	0.070	0.000	0.000
DA	0.000	0.000	0.473
MA	0.000	0.000	0.213
TA	0.000	0.000	0.017
RSU	0.000	0.000	0.002
MAE	0.059	0.000	0.000
MMF	0.012	0.000	0.000
DAE	0.091	0.000	0.000
TAE	0.004	0.000	0.000
HFPO Trimer	0.000	0.032	0.011
EVE	62.238	0.000	0.000
PPVE	0.000	527.028	0.000
PSEPVE	0.000	0.000	234.760
hydro-EVE	2.766	0.000	0.000
iso-EVE	4.149	0.000	0.000
C4	0.000	70.992	20.414

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	0.07	0.63	0.30
Cond VOC	7	63	30
Refining VOC	69	602	284

Pre-control VOC	107	927	437

Total before control VOC (lb.)	1471
Total after control VOC	1055

* this is very conservative, since EVE will be liquid at ambient temp

** this is very conservative, since PSEPVE will be liquid at ambient temp

2017 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 99.8% 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 PEVE/PMVE 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:

  0

Point Source Emissions Determination

A. Carbonyl Fluoride (COF_2) **CAS No. 353-50-4**

HF Potential:

Each mole of COF_2 (MW = 66) can generate 2 moles of HF (MW = 20).

$$1\,kg\,COF_2 \cdot \frac{1\,mole COF_2}{66\,g\,COF_2} \cdot \frac{20\,g\,HF}{1\,mole HF} \cdot \frac{2\,moles HF}{1\,mole COF_2} = 0.606\,kg\,HF$$

Therefore, each kg of COF_2 generates 0.606 kg HF

Quantity Generated

COF_2 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 / kg PMVE produced	=	**0.555**	
	X	201,657	kg PMVE produced
		111,926	kg COF_2 fed to condensation

COF_2 vented from PAF column is determined from a material balance on the column:
COF_2 vented from PAF column = COF_2 fed to PAF column - COF_2 fed to condensation

COF_2 fed to PAF column =		48.97	kg/h average precursor feed, (1066FC)
	X	7656	hours of operation (from uptime data)
	X	55%	typical COF_2 in precursor feed to PAF column
		206,203	kg COF_2 fed to PAF column

COF_2 vented from PAF column =

206,203	-	111,926	=	94,276 kg

COF_2 vented from condensation (primarily the reactor vent) will also vary with product split, and is therefore estimated using a relationship from the flowsheet:

kg COF_2 vented / kg PMVE produced	=	**0.059**	
	X	201,657	kg PMVE produced
COF_2 vented from condensation =		11,930	

Total COF_2 vented from process vents to WGS =

94,276	+	11,930	=	**106,207** kg

After-control emissions utilizing the 99.8% control efficient Waste Gas Scrubber (WGS)

VOC emissions:		106,207 kg COF_2 emitted to WGS	
	x	(100% - 99.8%)	
	=	212 kg VOC =	212 kg VOC **467 lb VOC**
HF Equivalent Emissions		212 kg COF_2	
	x	0.606 kg HF/kg COF_2	
	=	129 kg HF =	**283 lb HF**

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).

$$1\,kg\,PAF \cdot \frac{1\,mole PAF}{116 g\,PAF} \cdot \frac{20 g\,HF}{1\,mole HF} \cdot \frac{1\,mole HF}{1\,mole PAF} = 0.172 kg\,HF$$

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:

kg PAF in Condensation feed / kg PEVE produced	=	**0.716**	
	X	113,747	kg PEVE produced
		81,405	kg PAF fed to condensation

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

PAF fed to PAF column	=	48.97	kg/h average precursor feed, (1066FC)
	X	7656	hours of operation (from uptime data)
	X	44%	typical PAF in precursor feed to PAF column
		164,962	kg PAF fed to PAF column

PAF vented from PAF column =

164,962 - 81,405 = 83,557 kg

PAF vented from condensation (primarily the reactor vent) will also vary with product split, and is therefore estimated using a relationship from the flowsheet:

kg PAF vented / kg PEVE produced	=	**0.044**	
	X	113,747	kg PEVE produced

PAF vented from condensation = 5,005

Total PAF vented from process vents to WGS =

83,557 + 5,005 = **88,562** kg

After-control emissions utilizing the 99.8% control efficient Waste Gas Scrubber (WGS)

VOC emissions		88,562 kg PAF	
	x	(100% - 99.8%)	
	=	177 kg PAF =	177 kg VOC
			390 lb VOC

HF Equivalent Emissions		177 kg PAF	
	x	0.172 kg HF/kg PAF	
	=	31 kg HF =	**67 lb HF**

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).

$$1\,kg\,PMPF \cdot \frac{1\,mole\,PMPF}{232\,g\,PMPF} \cdot \frac{20\,g\,HF}{1\,mole\,HF} \cdot \frac{1\,mole\,HF}{1\,mole\,PMPF} = 0.086\,kg\,HF$$

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:

kg PMPF vented / kg PMVE produced	=	**0.21**	
	X	201,657	kg PMVE produced

PMPF vented from ABR system = **41,603** kg

After-control emissions utilizing the 99.8% control efficient Waste Gas Scrubber (WGS)

VOC emissions		41,603 kg PMPF	
	x	(100% - 99.8%)	
	=	83 kg PMPF =	83 kg VOC
			183 lb VOC
HF Equivalent Emissions		83 kg PMPF	
	x	0.086 kg HF/kg PMPF	
	=	7 kg HF =	**16 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).

$$1\,kg\,PEPF \frac{1\,mole\,PEPF}{282\,g\,PEPF} \cdot \frac{20\,g\,HF}{1\,mole\,HF} \cdot \frac{1\,mole\,HF}{1\,mole\,PEPF} = 0.071\,kg\,HF$$

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:

kg PEPF vented / kg PEVE produced	=	**0.15**	
	X	113,747	kg PEVE produced
PEPF vented from ABR system =		**17,216**	kg

After-control emissions utilizing the 99.8% control efficient Waste Gas Scrubber (WGS)

VOC emissions:		17,216 kg PEPF		
	x	(100% - 99.8%)		
		34 kg PEPF	=	34 kg VOC
				76 lb VOC
HF Equivalent Emissions		34 kg PEPF		
	x	0.071 kg HF/kg PEPF		
	=	**2 kg HF**	**=**	**5 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 compoonent in the vent from the Low Boiler Column. Composition of this vent stream is based on the flow sheet.

The low boiler column vented at a rate of

	0.01	kg/h vent rate, (1830FG)
X	7,656	hours of operation (from uptime data)
	77	kg vented from low boiler column

PMVE in the low boiler column vent stream =

49%	X	77	=	**38** kg

After-control emissions from the Waste Gas Scrubber with an assumed efficiency of zero percent (0%)

VOC Emissions = **38 kg VOC**
83 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		0.01	kg/h vent rate, (1830FG)
	X	7,656	hours of operation (from uptime data)
		77	kg vented from low boiler column

HFP in the low boiler column vent stream =

9%	X	77	=	7 kg

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	=	48.97	kg/h average precursor feed, (1066FC)
	X	7656	hours of operation (from uptime data)
	X	0.5%	typical HFP in precursor feed to PAF column
		1,875	kg HFP fed to PAF column

HFP vented from PAF column =

1,875	-	7	=	1,868 kg

After-control emissions from the Waste Gas Scrubber with an assumed efficiency of zero percent (0%)

VOC Emissions

	7 kg HFP from PAF Vent				
+	1,868 kg HFP from LBC Vent				
	1,875 kg HFP	=	1,875	kg VOC	
			4,124	**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

On April 3-4, 2018, source testing was performed on the VE-South Stack during the Perfluoromethyl vinyl ether (PMVE) / Perfluoroethyl vinyl ether (PEVE) campaign. The results of those source tests are shown in the below table.

VE-South (PMVE/PEVE) Source Test Results

Date	Test Run Number	Emission Rate (lb/hr)
04-03-2018	VE-South 1	0.0178
04-04-2018	VE-South 2	0.0245
04-04-2018	VE-South 3	0.0237
	Average Emission Rate	**0.022**

Operating hours of PMVE/PEVE Campaigns: 7,128 hours

0.022 lb/hr X 7,128 hours = 157 lb. HFPO

In addition, HFPO would be emitted from the VE-South stack when VE-South was not operating and HFPO was sending material to the PAF column. Emissions are calculated using the mass flow sent to the VE-S PAF column while VE-S is not operating and the composition of HFPO in the stream. HFPO emissions sent to the PAF column while VE-S was not operating are reported as emissions from the HFPO Process (NS-A) and reported on that process' air emissions inventory report.

I. HFPO Dimer Acid Fluoride **CAS No. 2062-98-8**
2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoyl fluoride

<u>HF Potential:</u>

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

$$1\,kg\,DAF \cdot \frac{1\,mole DAF}{332 g\,DAF} \cdot \frac{20 g\,HF}{1\,mole HF} \cdot \frac{1\,mole HF}{1\,mole DAF} = 0.120 kg\,HF$$

Therefore, each 1 kg of HFPO Dimer Acid Fluoride generates 0.060 kg of HF

<u>Quantity Released</u>

In early 2018, stack testing was performed on the Vinyl Ethers South Stack (ID No. NEP-Hdr2) for the HFPO Dimer anion. For the purpose of this report, it will be assumed that the measured compound was the HFPO Dimer Acid Fluoride ("DAF").

The stack testing results showed an average emission rate of 0.00106 lb/hr of DAF during the PMVE/PEVE campaign. These emissions would be the combination of the after-control process emissions and the indoor equipment emissions from valves and connectors.

As calculated below, the quantity of DAF emitted from the stack is small. For this report, the contribution of indoor equipment emissions will be ignored and it will be assumed that all of the measured stack emisssions is from process vent emissions. The estimated indoor equipment emissions will be included in the total equipment emissions, which will result in an over-reporting of the DAF emissions.

7,128 hours of operation during reporting year

0.00106 lb/hr DAF emission rate (from 2018 stack testing)

7.56 lb. DAF emitted from the VE South Stack (ID No. NEP-Hdr2)

1.58 lb. DAF from Indoor Equipment Leaks during PMVE/PEVE campaigns

5.98 lb. DAF after-control emitted from process vents during PMVE/PEVE campaigns

<u>HF Equivalent Emissions</u>

	5.98 lb-DAF
x	0.060 lb-HF / lb-DAF
=	0.36 lb-HF

I. VOC Summary - Point Source Emissions

	Nafion Compound Name	Before Control VOC Generated		After Control Stack Emissions	
		kg/yr VOC	lb/yr VOC	lb/yr VOC	lb/yr HF
A.	COF2	106,207	233,654	467	283
B.	PAF	88,562	194,837	390	67
C.	PMPF	41,603	91,527	183	16
D.	PEPF	17,216	37,875	76	5
E.	PMVE	38	83	83	0
F.	PEVE	0	0	0	0
G.	HFP	1,875	4,124	4,124	0
H.	HFPO	71	157	157	0
I.	HFPO Dimer Acid Fluoride	301	664	6	0.36
	Total	255,572	562,258	**5,480**	**372**

2017 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 99.8% 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

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 / kg PPVE	VE South PPVE Production kg / yr	Process Emissions lb / yr
HFP	0.041346	14,127	584
HFPO	0.072087	14,127	1,018
PPF[1]	0.031387	14,127	1
TFE	0.000051	14,127	1
PPVE	0.008300	14,127	117
C4	0.001317	14,127	19
C5	0.000105	14,127	1
HFPO-Dimer[1]	0.828342	14,127	23
HFPO Trimer	0.000000	14,127	0
AN	0.007672	14,127	108
CO2 (not a VOC)	0.078940	14,127	1,115

CO2 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

[1]Includes Scrubber Control Efficiency (for acid fluorides) = 99.8%

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	0.9	166.02	0.121	0.1
HFPO-Dimer	23.4	332.04	0.060	1.4
HFPO Trimer	0.0	498.07	0.040	0.0
			Total	**1.5**

* 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:

$$\frac{0.9 \text{ lb. PPF}}{\text{year}} \times \frac{20.006 \text{ lb. HF per mole HF}}{166.02 \text{ lb. PPF per mole PPF}} = \frac{0.1 \text{ lb. HF}}{\text{year}}$$

2017 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.

A. Fugitive Emissions from Condensation Reactor System

Condensation Tower (vents to stack)

Valve emissions:	322 valves x	0.00039 lb/hr/valve	=	0.126 lb/hr VOC
Flange emissions:	644 flanges x	0.00018 lb/hr/flange	=	0.116 lb/hr VOC
Pump emissions:	6 pump x	0.00115 lb/hr/pump	=	0.007 lb/hr VOC
Total fugitive emission rate			=	0.248 lb/hr VOC

Condensation Tower VOC

Total Condensation Fugitive Emissions:

VOC		0.248 lb/hr FE
	x	7656 Operating hr/yr
	=	1902 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,
Equivalent mass HC	383.265 lb hydrocarbon	85% hydrocarbon,
Inventoried with	9 gal fluorocarbon	15% 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 column

Inventoried with	30	gal fluorocarbon
Equivalent mass FC	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 column — all FC (70% PMPF, 27% PEPF, 1.5% dimer, 1.5% MD)

Inventoried with	30	gal fluorocarbon
Equivalent mass FC	375.75	lb fluorocarbon

Component	Mass fraction	lb
PMPF	0.700	263
PEPF	0.270	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 decanter

Inventoried with	30	gal fluorocarbon
Equivalent mass FC	375.75	lb fluorocarbon

Component	Mass fraction	lb
PMPF	0.72	271
PEPF	0.28	105

HFPO tank

	135	gal HFPO	
	1555.605	lb HFPO	1.38 SG

Waste FC tank

Inventoried with	40	gal fluorocarbon
Equivalent mass FC	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, and PPVE
Hydro PEVE	0.099	49.599	
PPVE	0.099	49.599	

Average system composition - Condensation

	lb	%	VOC emissions (lb)	Equivalent HF (lb)
COF2	241	3.64%	69	42
PAF	235	3.55%	67	12
HFP	26	0.39%	7	0
HFPO	1,557	23.51%	447	0
PMPF	2,591	39.10%	744	64
PEPF	1,057	15.95%	303	22
MD	249	3.75%	71	4
AN	571	8.62%	164	0
HydroPEVE	50	0.75%	14	0
PPVE	50	0.75%	14	0
total	6,626		1902	143

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	7,656	Operating hr/yr
=	3,292	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%	12	1
PEPF	33	0.37%	12	1
HFP	17	0.19%	6	0
PEVE	4,026	45.69%	1504	0
PMVE	4,703	53.37%	1757	0
total	8,811		3,292	2

C. HFPO Dimer Acid Fluoride Equipment Emissions

The equipment emissions of HFPO Dimer Acid Fluoride ("DAF") from valves, connectors, and pumps (located outdoors) will be estimated using the VE-North outdoor emission rates estimated from actual monitoring data, and scaled down based on the ratio of VE-North to VE-South component counts. It was estimated that VE-South outdoor equipment leak emission rates would be approximately 25% of that from VE-North (i.e., 59 VE-South components and 232 VE-North components).

2017 VE North Outdoor Equipment Leak Emissions (lb)	VE-South to VE-North Compontent Ratio	2017 VE South Outdoor Equipment Leak Emissions (lb)
1.65	25%	0.42

The indoor equipment emissions in VE-South process unit were calculated using the estimated outdoor equipment emissions and the ratio of equipment emissions from indoor and outdoor components located in the VE-South process unit. As detailed in ERM's LDAR Program Review Report, 21% of the VE-South equipment emissions are from components (containing at least 1% by weight HFPO-DA or HFPO-DAF) located outdoors and the remaining 79% of the VE-South equipment emissions are from components located indoors. Therefore, the emissions estimated from monitoring of the outdoor equipment were scaled up accordingly.

2017 VE North Indoor Equipment Leak Emissions (lb)	VE-South to VE-North Equipment Emissions Ratio	2017 VE South Indoor Equipment Leak Emissions (lb)
0.42	376%	1.58

Indoor HFPO Equipment Emissions (lb) =	1.58
Outdoor HFPO Equipment Emissions (lb) =	0.42
Total HFPO Equipment Emissions (lb) =	**2.0**

C. Acetonitrile fugitive emissions

No normal process vents of AN to stack. Equipment emissions are estimated above for normal process composition and leaks. Other than fugitive emissions, pretty much all the AN used in VE-S ends up going to the Waste HC ISO.

D. Total Fugitive Emissions

Emission Source	Total Emissions lb VOC
Condensation Tower	1,738
Agitated Bed Reactor & Refining	3,292
AN	164
Dimer Acid Fluoride	2
Total	**5,194**

E. Speciated Equipment Emissions Summary

Nafion® Compound	Equipment Emissions	
	lb VOC	lb HF
COF2	69	42
PAF	67	12
HFP	14	0
HFPO	447	0
PMPF	756	64
PEPF	316	22
HFPO Dimer	2	0
MD	71	4
HydroPEVE	14	0
PPVE	14	0
PEVE	1,504	0
PMVE	1,757	0
AN	164	0
TOTAL	**5,196**	**143**

A. VOC Emissions Summary

VE South Compound	CAS Chemical Name	CAS No.	PE/PM Emissions (lb.)	PPVE Emissions (lb.)	Accidental Releases (lb.)	Equipment Leaks (lb.)	Total Emissions (lb.)
COF2	Carbonyl Fluoride	353-50-4	467	0	0	69	537
PAF	Perfluoroacetyl Fluoride	354-34-7	390	0	0	67	457
PMPF	Perfluoromethoxypropionyl fluoride	2927-83-5	183	0	0	756	939
PEPF	Perfluoroethoxypropionyl fluoride	1682-78-6	76	0	0	316	391
PMVE	Perfluoromethyl vinyl ether	1187-93-5	83	0	0	1,757	1,840
PEVE	Perfluoroethyl vinyl ether	10493-43-3	0	0	0	1,504	1,504
HFP	Hexafluoroproplyene	116-15-4	4,124	584	0	14	4,722
HFPO	Hexafluoroproplyene Epoxide	428-59-1	157	1,018	55	447	1,677
HFPO Dimer Acid Fluoride	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	6	23	70	2	101
HFPO Trimer	Perfluoro-2,5-dimethyl-3,6-dioxanonanoyl fluoride	2641-34-1	0	0	0	0	0
MD	2,3,3,3-tetrafluoro-2-[1,1,2,3,3,3-hexafluoro-2-(trifluoromethoxy)propoxy]-propanoyl fluoride	2479-75-6	0	0	0	71	71
HydroPEVE	2,3,3,3-tetrafluoro-2-(pentafluoroethoxy)propanoyl fluoride	360796-50-5	0	0	0	14	14
PPVE	Perfluoropropyl vinyl ether	1623-05-8	0	117	0	14	131
PPF	Perfluoropropionyl fluoride	422-61-7	0	1	0	0	1
TFE	Tetrafluoroethylene	116-14-3	0	1	0	0	1
C4	Perfluoro-2-butene	360-89-4	0	19	0	0	19
C5	Perfluoropentene	376-87-4	0	1	0	0	1
AN	Acetonitrile	75-05-8	0	108	0	164	272
				Total VOC Emissions from VE South Process (lb.)			**12,680**

Loading of the HFPO Dimer Acid Fluoride ("DAF") ISO Tank Container

VE South Compound	CAS Chemical Name	CAS No.	Emissions (lb.)
HFPO Dimer Acid Fluoride	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	0.08

Total VOC Emissions from VE South Process (lb.)	**12,680**
Loading of the HFPO Dimer Acid Fluoride ("DAF") ISO Tank Container (lb.)	**0.08**
Total VOC Emissions (lb.)	**12,680**
Total VOC Emissions (tons)	**6.34**

B. Criteria Pollutant Summary

VE South Compound	CAS Chemical Name	CAS No.	Process Emissions (lb.)	Accidental Releases (lb.)	Total Emissions (lb.)
CO2	Carbon Dioxide	124-38-9	1,115	0	1,115
			Total CO2 Emissions (lb.)		**1,115**
			Total CO2 Emissions (tons)		**0.6**

C. Toxic Air Pollutant and Hazardous Air Pollutant Summary (TAP/HAP)

VE South Compound	CAS Chemical Name	CAS No.	Process Emissions (lb.)	Accidental Releases (lb.)	Total Emissions (lb.)
HF	Hydrogen Fluoride	7664-39-3	514	4	519
Acetonitrile	Acetonitrile	75-05-8	272	0	272

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: NS-D

Emission Source Description: Nafion RSU Process

Process and Emission Description:

The RSU process is a continuous manufacturing process. All emissions from this process vent to the Nafion Division Waste Gas Scrubber (WGS), Control Device ID No. NCD-Hdr1, which has a documented efficiency of 99.1%. The control of emissions of certain compounds will be addressed in the attached spreadsheet. Certain components (i.e. TFE) pass completely through the scrubber, therefore the efficiency is assumed to be 0%.

Basis and Assumptions:

The RSU process flowsheet #4 (W1207831) is used as a basis for relative compositions and flow rates of vent streams to the division WGS. A 30 kg/hr maximum RSU production rate is used as the basis for maximum vent rates.

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Information Inputs and Source of Inputs:

Information Input	Source of Inputs
RSU production quantity	RSU Production Facilitator
Speciated emission rates	RSU Process Flowsheet #4 (W1207831)

Point Source Emissions Determination:

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

Equipment Emissions and Fugitive Emissions Determination:

Emissions from equipment leaks which vent as stack (point source) emissions and 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. Per PHA 07-12 Rec# 3, a Scrubber was installed in the RSU process that would scrub any RV release from equipment inside the tower and also any leak that occured inside the RSU tower. Therefore, any equipment emissions from equipment inside the RSU tower will be scrubbed. However since the efficiency of the Scrubber has not been documented and the fact that the equipment emissions are extremely small for the RSU process, we have elected not to take credit for the Scrubber in regards to equipment emissions.

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	0.19835 kg TFE vented per RSU unit
Still	0.02206 kg TFE vented per RSU unit
Total	**0.27212** kg TFE vented per RSU unit

The before-control TFE generation is based on **4,739.8** RSU units 2017

TFE vented from the RSU Process in the reporting year:

$$\frac{0.27\text{ kg TFE}}{\text{RSU unit}} \quad x \quad 4{,}739.8 \text{ RSU units} \quad = \quad \mathbf{1{,}290} \text{ kg}$$

After-control emissions utilizing the 0% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

$$\text{Waste Gas Scrubber} \quad x \quad \frac{1{,}290 \text{ kg TFE}}{(100\% - 0\%) \text{ control efficiency}}$$

$$= \quad 1290 \text{ kg TFE} \quad = \quad 1290 \text{ kg VOC}$$

$$= \quad \mathbf{2843.5 \text{ lb. VOC}}$$

P- 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 **4,739.8** RSU units 2017

PAF vented from the RSU Process in the reporting year:

$\frac{0.186\text{ kg PAF}}{\text{RSU unit}}$ x 4,739.8 RSU units = **882** kg

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

VOC Emissions

Waste Gas Scrubber
882 kg PAF
x (100%-99.1%) control efficiency
= 7.94 kg PAF = 7.94 kg VOC
= **17.5** **lb. VOC**

HF Equivalent Emissions

7.94 kg PAF
x 0.172 kg HF/kg PAF
= 1.37 kg HF = **3.01** **lb. HF**

C. Rearranged Sultone (RSU) **CAS No. 677-67-8**
Difluoro(Fluorosulfonyl) Acetyl Fluoride

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 **4,739.8** RSU units 2017

RSU vented from the RSU Process in the reporting year:

$$\frac{0.063\ \text{kg RSU}}{\text{RSU unit}} \times 4{,}739.8\ \text{RSU units} = \mathbf{300}\ \text{kg}$$

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

VOC Emissions

Waste Gas Scrubber 300 kg RSU
(100%-99.1%) control efficiency
= 2.70 kg RSU = 2.70 kg VOC
= **5.9** **lb. VOC**

HF Equivalent Emissions

2.70 kg RSU
x 0.111 kg HF/kg RSU
= 0.30 kg HF = **0.66** **lb. HF**

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	0.00467 kg SU vented per RSU unit
Rearranger	0.00117 kg SU vented per RSU unit
Still	0 kg SU vented per RSU unit
Total	**0.006** kg SU vented per RSU unit

The before-control SU generation is based on **4,739.8** RSU units 2017

SU vented from the RSU Process in the reporting year:

$$\frac{0.006\ \text{kg SU}}{\text{RSU unit}} \times 4{,}739.8\ \text{RSU units} = \mathbf{28}\ \text{kg}$$

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

VOC Emissions

		28 kg SU			
Waste Gas Scrubber	x	(100%-99.1%) control efficiency			
	=	0.25 kg SU	=	0.25	kg VOC
			=	**0.5**	**lb. VOC**

HF Equivalent Emissions

		0.25 kg SU			
	x	0.111 kg HF/kg SU			
	=	0.0 kg HF	=	**0.06**	**lb. HF**

F. 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	**SO2 Vent Rate**
Reactor	0 kg SO2 vented per RSU unit
Rearranger	0.08803 kg SO2 vented per RSU unit
Still	0.00988 kg SO2 vented per RSU unit
Total	**0.098** kg SO2 vented per RSU unit

The before-control SO2 generation is based on **4,739.8** RSU units 2017

SO2 vented from the RSU Process in the reporting year:

$$\frac{0.098 \text{ kg SO2}}{\text{RSU unit}} \times 4{,}739.8 \text{ RSU units} = \mathbf{464} \text{ kg}$$

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

SO2 Emissions
Waste Gas Scrubber x (100%-99.1%) control efficiency — 464 kg SO2

= 4.18 kg SO2 = **9.2** **lb. SO2**

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).

$$1\,\text{kg}\,SO_3 \times \frac{1\,\text{mole}\,SO_3}{80\,\text{g}\,SO_3} \times \frac{98\,\text{g}\,H_2SO_4}{1\,\text{mole}\,H_2SO_4} \times \frac{1\,\text{mole}\,H_2SO_4}{1\,\text{mole}\,SO_3} = 1.225\,\text{kg}\,H_2S$$

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	SO3 Vent Rate
Reactor	0.00115 kg SO3 vented per RSU unit
Rearranger	0.188 kg SO3 vented per RSU unit
Still	0.02114 kg SO3 vented per RSU unit
Total	**0.211** kg SO3 vented per RSU unit

The before-control SO3 generation is based on **4,739.8** RSU units 2017

SO3 vented from the RSU Process in the reporting year:

$\frac{0.211 \text{ kg SO3}}{\text{RSU unit}}$ x 4,739.8 RSU units = **999** kg

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

SO3 Emissions 999 kg SO3
Waste Gas Scrubber x (100%-99.1%) control efficiency
= 8.99 kg SO3 = 19.8 lb. SO3

H2SO4 Equivalent Emissions 8.99 kg SO3
x 1.225 kg H2SO4 / kg SO3
= 11.01 kg H2SO4 =
24.3 **lb. H2SO4**

G. Telomeric Acid Fluoride (TAF)

Name	Structure	CAS No.

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/flang	=	0.099	lb/hr EE
Total equipment emission rate		=	0.189	lb/hr EE

Days of operation = 78

On average 0.13 lbs of HF are produced for every 1 lb of RSU, SU or PAF.

VOC:		0.189 lb/hr EE	**HF:**		0.189	lb/hr EE
	x	24 hours/day		x	24	hours/day
	x	78 days/year		x	78	days/year
	=	**353.8 lb/yr VOC from EE**		x	0.13	lb HF per lb VOC
				=	**46.0**	**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/flang	=	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	78 days/year		x	78	days/year
	=	**117.9 lb/yr SO3 from EE**		x	1.225	lb H2SO4 per lb SO3
				=	**144.5**	**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	78 days/year		
	=	**16.8 lb/yr VOC from FE**		

D. Total RSU Plant Non-Point Source Emissions

	Equipment Emissions		Fugitive Emissions		
Emission Source	**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	353.8	46.0	0	0	0
B. Fugitive Emissions From SO3 Storage Tank and Vaporizer	0	0	0	117.9	144.5
C. Fugitive Emissions From EDC Tank	0	0	16.8	0	0
Total for 2017	**353.8**	**46.0**	**16.8**	**117.9**	**144.5**

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	2843.5	350.8	0	0	3194.3
PAF	17.5	2.2	0	0	19.7
RSU	5.9	0.7	0	0.0	6.7
SU	0.5	0.1	0	0	0.6
EDC	0	0	16.8	0	16.8
Total	**2867.5**	**353.8**	**16.8**	**0.0**	**3238.2**

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 (2843.5 lb) divided by the total stack emission (2,867.5 lb), multiplied by the total equipment emissions (353.8 lb).

Specifically: $\frac{2843.5}{2867.5} \times 353.8 = 350.8$ lb. TFE

2017 Emission Summary - RSU Process (NS-D)

A. VOC Emissions by Compound and Source

RSU Compound	CAS Chemical Name	CAS No.	Point Source Emissions	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total VOC Emissions (lbs)
TFE	Tetrafluoroethylene	116-14-3	2843.5	0	350.8	0	3194.3
PAF	Trifluoroacetyl Fluoride	354-34-7	17.5	0	2.2	0	19.7
RSU	2,2-difluoro-2-(fluorosulfonyl) acetyl fluoride	677-67-8	5.9	0	0.7	0	6.7
SU	3,3,4,4-tetrafluoro-1,2-oxathietane 2,2-dioxide	697-18-7	0.5	0	0.1	0	0.6
EDC	1,2-Dichloroethane	107-06-2	0	16.8	0	0	16.8
COF2	Carbonyl Fluoride	353-50-4	5.9	0.0	1.08	0	6.9
n=1 TAF	Perfluoro-3,5-Dioxahexanoyl Fluoride	21703-43-5	17.6	0.0	1.08	0	18.7
Total for 2017			**2891.0**	**16.8**	**356.0**	**0**	**3263.8**
						Tons	**1.63**

B. Toxic Air Pollutant Summary

RSU Compound	CAS Chemical Name	CAS No.	Point Source Emissions	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total Emissions (lbs)
HF	Hydrogen Fluoride	7664-39-3	6.93	0	46.0	0	**52.92**
Fluorides	Fluorides		6.93	0.00	46.00	0.00	52.92
H2SO4	Sulfuric Acid	7664-93-9	24.3	144.5	0	0	**168.8**

C. Criteria Air Pollutant Summary

RSU Compound	CAS Chemical Name	CAS No.	Point Source Emissions	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total Emissions (lbs)
SO2	Sulfur dioxide	7446-09-5	9.2	0	0	0	**9.2**

2017 Air Emissions Inventory Report

Emission Source ID No.: NS-E

Emission Source Description: FPS Liquid Waste Stabilization

Process & Emission Description:

The FPS 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 FPS Division Waste Gas Scrubber (Control Device ID No. NCD-Hdr1) which has a documented control efficiency of 99.1% for acid fluoride compounds. The control of emissions of specific compounds will be addressed and detailed in the following pages.

The FPS 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)

Sample calculation using maintenance activity dated 1/0/00

Initial Weight	minus	Final Weight	equals	kg vented to Division WGS
0 kg	minus	0 kg	equals	0 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 99.1% control efficient Waste Gas Scrubber (WGS):

Percentage of acid fluoride VOCs removed by the WGS = 99.1%
Percentage of acid fluoride VOCs vented from the WGS = 100% minus 99.1%
Percentage of acid fluoride VOCs vented from the WGS = 0.9%

Therefore, VOCs vented to the atmosphere from the 1/0/00 maintenance activity is equal to:

Amount of VOCs vented to WGS:		0	kg of VOC
Percentage of VOCs vented from the WGS:	x	0.9%	
Quantity of VOCs vented from the WGS:	=	0	kg VOC
	=	**0.000**	**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) = **0 lb VOC**

COF2 (carbonyl fluoride) **CAS No. 353-50-4**

Sample calculation using maintenance activity dated 1/0/00

VOC emissions would be equal to:

0.000 lb VOC	0.30 lb COF2	=	0	lb COF2
	lb VOC			

TAF (telomeric acid fluoride) **CAS No. 690-43-7**
(perfluoro-3,5,7, 9,11-pentaoxadodecanoyl fluoride)

Sample calculation using maintenance activity dated 1/0/00

VOC emissions would be equal to:

0.000 lb VOC	0.70 lb TAF	=	0	lb VOC
	lb VOC			

Stack Emissions from Maintenance Activity (cont.)
for the Reactor
<u>HF Potential</u>

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)

$$\frac{1 \text{ lb COF2}}{} \left| \frac{1 \text{ mole COF2}}{66 \text{ lb COF2}} \right| \frac{20 \text{ lb HF}}{\text{mole HF}} \left| \frac{2 \text{ moles HF}}{1 \text{ mole COF2}} \right. = 0.606 \text{ lb of HF}$$

Therefore, each 1 lb of COF2 generates 0.606 lb of HF

TAF (telomeric acid fluoride) **CAS No. 690-43-7**
(perfluoro-3,5,7, 9,11-pentaoxadodecanoyl fluoride)

Each mole of TAF (MW = 330) can generate 1 mole of HF (MW =20)

$$\frac{1 \text{ lb TAF}}{} \left| \frac{1 \text{ mole TAF}}{330 \text{ lb TAF}} \right| \frac{20 \text{ lb HF}}{\text{mole HF}} \left| \frac{1 \text{ moles HF}}{1 \text{ mole TAF}} \right. = 0.061 \text{ lb of HF}$$

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

Sample calculation using maintenance activity dated 1/0/00

Quantity of VOCs vented from the WGS (see Page 2) = **0** **lb VOC**

HF equivalent emissions would be equal to:

$$\frac{0.000 \text{ lb VOC}}{} \left| \frac{0.30 \text{ lb COF2}}{\text{lb VOC}} \right| \frac{0.606 \text{ lb HF}}{\text{lb COF2}} = 0 \text{ lb HF}$$

$$\frac{0.000 \text{ lb VOC}}{} \left| \frac{0.70 \text{ lb TAF}}{\text{lb VOC}} \right| \frac{0.061 \text{ lb HF}}{\text{lb TAF}} = 0 \text{ lb HF}$$

Therefore, HF vented to the atmosphere from the 1/0/00 maintenance activity is equal to:

0 lb HF + 0 lb HF = 0 lb HF

Stack Emissions from Maintenance Activity (cont.)
for the Reactor
Calculation page

Date	Tank	Category	Reason	Weight of Tank Initial (kg)	Weight of Tank Final (kg)	Emitted VOC (lb)	Emitted HF (lb)
					Total Emissions	**0.00**	**0.00**

Total	VOC	=	0.00	lb	
	VOC =		0.0000	ton	STACK EMISSIONS
Total	HF =		0.00	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)
			Total Emissions	**0.00**	**0.00**	**0.00**

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 lb/hr VOC x 8760 hr/year = 399.54 lb VOC
0.1998 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.

$$\frac{399.5 \text{ lb VOC}}{} \left| \frac{0.30 \text{ lb COF2}}{\text{lb VOC}} \right. = \mathbf{119.86\ lb\ COF2}$$

$$\frac{399.5 \text{ lb VOC}}{} \left| \frac{0.70 \text{ lb TAF}}{\text{lb VOC}} \right. = \mathbf{279.68\ lb\ TAF}$$

See Page 3 for HF equivalents calculation:

$$\frac{399.5 \text{ lb VOC}}{} \left| \frac{0.30 \text{ lb COF2}}{\text{lb VOC}} \right| \frac{0.606 \text{ lb HF}}{\text{lb COF2}} = 72.644 \text{ lb HF}$$

$$\frac{399.5 \text{ lb VOC}}{} \left| \frac{0.70 \text{ lb TAF}}{\text{lb VOC}} \right| \frac{0.061 \text{ lb HF}}{\text{lb TAF}} = 16.95 \text{ lb HF}$$

72.644 lb HF + 16.95 lb HF = **89.6 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)
10/13/17	Storage	Maintenance	Annual Shutdown	32	0

Sample calculation using maintenance activity dated 10/13/17

Initial Weight	minus	Final Weight	equals	kg vented to Division WGS		
32 kg	minus	0 kg	equals	32	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 99.1% control efficient Waste Gas Scrubber (WGS):

Percentage of acid fluoride VOCs removed by the WGS = 99.1%
Percentage of acid fluoride VOCs vented from the WGS = 100% minus 99.1%
Percentage of acid fluoride VOCs vented from the WGS = 0.9%

Therefore, VOCs vented to the atmosphere from the 10/13/17 maintenance activity is equal to:

Amount of VOCs vented to WGS:		32	kg of VOC
Percentage of VOCs vented from the WGS:	x	0.9%	
Quantity of VOCs vented from the WGS:	=	0.288	kg VOC
	=	**0.635**	**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) = **0.63 lb VOC**

HFPO Trimer (perfluoro-2,5-dimethyl-3,6-dioxanonanoyl fluoride). **CAS No. 2641-34-1**

Sample calculation using maintenance activity dated 10/13/17

VOC emissions would be equal to:

0.635 lb VOC	1.00 lb Trimer	= 0.6349 lb HFPO Trimer
	lb VOC	

Stack Emissions from Maintenance Activity (cont.)
for the Storage Tank
<u>HF Potential</u>

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 lb HFPO Trimer = 100 lb of HF

1 lb HFPO Trimer = 0.0402 lb of HF

Therefore, each 1 lb of Trimer generates 0.04 lb of HF

Sample calculation using maintenance activity dated 10/13/17

Quantity of VOCs vented from the WGS (see Page 7) = **0.635 lb VOC**

HF equivalent emissions would be equal to:

0.635 lb VOC	1.00 lb Trimer	0.040 lb HF	=	0.025 lb HF
	lb VOC	lb Trimer		

Stack Emissions from Maintenance Activity (cont.)
for the Storage Tank
Calculation page

Date	Tank	Category	Reason	Weight of Tank Initial (kg)	Weight of Tank Final (kg)	Emitted VOC (lb)	Emitted HF (lb)
10/13/17	Storage	Maintenance	Annual Shutd	32	0	0.635	0.025

Total Emissions	0.63	0.03

Total	VOC =	0.63	lb	
	VOC =	0.0003	ton	STACK EMISSIONS
Total	HF =	0.03	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 VOC (lb)	Emitted Trimer (lb)	
10/13/17	Storage	Maintenance	nnual Shutdov	0.635	0.635	
		Total Emissions		0.63	0.63	0.00

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 lb/hr VOC x 8760 hr/year = 254.48 lb VOC
0.1272 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.

$$\frac{254.5 \text{ lb VOC}}{} \left| \frac{1.00 \text{ lb COF2}}{\text{lb VOC}} \right. = \textbf{254 lb HFPO Trimer}$$

See Page 3 for HF equivalents calculation:

$$\frac{399.5 \text{ lb VOC}}{} \left| \frac{1.00 \text{ lb Trimer}}{\text{lb VOC}} \right| \frac{0.040 \text{ lb HF}}{\text{lb Trimer}} = 16.0 \text{ lb HF}$$

Emissions from One Time Release
None

Emission Summary

A. VOC Emissions by Compound and Source

FPS Compound	CAS Chemical Name	CAS No.	Stack Emissions (lbs)	Fugitive Emissions (lbs)	Total Emissions (lbs)
COF2	Carbonic difluoride	353-50-4	0.00	119.9	119.9
HFPO Trimer	Perfluoro-2,5-dimethyl-3,6-dioxanonanoyl fluoride	2641-34-1	0.63	254.5	255.1
TAF	Trifluoromethyl carbonofluoridate	3299-24-9	0.00	279.7	279.7
			Total VOC (lb)		**654.7**
			Total VOC (ton)		**0.33**

B. Toxic Air Pollutant Summary

FPS Compound	CAS Chemical Name	CAS No.	Stack Emissions (lbs)	Fugitive Emissions (lbs)	Total Emissions (lbs)
HF	Hydrogen fluoride	7664-39-3	0.03	105.6	105.7

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: NS-F

Emission Source Description: Nafion MMF Process

Process and Emission Description:

The MMF process is a batch/semi-batch manufacturing process. All emissions from this process vent to the Nafion Division Waste Gas Scrubber (WGS), Control Device ID No. NCD-Hdr1, which has a documented efficiency of 99.1%. The control of emissions of certain compounds will be addressed in the following spreadsheets. Some compounds (i.e. TFE) pass completely through the scrubber, therefore the efficiency is assumed to be zero percent (0%).

Basis and Assumptions:

The MMF process flowsheets #9599 and #9600 are used as a basis for relative compositions and flow rates of vent streams to the division WGS.

Information Inputs and Source of Inputs:

Information Input	**Source of Inputs**
MMF production quantity	MMF Production Facilitator
Speciated emission rates	MMF Process Flowsheets

Point Source Emissions Determination:

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

Equipment Emissions and Fugitive Emissions Determination:

Emissions from equipment leaks which vent as stack (point source) emissions and true fugitive (non-point source) emissions have been determined using equipment component emission factors established by Chemours. The determination of those emissions are shown in a seperate section of this supporting documentation.

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, Dimethy Ester	616-38-6	260.9	151.1	0	0	412.0
DME	Dimethyl ether	115-10-6	0.2	0.1	0	0	0.3
MTVE	Methyl Trifluorovinyl Ether	3823-94-7	3.64	2.11	0	0	5.7
MTFE	1-methoxy-1,1,2,2-tetrafluoroethane	425-88-7	5.19	3.01	0	0	8.2
MTP	Methyl-3-methoxy-	755-73-7	4.19	2.43	0	0	6.6
BMTK	Bis(2-methoxytetrafluoroethyl)ketone	1422-71-5	0.36	0.210	0	0	0.6
MTP Acid	MTP Acid	93449-21-9	0.00	0.001	0	0	0.0
TFE	Tetrafluoroethylene	116-14-3	39.8	23.1	0	0	62.9
CH3F	Methyl Fluoride	593-53-3	3,321.4	0.0	0.0	0	3,321.4
MMF	Propanoic Acid, 2,2,3-Trifluoro-3-oxo,methyl ester	69116-71-8	0	0.0	28.1	0	28.1
Total VOC for 2017			**3,635.7**	**182.0**	**28.1**	**0**	**3,845.9**
						VOC (Tons)	**1.92**

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	23.7	4	0	27.3

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 emissiion 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		=	0.217 lb/hr EE

Days of operation = 35

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	35 days/year	x	35 days/year
=	**182.0 lb/yr VOC from EE**	x	0.13 lb HF per lb VOC
		=	**23.7 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		=	0.033 lb/hr FE

VOC:	0.033 lb. FE/hr	**HF:**	0.033 lb. FE/hr
x	24 hours/day	x	24 hours/day
x	35 days/year	x	35 days/year
=	**28.1 lb/yr VOC from EE**	x	0.13 lb HF per lb VOC
		=	**3.7 lb/yr HF from EE**

C. Total MMF Plant Non-Point Source Emissions

	Fugitive Emissions		Equipment Emissions	
Emission Source	**VOC lb/yr**	**HF lb/yr**	**VOC lb/yr**	**HF lb/yr**
A. Fugitive emissions from MMF equipment outside of the barricade:	182.0	23.7	0	0
B. Equipment Emissions From MMF Reactor and Transfer Tank	0	0	28.1	3.7
Total for 2017	**182.0**	**23.7**	**28.1**	**3.7**

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	260.9	151.1	0	0	412.0
DME	0.2	0.1	0	0	0.3
MTVE	3.6	2.1	0	0	5.7
MTFE	5.2	3.0	0	0	8.2
MTP	4.2	2.4	0	0	6.6
BMTK	0.4	0.2	0	0	0.6
MTP Acid	0.0	0.0	0	0	0.0
TFE	39.8	23.1	0	0	62.9
CH3F	3321.4	0	0	0	3321.4
MMF	0	0	28.1	0	28.1
Total	**3635.7**	**182.0**	**28.1**	**0.0**	**3845.9**

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 (excluding CH3F whose emissions are completely accounted for as Stack Emissions).

Example: The DMC equipment emissions were determined by the ratio of the DMC stack emission (260.9 lb.) divided by the total stack emission (3,635.7 lb.) minus the CH3F stack emissions (3,321.4 lb.) or 314.3 lb., which is multiplied by the total fugitive emissions (182.0 lb.).

Specifically: $\frac{260.9}{314.3} \,\Big|\, 182.0 = 151.1$ lb. DMC

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 #9600:

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 ol **993.2** MMF units in 2017

TFE vented from the MMF Process in the reporting year:

$$\frac{0.0182 \text{ kg TFE}}{\text{MMF unit}} \times 993.2 \text{ MMF unit} = \mathbf{18.08} \text{ kg TFE}$$

After-control emissions utilizing the 0% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

Waste Gas Scrubber: 18.08 kg TFE x (100%-0%) control efficiency

= 18.08 kg TFE = 39.85 lb. THF

= **39.85** **lb. VOC**

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 #9600:

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 **993.2** MMF units in 2017

DMC vented from the MMF Process in the reporting year:

$$\frac{0.1192 \text{ kg DMC}}{\text{MMF unit}} \times 993.2 \text{ MMF unit} = \mathbf{118.35} \text{ kg DMC}$$

After-control emissions utilizing the 0% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

		118.35	kg DMC		
Waste Gas Scrubber	x	(100%-0%)	control efficiency		
	=	118.35	kg DMC =	260.92	lb. DMC
			=	**260.92**	**lb. VOC**

C. DME **CAS No. 115-10-6**
Dimethyl ether

HF Potential:

DME is a VOC without the potential to form HF

DME Quantity Generated:

Before-control DME emission rate per the Process Flowsheet #9600:

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 **993.2** MMF units in 2017

DME vented from the MMF Process in the reporting year:

$$\frac{0.00917 \text{ kg DME}}{\text{MMF unit}} \times 993.2 \text{ MMF unit} = \mathbf{9.11} \text{ kg DME}$$

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

VOC Emissions

		9.11	kg DME		
Waste Gas Scrubber	x	(100%-99.1%)	control efficiency		
	=	0.08	kg DME =	0.18	lb. DME
			=	**0.18**	**lb. VOC**

D. MTVE **CAS No. 3823-94-7**
Methyl Trifluorovinyl Ether

HF Potential:

MTVE is a VOC without the potential to form HF

MTVE Quantity Generated:

Before-control MTVE emission rate per the Process Flowsheet #9600:

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 **993.2** MMF units in 2017

MTVE vented from the MMF Process in the reporting year:

$$\frac{0.00166 \text{ kg MTVE}}{\text{MMF unit}} \times 993.2 \text{ MMF unit} = \mathbf{1.65} \text{ kg MTVE}$$

After-control emissions utilizing the 0% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

$$\text{Waste Gas Scrubber} \times \frac{1.6515 \text{ kg MTVE}}{(100\%\text{-}0\%) \text{ control efficiency}}$$
$$= 1.6515 \text{ kg MTVE} = 3.641 \text{ lb. MTVE}$$
$$= \mathbf{3.641 \text{ lb. VOC}}$$

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 #9600:

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 **993.2** MMF units in 2017

MFTE vented from the MMF Process in the reporting year:

$$\frac{0.00237 \text{ kg MTFE}}{\text{MMF unit}} \times 993.2 \text{ MMF unit} = \mathbf{2.36} \text{ kg MTFE}$$

After-control emissions utilizing the 0% control efficient Waste Gas Scrubber (WGS):

VOC Emissions

$$\text{Waste Gas Scrubber} \times \frac{2.356 \text{ kg MTFE}}{(100\%\text{-}0\%) \text{ control efficiency}}$$

= 2.356 kg MTFE = 5.193 lb. MTFE

= **5.193 lb. VOC**

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 #9600:

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 **993.2** MMF units in 2017

MTP vented from the MMF Process in the reporting year:

$$\frac{0.00191 \text{ kg MTP}}{\text{MMF unit}} \times 993.2 \text{ MMF unit} = \mathbf{1.90} \text{ kg MTP}$$

After-control emissions utilizing the 0% control efficient Waste Gas Scrubber (WGS):

MTP Emissions

$$\text{Waste Gas Scrubber} \times \frac{1.900 \text{ kg MTP}}{(100\%-0\%) \text{ control efficiency}}$$

$$= 1.900 \text{ kg MTP} = 4.189 \text{ lb. MTP}$$

$$= \mathbf{4.189 \text{ lb. VOC}}$$

G. BMTK **CAS No. 1422-71-5**
Bis(2-methoxytetrafluoroethyl)ketone

HF Potential:
BMTK is a VOC without the potential to from HF.

BMTK Quantity Generated:

Before-control BMTK emission rate per the Process Flowsheet #9600:

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 **993.2** MMF units in 2017

BMTK vented from the MMF Process in the reporting year:

$$\frac{0.000165 \text{ kg BMTK}}{\text{MMF unit}} \times 993.2 \text{ MMF unit} = \mathbf{0.16} \text{ kg BMTK}$$

After-control emissions utilizing the 0% control efficient Waste Gas Scrubber (WGS):

BMTK Emissions

$$\text{Waste Gas Scrubber} \times \frac{0.16435 \text{ kg BMTK}}{(100\%\text{-}0\%) \text{ control efficiency}}$$

$$= 0.16435 \text{ kg BMTK} = 0.362 \text{ lb. BMTK}$$

$$= \mathbf{0.362} \textbf{ lb. VOC}$$

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 #9600:

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 **993.2** MMF units in 2017

* before-control emissions

MTP Acid vented from the MMF Process in the reporting year:

$$\frac{0.000055 \text{ kg MTP Acid}}{\text{MMF unit}} \times 993.2 \text{ MMF unit} = \mathbf{0.055} \text{ kg MTP Acid}$$

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

MTP Acid Emissions

Waste Gas Scrubber: 0.055 kg MTP Acid x (100%-99.1%) control efficiency

= 0.00049 kg MTP Acid = 0.0011 lb. MTP Acid

= **0.0011 lb. VOC**

I. CH3F **CAS No. 593-53-3**
Methyl fluoride

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	**CH3F Vent Rate**	
MTP Reactor	0	kg CH3F vented per MMF unit
Neutralizer	0	kg CH3F vented per MMF unit
Wash Tk	0	kg CH3F vented per MMF unit
Crude MTP Tk	0	kg CH3F vented per MMF unit
Crude DMC Tk	0	kg CH3F vented per MMF unit
DMC Still	0	kg CH3F vented per MMF unit
MMF Reactor	1.52	kg CH3F vented per MMF unit
Total	**1.52**	kg CH3F vented per MMF unit

The before-control CH3F emission is based on **993.2** MMF units in 2017

CH3F vented from the MMF Process in the reporting year:

$$\frac{1.52 \text{ kg CH3F}}{\text{MMF unit}} \times 993.2 \text{ MMF unit} = \mathbf{1{,}506.6} \text{ kg CH3F}$$

After-control emissions utilizing the 0% control efficient Waste Gas Scrubber (WGS):

CH3F Emissions

$$\text{Waste Gas Scrubber} \times \frac{1{,}506.6 \text{ kg CH3F}}{(100\%\text{-}0\%) \text{ control efficiency}}$$

$$= 1{,}506.6 \text{ kg CH3F} = 3321.4 \text{ lb. CH3F}$$

$$= \mathbf{3321.4} \textbf{ lb. VOC}$$

VOC Point Source Emission Determination

A. **PSEPVE** — **CAS No. 16090-14-5**
Perfluoro-2-(2-Fluorosulfonylethoxy) Propyl Vinyl Ether

Equivalent Weight (EW) = kg Polymer/kg mol Vinyl Ether (VE) molecule
For SR, VE = PSEPVE. PSEPVE molecular weight = 446

Example of monthly calculation (by mass balance):

1. PSEPVE Fed (M) 4032 kg PS

2. PSEPVE Transformed (P)

PSEPVE Transformed in to polymer:

PSEPVE in Polymer = 7825 kg Polymer x (446 kg PSEPVE / 1 kg mol PSEPVE) x (kg mol PSEPVE / 921 kg Polymer) = 3791 kg PS in Polymer

PSEPVE Transformed to Nonstandard Polymer (Example of monthly calculation):

PSEPVE in Polymer = 0 kg N/S Polymer x (446 kg PSEPVE / 1 kg mol PSEPVE) x (kg mol PSEPVE / 2 kg Polymer) = 0 kg PS in N/S. Polymer

PSEPVE Transformed Into Purge Polymer & Adhesions (Example of monthly calculation):

PSEPVE in Polymer = 362 kg purge Polymer & adh x (446 kg PSEPVE / 1 kg mol PSEPVE) x (kg mol PSEPVE / 923 kg Polymer) = 175 kg PS in Purge/Adh

Total PSEPVE in Polymer = 3966 kg PS

3. PSEPVE Untransformed (W): 719 kg PS

4. PSEPVE Emissions From Finishing Extrusion: 123 kg PS

5. PSEPVE Mass Balance:

	4032	M (PSEPVE Fed into Process)
-	3966	P (PSEPVE Transformed)
-	719	W (PSEPVE Untransformed)
+	0.4	S (Storage Tank Emissions)
+	123	PSEPVE Emissions From Finishing Extrusion
	-530	kg PSEPVE Emission

Monthly & Yearly Calcuation

	Month	Polymer	Std Polymer Wt Avg EW	N/S Polymer	N/S Polymer Wt Avg EW	Purge & Adhesions	Purge & Adhesion Wt Avg EW	VE to Filters/Sieves	PSEPVE Fed (M)	PSEPVE Transformed (P)	PSEPVE Untransformed (W)	PSEPVE Tank Vents (S)	Finishing VE Emission	PSEPVE Emission (kg)
1	Jan-17	9070	920	0	0	1057	919	845	5297	4900	2253	0.42	238	0
2	Feb-17	11634	969	132	1073	263	1037	183	5709	5509	227	0.40	0	0
3	Mar-17	7825	919	0	0	362	921	299	4032	3966	719	0.46	0	0
4	Apr-17	11226	951	0	0	270	994	391	5602	5372	519	0.41	235	0
5	May-17	10013	941	51	925	256	916	1124	6689	4886	1646	0.49	127	284
6	Jun-17	12547	944	0	0	313	1004	518	7261	6052	2118	0.41	334	0
7	Jul-17	9556	948	0	0	213	921	362	5904	4589	1364	0.42	0	0
8	Aug-17	3322	923	0	0	0	0	99	1636	1602	-235	0.43	0	269
9	Sep-17	6658	954	0	0	0	0	191	6707	3106	3265	0.42	99	435
10	Oct-17	4117	919	0	0	0	0	0	2988	1993	807	0.43	0	188
11	Nov-17	7952	922	85	919	478	920	414	4125	4110	25	0.46	0	0
12	Dec-17	9794	991	0	0	187	1004	257	4592	4480	139	0.45	698	672

Total PSEPVE Emission = 1848 kg PSEPVE
4074 lb PSEPVE

B. EVE CAS No. 63863-43-4

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

Equivalent Weight (EW) = kg Polymer/kg mol Vinyl Ether (VE) molecule
For CR, VE = EVE. EVE molecular weight = 422

Example of monthly calculation (by mass balance):

1. EVE Fed (M) 2345 kg EVE

2. EVE Transformed (P)

EVE Transformed in to polymer:

EVE in Polymer = 3338 kg std Polymer produced x (422 kg EVE / 1 kg mol EVE) x (kg mol EVE / 1046 kg Polymer) = 1347 kg EVE in Std. Polymer

EVE Transformed to Nonstandard Polymer (Example of monthly calculation):

EVE in Polymer = 0 kg N/S Polymer produced x (422 kg EVE / 1 kg mol EVE) x (kg mol EVE / 0 kg Polymer) = 0 kg EVE in N/S. Polymer

EVE Transformed Into Purge Polymer & Adhesions (Example of monthly calculation):

EVE in Polymer = 336 kg purge Polymer & adh x (422 kg EVE / 1 kg mol EVE) x (kg mol EVE / 1046 kg Polymer) = 135 kg EVE in Purge/Adh

Total EVE in Polymer = 1482 kg EVE

3. EVE Untransformed (W):: 176 kg EVE

4. EVE Emissions From Finishing Extrusion: 41 kg EVE

5. EVE Mass Balance:

	2345	M
-	1482	P
-	176	W
+	41	Finishing
+	0.05	S
	727	kg EVE Emission

Monthly & Yearly Calcuation

	Month	Polymer	Std Polymer Wt Avg EW	N/S Polymer	N/S Polymer Wt Avg EW	Purge & Adhesions	Purge & Adhesion Wt Avg EW	VE to Filters/Sieves	EVE Fed (M)	EVE Transformed (P)	EVE Untransformed (W)	EVE Tank Vents (S)	Finishing VE Emission	EVE Emission (kg)
1	Jan-17	0	0	0	0	0	0	0	0	0	0	0.05	77	77
2	Feb-17	0	0	0	0	0	0	0	0	0	0	0.04	0	0
3	Mar-17	0	0	0	0	0	0	0	0	0	0	0.05	35	35
4	Apr-17	0	0	0	0	0	0	0	0	0	0	0.05	0	0
5	May-17	0	0	0	0	0	0	0	0	0	0	0.05	98	98
6	Jun-17	0	0	0	0	0	0	0	0	0	0	0.05	0	0
7	Jul-17	0	0	0	0	0	0	0	0	0	0	0.05	0	0
8	Aug-17	7022	1046	237	785	462	916	76	4929	3173	1929	0.06	0	0
9	Sep-17	2440	1046	0	0	336	1046	129	880	1120	176	0.05	41	0
10	Oct-17	0	0	0	0	0	0	0	0	0	0	0.05	68	68
11	Nov-17	0	0	0	0	0	0	0	0	0	0	0.05	0	0
12	Dec-17	0	0	0	0	0	0	0	0	0	0	0.05	30	30

Total EVE Emission = 308 kg EVE
679 lb EVE

C. TFE
Tetrafluoroethylene

CAS No. 116-14-3

Equivalent Weight (EW) = kg Polymer/kg mol Vinyl Ether (VE) molecule

For SR, VE = PSEPVE.	PSEPVE molecular weight =	446
For CR, VE = EVE.	EVE molecular weight =	422
	TFE molecular weight =	100

Example of monthly calculation (by mass balance):

1. TFE Fed during SR (M): 7799 kg TFE

2. TFE Transformed during SR (P):

TFE Transformed in to polymer

TFE in Polymer = 11634 kg Polymer produced x (969 kg Polymer - 446 kg PSEPVE) / 1 kg mol PSEPVE x kg mol PSEPVE / 969 kg Polymer = 6282 kg TFE in Std. Polymer

TFE transformed to Nonstandard polymer:

TFE in Polymer = 132 kg N/S Polymer produced x (1073 kg Polymer - 446 kg PSEPVE) / 1 kg mol PSEPVE x kg mol PSEPVE / 1073 kg Polymer = 77 kg TFE in N/S Polymer

TFE transformed to purge polymer and adhesions:

TFE in Polymer = 263 kg purge Polymer & adh x (1037 kg Polymer - 446 kg PSEPVE) / 1 kg mol PSEPVE x kg mol PSEPVE / 1037 kg Polymer = 150 kg TFE in Purge/Adh

Total TFE Transformed = 6509 kg TFE

3. TFE Mass Balance (SR only):

7799 M
\- 6509 P
1290 kg TFE Emission during SR

4. TFE Fed during CR (M): 0 kg TFE

5. TFE Transformed during CR (P):

TFE Transformed in to polymer

TFE in Polymer = 0 kg std Polymer produced x (0 kg Polymer - 422 kg EVE) / 1 kg mol EVE x kg mol EVE / 0 kg Polymer = 0 kg TFE in Std. Polymer

TFE transformed to Nonstandard polymer:

TFE in Polymer = 0 kg N/S Polymer produced x (0 kg Polymer - 422 kg PSEPVE) / 1 kg mol PSEPVE x kg mol PSEPVE / 0 kg Polymer = 0 kg TFE in N/S Polymer

TFE transformed to purge polymer and adhesions:

TFE in Polymer = 0 kg purge Polymer & adh x (0 kg Polymer - 422 kg PSEPVE) / 1 kg mol PSEPVE x kg mol PSEPVE / 0 kg Polymer = 0 kg TFE in Purge/Adh

Total TFE Transformed CR = 0 kg TFE

6. TFE Mass Balance (CR only):

0 M
\- 0 P
0 kg TFE Emission during CR

7. Total TFE Emission (SR & CR):

1290 SR
\+ 0 CR
1290 kg TFE Emission during SR & CR

C. TFE, cont.

Monthly & Yearly Calcuation--SR

	Month	Polymer	Std Polymer Wt Avg EW	N/S Polymer	N/S Polymer Wt Avg EW	Purge & Adhesions	Purge & Adhesion Wt Avg EW	TFE Fed during SR (M)	TFE Transformed (P)		TFE Emission
1	Jan-17	9070	920	0	0	1057	919	6324	5216		1108
2	Feb-17	11634	969	132	1073	263	1037	7799	6509		1290
3	Mar-17	7825	919	0	0	362	921	5300	4212		1088
4	Apr-17	11226	951	0	0	270	994	7916	6113		1803
5	May-17	10013	941	51	925	256	916	7159	5424		1735
6	Jun-17	12547	944	0	0	313	1004	8271	6796		1475
7	Jul-17	9556	948	0	0	213	921	6182	5170		1012
8	Aug-17	3322	923	0	0	0	0	7357	1717		5640
9	Sep-17	6658	954	0	0	0	0	4746	3545		1201
10	Oct-17	4117	919	0	0	0	0	2616	2119		497
11	Nov-17	7952	922	85	919	478	920	6040	4396		1644
12	Dec-17	9794	991	0	0	187	1004	6767	5492		1275

SR TFE Emission = 19769 kg TFE
43582 lb TFE

Monthly & Yearly Calcuation--CR

	Month	Polymer	Std Polymer Wt Avg EW	N/S Polymer	N/S Polymer Wt Avg EW	Purge & Adhesions	Purge & Adhesion Wt Avg EW	TFE Fed during CR (M)	TFE Transformed (P)		TFE Emission
1	Jan-17	0	0	0	0	0	0	0	0		0
2	Feb-17	0	0	0	0	0	0	0	0		0
3	Mar-17	0	0	0	0	0	0	0	0		0
4	Apr-17	0	0	0	0	0	0	0	0		0
5	May-17	0	0	0	0	0	0	0	0		0
6	Jun-17	0	0	0	0	0	0	0	0		0
7	Jul-17	0	0	0	0	0	0	0	0		0
8	Aug-17	7022	1046	237	785	462	916	0	4548		-4548
9	Sep-17	2440	1046	0	0	336	1046	1434	1656		-222
10	Oct-17	0	0	0	0	0	0	0	0		0
11	Nov-17	0	0	0	0	0	0	0	0		0
12	Dec-17	0	0	0	0	0	0	0	0		0

CR TFE Emission = -4769 kg TFE
-10515 lb TFE

Total TFE Emission--SR & CR Combined

	Month	TFE Emission (kg)
1	Jan-17	1108
2	Feb-17	1290
3	Mar-17	1088
4	Apr-17	1803
5	May-17	1735
6	Jun-17	1475
7	Jul-17	1012
8	Aug-17	1093
9	Sep-17	979
10	Oct-17	497
11	Nov-17	1644
12	Dec-17	1275
		0

TFE Em. = 14999 kg TFE
33067 lb TFE

D. E2 CAS No. 3330-14-1

2H-Perfluoro(5-Methyl-3,6-Dioxanonane)

Example of monthly calculation (by mass balance):

1. E2 Fed SR (P): 283 kg E2

2. E2 Untransformed SR (W): -661 kg E2

3. Finishing E2 Emission during SR: 0 kg E2

4. E2 Mass Balance (SR Only):
   283 kg E2 Consumed
   \- -661 kg E2 losses to Filters & Sieves
   \+ 0 kg E2 emitted in Finishing
   944 kg E2 emission

5. E2 Fed CR (P):: 0 kg E2

6. E2 Untransformed CR (W): 0 kg E2

7. Finishing E2 Emission during CR: 9 kg E2

8. E2 Mass Balance (CR Only):
   0 kg E2 Consumed
   0 kg E2 losses to Filters & Sieves
   \+ 9 kg E2 emitted in Finishing
   9 kg E2 emission

9. Total E2 Emission (SR & CR):
   944 kg E2 emission during SR
   \+ 9 kg emission during CR
   953 kg E2 Emission during SR & CR

Monthly & Yearly Calcuation--SR

	Month	E2 Fed (P)	E2 Untransformed	Finishing E2 Emission	E2 Emission	
1	Jan-17	884	1019	59	-76	
2	Feb-17	1995	1498	0	497	
3	Mar-17	283	-661	0	944	
4	Apr-17	1742.6	1635	59	167	
5	May-17	574.85	281	32	326	
6	Jun-17	1664.7	2025	83	-277	
7	Jul-17	1767.9	1686	0	82	
8	Aug-17	5536	4536	0	1000	
9	Sep-17	3063.9	4709	25	-1621	
10	Oct-17	942.55	6224	0	-5281	
11	Nov-17	244.15	-106	0	350	
12	Dec-17	1817.35	1242	174	750	
			SR E2 Emission =		-3138	kg E2
					-6919	lb E2

Monthly & Yearly Calcuation--CR

Month		E2 Untransformed	Finishing E2 Emission	E2 Emission	
Jan-17		0	19	19	
Feb-17		0	0	0	
Mar-17		0	9	9	
Apr-17		0	0	0	
May-17		0	24	24	
Jun-17		0	0	0	
Jul-17		0	0	0	
Aug-17		138	0	-138	
Sep-17		245	10	-235	
Oct-17		0	17	17	
Nov-17		0	0	0	
Dec-17		0	7	7	
	CR E2 Emission =			-296	kg E2
				-653	lb E2

Total E2 Emission--SR & CR Combined

Month	E2 Emission (kg)	
Jan-17	0	
Feb-17	497	
Mar-17	953	
Apr-17	167	
May-17	351	
Jun-17	0	
Jul-17	82	
Aug-17	862	
Sep-17	0	
Oct-17	0	
Nov-17	350	
Dec-17	758	
E2 Em. =	4018	kg E2
	8859	lb E2

E. F-113 CAS No. 76-13-1

Trichloro-1,2,2-trifluoro-1,1,2 Ethane

1.F113 Mass Balance:
   0 kg F-113 Beginning Inventory
   \+ 0 kg F-113 Shipments
   \+ 0 kg F-113 used with 3P in Polymerization
   \+ 0 kg F-113 used with 3P in Semi-Works
   \- 0 kg F-113 waste sent off plant
   \- 0 kg F-113 Ending Inventory
   0 kg F-13 emission between SW & Polymerization

2. Division of Emissions between SW & Polymerization
   0 kg F-113 Ending Inventory
   0 kg F-113 Shipments
   0 kg F-113 used with 3P in Semi-Works
   0 kg F-113 used by Semi-Works

   0 kg F-113 used with 3P in Polymerization
   0 kg Refined by Polymerization in Recycle Still
   0 kg F-113 used by Polymerization

Polymerization % = (0 kg F-113 used by Polymerization / 0 kg F-113 Total) x 100 = 0.0 %

3. F113 Emission from Polymerization: (0.0 % / 100) x 0 kg F-113 Emission = 0 kg F-113 emission from Polymerization
0 lb F-113 emission from Polymerization

Point Source Emission Determination

A. HF — **CAS No. 7664-39-3**
Hydrogen Fluoride

HF Potential:

Some SR polymer is fluorinated with a mixture of 10% F2 90% N2.
Each mole of Fluorine (F2) reacts with one mole of SR polymer in the Fluorinator to produce 1 mole of HF.

$$R - CF_2 - H + F_2 \rightarrow HF + R - CF_3$$

Quantity Released:

Vapor released to scrubber during initial fluorine charge:

F2 introduced during the initial fluorine charge to Fluorinator:

$$\frac{2.2\ lb\ F_2}{h}\ x\ 0.1\ F_2\ x\ 0.5\ hour = 0.11\ lb\ F_2$$

Estimate 75% of initial fluorine reacts with polymer during each batch:

$$0.75\ x\ 0.11\ lb\ F_2\ x\ \frac{1\ lbmol\ HF}{1\ lbmol\ F_2}\ x\ \frac{1\ lbmol\ F_2}{38\ lb\ F_2}\ x\ \frac{20\ lbHF}{1\ lbmol\ HF} = 0.0434\ lb\ HF$$

Vapors released to scrubber during initial fluorine charge: 0.0434 lb HF per batch

Vapor released to scrubber during remainder of fluorination cycle:

F2 feed :

$$0.88\ lb/h\ F_2\ x\ 0.10\ F_2\ x\ 12\ hours = 1.056\ lb\ F_2$$

Estimate 60% of fluorine reacts with polymer:

$$0.60\ x\ 1.056\ lb\ F_2\ x\ \frac{1\ lbmol\ HF}{1\ lbmol\ F_2}\ x\ \frac{1\ lbmol\ F_2}{38\ lb\ F_2}\ x\ \frac{20\ lbHF}{1\ lbmol\ HF} = 0.3335\ lb\ HF$$

Vapors released to scrubber during fluorination cycle: 0.3335 lb HF per batch

Unreacted Fluorine released to scrubber: 0.4499 lb F2 per batch

Vapor released to scrubber during Hydrolysis step of Chem Stable Process: 0.661 lb HF per batch

Total vapors to scrubber: 0.0434 + 0.3335 + 0.4499 = 0.8268 lb HF and F2 per fluorination batch

Emissions per batch utilizing 99% fluorine scrubber efficiency:

NOTE: 99% conversion based on studies of Washington Works' Fluorine Scrubbers

	0.8268	lb HF and F2 per fluorination batch
x	(1 - 0.99)	
=	0.0083	lb HF and F2 per fluorination batch

	0.6610	lb HF per hydrolysis batch
x	(1 - 0.99)	
=	0.0066	lb HF per hydrolysis batch

After-Control HF and F2 Emissions:

	# fluorinations	# hydrolysis	lb HF and F2 per fluorination batch	lb HF per hydrolysis batch	Total
1st Quarter	38	19	0.3	0.1	0.4
2nd Quarter	36	18	0.3	0.1	0.4
3rd Quarter	24	12	0.2	0.1	0.3
4th Quarter	24	12	0.2	0.1	0.3
					1.4

CAS No. 67-56-1

B. MeOH
Methanol

Methanol can potentially be emitting from two tank vents in Polymerization. The Recovery Tank operates at a low enough temperature that no methanol exists in the vapor space, thus no methanol is released.
The Recirculation Tank vents whenever condensed liquid is introduced into the tank. This calcuation is based on a Vapor-Liquid Equilibrium calculation for E2, VE, and methanol.
There is also a vent of Methanol from the Conservation Vent on the Methanol tote.
Fugitive Emissions are also calculated based on the number and type of connections on the Methanol line.

Recirculation Tank Vent Rate:

Recirc Tank Vapor Space: 180 gal x (3.79 L / 1 gal) x 0.50 level = 341 L in vapor space

Recirc Tank Vent Rate: Assume vent rate is directly proportional to volume of liquid displacing the gas = 425 kg/h (Recycle Feed Rate) / 1.67 kg/L (Specific Gravity of Liquid)
= 254.49 L/h

(21.37 mol / 341 L in vapor space) x (254.49 L / 1 h) = 15.9 mol/h

Mass Flow Rate of Methanol:

15.9 mol/h x 0.057 vol% MeOH x (31.034 g MeOH / 1 mol MeOH) = 28.2 g/h MeOH

Methanol Emissions: 28.2 g/h MeOH x 458 hours = 12917 g MeOH
28 lb MeOH
12.9 kg MeOH

Coservation Vent Rate (MeOH Tote):

Conditions:
Pressure 4 kpa(g) 16.07 inwc
Temperature 25 °C

Vapor Pressure Constants (DIPPR):

A	B	C	D	E	
82.718	-6904.5	-8.8622	7.466E-06		2

MeOH Concentration & MW of gas in head space:
Pvp = 16.8 kpa(a) 67.60 inwc (a)
y (MeOH) = 0.160
MW (gas) = 28.64

Gas Density assuming ideal gas law:
PV = nRT ==> n/V = P/RT
R 8.31447 L·kPa·K-1·mol-1
n/V 0.04248556 mol/L
Density 1.21674541 g/L 0.076 lb/cf

Calculate emission based on worst case vendor information
Leak Rate 0.5 SCFH @ 26.315 inwc
Time 458 hours
Mass 17.39 lbs of gas mixture
MeOH 2.78 lbs of MeOH
1.26 kgs of MeOH

Fugitive Emissions

Component	Service	Emission Factor (lb/hr/component)	Number in Service	Emission Factor
Pump Seals	Light Liquid	0.00115	2	0.0023
Valves	Light Liquid	0.00036	60	0.0216
Flanges	All	0.00018	127	0.0229
				0.0468 lb/hr VOC
				0.0213 kg/hr VOC

Monthly & Yearly Calcuation--MeOH

	Month	Hours	Recirc Tank Emissions (kg)	Conserv Vent Emissions (kg)	Fugitive Emissions (kg)	Total MeOH Emissions (kg)	MeOH Flow 9636FC +1% (kg/hr)	Total MeOH Flow (kg)
1	Jan-17	458	13	1.26	10	24	3.03	1,388
2	Feb-17	460	13	1.27	10	24	3.03	1,394
3	Mar-17	378	11	1.04	8	20	3.03	1,145
4	Apr-17	508	14	1.40	11	27	3.03	1,539
5	May-17	456	13	1.26	10	24	3.03	1,382
6	Jun-17	560	16	1.54	12	29	3.03	1,697
7	Jul-17	422	12	1.16	9	22	3.03	1,279
8	Aug-17	420	12	1.16	9	22	3.03	1,273
9	Sep-17	348	10	0.96	7	18	3.03	1,054
10	Oct-17	176	5	0.49	4	9	3.03	533
11	Nov-17	367	10	1.01	8	19	3.03	1,112
12	Dec-17	320	9	0.88	7	17	3.03	970
				Total for the Year		254 kg		14,765 kg
						561 lb		32,551 lb

Yearly Emission Summary

A. VOC Compound Summary

NS-G SR/CR Resins Manufacturing Process			
Nafion® Compound	**CAS Chemical Name**	**CAS No.**	**Emission (lb)**
PSEPVE	Perfluoro-2-(2-Fluorosulfonylethoxy) Propyl Vinyl Ether	16090-14-5	4,074
EVE	Propanoic Acid, 3-[1-[Difluoro[(Trifluoroethenyl)oxy]Methyl]-1,2,2,2- Tetrafluoroethoxy]-2,2,3,3-Tetrafluoro-Methyl Ester	63863-43-4	679
TFE	Tetrafluoroethylene	116-14-3	33,067
E-2	2H-Perfluoro(5-Methyl-3,6-Dioxanonane)	3330-14-1	8,859
HFPO Dimer Acid Fluoride	2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoyl fluoride	2062-98-8	5
MeOH	Methanol	67-56-1	561
		Total VOC Emissions (lbs)	47,245
		Total VOC Emissions (tons)	**23.6**

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	1.7
MeOH	Methanol	67-56-1	561

AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source: IXM Membrane Process

Emission Source ID No.: NS-H

Process Description:

The resin membrane treatment process (hydrolysis) is carried out continuously by passing the film resin or laminated resin membrane through a succession of tanks containing the necessary reagent chemicals to complete the hydrolysis reaction. Chemically, the objective is to expose the membrane to the reagent solution under conditions of time, temperature, concentration and agitation which are sufficient to complete the desired reaction. Mechanically, the objective is to convey the sheet, that is changing in dimension as it reacts, through a series of vertical passes, in a number of tanks, in a straight line, at a constant tension, without folding, creasing or tearing.

The resin membrane treatment process is contained in a enclosed room. All emissions are contained within the room and vent through emission control stacks. Air is supplied into the room and vented on a once through basis.

The resin membrane treatment process (extrusion) is carried out continuouly by melting resin polymer pellets into an single screw extruder, heating to high temperatures so as to melt the resin polymer and extruded into film sheet form.

The resin membrane treatment process (extrusion) is contained in an enclosed room. All emissions are contained within the room and vented through emission control stacks. Air is supplied into the room and vented on a once through basis.

Basis and Assumptions:

- Vent to atmosphere via stack
- No fugitive emissions due to all emissions vented through stack.
- DMSO vapor pressure = 0.46 mm Hg @ 20°C
- KOH vapor pressure = 2.6 mm Hg @ 20°C
- HNO3 vapor pressure = 9 to 28 mm Hg @ 25°C
- CH3COOH or HOAc vapor pressure = 11.4 mm Hg @ 20°C
- DEG vapor pressure = 1 mm Hg @ 92°C
- NaOH vapor pressure = 13 mm Hg @ 60°C
- Molar volume of an Ideal Gas @ 0°C and 1 atm = 359 ft3/(lb-mole)
- Molecular Weight of DMSO = 78 (78 lb DMSO / mole DMSO)
- DMSO waste storage tank 6000 gallons.
- DMSO received in 55 gal drums, each drum weighing 500 lbs.

2017 NS-H Membrane Treatment (extrusion & hydrolysis) Summary Report

Acetic Acid Emissions		
1st Quarter	217	hrs
2nd Quarter	251	hrs
3rd Quarter	264	hrs
4th Quarter	209	hrs
Total	**941**	**hrs**
Acetic Acid Emissions Rate	0.727	lbs/hr
Acetic Acid Emissions	***684***	**lbs/yr**
DMSO Emissions		Units
Waste Shipped	0	lbs/yr
Waste in storage tk yr end	0	gallons
Waste in storage tk yr end	0	lbs
Waste % in storage tk yr end	0%	%
DMSO Waste Content	11%	wt%
DMSO in Waste liquid	0	lbs/yr
DMSO Shipped as Waste liquid	0	lbs/yr
KOH/DMSO waste pumped to waste	26,025	gal/yr
treatment	265,455	lbs/yr
DMSO pumped to waste treatment	29,200	lbs/yr
DMSO Inventory		
inv. Begin year	17	drums
inv. End year	16	drums
DMSO Drums Rec	104	drums
Wt/Drum	500	lb/drum
total DMSO consumed	52,500	lbs
DMSO Emissions	**23,300**	**lbs/yr**
Total VOC Emissions		
Acetic Acid Emissions	684	lbs/yr
DMSO Emissions	23,300	lbs/yr
Total VOC Emissions	**23,984**	**lbs/yr**
	11.99	**ton/yr**

Throughput (production)

Hydrolysis product produced.	257,172	m2
Hydrolysis surface treatment	170,215	m2

1st qrt % hrs of operations	23.24%
2nd qrt % hrs of operations	28.22%
3rd qrt % hrs of operations	24.33%
4th qrt % hrs of operations	24.22%

HF Emissions

SR Resin Extruded	83,999	kg/yr
CR Resin Extruded	8,754	kg/yr
Total polymer extruded	92,753	kg/yr
Amount of HF produced per kg of polymer processed at various temperatures.	0.00068	kg HF / kg SR @ 275 deg C
	0.00008	kg HF / kg CR @ 275 deg C
	83,999	kg SR Resin extruded per year
	0.00068	kg HF / kg SR @ 275 deg C
	56.7	kg HF emitted per year
	8,754	kg SR Resin extruded per year
	0.00008	kg HF / kg SR @ 275 deg C
	0.7	kg HF emitted per year
Total HF Formed	57	kg/yr
Total HF HAP/TAP Emissions	*126*	lbs/yr

2017 Air Emissions Inventory Supporting Documentation - Introduction

Emission Source ID No.: NS-I

Emission Source Description: IXM Membrane Coating Process

Process and Emission Description:

The IXM Membrane Coating Process is a batch process in which Nafion® membranes are spray coated with zirconium oxide and SR resin to enhance the performance of the membrane. The zirconium/resin is applied to the membrane as a dispersion in a mixture of ethanol, 1-propanol, and 2-propanol. A small amount of a high molecular weight surfactant (Triton X-100) is added to improve the wettability of the coating on the membrane.

All VOC emissions are exclusively from the evaporation of the alcohols, which make up 81.79% by weight the total mass of the sprayed coating. Sources of VOC emissions are the three tanks (Binder Storage Tank, Hi-Speed Dispersion Tank, and Paint Supply Tank), the Spray Booth Operation, and clean-up of the equipment using 2-propanol. The VOC emissions are uncontrolled.

The particulate matter (PM) emissions would be exclusively from the zirconium oxide, the SR resin, and the Triton X-100 surfactant, which make up 16.68% by weight the total mass of the sprayed coating. Overspray is captured by paint arrestors, currently a double-layer of the Research Products Spra-Gard Paint Arrestors Model 3232. Testing of a double layer of the paint arrestors showed that they were 99.77% efficient in removing the paint spray droplets from a conventional air gun. To be conservative, it will be assumed the paint arrestor control efficiency is 98%.

Basis and Assumptions:

The IXM Membrane Coating Process total VOC emissions are based on the total quantity of binder and coating consumed during the calendar year, and it is assumed that 100% of the alcohols (VOCs) in the binder and coating become air emissions.

To be conservative, it is assumed that the binder formula used throughout the year is the worst-case recipe that will produce the greatest quantity of VOC emissions. That formula is the "Low SR/ZrO2 Ratio, High Solids Binder" which has the following components' weight fraction in the binder:

Ethanol	78.18%
1-propanol	10.02%
2-propanol	3.68%

Water	4.11%
SR Resin	4.01%

The actual density of the binder typically runs between 0.81 and 0.83 kg/L. To be conservative, it is assumed that the binder density is 0.85 kg/L.

The PM emissions are determined using the following data and assumptions:

1) the total quantity of solids, meaning zirconium oxide (ZrO_2), Triton X-100, and SR Resin, consumed during the reporting year,

2) a transfer efficiency of 40% of the sprayed solids adhering to the membrane and 60% of the solids being the before-control PM quantity, and

3) a conservative paint arrestor control efficiency of 98%.

Information Inputs and Source of Information Inputs:

Information Input	Source of Information Inputs
Quantities of binder, 2-propanol, zirconium, and Triton X-100 consumed during reporting year	Products Production Facilitator
Quantity of waste 2-propanol alcohol (WFN-210) generated during reporting year	Environmental Manager
Membrane Coating Process operating days during reporting year	Products ATO Engineer
Membrane Coating Process operation as a quarterly percentage during reporting year	Products ATO Engineer

Point Source Emissions Determination:

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

Equipment Emissions and Fugitive Emissions Determination:

The IXM Membrane Coating Process is completely inside a building, therefore all emissions are point source and there are no fugitive emissions. Since the total VOC emissions are based on the total quantity of binder and coating consumed during the calendar year, and it is assumed that 100% of the alcohols in the binder and coating becomes an air emission, then any equipment leaks would be accounted for in this material balance.

2017 Air Emissions Inventory Summary

Volatile Organic Compounds (VOC) Emissions Summary

Compound	Chemical Name	CAS No.	Emissions (lb)
Ethanol	Ethanol	64-17-5	44,973
1-propanol	Propan-1-ol	71-23-8	5,766
2-propanol	Propan-2-ol	67-63-0	7,275
		VOC (lb)	**58,014**
		VOC (Tons)	**29.01**

Particulate Matter (PM) Emissions Summary

Compound	Chemical Name	CAS No.	Emissions (lb)
SR Resin	Ethanesulfonic acid, 2-[1-[difluoro[(1,2,2-trifluoroethenyl)oxy]methyl]-1,2,2,2-tetrafluoroethoxy]-1,1,2,2-tetrafluoro-, polymer	31175-20-9	28
Zirconium (ZrO_2)	Zirconium dioxide	1314-23-4	172
Triton X-100	Octylphenoxypolyethoxyethanol	9002-93-1	1
		PM (lb)	**200**
		TSP (Tons)	**0.10**
		PM_{10} (Tons)	**0.10**
		$PM_{2.5}$ (Tons)	**0.10**

NOTE: To be conservative, it is assumed the $PM_{2.5}$, PM_{10}, and Total Suspended Particulates (TSP) are the same quantity.

Point Source Volatile Organic Compounds (VOC) Emission Determination

The emissions of volatile organic compounds (VOC) from the IXM Membrane Coating Process is exclusively comprised of the ethanol, 1-propanol, and 2-propanol that are consumed during the calendar year. These three compounds make up the solvent of the coating that is sprayed on the Nafion® membranes, and also 2-propanol is used to clean the tanks and ancillary equipment.

The quantities of ethanol and 1-propanol that are consumed during the calendar year, are assumed to be completely emitted as VOC air emissions from the Spraybooth operation.

The 2-propanol emitted as VOC air emissions from the Spraybooth operation are determined by subtracting the quantity of 2-propanol that is collected as a solid waste (WFN-210) from the total quantity of 2-propanol that is consumed during the calendar year.

The emissions of these chemicals are determined through a material balance of the quantity of binder solution consumed during the year and the composition of that binder that results in the highest VOC emission rate, and the quantity of 2-propanol that was consumed during the year.

The binder composition, or Chemical Weight Fraction, is assumed to be that of the "Low SR/ZrO2 Ratio, High Solids Binder" formula that results in the worst-case or highest VOC emission rate for the IXM Membrane Coating Process.

The binder density during the reporting year is conservatively assumed to be 0.85 kg/L.

VOC Emissions from Binder Solution

30,698	liters of Binder consumed
0.85	kg/L (density of Binder)
26,093	kg Binder consumed
57,525	lb. Binder consumed

Binder Composition	Weight Fraction	Chemical Consumed (lb)	VOC Air Emissions (lb)
Ethanol	78.18%	44,973	44,973
1-propanol	10.02%	5,766	5,766
2-propanol	3.68%	2,116	2,116
Water	4.11%	2,364	
SR Resin	4.01%	2,306	
		57,525	**52,855**

VOC Emissions from Other (non-Binder) Sources

	13,394	lb. 2-propanol consumed
minus	8,235	lb. 2-propanol drummed solid waste (WFN-210)
	5,159	lb. 2-propanol as air emissions

Total VOC Emissions from IXM Membrane Coating Process

VOC Emissons	Binder Emissions (lb)	Other Emissions (lb)	Total Emissions (lb)
Ethanol	44,973		44,973
1-propanol	5,766		5,766
2-propanol	2,116	5,159	7,275
			58,014

Total VOC Emissions 58,014 lb. per year

29.01 tons per year

Point Source Particulate Matter ("PM") Emission Determination

The emissions of particulate matter (PM) from the IXM Membrane Coating Process is exclusively comprised of the SR Resin, zirconium dioxide, and Triton X-100 that are consumed during the calendar year. These three compounds make up the solids of the coating that is sprayed on the Nafion® membranes.

The emissions of these compounds are determined through a material balance of the quantity of binder solution consumed during the year and the composition of that binder, and the quantities of zirconium oxide and Triton X-100 that were consumed during the year.

The binder composition, or Chemical Weight Fraction, is assumed to be that of the "Low SR/ZrO2 Ratio, High Solids Binder" formula that results in the worst-case or highest VOC emission rate for the IXM Membrane Coating Process.

The transfer efficiency, or the fraction of the solids sprayed onto the membrane that adheres to the membrane, is believed to be 40%. Therefore, 60% of the solids sprayed during the year are assumed to be before-control particulate matter emissions.

The current paint arrestor filter spray removal efficiency is 99.37% for a single layer and 99.77% for a double layer of arrestor filters. While two layers are actually used in the Spray Booth, a 98% removal efficiency will be assumed for the particulate matter estimation.

The binder density during the reporting year is conservatively assumed to be 0.85 kg/L.

Consumed Solid (Non-Volatile) Compounds in Binder Solution

30,698 liters of Binder consumed
0.85 kg/L (density of Binder)
26,093 kg Binder consumed
57,525 lb. Binder consumed

Binder Chemical Composition	Chemical Weight Fraction	Chemical Consumed (lb)	Solid Compounds (lb)
Ethanol	78.18%	44,973	
1-propanol	10.02%	5,766	
2-propanol	3.68%	2,116	
Water	4.11%	2,364	

SR Resin	4.01%	2,306	2,306
	100.00%	**57,525**	

Consumed Solid (Non-Volatile) Compounds from Other (non-Binder) Sources

14,300 lb. zirconium oxide (ZrO_2) consumed

62 lb. Triton X-100 consumed

Before-Control PM Emissions from IXM Membrane Coating Process

PM Compound	Solids Sprayed on Membrane (lb)	Solids Adhered to Membrane (40% efficiency) (lb)	Before-Control PM Emissions (lb)
SR Resin	2,306	923	1,384
ZrO_2	14,300	5,720	8,580
Triton X-100	62	25	37

After-Control PM Emissions from IXM Membrane Coating Process

Actual Paint Arrestors Spray Removal Efficiency	99.77%
Assumed Paint Arrestors PM Capture Efficiency	98%

PM Compound	Before-Control PM Emissions (lb)	After-Control PM Emissions (lb)
SR Resin	1,384	28
ZrO_2	8,580	172
Triton X-100	37	1
TOTAL PM	**10,001**	**200**

Total PM Emissions 200 lb. per year

0.10 tons per year

2017 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No.: NS-K

Emission Source Description: E-2 Process

Process and Emission Description:

The E-2 Process is a batch manufacturing process. All emissions from this process vent to the atmosphere, some via a vertical stack. The control of emissions of certain compounds will be addressed in the attached spreadsheet.

Basis and Assumptions:

Engineering calculations using compositions, volumes and paritial pressures are used to determine amounts vented. See attached information for assumptions made for each vessel.

Information Inputs and Source of Info.:

Information Input	Source of Inputs
E-2 production quantity	E-2 Production Facilitator
Speciated emission rates	Attached calculations

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 which vent as stack (point source) emissions and 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.

2017 Emission Summary

A. VOC Emissions by Compound and Source

Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lb.)	Fugitive Emissions (lb.)	Equipment Emissions (lb.)	Accidental Emissions (lb.)	Total VOC Emissions (lb.)
E1	Propane, 1,1,1,2,2,3,3-heptafluoro-3-(1,2,2,2- tetrafluoroethoxy)-	3330-15-2	412.8	107.6	15	0	535.9
E2	2H-perfluoro(5-methyl-3,6-dioxanonane)	3330-14-1	317.0	82.6	133	0	532.2
E3	2H-perfluoro-5,8-dimethyl-3,6,9-trioxadodecane	3330-16-3	2.7	0.7	6	0	9.6
		TOTAL	**732.6**	**190.9**	**154**	**0**	**1,077.7**
					TOTAL (TON)		**0.54**

Point Source Emission Determination

A. "Freon" E1 **CAS No. 3330-15-2**
Propane, 1,1,1,2,2,3,3-heptafluoro-3-(1,2,2,2- tetrafluoroethoxy)-

HF Potential:

E1 is a VOC without the potential to form HF.

E1 Quantity Generated:

E1 emissions are calculated on a "per batch" basis from Detailed Point Source worksheet

Source	**E1 Emissions**	
Transfer Tank	2.00	lbs E1 vented per batch
Interface Tank	0.41	lbs E1 vented per batch
55 gal. drum	0.76	lbs E1 vented per batch
Total	**3.18**	lbs E1 vented per batch

The quantity (pounds) of E1 vented is based on 130 batches of produced Crude E-fluids

2017 annual E1 emissions vented from the E-Fluids Process are calculated by the following:

$$\frac{3.18 \text{ lb E1}}{\text{batch}} \times 130 \text{ batches} = 412.85 \text{ lb E1}$$

$$= \mathbf{412.8 \text{ lb VOC}}$$

B. "Freon" E2 **CAS No. 3330-14-1**
2H-perfluoro(5-methyl-3,6-dioxanonane)

HF Potential:

E2 is a VOC without the potential to form HF.

E2 Quantity Generated:

E2 emissions are calculated on a "per batch" basis from Detailed Point Source worksheet

Source	E2 Emissions	
Transfer Tank	1.54	lbs E2 vented per batch
Interface Tank	0.32	lbs E2 vented per batch
55 gal. drum	0.58	lbs E2 vented per batch
Total	**2.44**	lbs E2 vented per batch

The quantity (pounds) of E2 vented is based on 130 batches of produced Crude E-fluids

2017 annual E2 emissions vented from the E-Fluids Process are calculated by the following:

$$\frac{2.44 \text{ lb E2}}{\text{batch}} \times 130 \text{ batches} = 317.01 \text{ lb E2}$$

$$= \mathbf{317.0 \text{ lb VOC}}$$

C. "Freon" E3 **CAS No. 3330-16-3**
2H-perfluoro-5,8-dimethyl-3,6,9-trioxadodecane

HF Potential:

E3 is a VOC without the potential to form HF.

E3 Quantity Generated:

E3 Emissions calculated on per batch basis from Detailed Point Soure worksheet

Source	E3 Emissions	
Transfer Tank	0.01	lbs E3 vented per batch
Interface Tank	0.003	lbs E3 vented per batch
55 gal. drum	0.005	lbs E3 vented per batch
Total	**0.02**	lbs E3 vented per batch

The quantity (pounds) of E3 vented is based on 130 batches of produced Crude E-fluids

2017 annual E3 emissions vented from the E-Fluids Process are calculated by the following:

$$\frac{0.02 \text{ lb E3}}{\text{batch}} \quad x \quad 130 \text{ batches} = 2.71 \text{ lb E3}$$

$$= \mathbf{2.7} \textbf{ lb VOC}$$

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

Fugitive Emissions(FE) and 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 calculations below include equipment emissions inside buildings as well as vessel emissions outside (fugitive emissions).

A. Fugitive Emissions from Crude E-fluids tote:

This 180-gallon tote is filled with dry crude E-fluids from the 55 gallon drum. This material then gets transported to the Polymers area for use. This tote can hold several batches of material. This filling activity occurs on the outside of the E2 building. Assume the filling is at 30 degrees Celsius and assume that one batch of E-fluids displaces 33% of the tote, or 60 gallons of volume, during filling. These emissions will be "Fugitive" in nature.

Calculations:

PV = nRT (assumes the Ideal Gas Law)

33% Tote Volume = 60 gallons / 7.48 gal/ft^3 = 8.02 ft^3

Contents of vessel :

Component	MW	Kgs	Moles	Mol %	Vapor Pressure (psia)	Partial Pressure* (psia)
E1	286	22.00	0.08	15.09	14.00	2.11
E2	452	189.20	0.42	82.12	1.25	1.03
E3	618	8.80	0.01	2.79	0.23	0.0064
Total		220.00	0.51	100%		

* Partial Pressure = **Vapor Pressure** multiplied by **Mol%** divided by **100%**

Tank temperature = 30 degrees Celsius is equal to 545.69 degrees R

R = 10.73 psia-ft^3/lb-mol/degR

For E1: n = moles of E1 = (Partial pressure of E1) * (Volume) / (R) / (Temperature)

$$n = \frac{2.11 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{8.02 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.0029 \text{ lb-mol E1}$$

$$0.0029 \text{ lb-mol E1} \times \frac{286 \text{ lb E1}}{\text{lb-mol E1}} = \mathbf{0.83 \text{ lb E1/batch}}$$

For E2: n = moles of E2 = (Partial pressure of E2) * (Volume) / (R) / (Temperature)

$$n = \frac{1.03 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{8.02 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.0014 \text{ lb-mol E2}$$

$$0.0014 \text{ lb-mol E2} \times \frac{452 \text{ lb E2}}{\text{lb-mol E2}} = \mathbf{0.64 \text{ lb E2/batch}}$$

For E3: n = moles of E3 = (Partial pressure of E3) * (Volume) / (R) / (Temperature)

$$n = \frac{0.0064 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{8.02 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.000009 \text{ lb-mol E3}$$

$$0.000009 \text{ lb-mol E3} \times \frac{618 \text{ lb E3}}{\text{lb-mol E3}} = \mathbf{0.005 \text{ lb E3/batch}}$$

Total Fugitive Emissions from E2-Fluids process

Chemical	lb/batch	No. of batches	lbs
E1	0.83	130	107.6
E2	0.64	130	82.6
E3	0.005	130	0.7
Total			**190.9**

B. Equipment Emissions From Valves, Pumps and Flanges

The emission rates for valves, flanges, etc. have been established by the DuPont Company. The emission rates from these types of equipment in the E-fluids process is considered "Excellent" and therefore the following rates are use: valve = (0.00039 lb/hr), flange = (0.00018 lb/hr)

Calculations:

Valve emissions:	134 valves x 0.00039 lb/hr/valve =	0.0523	lb/hr VOC
Flange emissions:	20 flanges x 0.00018 lb/hr/flange =	0.0036	lb/hr VOC
Total equipment emission rate		0.0559	lb/hr VOC

VOC:		0.0559	lb/hr VOC	
	x	2,760	operating hrs/year	8760
	=	154.2	lb/yr VOC	

By Component:

We will assume that equipment emissions are the same composition as the crude E-fluids (I.e. 10% E1, 86% E2, and 4% E3)

Total Equipment Emissions from E-fluids process:

Chemical	Chemical Fraction	Total Equipment Emission Rate (lb/yr)	Total Equipment Emission Rate (lb/yr)
E1	10%	154.2	15.4
E2	86%	154.2	132.6
E3	4%	154.2	6.2
Total			154.2

Where the **Chemical Emission Rate** equals the **Total Equipment Emission Rate** multiplied by the **Chemical Fraction**

Accidental Releases to Atmosphere

A.

Material Released: E1
Quantity Released: 0 lbs
specific gravity =

E1 is a VOC without the potential to form HF.

B. Date:

Material Released: E2
Quantity Released: 0 lbs

E2 is a VOC without the potential to form HF.

C. Date:

Material Released: E3
Quantity Released: 0 lbs

E3 is a VOC without the potential to form HF.

E. Total Emissions from Accidental Releases

Source		lb E1	lb E2	lb E3
A		0.00	0.00	0.00
B		0.00	0.00	0.00
C		0.00	0.00	0.00
D		0.00	0.00	0.00
	Total	**0.00**	**0.00**	**0.00**

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: NS-M

Emission Source Description: TFE/CO2 Separation Process

Process and Emission Description:

The TFE/CO2 separation process is a continuous process. All emissions from this process vent to either the Nafion Division Waste Gas Scrubber (WGS) or the area vent stack. The control of emissions of the TFE compound will be addressed in the attached spreadsheet. TFE will pass completely through the scrubber, therefore the efficiency is assumed to be 0%.

Basis and Assumptions:

A mass balance is used as the basis for the TFE/CO2 area emissions. The TFE/CO2 emissions includes the TFE/CO2 area as well as the Polymers LJC and dryers. The flow of TFE/CO2 into the area is divided by two in order to determine the amount of TFE fed to the system. Then each of the end users (which includes polymers, semi-works, MMF and RSU) determine how much they have consumed and these numbers are subtracted from the total TFE into the system to determine the emissions. Mass flowmeters in each area are used to determine the total input and output flows.

Information Inputs and Source of Inputs:

Information Input	Source of Inputs
TFE/CO2 consumption	Precursor Production Facilitator/IP21
Polymers Consumption	Polymers Production Facilitator/IP21
Semiworks Consumption	Semiworks Production Facilitator/IP21
MMF Consumption	Precursor Production Facilitator/IP21
RSU Consumption	Precursor Production Facilitator/IP21

Point Source Emissions Determination:

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

Equipment Emissions and Fugitive Emissions Determination:

Emissions from equipment leaks which vent as stack (point source) emissions and 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.

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% CO_2):

Source	Quantity
TFE/CO2 fed to area	258,677 kg TFE/CO2
Total	**129,339 kg TFE fed to area**

From area facilitators:

Source	Quantity Consumed
Polymers consumption	77,968 kg TFE
Semiworks consumption	262 kg TFE
MMF consumption	7,644 kg TFE
RSU consumption	20,594 kg TFE
Total	**106,468 kg TFE consumed**

TFE vented from the TFE/CO2 area in the reporting year:

129,339 kg TFE fed
\- 106,468 kg TFE consumed
22,871 kg TFE vented

VOC Emissions

22,871 kg VOC
50,420 lb. VOC

B. Carbon dioxide (CO2) **CAS No. 124-38-9**

<u>CO2 Quantity Generated:</u>

From Precursor area facilitator (mixture is 50% TFE and 50% CO2):

Source	Quantity
TFE/CO2 fed to area	258,677 kg TFE/CO2
Total	**129,339 kg CO2 sent to Separator**

The separator is assumed to remove 99.95% of the CO2. Therefore, the CO2 in the exit stream is

Source	Quantity
CO2 in Product	64.7 kg CO2 exiting separator

Assume all CO2 in exit stream is vented.

CO2 Emissions

64.7 kg CO2
142.6 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 fugative 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 = 287

VOC:		0.005 lb/hr TFE FE
	x	24 hours/day
	x	287 days/year
	=	**33.5 lb/yr VOC from EE**

CO2:		0.005 lb/hr CO2 FE
	x	24 hours/day
	x	287 days/year
	=	**33.5 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 = 287

VOC:		0.0014 lb/hr TFE FE
	x	24 hours/day
	x	287 days/year
	=	**9.9 lb/yr VOC from EE**

CO2:		0.0014 lb/hr CO2 FE
	x	24 hours/day
	x	287 days/year
	=	**9.9 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:	33.5
B. Fugitive Emissions From TFE/CO2 Vaporizer	9.9
Total for 2017	**43.4**

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:	33.5
B. Fugitive Emissions From TFE/CO2 Vaporizer	9.9
Total for 2017	**43.4**

2017 Emission Summary

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	50,420	43	1,153	51,617
			Total VOC Emissions (lb)			**51,617**
			Total VOC Emissions (tons)			**25.81**

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	142.6	43.4	1153	1,339
			Total Emissions (lb)			**1,339**
			Total Emissions (tons)			**0.67**

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.

Volumes of the containers currently in use are as follows:

Container	Volume (L)	Reference
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 2017

Container Type	Quantity of Containers	VOC per container (lb)	VOC Emissions (lb)
ISO Container	7	1,413	9,891
UNT Cylinder	1	83	83
1-Ton cylinder	6	63	379
3AA Cylinder	15	4	62
Total VOC Emission for All Containers			**10,415**

Additional 2 full cylinders, 372 lb each, were vented to WGS in February 2017

2 X 372 lb. = **744 lb.**

TOTAL EMISSIONS

	VOC (lb.)
Container Decontamination	**10,415**
Additional Containers	**744**
TOTAL EMISSIONS	**11,159**

Total Containers Decontaminated	**29**

2017 Annual VOC Emissions Summary

HFPO Product Container Decontamination Process

Nafion® Compound	CAS Chemical Name	CAS No.	VOC Emissions (lbs)
HFPO	Hexafluoroproplyene oxide	428-59-1	11,159
		Total VOC Emissions (lb)	11,159
		Total VOC Emissions (tons)	5.58

Reported By: Amy Martin
Date: 6/21/2018

Emission Source ID Number: NS-O

Emission Source Description: Vinyl Ethers North (VEN) Product Container Decontamination Process

Container Emissions Estimation Basis:

PPVE, PSPEVE, and EVE are the products that are shipped to customers in ISO tank containers, UNT cylinders, 1-ton cylinders, 4BW cylinders, and 4BA/3AA cylinders from the Vinyl Ethers North ("VEN") Manufacturing Process. Usually only PPVE is shipped in 1-ton cylinders from the VEN area.
Empty containers returned to the site may be decontaminated by pressurizing with nitrogren and venting to the FPS Division Waste Gas Scrubber (Control Device ID No. NCD-Hdr) for numerous cycles. This scrubber has a documented control efficiency of 99.1% for all acid fluoride compounds. Some returned containers are filled on top of heels in cylinders without the need to decontaminate.
To determine the amount emitted from this process, the vapor density of each component is used along with the volume of the container.

The vapor densities are estimated using the ideal gas law equation.

It is assumed the temperature of the container systems is 77°F (25°C). It is also assumed that when the containers are emptied they remain full of vapors.

To calculate the amount of product vented per container, the container volume is multiplied by the vapor density.

Product	Vapor Density (lb/gal @ 25°C)
PPVE	0.0908
PSEPVE	0.1522
EVE	0.1440

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}").

$$M_{vap} = V \times \rho_{vap}$$

Volumes of the containers currently in use are as follows:

Container	Volume (gal)
ISO tank	4,491
UNT cylinder	264
1-ton cylinder	201
4BW cylinder	119
4BA/3AA cylinder	13

Estimated VOC emissions per container:

					Before-Control VOC	After-Control VOC
PPVE						
1-ton cylinder	201 gal	X	0.0908 lb/gal	=	18.23 lb.	18.23 lb.
4BW cylinder	119 gal	X	0.0908 lb/gal	=	10.79 lb.	10.79 lb.
4BA/3AA cylinder	13 gal	X	0.0908 lb/gal	=	1.20 lb.	1.20 lb.
PSEPVE						
1-ton cylinder	201 gal	X	0.1522 lb/gal	=	30.56 lb.	30.56 lb.
4BW cylinder	119 gal	X	0.1522 lb/gal	=	18.09 lb.	18.09 lb.
4BA/3AA cylinder	13 gal	X	0.1522 lb/gal	=	2.01 lb.	2.01 lb.
EVE						
1-ton cylinder	201 gal	X	0.1440 lb/gal	=	28.92 lb.	28.92 lb.
4BW cylinder	119 gal	X	0.1440 lb/gal	=	17.12 lb.	17.12 lb.
4BA/3AA cylinder	13 gal	X	0.1440 lb/gal	=	1.90 lb.	1.90 lb.

VOC Emission Calculation:

PPVE	Number of Containers		VOC per container		VOC Emissions
1-ton cylinder	31	X	18.23 lb.	=	565.0 lb.
4BW cylinder	7	X	10.79 lb.	=	75.5 lb.
4BA/3AA cylinder	0	X	1.20 lb.	=	0.0 lb.
					640.5 lb.
PSEPVE					
1-ton cylinder	0	X	30.56 lb.	=	0.0 lb.
4BW cylinder	0	X	18.09 lb.	=	0.0 lb.
4BA/3AA cylinder	0	X	2.01 lb.	=	0.0 lb.
					0.0 lb.
EVE					
1-ton cylinder	0	X	28.92 lb.	=	0.0 lb.
4BW cylinder	0	X	17.12 lb.	=	0.0 lb.
4BA/3AA cylinder	5	X	1.90 lb.	=	9.5 lb.
					9.5 lb.
			Total VOC Emissions		**650.1 lb.**

Reporting Year 2017

VE North (NS-O) VOC Container Emission Summary:

Compound	**CAS Chemical Name**	**CAS No.**	**VOC Emissions (lb.)**	**VOC Emissions (tons)**
PPVE	Perfluoropropyl Vinyl Ether	1623-05-8	640.55	0.32
PSEPVE	Perfluoro(4-methyl-3,6-dioxaoct-7-ene) sulfonyl fluoride	16090-14-5	0.00	0.00
EVE	3-[1-[difluoro[(1,2,2-trifluoro-ethenyl)oxy]methyl]-1,2,2,2-tetra-fluoroethoxy]-2,2,3,3-tetrafluoro-, methyl ester propanoic acid	63863-43-4	9.51	0.00
			650	**0.33**

Emission Source ID Number: NS-P

Emission Source Description: Vinyl Ethers South (VES) Product Container Decontamination Process

Container Emissions Estimation Basis:

PMVE, PEVE, and PPVE are the products that are shipped to off-site customers in 1-ton cylinders, 4BW cylinders, 4BA/3AA cylinders and ISO tank containers from the Vinyl Ethers South ("VES") Manufacturing Process. HFPO Dimer Acid Fluoride ("DAF") is loaded into ISO tank containers at the VES area for transporation to the PPA Process. If needed, the containers are decontaminated by pressurizing with nitrogren, venting to the VES Waste Gas Scrubber (WGS), and evacuating for numerous cycles.

To determine the amount emitted from this process, the vapor density of each component is used along with the volume of the container. DAF is determined separately.

The vapor densities are estimated using the ideal gas law equation.

It is assumed the temperature of the container systems is 77°F (25°C). It is also assumed that when the containers are emptied they remain full of vapors.

To calculate the amount of product vented per container, the container volume is multiplied by the vapor density.

Product	Vapor Density (lb/gal @ 10°C)
PMVE	0.0566
PEVE	0.0737
PPVE	0.0908

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 ("r_{vap}").

$$M_{vap} = V \times r_{vap}$$

Volumes of the containers currently in use are as follows:

Container	Volume (gal)
ISO tank	4,491
1-ton cylinder	201
4BW cylinder	119
4BA/3AA cylinder	13

HFPO Dimer Acid Fluoride

BASIS:

HFPO Dimer Acid Fluoride ("DAF") is pneumatically unloaded from an ISO Tank Container

Emissions are estimated using Raoult's Law and the initial pressure of the nitrogen-filled ISO

DAF ISO Container Pressure = 5 psig = 34.5 kPa gauge = 135.80 kPa absolute

Vapor Pressure of DAF 29 mmHg at 25 deg C = 3.80 kPa absolute at 298 deg K

Headspace Concentration: $\frac{3.80 \text{ kPa}}{135.80 \text{ kPa}} = \frac{0.0280 \text{ mole DAF}}{\text{mole headspace gas}} = \frac{0.0280 \text{ L DAF}}{\text{L headspace gas}}$

$$\frac{0.0280 \text{ mole DAF}}{\text{L headspace gas}} \left| \frac{\text{mole DAF}}{22.414 \text{ L DAF}} \right| \frac{332.4 \text{ g DAF}}{\text{mole DAF}} \left| \frac{\text{lb.}}{453.6 \text{ g}} \right| \frac{273\ °\text{K}}{298\ °\text{K}} = \frac{0.000838 \text{ lb. DAI}}{\text{L headspace gas}}$$

ISO Tank Container Capacit = 14,560 L (source: Eurotainer Initial Inspection Certificate)

$$\frac{14{,}560 \text{ L}}{\text{Container}} \times \frac{0.000838 \text{ lb. DAF}}{\text{L headspace gas}} = \frac{12.2 \text{ lb. DAF}}{\text{Container}}$$

HFPO DAF ISO Containers Decontaminated = 1

$$1 \text{ container} \times \frac{12.2 \text{ lb. DAF}}{\text{Container}} = 12.2 \text{ lb. DAF before control}$$

The mass of liquid in the ISO Tank Container was determined to be 219 lb. from the weigh

Total Before Control Emission = 12.2 + 219 = 231.2 lb. DAF

VES Waste Gas Scrubber Control Efficiency **99.8%**

231.2 lb. DAF before control × (100% - 99.8%) = 0.46 lb. DAF after control
0.46 lb. VOC after control

HF Equivalence: 0.46 lb-DAF x 0.060 lb-HF / lb-DAF = 0.0279 lb-HF

Estimated VOC emissions per container:

PMVE					**VOC per Container**
ISO tank	4,491 gal	X	0.0566 lb/gal	=	254.4 lb
1-ton cylinder	201 gal	X	0.0566 lb/gal	=	11.4 lb
4BW cylinder	119 gal	X	0.0566 lb/gal	=	6.7 lb
4BA/3AA cylinder	13 gal	X	0.0566 lb/gal	=	0.7 lb
PEVE					
1-ton cylinder	201 gal	X	0.0737 lb/gal	=	14.8 lb
4BW cylinder	119 gal	X	0.0737 lb/gal	=	8.8 lb
4BA/3AA cylinder	13 gal	X	0.0737 lb/gal	=	1.0 lb
PPVE					
1-ton cylinder	201 gal	X	0.0908 lb/gal	=	18.2 lb
4BW cylinder	119 gal	X	0.0908 lb/gal	=	10.8 lb
4BA/3AA cylinder	13 gal	X	0.0908 lb/gal	=	1.2 lb

VOC Emission Calculation:

PMVE	**Number of Containers**		**VOC per container**		**VOC Emissions**
ISO tank	2	X	254.4 lb	=	508.844 lb
1-ton cylinder	29	X	11.4 lb	=	329.850 lb
4BW cylinder	0	X	6.7 lb	=	0.0 lb
4BA/3AA cylinder	0	X	0.7 lb	=	0.0 lb
					838.7 lb
PEVE					
1-ton cylinder	1	X	14.8 lb	=	14.8 lb
4BW cylinder	2	X	8.8 lb	=	17.5 lb
4BA/3AA cylinder	0	X	1.0 lb	=	0.0 lb
					32.3 lb
PPVE					
1-ton cylinder	0	X	18.2 lb	=	0.0 lb
4BW cylinder	0	X	10.8 lb	=	0.0 lb
4BA/3AA cylinder	0	X	1.2 lb	=	0.0 lb
					0.0 lb
HFPO DAF	1		(see above estimation)	=	**0.46 lb**
			Total VOC Emissions		**871.5 lb**

Reporting Year 2017

VE South (NS-P) VOC Container Emission Summary:

Compound	**CAS Chemical Name**	**CAS No.**	**VOC Emissions (lb.)**
PMVE	Perfluoromethyl vinyl ether	1187-93-5	838.7
PEVE	Perfluoroethyl vinyl ether	10493-43-3	32.3
PPVE	Perfluoropropyl vinyl ether	1623-05-8	0.0
HFPO Dimer Acid Fluoride	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	0.5
		TOTAL VOC (lb.)	**871.5**
		TOTAL VOC (ton)	**0.436**

PMVE	**CAS Chemical Name**	**CAS No.**	**Total Emissions (lb.)**
HF	Hydrogen Fluoride	7664-39-3	0.0279

NATURAL GAS COMBUSTION EMISSIONS CALCULATOR REVISION M 06/22/2015 - OUTPUT SCREEN

NCDENR

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.

SOURCE / FACILITY / USER INPUT SUMMARY (FROM INPUT SCREEN)

COMPANY:	**Chemours Company - Fayetteville Works**			FACILITY ID NO.:	0900009
				PERMIT NUMBER:	03735T43
EMISSION SOURCE DESCRIPTION:	139.4 MMBTU/HR NATURAL GAS-FIRED BOILER			FACILITY CITY:	Fayetteville
EMISSION SOURCE ID NO.:	PS-A			FACILITY COUNTY:	Bladen
CONTROL DEVICE:	NO CONTROL			POLLUTANT	CONTROL EFF.
SPREADSHEET PREPARED BY:	Michael E. Johnson			NOX	CALC'D AS 0%
ACTUAL FUEL THROUGHPUT:	626.40	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)	NO SNCR APPLIED	
REQUESTED MAX. FUEL THRPT:	1,197.20	10^6 SCF/YR	HOURS OF OPERATIONS: 24		

CRITERIA AIR POLLUTANT EMISSIONS INFORMATION

AIR POLLUTANT EMITTED	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) tons/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) tons/yr	POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS) tons/yr	EMISSION FACTOR lb/mmBtu uncontrolled	EMISSION FACTOR lb/mmBtu controlled
PARTICULATE MATTER (Total)	1.04	2.38	1.04	4.55	1.04	4.55	0.007	0.007
PARTICULATE MATTER (Condensable)	0.78	1.79	0.78	3.41	0.78	3.41	0.006	0.006
PARTICULATE MATTER (Filterable)	0.26	0.60	0.26	1.14	0.26	1.14	0.002	0.002
SULFUR DIOXIDE (SO2)	0.08	0.19	0.08	0.36	0.08	0.36	0.001	0.001
NITROGEN OXIDES (NOx)	25.97	59.51	25.97	113.73	25.97	113.73	0.186	0.186
CARBON MONOXIDE (CO)	11.48	26.31	11.48	50.28	11.48	50.28	0.082	0.082
VOLATILE ORGANIC COMPOUNDS (VOC)	0.75	1.72	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 (AFTER CONTROLS / LIMITS) lb/hr	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) lbs/yr	POTENTIAL EMSSIONS (BEFORE CONTROLS / LIMITS) lb/hr	POTENTIAL EMSSIONS (BEFORE CONTROLS / LIMITS) lbs/yr	POTENTIAL EMSSIONS (AFTER CONTROLS / LIMITS) lb/hr	POTENTIAL EMSSIONS (AFTER CONTROLS / LIMITS) lbs/yr	EMISSION FACTOR lb/mmBtu uncontrolled	EMISSION FACTOR lb/mmBtu 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	2.00E+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	1.25E-01	2.73E-05	2.39E-01	2.73E-05	2.39E-01	1.96E-07	1.96E-07
Benzene (TH)	71432	2.87E-04	1.32E+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	7.52E-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	7.52E-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	6.89E-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	8.77E-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	5.26E-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	4.70E+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	1.13E+03	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	3.13E-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	2.38E-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	1.63E-01	3.55E-05	3.11E-01	3.55E-05	3.11E-01	2.55E-07	2.55E-07
Napthalene (H)	91203	8.34E-05	3.82E-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	1.32E+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	1.50E-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	2.13E+00	4.65E-04	4.07E+00	4.65E-04	4.07E+00	3.33E-06	3.33E-06
Total HAPs		2.58E-01	1.18E+03	2.58E-01	2.26E+03	2.58E-01	2.26E+03	1.85E-03	1.85E-03
Highest HAP	Hexane	2.46E-01	1.13E+03	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)

TOXIC AIR POLLUTANT	CAS Num.	EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS lb/hr	lb/day	lb/yr	EMISSION FACTOR lb/mmBtu uncontrolled	EMISSION FACTOR lb/mmBtu 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	2.00E+03	3.14E-03	3.14E-03
Arsenic unlisted compounds (TH)	ASC-other	2.73E-05	6.56E-04	1.25E-01	1.96E-07	1.96E-07
Benzene (TH)	71432	2.87E-04	6.89E-03	1.32E+00	2.06E-06	2.06E-06
Benzo(a)pyrene (TH)	50328	1.64E-07	3.94E-06	7.52E-04	1.18E-09	1.18E-09
Beryllium metal (unreacted) (TH)	7440417	1.64E-06	3.94E-05	7.52E-03	1.18E-08	1.18E-08
Cadmium metal (elemental unreacted) (TH)	7440439	1.50E-04	3.61E-03	6.89E-01	1.08E-06	1.08E-06
Soluble chromate compounds, as chromium (VI) equivalent	SolCR6	1.91E-04	4.59E-03	8.77E-01	1.37E-06	1.37E-06
Formaldehyde (TH)	50000	1.03E-02	2.46E-01	4.70E+01	7.35E-05	7.35E-05
Hexane, n- (TH)	110543	2.46E-01	5.90E+00	1.13E+03	1.76E-03	1.76E-03
Manganese unlisted compounds (TH)	MNC-other	5.19E-05	1.25E-03	2.38E-01	3.73E-07	3.73E-07
Mercury vapor (TH)	7439976	3.55E-05	8.53E-04	1.63E-01	2.55E-07	2.55E-07
Nickel metal (TH)	7440020	2.87E-04	6.89E-03	1.32E+00	2.06E-06	2.06E-06
Toluene (TH)	108883	4.65E-04	1.12E-02	2.13E+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, EPA MRR CALCULATION METHOD: TIER 1 metric tons/yr	metric tons/yr, CO2e	short tons/yr	POTENTIAL EMISSIONS short tons/yr	short tons/yr, CO2e
CARBON DIOXIDE (CO_2)	34141.59	34,141.59	37,634.61	71,369.12	71369.12
METHANE (CH_4)	6.44E-01	1.61E+01	7.10E-01	1.35E+00	3.37E+01
NITROUS OXIDE (N_2O)	6.44E-02	1.92E+01	7.10E-02	1.35E-01	4.01E+01
		TOTAL CO2e (metric tons) 34,176.87		TOTAL CO2e (short tons)	71,442.89

NOTE: CO2e means CO2 equivalent

NOTE: The DAQ Air Emissions Reporting Online (AERO) system requires short tons be reported. The EPA MRR requires metric tons be reported.

NOTE: Do not use greenhouse gas emission estimates from this spreadsheet for PSD (Prevention of Significant Deterioration) purposes.

NATURAL GAS COMBUSTION EMISSIONS CALCULATOR REVISION M 06/22/2015 - OUTPUT SCREEN

NCDENR

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.

SOURCE / FACILITY / USER INPUT SUMMARY (FROM INPUT SCREEN)

COMPANY:	**The Chemours Company FC, LLC**	FACILITY ID NO.:	0900009
		PERMIT NUMBER:	03735T43
EMISSION SOURCE DESCRIPTION:	88.4 MMBTU/HR NATURAL GAS-FIRED BOILER	FACILITY CITY:	Fayetteville
EMISSION SOURCE ID NO.:	PS-B	FACILITY COUNTY:	Bladen
CONTROL DEVICE:	NO CONTROL	POLLUTANT	CONTROL EFF.
SPREADSHEET PREPARED BY:	Michael E. Johnson	NOX	CALC'D AS 0%
ACTUAL FUEL THROUGHPUT:	31.34 10^6 SCF/YR	FUEL HEAT VALUE: 1,020 BTU/SCF	
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

	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS)		POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS)		POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS)		EMISSION FACTOR lb/mmBtu	
AIR POLLUTANT EMITTED	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	uncontrolled	controlled
PARTICULATE MATTER (Total)	0.66	0.12	0.66	2.88	0.66	2.88	0.007	0.007
PARTICULATE MATTER (Condensable)	0.49	0.09	0.49	2.16	0.49	2.16	0.006	0.006
PARTICULATE MATTER (Filterable)	0.16	0.03	0.16	0.72	0.16	0.72	0.002	0.002
SULFUR DIOXIDE (SO2)	0.05	0.01	0.05	0.23	0.05	0.23	0.001	0.001
NITROGEN OXIDES (NOx)	8.67	1.57	8.67	37.96	8.67	37.96	0.098	0.098
CARBON MONOXIDE (CO)	7.28	1.32	7.28	31.89	7.28	31.89	0.082	0.082
VOLATILE ORGANIC COMPOUNDS (VOC)	0.48	0.09	0.48	2.09	0.48	2.09	0.005	0.005

TOXIC / HAZARDOUS AIR POLLUTANT EMISSIONS INFORMATION

		ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS)		POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS)		POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS)		EMISSION FACTOR lb/mmBtu	
TOXIC / HAZARDOUS AIR POLLUTANT	CAS NUMBER	lb/hr	lbs/yr	lb/hr	lbs/yr	lb/hr	lbs/yr	uncontrolled	controlled
Acetaldehyde (TH)	75070	1.32E-06	4.76E-04	1.32E-06	1.15E-02	1.32E-06	1.15E-02	1.49E-08	1.49E-08
Acrolein (TH)	107028	1.56E-06	5.64E-04	1.56E-06	1.37E-02	1.56E-06	1.37E-02	1.76E-08	1.76E-08
Ammonia (T)	7664417	2.77E-01	1.00E+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	6.27E-03	1.73E-05	1.52E-01	1.73E-05	1.52E-01	1.96E-07	1.96E-07
Benzene (TH)	71432	1.82E-04	6.58E-02	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	3.76E-05	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	3.76E-04	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	3.45E-02	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	4.39E-02	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	2.63E-03	7.28E-06	6.38E-02	7.28E-06	6.38E-02	8.24E-08	8.24E-08
Formaldehyde (TH)	50000	6.50E-03	2.35E+00	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	5.64E+01	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	1.57E-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	1.19E-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	8.15E-03	2.25E-05	1.97E-01	2.25E-05	1.97E-01	2.55E-07	2.55E-07
Napthalene (H)	91203	5.29E-05	1.91E-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	6.58E-02	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	7.52E-04	2.08E-06	1.82E-02	2.08E-06	1.82E-02	2.35E-08	2.35E-08
Toluene (TH)	108883	2.95E-04	1.07E-01	2.95E-04	2.58E+00	2.95E-04	2.58E+00	3.33E-06	3.33E-06
Total HAPs		1.64E-01	5.91E+01	1.64E-01	1.43E+03	1.64E-01	1.43E+03	1.85E-03	1.85E-03
Highest HAP	Hexane	1.56E-01	5.64E+01	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 lb/mmBtu	
TOXIC AIR POLLUTANT	CAS Num.	lb/hr	lb/day	lb/yr	uncontrolled	controlled
Acetaldehyde (TH)	75070	1.32E-06	3.16E-05	4.76E-04	1.49E-08	1.49E-08
Acrolein (TH)	107028	1.56E-06	3.74E-05	5.64E-04	1.76E-08	1.76E-08
Ammonia (T)	7664417	2.77E-01	6.66E+00	1.00E+02	3.14E-03	3.14E-03
Arsenic unlisted compounds (TH)	ASC-other	1.73E-05	4.16E-04	6.27E-03	1.96E-07	1.96E-07
Benzene (TH)	71432	1.82E-04	4.37E-03	6.58E-02	2.06E-06	2.06E-06
Benzo(a)pyrene (TH)	50328	1.04E-07	2.50E-06	3.76E-05	1.18E-09	1.18E-09
Beryllium metal (unreacted) (TH)	7440417	1.04E-06	2.50E-05	3.76E-04	1.18E-08	1.18E-08
Cadmium metal (elemental unreacted) (TH)	7440439	9.53E-05	2.29E-03	3.45E-02	1.08E-06	1.08E-06
Soluble chromate compounds, as chromium (VI) equivalent	SolCR6	1.21E-04	2.91E-03	4.39E-02	1.37E-06	1.37E-06
Formaldehyde (TH)	50000	6.50E-03	1.56E-01	2.35E+00	7.35E-05	7.35E-05
Hexane, n- (TH)	110543	1.56E-01	3.74E+00	5.64E+01	1.76E-03	1.76E-03
Manganese unlisted compounds (TH)	MNC-other	3.29E-05	7.90E-04	1.19E-02	3.73E-07	3.73E-07
Mercury vapor (TH)	7439976	2.25E-05	5.41E-04	8.15E-03	2.55E-07	2.55E-07
Nickel metal (TH)	7440020	1.82E-04	4.37E-03	6.58E-02	2.06E-06	2.06E-06
Toluene (TH)	108883	2.95E-04	7.07E-03	1.07E-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 — EPA MRR CALCULATION METHOD: TIER 1			POTENTIAL EMISSIONS	
	metric tons/yr	metric tons/yr, CO2e	short tons/yr	short tons/yr	short tons/yr, CO2e
CARBON DIOXIDE (CO_2)	1708.28	1,708.28	1,883.05	45,258.47	45258.47
METHANE (CH_4)	3.22E-02	8.05E-01	3.55E-02	8.54E-01	2.13E+01
NITROUS OXIDE (N_2O)	3.22E-03	9.60E-01	3.55E-03	8.54E-02	2.54E+01
		TOTAL CO2e (metric tons): 1,710.04			TOTAL CO2e (short tons): 45,305.25

NOTE: CO2e means CO2 equivalent
NOTE: The DAQ Air Emissions Reporting Online (AERO) system requires short tons be reported. The EPA MRR requires metric tons be reported.
NOTE: 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

NCDENR

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.

SOURCE / FACILITY / USER INPUT SUMMARY (FROM INPUT SCREEN)

COMPANY:	**Chemours Company - Fayetteville Works**	MAX HEAT INPUT:	88.40	MMBTU/HR
FACILITY ID NO.:	0900009	FUEL HEAT VALUE:	140,000	BTU/GAL
PERMIT NUMBER:	03735T43	HHV for GHG CALCULATIONS:	0.138	mm BTU/GAL
FACILITY CITY:	Fayetteville	ACTUAL ANNUAL FUEL USAGE:	129	GAL/YR
FACILITY COUNTY:	Bladen	MAXIMUM ANNUAL FUEL USAGE:	5,531,314	GAL/YR
USER NAME:	Michael E. Johnson	MAXIMUM SULFUR CONTENT:	0.0	%
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:	0.0015	%

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) lb/hr	ACTUAL tons/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	(BEFORE) tons/yr	POTENTIAL (AFTER CONTROLS / LIMITS) lb/hr	(AFTER) tons/yr	EMISSION FACTOR (lb/10^3 gal) uncontrolled	controlled
TOTAL PARTICULATE MATTER (PM) (FPM+CPM)	2.08	0.00	2.08	9.13	2.08	9.13	3.30E+00	3.30E+00
FILTERABLE PM (FPM)	1.26	0.00	1.26	5.53	1.26	5.53	2.00E+00	2.00E+00
CONDENSABLE PM (CPM)	0.82	0.00	0.82	3.60	0.82	3.60	1.30E+00	1.30E+00
FILTERABLE PM<10 MICRONS (PM_{10})	0.63	0.00	0.63	2.77	0.63	2.77	1.00E+00	1.00E+00
FILTERABLE PM<2.5 MICRONS ($PM_{2.5}$)	0.16	0.00	0.16	0.69	0.16	0.69	2.50E-01	2.50E-01
SULFUR DIOXIDE (SO_2)	0.13	0.00	0.13	0.59	0.13	0.59	2.13E-01	2.13E-01
NITROGEN OXIDES (NO_x)	12.63	0.00	12.63	55.31	12.63	55.31	2.00E+01	2.00E+01
CARBON MONOXIDE (CO)	3.16	0.00	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) lb/hr	ACTUAL lb/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	(BEFORE) lb/yr	POTENTIAL (AFTER CONTROLS / LIMITS) lb/hr	(AFTER) lb/yr	EMISSION FACTOR (lb/10^3 gal) 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	7.2E-05	3.5E-04	3.1E+00	3.5E-04	3.1E+00	5.60E-04	5.60E-04
Benzene	(TH)	71432	1.7E-03	3.5E-04	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	5.4E-05	2.7E-04	2.3E+00	2.7E-04	2.3E+00	4.20E-04	4.20E-04
Cadium Metal (elemental unreacted)	(TH)	7440439	2.7E-04	5.4E-05	2.7E-04	2.3E+00	2.7E-04	2.3E+00	4.20E-04	4.20E-04
Chromic Acid (VI)	(TH)	7738945	2.7E-04	5.4E-05	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	1.1E-04	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	4.8E-03	2.4E-02	2.1E+02	2.4E-02	2.1E+02	3.73E-02	3.73E-02
Formaldehyde	(TH)	50000	3.0E-02	6.2E-03	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	1.6E-04	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	1.1E-04	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	5.4E-05	2.7E-04	2.3E+00	2.7E-04	2.3E+00	4.20E-04	4.20E-04
Methyl chloroform	(TH)	71556	1.5E-04	3.0E-05	1.5E-04	1.3E+00	1.5E-04	1.3E+00	2.36E-04	2.36E-04
Napthalene	(H)	91203	2.1E-04	4.3E-05	2.1E-04	1.8E+00	2.1E-04	1.8E+00	3.33E-04	3.33E-04
Nickle Metal	(TH)	7440020	2.7E-04	5.4E-05	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	4.3E-04	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	2.7E-04	1.3E-03	1.2E+01	1.3E-03	1.2E+01	2.10E-03	2.10E-03
Toluene	(TH)	108883	5.0E-02	1.0E-02	5.0E-02	4.4E+02	5.0E-02	4.4E+02	7.97E-02	7.97E-02
Xylene	(TH)	1330207	8.8E-04	1.8E-04	8.8E-04	7.7E+00	8.8E-04	7.7E+00	1.40E-03	1.40E-03
Total HAP	(H)		9.1E-02	1.8E-02	9.1E-02	7.9E+02	9.1E-02	7.9E+02	1.4E-01	1.4E-01
Largest HAP	(H)		5.03E-02	1.03E-02	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)

TOXIC AIR POLLUTANT		CAS Num.	EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS lb/hr	lb/day	lb/yr	EMISSION FACTOR (lb/10^3 gal) 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
Cadium 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)	71556	1.49E-04	3.58E-03	1.31E+00	2.36E-04	2.36E-04
Nickle 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

Distillate Fuel Oil No. 2	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	
GREENHOUSE GAS POLLUTANT	EPA MRR CALCULATION METHOD: TIER 1						
	metric tons/yr	metric tons/yr, **CO2e**	short tons/yr	short tons/yr	short tons/yr, **CO2e**	short tons/yr	short tons/yr, **CO2e**
CARBON DIOXIDE (CO_2)	1.32	1.32	1.45	63,133.09	63,133.09	63,133.09	63,133.09
METHANE (CH_4)	5.34E-05	1.12E-03	5.89E-05	2.56E+00	5.38E+01	2.56E+00	5.38E+01
NITROUS OXIDE (N_2O)	1.07E-05	3.31E-03	1.18E-05	5.12E-01	1.59E+02	5.12E-01	1.59E+02
	TOTAL	**1.32**		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:

129 gallons of No. 2 fuel oil were burned in 2017

$$129 \text{ gal. No. 2 F.O.} \times \frac{0.140 \text{ MM-BTU}}{\text{gal. No. 2 F.O.}} = 1.81\text{E}{+}01 \text{ MM-BTU}$$

$$1.81\text{E}{+}01 \text{ MM-BTU} \times \frac{7.1\text{E-}05 \text{ lb HCl}}{\text{MM-BTU}} = \mathbf{0.00 \text{ lb HCl}}$$

31.342 MM-scf of Natural Gas were burned in 2017

$$31.342 \text{ MM-scf Natural Gas} \times \frac{1{,}028 \text{ BTU}}{\text{scf Natural Gas}} = 32{,}220 \text{ MM-BTU}$$

$$32{,}220 \text{ MM-BTU} \times \frac{1.2\text{E-}05 \text{ lb HCl}}{\text{MM-BTU}} = \mathbf{0.4 \text{ lb HCl}}$$

Total HCl emissions:

0.0 lb HCl from No. 2 F.O.
\+ 0.4 lb HCl from Natural Gas
0.4 lb. HCl emissions

Annual Air Emissions Inventory Report - Semiworks 1

HFPO Dimer Acid
2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoic acid
CAS No.: 13252-13-6

BASIS:

During 2018, source testing was performed at the Semi-works stack during a dimer acid peroxide (DP) synthesis campaign for the HFPO Dimer anion. The stack testing conducted on March 23, 2018 showed an average emission rate of 0.00155 lb/hr of HFPO-DA.

The source of the emissions measured in the stack exhaust would be a combination of process vents and indoor equipment leaks. As there is no outdoor equipment associated with the Semiworks operation, the stack emissions represent the total emissions of HFPO Dimer Acid from that process.

For the purpose of this report, it will be assumed the emitted form of the HFPO Dimer anion is as the HFPO Dimer Acid.

ESTIMATION OF HFPO DIMER ACID EMISSIONS

0.00155	lb/hr HFPO Dimer anion
329.04	molecular weight of HFPO Dimer anion
330.05	molecular weight of HFPO Dimer Acid
0.00155	lb/hr HFPO Dimer Acid
345	hours of producing the Dimer Acid Peroxide
0.5	lb. HFPO Dimer Acid emissions for reporting year

Emission Summary

VOC Emissions by Compound

Semiworks Compound	CAS Chemical Name	CAS No.	Total Emissions (lb)
TFE	Tetrafluoroethylene	116-14-3	73.7
PSEPVE	Perfluoro-2-(2-fluorosulfonylethoxy) propyl vinyl ether	16090-14-5	112.3
E2	2H-perfluoro(5-methyl-3,6-dioxanonane)	3330-14-1	203.9
PAF	Perfluoroacetyl fluoride	354-34-7	14.4
HFPO Dimer Acid	2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) propanoic acid	13252-13-6	0.5
Initiator	Peroxide, bis[2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-1-oxopropyl]	56347-79-6	7.6
		TOTAL VOC (lb)	**412.3**
		TOTAL VOC (Tons)	**0.21**

Toxic Air Polluntant Summary

Semiworks Compound	CAS Chemical Name	CAS No.	Total Emissions (lb)
HF NOTE 1	Hydrogen Fluoride	7664-39-3	2.5
Fluorides NOTE 2	Fluorides (sum of all fluoride compounds)	16984-48-8	2.5
F-113	1,1,2-trichloro-1,2,2-trifluoro ethane	76-13-1	796.5

NOTE 1 The reported HF emission is the sum of the stochiometric equivilency of PAF and HFPO Dimer Acid Fluoride conversion to HF (see below)

NOTE 2 NC-DAQ requires that HF be also reported as "Fluorides"

Estimate of HF Equivalent of Acid Fluoride Emissions

	MW	lb.
HFPO Dimer Acid	330.05	0.54
HFPO Dimer Acid Fluoride	332.04	0.54

HF (MW)	20.01

Acid Fluoride (AF)	MW_{AF}	AF (lb)	MW_{HF}	MW_{HF} / MW_{AF}	HF (lb)
PAF	116.01	14.4	20.01	0.17245	2.5
HFPO DAF	332.04	0.5	20.01	0.06025	0.0
				TOTAL HF	**2.5**

SEMIWORKS SUMMARY

Campaign Starts: **6/9/2017**
Campaign Ends: **6/14/2017**
Month **6**

SW-1		17-SXF-1.0					**Total**
VOC's	**lb.**	411.8					**411.80**
F-113	**lb.**	796.5					**796.47**
TFE	**lb.**	73.7					**73.7**
PSEPVE	**lb.**	112.3					**112.3**
E2	**lb.**	203.9					**203.9**
Inititiator	**lb.**	7.6					**7.6**
PAF	**lb.**	14.4					**14.4**
AF's	**lb.**	14.4					**14.44**
HCl	**lb.**	0					**0.00**
~~SW-2~~							
~~VOC's~~	**~~lbs~~**	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	**~~0~~**
~~F-113~~	~~lbs~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	**~~0~~**
~~AF's~~	~~lbs~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	**~~0~~**

Production:	kg	Polymer	327.40
	kg	DP	1813
		Total Productioi	**2140.40**

Hours of producing the Dimer Acid Peroxide 345

General explanation:

Semi-works is a research & development area that operates under a wide range of conditions. Emissions are calculated for each individual campaign. In all cases, material balances are used to determine emissions. Since all emissions occur within the semi-works facility, they are all assumed to be point source emissions via the process stack SW-1. The only emissions calculated for SW-2 are acid fluoride emissions associated with running melt flow samples under the lab hood.

Polymerization Campaign Emissions Determination:
The production and raw material information is entered for each campaign on a worksheet. The individual sheets in this workbook are copies of the completed worksheets for each campaign. Data in green fields is entered when applicable for the polymerization campaign. The other cells are calculated cells. The emissions for the campaign are calculated at the bottom of the worksheet. For the annual emissions calculations, the emissions from these campaigns are totaled onto a summary sheet. In this workbook, that is called "Campaign Summary". A summary by month is found on "Year End Summary".

Example Mass Balance Calculations for polymerization campaigns: (using ***5-SXF-1.1*** *worksheet for example)*
The emissions are determined by mass balance around the system. Data used in the calculation is obtained from production records and entered into the worksheet. The following is entered into the worksheet after each campaign:

1) Enter the starting material at the beginning of the campaign. This would include any material in the recovery tank and condensate tank. The composition of the material in each tank is determined by lab analysis and/or on-line GC.
2) Enter the amount of initiator added to the system, based on integrator on initiator feed. The concentration of initiator is determined by lab analysis.
3) Enter the amount of TFE added to the system, based on the integrator for TFE feed.
4) Enter the amounts of solvent (E2, F113) and monomer (PSEPVE) added to the system during the campaign. Drum weights before and after the campaign are used to determine this.

Enter starting and addition data as described in steps 1-4 above in the green shaded areas.
Spreadsheet sums all inputs for each component in right hand column (column M)....see embedded comments for details

Starting Material										
Item	**Recovery Tank**	**Monomer Tank**	**Condensate Tank**	**Initiator Tank**	**Addition (TFE)**	**Addition (E2)**	**Addition (PS)**	**Addition (F113)**		
Weight (Kg):	0.00	0.00	0.00	20.08	114.39	0.00	97.00	666.00	0.00	
Compositions:										
%E2	0.00%		94.00%	96.00%	0.00%	100.00%	0.00%	0.00%	0.00%	
%PSEPVE	8.00%		6.00%			0.00%	100.00%	0.00%	45.00%	
%TFE	0.00%		0.00%		100.00%	0.00%	0.00%	0.00%	0.00%	
%F113	92.00%		0.00%	0.00%		0.00%	0.00%	100.00%	55.00%	
%Inititiato	0.00%		0.00%	4.00%		0.00%	0.00%	0.00%	0.00%	**Totals**
Weights										
E2	0.00	0.00	0.00	19.28	0.00	0.00	0.00	0.00	0.00	**19.3**
PSEPVE	0.00	0.00	0.00	0.00	0.00	0.00	97.00	0.00	0.00	**97.0**
TFE	0.00	0.00	0.00	0.00	114.39	0.00	0.00	0.00	0.00	**114.4**
F113	0.00	0.00	0.00	0.00	0.00	0.00	0.00	666.00	0.00	**666.0**
Inititiator	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	**0.8**

5) Enter the amount and composition of material in the recovery tank, condensate tank, in collection drum, or held up in the system at the end of the campaign.
Spreadsheet sums all inputs for each component in right hand column (column M)....similar to above

Ending Material									
Item	**Recovery Tank**		**Condensate Tank**	**E2 tank**	**Drained to drum**	**Holdup**			
Tank level (jet off)									
Weight (Kg):	200.00		107.00		85.00	0.00	0.00		
Compositions									
%E2	3.89%		4.69%	100.00%	4.69%	72.00%			
%PSEPVE	7.50%		6.92%		6.92%	28.00%			
%TFE	0.00%				0.00%	0.00%			
%F113	87.79%		88.20%		88.20%	0.00%			
%Inititiato	0.00%				0.00%	0.00%			**Totals**
Weights									
E2	7.78	0.00	5.02	0.00	3.99	0.00	0.00		**16.8**
PSEPVE	15.00	0.00	7.40	0.00	5.88	0.00	0.00		**28.3**
TFE	0.00	0.00	0.00	0.00	0.00	0.00	0.00		**0.0**

F113	175.58	0.00	94.37	0.00	74.97	0.00	0.00			344.9
Inititiator	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.0

6) Enter total weight of polymer produced, and average EW.
7) Enter approximate weight (5 kg) of adhesions on vessel walls and in piping. The adhesions are assumed to be pTFE with an EW of 1700.
8) Enter amount and composition of slurry left over at the end of the campaign. The EW is assumed to be 1080 as a result of over saturation of initiator and limited TFE present during shutdown conditions.

Production					
Item	Polymer	Adhesions	Slurry		
Weight (Kg):	138.30	5.00	0.00		
Compositions					
EW	1470	1700	1000		
%Polymer	1	1	0.1		
%E2			0.72		
%PSEPVE			0.28		
%TFE			0		
%F113			0.79011		Totals
Weights					
Polymer	138.30	5.00	0.00		143.3
E2	0.00	0.00	0.00		0.0
PSEPVE	41.96	1.31	0.00		43.3
TFE	96.34	3.69	0.00		100.0
F113	0.00	0.00	0.00		0.0
VE in Poly	41.96	1.31	0.00		

The total for each component added, remaining, and production output as calculated in column M for each section of the spreadsheet above is duplicated in the table below. Emissions are difference between amount consumed and amount in product.

Material Balance Summary							
Compound	Added	Remaining	Used	Production	Other		Totals
E2	19.3	16.8	2.5	0.0			2.5
PSEPVE	97.0	28.3	68.7	43.3			25.4
TFE	114.4	0.0	114.4	100.0			14.4
F113	666.0	344.9	321.1	0.0			321.1
Inititiator	0.8	0.0	0.8	0.0			0.8

The final section of the spreadsheet summarizes the reportable emissions in pounds for SW-1. Refer to embedded comments for details.

Lbs of Emissions	
SW-1	
VOC's	94.8 lbs
F-113	706.4 lbs
AF's	2.766 lbs

9) Enter in the number of melt flow samples processed in the semi-works lab during the campaign. This is entered in the green box under SW-2. If all samples are sent to the mfg lab, this will be zero.

SW-2	
# of MF samples	0
grams emissions	0 g
lbs of emissions	0.0000 lb

Example Mass Balance Calculations for slurry reclaim campaigns:

The slurry reclaim process is used to recover valuable solvent and monomer from drums of polymer slurry. The semi-works flash dryer is used to flash off the solvent and monomer liquid into a vapor state, so that the solids can be collected in a bag filter. The vapors are then condensed back into liquid which can be reclaimed. Due to a high nitrogen (noncondensible) flow, some of the solvent and monomer escapes the condenser as vapor to the SW-1 stack. A mass balance approach is used to determine how much vapor has been lost, so that this can be included in annual air emissions summary.

Here is a summary of the material balance calculation.

1) Weight of drums processed through the system are recorded. The reported composition of the drums is used to determine VOC and F113 content. Solids and other non-recoverable waste are backed out, based on a material balance on solids (polymer and waste collected).
2) Any fresh E2 solution used for startup of the flash drying system is accounted for in the balance.
3) Outputs include weight of reclaimed liquid collected in drums, weight of solid polymer collected, and weight of solid waste in drums.

Example Mass Balance Calculations for TFESK campaigns:
The production of TFESK requires the use of TFE. TFE emissions and potential TFESK emissions are estimated based upon a material balance around the system. Data used in the calculation is obtained from production records for each campaign and entered into the worksheet. The following is entered into the worksheet after each campaign:

1) Enter the amount of TFE received; minus the amount required to produce the product.
2) Enter the number of bacthes dried during the month.
3) Enter the amount of TFESK solids removed from the oven.
4) Enter the average amount of dried TFESK collected per batch for the campaign being reported.

Outputs from the material balance include the estimated emissions of TFE and TFESK

Campaign ID: 17-SXF-1.0

Start Date: 6/9/17 12:00 End Date: 6/14/2017

Starting Material

Item	Addition (initiator)	Addition (TFE)	Addition (E2)	Additions to the system Addition (PSEPVE)	Addition (F113)	Addition (condensate)	Addition (condensate)	Addition (condensate)	
Weight (Kg):	90	260.76	158.23	192.78	656.81	0.00	0.00	0.00	
Compositions:						1673330	1673331		
%E2	96.19%	0.00%	100.00%	0.00%	0.00%	15.00%	15.27%	0.00%	
%PSEPVE	0.00%	0.00%	0.00%	100.00%	0.00%	7.97%	5.67%	0.00%	
%TFE	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
%F113	0.00%	0.00%	0.00%	0.00%	100.00%	75.77%	78.26%	0.00%	
%Inititiator	3.81%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**Totals**
Weights									
E2	86.57	0.00	158.23	0.00	0.00	0.00	0.00	0.00	**244.8**
PSEPVE	0.00	0.00	0.00	192.78	0.00	0.00	0.00	0.00	**192.8**
TFE	0.00	260.76	0.00	0.00	0.00	0.00	0.00	0.00	**260.8**
F113	0.00	0.00	0.00	0.00	656.81	0.00	0.00	0.00	**656.8**
Inititiator	3.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**3.4**

Ending Material

Item	Recovery Tank					Return (condensate)	Return (condensate)	Return (condensate)	Return (condensate)	Return (condensate)	
						FC-8858	FC-8859				
Weight (Kg):		0.00				194.00	300.00				
Compositions						69282	69283				
%E2		0.00%				37.52%	26.51%	0.00%	0.00%	0.00%	
%PSEPVE		0.00%				9.18%	8.00%	0.00%	0.00%	0.00%	
%TFE		0.00%				0.00%	0.00%	0.00%	0.00%	0.00%	
%F113		0.00%				52.61%	64.49%	0.00%	0.00%	0.00%	
%Inititiator		0.00%				0.00%	0.00%	0.00%	0.00%	0.00%	**Totals**
Weights											
E2	0.00	0.00	0.00	0.00	0.00	72.79	79.53	0.00	0.00	0.00	**152.3**
PSEPVE	0.00	0.00	0.00	0.00	0.00	17.81	24.00	0.00	0.00	0.00	**41.8**
TFE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
F113	0.00	0.00	0.00	0.00	0.00	102.06	193.47	0.00	0.00	0.00	**295.5**
Inititiator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**

Production

Item	Polymer	Throw Away	Slurry	Totals
Weight (Kg):	327.40	0.00	0.00	
Compositions				
EW	1459		0	
%Polymer	100.00%	100.00%	0.00%	
%E2			0.00%	
%PSEPVE			0.00%	
%TFE			0.00%	
%F113			0.00%	
Weights				
Polymer	327.40	0.00	0.00	327.4
E2	0.00	0.00	0.00	0.0
PSEPVE	100.05	0.00	0.00	100.1
TFE	227.35	0.00	0.00	227.3
F113	0.00	0.00	0.00	0.0
VE in Polymer	100.05	0.00	0.00	

Material Balance Summary

Compound	Added	Remaining	Used	Production	Other	*Totals*
E2	244.8	152.3	92.5	0.0		92.5
PSEPVE	192.8	41.8	151.0	100.1		50.9
TFE	260.8	0.0	260.8	227.3		33.4
F113	656.8	295.5	361.3	0.0		361.3
Inititiator	3.4	0.0	3.4	0.0		3.4

VE Yield

Vinyl Ether =	PSEPVE	MW =	446
VE in polymer	100.1	% in polymer =	66.3%
VE used	151.0		

Lbs of Emissions

SW-1

VOC's	411.8 lb.
F-113	796.5 lb.
TFE	73.7 lb.
E-2	203.9 lb.
PSEPVE	112.3 lb.
Inititiator	7.6 lb.
PAF	14.4 lb.
AF's	14.4 lb.

SW-2

# of MF samples	0.0	All run in mfg lab
grams emissions	0.0 g	
lbs of emissions	0.0 lb	

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: WTS-A

Emission Source Description: Central Wastewater Treatment Plant

Process and Emission Description:

The Wastewater Treatment Plant (WWTP) consists of the biological treatment of process and sanitary wastewater utilizing extended aeration. The WWTP is comprised of an open equalization basin and open-top tanks and clarifiers. The basin is mixed using floating mixers and the tanks are aerated primarily with diffused air.

Emissions from the WWTP result from the volatilization of solubilized compounds which are air stripped via the aeration of the wastewater. The extent of the volatilization is a function of the specific compound's solubility in water and its vapor pressure, typically expressed as the compound's Henry's Law Constant. Also, the volatilization of an organic compound is dependent on its rate of biodegradability. For example, methanol which is a Hazardous Air Pollutant (HAP), is highly biodegradable, and as such its biodegradation rate is much faster than its volatilazation rate, thereby limiting the air emissions of methanol from the WWTP.

Basis and Assumptions:

The three major compounds that are treated in the WWTP are butyraldehyde, ethylene glycol, and methanol.

The emissions of methanol from the WWTP were determined using the EPA WATER8 model. This modeling takes into account the specific operational units of the WWTP to predict the ultimate fate of specific compounds.

The Henry's Law Constant for ethylene glycol is 6.0 × 10e-08 atm-m3/mole. Not surprisingly, ethylene glycol is exempt from the wastewater control requirements of 40 CFR 63 Subpart G as ethylene glycol is excluded from Table 9 of that subpart.

Because of the above, it will be assumed that the WWTP unit operation's emission factors for ethylene glycol are the same as those for dimethylformamide. However, the biodegradation rate of ethylene glycol will be assumed to be the same as that of methanol, since the technical literature found in the Handbook of Environmental Data on Organic Chemicals indicates that for an acclimated system, ethylene glycol is biodegraded at twice the rate of methanol. To be conservative, the slower methanol rate will be used.

The Henry's Law Constant for butyraldehyde is 1.15 × 10e-04 atm-m3/mole which is higher than the Henry's Law Constant for methanol of 4.55 × 10e-06 atm-m3/mole, meaning the quantity that is air stripped from the wastewater would be expected to be higher than that for methanol. According to the Handbook of Environmental Data on Organic Chemicals, butyraldehyde is biodegraded at the same rate of methanol in an acclimated system.

Because of the above, it will be assumed that the WWTP unit operation's emission factors for butyraldehyde are twice as those for methanol.

The WWTP is fed 30% aqueous ammonia as a nutrient for the biological microbes. To be conservative, the emissions of ammonia from the WWTP will assume that none of the NH_3 is utilized by the microbes, who would convert the ammonia into nonvolatile nitrate. The emissions of ammonia is determined using Henry's Law.

Information Inputs and Source of Inputs:

Information Inputs	**Source of Inputs**
Estimated quantity of compounds entering the WWTP for the year	SARA 313 Report and other Air Emission Inventory inputs

Fugitive Emissions Determination:

All air emissions from the Wastewater Treatment Plant are fugitive. Estimates of the emission for individual components are given in the following pages.

2017 Emissions from Wastewater Treatment Plant (WTS-A)

	BA	EtGly	MeOH
To WWTP from Kuraray Butacite (lb)	330,781	14,390	186,724
To WWTP from Chemours IXM Resins (lb)	-	-	33,618
To WWTP from Other Sources (lb)	-	-	-
Total to WWTP (lb)	330,781	14,390	220,342
Quantity entering EQB (lb)	330,781	14,390	220,342
Percent of compound volatilized	23.42%	0.29%	11.71%
Quantity volatilized from EQB (lb)	77,469	42	25,802
Quantity leaving EQB (lb)	253,312	14,348	194,540
Quantity entering Predigester (lb)	253,312	14,348	194,540
Percent of compound volatilized	8.30%	0.10%	4.15%
Quantity volatilized from Predigester (lb)	21,025	14	8,073
Quantity leaving Predigester (lb)	232,287	14,334	186,467
Quantity entering Aeration Tank (lb)	232,287	14,334	186,467
Percent of compound volatilized	0.16%	0.002%	0.08%
Quantity volatilized from Aeration Tank (lb)	372	0	149
Percent of compound biodegraded	85.00%	85.00%	85.00%
Quantity biodegraded in Aeration Tank (lb)	197,444	12,184	158,497
Quantity leaving to Cape Fear River (lb)	34,471	2,150	27,821
Kuraray Quantity to Cape Fear River (lb)	34,471	2,150	23,576
Chemours Quantity to Cape Fear River (lb)	-	-	4,245
Total Quantity to Cape Fear River (lb)	**34,471**	**2,150**	**27,821**
Kuraray Fraction Volatilized to Air (lb)	98,865	56	28,833
Chemours Fraction Volatilized to Air (lb)	-	-	5,191
Total Volatilized to Air (lb)	**98,865**	**56**	**34,025**

Source of Volatilization Percentages: EPA WATER9 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.

2017 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: WTS-A

Emission Source Description: Central Wastewater Treatment Plant

Ammonia (NH_3) Emissions

The wastewater treatment plant ("WWTP") is fed aqueous ammonia (30% NH_3) as a nutrient for the biological microbes.

In 2017, the WWTP consumed 32,850 pounds of 30% NH3 aqueous ammonia, which equates to 9,855 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. 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 NH_3 in the Aeration Tank

$$\frac{9{,}855 \text{ lb. } NH_3}{\text{year}} \times \frac{\text{year}}{3{,}044{,}100{,}000 \text{ lb. water}} = \frac{0.00000324 \text{ lb. } NH_3}{\text{lb. water}}$$

$$\frac{0.00000324 \text{ lb. } NH_3}{\text{lb. water}} \times \frac{453.6 \text{ g } NH_3}{\text{lb. } NH_3} \times \frac{2{,}204.6 \text{ lb. water}}{m^3 \text{ water}} = \frac{3.24 \text{ g } NH_3}{m^3 \text{ water}}$$

Henry's Law Constant for Ammonia in water at 30 deg C (see Note 1)

$$K_h = (0.2138/T)\,10^{6.123-1825/T}$$

$$K_h = \frac{0.000888 \text{ g } NH_3 / m^3 \text{ air}}{\text{g } NH_3 / m^3 \text{ water}}$$

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 NH_3 in the Aeration Tank's Diffused Air

$$\frac{0.000888 \text{ g } NH_3 / m^3 \text{ air}}{\text{g } NH_3 / m^3 \text{ water}} \times \frac{3.24 \text{ g } NH_3}{m^3 \text{ water}} = \frac{0.00287 \text{ g } NH_3}{m^3 \text{ air}}$$

Emission of NH_3 from the Aeration Tank's Diffused Air

Basis: Diffused air injection rate of 2,000 ft^3 air per minute

$$\frac{2{,}000 \text{ ft}^3 \text{ air}}{\text{minute}} \times \frac{m^3}{35.315 \text{ ft}^3} \times \frac{525{,}600 \text{ min}}{\text{year}} = \frac{29{,}766{,}388 \text{ m}^3 \text{ air}}{\text{year}}$$

$$\frac{0.00287 \text{ g } NH_3}{m^3 \text{ air}} \times \frac{29{,}766{,}388 \text{ m}^3 \text{ air}}{\text{year}} \times \frac{\text{lb.}}{453.6 \text{ g}} = \frac{189 \text{ lb. } NH_3}{\text{year}}$$

Emission of NH_3 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 quiessent 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.

Emission of NH_3 from the WWTP Clarifiers = 189 lb NH_3 / year

Total Emission of NH_3 from the WWTP System (ID No. WT-A)

Emission of NH_3 from the WWTP Aeration Tank = 189 lb. NH_3 / year
Emission of NH_3 from the WWTP Clarifiers = 189 lb. NH_3 / year

Emission of NH_3 from the WWTP System = 377 lb. NH_3 / year

Dimethyl sulfoxide (DMSO) **CAS No. 67-68-5**

DMSO Fugitive Emissions from WWTP Equipment

The fugitive emissions of DMSO from the unit operations are esimated by the calculated concentration of DMSO in the air space above each WWTP equipment, the horizontal dimension of each WWTP equipment, an assumed vertical component of the moving air volume across each WWTP equipment, and the average air speed for the reporting year.

It will be assumed that the vertical height of the air volume moving horizontally over the WWTP equipment is one (1) meter. It is felt this assumption is reasonable for this emission esitimation given the Henry's Law Constant for DMSO that indicates the extremely low volatilization of DMSO from water.

It will be assumed that none of the DMSO is biologically degraded in the WWTP.

It will be assumed that the DMSO was present in the WWTP wastewater for 8,760 hours during the reporting year.

Estimated concentration of DMSO in the air space above the WWTP water: 5.61E-06 g DMSO / m3 air

Average wind speed reported for the Fayetteville Regional Airport (FAY): 3.27 m/s

	Horizontal Length (m)	Vertical Height (m)	Wind Speed (m/s)	Horizontal Air Flow (m3 / s)	g DMSO per m3 air	g DMSO per second	lb DMSO per year
Eq. Basin	33.5	1	3.27	109.5	5.61E-06	6.15E-04	42.8
Predigester	13.5	1	3.27	44.1	5.61E-06	2.48E-04	17.2
Aeration Tk	30.3	1	3.27	99.1	5.61E-06	5.56E-04	38.7
Clarifier	25.9	1	3.27	84.7	5.61E-06	4.75E-04	33.1
						TOTAL	**131.7**

DMSO Emissions from the Aeration Tank Diffused Air System

Diffused air injection rate: 2,000 ft^3 air per minute

$$\frac{2{,}000 \text{ ft3 air}}{\text{min}} \cdot \frac{0.0283 \text{ m3 air}}{\text{ft3 air}} \cdot \frac{525{,}600 \text{ min}}{\text{year}} = 2.97.E+07 \frac{\text{m3 air}}{\text{year}}$$

$$\frac{2.97.E+07 \text{ m3 air}}{\text{year}} \cdot \frac{5.61E-06 \text{ g DMSO}}{\text{m3 air}} = 167 \text{ g DMSO / year}$$

$$= 0.4 \text{ lb DMSO / year}$$

Total DMSO Emissions

DMSO Fugitive Emissions from WWTP Equipment	131.7 lb/yr
DMSO Emissions from the Aeration Tank Diffused Air System	0.4 lb/yr
	132.1 lb/yr

2017 Emissions from Wastewater Treatment Plant (WTS-A)

Dimethyl sulfoxide (DMSO) **CAS No. 67-68-5**

Basis:

A waste comprised of Dimethyl sulfoxide (DMSO) and potassium hydroxide (KOH) was sent to the wastewater treatment plant (WWTP) for some period of time during the reporting year. The waste stream concentration was approximately 10% DMSO, 24% KOH, and the remainder being water.

The waste was transferred to the WWTP at a rate of 5 gallons per hour. The specific gravity of 24% KOH is 1.226 at 20°C. This equates to 1227 lb/day of the waste sent to the WWTP, or 122.7 lb/day of DMSO sent to the WWTP.

Assuming the influent to the WWTP is an average of approximately 1 million gallons per day or 8.34 MM-lb per day, the average concentration of DMSO in the influent would be $1.47e10^{-5}$ by weight.

Concentration of DMSO in WWTP Influent

$$\frac{1.47\text{E-}05 \text{ g DMSO}}{\text{g water}} \left| \frac{\text{mole DMSO}}{78.13 \text{ g DMSO}} \right| \frac{1000 \text{ g water}}{\text{kg water}} = 1.88\text{E-}04 \frac{\text{mole DMSO}}{\text{kg water}}$$

The Henry's Law Constant for DMSO solubility in water at 298°K is reported as $1.17e10^{5}$ mole/kg/atm. [Source: "The Henry's law constant of dimethly sulphoxide", Watts and Brimblecombe, Environmental Technology Letters 8(1-12):483-486 · January 1987

Partial Pressure of DMSO above the WWTP Wastewater

$$\frac{1.88\text{E-}04 \text{ mole DMSO / kg water}}{1.17\text{E+}05 \text{ mole DMSO / kg water / atmosphere}} = 1.61\text{E-}09 \text{ atm}$$

Mole Fraction of DMSO in Gas Phase above WWTP Wastewater

$$\frac{\text{Partial Pressure}}{\text{System Pressure}} = \frac{1.61\text{E-}09 \text{ atm}}{1 \text{ atm}} = \frac{1.61\text{E-}09 \text{ mole DMSO}}{\text{mole air}}$$

$$1.61\text{E-}09 \text{ mole DMSO} \times \frac{78.13 \text{ g DMSO}}{\text{mole DMSO}} = 1.26\text{E-}07 \text{ g DMSO}$$

$$\frac{1 \text{ mole air}}{} \left| \frac{22.4 \text{ L air}}{\text{mole air}} \right| \frac{\text{m3 air}}{1000 \text{ L air}} = 0.0224 \text{ m3 air}$$

$$1.61\text{E-}09 \frac{\text{mole DMSO}}{\text{mole air}} = \frac{1.26\text{E-}07 \text{ g DMSO}}{0.0224 \text{ m3 air}} = 5.61\text{E-}06 \frac{\text{g DMSO}}{\text{m3 air}}$$

2017 Air Emissions Summary

WTS-A Central Wastewater Treatment Plant

A. VOC Compound Summary

Compound	CAS Chemical Name	CAS No.	Emission (lb.)
BA	Butyraldehyde	123-72-8	98,865
EtGly	Ethylene Glycol	107-21-1	56
MeOH	Methanol	67-56-1	34,025
DMSO	Dimethyl Sulfoxide	67-68-5	132
	Total VOC Emissions (lb.)		133,079
	Total VOC Emissions (tons)		66.54

B. Hazardous / Toxic Air Pollutant Summary

Compound	CAS Chemical Name	CAS No.	Emission (lbs)
EtGly	Ethylene Glycol	107-21-1	56
MeOH	Methanol	67-56-1	34,025
NH3	Ammonia	7664-41-7	377