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Chemours™

CHEMOURS COMPANY
FAYETTEVILLE WORKS

AIR PERMIT NUMBER 03735T42
FACILITY ID 0900009

2015
AIR
EMISSIONS
INVENTORY
REPORT

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 2015

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: 6/14/2016
Printed Name: Ellis McGaughy Signature: Ellis H. McGaughy

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.

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

Information on this Form cannot be held confidential

Wastewater Sludge Dryers

(Title V ID Nos. WTS-B and WTS-C)

(AERO ID G-42)

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:

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

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:

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

For example, converting 0.021 ppmv of methyl amine (MW = 31) to mg/m^3 follows:

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

Conversion of concentration from ppmv to mg/m³

Compound	Molecular Weight (grams per mole)	Odor Threshold (ppmv)	Odor Threshold (mg/m³)
Methyl amine	31	0.021	0.026
Ammonia	17	1.5	1.035
Hydrogen sulfide	34	0.13	0.179
Methyl mercaptan	48	0.002	0.004
Dimethyl sulfide	62	0.001	0.048
3-Methyl-1H-indole	131	0.019	0.101

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

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

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

Emissions Determination:

		Multiplied by:	Multiplied by:	Equals:
Compound	**Odor Threshold (mg/m³)**	**Scrubber Flow Rate (m³/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**

Polymer Processing Aid Process

AS-A

0542

2015 AIR EMISSIONS SUMMARY
POLYMER PROCESSING AID PROCESS

VOC Emisions	lb/yr
FRD901	0.3
Dimer	28.2
Dimer Acid	4.1
Total VOC emissions (lb/yr)	32.6
Total VOC emissions (ton/yr)	0.02

Particulate (PM) Emisions	lb/yr
FRD902	2.5
Total PM emissions (lb/yr)	2.5
Total PM emissions (ton/yr)	0.001

Toxic Air Pollutant (TAP) Emisions	lb/yr
Ammonia	61.7
HF	3.8
H2SO4	45.8

Note: NCDAQ requires that Acid Fluorides be reported as "Fluorides" as well as HF.

✓

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	88
Total vapor displaced during year [liters]	73,278
P_{NH3} [mm Hg]	64.097
Y_{NH3}	0.08434
Total NH_3 vapor displaced during year[liters	6180.1
Total NH_3 vapor displaced during year [lbs]	10.3309

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

902 Reactor Charging

Number of batches per year	328
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]	164
Total fugitive emmisions [lbs]	3.0717

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

905 Reactor Charging

Number of batches per year	18
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]	108
Total fugitive emmisions [lbs]	13.8024

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]	34.5307
Assumed Efficiency of Scrubber	0
Ammonia exiting Stack [lbs/year]	34.5307

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 (100F)

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] **61.7**

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

Assumptions & Notes

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

Sulfuric Acid Storage Tank Filling

Average fill size [gallons]	3000
Number of fills per year	7
Total vapor displaced during year [liters]	79485
P_{H2SO4} [mm Hg]	0.00986
Y_{H2SO4}	1.298E-05
Total H_2SO_4 vapor displaced during year [liters]	1.03161
Total H_2SO_4 vapor displaced during year [lbs]	0.00995

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

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

Hydrolysis Reactor Charging

Number of acid charges per year	328
Average pump run time per batch (min)	15
Number of flanges in line	25
Number of open valves in line	9
Number of pump seals	1
Total pump time for year [hours]	82
Total fugitive emmisions [lbs]	3.84826

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

Hydrolysis Reactor Emissions

Vessel capacity [gal]	600
Hydro Reactor Charge of water [lbs]	2000
Hydro Reactor Charge of H_2SO_4 [lbs]	590
Batches per year	984
Avg Level of Vessel at Vent [gallons]	490
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]	2.744E-07
H_2SO_4 vapor vented to Scrubber [lbs/year]	0.026488
Assumed Efficiency of Scrubber	0.95
H_2SO_4 exiting Stack [lbs/year]	0.001324

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

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

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]	3.66383

Closed valves and instruments connections considered flanges
Because Sulfuric has such a low VP, leaks out of vessel above the liquid line are negligible

Dilution Tank Emissions (Mix and Settle)

Entire available head space is vented to the Scrubber

Vessel capacity [gal]	1,963
Avg Level of Vessel at Vent [gallons]	800
Batches per year	0
Mass fraction of H_2SO_4	0.2
Pressure of Vessel at Vent [mm Hg]	760
X_{H2SO4}	0.57672
P_{H2SO4} [mm Hg]	0.00577
Y_{H2SO4}	7.588E-06
H_2SO_4 vapor vented to Scrubber [liters/batch]	0.03340
H_2SO_4 vapor vented to Scrubber [lbs/year]	0.00000
Assumed Efficiency of Scrubber	0.95
H_2SO_4 exiting Stack [lbs/year]	0.00000

Dilution Trailer Loadout Emissions

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

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

Total H_2SO_4 Emissions [lbs/year] **45.8**

Hydrofluoric Acid (HF)

Molecular Weight of HF	20
Molecular Weight of DAF	332
Molecular Weight of H_2SO_4	98.1
Molecular Weight of Dimer Acid	330
Molecular Weight of Water	18
VP at 60°C [mm Hg]	2
K_{HF}	0.006

Equipment Leak Rates [lb/hr]

	Good	Excellent
Pump Seal	0.0075	0.00115
Valves	0.00352	0.00036
Flanges	0.00031	0.00018

Hydrolysis Reactor Emissions

Vessel capacity [gal]	600
Water Charge [lbs]	2040
93% Sulfuric Charge [lbs]	600
DAF Charge [lbs]	1700
HF (post reaction) [lbs]	102.41
Dimer Acid (post reaction) [lbs]	1689.76
Water (post reaction) [lbs]	1947.83
Sulfuric (post reaction) [lbs]	600
Avg Level of Vessel at Vent [gal]	490
Mass Fraction of HF	0.0236
X_{HF}	0.0411
P_{HF} [mm Hg]	0.1874
Y_{HF}	0.000247
HF vapor vented to Scrubber [lb mol/batch]	8.65E-06
HF vapor vented to Scrubber [lbs/year]	0.0479
Assumed Efficiency of Scrubber	0.95
HF exiting Stack [lbs/year]	0.00240
Avg time vessel contains Virgin material [days/yr]	150
Number of vessel flanges (below inventory line)	7
Number of open valves (below inventory line)	0
Fugitive HF emissions [lbs/year]	2.093

Trailer Loadout Emissions

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

Emissions based on DAF 1.699

Total HF Emissions [lbs/year] 3.8

Assumptions & Notes

Worst Case - 100% conversion resulting in maximum HF generation

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

Gas Constant
10.73 ft3 psi / °R lb mol
0.019 psi / mm Hg
7.48 gal / ft3

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

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

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

Perfluoro-2-Propoxy Propionyl Fluoride ($C_6F_{12}O_2$) (Dimer)

Emissons based on data collected during stack testing in 2006.		Note 1
Virgin Campaign Emission Rate [lbs/hr]	0.008	Note 2
Amount of Annual Time dedicated to FRD Production [fraction]	0.47	
Fraction of Emissions that are Dimer	0.85626	Note 3

Total DAF Emissions [lbs/year] **28.2**

Assumptions & Notes

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

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

Note 3 Based on 2006 analysis.

Perfluoro-2-Propoxy Propionic Acid ($C_6F_{11}O_3H$) (Dimer Acid GX903)

Emissons based on data collected during stack testing in 2006.		Note 1
Virgin Campaign Emission Rate [lbs/hr]	0.008	Note 2
Purified Campaign Emission Rate [lbs/hr]	0.0024	
Amount of Annual Time dedicated to GX Virgin Production [fraction]	0.47	
Amount of Annual Time dedicated to GX Purified Production [fraction]	0.10	
Fraction of Emissions that are Dimer Acid	0.0896	Note 3

Total Dimer Acid Emissions [lbs/year] **4.1**

Assumptions & Notes

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

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

Note 3 Based on 2006 analysis.

FRD901

Definitions

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

Assumptions

Ideal Gas Laws apply and all solutions are considered Ideal Solutions

Vapor Pressure is constant over temperature range. Value used is for worst case ie. max ambient temp (90 F)

Constants

Molecular Weight of FRD901: 1533

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

Pump Seals	0.00750
Valves	0.00352
Flanges	0.00031

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

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 & 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	14
Total vapor displaced during year [liters]	1,484
P_{901} [mm Hg]	0.004
Y_{901}	0.00000
Total 901 vapor displaced during year[liters]	0.0071
Total 901 vapor displaced during year [lbs]	0.0011
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]	4.7
Total fugitive emmisions [lbs]	0.0834

901 Reactor Charging

Number of batches per year	18
Average drop time per batch (min)	45
Number of flanges in line	6
Number of open valves in line	4
Number of pump seals (air diaphragm)	0
Total drop time for year [hours]	13.5
Total fugitive emmisions [lbs]	0.2152

Total FRD901 Emissions [lb/year] **0.3**

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Propanoic acid, 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-, ammonium salt (GX902)

Emissons based on data collected during stack testing in 2006.		Note 1
Virgin Campaign Emission Rate [lbs/hr]	0.008	Note 2
Purified Campaign Emission Rate [lbs/hr]	0.0024	
Amount of Annual Time dedicated to GX Virgin Production [fraction]	0.47	
Amount of Annual Time dedicated to GX Purified Production [fraction]	0.10	
Fraction of Emissions that are GX902	0.05413	Note 3

Total GX902 Emissions [lb/year] **2.5**

Assumptions & Notes

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

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

Note 3 Based on 2006 analysis.

0348

AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No.: FS-B

Emission Source Description: Polyvinyl Fluoride Process No. 1

Process and Emission Description:

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

Basis and Assumptions:

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

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

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

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

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

Point Source Emissions Determination:

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

Equipment Emissions and Fugitive Emissions Determination:

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

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

Year 2015

Analytical Equipment Vent Flow Rates

Vent No. FEP-B1 flow rate (Q_{FEP-B1})	4,338	pounds
Analytical Equipment VOC emissions (E_{FEP-B1})	4,338	pounds

Maintenance Header Vent Flow Rates

Vent No. FEP-B2 flow rate (Q_{FEP-B2})	40,777	pounds
Maintenance Headers VOC emissions (E_{FEP-B2})	40,777	pounds

Flash Tank Vent Flow Rates

Emissions from Vent No. FEP-B3 flow rate (Q_{FEP-B3})	3,613	pounds
Flash Tanks VOC emissions (E_{FEP-B3})	3,613	pounds

Fugitive Emissions

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

Accidental Releases

Accidental releases from FS-B (Q_{A-B})	1	pounds
Total accidental releases (E_A)	1	pounds

VOC emissions (E) from the PVF-1 facility

Analytical Equipment VOC emissions (E_{FEP-B1})	4,338	pounds
Maintenance Headers VOC emissions (E_{FEP-B2})	40,777	pounds
Flash Tanks VOC emissions (E_{FEP-B3})	3,613	pounds
Total fugitive emissions (E_F)	1,886	pounds
Total accidental releases (E_A)	1	pounds
Total VOC emissions (E) from the PVF-1 facility	**50,615**	pounds
* Note: VOC emissions are exclusively vinyl fluoride	**25.31**	tons

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

Year 2015

Basis and Assumptions:

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

Determination of Particulate Matter Emissions

Production during reporting year	3,418	PPU
PM Emission Factor	0.488	lb-PM / PPU
Total PM emissions from the PVF-1 facility	**1,669**	pounds
	0.83	tons

Polyvinyl Fluoride Process No. 2

FS-C

0566

AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No.: FS-C

Emission Source Description: Polyvinyl Fluoride Process No. 2

Process and Emission Description:

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

Basis and Assumptions:

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

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

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

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

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

Point Source Emissions Determination:

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

Equipment Emissions and Fugitive Emissions Determination:

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

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

Year 2015

Analytical Equipment Vent Flow Rates

Vent No. FEP-C1 flow rate (Q_{FEP-C1})	1,802	pounds
Analytical Equipment VOC emissions (E_{FEP-C1})	1,802	pounds

Maintenance Header Vent Flow Rates

Vent No. FEP-C2 flow rate (Q_{FEP-C2})	19,438	pounds
Maintenance Headers VOC emissions (E_{FEP-C2})	19,438	pounds

Flash Tank Vent Flow Rates

Emissions from Vent No. FEP-C3 flow rate (Q_{FEP-C3})	2,824	pounds
Flash Tanks VOC emissions (E_{FEP-C3})	2,824	pounds

Fugitive Emissions

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

Accidental Releases

Accidental releases from FS-C (Q_{A-C})	0	pounds
Total accidental releases (E_A)	0	pounds

VOC emissions (E) from the PVF-2 facility

Analytical Equipment VOC emissions (E_{FEP-C1})	1,802	pounds
Maintenance Headers VOC emissions (E_{FEP-C2})	19,438	pounds
Flash Tanks VOC emissions (E_{FEP-C3})	2,824	pounds
Total fugitive emissions (E_F)	1,886	pounds
Total accidental releases (E_A)	0	pounds
Total VOC emissions (E) from the PVF-2 facility	**25,950**	pounds
* Note: VOC emissions are exclusively vinyl fluoride	**12.98**	tons

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

Year 2015

Basis and Assumptions:

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

Determination of Particulate Matter Emissions

Production during reporting year	3,202	PPU
PM Emission Factor	0.488	lb-PM / PPU
Total PM emissions from the PVF-2 facility	**1,564**	pounds
	0.78	tons

Completed By:	Christopher A. Chanelli
Date Completed:	January 25, 2016

HFA-Hydrate Reactor System

GHG-HDR

0553

2015 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: GHG-HDR

Emission Source Description: HFA-Hydrate Destruction Reactor System

Process and Emission Description:

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

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

Basis and Assumptions:

The basis of the HFC-23 emissions is the formation of HFA-hydrate in the HFPO Process. In the HDR system, the HFA-hydrate is chemically decomposed to HFC-23. Per the HFPO Process flowsheet (W1208078), 0.4 kg of HFC-23 is formed and emitted for every 30.48 HFP Units fed into the HFPO Process. Therefore, the emission of HFC-23 is proportional to the quantity of HFP make-up fed to the HFPO Process. 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 583,653 HFP Units

$$\frac{0.4 \text{ kg } CHF_3}{30.48 \text{ HFP Units}} \times 583{,}653 \text{ HFP Units} = 7{,}658 \text{ kg } CHF_3$$

$$= 16{,}884 \text{ lb. } CHF_3$$

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:

$$\frac{0.0114 \text{ kg } CHF_3}{1.00 \text{ HFP Units}} \times 583{,}653 \text{ HFP Units} = 6{,}672 \text{ kg } CHF_3$$

$$= 14{,}709 \text{ lb. } CHF_3$$

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).

$$16{,}884 \text{ lb. } CHF_3 \text{ minus } 14{,}709 \text{ lb. } CHF_3 = 2{,}175 \text{ lb. CHF3}$$

$$= 1.09 \text{ ton } CF_3H$$

Polyvinyl Fluoride Process No. 1 House Vacuum System

I-01A

DuPont PVF Manufacturing Facility

Determination of Actual PM-10 Emissions: PVF-1 House Vacuum System

Particulate Matter Emissions Determination

For general good housekeeping purposes, the DuPont PVF-1 Process uses a vacuum system (ID No. PVF-Vac-A) to remove any PVF resin powder (particulate matter) from the building's floor and equipment. The emission of particulate matter from this vacuum system is controlled by a two-stage fabric filter.

The 1st-stage fabric filter (Control Device ID No. CD-PVF-A1) is a TDC Filter QX blended cellulous / synthetic fiber paper filter. Its efficiency for capturing / controlling particles is 48% for 0.3 - 1.0 micron size, 88% for 1.0 - 3.0 micron size, and 99% for 3.0 - 10.0 micron size.

The 2nd-stage fabric filter (Control Device ID No. CD-PVF-A2) is a TDC Filter SB-ME heavy-duty spunbond 100% polyester metalized spunbond filter media with a conductive coating to prevent static buildup. Its MERV Test results shows the filter's efficiency for capturing / controlling particles is 38% for 0.3 - 1.0 micron size, 72% for 1.0 - 3.0 micron size, and 98% for 3.0 - 10.0 micron size.

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

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

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

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

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

$$\begin{matrix}\text{Uncontrolled}\\\text{Emissions}\end{matrix} \times 70\% \times 48\% + \begin{matrix}\text{Uncontrolled}\\\text{Emissions}\end{matrix} \times 30\% \times 88\% = 8160\text{ lb.}$$

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

DuPont PVF Manufacturing Facility

Determination of Actual PM-10 Emissions: PVF-1 House Vacuum System (continued)

Particulate Matter less than 1.0 µm

13,600 lb. PVF	X	70%	=	9,520 lb. PVF < 1 µm
9,520 lb. PVF	X	48%	=	4,570 lb. PVF < 1 µm captured / controlled
9,520 lb. PVF	X	52%	=	4,950 lb. PVF < 1 µm sent to 2nd-stage

Vendor literature from TDC Filter states the capture / control efficiency of their SB-ME Filter media is 38% for particles less than 1.0 µm.

4,950 lb. PVF	X	38%	=	1,881 lb. PVF < 1 µm captured / controlled
4,950 lb. PVF	X	62%	=	3,069 lb. PVF < 1 µm emitted to atmosphere

Particulate Matter greater than 1.0 µm

13,600 lb. PVF	X	30%	=	4,080 lb. PVF > 1 µm
4,080 lb. PVF	X	88%	=	3,590 lb. PVF > 1 µm captured / controlled
4,080 lb. PVF	X	12%	=	490 lb. PVF > 1 µm sent to 2nd-stage

Vendor literature from TDC Filter states the capture / control efficiency of their SB-ME Filter Media is 72% for particles between 1.0 µm and 3.0 µm, and 98% for particles greater than 3.0 µm. To be conservative, it will be assumed the efficiency is 72% for particles greater than 1.0 µm.

490 lb. PVF	X	72%	=	353 lb. PVF > 1 µm captured / controlled
490 lb. PVF	X	28%	=	137 lb. PVF > 1 µm emitted to atmosphere

PVF-1 House Vacuum System: Total Annual Actual Particulate Matter Emissions

Total actual PVF resin emissions	=	3,069 lb. PVF < 1 µm emitted to atmosphere
		137 lb. PVF > 1 µm emitted to atmosphere
		3,206 lb. PVF emitted to atmosphere
Assume vacuum is operated 2 hour/day		4.39 lb/hour Particulate Matter
		3,206 lb/year Particulate Matter
		1.603 ton/year Particulate Matter

Polyvinyl Fluoride Process No. 2 House Vacuum System

I-01B

DuPont PVF Manufacturing Facility

Determination of Actual PM-10 Emissions: PVF-2 House Vacuum System

Particulate Matter Emissions Determination

For general good housekeeping purposes, the DuPont PVF-2 Process uses a vacuum system (ID No. PVF-Vac-B) to remove any PVF resin powder (particulate matter) from the building's floor and equipment. The emission of particulate matter from this vacuum system is controlled by a two-stage fabric filter.

The 1st-stage fabric filter (Control Device ID No. CD-PVF-B1) is a TDC Filter QX blended cellulous / synthetic fiber paper filter. Its efficiency for capturing / controlling particles is 48% for 0.3 - 1.0 micron size, 88% for 1.0 - 3.0 micron size, and 99% for 3.0 - 10.0 micron size.

The 2nd-stage fabric filter (Control Device ID No. CD-PVF-B2) is a TDC Filter SB-ME heavy-duty spunbond 100% polyester metalized spunbond filter media with a conductive coating to prevent static buildup. Its MERV Test results shows the filter's efficiency for capturing / controlling particles is 38% for 0.3 - 1.0 micron size, 72% for 1.0 - 3.0 micron size, and 98% for 3.0 - 10.0 micron size.

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

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

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

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

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

$$\begin{matrix}\text{Uncontrolled}\\ \text{Emissions}\end{matrix} \times 70\% \times 48\% + \begin{matrix}\text{Uncontrolled}\\ \text{Emissions}\end{matrix} \times 30\% \times 88\% = 8160 \text{ lb.}$$

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

DuPont PVF Manufacturing Facility

Determination of Actual PM-10 Emissions: PVF-2 House Vacuum System

(continued)

Particulate Matter less than 1.0 µm

13,600 lb. PVF	X	70%	=	9,520 lb. PVF < 1 µm
9,520 lb. PVF	X	48%	=	4,570 lb. PVF < 1 µm captured / controlled
9,520 lb. PVF	X	52%	=	4,950 lb. PVF < 1 µm sent to 2nd-stage

Vendor literature from TDC Filter states the capture / control efficiency of their SB-ME Filter media is 38% for particles less than 1.0 µm.

4,950 lb. PVF	X	38%	=	1,881 lb. PVF < 1 µm captured / controlled
4,950 lb. PVF	X	62%	=	3,069 lb. PVF < 1 µm emitted to atmosphere

Particulate Matter greater than 1.0 µm

13,600 lb. PVF	X	30%	=	4,080 lb. PVF > 1 µm
4,080 lb. PVF	X	88%	=	3,590 lb. PVF > 1 µm captured / controlled
4,080 lb. PVF	X	12%	=	490 lb. PVF > 1 µm sent to 2nd-stage

Vendor literature from TDC Filter states the capture / control efficiency of their SB-ME Filter Media is 72% for particles between 1.0 µm and 3.0 µm, and 98% for particles greater than 3.0 µm. To be conservative, it will be assumed the efficiency is 72% for particles greater than 1.0 µm.

490 lb. PVF	X	72%	=	353 lb. PVF > 1 µm captured / controlled
490 lb. PVF	X	28%	=	137 lb. PVF > 1 µm emitted to atmosphere

PVF-2 House Vacuum System: Total Annual Actual Particulate Matter Emissions

Total actual PVF resin emissions	=	3,069 lb. PVF < 1 µm emitted to atmosphere
		137 lb. PVF > 1 µm emitted to atmosphere
		3,206 lb. PVF emitted to atmosphere
Assume vacuum is operated 2 hour/day		4.39 lb/hour Particulate Matter
		3,206 lb/year Particulate Matter
		1.603 ton/year Particulate Matter

Waste DMSO Storage Tank

I-02

0537

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 can not currently be disposed of onsite. When the material in Hydrolysis can no longer be used for the process, the chemical is transferred to the Waste DMSO Storage Tank. From this tank, the waste DMSO solution is pumped to the facility's NPDES permitted wastewater treatment plant for disposal. The tank is 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 = **0.447 ton DMSO / year**

Emissions Summary:

Point Source Emissions + Fugitive Emissions = Total Emissions

0.018 ton DMSO / year + 0.447 ton DMSO / year = **0.47 ton DMSO / year**

0331

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***.

2015 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 Fluoromonomers and Nafion 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	SARA 313 Report from Waste Shipment Clerk

Point Source Emissions Determination:

None

Fugitive Emissions Determination:

Shown on the following page.

Air Emissions Inventory Supporting Documentation

Emission Source ID No.: I-03

Emission Source Description: Fugitive Emissions of Methylene Chloride

	1Q15	2Q15	3Q15	4Q15	TOTAL
Methylene Chloride Losses (lb)	13,121	4,002	553	4,018	21,694

Chlorination of Riverwater to Control Mussel Growth in Equipment

I-04

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.

Sitewide Laboratory Emissions

I-05

05 39

2015 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

Outdoor Abrasive Blasting Operation for Items Exceeding 8-Feet in Any Dimension

I-06

0551

2015 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	Fluor Daniels personnel responsible for the abrasive blasting operation.

Point Source Emissions Determination:

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

Equipment Emissions and Fugitive Emissions Determination:

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

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	4,000 pounds

$$\frac{4{,}000 \text{ lb. abrasive}}{\text{year}} \times \frac{27 \text{ lb. PM}}{1{,}000 \text{ lb. abrasive}} = \frac{108 \text{ lb. PM}}{\text{year}}$$

$$= \frac{0.05 \text{ ton PM}}{\text{year}}$$

Pollutant	Emissions (ton/year)
Particulate Matter (TSP)	0.05
PM_{10} (< 10 micron)	0.05
$PM_{2.5}$ (< 2.5 micron)	0.05

Paint Shop

I-07

05522

2015 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
Total gallons of paint consumed	KBR personnel responsible for the Paint Shop

Point Source Emissions Determination:

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

Equipment Emissions and Fugitive Emissions Determination:

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

Emission Source ID No.: I-07

VOC Emissions Determination

Worst-case 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	30.0%	750	12.71	2,860
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
- Krylon Orange contains 30.0% xylene
- DuPont Imron Accelerator 389-S contains 0.2% hexamethylene diioscyanate
- Latex Exterior Paint contains 2.0% ethylene glycol

Self-Contained Abrasive Blasting Cabinets

I-08

0550

2015 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.

Fugitive Emission Determination

PM Emissions Determination

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

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

Assumptions:

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

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

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

Paint Spray Booths

I-09

05-49

2015 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 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.

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

Dispersion Process

I-12

0562

Nafion Dispersions Process (I-12)

Product	Amount (L)
D0521	0
D520	117
D521	1,605
D1020	0
D1021	472
D1031	0
D2020	1,462
D2021	137
D2029	21
D2820	0
TOTAL	3,814

Vapor density of n-propanol = 2.46 g/l

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

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

$$\frac{3{,}814 \text{ Liters}}{\text{year}} \times \frac{2.46 \text{ grams NPA}}{\text{Liter}} = \frac{9{,}369 \text{ grams}}{\text{year}}$$

$$= \frac{21 \text{ lb. VOC}}{\text{year}}$$

$$= \frac{0.01 \text{ ton VOC}}{\text{year}}$$

Hexfluoropropylene Oxide (HFPO) Process

NS-A

Emission Summary

A. VOC Compound Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source and Non-point Source Emissions (lb.)	Accidental Emissions (lb.)	Total Emissions (lb.)
COF2	Carbonyl Fluoride	353-50-4	547	0	547
PAF	Trifluoroacetyl Fluoride	354-34-7	556	0	556
A/F Solvent (TFF)	Perfluoro-3,5,7,9,11-pentaoxadodecanoyl fluoride	690-43	1,045	0	1,045
A/F Solvent (TAF)	Trifluoromethyl ester of carbonofluoridic acid	3299-24-9	1,584	0	1,584
HFP	Hexafluoroproplyene	116-15-4	49,439	0	49,439
HFPO	Hexafluoroproplyene Epoxide	428-59-1	29,022	5	29,027
Benzene	Benzene	71-43-2	3	0	3
Toluene	Methylbenzene	108-88-3	155	1	156
				Total VOC Emissions (lbs)	**82,357**
				Total VOC Emissions (tons)	**41.18**

B. Toxic Air Polluntant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lb.)	Non-pt Source Emissions (lb.)	Accidental Emissions (lb.)	Total Emissions (lb.)
Benzene	Benzene	71-43-2		3	0	3
Fluorides (as HF)	Fluorides (sum of all fluoride compounds)	16984-48-8	1,218	100	0	1,317
HF	Hydrogen Fluoride	7664-39-3	1,218	100	0	1,317
Methylene Chloride	Methylene Chloride	75-09-2	0	0	0	0
Toluene	Methylbenzene	108-88-3		155	1	155

C. GHG Pollutants Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions (lb.)	Total Emissions (lb.)	Total Emissions (ton)
CO2	Carbon Dioxide	124-38-9	106,308	106,308	53.15
Fluoroform	Trifluoromethane (HFC-23)	75-46-7	14,709	14,709	7.35

0511

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 =	222,773.43	X	0.4715	=	105,038 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 =	234,240.56	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 =	408,275.44	X	0	=	0 lb COF2
COF_2 sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab):				=	8,418 lb COF2

Total COF_2 Emitted from Process =		105,038 lb COF_2 from A/F Column
(sent to WGS)	+	0 lb COF_2 from Stripper Column
	+	0 lb COF_2 from Solvent Recycle Tank
	+	8,418 lb COF_2 sent to VE-South Process when VE-S shutdown
	=	113,456 lb COF_2 sent to WGS

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

VOC Emissions		113,456 lb COF_2	
Waste Gas Scrubber	x	0.90%	
	=	454 lb COF_2	(VOC)

HF Equivalent Emissions		454 lb COF_2	
	x	0.606 lb HF/lb COF_2	
	=	275 lb HF	(Equivalent HF)

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

CAS No. 354-34-7

HF Potential:

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

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

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 = 222,773.43 X 0.5009 = 111,587 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 = 234,240.56 X 0.0038 = 890 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 = 408,275.44 X 0 = 0 lb PAF

PAF sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab): = 7,155 lb PAF

Total COF_2 Emitted from Process = 111,587 lb PAF from A/F Column
(sent to WGS)
+ 890 lb PAF from Stripper Column
+ 0 lb PAF from Solvent Recycle Tank
+ 7,155 lb PAF sent to VE-South Process when VE-S shutdown
= 119,633 lb PAF sent to WGS

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

VOC Emissions
119,633 lb PAF
Waste Gas Scrubber x 0.90%
= 479 lb PAF (VOC)

HF Equivalent Emissions
479 lb PAF
x 0.172 lb HF/lb PAF
= 82 lb HF (Equivalent HF)

C. Acid Fluoride Solvent - mixture of TAF and TFF
Perfluoro-3,5,7,9,11-pentaoxadodecanoyl fluoride (TFF)
Trifluoromethyl ester of carbonofluoridic acid (TAF)

CAS Nos. 690-43-7
3299-24-9

HF Potential:

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

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

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

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

Telomeric Fluoroformates break down into multiples of COF_2 (MW = 66), which in turn generate 2 moles of HF (MW =20).
Using n=4 would mean for every mole of TFF, 6 moles of 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.

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

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

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

Quantity Generated:

The only 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 From "Vent Flows" Tab = Total Solvent tank vent flow [lb] * Average AF mass fraction in Solvent tank vent [lb AF/lb]
408,275.44 X 0.8691 = 354,832 lb TAF/TFF

Total AF Emitted from Process = (sent to WGS) 354,832 lb AF sent to WGS

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

VOC Emissions
Waste Gas Scrubber 354,832 lb AF
x 0.90%
= 1,419 lb total AF (VOC)
69% TAF and 31% TFF, based on May 2012 estimate

VOC Emissions
For TFF: 109,998 lb TFF 31% TFF
x 0.90% Waste Gas Scrubber
= 440 lb TFF 440 lb VOC

For TAF: 244,834 lb TAF 69% TAF
x 0.90% Waste Gas Scrubber
= 979 lb TAF 979 lb VOC

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

= 1,419 lb AF solvent, assumed all TFF X 0.606 lb HF/lb TFF = **860 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 =	222,773.43	X	0.0193	=	4,300 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 =	234,240.56	X	0.1112	=	26,048 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 =	408,275.44	X	0.0079	=	3,225 lb HFP
HFP sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab):				=	310 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.
3,032,751 / 13,500 = 225

Total HFP from decontamination of unloading hoses = Number of events * (vented from liquid hose + vapor hose + compressor + piping)
= 225 X 20 = 4,410 kg HFP
9,722 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 147
HFP vented = %HFP x lb of VOC per dryer change x number of dryer changes in the year= **347** 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>

	4,300	lb HFP from A/F Column		
+	26,048	lb HFP from Stripper Column		
+	3,225	lb HFP from Solvent Recycle Tank		
+	9,722	lb HFP from Unloading Hoses		
+	347	lb HFP from crude dryer changes		
+	310	lb HFP sent to VE-South Process when VE-S shutdown		
=	43,951	lb HFP	43,951	lb VOC

E. Hexafluoropropylene Oxide (HFPO) **CAS No. 428-59-1**

HF Potential:

HFPO is a VOC without the potential to form HF.

Quantity Released:

Vented from A/F Column:	Total AF column vent flow [lb] * Average HFPO mass fraction in AF column vent [lb HFPO/lb]				
From "Vent Flows" Tab =	222,773.43	X	0.0019	=	423 lb HFPO
Vented from Stripper Column:	Total Stripper col vent flow [lb] * Average HFPO mass fraction in Stripper column vent [lb HFPO/lb]				
From "Vent Flows" Tab =	234,240.56	X	0.0496	=	11,618 lb HFPO
Vented from Solvent Recycle	Total Solvent tank vent flow [lb] * Average HFPO mass fraction in Solvent tank vent [lb HFPO/lb]				
From "Vent Flows" Tab =	408,275.44	X	0.0216	=	8,819 lb HFPO

HFPO sent to VE-South Process when VE-S shutdown (from "VE-S Flow" Tab): = 30 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)
= 52 X 4.92 = 256 kg HFPO
564 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= **347** 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

	423	lb HFPO from A/F Column
+	11,618	lb HFPO from Stripper Column
+	8,819	lb HFPO from Solvent Recycle Tank
+	564	lb HFPO from Unloading Hoses
+	347	lb HFPO from dryer changes
+	30	lb HFPO sent to VE-South Process when VE-S shutdown
=	21,801	lb HFP 21,801 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	454	275
B.	PAF	479	82
C.	Acid Fluoride Solvent (TFF)	440	860
	Acid Fluoride Solvent (TAF)	979	
D.	HFP	43,951	0
E.	HFPO	21,801	0
	Total for year (lb)	**68,104**	**1,218**

Equiv HF represents conservative estimate total for TFF+TAF

I. Equipment Emissions

Equipment Emissions are a function of the number of emission points in the plant (valves, flanges, pump seals). For the equipment emission calculations the inventory shown below is conservative and based on plant and process diagrams. Note that the emission types are as follows: Equipment Emissions (EE) inside buildings = Stack Emissions (SE)
Equipment Emissions (EE) outside buildings = Equipment Fugitive Emissions (FE)
Maintenance Fugitive Emissions (ME)

A. Equipment Emissions Inside Buildings (Stack Emissions)

1. Equipment Emissions (EE) from Barricade:

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

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 7058.9 operating hr/year
x 0.840 lb. A/F VOC/lb. EE
= 987.551 lb VOC generated

987.551 lb VOC generated
x (100%-95%) scrubber efficiency
= 49.378 lb VOC emitted

From non-acid fluorides:
0.167 lb. EE/hr
x 7058.9 operating hr/year
x 0.160 lb. Non-A/F VOC/lb. EE
= 188.105 lb VOC

Total Barricade VOC Emissions:
49.378 lb VOC
\+ 188.105 lb VOC
= 237.483 **lb VOC**

Barricade HF:
0.167 lb. EE/hr
x 7059 operating hr/year
x 0.505 lb. HF/lb. EE
x (100%-95%) scrubber efficiency
= **29.685 lb HF**

2. Equipment Emissions (EE) From HFPO Tower

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

A/F Column, Scrubbers, Dryers, Stripper Column & Associated Equipment															
			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
Assume that : 97 wt. % of the process material are VOCs;												Average HF Potential			0.044087

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:		0.226 lb. EE/hr	HF:		0.226 lb. EE/hr
	x	7059 operating hr/year		x	7059 operating hr/year
	x	0.970 lb. VOC/lb. EE		x	0.044 lb. HF/lb. EE
		1546.078 lb VOC		=	**70.131 lb HF**

B. Equipment Emissions Outside Buildings (Fugitive Emissions)

1. Fugitive Emissions (FE) From Outside Unit Operations

From ASPEN Model:

Reactor/Solvent Recycle/Solvent Column & Associated Equipment														
			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
Assume that :	100 wt. % of the process material are VOCs										Average HF Potential			0

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:		0.241 lb. FE/hr	HF:	0.241 lb. FE/hr
	x	7059 opearting hr/year	x	7059 operating hr/year
	x	1.00 lb. VOC/lb. FE	x	0.0 lb. HF/lb. FE
	=	**1703 lb VOC**	=	**0.00 lb HF**

1547 lb VOC excluding toluene, which is calculated below by mass balance

2. Fugitive Emissions From HFP Storage and Feed

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

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

VOC:		0.071 lb. FE/hr	HF:	0.071 lb. FE/hr
	x	7059 operating hr/year	x	7058.88 operating hr/year
	x	1.00 lb. VOC/lb. FE	x	0.0 lb. HF/lb. FE
	=	**502 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: 560.23 lbs

Benzene emissions:

$$560.228571 \text{ lbs} \times \frac{1.90 \text{ lb emission}}{368 \text{ lb benzene}} = 2.89 \text{ lb benzene emission}$$

4. Fugitive Emissions of Toluene by Mass Balance

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

Assume that: 95% of raw ingredient becomes waste

Mass Balance:

Toluene inventory in process as first day of month ('User E	+	3935.20 lb		1-Jan
Toluene added to process:	+	20026 lb		
Toluene inventory in process as of last day of month ('Use	-	5480.00 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:	-	18326 lb		
Toluene released to air via permitted stack:	-	0 lb		
Toluene released to process wastewater:	-	0 lb		
Toluene released to the ground (spill):	-	0 lb		
Unaccounted for difference in mass:	=	155 lb toluene	=	155 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	237.48	29.69		
A-2	HFPO Tower	1546.08	70.13		
B-1	Outside operations(excluding toluene system)			1547	
B-2	HFP Storage and Feed			501.89	
B-3	Benzene system			2.89	
B-4	Toluene mass balance			155.20	
	Total	1783.56	99.82	2207.38	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) are reported as 50% TAF and 50% TFF
A1 Non-AF VOCs from the barricade (E48) are reported as 50% HFP and 50% HFPO
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 60% HFP and 40% HFPO.
B2 HFP system VOCs are 100% HFP
B3 VOCs calculated in B3 are 100% benzene
B4 Toluene system emissions are 100% toluene

Compound	lb VOC
COF2	92.76
PAF	77.30
A/F Solvent (TFF)	24.69
A/F Solvent (TAF)	24.69
HFP	2312.88
HFPO	1300.52
Benzene	2.89
Toluene	155.20
Total VOC	3990.94

Equipment Cleaned/ Decontaminated	HFP (lb/yr)	HFPO (lb/yr)	TAF (lb/yr)	TFF (lb/yr)	COF2 (lb/yr)	PAF (lb/yr)
TOTAL	3175.23	5920.32	580.11	580.11	0.05	0.05
					Total VOC (lb/yr)	**10255.87**

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

Accidental Releases to Atmosphere

There were 3 accidental releases to the atmosphere recorded in 2015. Refer to incident reports for more information

I. Total Emissions from Accidental Releases

	Source (Incident date)	TAF (lb)	TFF (lb)	HFP (lb)	HFPO (lb)	COF2 (lb)	PAF (lb)	HFA (lb)	MeCl (lb)	Toluene (lb)	VOC (lb)	HF (lb)
A.	15-0028-RCI 2/22/15	0.00	0.00	0	0	0	0	0	0	0	0.00	0.00
B.	15-0076-RCI 5/21/15	0.0	0.0	0	0	0	0	0	0	0.5	0.50	0
C.	15-0120-RCI 8/14/2015	0.0	0.0	0.00	5.00	0	0	0	0	0	5.0	0
D.												
E.												
F.												
G.												
H.												
I.												
J.												
K.												
L.												
M.												
	Total	0	0	0	5	0	0	0	0	1	5.5	0

Vinyl Ethers North Process

NS-B

E0512

2015 Emissions Summary

A. VOC Emissions Summary

Nafion® Compound	CAS Chemical Name	CAS No.	EVE Process Emission (lb.)	PPVE Process Emission (lb.)	PSEPVE Process Emission (lb.)	Accid'l Releases (lb.)	Total Vinyl Ethers North Emissions (lb.)
HFP	Hexafluoropropylene	116-15-4	147	11,247	296		11,691
HFPO	Hexafluoropropylene oxide	428-59-1	145	22,803	1,205		24,152
HFPO-Dimer	2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-	2062-98-8	1	38	0		39
EVE	(Trifluoroethenyl oxy] Methyl]-1,2,2,2-Tetrafluoroethoxy] -2,2,3,3-Tetrafluoro-, Methyl Ester	63863-43-4	71	0	0		71
PPVE	Perfluoropropyl vinyl ether	1623-05-8	0	2,868	0		2,868
PSEPVE	Perfluoro-2-(2-Fluorosulfonylethoxy) Propyl Vinyl Ether	16090-14-5	0	0	277		277
PPF	Perfluoropropionyl fluoride	422-61-7	0	79	0		79
TFE	Tetrafluoroethylene	116-14-3	63	20	478		561
C4	Perfluoro-2-butene	360-89-4	0	440	1,095		1,535
C5	Perfluoropentene	376-87-4	0	38	0		38
Diglyme	Diethylene Glycol Dimethyl Ether	111-96-6	0	0	0		0
AN	Acetonitrile	75-05-8	0	375	0		375
ADN	Adiponitrile	111-69-3	0	0	0		0
TTG	Tetraglyme	143-24-8	2	0	0		2
DA	Tetrafluoro-2[Hexafluoro-2-(Tetrafluoro-2-{Fluorosulfonyl}Ethoxy) Propoxy	4089-58-1	0	0	14		14
Hydro-PSEPVE	Tetrafluoro-2-[Trifluoro-2-(1,2,2,2-Tetra-fluoroethoxy)-1-	755-02-9	0	0	0		0
MA	Tetrafluoro-2-[Tetrafluoro-2-(Fluorosulfonyl)Ethoxy]-Propanoyl	4089-57-0	0	0	6		6
MAE	Methyl Perfluoro (5-(Fluoroformyl)-4-Oxahexanoate)	69116-72-9	2	0	0		2
DAE	Methyl Perfloro (8-(Fluoroformyl)-5-methyl-4,7-Dioxanonanoate)	69116-73-0	3	0	0		3
TAE	Methyl Perfluoro (11-(Fluoroformyl)-5,8-Dimethyl-4,7,10-	69116-67-2	0	0	0		0
hydro-EVE	Methyl Perfloro-5-methyl-4,7-dioxanon-8-hydroaneoate	87483-34-9	6	0	0		6
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	0	0	0		0
HFPO Trimer	Perfluoro-2,5-Dimethyl-3,6-	2641-34-1	0	1	0		1
Iso-PSEPVE	Perfluoro-1-Methyl-2-(2	34805-58-8	0	0	0		0
	Total VOC Emissions (lbs)		448	37,908	3,372	0	41,728
	Total VOC Emissions (tons		0.2	19.0	1.7	0	20.9

B. VOC Control Device Efficiency

VOCs Generated Before Control (lbs)					VOCs After Control (lbs)
Process Emissions (lb.)	Equip't Emiss'n (lb.)	Maint. Emiss'n (lb.)	Accid'l Releases (lb.)	Total VOC Generated (lbs)	Total VOC Emitted (lbs)
48,073	2,888	1,301	0	52,262	**41,728**

52,262 lb VOC generated
41,728 lb VOC emitted
10,533 lb VOC removed in control device

10,533 lb VOC removed in control device
52,262 lb VOC generated
= **20.16% VOC control efficiency**

2015 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 99.6% for all acid fluoride compounds. Some emitted compounds are assumed to pass completely through the scrubber, so the control efficiency for those compounds is assumed to be 0%. The control of emissions of specific compounds will be addressed and detailed in the following pages.

The 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.

B. HFPO
Hexafluoropropylene oxide

CAS No. 428-59-1

HF Potential:

HFPO is a VOC without the potential to form HF

Quantity Released

HFPO unreacted in condensation is vented to the WGS.

HFPO vented per the process flowsheet

Vented from the Condensation Reactor: $\frac{3.28\ kg\ HFPO}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

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 535 kg total Condensation Reactor vent stream (22266FG).
HFPO vented based on 21,690 kg total Crude Receiver vent stream (22701FG).
HFPO vented based on 4 kg total Foreshots Receiver vent stream (22826FG).

HFPO vented from Condensation Reactor:

$\frac{3.28\ kg\ HFPO}{3.66\ kg\ CndRx}$ x 535 kg CndRx = 480 kg HFPO

HFPO vented from Crude Receiver

$\frac{0.00\ kg\ HFPO}{18.76\ kg\ CrRec}$ x 21,690 kg CrRec = 0 kg HFPO

HFPO vented from Foreshots Receiver

$\frac{0.00\ kg\ HFPO}{0.33\ kg\ FsRec}$ x 4 kg FsRec = 0 kg HFPO

VOC Emissions				
		480 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
	=	480 kg HFPO	=	480 kg VOC
				1,055 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	535	kg total Condensation Reactor vent stream (22266FG).
PPF vented based on	21,690	kg total Crude Receiver vent stream (22701FG).
PPF vented based on	4	kg total Foreshots Receiver vent stream (22826FG).

Before control PPF vented from Condensation Reactor:

$\frac{0.20\ kg\ PPF}{3.66\ kg\ CndRx}$ x 535 kg CndRx = 30 kg PPF

PPF vented from Crude Receiver

$\frac{0.00\ kg\ PPF}{18.76\ kg\ CrRec}$ x 21,690 kg CrRec = 0 kg PPF

PPF vented from Foreshots Receiver

$\frac{0.00\ kg\ PPF}{0.33\ kg\ FsRec}$ x 4 kg FsRec = 0 kg PPF

Total before-control PPF vented = 30 kg PPF

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

VOC Emissions

		30 kg PPF			
Waste Gas Scrubber	x	(100%-99.6%) Control Efficiency			
	=	0.12 kg PAF	=	**0.12**	kg VOC
			=	**0.26**	**lb. VOC**

HF Equivalent Emissions

	0 kg PPF	
x	0.120 kg HF/kg PPF	
=	0.01 kg HF	**0.03 lb. HF**

D. TFE
Tetrafluoroethylene

CAS No. 116-14-3

HF Potential:

TFE is a VOC without the potential to form HF

Quantity Released

TFE is a byproduct that can be formed in the ABR system. It is an inert in VE-North that is vented to the WGS.

TFE vented per the process flowsheet

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

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	535 kg total Condensation Reactor vent stream (22266FG).
TFE vented based on	21,690 kg total Crude Receiver vent stream (22701FG).
TFE vented based on	4 kg total Foreshots Receiver vent stream (22826FG).

TFE vented from Condensation Reactor:

0.00 / 3.66 kg TFE / kg CndRx	x	535 kg CndRx	=	0 kg TFE

TFE vented from Crude Receiver

0.19 / 18.76 kg TFE / kg CrRec	x	21,690 kg CrRec	=	217 kg TFE

TFE vented from Foreshots Receiver

0.00 / 0.33 kg TFE / kg FsRec	x	4 kg FsRec	=	0 kg TFE

VOC Emissions

		0 kg from Condensation Reactor		
	+	217 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
=		217 kg TFE	=	217 kg VOC
				477 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 535 kg total Condensation Reactor vent stream (22266FG).
PSEPVE vented based on 21,690 kg total Crude Receiver vent stream (22701FG).
PSEPVE vented based on 4 kg total Foreshots Receiver vent stream (22826FG).

PSEPVE vented from Condensation Reactor:

0.00 / 3.66 kg PSEPVE / kg CndRx	x	535 kg CndRx	=	0 kg PSEPVE

PSEPVE vented from Crude Receiver

0.00 / 18.76 kg PSEPVE / kg CrRec	x	21,690 kg CrRec	=	0 kg PSEPVE

PSEPVE vented from Foreshots Receiver

0.07 / 0.33 kg PSEPVE / kg FsRec	x	4 kg FsRec	=	0.84 kg PSEPVE

VOC Emissions

		0 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	0.84 kg from Foreshots Receiver		
=		0.84 kg PSEPVE	=	0.84 kg VOC
				1.84 lb VOC

F. C4 **CAS No. 360-89-4**
Perfluoro-2-butene

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 535 kg total Condensation Reactor vent stream (22266FG).
C4s vented based on 21,690 kg total Crude Receiver vent stream (22701FG).
C4s vented based on 4 kg total Foreshots Receiver vent stream (22826FG).

C4s vented from Condensation Reactor:

0.00 / 3.66 kg C4s / kg CndRx	x	535 kg CndRx	=	0 kg C4s

C4s vented from Crude Receiver

0.41 / 18.76 kg C4s / kg CrRec	x	21,690 kg CrRec	=	477 kg C4s

C4s vented from Foreshots Receiver

0.10 / 0.33 kg C4s / kg FsRec	x	4 kg FsRec	=	1 kg C4s

VOC Emissions

		0 kg from Condensation Reactor		
	+	477 kg from Crude Receiver		
	+	1 kg from Foreshots Receiver		
=		478 kg C4s	=	478 kg VOC
				1,052 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: $\frac{0\ kg\ HFPO Trimer}{18.76\ kg\ Crude Receiver\ Vent}$

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

HFPO Trimer vented based on 535 kg total Condensation Reactor vent stream (22266FG).
HFPO Trimer vented based on 21,690 kg total Crude Receiver vent stream (22701FG).
HFPO Trimer vented based on 4 kg total Foreshots Receiver vent stream (22826FG).

Before control HFPO Trimer vented from Condensation Reactor:

0.00 / 3.66 kg HFPO Trimer / kg CndRx	x	535 kg CndRx	=	0 kg HFPO Trimer

HFPO Trimer vented from Crude Receiver

0.00 / 18.76 kg HFPO Trimer / kg CrRec	x	21,690 kg CrRec	=	0 kg HFPO Trimer

HFPO Trimer vented from Foreshots Receiver

0.01 / 0.33 kg HFPO Trimer / kg FsRec	x	4 kg FsRec	=	0.17 kg HFPO Trimer

Total before-control HFPO Trimer vented 0.17 kg VOC

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

VOC Emissions

Waste Gas Scrubber

	0.17	kg HFPO Trimer		
x	(100%-99.6%)	Control Efficiency		
=	0.0007	kg HFPO Trimer	=	0.0007 kg VOC
			=	**0.001 lb. VOC**

HF Equivalent Emissions

	0.0007	kg HFPO Trimer	
x	0.040	kg HF/kg HFPO Trimer	
=	0.00003	kg HF	**0.00006 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 535 kg total Condensation Reactor vent stream (22266FG).
MA vented based on 21,690 kg total Crude Receiver vent stream (22701FG).
MA vented based on 4 kg total Foreshots Receiver vent stream (22826FG).

Before control MA vented from Condensation Reactor:

$\frac{0.00\ kg\ MA}{3.66\ kg\ CndRx}$ x 535 kg CndRx = 0 kg MA

MA vented from Crude Receiver

$\frac{0.00\ kg\ MA}{18.76\ kg\ CrRec}$ x 21,690 kg CrRec = 0 kg MA

MA vented from Foreshots Receiver

$\frac{0.0045\ kg\ MA}{0.33\ kg\ FsRec}$ x 4 kg FsRec = 0.056 kg MA

Total before-control MA vented = 0.056 kg MA

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

VOC Emissions		0.056 kg MA		
	Waste Gas Scrubber	x (100%-99.6%) Control Efficiency		
		= 0.00022 kg MA	=	0.00022 kg VOC
			=	**0.000 lb. VOC**

HF Equivalent Emissions	0.00022 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 535 kg total Condensation Reactor vent stream (22266FG).
DA vented based on 21,690 kg total Crude Receiver vent stream (22701FG).
DA vented based on 4 kg total Foreshots Receiver vent stream (22826FG).

Before control DA vented from Condensation Reactor:
$\frac{0.00\,kg\,DA}{3.66\,kg\,CndRx}$ x 535 kg CndRx = 0 kg DA

DA vented from Crude Receiver
$\frac{0.00\,kg\,DA}{18.76\,kg\,CrRec}$ x 21,690 kg CrRec = 0 kg DA

DA vented from Foreshots Receiver
$\frac{0.13\,kg\,DA}{0.33\,kg\,FsRec}$ x 4 kg FsRec = 1.62 kg DA

Total before-control DA vented = 1.62 kg DA

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

VOC Emissions

		1.62 kg DA		
Waste Gas Scrubber	x	(100%-99.6%) Control Efficiency		
	=	0.0065 kg DA	=	0.006 kg VOC
			=	**0.014 lb. VOC**

HF Equivalent Emissions

		0.0065 kg DA		
	x	0.039 kg HF/kg DA		
	=	0.00025 kg HF	=	**0.00 lb. HF**

J. Hydro PSEPVE **CAS No. 755-02-9**

Tetrafluoro-2-[Trifluoro-2-(1,2,2,2-Tetra-fluoroethoxy)-1-(Trifluoromethyl) Ethoxy]-Ethane Sulfonyl Fluoride

HF Potential:

Hydro-PSEPVE is a VOC without the potential to form HF

Quantity Released

Hydro-PSEPVE vented per the process flowsheet

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

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	535	kg total Condensation Reactor vent stream (22266FG).
Hydro-PSEPVE vented based on	21,690	kg total Crude Receiver vent stream (22701FG).
Hydro-PSEPVE vented based on	4	kg total Foreshots Receiver vent stream (22826FG).

Hydro-PSEPVE vented from Condensation Reactor:

$$\frac{0.00\ \text{kg Hydro-PSEPVE}}{3.66\ \text{kg CndRx}} \times 535\ \text{kg CndRx} = 0\ \text{kg Hydro-PSEPVE}$$

Hydro-PSEPVE vented from Crude Receiver

$$\frac{0.00\ \text{kg Hydro-PSEPVE}}{18.76\ \text{kg CrRec}} \times 21{,}690\ \text{kg CrRec} = 0\ \text{kg Hydro-PSEPVE}$$

Hydro-PSEPVE vented from Foreshots Receiver

$$\frac{0.0045\ \text{kg Hydro-PSEPVE}}{0.33\ \text{kg FsRec}} \times 4\ \text{kg FsRec} = 0.056\ \text{kg Hydro-PSEPVE}$$

VOC Emissions				
		0 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	0.056 kg from Foreshots Receiver		
	=	0.056 kg Hydro-PSEPV	=	0.056 kg VOC
				0.123 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 $\frac{0\ kg\ Iso-PSEPVE}{18.76\ kg\ Crude\ Receiver\ Vent}$

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

Iso-PSEPVE vented based on 535 kg total Condensation Reactor vent stream (22266FG).
Iso-PSEPVE vented based on 21,690 kg total Crude Receiver vent stream (22701FG).
Iso-PSEPVE vented based on 4 kg total Foreshots Receiver vent stream (22826FG).

Iso-PSEPVE vented from Condensation Reactor:

$\frac{0.00\ kg\ Iso\text{-}PSEPVE}{3.66\ kg\ CndRx}$ x 535 kg CndRx = 0 kg Iso-PSEPVE

Iso-PSEPVE vented from Crude Receiver

$\frac{0.00\ kg\ Iso\text{-}PSEPVE}{18.76\ kg\ CrRec}$ x 21,690 kg CrRec = 0 kg Iso-PSEPVE

Iso-PSEPVE vented from Foreshots Receiver

$\frac{0.014\ kg\ Iso\text{-}PSEPVE}{0.33\ kg\ FsRec}$ x 4 kg FsRec = 0.168 kg Iso-PSEPVE

VOC Emissions

	0 kg from Condensation Reactor			
+	0 kg from Crude Receiver			
+	0.168 kg from Foreshots Receiver			
=	0.168 kg Iso-PSEPVE	=	0.168 kg VOC	
			0.369 lb VOC	

L. Diglyme

CAS No. 111-96-6

The emissions of diglyme is based on a mass balance

Quantity Released

=	4,631	kg diglyme introduced into processes
=	4,631	kg diglyme transferred to H/C waste tank
=	0	kg diglyme unaccounted for and assumed emitted
=	**0**	**lb.Diglyme**

Emissions of diglyme from PSEPVE = **0** **lb. Diglyme**

M. Sulfonyl Fluoride (SOF2) **CAS No. 7783-42-8**

HF Potential:

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

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

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 535 kg total Condensation Reactor vent stream (22266FG).
SOF2 vented based on 21,690 kg total Crude Receiver vent stream (22701FG).
SOF2 vented based on 4 kg total Foreshots Receiver vent stream (22826FG).

Before control SOF2 vented from Condensation Reactor:

$\frac{0.00\ kg\ SOF2}{3.66\ kg\ CndRx}$ x 535 kg CndRx = 0 kg SOF2

SOF2 vented from Crude Receiver

$\frac{0.00\ kg\ SOF2}{18.76\ kg\ CrRec}$ x 21,690 kg CrRec = 0 kg SOF2

SOF2 vented from Foreshots Receiver

$\frac{0.00\ kg\ SOF2}{0.33\ kg\ FsRec}$ x 4 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%-99.6%) 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)

N. 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 $\frac{0\ kg\ CO2}{0.33\ kg\ Foreshot\ Receiver\ Vent}$

CO vented based on	535	kg total Condensation Reactor vent stream (22266FG).
CO vented based on	21,690	kg total Crude Receiver vent stream (22701FG).
CO vented based on	4	kg total Foreshots Receiver vent stream (22826FG).

CO2 vented from Condensation Reactor:

$\frac{0.00}{3.66}$ kg CO / kg CndRx x 535 kg CndRx = 0 kg CO2

CO2 vented from Crude Receiver

$\frac{17.45}{18.76}$ kg CO2 / kg CrRec x 21,690 kg CrRec = 20,171 kg CO2

CO2 vented from Foreshots Receiver

$\frac{0.00}{0.33}$ kg CO2 / kg FsRec x 4 kg FsRec = 0 kg CO2

CO2 Emissions Exit WGS

	0	kg from Condensation Reactor		
+	81	kg from Crude Receiver		
+	0	kg from Foreshots Receiver		
=	81	kg CO2	=	**178 lb CO2**
				(not a VOC)

O. VOC Summary

	Nafion Compound Name	Before Control Generated		After Control Stack Emissions	
				VOC	HF
		kg/yr	lb/yr	lb/yr	lb/yr
A.	HFP	108	238	238	
B.	HFPO	480	1057	1,057	
C.	PPF	30	66	0.26	0.03
D.	TFE	217	478	478	
E.	PSEPVE	1	2	2	
F.	C4	478	1055	1,055	
G.	HFPO Trimer	0.17	0	0.00	0.00
H.	MA	0.06	0	0.000	0.00
I.	DA	1.62	4	0.01	0.00
J.	Hydro PSEPVE	0.06	0.1	0.1	
K.	Iso PSEPVE	0.17	0	0	
L.	Diglyme	0	0	0	
M.	SOF2 (not a VOC)				
N.	CO2 (not a VOC)				0
	Total	**1,316**	**2,901**	**2,831**	**0.0**

P. Total Emission Summary**

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

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions (Note 1) lb/yr	Maintenance Emissions (Note 2) lb/yr	Total Emissions lb/yr
A.	HFP	238	31	27	296
B.	HFPO	1,057	141	6	1,205
C.	PPF	0.26	0	0	0
D.	TFE	478	0	0	478
E.	PSEPVE	2	275	0	277
F.	C4	1;055	21	20	1,095
G.	HFPO Trimer	0.00	0	0	0
H.	MA	0.00	0	5	6
I.	DA	0.01	2	12	14
J.	Hydro-PSEPVE	0.1	0	0	0
K.	Iso-PSEPVE	0.4	0	0	0
L.	Diglyme		70	3	0
M.	SOF2 (not a VOC)	0.0	0	0	0
N.	CO2 (not a VOC)		0	0	178
*	TA		0	0	0
*	RSU		0	0	0
*	HFPO-Dimer		0	0	0
	Total	2,831	0	0	**3,550**

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

Total Non AF 2,831

Total AF 0.28

HF Equivalent Emissions

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
C.	PPF	0.03	0.00	0.01	0.04
G.	HFPO Trimer	0.00	0.00	0.01	0.01
H.	MA	0.00	0.03	0.30	0.33
I.	DA	0.00	0.08	0.46	0.54
M.	SOF2	0.00			0.00
*	TA		0.00	0.01	0.01
*	RSU		0.00	0.00	0.01
*	HFPO-Dimer		0.00	0.02	0.02
	Total	**0.03**	**0.11**	**0.78**	**0.92**

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:

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

2015 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: $\dfrac{0.05\ kg\ HFP}{2.35\ kg\ CondRx\ Vent\ Flow}$

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

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

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

HFP vented based on	2,450 kg total Condensation Reactor vent stream (22266FG).
HFP vented based on	15,726 kg total Crude Receiver vent stream (22701FG).
HFP vented based on	1,021 kg total Foreshots Receiver vent stream (22826FG).
HFP vented based on	16,780 kg in the Stripper vent stream (22231FC).

HFP vented from Condensation Reactor:

$\dfrac{0.05\ kg\ HFP}{2.35\ kg\ CndRx}$ x 2,450 kg CndRx = 57 kg HFP

HFP vented from Crude Receiver

$\dfrac{0.00\ kg\ HFP}{3.97\ kg\ CrRec}$ x 15,726 kg CrRec = 0 kg HFP

HFP vented from Foreshots Receiver

$\dfrac{0.01\ kg\ HFP}{1.06\ kg\ FsRec}$ x 1,021 kg FsRec = 9 kg HFP

HFP vented from Stripper

$\dfrac{30\ kg\ HFP}{100\ kg\ Strpr}$ x 16,780 kg Strpr = 5,034 kg HFP

VOC Emissions

		57 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	9 kg from Foreshots Receiver		
		5,034 kg from Stripper		
	=	5,099 kg HFP	=	5,099 kg VOC
				11,242 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: $\frac{0.11\ kg\ HFPO}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}$

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

Vented from the Foreshots Receiver $\frac{0\ kg\ HFPO}{1.06\ kg\ Foreshots Receiver Vent}$

Vented from the Stripper $\frac{60\ kg\ HFPO}{100\ kg\ Stripper\ Vent}$

HFPO vented based on 2,450 kg total Condensation Reactor vent stream (22266FG).
HFPO vented based on 15,726 kg total Crude Receiver vent stream (22701FG).
HFPO vented based on 1,021 kg total Foreshots Receiver vent stream (22826FG).
HFP vented based on 16,780 kg in the Stripper vent stream (22231FC).

HFPO vented from Condensation Reactor:

$\frac{0.11\ \text{kg HFPO}}{2.35\ \text{kg CndRx}}$ x 2,450 kg CndRx = 118 kg HFPO

HFPO vented from Crude Receiver

$\frac{0.00\ \text{kg HFPO}}{3.97\ \text{kg CrRec}}$ x 15,726 kg CrRec = 0 kg HFPO

HFPO vented from Foreshots Receiver

$\frac{0.00\ \text{kg HFPO}}{1.06\ \text{kg FsRec}}$ x 1,021 kg FsRec = 0 kg HFPO

HFP vented from Stripper

$\frac{60\ \text{kg HFPO}}{100\ \text{kg Strpr}}$ x 16,780 kg Strpr = 10,068 kg HFPO

VOC Emissions

		118 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
	+	10,068 kg from Stripper		
=		10,186 kg HFPO	=	10,186 kg VOC
				22,457 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 $\frac{0\ kg\ PPF}{3.97\ kg\ Crude\ Receiver\ Vent}$

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

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

PPF vented based on 2,450 kg total Condensation Reactor vent stream (22266FG).
PPF vented based on 15,726 kg total Crude Receiver vent stream (22701FG).
PPF vented based on 1,021 kg total Foreshots Receiver vent stream (22826FG).
PPF vented based on 16,780 kg in the Stripper vent stream (22231FC).

Before control PPF vented from Condensation Reactor:
$\frac{2.14\ kg\ PPF}{2.35\ kg\ CndRx}$ x 2,450 kg CndRx = 2,227 kg PPF

PPF vented from Crude Receiver
$\frac{0.00\ kg\ PPF}{3.97\ kg\ CrRec}$ x 15,726 kg CrRec = 0 kg PPF

PPF vented from Foreshots Receiver
$\frac{0.00\ kg\ PPF}{1.06\ kg\ FsRec}$ x 1,021 kg FsRec = 0 kg PPF

PPF vented from Stripper
$\frac{10\ kg\ PPF}{100\ kg\ Strpr}$ x 16,780 kg Strpr = 1,678 kg PPF

Total before-control PPF vented = 3,905 kg PPF

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

VOC Emissions
3,905 kg PAF
Waste Gas Scrubber x (100%-99.1%)
= 35 kg PAF = 35 kg VOC
= **77 lb. VOC**

HF Equivalent Emissions
35 kg PAF
x 0.120 kg HF/kg PAF
= 4 kg HF = **9.3 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 2,450 kg total Condensation Reactor vent stream (22266FG).
TFE vented based on 15,726 kg total Crude Receiver vent stream (22701FG).
TFE vented based on 1,021 kg total Foreshots Receiver vent stream (22826FG).
TFE vented based on 16,780 kg in the Stripper vent stream (22231FC).

TFE vented from Condensation Reactor:

$\frac{0.00\ kg\ TFE}{2.35\ kg\ CndRx}$ x 2,450 kg CndRx = 0 kg TFE

TFE vented from Crude Receiver

$\frac{0.0012\ kg\ TFE}{3.97\ kg\ CrRec}$ x 15,726 kg CrRec = 5 kg TFE

TFE vented from Foreshots Receiver

$\frac{0.0045\ kg\ TFE}{1.06\ kg\ FsRec}$ x 1,021 kg FsRec = 4 kg TFE

TFE vented from Stripper

$\frac{0\ kg\ TFE}{100\ kg\ Strpr}$ x 16,780 kg Strpr = 0 kg TFE

VOC Emissions				
		0 kg from Condensation Reactor		
	+	5 kg from Crude Receiver		
	+	4 kg from Foreshots Receiver		
	+	0 kg from Stripper		
=		9 kg TFE	=	9 kg VOC
				20 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: $\dfrac{0\ kg\ PPVE}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}$

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

Vented from the Foreshots Receiver $\dfrac{0.88\ kg\ PPVE}{1.06\ kg\ ForeshotsReceiverVent}$

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

PPVE vented based on 2,450 kg total Condensation Reactor vent stream (22266FG).
PPVE vented based on 15,726 kg total Crude Receiver vent stream (22701FG).
PPVE vented based on 1,021 kg total Foreshots Receiver vent stream (22826FG).
PPVE vented based on 16,780 kg in the Stripper vent stream (22231FC).

PPVE vented from Condensation Reactor:

$\dfrac{0.00\ kg\ PPVE}{2.35\ kg\ CndRx}$ x 2,450 kg CndRx = 0 kg PPVE

PPVE vented from Crude Receiver

$\dfrac{0.0020\ kg\ PPVE}{3.97\ kg\ CrRec}$ x 15,726 kg CrRec = 8 kg PPVE

PPVE vented from Foreshots Receiver

$\dfrac{0.88\ kg\ PPVE}{1.06\ kg\ FsRec}$ x 1,021 kg FsRec = 847 kg PPVE

PPVE vented from Stripper

$\dfrac{0\ kg\ PPVE}{100\ kg\ Strpr}$ x 16,780 kg Strpr = 0 kg PPVE

VOC Emissions		0 kg from Condensation Reactor		
	+	8 kg from Crude Receiver		
	+	847 kg from Foreshots Receiver		
	+	0 kg from Stripper		
=		854 kg PPVE	=	854 kg VOC
				1,884 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	2,450 kg total Condensation Reactor vent stream (22266FG).
C4s vented based on	15,726 kg total Crude Receiver vent stream (22701FG).
C4s vented based on	1,021 kg total Foreshots Receiver vent stream (22826FG).
C4s vented based on	16,780 kg in the Stripper vent stream (22231FC).

C4s vented from Condensation Reactor:

$\frac{0.00 \text{ kg C4s}}{2.35 \text{ kg CndRx}}$ x 2,450 kg CndRx = 0 kg C4s

C4s vented from Crude Receiver

$\frac{0.0012 \text{ kg C4s}}{3.97 \text{ kg CrRec}}$ x 15,726 kg CrRec = 5 kg C4s

C4s vented from Foreshots Receiver

$\frac{0.15 \text{ kg C4s}}{1.06 \text{ kg FsRec}}$ x 1,021 kg FsRec = 144 kg C4s

C4s vented from Stripper

$\frac{0 \text{ kg C4s}}{100 \text{ kg Strpr}}$ x 16,780 kg Strpr = 0 kg C4s

VOC Emissions

		0 kg from Condensation Reactor		
	+	5 kg from Crude Receiver		
	+	144 kg from Foreshots Receiver		
	+	0 kg from Stripper		
=		149 kg C4s	=	149 kg VOC
				328 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	2,450	kg total Condensation Reactor vent stream (22266FG).
C5s vented based on	15,726	kg total Crude Receiver vent stream (22701FG).
C5s vented based on	1,021	kg total Foreshots Receiver vent stream (22826FG).
C5s vented based on	16,780	kg in the Stripper vent stream (22231FC).

C5s vented from Condensation Reactor:

$\frac{0.00\ kg\ C5s}{2.35\ kg\ CndRx}$ x 2,450 kg CndRx = 0 kg C5s

C5s vented from Crude Receiver

$\frac{0.00\ kg\ C5s}{3.97\ kg\ CrRec}$ x 15,726 kg CrRec = 0 kg C5s

C5s vented from Foreshots Receiver

$\frac{0.02\ kg\ C5s}{1.06\ kg\ FsRec}$ x 1,021 kg FsRec = 17 kg C5s

C4s vented from Stripper

$\frac{0\ kg\ C5s}{100\ kg\ Strpr}$ x 16,780 kg Strpr = 0 kg C5s

VOC Emissions

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

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.
They are inerts in VE-North that are vented to the WGS.

CO2 vented per the process flowsheet

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

Vented from the Crude Receiver $\frac{1.27\ kg\ CO}{3.97\ kg\ Crude\ Receiver\ Vent}$

Vented from the Foreshots Receiver $\frac{0\ kg\ CO}{1.06\ kg\ Foreshots Receiver Vent}$

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

CO2 vented based on	2,450	kg total Condensation Reactor vent stream (22266FG).
CO2 vented based on	15,726	kg total Crude Receiver vent stream (22701FG).
CO2 vented based on	1,021	kg total Foreshots Receiver vent stream (22826FG).
CO2 vented based on	16,780	kg in the Stripper vent stream (22231FC).

CO2 vented from Condensation Reactor:

$\frac{0.00\ kg\ CO2}{2.35\ kg\ CndRx}$ x 2,450 kg CndRx = 0 kg CO2

CO2 vented from Crude Receiver

$\frac{3.45\ kg\ CO2}{3.97\ kg\ CrRec}$ x 15,726 kg CrRec = 13,682 kg CO2

CO2 vented from Foreshots Receiver

$\frac{0.00\ kg\ CO2}{1.06\ kg\ FsRec}$ x 1,021 kg FsRec = 0 kg CO2

CO2 vented from Stripper

$\frac{0\ kg\ CO2}{100\ kg\ Strpr}$ x 16,780 kg Strpr = 0 kg CO2

CO2 Emissions

		0 kg from Condensation Reactor			
	+	13,682 kg from Crude Receiver			
	+	0 kg from Foreshots Receiver			
	+	0 kg from Stripper			
=		13,682 kg CO2	=	**30,163 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	11,776 kg AN fed
Hydrocarbon waste sent to Hydrocarbon waste tank =	11,776 kgs H/C waste
PPVE generated during the year	202,957 kg PPVE

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

AN portion of hydrocarbon waste stream:

	11,776	kg to H/C waste
x	(1-(.1))	
=	11,187	kg AN to H/C waste

Material Balance

Based on total Vinyl ether produced 202,957 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:

	202,957	kg PPVE	
\	0.90	Crude	
\	0.70	AF	
x	0.0015	ppm AN	
=	483	kg AN	in Feed to ABR

VOC Emission

	11,776	kg AN fed
	11,187	kg AN to H/C waste
-	483	kg AN to ABR
	106	kg AN
	106	**kg VOC**
	233	**lb VOC**

AN only used during a PPVE Campaign

Total AN 233 **lb VOC**

J. VOC Summary

Nafion Compound Name		Before Control Generated		After Control Stack Emissions
		kg/yr	lb/yr	VOC lb/yr
A.	HFP	5,099	11,242	11,242
B.	HFPO	10,186	22,457	22,457
C.	PPF	3,905	8,610	77
D.	TFE	9	20	20
E.	PPVE	854	1,884	1,884
F.	C4	149	328	328
G.	C5	17	38	38
I.	AN	106	233	233
	Total	20,326	44,812	36,279

K. Total Emission Summary**

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

Nafion Compound Name		Process Emissions lb/yr	Equipment Emissions (Note 1) lb/yr	Maintenance Emissions (Note 2) lb/yr	Total Emissions lb/yr
A.	HFP	11,242	5	0	11,247
B.	HFPO	22,457	331	15	22,803
C.	PPF	77	0	1	79
D.	TFE	20	0	0	20
E.	PPVE	1,884	543	441	2,868
F.	C4	328	53	59	440
G.	C5	38	0	0	38
H.	CO2 (not a VOC)	30,163	0	0	30,163
I.	AN	233	136	6	375
*	HFPO-Dimer		7	31	38
*	HFPO Trimer		0	1	1
	Total	**66,443**	**1,075**	**555**	**68,072**

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

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

CO not realistically expected through equipment or maintenance emissions

AN total based on material balance, see section K.

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

L. HF Equivalent Emissions

Nafion Compound Name		Process Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
C.	PPF	9.3	0.0	0.13	9.47
*	HFPO-Dimer		0.4	1.86	2.27
*	HFPO Trimer		0.0	0.03	0.03
	Total	**9.3**	**0**	**2.01**	**11.77**

* 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:

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

2015 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	190 kg total Condensation Reactor vent stream (22266FG).
HFP vented based on	2,589 kg total Crude Receiver vent stream (22701FG).
HFP vented based on	2 kg total Foreshots Receiver vent stream (22826FG).

HFP vented from Condensation Reactor:

$\frac{0.17\text{ kg HFP}}{0.50\text{ kg CndRx}}$ x 190 kg CndRx = 66 kg HFP

HFP vented from Crude Receiver

$\frac{0.00\text{ kg HFP}}{15.91\text{ kg CrRec}}$ x 2,589 kg CrRec = 0 kg HFP

HFP vented from Foreshots Receiver

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

VOC Emissions				
		66 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
	=	**66** kg HFP	=	66 kg VOC
				146 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 190 kg total Condensation Reactor vent stream (22266FG).
HFPO vented based on 2,589 kg total Crude Receiver vent stream (22701FG).
HFPO vented based on 2 kg total Foreshots Receiver vent stream (22826FG).

HFPO vented from Condensation Reactor:

$\frac{0.13\ kg\ HFPO}{0.50\ kg\ CndRx}$ x 190 kg CndRx = 49 kg HFPO

HFPO vented from Crude Receiver

$\frac{0.00\ kg\ HFPO}{15.91\ kg\ CrRec}$ x 2,589 kg CrRec = 0 kg HFPO

HFPO vented from Foreshots Receiver

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

VOC Emissions

VOC Emissions		49 kg from Condensation Reactor		
	+	0 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
	=	49 kg HFPO	=	49 kg VOC
				108 lb VOC

C. Perfluoro-2-Propoxy Propionyl Fluoride (HFPO Dimer) **CAS No. 2062-98-8**

HF Potential:

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

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

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

Quantity Released

Before-control HFPO Dimer vented per the process flowsheet

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

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

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

HFPO Dimer vented based on	190	kg total Condensation Reactor vent stream (22266FG).
HFPO Dimer vented based on	2,589	kg total Crude Receiver vent stream (22701FG).
HFPO Dimer vented based on	2	kg total Foreshots Receiver vent stream (22826FG).

Before control HFPO Dimer vented from Condensation Reactor:

$\frac{0.05\ \text{kg HFPO Dimer}}{0.50\ \text{kg CndRx}}$ x 190 kg CndRx = 19 kg HFPO Dimer

HFPO Dimer vented from Crude Receiver

$\frac{0.00\ \text{kg HFPO Dimer}}{15.91\ \text{kg CrRec}}$ x 2,589 kg CrRec = 0 kg HFPO Dimer

HFPO Dimer vented from Foreshots Receiver

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

Total before-control HFPO Dimer vented = 19 kg HFPO Dimer

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

VOC Emissions

Waste Gas Scrubber

19 kg Dimer
x (100%-99.1%)
= 0.17 kg Dimer 0.17 kg VOC
= **0.38 lb. VOC**

HF Equivalent Emissions

0.17 kg Dimer
x 0.060 kg HF/kg Dimer
= 0.01 kg HF **0.02 lb. HF**

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

HF Potential:

TFE is a VOC without the potential to form HF

Quantity Released

TFE is a byproduct that can be formed in the ABR system. It is an inert in VE-North that is vented to the WGS.

TFE vented per the process flowsheet

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

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	190 kg total Condensation Reactor vent stream (22266FG).
TFE vented based on	2,589 kg total Crude Receiver vent stream (22701FG).
TFE vented based on	2 kg total Foreshots Receiver vent stream (22826FG).

TFE vented from Condensation Reactor:

$\frac{0.00}{0.50} \frac{kg\ TFE}{kg\ CndRx}$ x 190 kg CndRx = 0 kg TFE

TFE vented from Crude Receiver

$\frac{0.18}{15.91} \frac{kg\ TFE}{kg\ CrRec}$ x 2,589 kg CrRec = 28 kg TFE

TFE vented from Foreshots Receiver

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

VOC Emissions

		0 kg from Condensation Reactor		
	+	28 kg from Crude Receiver		
	+	0 kg from Foreshots Receiver		
	=	28 kg TFE	=	28 kg VOC
				63 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).

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

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

Quantity Released

Before-control MAE vented per the process flowsheet

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

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	190 kg total Condensation Reactor vent stream (22266FG).
MAE vented based on	2,589 kg total Crude Receiver vent stream (22701FG).
MAE vented based on	2 kg total Foreshots Receiver vent stream (22826FG).

Before control MAE vented from Condensation Reactor:

0.00 kg MAE / 0.50 kg CndRx	x	190 kg CndRx	=	0 kg MAE

MAE vented from Crude Receiver

0.00 kg MAE / 15.91 kg CrRec	x	2,589 kg CrRec	=	0 kg MAE

MAE vented from Foreshots Receiver

0.04 kg MAE / 0.14 kg FsRec	x	2 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%)	
	=	0.00 kg MAE	0.00 kg VOC
		=	**0.01 lb. VOC**

HF Equivalent Emissions

	0.00 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 190 kg total Condensation Reactor vent stream (22266FG).
EVE vented based on 2,589 kg total Crude Receiver vent stream (22701FG).
EVE vented based on 2 kg total Foreshots Receiver vent stream (22826FG).

EVE vented from Condensation Reactor:

0.00 / 0.50 kg EVE / kg CndRx	x	190 kg CndRx	=	0 kg EVE

EVE vented from Crude Receiver

0.00 / 15.91 kg EVE / kg CrRec	x	2,589 kg CrRec	=	0 kg EVE

EVE vented from Foreshots Receiver

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

VOC Emissions

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

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

The emissions of Tetraglyme is based on a mass balance.

Quantity Released

	=	148	kg TTG introduced into processes
	=	148	kg TTG transferred to H/C waste tank
	=	0	kg TTG unaccounted for and assumed emitted
	=	**0**	**lb. Tetraglyme**

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

H. Carbon Monoxide (CO)

CAS No. 630-08-0

HF Potential:

CO can not form HF

Quantity Released

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

CO vented per the process flowsheet

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

Vented from the Crude Receiver $\frac{0.59\ kg\ CO}{14.91\ kg\ Crude\ Receiver\ Vent}$

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

CO vented based on	190 kg total Condensation Reactor vent stream (22266FG).
CO vented based on	2,589 kg total Crude Receiver vent stream (22701FG).
CO vented based on	2 kg total Foreshots Receiver vent stream (22826FG).

CO vented from Condensation Reactor:

$\frac{0.00\ kg\ CO}{0.50\ kg\ CndRx}$ x 190 kg CndRx = 0 kg CO

CO vented from Crude Receiver

$\frac{0.59\ kg\ CO}{15.91\ kg\ CrRec}$ x 2,589 kg CrRec = 96 kg CO

CO vented from Foreshots Receiver

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

CO Emissions

	0 kg from Condensation Reactor		
+	96 kg from Crude Receiver		
+	0 kg from Foreshots Receiver		
=	96 kg CO	=	**211 lb CO**

(not a VOC)

I. Adiponitrile **CAS No. 111-69-3**

HF Potential

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

Quantity Released

ADN emissions based on 1,479 kg ADN fed

VE North ADN Sent to waste Hydrocarbon tank = 1,479 kgs H/C waste

VOC Emission

	1,479 kg ADN fed	
-	1,479 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	66	146	146
B.	HFPO	49	108	108
C.	HFPO-Dimer	19	42	0
D.	TFE	28	63	63
E.	MAE	1	1	0.0
F.	EVE	0	0	0.1
G.	TTG	0	0	0
K.	ADN	0	0	0
	Total	**163**	**360**	**317.4**

K. Total Emission Summary**

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

Nafion Compound Name		Process Emissions lb/yr	Equipment Emissions (Note 1) lb/yr	Maintenance Emissions (Note 2) lb/yr	Total Emissions lb/yr
A.	HFP	146	1	0	147
B.	HFPO	108	35	2	145
C.	HFPO-Dimer	0	0	0	1
D.	TFE	63	0	0	63
E.	MAE	0	0	1	2
F.	EVE	0	70	0	71
G.	TTG	0	2	0	2
H.	CO (not a VOC)				211
I.	ADN		15	1	0
*	DAE		0	2	3
*	TAE		0	0	0
*	MMF		0	0	0
*	hydro-EVE		3	3	6
*	iso-EVE		6	4	10
	Total	**317**	**133**	**13**	**659**

Note 1 - See section titled "Equipment Emissions" for details
Note 2 - See section titled "Maintenance Emissions" for details
H. CO not realistically expected through equipment or maintenance emissions. Not a VOC
I. ADN total based on material balance, see section I.
* Not normally emitted from the process as a routine stack emission

Total Non AF ##

Total AF 0

L. HF Equivalent Emissions

	Nafion Compound Name	Process Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
C.	HFPO-Dimer	0.000	0.001	0.014	0.015
E.	MAE	0.000	0.008	0.091	0.099
*	DAE		0.019	0.092	0.111
*	TAE		0.000	0.003	0.003
*	MMF		0.003	0.037	0.041
	Total	**0.00**	**0.03**	**0.24**	**0.27**

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

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

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

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

2015 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 68% acid fluorides and 32% 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 354
(g) average MW for non-acid fluoride component = 166 (average of HFPO & HFP)
(h) number of deinventory events = 7

List of Process Vessels

Condensation Tower	Volume (ft^3)	Volume (gallons)
Reactor Decanter	5	41
Stripper Feed Decanter	7	51
Stripper Overhead Receiver	5	40
A/F Column	27	203
A/F Overhead Receiver	14	106
A/F Tails Decanter	1	10
ABR Feed Tank	27	202
Total Volume	**87**	654

VOC Emissions

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

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

$$0.22 \frac{\text{lb-mol gas}}{\text{deinventory event}} \times 7 \frac{\text{deinventory events}}{\text{year}} = 1.56 \frac{\text{lb-mol gas}}{\text{year}}$$

$$1.56 \frac{\text{lb-mol gas}}{\text{year}} \times 32\% \text{ non-acid fluorides} \times 166 \frac{\text{lb non-A/F}}{\text{lb-mol gas}} = 83.8 \frac{\text{lb non-A/F}}{\text{year}}$$

Before-control A/F vented from Condensation:

$$1.56 \frac{\text{lb-mol gas}}{\text{year}} \times 68\% \text{ acid fluorides} \times 354 \frac{\text{lb A/F}}{\text{lb-mol gas}} = 373 \frac{\text{lb A/F}}{\text{year}}$$

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

	373	lb/yr A/F VOC
×	(100%-99.6%)	control efficiency
	1.5	lb/yr A/F VOC

Total VOC:

	83.8	lb/yr non-A/F VOC
+	1.5	lb/yr A/F VOC
	85.3	**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 290
(g) number of deinventory events = 7

HF Potential

Vinyl ethers are VOCs without the potential to form HF

List of Process Vessels

Refining	Volume (ft^3)	Volume (gallons)
Ether Still	107	803
Ether Still Overhead Receiver	9	69
Product Receiver	46	348
Total Volume	**163**	**1220**

VOC Emissions

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

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

$$0.42 \frac{\text{lb-mol gas}}{\text{deinventory event}} \times \frac{7 \text{ deinventory events}}{\text{year}} = 2.91 \frac{\text{lb-mol gas}}{\text{year}}$$

$$2.91 \frac{\text{lb-mol gas}}{\text{year}} \times 290 \frac{\text{lb VOC}}{\text{lb-mol gas}} = \mathbf{844.3} \frac{\textbf{lb VOC}}{\textbf{year}}$$

D. Component Summary - All maintenance emissions

Component	EVE	PPVE	PSEPVE
	lb	lb	lb
HFP	0	0	27
HFPO	2	15	6
HFPO-Dimer	0	31	0
PPF	0	1	0
Diglyme	0	0	3
AN	0	6	0
ADN	1	0	0
TTG	0	0	0
DA	0	0	12
MA	0	0	5
TA	0	0	0
RSU	0	0	0
MAE	1	0	0
MMF	0	0	0
DAE	2	0	0
TAE	0	0	0
HFPO Trimer	0	1	0
EVE *	0	0	0
PPVE	0	441	0
PSEPVE **	0	0	0
hydro-EVE	3	0	0
iso-EVE	4	0	0
C4	0	59	20

Composite compositions for each area, Condensation, ABR, and Refining, were determined on the Vessel Composition worksheet, taking into account run hours on each campaign and approximate compositions. The mass fraction for each component was then multiplied by the VOC from these areas.

Campaign	EVE	PPVE	PSEPVE
Campaign Fract'n	0.08	0.60	0.32
Cond VOC	7	51	28
Refining VOC	67	504	274

Pre-control VOC	103	776	422

Total before control VOC (lb.)	1301
Total after control VOC	928

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

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

2015 Equipment Emissions Determination

Equipment Emissions (EE) are a function of the number of emission points in the plant (valves, flanges, pump seals). For the equipment emission calculations the inventory shown below is conservative and based on plant and process diagrams. Note that the division scrubber efficiency is 99.6% for control of acid fluorides.

A. Equipment Emissions from Condensation Reactor 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	431	3,240	1,760
Total VOC generated per campaign	149	1123	610

Component	EVE	After control**	PPVE	After control**	PSEPVE	After control**
	lb	lb	lb	lb	lb	lb
HFP	1	1	5	5	1	1
HFPO	35	35	331	331	141	141
HFPO-Dimer	5	**0**	613	**2**	8	**0**
PPF	1	**0**	23	**0**	1	**0**
Diglyme	0	0	0	0	70	70
AN	0	0	136	136	0	0
ADN	15	15	0	0	0	0
TTG	2	2	0	0	0	0
DA	0	**0**	0	**0**	257	**1**
MA	0	**0**	0	**0**	115	**0**
TA	0	**0**	0	**0**	9	**0**
RSU	0	**0**	0	**0**	1	**0**
MAE	32	**0**	0	**0**	0	**0**
MMF	6	**0**	0	**0**	0	**0**
DAE	49	**0**	0	**0**	0	**0**
TAE	2	**0**	0	**0**	0	**0**
HFPO Trimer	0	**0**	15	**0**	6	**0**
Total	**149**	**53**	**1,123**	**474**	**610**	**214**

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	430.7345	3,240	1,760
Total VOC per campaign	27.45932	207	112

Component	**EVE**	**PPVE**	**PSEPVE**
	lb	**lb**	**lb**
HFP	0	0	8
HFPO-Dimer	0	2	0
EVE	23	0	0
PPVE	0	198	0
DA	0	0	1
DAE	0	0	0
PSEPVE	0	0	98
hydro-EVE	1	0	0
iso-EVE	2	0	0
C4	0	6	6
Total	**27**	**207**	**112**

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	430.7345	3,240	1,760
Total VOC per campaign	52.33424	394	214

Component	EVE	PPVE	PSEPVE
	lb	lb	lb
HFP	0	0	21
HFPO-Dimer	0	2	0
EVE	47	0	0
PPVE	0	345	0
PSEPVE	0	0	177
hydro-EVE	2	0	0
iso-EVE	3	0	0
C4	0	46	15
Total	**52**	**394**	**214**

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

D. Component Summary - All equipment emissions

Component	EVE	PPVE	PSEPVE	Total
	lb	lb	lb	lb
HFP	1	5	31	36
HFPO	35	331	141	507
HFPO-Dimer	0	7	0	7
PPF	0	0	0	0
Diglyme	0	0	70	70
AN	0	136	0	136
ADN	15	0	0	15
TTG	2	0	0	2
DA	0	0	2	2
MA	0	0	0	0
TA	0	0	0	0
RSU	0	0	0	0
MAE	0	0	0	0
MMF	0	0	0	0
DAE	0	0	0	0
TAE	0	0	0	0
HFPO Trimer	0	0	0	0
EVE	70	0	0	70
PPVE	0	543	0	543
PSEPVE	0	0	275	275
hydro-EVE	3	0	0	3
iso-EVE	6	0	0	6
C4	0	53	21	74
				1747

Vinyl Ethers South Process

NS-C

E0513

2015 Emission Summary

A. VOC Emissions Summary

Nafion® Compound	CAS Chemical Name	CAS No.	PE/PM Emissions (lb.)	PPVE Emissions (lb.)	Accidental Releases (lb.)	Total Emissions (lb.)
COF2	Carbonyl Fluoride	353-50-4	644	0	0	644
PAF	Perfluoroacetyl Fluoride	354-34-7	772	0	0	772
PMPF	Perfluoromethoxypropionyl fluoride	2927-83-5	1,090	0	0	1,090
PEPF	Perfluoroethoxypropionyl fluoride	1682-78-6	407	0	0	407
PMVE	Perfluoromethyl vinyl ether	1187-93-5	20,482	0	0	20,482
PEVE	Perfluoroethyl vinyl ether	10493-43-3	1,177	0	0	1,177
HFP	Hexafluoroproplyene	116-15-4	4,087	0	0	4,087
HFPO	Hexafluoroproplyene Epoxide	428-59-1	4,425	0	0	4,425
AN	Acetonitrile	75-05-8	1,606	0	0	1,606
HFPO Dimer	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	6	0	0	6
MD			56	0	0	56
HydroPEVE			11	0	0	11
PPVE	Perfluoropropyl vinyl ether	1623-05-8	11	0	0	11
PPF	Perfluoropropionyl fluoride	422-61-7	0	0	0	0
TFE	Tetrafluoroethylene	116-14-3	0	0	0	0
C4	Perfluoro-2-butene	360-89-4	0	0	0	0
C5	Perfluoropentene	376-87-4	0	0	0	0
					Total VOC Emissions (lb.)	**34,776**
					Total VOC Emissions (tons)	**17.39**

B. Criteria Pollutant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Process Emissions (lb.)	Accidental Releases (lb.)	Total Emissions (lb.)
CO	Carbon Monoxide	630-08-0	0	0	0
				Total CO Emissions (lb.)	**0**
				Total CO Emissions (tons)	**0.0**

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

Nafion® Compound	CAS Chemical Name	CAS No.	Process Emissions (lb.)	Accidental Releases (lb.)	Total Emissions (lb.)
HF	Hydrogen Fluoride	7664-39-3	648	0	648
Acetonitrile	Acetonitrile	75-05-8	1,606	0	1,606

2015 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No: NS-C

Emission Source Description: VE-South PEVE / PMVE Manufacturing Process

Process & Emission Description: The VE-South PEPM manufacturing process is a continuous chemical reaction. All emissions from the process are vented through the VE-South Waste Gas Scrubber (Control Device ID No. NCD-Hdr2) which has a documented control efficiency of 99.6% for all acid fluoride compounds. Some emitted compounds are assumed to pass completely through the scrubber, so the control efficiency for those compounds is assumed to be 0%. The control of emissions of specific compounds will be addressed and detailed in the following pages.

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

Basis and Assumptions:

- A process flowsheet, developed from operating data during a typical month, May 2005, is the basis for relative concentrations of before-control emissions of gaseous wastes.
- The flowsheet is available under the "flowsheet" tab for reference and includes the basis for ratios used in this calculation.
- Because an overall material balance for the year is used for calculation of emissions, "maintenance emissions" related to turnarounds are assumed to be included with the calculated emissions. The usual practice is to deinventory liquids and then vent vessels to the Waste Gas Scrubber.
- All emission determination calculations are available on the EXCEL spreadsheet found at: P:/Emissions/VE-S Emissions

Point Source Emissions Determination

A. Carbonyl Fluoride (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 COF_2 in feed to condensation to the overall amount of PMVE produced:

kg COF_2 in Condensation feed / kg PMVE produced	=	**0.555**
	X	275,769 kg PMVE produced
		153,061 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	=	61.85 kg/h average precursor feed, (1066FC)
	X	5992 hours of operation (from uptime data)
	X	55% typical COF_2 in precursor feed to PAF column
		203,833 kg COF_2 fed to PAF column

COF_2 vented from PAF column = 203,833 - 153,061 = 50,772 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	275,769 kg PMVE produced

COF_2 vented from condensation = 16,315

Total COF_2 vented from process vents to WGS = 50,772 + 16,315 = **67,086** kg

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

VOC emissions:		67,086 kg COF_2 emitted to WGS		
	x	(100% - 99.6%)		
	=	268 kg VOC	=	268 kg VOC **590 lb VOC**
HF Equivalent Emissions		268 lb COF_2		
	x	0.606 kg HF/kg COF_2		
	=	163 kg HF	=	**358 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	120,978	kg PEVE produced
		86,580	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	=	61.85	kg/h average precursor feed, (1066FC)
	X	5992	hours of operation (from uptime data)
	X	44%	typical PAF in precursor feed to PAF column
		163,066	kg PAF fed to PAF column

PAF vented from PAF column = 163,066 - 86,580 = 76,486 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	120,978	kg PEVE produced

PAF vented from condensation = 5,323

Total PAF vented from process vents to WGS = 76,486 + 5,323 = **81,809** kg

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

VOC emissions		81,809 kg PAF		=
	x	(100% - 99.6%)		
	=	327 kg PAF	=	327 kg VOC
				720 lb VOC
HF Equivalent Emissions		327 kg PAF		
	x	0.172 kg HF/kg PAF		
	=	56 kg HF	=	**124 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).

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

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	275,769	kg PMVE produced
PMPF vented from ABR system =		**56,893**	kg

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

VOC emissions		56,893 kg PMPF		
	x	(100% - 99.6%)		
	=	228 kg PMPF	=	228 kg VOC
				501 lb VOC
HF Equivalent Emissions		228 kg PMPF		
	x	0.086 kg HF/kg PMPF		
	=	20 kg HF	=	**43 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).

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

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	120,978	kg PEVE produced

PEPF vented from ABR system = **18,311** kg

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

VOC emissions:		18,311 kg PEPF		
	x	(100% - 99.6%)		
		73 kg PEPF	=	73 kg VOC
				161 lb VOC
HF Equivalent Emissions		73 kg PEPF		
	x	0.071 kg HF/kg PEPF		
	=	**5 kg HF**	=	**11 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		2.940	kg/h vent rate, (1830FG)
	X	5,992	hours of operation (from uptime data)
		17,616	kg vented from low boiler column

PMVE in the low boiler column vent stream = 49% X 17,616 = **8,685** kg

After-control emissions from the Waste Gas Scrubber with an assumed efficiency of zero percent (0%)
VOC Emissions = **8,685 kg VOC**
19,107 lb VOC

F. Perfluoroethyl vinyl ether (PEVE) **CAS No. 10493-43-3**

HF Potential:

PEVE is a VOC without the potential to form HF.

Quantity Released

There are no point source emissions identified which contain PEVE.

VOC Emissions = **0 kg VOC**
0 lb VOC

G. Hexafluoropropylene (HFP) **CAS No. 116-15-4**

HF Potential:

HFP is a VOC without the potential to form HF.

Quantity Released

HFP is an inert in the process that is vented from the PAF column and from the low boiler column.

HFP in the LBC vent stream is based on the flow sheet and estimated total vented.

The low boiler column vented at a rate of		2.940	kg/h vent rate, (1830FG)			
	X	5,992	hours of operation (from uptime data)			
		17,616	kg vented from low boiler column			
HFP in the low boiler column vent stream =		9%	X	17,616	=	1,533 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	=		61.85	kg/h average precursor feed, (1066FC)		
	X		5992	hours of operation (from uptime data)		
	X		0.5%	typical HFP in precursor feed to PAF column		
			1,853	kg HFP fed to PAF column		
HFP vented from PAF column =	1,853	-	1,533		=	320 kg

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

VOC Emissions

	1,533	kg HFP from PAF Vent			
+	320	kg HFP from LBC Vent			
	1,853	kg HFP	=	1,853	kg VOC
				4,077	**lb VOC**

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

HF Potential:

HFPO is a VOC without the potential to form HF.

Quantity Released

HFPO is an inert in the process that is vented from the PAF column. It is assumed that all HFPO fed to the PAF column is vented.

HFPO fed to PAF column	=	61.85 kg/h average precursor feed, (1066FC)
	X	5992 hours of operation (from uptime data)
	X	0.5% typical HFPO in precursor feed to PAF column
		1,853 kg HFPO fed to PAF column
	=	1,853 kg HFPO vented from PAF column

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

VOC Emissions

1,853 kg HFPO	=	1,853 kg VOC
		4,077 lb VOC

I. VOC Summary - Point Source Emissions

Nafion Compound Name		Before Control VOC Generated kg/yr VOC	Before Control VOC Generated lb/yr VOC	After Control Stack Emissions lb/yr VOC	After Control Stack Emissions lb/yr HF
A.	COF2	67,086	147,590	590	358
B.	PAF	81,809	179,981	720	124
C.	PMPF	56,893	125,165	501	43
D.	PEPF	18,311	40,283	161	11
E.	PMVE	8,685	19,107	19,107	0
F.	PEVE	0	0	0	0
G.	HFP	1,853	4,077	4,077	0
H.	HFPO	1,853	4,077	4,077	0
	Total	236,490	520,279	**29,232**	**537**

J. VOC Summary - All sources

Nafion Compound Name		After Control Stack Emissions		Equipment Emissions (Note 1)		Total Emissions	
		lb/yr VOC	lb/yr HF	lb/yr VOC	lb/yr HF	lb/yr VOC	lb/yr HF
A.	COF2	590	358	54	33	644	390
B.	PAF	720	124	53	9	772	133
C.	PMPF	501	43	589	50	1090	93
D.	PEPF	161	11	246	17	407	28
E.	PMVE	19,107	0	1375	0	20482	0
F.	PEVE	0	0	1177	0	1177	0
G.	HFP	4,077	0	11	0	4087	0
H.	HFPO	4,077	0	348	0	4425	0
	HFPO Dimer			6	0	6	0
	MD			56	3	56	3
	HydroPEVE			11	0	11	0
	PPVE			11	0	11	0
	AN			1606	0	1606	0
	Total	**29,232**	**537**	**5,544**	**112**	**34,776**	**648**

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

2015 Fugitive Emissions Determination

Fugitive Emissions (FE) are a function of the number of emission points in the plant (valves, flanges, pump seals). For the fugitive emission calculations the inventory shown below is conservative and based on plant and process diagrams.

Note that the division scrubber efficiency is 99.6% for control of acid fluorides.

A. Fugitive Emissions from Condensation Reactor System

Condensation Tower (vents to stack)

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

Condensation Tower VOC

Total Condensation Fugitive Emissions:

VOC		0.248	lb/hr FE
	x	5992	Operating hr/yr
	=	1488	lb FE

Composition of Condensation Tower Fugitive Emissions is estimated based on typical process inventory:

PAF column:

Inventoried with	30	gal fluorocarbon
Equivalent mass FC	375.75	lb fluorocarbon

Component	Mass fraction	lb
COF2	0.45	169
PAF	0.54	203
HFP	0.005	2
HFPO	0.005	2

Reactor loop

Inventoried with	51	gal hydrocarbon	assumes 60 gallons, 85% hydrocarbon, 15% fluorocarbon
Equivalent mass HC	383.265	lb hydrocarbon	
Inventoried with	9	gal fluorocarbon	
Equivalent mass FC	112.725	lb fluorocarbon	

Component	Mass fraction	lb	
COF2	0.09	10	
PAF	0.04	5	
HFP	0.03	3	
PMPF	0.59	67	
PEPF	0.23	26	
Dimer	0.01	1	
MD	0.01	1	
AN		383	Hydrocarbon

Reactor decanter

Inventoried with	25	gal hydrocarbon	assumes 50 gal, 50% HC, 50% FC
Equivalent mass HC	187.875	lb hydrocarbon	
Inventoried with	25	gal fluorocarbon	
Equivalent mass FC	313.125	lb fluorocarbon	

Component	Mass fraction	lb	
COF2	0.09	28	
PAF	0.04	13	
HFP	0.03	9	
PMPF	0.59	185	
PEPF	0.23	72	
Dimer	0.01	3	
MD	0.01	3	
AN		188	Hydrocarbon

Stripper 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	0.7	263
PEPF	0.27	101
Dimer	0.015	6
MD	0.015	6

AF overhead

Inventoried with	1000	kg FC
	2200	lb FC

Component	Mass fraction	lb
PMPF	0.72	1,584
PEPF	0.28	616

AF 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	
Hydro PEVE	0.099	49.599	
PPVE	0.099	49.599	
PEPF	0.099	49.599	assumes 30% is waste from refining purges, high boilers PEPF, hydro PEVE, and PPVE

Average system composition - Condensation

	lb	%	VOC emissions (lb)	Equivalent HF (lb)
COF2	241	3.63%	54	33
PAF	235	3.53%	53	9
HFP	26	0.39%	6	0
HFPO	1,557	23.41%	348	0
PMPF	2,591	38.94%	580	50
PEPF	1,057	15.88%	236	17
Dimer	28	0.42%	6	0.4
MD	249	3.74%	56	3
AN	571	8.58%	128	0
HydroPEVE	50	0.75%	11	0
PPVE	50	0.75%	11	0
total	6,653		1488	112

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	5,992	Operating hr/yr
=	2,577	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%	10	1
PEPF	33	0.37%	10	1
HFP	17	0.19%	5	0
PEVE	4,026	45.69%	1177	0
PMVE	4,703	53.37%	1375	0
total	8,811		2,577	2

✓

C. Acetonitrile fugitive emissions

No normal process vents of AN to stack. Equipment emissions are estimated above for normal process composition and leaks.

A material balance is also done to ensure all AN losses are accounted for. When material balance shows negative loss, only the estimated equipment emissions are included.

VOC Emission

AN to hydrocarbon waste from VE-S = 13,440

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

AN portion of hydrocarbon waste stream:

	13,440	kg to H/C waste
x	(1-(.05))	
=	12,768	kg AN to H/C waste

	13,440	kg AN fed		
-	12,768	kg AN to waste		
	672	kg AN lost	=	672 **kg VOC**
				1,478 lb VOC additional AN loss

Note: Based on this material balance, it is assumed that no AN is emitted to atmosphere from fugitive emissions, other than what is determined above.

The amount of hydrocarbon sent to waste is probably overestimated due to inaccuracies in calculation of VE-N portion of the waste.

D. Total Fugitive Emissions

Emission Source	Total Emissions lb VOC
Condensation Tower	1,361
Agitated Bed Reactor & Refining	2,577
AN	1,606
Total	**5,544**

E. Speciated Equipment Emissions Summary

Nafion® Compound	Equipment Emissions	
	lb VOC	lb HF
COF2	54	33
PAF	53	9
HFP	11	0
HFPO	348	0
PMPF	589	50
PEPF	246	17
HFPO Dimer	6	0.4
MD	56	3
HydroPEVE	11	0
PPVE	11	0
PEVE	1,177	0
PMVE	1,375	0
AN	1,606	0
TOTAL	**5,544**	**112**

RSU Process

NS-D

0514

2015 Air Emissions Inventory Supoorting 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 99.6%. 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.

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.

2015 Emission Summary - RSU Process (NS-D)

A. VOC Emissions by Compound and Source

Nafion® 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	3500.0	0	240.8	0	3740.8
PAF	Trifluoroacetyl Fluoride	354-34-7	9.7	0	0.7	0	10.3
RSU	Difluoro(Fluorosulfonyl)Acetyl Fluoride	677-67-8	3.3	0	0.2	0.0	3.5
SU	2-Hydroxytetrafluoroethane Sulfonic Acid Sultone	697-18-7	9.7	0	0.7	0	10.3
EDC	1,2-Dichloroethane	107-06-2	0	16.2	0	0	16.2
Total for 2015			**3522.6**	**16.2**	**242.4**	**0.0**	**3781.2**
						Tons	**1.89**

B. Toxic Air Pollutant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total TAP Emissions (lbs)
HF	Hydrogen Fluoride	7664-39-3	3.10	0	31.5	0.0	**31.51**
H2SO4	Sulfuric Acid	7664-93-9	13.4	138.9	0	0	**152.3**

C. Criteria Air Pollutant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Point Source Emissions	Fugitive Emissions (lbs)	Equipment Emissions (lbs)	Accidental Emissions (lbs)	Total VOC Emissions (lbs)
SO2	Sulfur dioxide	7446-09-5	5.3	0	0	0	**5.3**

Point Source Emission Determination

A. Tetrafluoroethylene (TFE) **CAS No. 116-14-3**

HF Potential:

TFE is a VOC without the potential to form HF.

TFE Quantity Generated:

Before-control TFE generation per the Process Flowsheet #4 (W1207831):

Source	TFE Vent Rate
Reactor	0.05171 kg TFE vented per RSU unit
Rearranger	0.19559 kg TFE vented per RSU unit
Still	0.02206 kg TFE vented per RSU unit
Total	**0.26936** kg TFE vented per RSU unit

The before-control TFE generation is based on **5,893.8** RSU units in 2015

TFE vented from the RSU Process in the reporting year:

$$\frac{0.2694 \text{ kg TFE}}{\text{RSU unit}} \times 5{,}893.8 \text{ RSU units} = \mathbf{1{,}588} \text{ kg TFE}$$

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

VOC Emissions

$$\text{Waste Gas Scrubber} \times \frac{1{,}588 \text{ kg TFE}}{(100\% - 0\%) \text{ control efficiency}}$$

$$= 1588 \text{ TFE} = 1588 \text{ kg VOC}$$

$$= \mathbf{3500.0 \text{ lb. VOC}}$$

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

HF Potential:

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

$$1\text{ kg PAF}\times\frac{1\text{ mole PAF}}{116\text{ g PAF}}\times\frac{20\text{ g HF}}{1\text{ mole HF}}\times\frac{1\text{ mole HF}}{1\text{ mole PAF}}=0.172\text{ kg HF}$$

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

PAF Quantity Generated:

Before-control PAF generation per the Process Flowsheet #4 (W1207831):

Source	PAF Vent Rate
Reactor	0 kg PAF vented per RSU unit
Rearranger	0.16755 kg PAF vented per RSU unit
Still	0.01862 kg PAF vented per RSU unit
Total	**0.186** kg PAF vented per RSU unit

The before-control PAF generation is based on **5,893.8** RSU units in 2015

PAF vented from the RSU Process in the reporting year:

$$\frac{0.186\text{ kg PAF}}{\text{RSU unit}} \times 5{,}893.8\text{ RSU units} = \mathbf{1{,}097}\text{ kg PAF}$$

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

VOC Emissions
Waste Gas Scrubber
1,097 kg PAF
x (100%-99.6%) control efficiency
= 4.39 kg PAF = 4.39 kg VOC
= **9.7** **lb. VOC**

HF Equivalent Emissions
4.39 kg PAF
x 0.172 kg HF/kg PAF
= 0.75 kg HF = **1.66** **lb. HF**

C. Rearranged Sultone (RSU)
Difluoro(Fluorosulfonyl) Acetyl Fluoride

CAS No. 677-67-8

HF Potential:

Each mole of RSU (MW = 180) can generate 1 moles of HF (MW = 20).

$$1\text{ kg RSU}\times\frac{1\text{ mole RSU}}{180\text{ g RSU}}\times\frac{20\text{ g HF}}{1\text{ mole HF}}\times\frac{1\text{ mole HF}}{1\text{ mole RSU}}=0.111\text{ kg HF}$$

Therefore, each 1 kg of RSU generates 0.111 kg of HF

RSU Quantity Generated:

Before-control RSU generation per the Process Flowsheet #4 (W1207831):

Source	RSU Vent Rate	
Reactor	0	kg RSU vented per RSU unit
Rearranger	0.05677	kg RSU vented per RSU unit
Still	0.00644	kg RSU vented per RSU unit
Total	**0.063**	kg RSU vented per RSU unit

The before-control RSU generation is based on **5,893.8** RSU units in 2015

RSU vented from the RSU Process in the reporting year:

$$\frac{0.063\text{ kg RSU}}{\text{RSU unit}} \times 5{,}893.8\text{ RSU units} = \mathbf{373}\text{ kg RSU}$$

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

VOC Emissions

Waste Gas Scrubber: 373 kg RSU × (100%-99.6%) control efficiency

= 1.49 kg RSU = 1.49 kg VOC

= **3.3** **lb. VOC**

HF Equivalent Emissions

1.49 kg RSU

x 0.111 kg HF/kg RSU

= 0.17 kg HF = **0.36** **lb. HF**

D. Sultone (SU) **CAS No. 697-18-7**
TFE Sultone (2-Hydroxytetrafluoroethane Sulfonic Acid)

HF Potential:

Each mole of SU (MW = 180) can generate 1 mole of HF (MW = 20).

$$1\text{ kg SU} \times \frac{1\text{ mole SU}}{180\text{ g SU}} \times \frac{20\text{ g HF}}{1\text{ mole HF}} \times \frac{1\text{ mole HF}}{1\text{ mole SU}} = 0.111\text{ kg HF}$$

Therefore, each 1 kg of SU generates 0.111 kg of HF

SU Quantity Generated:

Before-control SU generation per the Process Flowsheet #4 (W1207831):

Source	SU Vent Rate
Reactor	0 kg SU vented per RSU unit
Rearranger	0.16755 kg SU vented per RSU unit
Still	0.01862 kg SU vented per RSU unit
Total	**0.186** kg SU vented per RSU unit

The before-control SU generation is based on **5,893.8** RSU units in 2015

SU vented from the RSU Process in the reporting year:

$$\frac{0.186\text{ kg SU}}{\text{RSU unit}} \times 5{,}893.8\text{ RSU units} = \mathbf{1{,}097}\text{ kg SU}$$

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

VOC Emissions
1,097 kg SU
Waste Gas Scrubber x (100%-99.6%) control efficiency
= 4.39 SU = 4.39 kg VOC
= **9.7** **lb. VOC**

HF Equivalent Emissions
4.39 kg SU
x 0.111 kg HF/kg SU
= 0.5 kg HF = **1.07** **lb. HF**

E. Sulfur dioxide (SO2) CAS No. 354-34-7

Air Pollutant Description:

Sulfur dioxide is a criteria pollutant and will be reported as such on the NC DAQ forms.

SO2 Quantity Generated:

Before-control SO2 generation per the Process Flowsheet #4 (W1207831):

Source	SO2 Vent Rate
Reactor	0 kg SO2 vented per RSU unit
Rearranger	0.09124 kg SO2 vented per RSU unit
Still	0.00988 kg SO2 vented per RSU unit
Total	**0.101** kg SO2 vented per RSU unit

The before-control SO2 generation is based on **5,893.8** RSU units in 2015

SO2 vented from the RSU Process in the reporting year:

$$\frac{0.101\ \text{kg SO2}}{\text{RSU unit}} \times 5{,}893.8\ \text{RSU units} = \mathbf{596}\ \text{kg SO2}$$

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

SO2 Emissions
Waste Gas Scrubber

$$596\ \text{kg SO2} \times (100\%-99.6\%)\ \text{control efficiency} = 2.38\ \text{kg SO2} = \mathbf{5.3}\ \textbf{lb. SO2}$$

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).

$$1\,\text{kg SO}_3 \times \frac{1\,\text{mole SO}_3}{80\,\text{g SO}_3} \times \frac{98\,\text{g H}_2\text{SO}_4}{1\,\text{mole H}_2\text{SO}_4} \times \frac{1\,\text{mole H}_2\text{SO}_4}{1\,\text{mole SO}_3} = 1.225\,\text{kg H}_2\text{SO}_4$$

Therefore, each 1 kg of SO3 generates 1.225 kg of H2SO4

SO3 Quantity Generated:

Before-control SO3 generation per the Process Flowsheet #4 (W1207831):

Source	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 **5,893.8** RSU units in 2015

SO3 vented from the RSU Process in the reporting year:

$$\frac{0.211\ \text{kg SO3}}{\text{RSU unit}} \times 5{,}893.8\ \text{RSU units} = \mathbf{1{,}242}\ \text{kg SO3}$$

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

SO3 Emissions
1,242 kg SO3
Waste Gas Scrubber x (100%-99.6%) control efficiency
= 4.97 kg SO3 = 11.0 lb. SO3

H2SO4 Equivalent Emissions
4.97 kg SO3
x 1.225 kg H2SO4 / kg SO3
= 6.09 kg H2SO4 =
13.4 lb. H2SO4

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	=	0.045 lb/hr EE
Total equipment emission rate		=	0.135 lb/hr EE

Days of operation = 75

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

VOC:	0.135 lb/hr EE	**HF:**		0.135 lb/hr EE
x	24 hours/day		x	24 hours/day
x	75 days/year		x	75 days/year
=	**242.4 lb/yr VOC from EE**		x	0.13 lb HF per lb VOC
			=	**31.5 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	75 days/year		x	75 days/year
=	**113.4 lb/yr SO3 from EE**		x	1.225 lb H2SO4 per lb SO3
			=	**138.9 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	75 days/year		
=	**16.2 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	242.4	31.5	0	0	0
B. Fugitive Emissions From SO3 Storage Tank and Vaporizer	0	0	0	113.4	138.9
C. Fugitive Emissions From EDC Tank	0	0	16.2	0	0
Total for 2015	**242.4**	**31.5**	**16.2**	**113.4**	**138.9**

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	3500.0	240.8	0	0	3740.8
PAF	9.7	0.7	0	0	10.3
RSU	3.3	0.2	0	0.0	3.5
SU	9.7	0.7	0	0	10.3
EDC	0	0	16.2	0	16.2
Total	**3522.6**	**242.4**	**16.2**	**0.0**	**3781.2**

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 (1,997.9 lb) divided by the total stack emission (2,010.8 lb), multiplied by the total equipment emissions (229.4 lb).

Specifically: $\frac{3500.0}{3522.6} \,|\, 242.4 = 240.8$ lb. TFE

Liquid Waste Stabilization

NS-E

0515

2015

Emission Source ID No.: NS-E

Emission Source Description: Nafion Liquid Waste Stabilization

Process & Emission Description:

The Nafion liquid waste stabilization is a continuous system of storage with batch neutralization. To comply with the regulatory requirements of RCRA SubPart CC, neither the storage tank nor the reactor vent during normal operating conditions. All venting from this system occurs as a non-routine maintenance activity, which is detailed in the following pages. All emissions from this system are vented through the Nafion Division Waste Gas Scrubber (Control Device ID No. NCD-Hdr1) which has a documented control efficiency of 99.6% for acid fluoride compounds. The control of emissions of specific compounds will be addressed and detailed in the following pages.

The Nafion liquid waste stabilization process emits compounds in the acid fluoride family. In the presence of water, these acid fluorides will eventually hydrolyse to hydrogen fluoride. For the purpose of this emissions inventory, a conservative approach will be take and the acid fluorides will be reported both as a VOC and as the equivalent quantity of hydrogen fluoride.

Basis and Assumptions:

- For the HF emissions the entire gas flow is assumed to be HF
- The VOC emissions are assumed to be 30% COF2 and 70% TAF for the Reactor
- The VOC emissions are calculated based on Trimer and RSU for the Storage Tank
- The ideal gas law is used.

Information Inputs and Source Inputs:

Information Input	Source of Inputs
Weight of Tank	IP21 (W03450WG and W03606WG)
Category and Reason for Emission	Waste Mechanical Facilitator

Point Source Emissions Determination:

Shown on the following pages

Fugitive Emissions Determination:

Shown on the following pages.

Stack Emissions from Maintenance Activity or Emergency Activity for the Reactor

Background

Before performing maintenance on the reactor or storage tank, the pressure from the system is vented to the Division WGS. Each vent is recorded in IP21 by the weight before and after the vent. There can be times when the pressure in either the reactor or storage tank rises rapidly due to reaction. During these times if the pressure rises above 700 kpa in either tank, a pressure control valve can be opened to vent the tank to avoid the relief valve opening. See chart below.

Date	Tank	Category	Reason	Tank Weight Initial (kg)	Tank Weight Final (kg)
6/5/15	Reactor	Maintenance	pump maintenance	411	0
9/19/15	Reactor	Maintenance	Annual Shutdown	74	15

Sample calculation using maintenance activity dated 6/5/15

Initial Weight minus Final Weight equals kg vented to Division WGS

411 kg minus 0 kg equals 411 kg vented to WGS

Assume that all of the above is VOC emissions This assumption also overstates the true emissions as inerts, such as nitrogen are not counted.

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

Percentage of acid fluoride VOCs removed by the WGS = 99.6%
Percentage of acid fluoride VOCs vented from the WGS = 100% minus 99.6%
Percentage of acid fluoride VOCs vented from the WGS = 0.4%

Therefore, VOCs vented to the atmosphere from the 6/5/15 maintenance activity is equal to:

Amount of VOCs vented to WGS: 411 kg of VOC
Percentage of VOCs vented from the WGS: x 0.4%
Quantity of VOCs vented from the WGS: = 1.644 kg VOC
= **3.62436 lb VOC**

Stack Emissions from Maintenance Activity (cont.)
for the Reactor
<u>VOC Emissions by Compound</u>

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) = **3.6244 lb VOC**

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

Sample calculation using maintenance activity dated 6/5/15

VOC emissions would be equal to:

$$\frac{3.624 \text{ lb VOC}}{} \left| \frac{0.30 \text{ lb COF2}}{\text{lb VOC}} \right. = 1.0873 \text{ lb COF2}$$

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

Sample calculation using maintenance activity dated 6/5/15

VOC emissions would be equal to:

$$\frac{3.624 \text{ lb VOC}}{} \left| \frac{0.70 \text{ lb TAF}}{\text{lb VOC}} \right. = 2.5371 \text{ lb VOC}$$

Stack Emissions from Maintenance Activity (cont.)
for the Reactor
HF Potential

Assume that the vapor is 30% COF2 and 70% TAF. This assumption is based on process knowledge of the system.

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

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

1 lb COF2	1 mole COF2	20 lb HF	2 moles HF	=	0.606 lb of HF
	66 lb COF2	mole HF	1 mole COF2		

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)

1 lb TAF	1 mole TAF	20 lb HF	1 moles HF	=	0.061 lb of HF
	330 lb TAF	mole HF	1 mole TAF		

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

Sample calculation using maintenance activity dated 6/5/15

Quantity of VOCs vented from the WGS (see Page 2) = **3.6244 lb VOC**

HF equivalent emissions would be equal to:

3.624 lb VOC	0.30 lb COF2	0.606 lb HF	=	0.659 lb HF
	lb VOC	lb COF2		

3.624 lb VOC	0.70 lb TAF	0.061 lb HF	=	0.1538 lb HF
	lb VOC	lb TAF		

Therefore, HF vented to the atmosphere from the 6/5/15 maintenance activity is equal to:

0.659 lb HF + 0.1538 lb HF = 0.8127 lb HF

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

Date	Tank	Category	Reason	Weight of Tank		Emitted VOC (lb)	Emitted HF (lb)
				Initial (kg)	Final (kg)		
6/5/15	Reactor	Maintenance	pump maintenanc	411	0	3.624	0.813
9/19/15	Reactor	Maintenance	Annual Shutdown	74	15	0.520	0.117

Total Emissions	4.14	0.93

Total	VOC	=	4.14	lb	
	VOC =		0.0021	ton	STACK EMISSIONS
Total	HF =		0.93	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)
6/5/15	Reactor	Maintenance	pump maintenance	3.624	1.087	2.537
9/19/15	Reactor	Maintenance	Annual Shutdown	0.520	0.156	0.364

Total Emissions	4.14	1.24	2.90

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.

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

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

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)
9/18/15	Storage	Maintenance	Annual Shutdown	231	143

Sample calculation using maintenance activity dated 9/18/15

Initial Weight	minus	Final Weight	equals	kg vented to Division WGS	
231 kg	minus	143 kg	equals	88	kg vented to WGS

Assume that all of the above is VOC emissions This assumption also overstates the true emissions as inerts, such as nitrogen are not counted.

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

Percentage of acid fluoride VOCs removed by the WGS = 99.6%
Percentage of acid fluoride VOCs vented from the WGS = 100% minus 99.6%
Percentage of acid fluoride VOCs vented from the WGS = 0.4%

Therefore, VOCs vented to the atmosphere from the 9/18/15 maintenance activity is equal to:

Amount of VOCs vented to WGS:		88	kg of VOC
Percentage of VOCs vented from the WGS:	x	0.4%	
Quantity of VOCs vented from the WGS:	=	0.352	kg VOC
	=	**0.776019**	**lb VOC**

Stack Emissions from Maintenance Activity (cont.)
for the Storage Tank
<u>VOC Emissions by Compound</u>

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) = **0.78 lb VOC**

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

Sample calculation using maintenance activity dated 9/18/15

VOC emissions would be equal to:

0.776 lb VOC	1.00 lb Trimer	= 0.776 lb HFPO Trimer
	lb VOC	

Stack Emissions from Maintenance Activity (cont.)
for the Storage Tank
HF Potential

Assume that the vapor is 100% Trimer. This assumption is based on process knowledge of the system.

HFPO Trimer (perfluoro-2,5-dimethyl-3,6-dioxanonanoyl fluoride)

2490 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 9/18/15

Quantity of VOCs vented from the WGS (see Page 2) = **0.78 lb VOC**

HF equivalent emissions would be equal to:

0.776 lb VOC	1.00 lb Trimer	0.040 lb HF	=	0.031 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)
9/18/15	Storage	Maintenance	Annual Shutd	231	143	0.776	0.031

Total Emissions	0.78	0.03

Total VOC = 0.78 lb
VOC = 0.0004 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)	
9/18/15	Storage	Maintenance	nnual Shutdov	0.776	0.776	

Total Emissions	0.78	0.78	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

Nafion® Compound	CAS Chemical Name	CAS No.	Stack Emissions (lbs)	Fugitive Emissions (lbs)	Total Emissions (lbs)
COF2	Carbonic difluoride	353-50-4	1.24	119.9	121.1
HFPO Trimer	Perfluoro-2,5-dimethyl-3,6-dioxanonanoyl fluoride	2641-34-1	0.78	254.5	255.3
TAF	Trifluoromethyl carbonofluoridate	3299-24-9	2.90	279.7	282.6
			Total VOC (lb)		**658.9**
			Total VOC (ton)		**0.33**

B. Toxic Air Pollutant Summary

Nafion® Compound	CAS Chemical Name	CAS No.	Stack Emissions (lbs)	Fugitive Emissions (lbs)	Total Emissions (lbs)
HF	Hydrogen fluoride	7664-39-3	16.98	89.6	106.6

MMF Process

NS-F

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	168.7	164.1	0	0	332.9
DME	Dimethyl ether	115-10-6	0.1	0.1	0	0	0.1
MTVE	Methyl Trifluorovinyl Ether	3823-94-7	0.01	0.01	0	0	0.0
MTFE	1-methoxy-1,1,2,2-tetrafluoroethane	425-88-7	0.01	0.01	0	0	0.0
MTP	Methyl-3-methoxy-	755-73-7	0.01	0.01	0	0	0.0
BMTK	Bis(2-methoxytetrafluoroethyl)ketone	1422-71-5	0.00	0.001	0	0	0.0
MTP Acid	MTP Acid	93449-21-9	0.00	0.000	0	0	0.0
TFE	Tetrafluoroethylene	116-14-3	25.8	25.1	0	0	50.8
CH3F	Methyl Fluoride	593-53-3	8.6	8.4	6.7	0	23.7
MMF	Propanoic Acid, 2,2,3-Trifluoro-3-oxo,methyl ester	69116-71-8	0	0.0	23.8	0	23.8
Total VOC for 2015			**203.2**	**197.6**	**30.5**	**0**	**431.3**
						VOC (Tons)	**0.22**

B. Toxic Air Polluntant 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	25.7	4	0	29.7

0516

Point Source Emission Determination

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

HF Potential:

TFE is a VOC without the potential to form HF.

TFE Quantity Generated:

Before-control TFE emission rate per the Process Flowsheet #5600:

Source	TFE Vent Rate	
MTP Rx	0.0182	kg TFE vented per MMF unit
Neutralizer	0	kg TFE vented per MMF unit
Wash Tk	0	kg TFE vented per MMF unit
Crude MTP Tk	0	kg TFE vented per MMF unit
Crude DMC Tk	0	kg TFE vented per MMF unit
DMC Still	0	kg TFE vented per MMF unit
Total	**0.0182**	kg TFE vented per MMF unit

The before-control TFE emission is based oı **642.2** MMF units in 2015

TFE vented from the MMF Process in the reporting year:

$$\frac{0.0182 \text{ kg TFE}}{\text{MMF unit}} \times 642.2 \text{ MMF unit} = \mathbf{11.69} \text{ kg TFE}$$

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

VOC Emissions

$$\text{Waste Gas Scrubber} \times \frac{11.69 \text{ kg TFE}}{(100\%\text{-}0\%) \text{ control efficiency}}$$

$$= 11.69 \text{ kg TFE} = 25.77 \text{ lb. THF}$$

$$= \mathbf{25.77} \textbf{ lb. VOC}$$

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 #5600:

Source	DMC Vent Rate	
MTP Rx	0.0249	kg DMC vented per MMF unit
Neutralizer	0.0315	kg DMC vented per MMF unit
Wash Tk	0.0057	kg DMC vented per MMF unit
Crude MTP Tk	0.0075	kg DMC vented per MMF unit
Crude DMC Tk	0.0099	kg DMC vented per MMF unit
DMC Still	0.0396	kg DMC vented per MMF unit
Total	**0.1192**	kg DMC vented per MMF unit

The before-control DMC emission is based on **642.2** MMF units in 2015

DMC vented from the MMF Process in the reporting year:

$$\frac{0.1192 \text{ kg DMC}}{\text{MMF unit}} \times 642.2 \text{ MMF unit} = \mathbf{76.53} \text{ kg DMC}$$

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

VOC Emissions

$$\text{Waste Gas Scrubber} \times \frac{76.53 \text{ kg DMC}}{(100\%\text{-}0\%) \text{ control efficiency}}$$

= 76.53 kg DMC = 168.72 lb. DMC

= **168.72** **lb. VOC**

C. DME
Dimethyl ether

CAS No. 115-10-6

HF Potential:

DME is a VOC without the potential to form HF

DME Quantity Generated:

Before-control DME emission rate per the Process Flowsheet #5600:

Source	DME Vent Rate	
MTP Rx	0	kg DME vented per MMF unit
Neutralizer	0.000214	kg DME vented per MMF unit
Wash Tk	0.000138	kg DME vented per MMF unit
Crude MTP Tk	0.000221	kg DME vented per MMF unit
Crude DMC Tk	0	kg DME vented per MMF unit
DMC Still	0.00860	kg DME vented per MMF unit
Total	**0.00917**	kg DME vented per MMF unit

The before-control RSU emission is based on **642.2** MMF units in 2015

DME vented from the MMF Process in the reporting year:

$$\frac{0.00917 \text{ kg DME}}{\text{MMF unit}} \times 642.2 \text{ MMF unit} = \mathbf{5.89} \text{ kg DME}$$

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

VOC Emissions

Waste Gas Scrubber x 5.89 kg DME × (100%-99.6%) control efficiency
= 0.02 kg DME = 0.05 lb. DME
= **0.05 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 #5600:

Source	**MTVE Vent Rate**	
MTP Rx	0.00057	kg MTVE vented per MMF unit
Neutralizer	0.00049	kg MTVE vented per MMF unit
Wash Tk	0.00019	kg MTVE vented per MMF unit
Crude MTP Tk	0.00042	kg MTVE vented per MMF unit
Crude DMC Tk	0	kg MTVE vented per MMF unit
DMC Still	0	kg MTVE vented per MMF unit
Total	**0.00166**	kg MTVE vented per MMF unit

The before-control MTVE emission is based on **642.2** MMF units in 2015

MTVE vented from the MMF Process in the reporting year:

$$\frac{0.00166 \text{ kg MTVE}}{\text{MMF unit}} \times 642.2 \text{ MMF unit} = \mathbf{1.07} \text{ kg MTVE}$$

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

VOC Emissions

$$\text{Waste Gas Scrubber} \quad \frac{1.0679 \text{ kg MTVE} \times (100\%-99.6\%) \text{ control efficiency}}{} = 0.0043 \text{ kg MTVE} = 0.009 \text{ lb. MTVE}$$

$$= \mathbf{0.009 \text{ lb. VOC}}$$

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 #5600:

Source	**MTFE Vent Rate**	
MTP Rx	0.001269	kg MTFE vented per MMF unit
Neutralizer	0.000489545	kg MTFE vented per MMF unit
Wash Tk	0.00019306	kg MTFE vented per MMF unit
Crude MTP Tk	0.000420595	kg MTFE vented per MMF unit
Crude DMC Tk	0	kg MTFE vented per MMF unit
DMC Still	0	kg MTFE vented per MMF unit
Total	**0.00237**	kg MTFE vented per MMF unit

The before-control MTFE emission is based on **642.2** MMF units in 2015

MFTE vented from the MMF Process in the reporting year:

$$\frac{0.00237 \text{ kg MTFE}}{\text{MMF unit}} \times 642.2 \text{ MMF unit} = \mathbf{1.52} \text{ kg MTFE}$$

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

VOC Emissions

		1.523	kg MTFE			
Waste Gas Scrubber	x	(100%-99.6%)	control efficiency			
	=	0.006	kg MTFE	=	0.013	lb. MTFE
				=	**0.013**	**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 #5600:

Source	**MTP Vent Rate**	
MTP Rx	0.0000028	kg MTP vented per MMF unit
Neutralizer	0.001041	kg MTP vented per MMF unit
Wash Tk	0.000365	kg MTP vented per MMF unit
Crude MTP Tk	0.000503	kg MTP vented per MMF unit
Crude DMC Tk	0.0000007	kg MTP vented per MMF unit
DMC Still	0	kg MTP vented per MMF unit
Total	**0.00191**	kg MTP vented per MMF unit

The before-control MTP emission is based on **642.2** MMF units in 2015

MTP vented from the MMF Process in the reporting year:

$$\frac{0.00191 \text{ kg MTP}}{\text{MMF unit}} \times 642.2 \text{ MMF unit} = \mathbf{1.23} \text{ kg MTP}$$

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

MTP Emissions

$$\text{Waste Gas Scrubber} \quad \frac{1.229 \text{ kg MTP} \times (100\%\text{-}99.6\%) \text{ control efficiency}}{} = 0.005 \text{ kg MTP} = 0.011 \text{ lb. MTP}$$

$$= \mathbf{0.011 \text{ lb. VOC}}$$

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 #5600:

Source	BMTK Vent Rate	
MTP Rx	0	kg BMTK vented per MMF unit
Neutralizer	0.000089635	kg BMTK vented per MMF unit
Wash Tk	0.000034475	kg BMTK vented per MMF unit
Crude MTP Tk	0.00004137	kg BMTK vented per MMF unit
Crude DMC Tk	0	kg BMTK vented per MMF unit
DMC Still	0	kg BMTK vented per MMF unit
Total	**0.00016548**	kg BMTK vented per MMF unit

The before-control BMTK emission is based on **642.2** MMF units in 2015

BMTK vented from the MMF Process in the reporting year:

$$\frac{0.000165 \text{ kg BMTK}}{\text{MMF unit}} \times 642.2 \text{ MMF unit} = \mathbf{0.11} \text{ kg BMTK}$$

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

BMTK Emissions

Waste Gas Scrubber: 0.10627 kg BMTK x (100%-99.6%) control efficiency

= 0.00043 kg BMTK = 0.001 lb. BMTK

= **0.001** **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 #5600:

Source	MTP Acid Vent Rate	
MTP Rx	0.000000	kg MTP Acid vented per MMF unit
Neutralizer	0	kg MTP Acid vented per MMF unit
Wash Tk	0.000020685	kg MTP Acid vented per MMF unit
Crude MTP Tk	0.000034475	kg MTP Acid vented per MMF unit
Crude DMC Tk	0	kg MTP Acid vented per MMF unit
DMC Still	0	kg MTP Acid vented per MMF unit
Total	**0.00005516**	kg MTP Acid vented per MMF unit

The MTP Acid emission* is based on **642.2** MMF units in 2015
* before-control emissions

MTP Acid vented from the MMF Process in the reporting year:

$$\frac{0.000055 \text{ kg MTP Acid}}{\text{MMF unit}} \times 642.2 \text{ MMF unit} = \mathbf{0.035} \text{ kg MTP Acid}$$

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

MTP Acid Emissions

$$\text{Waste Gas Scrubber} \quad \frac{0.035 \text{ kg MTP Acid}}{\times\ (100\%-99.6\%) \text{ control efficiency}}$$

$$= 0.00014 \text{ kg MTP Acid} = 0.0003 \text{ lb. MTP Acid}$$

$$= \mathbf{0.0003} \textbf{ lb. VOC}$$

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 **642.2** MMF units in 2015

CH3F vented from the MMF Process in the reporting year:

$$\frac{1.52 \text{ kg CH3F}}{\text{MMF unit}} \times 642.2 \text{ MMF unit} = \mathbf{974.2} \text{ kg CH3F}$$

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

CH3F Emissions

Waste Gas Scrubber: 974.2 kg CH3F x (100%-99.6%) control efficiency

= 3.9 kg CH3F = 8.6 lb. CH3F

= **8.6** **lb. VOC**

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 = 38

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	38 days/year		x	38 days/year
	=	**197.6 lb/yr VOC from EE**		x	0.13 lb HF per lb VOC
				=	**25.7 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	38 days/year		x	38 days/year
	=	**30.5 lb/yr VOC from EE**		x	0.13 lb HF per lb VOC
				=	**4.0 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:	197.6	25.7	0	0
B. Equipment Emissions From MMF Reactor and Transfer Tank	0	0	30.5	4.0
Total for 2015	**197.6**	**25.7**	**30.5**	**4.0**

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	168.7	164.1	0	0	332.9
DME	0.1	0.1	0	0	0.1
MTVE	0.01	0.01	0	0	0.02
MTFE	0.01	0.01	0	0	0.03
MTP	0.01	0.01	0	0	0.02
BMTK	0.001	0.001	0	0	0.002
MTP Acid	0.0003	0.000	0	0	0.001
TFE	25.8	25.1	0	0	50.8
CH3F	8.6	8.4	6.7	0	23.7
MMF	0	0	23.8	0	23.8
Total	**203.2**	**197.6**	**30.5**	**0.0**	**431.3**

Note: Speciated equipment emissions were estimated by assuming that each compound's equipment emission concentration was equal to that compound's stack emission fraction of the total stack emission.

Example: The DMC equipment emissions were determined by the ratio of the DMC stack emission (254.7 lb) divided by the total stack emission (306.7 lb), multiplied by the total equipment emissions (358.9 lb).

Specifically: $\dfrac{168.7}{203.2} \times 197.6$ = 164.1 lb. DMC

Resins Process

NS-G

0517

Yearly Emission Summary

A. VOC Compound Summary

NS-G SR/CR Resins Manufacturing Process			
Compound	**CAS Chemical Name**	**CAS No.**	**Emission (lb)**
PSEPVE	Perfluoro(4-methyl-3,6-dioxaoct-7-ene) sulfonyl fluoride	16090-14-5	1,513
EVE	methyl 2,2,3,3-tetrafluoro-3-({1,1,1,2,3,3-hexafluoro-3-[(trifluoroethenyl)oxy]propan-2-yl}oxy)propanoate	63863-43-4	1,372
TFE	Tetrafluoroethylene	116-14-3	12,153
E-2	2H-Perfluoro(5-Methyl-3,6-Dioxanonane)	3330-14-1	3,492
MeOH	Methanol	67-56-1	149
		Total VOC Emissions (lb.)	18,679
		Total VOC Emissions (tons)	**9.34**

B. Toxic Air Pollutant Summary

NS-G SR/CR Resins Manufacturing Process			
Compound	**CAS Chemical Name**	**CAS No.**	**Emission (lb)**
F-113	Trichloro-1,2,2-trifluoro-1,1,2 Ethane	76-13-1	0
HF	Hydrogen Fluoride	7664-39-3	0.6
MeOH	Methanol	67-56-1	149

Total raw materials fed (M) , kgs

	E-2 Solution Addition	PSEPVE Solution Addition	Totalized PSEPVE Feed	EVE Solution Addition	Totalized EVE Feed	Totalized TFE Make-up	Totalized DP Addition	SR Consumption	CR Consumption	M (kg)
Jan-15	561	1,944	4,230	0	0	5,717	484	8,559	1,375	22,870
Feb-15	601	764	5,033	0	0	6,197	425	7,640	441	21,101
Mar-15	1,533	1,333	3,499	0	0	4,553	428	4,743	2,233	18,322
Apr-15	4,177	2,101	1,204	0	0	1,556	141	8,319	1,880	19,378
May-15	1,192	1,213	4,006	0	0	4,696	510	7,114	1,268	19,999
Jun-15	280	318	3,480	0	0	3,958	244	6,323	0	14,603
Jul-15	1,796	288	3,439	0	0	3,951	231	6,119	2,843	18,667
Aug-15	276	1,632	5,280	0	0	6,471	393	10,071	442	24,565
Sep-15	1,769	189	1,750	0	0	1,984	120	4,114	0	9,926
Oct-15	5,162	0	0	1,905	2,993	4,611	208	0	450	15,329
Nov-15	2,573	2,556	4,596	0	0	5,559	232	9,005	2,158	26,679
Dec-15	1,488	0	5,792	0	0	7,471	401	9,186	2,678	27,016

Total transformed materials collected (P) , kgs

	Polymer	N/S Polymer	Purge & Adhesions	Purge	Vent Port Juice	P (kg)
Jan-15	7,445	746	242	452	246	9,132
Feb-15	10,025	48	160	175	0	10,409
Mar-15	6,833	49	0	61	0	6,942
Apr-15	2,095	0	239	401	165	2,900
May-15	7,472	207	86	39	0	7,803
Jun-15	6,251	0	195	418	285	7,148
Jul-15	6,656	0	0	211	0	6,867
Aug-15	10,526	0	302	262	187	11,277
Sep-15	3,063	0	0	257	0	3,320
Oct-15	6,982	0	0	10	0	6,992
Nov-15	8,532	0	416	244	35	9,227
Dec-15	11,812	0	0	0	0	11,812

Total untransformed materials collected (W) , kgs

	SR Issued	CR Issued	Solution Increase	VE to Filters/Sieves	E2 to Filters/Sieves	W (kg)
Jan-15	8,370	1,290	2,881	448	493	13,483
Feb-15	7,594	398	947	877	761	10,577
Mar-15	6,375	2,161	2,077	290	341	11,245
Apr-15	8,100	1,703	3,000	1,710	1,486	15,999
May-15	6,842	1,224	3,321	200	183	11,770
Jun-15	6,091	0	-95	436	376	6,809
Jul-15	6,320	2,751	1,837	85	73	11,067
Aug-15	10,249	420	1,098	752	721	13,240
Sep-15	4,187	0	1,869	175	150	6,381
Oct-15	0	441	6,611	0	0	7,052
Nov-15	7,891	2,065	5,192	378	326	15,853
Dec-15	9,820	2,146	150	411	355	12,882

VOC emissions from the filling of storage tanks (S)

	Total PSEPVE loss from Tank	Total EVE loss from Tank	Total E-2 loss from Tank	Total MeOH Emissions (kg)	S (kg)
Jan-15	0	0	1	22	23
Feb-15	0	0	1	25	27
Mar-15	0	0	1	15	17
Apr-15	0	0	1	7	8
May-15	0	0	1	15	16
Jun-15	0	0	1	19	20
Jul-15	0	0	1	19	20
Aug-15	0	0	1	21	23
Sep-15	0	0	1	8	9
Oct-15	0	0	1	12	14
Nov-15	0	0	1	21	22
Dec-15	0	0	1	21	23

Total VOC Emissions (lb) : $E = (M - P - W + S) \times 2.2$

	M (kg)	P (kg)	W (kg)	S (kg)	E (kg)	E (lb)
Jan-15	22,870	9,132	13,483	23	278	612
Feb-15	21,101	10,409	10,577	27	141	311
Mar-15	18,322	6,942	11,245	17	152	333
Apr-15	19,378	2,900	15,999	8	487	1,071
May-15	19,999	7,803	11,770	16	443	974
Jun-15	14,603	7,148	6,809	20	667	1,467
Jul-15	18,667	6,867	11,067	20	754	1,658
Aug-15	24,565	11,277	13,240	23	71	156
Sep-15	9,926	3,320	6,381	9	234	515
Oct-15	15,329	6,992	7,052	14	1,299	2,857
Nov-15	26,679	9,227	15,853	22	1,621	3,566
Dec-15	27,016	11,812	12,882	23	2,344	5,158
			Total VOC Emissions (lb)			**18,679**
			Total VOC Emissions (ton)			**9.34**

Nafion® Membrane Process

NS-H

05181

Emission source/Operating Scenario Data

1. Emission Source ID No. **NS-H**

Actual emissions per pollutant listed for source/process identified on page 1:

Criteria (NAAQS) pollutants	Pollutant code	Emissions-Criteria pollutants (tons/yr)	Emission estimation method code	control efficiency
		2015		
Carbon Monoxide	CO	0	2	
NOx	NOx	0	2	
TSP	TSP	0	2	
PM 2.5	PM-2.5	0	2	
PM 10	PM-10	0	2	
SO2	SO2	0	2	
VOC	VOC	14.7	2	0%

Criteria (NAAQS) pollutants	Pollutant code	Emissions-Criteria pollutants (lb/yr)	Emission estimation method code	control efficiency
		2015		
HAP/TAP pollutants	CAS #		2	0%
Acetic Acid	64-19-7	95	2	0%
Hydrogen Fluoride	7664-39-03	119	2	0%

NS-H Membrane treatment (extrusion & hydrolysis) summary report.

DMSO Emissions yr	Units	2015
Waste Shipped	lbs/yr	38100
Waste in storage tk yr end	gallons	5293
Waste in storage tk yr end	lbs	53992
Waste % in storage tk yr end	%	88%
DMSO Waste Content	wt%	11%
DMSO in Waste liquid	lbs/yr	10130
DMSO Shipped as Waste liquid	lbs/yr	4191
KOH/DMSO waste pumped to waste treatment	gal/yr	18108
	lbs/yr	184705
DMSO pumped to waste treatment	lbs/yr	20318
DMSO Inventory		
inv. Begin year	drums	**12**
inv. End year	drums	**16.668**
DMSO Drums Rec	drums	**124**
Wt/Drum	lb/drum	500
total DMSO consumed	lbs	59666
DMSO Emissions into air	lbs/yr	29218
DMSO Emissions into air	**tons/yr**	**14.61**
Acetic Acid Emissions air		
1st Quarter	hrs	17.7
2nd Quarter	hrs	9.5
3rd Quarter	hrs	39.8
4th Quarter	hrs	63.2
Total	hrs	130.2
Acetic Acid Emissions Rate	lbs/hr	0.727
Acetic Acid HAP/TAP Emissions	lbs/yr	*94.6*
Acetic Acid HAP/TAP Emissions	**tons/yr**	**0.047**
Total VOC Emissions	lbs/yr	29313
Total VOC Emissions	**tons/yr**	**14.66**

Throughput (production)

Hydrolysis product produced.	m2	201136.89
Hydrolysis surface treatment	m2	30745.65

1st qrt % hrs of operations	26.49%
2nd qrt % hrs of operations	20.31%
3rd qrt % hrs of operations	27.15%
4th qrt % hrs of operations	26.05%

HF Emissions

SR Resin Extruded	kg/yr	78,981
CR Resin Extruded	kg/yr	7,834
total polymer extruded	kg/yr	86,815

kg HF / kg SR @ 275 deg C	0.00068
kg HF / kg CR @ 275 deg C	0.00008

kg SR Resin extruded per year	78,981
kg HF / kg SR @ 275 deg C	0.00068
kg HF emitted per year	53.3

kg SR Resin extruded per year	7,834
kg HF / kg SR @ 275 deg C	0.00008
kg HF emitted per year	0.6

Total HF Formed kg/yr	54
Total HF HAP/TAP Emissions lbs/yr	*119*

Nafion® Membrane Coating

NS-I

05 19

Emission source/Operating Scenario Data

1. Emission Source ID No. NS-I

Actual emissions per pollutant listed for source/process identified on page 1:

Criteria (NAAQS) pollutants	Pollutant code	Emissions-Criteria pollutants (tons/yr)	Emission estimation	control efficiency
		2015		
Carbon Monoxide	CO	0	8	
NOx	NOx	0	8	
TSP	TSP	0.34	8	0%
PM 2.5	PM-2.5	0.34	8	0%
PM 10	PM-10	0.34	8	0%
SO2	SO2	0	8	
VOC	VOC	29.68	8	0%

Coating Process yr		2015
Max Spray Coat Rate	cc/min (2 guns)	400
Max Process Rate	gal/hr	6.3
Paint Batches	batch	192
Gallons/batch	gals	50
Gallons from Original batches	gals	9600
Remade batches	batchs	0
Gallons added/batch	gals	5
Gallons added to remake batchs	gals	0
Annual Process Throughput	gals/yr	9600
Coating Density	lb/gal	7.928
Coating Consumed	lbs/yr	76109
VOC Emissions		
Ethanol	wt %	69%
Methanol	wt %	1%
1-Propanol	wt %	8%
Annual VOC Emissions	lbs/yr	59365
	tons/yr	**29.68**
TSP Emissions		
Coating Solids	wt %	18%
Paint Arrestor Effic	%	95%
Solids Produced	lb/yr	13700
Annual TSP Emissions	lbs/yr	685.0
total suspended particles	**tons/yr**	**0.34**

E-2 Process

NS-K

0527

2015 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No.: NS-K

Emission Source Description: Nafion E-Fluids Production Process

Process and Emission Description:

The E2 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
E2 production quantity	E2 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.

2015 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	260.7	24.1	0	0	284.8
E2	2H-perfluoro(5-methyl-3,6-dioxanonane)	3330-14-1	199.1	18.2	0	0	217.3
E3	2H-perfluoro-5,8-dimethyl-3,6,9-trioxadodecane	3330-16-3	1.7	0.2	0	0	1.9
		TOTAL	**461.6**	**42.4**	**0**	**0**	**504.0**
					TOTAL (TON)		**0.25**

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	0.29	lbs E1 vented per batch
55 gal. drum	0.53	lbs E1 vented per batch
Total	**2.82**	lbs E1 vented per batch

The quantity (pounds) of E1 vented is based on 42 batches of produced Crude E-fluids

2015 annual E1 emissions vented from the E-Fluids Process are calculated by the following:

$$\frac{2.82 \text{ lb E1}}{\text{batch}} \times 42 \text{ batches} = 118.25 \text{ kg E1}$$
$$= 260.7 \text{ lb E1}$$
$$= \mathbf{260.7 \text{ lb VOC}}$$

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	0.22	lbs E2 vented per batch
55 gal. drum	0.40	lbs E2 vented per batch
Total	**2.15**	lbs E2 vented per batch

The quantity (pounds) of E2 vented is based on 42 batches of produced Crude E-fluids

2015 annual E2 emissions vented from the E-Fluids Process are calculated by the following:

$$\frac{2.15 \text{ lb E2}}{\text{batch}} \times 42 \text{ batches} = 90.32 \text{ kg E2}$$

$$= 199.1 \text{ lb E2}$$

$$= \mathbf{199.1 \text{ lb VOC}}$$

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	0.002	lbs E3 vented per batch
55 gal. drum	0.004	lbs E3 vented per batch
Total	**0.02**	lbs E3 vented per batch

The quantity (pounds) of E3 vented is based on 42 batches of produced Crude E-fluids

2015 annual E3 emissions vented from the E-Fluids Process are calculated by the following:

$$\frac{0.02 \text{ lb E3}}{\text{batch}} \times 42 \text{ batches} = 0.79 \text{ kg E3}$$
$$= 1.7 \text{ lb E3}$$
$$= \mathbf{1.7 \text{ lb VOC}}$$

Detailed Point Source Calculations

Background
Three vessels inside the E2 Building vent to the E2 Bldg. stack (EP-NEP-1). The vessels are the Transfer Tank, Interface Tank and a polypropylene 55 gal. drum. The crude E-fluids tote is filled on the outside on the E2 building, therefore vented emissions from this tote are true "Fugitive Emissions" and will be reported as such.

A. Transfer Tank

The Transfer tank is a 150 gallon vessel that is filled at a rate of 7.3 gal/min. The operating temperature during the filling is 40 degrees C. The tank is filled with 125 gallons of material. We will assume that entire tank volume (20 ft^3) is vented on filling.

Calculations:

PV = nRT (assumes the Ideal Gas Law)

Tank Volume = 150 gallons / 7.48 gal/ft^3 = 20.05 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	0.01
Total		220.00	0.51	100%		

* Partial Pressure = **Vapor Pressure** multiplied by **Mol%** divided by **100%**

Tank temperature = 40 degrees Celsius is equal to 563.69 degrees R

R = 10.73 psia-ft^3/lb-mol/degR

For E1: n = moles of E1 = (Partial pressure of E1) * (Volume) / (R) / (Temperature)

$$n = \frac{2.11 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{20.05 \text{ ft}^3}{563.69 \text{ degrees R}} = 0.0070 \text{ lb-mol E1}$$

$$0.0070 \text{ lb-mol E1} \times \frac{286 \text{ lb E1}}{\text{lb-mol E1}} = \textbf{2.00 lb E1/batch}$$

For E2: n = moles of E2 = (Partial pressure of E2) * (Volume) / (R) / (Temperature)

$$n = \frac{1.03 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{20.05 \text{ ft}^3}{563.69 \text{ degrees R}} = 0.0034 \text{ lb-mol E2}$$

$$0.0034 \text{ lb-mol E2} \times \frac{452 \text{ lb E2}}{\text{lb-mol E2}} = \textbf{1.54 lb E2/batch}$$

For E3: n = moles of E3 = (Partial pressure of E3) * (Volume) / (R) / (Temperature)

$$n = \frac{0.01 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{20.05 \text{ ft}^3}{563.69 \text{ degrees R}} = 0.000021 \text{ lb-mol E3}$$

$$0.000021 \text{ lb-mol E3} \times \frac{618 \text{ lb E3}}{\text{lb-mol E3}} = \textbf{0.01 lb E3/batch}$$

B. Interface Tank

The Interface Tank is a 30 gallon vessel. The E-fluids are seperated from aqueous material in the Transfer Tank and are sent to the Interface Tank. Once the Interface Tank is close to full, material is taken from the Interface Tank to a 55 gallon drum. Assume temperature is 30 degrees C and entire tank volume is vented during filling.

Calculations:

PV = nRT (assumes the Ideal Gas Law)

Tank Volume = 30 gallons / 7.48 gal/ft^3 = 4.01 ft^3

Contents of vessel :

Component	MW	Kgs	Moles	Mol %	Vapor Pressure (psia)	Partial Pressure* (psia)
E1	286	22.00	0.08	15.09	9.70	1.46
E2	452	189.20	0.42	82.12	0.85	0.70
E3	618	8.80	0.01	2.79	0.17	0.00
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)

$$n = \frac{1.46 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{4.01 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.0010 \text{ lb-mol E1}$$

$$0.0010 \text{ lb-mol E1} \times \frac{286 \text{ lb E1}}{\text{lb-mol E1}} = \mathbf{0.29 \text{ lb E1/batch}}$$

For E2: n = moles of E2 = (Partial pressure of E2) * (Volume) / (R) / (Temperature)

$$n = \frac{0.70 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{4.01 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.0005 \text{ lb-mol E2}$$

$$0.0005 \text{ lb-mol E2} \times \frac{452 \text{ lb E2}}{\text{lb-mol E2}} = \mathbf{0.22 \text{ lb E2/batch}}$$

For E3: n = moles of E3 = (Partial pressure of E3) * (Volume) / (R) / (Temperature)

$$n = \frac{0.00 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{4.01 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.000003 \text{ lb-mol E3}$$

$$0.000003 \text{ lb-mol E3} \times \frac{618 \text{ lb E3}}{\text{lb-mol E3}} = \mathbf{0.002 \text{ lb E3/batch}}$$

C. 55 gallon drum

This drum receives material from the Interface Tank. The E-fluids are pumped from this drum through the dryer to remove any moisture that is present, before final loading into the Crude E-fluids tote. Assume filling temerature is 30 degrees C and entire drum volume vents during filling.

Calculations:

PV = nRT (assumes the Ideal Gas Law)

Tank Volume = 55 gallons / 7.48 gal/ft^3 = 7.35 ft^3

Contents of vessel :

Component	MW	Kgs	Moles	Mol %	Vapor Pressure (psia)	Partial Pressure* (psia)
E1	286	22.00	0.08	15.09	9.70	1.46
E2	452	189.20	0.42	82.12	0.85	0.70
E3	618	8.80	0.01	2.79	0.17	0.00
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)

$$n = \frac{1.46 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{7.35 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.0018 \text{ lb-mol E1}$$

$$0.0018 \text{ lb-mol E1} \times \frac{286 \text{ lb E1}}{\text{lb-mol E1}} = \mathbf{0.53 \text{ lb E1/batch}}$$

For E2: n = moles of E2 = (Partial pressure of E2) * (Volume) / (R) / (Temperature)

$$n = \frac{0.70 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{7.35 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.0009 \text{ lb-mol E2}$$

$$0.0009 \text{ lb-mol E2} \times \frac{452 \text{ lb E2}}{\text{lb-mol E2}} = \mathbf{0.40 \text{ lb E2/batch}}$$

For E3: n = moles of E3 = (Partial pressure of E3) * (Volume) / (R) / (Temperature)

$$n = \frac{0.00 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{7.35 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.000006 \text{ lb-mol E3}$$

$$0.000006 \text{ lb-mol E3} \times \frac{618 \text{ lb E3}}{\text{lb-mol E3}} = \mathbf{0.004 \text{ lb E3/batch}}$$

D. Total Point Source Emissions from E2-Fluids process

Chemical	lb/batch	No. of batches	lbs
E1	2.82	42	118.3
E2	2.15	42	90.3
E3	0.02	42	0.8
Total			**209.4**

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	9.70	1.46
E2	452	189.20	0.42	82.12	0.85	0.70
E3	618	8.80	0.01	2.79	0.17	0.0047
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)

$$n = \frac{1.46 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{8.02 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.0020 \text{ lb-mol E1}$$

$$0.0020 \text{ lb-mol E1} \times \frac{286 \text{ lb E1}}{\text{lb-mol E1}} = \mathbf{0.57\ lb\ E1/batch}$$

For E2: n = moles of E2 = (Partial pressure of E2) * (Volume) / (R) / (Temperature)

$$n = \frac{0.70 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{8.02 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.0010 \text{ lb-mol E2}$$

$$0.0010 \text{ lb-mol E2} \times \frac{452 \text{ lb E2}}{\text{lb-mol E2}} = \mathbf{0.43\ lb\ E2/batch}$$

For E3: n = moles of E3 = (Partial pressure of E3) * (Volume) / (R) / (Temperature)

$$n = \frac{0.0047 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{8.02 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.000007 \text{ lb-mol E3}$$

$$0.000007 \text{ lb-mol E3} \times \frac{618 \text{ lb E3}}{\text{lb-mol E3}} = \mathbf{0.004\ lb\ E3/batch}$$

Total Fugitive Emissions from E2-Fluids process

Chemical	lb/batch	No. of batches	lbs
E1	0.57	42	24.1
E2	0.43	42	18.2
E3	0.004	42	0.2
Total			**42.4**

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	0	operating hrs/year	8760
	=	0.0	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%	0.0	0.0
E2	86%	0.0	0.0
E3	4%	0.0	0.0
Total			0.0

Where the **Chemical Emission Rate** equals the **Total Equipment Emission Rate** multiplied by the **Chemical Fraction**

TFE/CO2 Separation Process

NS-M

E0554

2015 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.

2015 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	12720.5	38.0	0	12758.5
			Total VOC Emissions (lb)			**12758**
			Total VOC Emissions (tons)			**6.38**

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	105.4	38.0	0	143.4
			Total Emissions (lb)			**143.4**
			Total Emissions (tons)			**0.07**

Point Source Emission Determination

A. Tetrafluoroethylene (TFE) CAS No. 116-14-3

HF Potential:

TFE is a VOC without the potential to form HF.

TFE Quantity Generated:

From Precursor area facilitator (mixture is 50% TFE and 50% CO2):

Source	Quantity
TFE/CO2 fed to area	191,270 kg TFE/CO2
Total	**95,635 kg TFE fed to area**

From area facilitators:

Source	Quantity Consumed
Polymers consumption	56,956 kg TFE
Semiworks consumption	1,159 kg TFE
MMF consumption	5,720 kg TFE
RSU consumption	26,030 kg TFE
Total	**89,865 kg TFE consumed**

TFE vented from the TFE/CO2 area in the reporting year:

95635 kg TFE fed
- 89865 kg TFE consumed

5770 kg TFE vented

VOC Emissions

5770.0 kg VOC
12720.5 lb. VOC

B. Carbon dioxide (CO_2) — CAS No. 124-38-9

<u>CO2 Quantity Generated:</u>

From Precursor area facilitator (mixture is 50% TFE and 50% CO_2):

Source	Quantity
TFE/CO2 fed to area	191,270 kg TFE/CO2
Total	**95,635 kg CO2 sent to Separator**

The separator is assumed to remove 99.95% of the CO_2. Therefore, the CO_2 in the exit strean

Source	Quantity
CO2 in Product	47.8 kg CO2 exiting separator

Assume all CO_2 in exit stream is vented.

CO2 Emissions

47.8 kg CO2
105.4 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. Fugative 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 = 251

VOC:	0.005	lb/hr TFE FE
x	24	hours/day
x	251	days/year
=	**29.3**	**lb/yr VOC from EE**

CO2:	0.005	lb/hr CO2 FE
x	24	hours/day
x	251	days/year
=	**29.3**	**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 = 251

VOC:	0.0014	lb/hr TFE FE
x	24	hours/day
x	251	days/year
=	**8.7**	**lb/yr VOC from EE**

CO2:	0.0014	lb/hr CO2 FE
x	24	hours/day
x	251	days/year
=	**8.7**	**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:	29.3
B. Fugitive Emissions From TFE/CO2 Vaporizer	8.7
Total for 2015	**38.0**

Note: All VOC emissions are TFE. There are no other VOC's used in the TFE/CO2 area.

Emission Source	CO2 lb/yr
A. Fugative emissions from TFE/CO2 Truck Unloading area:	29.3
B. Fugitive Emissions From TFE/CO2 Vaporizer	8.7
Total for 2015	**38.0**

HFPO Product Container Decontamination Process

NS-N

0558

2015 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	19,406
HFA	Hexafluoroacetone	684-16-2	0
		Total VOC Emissions (lb)	19,406
		Total VOC Emissions (tons)	9.70

Emission Unit ID: NS-N

Emission Source Description: HFPO Product Container Decontamination Process

Emission Calculation Basis:

HFPO product containers returned from customers are decontaminated by venting residual hexafluoropropylene oxide ("HFPO") to the Nafion Division Waste Gas Scrubber (WGS). To determine the amount emitted from this process, the vapor density of HFPO is used along with the volume of the container.

Vapor density is based on Aspen process simulation data at 13°C, which is **0.0377** kg/L.

13°C was chosen based on the average 24 hour temperature for Audubon, NJ, which is located 30 miles northeast of Deepwater, NJ, the location of the primary customer of ISO containers and ton cylinders, i.e. where containers are emptied. (determined from www.worldclimate.com).

The mass of vapor in a container emptied of liquid is equal to the volume of the container multiplied by the vapor density.

$$M_{vap} = V * \rho_{vap}$$

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 2015

Container Type	Quantity of Containers	VOC per container (lb)	VOC Emissions (lb)	F-GHG Emissions (mT)
ISO Container	9	1,413	12,716	5.768
UNT Cylinder	15	83	1,247	0.566
1-Ton cylinder	28	63	1,769	0.802
3AA Cylinder	18	4	75	0.034
Total VOC Emission for All Containers			**15,807**	**7.170**
Total VOC Emission for All Containers			**7.90**	**tons**

Total Containers Decontaminated	**70**

Vinyl Ethers North Product Container Decontamination Process

NS-O

0559

Emission Unit IDs: NS-O

Emission Source Description: Vinyl Ethers North (VE-N) Product Container Decontamination Process

Container Emission Estimation Basis:

Dimer, PPVE, PSPEVE and EVE are the products that are produced in the VEN facility. Usually only PPVE is shipped to customers in 1-ton cylinders from the VE Nouth Manufacturing Process. Prior to filling the containers, they are decontaminated by pressurizing with Nitrogren, venting to the Waste Gas Scrubber (WGS) and evacuating for numerous cycles. TA NF-11-1821 has been written to fill on top of heels in cylinders without the need to decontaminate. This will greatly reduce the emissions as a result of decontaminating product shipping containers. This reduction should be reflected in the 2012 VE-N product container emissions report

To determine the amount emitted from this process, the vapor density of each component is used along with the volume of the container.

Approximately 50°F (10°C) average year round temperature for Parkersburg, WV where containters are emptied (use this temperature as worse case for all products). Assume when containers are emptied they remain full of vapors.

All emissions from the process are vented through the Nafion Division Waste Gas Scrubber (Control Device ID No. NCD-Hdr) which has a documented control efficiency of 99.6% for all acid fluoride compounds. Dimer is an acid fluoride.

Vapor density is based on data from PM Report #231, PM Report PM-E-487 extrapolated to 10°C and the ideal gas equation.

Product	Vapor Density (lb/gal) @ 10°C
Dimer	0.020
PSEPVE	0.001
PPVE	0.034
EVE	0.010

The mass of vapor ("M_{vap}") in a container emptied of liquid is equal to the volume of the container ("V") multiplied by the vapor density ("ρ_{vap}").

$$M_{vap} = V * \rho_{vap}$$

Volumes of the containers currently in use are as follows:

Container	Volume (gal)
ISO	3828
UNT	264
1 ton cylinder	200
4BW cylinder	57
4BA/3AA cylinder	15

Estimated emissions:

Dimer					**Before Control**	**After Control**
ISO	### gal	X	0.020 lb/gal	=	76.56 lb	0.30624 lb
UNT	264 gal	X	0.020 lb/gal	=	5.28 lb	0.02112 lb
1 ton cylinder	200 gal	X	0.020 lb/gal	=	4 lb	0.016 lb
4BW cylinder	57 gal	X	0.020 lb/gal	=	1.14 lb	0.0046 lb
4BA/3AA cylinder	15 gal	X	0.020 lb/gal	=	0.3 lb	0.0012 lb
PSEPVE						
1 ton cylinder	200 gal	X	0.001 lb/gal	=	0.2 lb	0.2 lb
4BW cylinder	57 gal	X	0.001 lb/gal	=	0.057 lb	0.057 lb
4BA/3AA cylinder	15 gal	X	0.001 lb/gal	=	0.015 lb	0.015 lb
PPVE						
1 ton cylinder	200 gal	X	0.034 lb/gal	=	6.8 lb	6.8 lb
4BW cylinder	57 gal	X	0.034 lb/gal	=	1.938 lb	1.938 lb
4BA/3AA cylinder	15 gal	X	0.034 lb/gal	=	0.51 lb	0.51 lb
EVE						
1 ton cylinder	200 gal	X	0.010 lb/gal	=	2 lb	2 lb
4BW cylinder	57 gal	X	0.010 lb/gal	=	0.57 lb	0.57 lb
4BA/3AA cylinder	15 gal	X	0.010 lb/gal	=	0.15 lb	0.15 lb

Emission Calculation:

Dimer	**Quantity of Containers**		**VOC per container**		**VOC Emissions**
ISO	1	X	0.306 lb	=	0.306 lb
UNT	10	X	0.021 lb	=	0.211 lb
1 ton cylinder	0	X	0.016 lb	=	0 lb
4BW cylinder	0	X	0.005 lb	=	0 lb
4BA/3AA cylinder	0	X	0.001 lb	=	0 lb

PSEPVE

1 ton cylinder	0	X	0.2 lb	=	0 lb
4BW cylinder	0	X	0.1 lb	=	0 lb
4BA/3AA cylinder	0	X	0.0 lb	=	0 lb

PPVE

1 ton cylinder	25	X	6.8 lb	=	170 lb
4BW cylinder	28	X	1.9 lb	=	54.26 lb
4BA/3AA cylinder	0	X	0.5 lb	=	0 lb

EVE

1 ton cylinder	0	X	2.0 lb	=	0 lb
4BW cylinder	0	X	0.6 lb	=	0 lb
4BA/3AA cylinder	0	X	0.2 lb	=	0 lb

Year **2015**

VE-North Product Container Decontamination Process Emission Summary:

Nafion® Compound	CAS Chemical Name	CAS No.	Total Emissions (lb.)
DIMER	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	0.5
PSEPVE	Perfluorinated Sulfonyl Vinyl Ether	16090-14-5	0.0
PPVE	Perfluoropropyl Vinyl Ether	1623-05-8	224.3
EVE	Ester Vinyl Ether	63863-43-4	0.0

Total VOC Emissions (lb.)	225
Total VOC Emissions (tons)	**0.11**

Vinyl Ethers South Product Container Decontamination Process

NS-P

0560

Emission Unit IDs: NS-P

Emission Source Description: Vinyl Ethers South(VE-S) Product Container Decontamination Process

Container Emission Estimation Basis:

PMVE, PEVE and PPVE are the products that are shipped to customers in 1-ton cylinders, 4BW cylinders, 4BA/3AA cylinders and ISO tank containers from the VE South Manufacturing Process. Prior to filling the containers, they are decontaminated by pressurizing with Nitrogren, venting to the Waste Gas Scrubber(WGS) and evacuating for numerous cycles. TA's(NF-09-1737 & NF-11-1821) have been written to fill on top of heels in ISO containers as well as cylinders without the need to decontaminate. This will greatly reduce the emissions as a result of decontaminating product shipping containers. This reduction should be reflected in the 2012 VE-S product container emissions report

It is assumed that the product split between PMVE and PEVE is 70 to 30 by weight and remains unchanged. PPVE is produced very infrequently in VE-S and is not used in the max to emit calculations shown below.

It is assumed that the container split between cylinders and ISO's remains unchanged. For PMVE, 48% to Iso and 52% to ton cylinders. Assume all PEVE is placed into 1 ton cylinders

At design capacity rates of the VE South Manufacturing Process, a maximum of 1,500 kg per day at 70%/30% PM/PE split can be produced. For 365 operating days per year and 100% uptime(worse case), this equates to 383,250 kgs of PMVE and 164,250 kgs of PEVE.

Approx. 50°F(10°C) average year round temperature for Dordrecht Plant in the Netherlands,where PMVE ISO containers are emptied(use this temp as worse case for all products). Assume when containers are emptied they remain full of vapors. Vapor density for PMVE at this temp is 0.2258 lb/gal and for PEVE 0.0901 lb/gal. These densities were computed using the Peng-Robinson modification of the Redlich-Kwong equation of state.

Iso volume is 4,480 gallons. 1 ton container volume is 200 gallons

To calculate the amount of product vented per container, the container volume is multiplied by the vapor density

Maximum Potential Emissions Calculations

Decontaminated PMVE 1-ton cylinders (potential) :	**243**	cylinders
PMVE Product vented per 1-ton cylinder :	**45**	lb. VOC per cylinder
PMVE Emissions from 1-ton cylinders (potential) :	**10,976**	lb. VOC per year
Decontaminated PMVE ISO tank containers (potential) :	**12**	containers
PMVE Product vented per ISO tank container :	**1,012**	lb. VOC per container
PMVE Emissions from ISO tank containers (potential) :	**12,406**	lb. VOC per year
Decontaminated PEVE 1-ton cylinders (potential) :	**205**	cylinders
PEVE Product vented per 1-ton cylinder :	**18**	lb. VOC per cylinder
PEVE Emissions from 1-ton cylinders (potential) :	**3,700**	lb. VOC per year
Total potential emissions :	**27,081**	lb. VOC per year
Total potential emissions :	**13.5**	tons VOC per year

Year 2015

VE-South VOC Container Emission Summary:

Nafion® Compound	CAS Chemical Name	CAS No.	Total Emissions (TPY)
PMVE	Perfluoromethyl vinyl ether	1187-93-5	2.43
PEVE	Perfluoroethyl vinyl ether	10493-43-3	0.03
PPVE	Perfluoropropyl vinyl ether	1623-05-8	0.00

Actual TPY Emitted from Containers **2.46**

Natural Gas/No. 2 Fuel Oil Fuel Oil-Fired Boiler

(139.4 Million BTU Per Hour Maximum Heat Input)

PS-A

0565

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:	03735T42
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:	520.34 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	tons/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	tons/yr	POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	tons/yr	EMISSION FACTOR lb/mmBtu uncontrolled	controlled
PARTICULATE MATTER (Total)	1.04	1.98	1.04	4.55	1.04	4.55	0.007	0.007
PARTICULATE MATTER (Condensable)	0.78	1.48	0.78	3.41	0.78	3.41	0.006	0.006
PARTICULATE MATTER (Filterable)	0.26	0.49	0.26	1.14	0.26	1.14	0.002	0.002
SULFUR DIOXIDE (SO2)	0.08	0.16	0.08	0.36	0.08	0.36	0.001	0.001
NITROGEN OXIDES (NOx)	25.97	49.43	25.97	113.73	25.97	113.73	0.186	0.186
CARBON MONOXIDE (CO)	11.48	21.85	11.48	50.28	11.48	50.28	0.082	0.082
VOLATILE ORGANIC COMPOUNDS (VOC)	0.75	1.43	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	lbs/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	lbs/yr	POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	lbs/yr	EMISSION FACTOR lb/mmBtu uncontrolled	controlled
Acetaldehyde (TH)	75070	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acrolein (TH)	107028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ammonia (T)	7664417	4.37E-01	1.67E+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	1.04E-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	1.09E+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	6.24E-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	6.24E-03	1.64E-06	1.44E-02	1.64E-06	1.44E-02	1.18E-08	1.18E-08
Cadmium metal (elemental unreacted) (TH)	7440439	1.50E-04	5.72E-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	7.28E-01	1.91E-04	1.68E+00	1.91E-04	1.68E+00	1.37E-06	1.37E-06
Cobalt unlisted compounds (H)	COC-other	1.15E-05	4.37E-02	1.15E-05	1.01E-01	1.15E-05	1.01E-01	8.24E-08	8.24E-08
Formaldehyde (TH)	50000	1.03E-02	3.90E+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	9.37E+02	2.46E-01	2.15E+03	2.46E-01	2.15E+03	1.76E-03	1.76E-03
Lead unlisted compounds (H)	PBC-other	6.83E-05	2.60E-01	6.83E-05	5.99E-01	6.83E-05	5.99E-01	4.90E-07	4.90E-07
Manganese unlisted compounds (TH)	MNC-other	5.19E-05	1.98E-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	1.35E-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	3.17E-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	1.09E+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	1.25E-02	3.28E-06	2.87E-02	3.28E-06	2.87E-02	2.35E-08	2.35E-08
Toluene (TH)	108883	4.65E-04	1.77E+00	4.65E-04	4.07E+00	4.65E-04	4.07E+00	3.33E-06	3.33E-06
Total HAPs		2.58E-01	9.82E+02	2.58E-01	2.26E+03	2.58E-01	2.26E+03	1.85E-03	1.85E-03
Highest HAP	Hexane	2.46E-01	9.37E+02	2.46E-01	2.15E+03	2.46E-01	2.15E+03	1.76E-03	1.76E-03

TOXIC AIR POLLUTANT EMISSIONS INFORMATION (FOR PERMITTING PURPOSES)

TOXIC AIR POLLUTANT	CAS Num.	EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS lb/hr	lb/day	lb/yr	EMISSION FACTOR lb/mmBtu uncontrolled	controlled
Acetaldehyde (TH)	75070	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acrolein (TH)	107028	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ammonia (T)	7664417	4.37E-01	1.05E+01	1.67E+03	3.14E-03	3.14E-03
Arsenic unlisted compounds (TH)	ASC-other	2.73E-05	6.56E-04	1.04E-01	1.96E-07	1.96E-07
Benzene (TH)	71432	2.87E-04	6.89E-03	1.09E+00	2.06E-06	2.06E-06
Benzo(a)pyrene (TH)	50328	1.64E-07	3.94E-06	6.24E-04	1.18E-09	1.18E-09
Beryllium metal (unreacted) (TH)	7440417	1.64E-06	3.94E-05	6.24E-03	1.18E-08	1.18E-08
Cadmium metal (elemental unreacted) (TH)	7440439	1.50E-04	3.61E-03	5.72E-01	1.08E-06	1.08E-06
Soluble chromate compounds, as chromium (VI) equivalent	SolCR6	1.91E-04	4.59E-03	7.28E-01	1.37E-06	1.37E-06
Formaldehyde (TH)	50000	1.03E-02	2.46E-01	3.90E+01	7.35E-05	7.35E-05
Hexane, n- (TH)	110543	2.46E-01	5.90E+00	9.37E+02	1.76E-03	1.76E-03
Manganese unlisted compounds (TH)	MNC-other	5.19E-05	1.25E-03	1.98E-01	3.73E-07	3.73E-07
Mercury vapor (TH)	7439976	3.55E-05	8.53E-04	1.35E-01	2.55E-07	2.55E-07
Nickel metal (TH)	7440020	2.87E-04	6.89E-03	1.09E+00	2.06E-06	2.06E-06
Toluene (TH)	108883	4.65E-04	1.12E-02	1.77E+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)	28360.70	28,360.70	31,262.29	71,369.12	71369.12
METHANE (CH_4)	5.35E-01	1.34E+01	5.90E-01	1.35E+00	3.37E+01
NITROUS OXIDE (N_2O)	5.35E-02	1.59E+01	5.90E-02	1.35E-01	4.01E+01
	TOTAL CO2e (metric tons)	28,390.01		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.

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.

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

COMPANY:	**Chemours Company - Fayetteville Works**	MAX HEAT INPUT:	139.40	MMBTU/HR
FACILITY ID NO.:	0900009	FUEL HEAT VALUE:	140,000	BTU/GAL
PERMIT NUMBER:	03735T42	HHV for GHG CALCULATIONS:	0.138	mm BTU/GAL
FACILITY CITY:	Fayetteville	ACTUAL ANNUAL FUEL USAGE:	59	GAL/YR
FACILITY COUNTY:	Bladen	MAXIMUM ANNUAL FUEL USAGE:	8,722,457	GAL/YR
USER NAME:	Michael E. Johnson	MAXIMUM SULFUR CONTENT:	0.5	%
EMISSION SOURCE DESCRIPTION:	No. 2 oil-fired Boiler	**REQUESTED PERMIT LIMITATIONS**		
EMISSION SOURCE ID NO.:	PS-A	MAX. FUEL USAGE:	8,722,457	GAL/YR
		MAX. SULFUR CONTENT:	0.5	%

TYPE OF CONTROL DEVICES	POLLUTANT	CONTROL EFF.
NONE/OTHER	PM	0
NONE/OTHER	SO2	0
NONE/OTHER	NOx	0

METHOD USED TO COMPUTE ACTUAL GHG EMISSIONS: TIER 1: DEFAULT HIGH HEAT VALUE AND DEFAULT EF

CARBON CONTENT USED FOR GHGS (kg C/gal): CARBON CONTENT NOT USED FOR CALCULATION TIER CHOSEN

CRITERIA AIR POLLUTANT EMISSIONS INFORMATION

AIR POLLUTANT EMITTED	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	ACTUAL tons/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	(BEFORE) tons/yr	POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	(AFTER) tons/yr	EMISSION FACTOR (lb/10^3 gal) uncontrolled	controlled
TOTAL PARTICULATE MATTER (PM) (FPM+CPM)	3.29	0.00	3.29	14.39	3.29	14.39	3.30E+00	3.30E+00
FILTERABLE PM (FPM)	1.99	0.00	1.99	8.72	1.99	8.72	2.00E+00	2.00E+00
CONDENSABLE PM (CPM)	1.29	0.00	1.29	5.67	1.29	5.67	1.30E+00	1.30E+00
FILTERABLE PM<10 MICRONS (PM_{10})	1.00	0.00	1.00	4.36	1.00	4.36	1.00E+00	1.00E+00
FILTERABLE PM<2.5 MICRONS ($PM_{2.5}$)	0.25	0.00	0.25	1.09	0.25	1.09	2.50E-01	2.50E-01
SULFUR DIOXIDE (SO_2)	70.70	0.00	70.70	309.65	70.70	309.65	7.10E+01	7.10E+01
NITROGEN OXIDES (NO_x)	23.90	0.00	23.90	104.67	23.90	104.67	2.40E+01	2.40E+01
CARBON MONOXIDE (CO)	4.98	0.00	4.98	21.81	4.98	21.81	5.00E+00	5.00E+00
VOLATILE ORGANIC COMPOUNDS (VOC)	0.20	0.00	0.20	0.87	0.20	0.87	2.00E-01	2.00E-01
LEAD	0.00	0.00	0.00	0.01	0.00	0.01	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 EMISSIONS (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	5.6E-04	3.3E-05	5.6E-04	4.9E+00	5.6E-04	4.9E+00	5.60E-04	5.60E-04
Benzene	(TH)	71432	2.7E-03	1.6E-04	2.7E-03	2.4E+01	2.7E-03	2.4E+01	2.75E-03	2.75E-03
Beryllium Metal (unreacted)	(TH)	7440417	4.2E-04	2.5E-05	4.2E-04	3.7E+00	4.2E-04	3.7E+00	4.20E-04	4.20E-04
Cadium Metal (elemental unreacted)	(TH)	7440439	4.2E-04	2.5E-05	4.2E-04	3.7E+00	4.2E-04	3.7E+00	4.20E-04	4.20E-04
Chromic Acid (VI)	(TH)	7738945	4.2E-04	2.5E-05	4.2E-04	3.7E+00	4.2E-04	3.7E+00	4.20E-04	4.20E-04
Cobalt Unlisted Compounds	(H)	COC-Other	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
Ethylbenzene	(H)	100414	8.1E-04	4.8E-05	8.1E-04	7.1E+00	8.1E-04	7.1E+00	8.17E-04	8.17E-04
Fluorides (sum fluoride compounds)	(T)	16984488	3.7E-02	2.2E-03	3.7E-02	3.3E+02	3.7E-02	3.3E+02	3.73E-02	3.73E-02
Formaldehyde	(TH)	50000	4.8E-02	2.8E-03	4.8E-02	4.2E+02	4.8E-02	4.2E+02	4.80E-02	4.80E-02
Lead Unlisted Compounds	(H)	PBC-Other	1.3E-03	7.4E-05	1.3E-03	1.1E+01	1.3E-03	1.1E+01	1.26E-03	1.26E-03
Manganese Unlisted Compounds	(TH)	MNC-Other	8.4E-04	5.0E-05	8.4E-04	7.3E+00	8.4E-04	7.3E+00	8.40E-04	8.40E-04
Mercury, vapor	(TH)	7439976	4.2E-04	2.5E-05	4.2E-04	3.7E+00	4.2E-04	3.7E+00	4.20E-04	4.20E-04
Methyl chloroform	(TH)	71566	2.3E-04	1.4E-05	2.3E-04	2.1E+00	2.3E-04	2.1E+00	2.36E-04	2.36E-04
Napthalene	(H)	91203	3.3E-04	2.0E-05	3.3E-04	2.9E+00	3.3E-04	2.9E+00	3.33E-04	3.33E-04
Nickle Metal	(TH)	7440020	4.2E-04	2.5E-05	4.2E-04	3.7E+00	4.2E-04	3.7E+00	4.20E-04	4.20E-04
Phosphorus Metal, Yellow or White	(H)	7723140	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
POM rates uncontrolled	(H)	POM	3.3E-03	1.9E-04	3.3E-03	2.9E+01	3.3E-03	2.9E+01	3.30E-03	3.30E-03
Selenium compounds	(H)	SEC	2.1E-03	1.2E-04	2.1E-03	1.8E+01	2.1E-03	1.8E+01	2.10E-03	2.10E-03
Toluene	(TH)	108883	7.9E-02	4.7E-03	7.9E-02	6.9E+02	7.9E-02	6.9E+02	7.97E-02	7.97E-02
Xylene	(TH)	1330207	1.4E-03	8.3E-05	1.4E-03	1.2E+01	1.4E-03	1.2E+01	1.40E-03	1.40E-03
Total HAP	(H)		1.4E-01	8.5E-03	1.4E-01	1.3E+03	1.4E-01	1.3E+03	1.4E-01	1.4E-01
Largest HAP	(H)		7.93E-02	4.70E-03	7.93E-02	6.95E+02	7.93E-02	6.95E+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	5.58E-04	1.34E-02	4.88E+00	5.60E-04	5.60E-04
Benzene	(TH)	71432	2.74E-03	6.57E-02	2.40E+01	2.75E-03	2.75E-03
Beryllium Metal (unreacted)	(TH)	7440417	4.18E-04	1.00E-02	3.66E+00	4.20E-04	4.20E-04
Cadium Metal (elemental unreacted)	(TH)	7440439	4.18E-04	1.00E-02	3.66E+00	4.20E-04	4.20E-04
Soluble chromate compounds, as chromium (\	(TH)	SolCR6	4.18E-04	1.00E-02	3.66E+00	4.20E-04	4.20E-04
Fluorides (sum fluoride compounds)	(T)	16984488	3.71E-02	8.91E-01	3.25E+02	3.73E-02	3.73E-02
Formaldehyde	(TH)	50000	4.78E-02	1.15E+00	4.19E+02	4.80E-02	4.80E-02
Manganese Unlisted Compounds	(TH)	MNC-Other	8.36E-04	2.01E-02	7.33E+00	8.40E-04	8.40E-04
Mercury, vapor	(TH)	7439976	4.18E-04	1.00E-02	3.66E+00	4.20E-04	4.20E-04
Methyl chloroform	(TH)	71566	2.35E-04	5.64E-03	2.06E+00	2.36E-04	2.36E-04
Nickle Metal	(TH)	7440020	4.18E-04	1.00E-02	3.66E+00	4.20E-04	4.20E-04
Toluene	(TH)	108883	7.93E-02	1.90E+00	6.95E+02	7.97E-02	7.97E-02
Xylene	(TH)	1330207	1.39E-03	3.35E-02	1.22E+01	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)	0.60	0.60	0.66	99,556.02	99,556.02	99,556.02	99,556.02
METHANE (CH_4)	2.44E-05	5.13E-04	2.69E-05	4.04E+00	8.48E+01	4.04E+00	8.48E+01
NITROUS OXIDE (N_2O)	4.89E-06	1.51E-03	5.39E-06	8.08E-01	2.50E+02	8.08E-01	2.50E+02
TOTAL		**0.60**		TOTAL	**99,891.19**	TOTAL	**99,891.19**

NOTES: 1) CO2e means CO2 equivalent

2) The DAQ Air Emissions Reporting Online (AERO) system requires short tons and the EPA MRR requires metric tons

Boiler PS-A

Hydrogen Chloride (HCl) **CAS No. 7647-01-0**

The EPA Industrial Boiler MACT rulemaking emission factor for uncontrolled residual and distillate oil firing is given as 7.1E-5 lb/MMBtu in Docket Document Number II-B-8, Development of Average Emission Factors and Baseline Emission Estimates for the Industrial, Commercial, and Institutional Boilers and Process Heaters NESHAP, October 2002; so that figure is used as the latest information from EPA.

EPA emission factor = **7.1E-05** pounds of HCl per million BTUs generated in the boiler.

From the memo from Christy Burlew and Roy Oommen, Eastern Research Group to Jim Eddinger, U.S. EPA, OAQPS, October, 2002, Development of Average Emission Factors and Baseline Emission Estimates for the Industrial, Commercial, and Institutional Boilers and Process Heaters National Emission Standard for Hazardous Air Pollutants, Appendix A, the HCl emission factor for natural gas combustion is 1.24 x 10-5 lb. per MM-BTU.

Emission factor = **1.24E-05** pounds of HCl per million BTUs generated in the boiler.

PS-A emissions of HCl:

59 gallons of No. 2 fuel oil were burned in 2015

$$59 \text{ gal. No. 2 F.O.} \times \frac{0.140 \text{ MM-BTU}}{\text{gal. No. 2 F.O.}} = 8.26\text{E+00 MM-BTU}$$

$$8.26\text{E+00 MM-BTU} \times \frac{7.1\text{E-05 lb HCl}}{\text{MM-BTU}} = \mathbf{0.0 \text{ lb HCl}}$$

520.34 MM-scf of Natural Gas were burned in 2015

$$520.340 \text{ MM-scf Natural Gas} \times \frac{1{,}028 \text{ BTU}}{\text{scf Natural Gas}} = 534{,}910 \text{ MM-BTU}$$

$$534{,}910 \text{ MM-BTU} \times \frac{1.2\text{E-05 lb HCl}}{\text{MM-BTU}} = \mathbf{6.6 \text{ lb HCl}}$$

Total HCl emissions:

0.0 lb HCl from No. 2 F.O.
\+ 6.6 lb HCl from Natural Gas

6.6 lb. HCl emissions

Natural gas/No. 2 fuel oil /No. 6 fuel oil-fired boiler

(88.4 Million BTU Per Hour Maximum Heat Input)

PS-B

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:	03735T42
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:	120.16	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

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/mmBtu uncontrolled	controlled
PARTICULATE MATTER (Total)	0.66	0.46	0.66	2.88	0.66	2.88	0.007	0.007
PARTICULATE MATTER (Condensable)	0.49	0.34	0.49	2.16	0.49	2.16	0.006	0.006
PARTICULATE MATTER (Filterable)	0.16	0.11	0.16	0.72	0.16	0.72	0.002	0.002
SULFUR DIOXIDE (SO2)	0.05	0.04	0.05	0.23	0.05	0.23	0.001	0.001
NITROGEN OXIDES (NOx)	8.67	6.01	8.67	37.96	8.67	37.96	0.098	0.098
CARBON MONOXIDE (CO)	7.28	5.05	7.28	31.89	7.28	31.89	0.082	0.082
VOLATILE ORGANIC COMPOUNDS (VOC)	0.48	0.33	0.48	2.09	0.48	2.09	0.005	0.005

TOXIC / HAZARDOUS AIR POLLUTANT EMISSIONS INFORMATION

TOXIC / HAZARDOUS AIR POLLUTANT	CAS NUMBER	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	ACTUAL lbs/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	(BEFORE) lbs/yr	POTENTIAL (AFTER CONTROLS / LIMITS) lb/hr	(AFTER) lbs/yr	EMISSION FACTOR lb/mmBtu uncontrolled	controlled
Acetaldehyde (TH)	75070	1.32E-06	1.83E-03	1.32E-06	1.15E-02	1.32E-06	1.15E-02	1.49E-08	1.49E-08
Acrolein (TH)	107028	1.56E-06	2.16E-03	1.56E-06	1.37E-02	1.56E-06	1.37E-02	1.76E-08	1.76E-08
Ammonia (T)	7664417	2.77E-01	3.85E+02	2.77E-01	2.43E+03	2.77E-01	2.43E+03	3.14E-03	3.14E-03
Arsenic unlisted compounds (TH)	ASC-other	1.73E-05	2.40E-02	1.73E-05	1.52E-01	1.73E-05	1.52E-01	1.96E-07	1.96E-07
Benzene (TH)	71432	1.82E-04	2.52E-01	1.82E-04	1.59E+00	1.82E-04	1.59E+00	2.06E-06	2.06E-06
Benzo(a)pyrene (TH)	50328	1.04E-07	1.44E-04	1.04E-07	9.11E-04	1.04E-07	9.11E-04	1.18E-09	1.18E-09
Beryllium metal (unreacted) (TH)	7440417	1.04E-06	1.44E-03	1.04E-06	9.11E-03	1.04E-06	9.11E-03	1.18E-08	1.18E-08
Cadmium metal (elemental unreacted) (TH)	7440439	9.53E-05	1.32E-01	9.53E-05	8.35E-01	9.53E-05	8.35E-01	1.08E-06	1.08E-06
Chromic acid (VI) (TH)	7738945	1.21E-04	1.68E-01	1.21E-04	1.06E+00	1.21E-04	1.06E+00	1.37E-06	1.37E-06
Cobalt unlisted compounds (H)	COC-other	7.28E-06	1.01E-02	7.28E-06	6.38E-02	7.28E-06	6.38E-02	8.24E-08	8.24E-08
Formaldehyde (TH)	50000	6.50E-03	9.01E+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	2.16E+02	1.56E-01	1.37E+03	1.56E-01	1.37E+03	1.76E-03	1.76E-03
Lead unlisted compounds (H)	PBC-other	4.33E-05	6.01E-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	4.57E-02	3.29E-05	2.88E-01	3.29E-05	2.88E-01	3.73E-07	3.73E-07
Mercury vapor (TH)	7439976	2.25E-05	3.12E-02	2.25E-05	1.97E-01	2.25E-05	1.97E-01	2.55E-07	2.55E-07
Napthalene (H)	91203	5.29E-05	7.33E-02	5.29E-05	4.63E-01	5.29E-05	4.63E-01	5.98E-07	5.98E-07
Nickel metal (TH)	7440020	1.82E-04	2.52E-01	1.82E-04	1.59E+00	1.82E-04	1.59E+00	2.06E-06	2.06E-06
Selenium compounds (H)	SEC	2.08E-06	2.88E-03	2.08E-06	1.82E-02	2.08E-06	1.82E-02	2.35E-08	2.35E-08
Toluene (TH)	108883	2.95E-04	4.09E-01	2.95E-04	2.58E+00	2.95E-04	2.58E+00	3.33E-06	3.33E-06
Total HAPs		1.64E-01	2.27E+02	1.64E-01	1.43E+03	1.64E-01	1.43E+03	1.85E-03	1.85E-03
Highest HAP	Hexane	1.56E-01	2.16E+02	1.56E-01	1.37E+03	1.56E-01	1.37E+03	1.76E-03	1.76E-03

TOXIC AIR POLLUTANT EMISSIONS INFORMATION (FOR PERMITTING PURPOSES)

EXPECTED ACTUAL EMISSIONS AFTER CONTROLS / LIMITATIONS

TOXIC AIR POLLUTANT	CAS Num.	lb/hr	lb/day	lb/yr	EMISSION FACTOR lb/mmBtu uncontrolled	controlled
Acetaldehyde (TH)	75070	1.32E-06	3.16E-05	1.83E-03	1.49E-08	1.49E-08
Acrolein (TH)	107028	1.56E-06	3.74E-05	2.16E-03	1.76E-08	1.76E-08
Ammonia (T)	7664417	2.77E-01	6.66E+00	3.85E+02	3.14E-03	3.14E-03
Arsenic unlisted compounds (TH)	ASC-other	1.73E-05	4.16E-04	2.40E-02	1.96E-07	1.96E-07
Benzene (TH)	71432	1.82E-04	4.37E-03	2.52E-01	2.06E-06	2.06E-06
Benzo(a)pyrene (TH)	50328	1.04E-07	2.50E-06	1.44E-04	1.18E-09	1.18E-09
Beryllium metal (unreacted) (TH)	7440417	1.04E-06	2.50E-05	1.44E-03	1.18E-08	1.18E-08
Cadmium metal (elemental unreacted) (TH)	7440439	9.53E-05	2.29E-03	1.32E-01	1.08E-06	1.08E-06
Soluble chromate compounds, as chromium (VI) equivalent	SolCR6	1.21E-04	2.91E-03	1.68E-01	1.37E-06	1.37E-06
Formaldehyde (TH)	50000	6.50E-03	1.56E-01	9.01E+00	7.35E-05	7.35E-05
Hexane, n- (TH)	110543	1.56E-01	3.74E+00	2.16E+02	1.76E-03	1.76E-03
Manganese unlisted compounds (TH)	MNC-other	3.29E-05	7.90E-04	4.57E-02	3.73E-07	3.73E-07
Mercury vapor (TH)	7439976	2.25E-05	5.41E-04	3.12E-02	2.55E-07	2.55E-07
Nickel metal (TH)	7440020	1.82E-04	4.37E-03	2.52E-01	2.06E-06	2.06E-06
Toluene (TH)	108883	2.95E-04	7.07E-03	4.09E-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 metric tons/yr	metric tons/yr, CO2e	short tons/yr	POTENTIAL EMISSIONS short tons/yr	short tons/yr, CO2e
CARBON DIOXIDE (CO_2)	6549.45	6,549.45	7,219.53	45,258.47	45258.47
METHANE (CH_4)	1.24E-01	3.09E+00	1.36E-01	8.54E-01	2.13E+01
NITROUS OXIDE (N_2O)	1.24E-02	3.68E+00	1.36E-02	8.54E-02	2.54E+01
		TOTAL CO2e (metric tons)	6,556.22	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.

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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.

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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:	03735T42	HHV for GHG CALCULATIONS:	0.138	mm BTU/GAL
FACILITY CITY:	Fayetteville	ACTUAL ANNUAL FUEL USAGE:	50	GAL/YR
FACILITY COUNTY:	Bladen	MAXIMUM ANNUAL FUEL USAGE:	5,531,314	GAL/YR
USER NAME:	Michael E. Johnson	MAXIMUM SULFUR CONTENT:	0.5	%
EMISSION SOURCE DESCRIPTION:	No. 2 oil-fired Boiler	**REQUESTED PERMIT LIMITATIONS**		
EMISSION SOURCE ID NO.:	PS-B	MAX. FUEL USAGE:	5,531,314	GAL/YR
		MAX. SULFUR CONTENT:	0.5	%

TYPE OF CONTROL DEVICES	POLLUTANT	CONTROL EFF.
NONE/OTHER	PM	0
NONE/OTHER	SO2	0
NONE/OTHER	NOx	0

METHOD USED TO COMPUTE ACTUAL GHG EMISSIONS: TIER 1: DEFAULT HIGH HEAT VALUE AND DEFAULT EF

CARBON CONTENT USED FOR GHGS (kg C/gal): CARBON CONTENT NOT USED FOR CALCULATION TIER CHOSEN

CRITERIA AIR POLLUTANT EMISSIONS INFORMATION

AIR POLLUTANT EMITTED	ACTUAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	tons/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	tons/yr	POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	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)	44.83	0.00	44.83	196.36	44.83	196.36	7.10E+01	7.10E+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	lb/yr	POTENTIAL EMISSIONS (BEFORE CONTROLS / LIMITS) lb/hr	lb/yr	POTENTIAL EMISSIONS (AFTER CONTROLS / LIMITS) lb/hr	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	2.8E-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	1.4E-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	2.1E-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	2.1E-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	2.1E-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	4.1E-05	5.2E-04	4.5E+00	5.2E-04	4.5E+00	8.17E-04	8.17E-04
Fluorides (sum fluoride compounds)	(T)	16984488	2.4E-02	1.9E-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	2.4E-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	6.3E-05	8.0E-04	7.0E+00	8.0E-04	7.0E+00	1.26E-03	1.26E-03
Manganese Unlisted Compounds	(TH)	MNC-Other	5.3E-04	4.2E-05	5.3E-04	4.6E+00	5.3E-04	4.6E+00	8.40E-04	8.40E-04
Mercury, vapor	(TH)	7439976	2.7E-04	2.1E-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	1.2E-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	1.7E-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	2.1E-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	1.7E-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	1.1E-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	4.0E-03	5.0E-02	4.4E+02	5.0E-02	4.4E+02	7.97E-02	7.97E-02
Xylene	(TH)	1330207	8.8E-04	7.0E-05	8.8E-04	7.7E+00	8.8E-04	7.7E+00	1.40E-03	1.40E-03
Total HAP	(H)		9.1E-02	7.2E-03	9.1E-02	7.9E+02	9.1E-02	7.9E+02	1.4E-01	1.4E-01
Largest HAP	(H)		5.03E-02	3.98E-03	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 (\	(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

GREENHOUSE GAS POLLUTANT	**ACTUAL EMISSIONS** EPA MRR CALCULATION METHOD: TIER 1 metric tons/yr	metric tons/yr, **CO2e**	short tons/yr	**POTENTIAL EMISSIONS - utilize max heat input capacity and EPA MRR Emission Factors** short tons/yr	short tons/yr, **CO2e**	**POTENTIAL EMISSIONS With Requested Emission Limitation - utilize requested fuel limit and EPA MRR Emission Factors** short tons/yr	short tons/yr, **CO2e**
CARBON DIOXIDE (CO_2)	0.51	0.51	0.56	63,133.09	63,133.09	63,133.09	63,133.09
METHANE (CH_4)	2.07E-05	4.35E-04	2.28E-05	2.56E+00	5.38E+01	2.56E+00	5.38E+01
NITROUS OXIDE (N_2O)	4.14E-06	1.28E-03	4.56E-06	5.12E-01	1.59E+02	5.12E-01	1.59E+02
	TOTAL	**0.51**		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:

50 gallons of No. 2 fuel oil were burned in 2015

$$50 \text{ gal. No. 2 F.O.} \times \frac{0.140 \text{ MM-BTU}}{\text{gal. No. 2 F.O.}} = 7.00\text{E+00 MM-BTU}$$

$$7.00\text{E+00 MM-BTU} \times \frac{7.1\text{E-05 lb HCl}}{\text{MM-BTU}} = \mathbf{0.00 \text{ lb HCl}}$$

120.16 MM-scf of Natural Gas were burned in 2015

$$120.160 \text{ MM-scf Natural Gas} \times \frac{1{,}028 \text{ BTU}}{\text{scf Natural Gas}} = 123{,}524 \text{ MM-BTU}$$

$$123{,}524 \text{ MM-BTU} \times \frac{1.2\text{E-05 lb HCl}}{\text{MM-BTU}} = \mathbf{1.5 \text{ lb HCl}}$$

Total HCl emissions:

0.0 lb HCl from No. 2 F.O.
\+ 1.5 lb HCl from Natural Gas

1.5 lb. HCl emissions

Semiworks Polymerization Operation

SW-1

SEMIWORKS SUMMARY

			Campaign Starts:	01-06-2015	03-17-2015	05-11-2015	12-07-2015		
			Campaign Ends:	01-12-2015	03-23-2015	05-20-2015	12-14-2015		
			Month	1	3	5	12		
Chemours Compound	CAS Chemical Name	CAS No.	TOTAL	15-SXF-1.0	15-SXF-2.0	15-SXF-3.0	15-SXF-4.0		
TFE	Tetrafluoroethylene	116-14-3	**201.6**	34.1	62.1	39.7	65.8		
PSEPVE	Perfluoro-2-(2-fluorosulfonyl ethoxy) propyl vinyl ether	16090-14-5	**483.3**	140.7	111.7	98.5	132.4		
E-2	2H-perfluoro(5-methyl-3,6-dioxanonane)	3330-14-1	**876.5**	207.5	239.5	207.6	221.9		
PAF	Trifluoroacetyl Fluoride	354-34-7	**66.8**	17.7	15.4	14.7	19.0		
Initiator	Perfluoro-2-methyl-3-oxahexanoyl peroxide	56347-79-6	**36.5**	8.7	10.7	8.6	8.4		
		CAMPAIGN TOTAL VOC (lb.)		**408.7**	**439.5**	**369.0**	**447.4**		
		TOTAL ANNUAL VOC (lb.)	**1664.7**						
		TOTAL ANNUAL VOC (ton)	**0.83**						

HAP and TAP COMPOUNDS

Chemours Compound	CAS Chemical Name	CAS No.	TOTAL	15-SXF-1.0	15-SXF-2.0	15-SXF-3.0	15-SXF-4.0		
F-113	1,1,2-trichloro-1,2,2-trifluoroethane	76-13-1	**2305.5**	524.5	656.5	522.1	602.5		
HCl	Hydrogen chloride	7647-01-0	**0**	0	0	0	0		
HF	Hydrogen fluoride	7664-39-3	**66.8**	17.7	15.4	14.7	19.0		

0524

Campaign ID: 15-SXF-1.0

Start Date: 1/6/2015 End Date: 1/12/2015

Starting Material

Item	Addition (initiator)	Addition (TFE)	Addition (E2)	Addition (PSEPVE)	Addition (F113)	Addition (condensate)	Addition (condensate)	Addition (condensate)	Totals (kg)
				Additions to the system					
						FC-8763	FC-8764		
Weight (Kg):	116.5	300.36	0	183.8	177.3	253.60	304.20	0.00	
Compositions:						1673330	1673331		
%E2	96.60%	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	3.40%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Weights									
E2	112.54	0.00	0.00	0.00	0.00	38.04	46.45	0.00	197.0
PSEPVE	0.00	0.00	0.00	183.80	0.00	20.21	17.25	0.00	221.3
TFE	0.00	300.36	0.00	0.00	0.00	0.00	0.00	0.00	300.4
F113	0.00	0.00	0.00	0.00	177.30	192.15	238.07	0.00	607.5
Inititiator	3.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.0

Ending Material

Item	Recovery Tank					Return (condensate)	Return (condensate)	Return (condensate)	Return (condensate)	Return (condensate)	Totals (kg)
						FC-8788	FC-8789				
Weight (Kg):		0.00				296.00	222.80				
Compositions						1680731	1680732				
%E2		0.00%				18.88%	21.06%	0.00%	0.00%	0.00%	
%PSEPVE		0.00%				7.76%	7.77%	0.00%	0.00%	0.00%	
%TFE		0.00%				0.00%	0.00%	0.00%	0.00%	0.00%	
%F113		0.00%				71.85%	70.35%	0.00%	0.00%	0.00%	
%Inititiator		0.00%				0.00%	0.00%	0.00%	0.00%	0.00%	
Weights											
E2	0.00	0.00	0.00	0.00	0.00	55.88	46.92	0.00	0.00	0.00	102.8
PSEPVE	0.00	0.00	0.00	0.00	0.00	22.97	17.31	0.00	0.00	0.00	40.3
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	212.68	156.74	0.00	0.00	0.00	369.4
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 (kg)
Weight (Kg):	402.00	0.00	0.00	
Compositions				
EW	1531		0	
%Polymer	100.00%	100.00%	0.00%	
%E2			0.00%	
%PSEPVE			0.00%	
%TFE			0.00%	
%F113			0.00%	
Weights				
Polymer	402.00	0.00	0.00	402.0
E2	0.00	0.00	0.00	0.0
PSEPVE	117.11	0.00	0.00	117.1
TFE	284.89	0.00	0.00	284.9
F113	0.00	0.00	0.00	0.0
VE in Polymer	117.11	0.00	0.00	

Material Balance Summary

Compound	Added	Remaining	Used	Production	Other	Totals (kg)
E2	197.0	102.8	94.2	0.0		94.2
PSEPVE	221.3	40.3	181.0	117.1		63.9
TFE	300.4	0.0	300.4	284.9		15.5
F113	607.5	369.4	238.1	0.0		238.1
Initiator	4.0	0.0	4.0	0.0		4.0

VE Yield

Vinyl Ether =	PSEPVE	MW = 446
VE in polymer	117.1	% in polymer = 64.7%
VE used	181.0	

Air Emissions (lb.)

SW-1		SW-2		
TFE	34.1 lb.	# of MF samples	0.0	All run in mfg lab
PSEPVE	140.7 lb.	grams emissions	0.0 g	
E-2	207.5 lb.	lbs of emissions	0.0 lb	
PAF	17.7 lb.			
Inititiator	8.7 lb.			
F-113	524.5 lb.			

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Campaign ID: 15-SXF-2.0

Start Date: 3/17/2015 End Date: 3/23/2015

Starting Material — Additions to the system

Item	Addition (Initiator)	Addition (TFE)	Addition (E2)	Addition (PSEPVE)	Addition (F113)	Addition (condensate)	Addition (condensate)	Addition (condensate)	Totals (kg)
						FC-8788	FC-8789		
Weight (Kg):	130	277.3	0	159.2	300.1	296.20	222.80	0.00	
Compositions:						1680731	1680732		
%E2	96.25%	0.00%	100.00%	0.00%	0.00%	18.88%	21.06%	0.00%	
%PSEPVE	0.00%	0.00%	0.00%	100.00%	0.00%	7.76%	7.77%	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%	71.85%	70.35%	0.00%	
%Inititiator	3.75%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Weights									
E2	125.13	0.00	0.00	0.00	0.00	55.92	46.92	0.00	228.0
PSEPVE	0.00	0.00	0.00	159.20	0.00	22.99	17.31	0.00	199.5
TFE	0.00	277.30	0.00	0.00	0.00	0.00	0.00	0.00	277.3
F113	0.00	0.00	0.00	0.00	300.10	212.82	156.74	0.00	669.7
Inititiator	4.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.9

Ending Material

Item		Recovery Tank				Return (condensate)	Return (condensate)	Return (condensate)	Return (condensate)	Return (condensate)	Totals (kg)
						FC-8801	FC-8802				
Weight (Kg):		0.00				300.00	244.00				
Compositions						1705016	1705017				
%E2		0.00%				20.70%	23.42%	0.00%	0.00%	0.00%	
%PSEPVE		0.00%				9.40%	8.06%	0.00%	0.00%	0.00%	
%TFE		0.00%				0.00%	0.00%	0.00%	0.00%	0.00%	
%F113		0.00%				68.69%	67.85%	0.00%	0.00%	0.00%	
%Inititiator		0.00%				0.00%	0.00%	0.00%	0.00%	0.00%	
Weights											
E2	0.00	0.00	0.00	0.00	0.00	62.10	57.14	0.00	0.00	0.00	119.2
PSEPVE	0.00	0.00	0.00	0.00	0.00	28.20	19.67	0.00	0.00	0.00	47.9
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	206.07	165.55	0.00	0.00	0.00	371.6
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 (kg)
Weight (Kg):	350.00	0.00	0.00	
Compositions				
EW	1547		0	
%Polymer	100.00%	100.00%	0.00%	
%E2			0.00%	
%PSEPVE			0.00%	
%TFE			0.00%	
%F113			0.00%	
Weights				
Polymer	350.00	0.00	0.00	350.0
E2	0.00	0.00	0.00	0.0
PSEPVE	100.90	0.00	0.00	100.9
TFE	249.10	0.00	0.00	249.1
F113	0.00	0.00	0.00	0.0
VE in Polymer	100.90	0.00	0.00	

Material Balance Summary

Compound	Added	Remaining	Used	Production	Other	Totals (kg)
E2	228.0	119.2	108.7	0.0		108.7
PSEPVE	199.5	47.9	151.6	100.9		50.7
TFE	277.3	0.0	277.3	249.1		28.2
F113	669.7	371.6	298.0	0.0		298.0
Inititiator	4.9	0.0	4.9	0.0		4.9

VE Yield

Vinyl Ether =	PSEPVE	MW = 446	
VE in polymer	100.9	% in polymer =	66.5%
VE used	151.6		

Air Emissions (lb.)

SW-1		*SW-2*		
TFE	62.1 lb.	# of MF samples	0.0	All run in mfg lab
PSEPVE	111.7 lb.	grams emissions	0.0 g	
E-2	239.5 lb.	lbs of emissions	0.0 lb	
PAF	15.4 lb.			
Inititiator	10.7 lb.			
F-113	656.5 lb.			

Campaign ID: 15-SXF-3.0

Start Date: 5/11/2015 End Date: 5/20/2015

Starting Material

Additions to the system

Item	Addition (initiator)	Addition (TFE)	Addition (E2)	Addition (PSEPVE)	Addition (F113)	Addition (condensate)	Addition (condensate)	Addition (condensate)	Totals (kg)
						FC-8801	FC-8802		
Weight (Kg):	105.8	251	0	140.2	213.9	300.00	244.00	0.00	
Compositions:						1705016	1705017		
%E2	96.30%	0.00%	100.00%	0.00%	0.00%	20.70%	23.42%	0.00%	
%PSEPVE	0.00%	0.00%	0.00%	100.00%	0.00%	9.40%	8.06%	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%	68.69%	67.85%	0.00%	
%Inititiator	3.70%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Weights									
E2	101.89	0.00	0.00	0.00	0.00	62.10	57.14	0.00	221.1
PSEPVE	0.00	0.00	0.00	140.20	0.00	28.20	19.67	0.00	188.1
TFE	0.00	251.00	0.00	0.00	0.00	0.00	0.00	0.00	251.0
F113	0.00	0.00	0.00	0.00	213.90	206.07	165.55	0.00	585.5
Inititiator	3.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.9

Ending Material

Item	Recovery Tank					Return (condensate)	Return (condensate)	Return (condensate)	Return (condensate)	Return (condensate)	Totals (kg)
						FC-8813	FC-8814				
Weight (Kg):		0.00				300.00	223.00				
Compositions						1723215	1723216				
%E2		0.00%				23.70%	25.02%	0.00%	0.00%	0.00%	
%PSEPVE		0.00%				9.14%	7.14%	0.00%	0.00%	0.00%	
%TFE		0.00%				0.00%	0.00%	0.00%	0.00%	0.00%	
%F113		0.00%				66.13%	67.31%	0.00%	0.00%	0.00%	
%Inititiator		0.00%				0.00%	0.00%	0.00%	0.00%	0.00%	
Weights											
E2	0.00	0.00	0.00	0.00	0.00	71.10	55.79	0.00	0.00	0.00	126.9
PSEPVE	0.00	0.00	0.00	0.00	0.00	27.42	15.92	0.00	0.00	0.00	43.3
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	198.39	150.10	0.00	0.00	0.00	348.5
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 (kg)
Weight (Kg):	333.00	0.00	0.00	
Compositions				
EW	1485		0	
%Polymer	100.00%	100.00%	0.00%	
%E2			0.00%	
%PSEPVE			0.00%	
%TFE			0.00%	
%F113			0.00%	
Weights				
Polymer	333.00	0.00	0.00	333.0
E2	0.00	0.00	0.00	0.0
PSEPVE	100.01	0.00	0.00	100.0
TFE	232.99	0.00	0.00	233.0
F113	0.00	0.00	0.00	0.0
VE in Polymer	100.01	0.00	0.00	

Material Balance Summary

Compound	Added	Remaining	Used	Production	Other	Totals (kg)
E2	221.1	126.9	94.2	0.0		94.2
PSEPVE	188.1	43.3	144.7	100.0		44.7
TFE	251.0	0.0	251.0	233.0		18.0
F113	585.5	348.5	237.0	0.0		237.0
Inititiator	3.9	0.0	3.9	0.0		3.9

VE Yield

Vinyl Ether =	PSEPVE	MW = 446
VE in polymer	100.0	% in polymer = 69.1%
VE used	144.7	

Lbs of Emissions

SW-1		SW-2		
TFE	39.7 lb.	# of MF samples	0.0	All run in mfg lab
PSEPVE	98.5 lb.	grams emissions	0.0 g	
E-2	207.6 lb.	lbs of emissions	0.0 lb	
PAF	14.7 lb.			
Inititiator	8.6 lb.			
F-113	522.1 lb.			

Campaign ID: 15-SXF-4.0

Start Date: 12/7/2015 | End Date: 12/14/2015

Starting Material

Item	Addition (Initiator)	Addition (TFE)	Addition (E2)	Addition (PSEPVE)	Addition (F113)		Addition (condensate)	Addition (condensate)	Addition (condensate)	
							FC-8813	FC-8814		
Weight (Kg):	105.6	332.28	0	187.3	331.8		300.00	223.00	0.00	
Compositions:							1723215	1723216		
%E2	96.40%	0.00%	100.00%	0.00%	0.00%		23.70%	25.02%	0.00%	
%PSEPVE	0.00%	0.00%	0.00%	100.00%	0.00%		9.14%	7.14%	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%		66.13%	37.31%	0.00%	
%Inititiator	3.60%	0.00%	0.00%	0.00%	0.00%		0.00%	0.00%	0.00%	Totals (kg)
Weights										
E2	101.80	0.00	0.00	0.00	0.00		71.10	55.79	0.00	228.7
PSEPVE	0.00	0.00	0.00	187.30	0.00		27.42	15.92	0.00	230.6
TFE	0.00	332.28	0.00	0.00	0.00		0.00	0.00	0.00	332.3
F113	0.00	0.00	0.00	0.00	331.80		198.39	83.20	0.00	613.4
Inititiator	3.80	0.00	0.00	0.00	0.00		0.00	0.00	0.00	3.8

Additions to the system

Ending Material

Item		Recovery Tank				Return (condensate)	Return (condensate)	Return (condensate)	Return (condensate)	Return (condensate)	
						FC-8837	FC-8838				
Weight (Kg):		0.00				302.00	212.00				
Compositions						1799538	1799539				
%E2		0.00%				21.92%	29.13%	0.00%	0.00%	0.00%	
%PSEPVE		0.00%				7.48%	9.13%	0.00%	0.00%	0.00%	
%TFE		0.00%				0.00%	0.00%	0.00%	0.00%	0.00%	
%F113		0.00%				69.70%	61.02%	0.00%	0.00%	0.00%	
%Inititiator		0.00%				0.00%	0.00%	0.00%	0.00%	0.00%	Totals (kg)
Weights											
E2	0.00	0.00	0.00	0.00	0.00	66.20	61.76	0.00	0.00	0.00	128.0
PSEPVE	0.00	0.00	0.00	0.00	0.00	22.59	19.36	0.00	0.00	0.00	41.9
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	210.49	129.36	0.00	0.00	0.00	339.9
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	
Weight (Kg):	431.00	0.00	0.00	
Compositions				
EW	1495		0	
%Polymer	100.00%	100.00%	0.00%	
%E2			0.00%	
%PSEPVE			0.00%	
%TFE			0.00%	
%F113			0.00%	Totals (kg)
Weights				
Polymer	431.00	0.00	0.00	431.0
E2	0.00	0.00	0.00	0.0
PSEPVE	128.58	0.00	0.00	128.6
TFE	302.42	0.00	0.00	302.4
F113	0.00	0.00	0.00	0.0
VE in Polymer	128.58	0.00	0.00	

Material Balance Summary

Compound	Added	Remaining	Used	Production	Other	Totals (kg)
E2	228.7	128.0	100.7	0.0		100.7
PSEPVE	230.6	41.9	188.7	128.6		60.1
TFE	332.3	0.0	332.3	302.4		29.9
F113	613.4	339.9	273.5	0.0		273.5
Inititiator	3.8	0.0	3.8	0.0		3.8

VE Yield

Vinyl Ether =	PSEPVE	MW = 446
VE in polymer	128.6	% in polymer = 68.1%
VE used	188.7	

Air Emissions (lb.)

SW-1		SW-2		
TFE	65.8 lb.	# of MF samples	0.0	All run in mfg lab
PSEPVE	132.4 lb.	grams emissions	0.0 g	
E-2	221.9 lb.	lbs of emissions	0.0 lb	
PAF	19.0 lb.			
Inititiator	8.4 lb.			
F-113	602.5 lb.			

Extended Aeration Biological Wastewater Treatment Facility

WTS-A

E05437

2015 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

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. Typically the WWTP consumes 69,000 lb/yr of this solution, which equates to 20,010 lb/yr of 100% ammonia. 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 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.

2015 Air Emissions Summary

WTS-A Central Wastewater Treatment Plant

A. VOC Compound Summary

Chemours Compound	CAS Chemical Name	CAS No.	Emission (lb.)
BA	Butyraldehyde	123-72-8	139,869
EtGly	Ethylene Glycol	107-21-1	14
MeOH	Methanol	67-56-1	33,974
	Total VOC Emissions (lb.)		173,857
	Total VOC Emissions (tons)		86.93

B. Hazardous / Toxic Air Pollutant Summary

Chemours Compound	CAS Chemical Name	CAS No.	Emission (lb.)
EtGly	Ethylene Glycol	107-21-1	14
MeOH	Methanol	67-56-1	33,974
NH3	Ammonia	7664-41-7	801

2015 Emissions from Wastewater Treatment Plant (WTS-A)

	BA	EtGly	MeOH
To WWTP from Kuraray Butacite (lb)	467,969	3,515	190,442
To WWTP from Chemours IXM Resins (lb)	-	-	29,573
Total to Chemours WWTP (lb)	**467,969**	**3,515**	**220,015**
Quantity entering EQB (lb)	467,969	3,515	220,015
Percent of compound volatilized	23.42%	0.29%	11.71%
Quantity volatilized from EQB (lb)	109,598	10	25,764
Quantity leaving EQB (lb)	358,371	3,505	194,251
Quantity entering Predigester (lb)	358,371	3,505	194,251
Percent of compound volatilized	8.30%	0.10%	4.15%
Quantity volatilized from Predigester (lb)	29,745	4	8,061
Quantity leaving Predigester (lb)	328,626	3,501	186,190
Quantity entering Aeration Tank (lb)	328,626	3,501	186,190
Percent of compound volatilized	0.16%	0.002%	0.08%
Quantity volatilized from Aeration Tank (lb)	526	0	149
Percent of compound biodegraded	85.00%	85.00%	85.00% See Note 1
Quantity biodegraded in Aeration Tank (lb)	279,332	2,976	158,261
Quantity leaving to Cape Fear River (lb)	48,768	525	27,780
Kuraray Quantity to Cape Fear River (lb)	48,768	525	24,046
Chemours Quantity to Cape Fear River (lb)	-	-	3,734
Total Quantity to Cape Fear River (lb)	**48,768**	**525**	**27,780**
Butacite Fraction Volatilized to Air (lb)	139,869	14	29,408
Nafion Fraction Volatilized to Air (lb)	-	-	4,567
Total Volatilized to Air (lb)	**139,869**	**14**	**33,974**

Source of Reduction Factors: EPA WATER8 computer model

BA = Butyraldehyde
EtGly = Ethylene Glycol
MeOH = Methanol

Note 1: Based on best professional judgement of Ken W. Cook, PE (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% of these simple organic compounds during the 18-hour residence period.

2015 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 2015, the WWTP consumed 69,706 pounds of 30% aqueous ammonia, which equates to 20,912 pounds of 100% ammonia (100% NH3).

The aqueous ammonia is fed directly into the WWTP Aeration Tank that is aerated via 2,000 cubic feet per minute of diffused air injected into the bottom of the tank.

The aqueous ammonia is fed directly into the WWTP Aeration Tank that is aerated via 2,000 cubic feet per minute of diffused air injected into the bottom of the tank. To be conservative, the emissions of ammonia from the WWTP will assume that none of the NH3 is utilized by the microbes, who would convert the ammonia into nonvolatile nitrate.

The WWTP influent averages approximately one (1) million gallons of water per day, which is equal to 3,044,100,000 lb. of water per year.

Concentration of NH_3 in the Aeration Tank

$$\frac{20{,}912 \text{ lb. } NH_3}{\text{year}} \times \frac{\text{year}}{3{,}044{,}100{,}000 \text{ lb. water}} = \frac{0.00000687 \text{ lb. } NH_3}{\text{lb. water}}$$

$$\frac{0.00000687 \text{ lb. } NH_3}{\text{lb. water}} \times \frac{453.6 \text{ g } NH_3}{\text{lb. } NH_3} \times \frac{2{,}204.6 \text{ lb. water}}{m^3 \text{ water}} = \frac{6.87 \text{ g } NH_3}{m^3 \text{ water}}$$

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

$$\frac{0.000888 \text{ g } NH_3 / m^3 \text{ air}}{\text{g } NH_3 / m^3 \text{ water}} \times \frac{6.87 \text{ g } NH_3}{m^3 \text{ water}} = \frac{0.00610 \text{ g } NH_3}{m^3 \text{ air}}$$

Emission of NH_3 from the Aeration Tank's Diffused Air

Basis: Diffused air injection rate of 2,000 ft^3 air per minute

$$\frac{2{,}000 \text{ ft}^3 \text{ air}}{\text{minute}} \text{ X } \frac{m^3}{35.315 \text{ ft}^3} \text{ X } \frac{525{,}600 \text{ min}}{\text{year}} = \frac{29{,}766{,}388 \text{ m}^3 \text{ air}}{\text{year}}$$

$$\frac{0.00610 \text{ g } NH_3}{m^3 \text{ air}} \text{ X } \frac{29{,}766{,}388 \text{ m}^3 \text{ air}}{\text{year}} \text{ X } \frac{\text{lb.}}{453.6 \text{ g}} = \frac{400.3 \text{ lb. } NH_3}{\text{year}}$$

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 = 400.3 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 = 400.3 lb. NH_3 / year

Emission of NH_3 from the WWTP Clarifiers = 400.3 lb. NH_3 / year

Emission of NH_3 from the WWTP System = 800.6 lb. NH_3 / year