I. VOC Summary - Point Source Emissions

Nafion Compound Name		Before Control VOC Generated		After Control Stack Emissions	
		kg/yr VOC	lb/yr VOC	lb/yr VOC	lb/yr HF
A.	COF2	29,218	64,280	257	156
B.	PAF	44,328	97,523	390	67
C.	PMPF	46,994	103,388	414	36
D.	PEPF	15,641	34,410	138	10
E.	PMVE	966	2,125	2,125	0
F.	PEVE	0	0	0	0
G.	HFP	1,292	2,843	2,843	0
H.	HFPO	1,292	2,843	2,843	0
	Total	139,733	307,412	**9,010**	**269**

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	257	156	49	30	306	186
B.	PAF	390	67	48	8	438	75
C.	PMPF	414	36	535	45	949	81
D.	PEPF	138	10	223	15	361	25
E.	PMVE	2,125	0	1249	0	3374	0
F.	PEVE	0	0	1069	0	1069	0
G.	HFP	2,843	0	10	0	2853	0
H.	HFPO	2,843	0	316	0	3160	0
	HFPO Dimer			6	0	6	0
	MD			51	3	51	3
	HydroPEVE			10	0	10	0
	PPVE			10	0	10	0
	AN			116	0	116	0
	Total	**9,010**	**269**	**3,692**	**101**	**12,702**	**370**

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

2008 Emission Summary

Report date 8/18/2009
Prepared by Broderick Locklear

A. VOC Emissions Summary

Nafion® Compound	CAS Chemical Name	CAS No.	PE/PM Emissions (lbs)	Accidental Releases (lbs)	Total Emissions (lbs)
COF2	Carbonyl Fluoride	353-50-4	306	0	306
PAF	Perfluoroacetyl Fluoride	354-34-7	438	0	438
PMPF	Perfluoromethoxypropionyl fluoride	2927-83-5	949	0	949
PEPF	Perfluoroethoxypropionyl fluoride	1682-78-6	361	0	361
PMVE	Perfluoromethyl vinyl ether	1187-93-5	3,374	0	3,374
PEVE	Perfluoroethyl vinyl ether	10493-43-3	1,069	0	1,069
HFP	Hexafluoroproplyene	116-15-4	2,853	0	2,853
HFPO	Hexafluoroproplyene Epoxide	428-59-1	3,160	0	3,160
AN	Acetonitrile	75-05-8	116	0	116
HFPO Dimer	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	6	0	6
MD			51	0	51
HydroPEVE			10	0	10
PPVE	Perfluoropropyl vinyl ether	1623-05-8	10	0	10
		Total VOC Emissions (lbs)	**12,702**	**0**	**12,702**
		Total VOC Emissions (tons)	**6.4**	**0.0**	**6.4**

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

Nafion® Compound	CAS Chemical Name	CAS No.	PE/PM Emissions (lbs)	Accidental Releases (lbs)	Total Emissions (lbs)
HF	Hydrogen Fluoride	7664-39-3	370	0.00	370
Acetonitrile	Acetonitrile	75-05-8	116	0.0	116

Reactor loop

Inventoried with	51	gal hydrocarbon*
Equivalent mass HC	383.3	lb hydrocarbon
Inventoried with	9	gal fluorocarbon*
Equivalent mass FC	112.7	lb fluorocarbon

* assumes 60 gallons, 85% hydrocarbon, 15% fluorocarbon

Component	FC mass fraction		Mass of FC		Quantity (lb.)
COF2	0.09	X	112.7	=	10.1
PAF	0.04	X	112.7	=	4.5
HFP	0.03	X	112.7	=	3.4
PMPF	0.59	X	112.7	=	66.5
PEPF	0.23	X	112.7	=	25.9
Dimer	0.01	X	112.7	=	1.1
MD	0.01	X	112.7	=	1.1
AN	Hydrocarbon		383.3	=	383.3

Reactor decanter

Inventoried with	25	gal hydrocarbon*
Equivalent mass HC	187.9	lb hydrocarbon
Inventoried with	25	gal fluorocarbon*
Equivalent mass FC	313.1	lb fluorocarbon

* assumes 50 gallons, 50% HC, 50% FC

Component	FC mass fraction		Mass of FC		Quantity (lb.)
COF2	0.09	X	313.1	=	28.2
PAF	0.04	X	313.1	=	12.5
HFP	0.03	X	313.1	=	9.4
PMPF	0.59	X	313.1	=	184.7
PEPF	0.23	X	313.1	=	72.0
Dimer	0.01	X	313.1	=	3.1
MD	0.01	X	313.1	=	3.1
AN	Hydrocarbon		187.9	=	187.9

Stripper column

Inventoried with	30	gal fluorocarbon
Equivalent mass FC	375.75	lb fluorocarbon

Component	FC mass fraction		Mass of FC		Quantity (lb.)
COF2	0.09	X	375.8	=	33.8
PAF	0.04	X	375.8	=	15.0
HFP	0.03	X	375.8	=	11.3
PMPF	0.59	X	375.8	=	221.7
PEPF	0.23	X	375.8	=	86.4
Dimer	0.01	X	375.8	=	3.8
MD	0.01	X	375.8	=	3.8

AF column

Inventoried with 30 gal fluorocarbon*
Equivalent mass FC 375.75 lb fluorocarbon

* all FC (70% PMPF, 27% PEPF, 1.5% dimer, 1.5% MD)

Component	FC mass fraction		Mass of FC		Quantity (lb.)
PMPF	0.70	X	375.75	=	263.0
PEPF	0.27	X	375.75	=	101.5
Dimer	0.015	X	375.75	=	5.6
MD	0.015	X	375.75	=	5.6

AF overhead

Inventoried with 1,000 kg FC
2,200 lb FC

Component	FC mass fraction		Mass of FC		Quantity (lb.)
PMPF	0.72	X	2,200	=	1,584
PEPF	0.28	X	2,200	=	616

AF decanter

Inventoried with 30 gal fluorocarbon
Equivalent mass FC 375.8 lb fluorocarbon

Component	FC mass fraction		Mass of FC		Quantity (lb.)
PMPF	0.72	X	375.8	=	271
PEPF	0.28	X	375.8	=	105

HFPO tank

135 gal HFPO
1,556 lb HFPO

Waste FC tank

Inventoried with 40 gal fluorocarbon*
Equivalent mass FC 501 lb fluorocarbon*

* assumes 70% is condensation waste (4% dimer, 67% MD, 29% ED); 30% is from refining purges, high boilers PEPF, hydro PEVE, and PPVE

Component	FC mass fraction		Mass of FC		Quantity (lb.)
Dimer	0.03	X	501	=	14
MD	0.47	X	501	=	235
ED	0.20	X	501	=	102
PEPF	0.10	X	501	=	50
Hydro PEVE	0.10	X	501	=	50
PPVE	0.10	X	501	=	50

Refining

Inventoried with 3,000 kg FC
6,600 lb FC

Component	Mass fraction		Mass of FC		Quantity (lb.)
PMVE	0.50	X	6,600	=	3,300
PEVE	0.50	X	6,600	=	3,300

Average System Composition - ABR/Refining

	Quantity in System (lb)	Fraction in System (%)	Fugitive emissions (lb)	Equivalent HF (lb)
PMPF	33	0.4%	9	0.8
PEPF	33	0.4%	9	0.6
HFP	17	0.2%	4	non-A/F
PEVE	4,026	46%	1,069	non-A/F
PMVE	4,703	53%	1,249	non-A/F
Total	**8,811**		**2,340**	**1.4**

Example:
8,811 lb. total fugitive emissions from ABR & Refining System
X 0.4% of ABR & Refining System total quantity is PMPF
= 9 lb. PMPF as a fugitive emission

C. Acetonitrile fugitive emissions

No normal process vents of acetonitrile ("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 = total HC waste – VE-N waste = 16,760 kg AN

Assume that: 5% of spent acetonitrile are fluorocarbons.

AN portion of hydrocarbon waste stream:

16,760 kg to H/C waste
X (100% - 5%)
= 15,922 kg AN to H/C waste

13,855 kg AN fed
15,922 kg AN to waste
-2,067 kg AN lost = 0 kg VOC
0 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	1,237
Agitated Bed Reactor & Refining	2,340
AN	114
Total	**3,692**

E. Speciated Equipment Emissions Summary

Nafion® Compound	Equipment Emissions	
	lb VOC	lb HF
COF2	48	29
PAF	47	8
HFP	10	0
HFPO	312	0
PMPF	527	45
PEPF	220	15
HFPO Dimer	6	0
MD	50	3
HydroPEVE	10	0
PPVE	10	0
PEVE	1,069	0
PMVE	1,249	0
AN	114	0
TOTAL	3,672	100

2008 Emission Summary

Report date 1/21/2009
Prepared by Broderick Locklear

A. VOC Emissions Summary

Nafion® Compound	CAS Chemical Name	CAS No.	PE/PM Emissions (lbs)	Accidental Releases (lbs)	Total Emissions (lbs)
COF2	Carbonyl Fluoride	353-50-4	78	0	78
PAF	Perfluoroacetyl Fluoride	354-34-7	665	0	665
PMPF	Perfluoromethoxypropionyl fluoride	2927-83-5	941	0	941
PEPF	Perfluoroethoxypropionyl fluoride	1682-78-6	358	0	358
PMVE	Perfluoromethyl vinyl ether	1187-93-5	3,374	0	3,374
PEVE	Perfluoroethyl vinyl ether	10493-43-3	1,069	0	1,069
HFP	Hexafluoroproplyene	116-15-4	2,853	0	2,853
HFPO	Hexafluoroproplyene Epoxide	428-59-1	3,155	0	3,155
AN	Acetonitrile	75-05-8	114	0	114
HFPO Dimer	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	6	0	6
MD			50	0	50
HydroPEVE			10	0	10
PPVE	Perfluoropropyl vinyl ether	1623-05-8	10	0	10
	Total VOC Emissions (lbs)		**12,682**	**0**	**12,682**
	Total VOC Emissions (tons)		**6.3**	**0.0**	**6.3**

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

Nafion® Compound	CAS Chemical Name	CAS No.	PE/PM Emissions (lbs)	Accidental Releases (lbs)	Total Emissions (lbs)
HF	Hydrogen Fluoride	7664-39-3	270	0.00	270
Acetonitrile	Acetonitrile	75-05-8	114	0.0	114

2008 Air Emissions Inventory Supporting Documentation

Emission Source ID No.: NS-D

Emission Source Description: Nafion RSU Process

Process and Emission Description:

The RSU process is a continuous manufacturing process. All emissions from this process vent to the Nafion Division Waste Gas Scrubber (WGS),Control Device ID No. NCD-Hdr1, which has a documented efficiency of 99.6%. 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.

Emission Summary

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	2502.0	0	231.2	16	2749.1
PAF	Trifluoroacetyl Fluoride	354-34-7	6.9	0	0.6	0	7.6
RSU	Difluoro(Fluorosulfonyl)Acetyl Fluoride	677-67-8	2.3	0	0.2	0.0	2.6
SU	2-Hydroxytetrafluoroethane Sulfonic Acid Sultone	697-18-7	6.9	0	0.6	0	7.6
EDC	1,2-Dichloroethane	107-06-2	0	15.6	0	0	15.6
	Total for 2008		**2518.2**	**15.6**	**232.7**	**16.0**	**2782.4**
						Tons	**1.39**

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	2.22	0	30.2	1.8	**32.02**
H2SO4	Sulfuric Acid	7664-93-9	9.6	133.4	0	0	**143.0**

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	3.8	0	0	0	**3.8**

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 buildings 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

Barricade:

Valve emissions:	250 valves x 0.00036 lb/hr/valve	=	0.090 lb/hr EE
Flange emissions:	550 flanges x 0.00018 lb/hr/flange	=	0.045 lb/hr EE
Total equipment emission rate		=	0.135 lb/hr EE

Days of operation = 72

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	72 days/year		x	72 days/year
	=	**232.7 lb/yr VOC from EE**		x	0.13 lb HF per lb VOC
				=	**30.2 lb/yr HF from EE**

B. Fugitive Emissions From SO3 Storage Tank and Vaporizer

This equipment is not inside a building, therefore emissions are true Fugitive Emissions

Valve emissions:	85 valves x 0.00036 lb/hr/valve	=	0.031	lb/hr FE
Flange emissions:	180 flanges x 0.00018 lb/hr/flange	=	0.032	lb/hr FE
Total fugitive emission rate		=	0.063	lb/hr FE

SO3:		0.063 lb. FE/hr	**H2SO4:**		0.063	lb. FE/hr
	x	24 hours/day		x	24	hours/day
	x	72 days/year		x	72	days/year
	=	**108.9 lb/yr SO3 from EE**		x	1.225	lb H2SO4 per lb SO3
				=	**133.4**	**lb/yr H2SO4 from FE**

C. Fugitive Emissions From EDC Tank

This equipment is not inside a building, therefore emissions are true Fugitive Emissions

Valve emissions:	20 valves x 0.00036 lb/hr/valve	=	0.007	lb/hr FE
Flange emissions:	10 flanges x 0.00018 lb/hr/flange	=	0.002	lb/hr FE
Total fugitive emission rate		=	0.009	lb/hr FE

VOC:		0.009 lb/hr FE	HF:	0
	x	24 hours/day		
	x	72 days/year		
	=	**15.6 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	232.7	30.2	0	0	0
B. Fugitive Emissions From SO3 Storage Tank and Vaporizer	0	0	0	108.9	133.4
C. Fugitive Emissions From EDC Tank	0	0	15.6	0	0
Total for 2008	**232.7**	**30.2**	**15.6**	**108.9**	**133.4**

E. VOC Emission by Source Type

Nafion® Compound	Emissions from Stack (lb)	Equipment Emissions (lb)	Fugitive Emissions (lb)	Accidental Releases (lb)	Total Emissions (lb)
TFE	2502.0	231.2	0	0	2733.1
PAF	6.9	0.6	0	0	7.6
RSU	2.3	0.2	0	462.0	464.6
SU	6.9	0.6	0	0	7.6
EDC	0	0	15.6	0	15.6
Total	**2518.2**	**232.7**	**15.6**	**462.0**	**3228.4**

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: $\frac{2502.0}{2518.2} \times 232.7 = 231.2$ lb. TFE

Accidental Releases to Atmosphere

A. Incident 2008-106 Date: 8/4/2008

Material Released: RSU
Quantity Released: 0 lbs

Material Released: SO3
Quantity Released: 0 lbs

Material Released: TFE
Quantity Released: 16 lbs

HF Potential:
1 mole of RSU will generate 1 mole of HF

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

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

Quantity VOC Released:

0.0 lbs RSU = 0.0 lbs VOC from RSU

0.0 lbs SO3 = 0 lb VOC from SO3

16.0 lbs TFE = 16 lb VOC from TFE

Total VOC Released = **16.0** **lbs VOC from RSU**

Quantity HF Released:
HF Equivalent Emissions = 16 lb RSU
x 0.111 lb HF/lb RSU
1.8 lb HF

B. Total Emissions from Accidental Releases

Source		lb RSU	lb SO3	lb TFE	lb/yr VOC	lb/yr HF
A.	Incident 2008-106	0.0	0	16	16.0	1.78
Total for 2008		**0.0**	**0**	**16**	**16.0**	**1.78**

2007 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

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% COF_2 and 70% TAF
- The reactor and storage tank are assumed to have the same concentration.
- The ideal gas law is used.

Information Inputs and Source Inputs:

Information Input	Source of Inputs
Weight of Tank	IP21 (H3450WG and H3606WG)
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

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)
8/18/08	Storage Tank	Maintenance	Shutdown work	40	0

Sample calculation using maintenance activity dated 8/18/08

Initial Weight minus Final Weight equals kg vented to Division WGS

40 kg minus 0 kg equals 40 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 8/18/08 maintenance activity is equal to:

Amount of VOCs vented to WGS: 40 kg of VOC
Percentage of VOCs vented from the WGS: x 0.4%
Quantity of VOCs vented from the WGS: = 0.16 kg VOC
= **0.35274 lb VOC**

Stack Emissions from Maintenance Activity (cont.)

<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) = **0.3527 lb VOC**

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

Sample calculation using maintenance activity dated 8/18/08

VOC emissions would be equal to:

$$\frac{0.353 \text{ lb VOC}}{} \Big| \frac{0.30 \text{ lb COF2}}{\text{lb VOC}} = 0.1058 \text{ lb COF2}$$

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

Sample calculation using maintenance activity dated 8/18/08

VOC emissions would be equal to:

$$\frac{0.353 \text{ lb VOC}}{} \Big| \frac{0.70 \text{ lb TAF}}{\text{lb VOC}} = 0.2469 \text{ lb VOC}$$

Stack Emissions from Maintenance Activity (cont.)

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 8/18/08

Quantity of VOCs vented from the WGS (see Page 2) = **0.3527 lb VOC**

HF equivalent emissions would be equal to:

0.353 lb VOC	0.30 lb COF2	0.606 lb HF	=	0.0641 lb HF
	lb VOC	lb COF2		

0.353 lb VOC	0.70 lb TAF	0.061 lb HF	=	0.015 lb HF
	lb VOC	lb TAF		

Therefore, HF vented to the atmosphere from the 8/18/08 maintenance activity is equal to:

0.0641 lb HF + 0.015 lb HF = 0.0791 lb HF

Stack Emissions from Maintenance Activity (cont.)

Calculation page

Date	Tank	Category	Reason	Weight of Tank Initial (kg)	Weight of Tank Final (kg)	Emitted VOC (lb)	Emitted HF (lb)
8/18/08	Storage Tank	Maintenance	Valve Repair	40	0	0.353	0.079

Total Emissions	0.35	0.08

Total	VOC	=	0.35	lb	
	VOC =		0.0002	ton	STACK EMISSIONS
Total	HF =		0.08	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)
8/18/08	Storage Tank	Maintenance	Valve Repair	0.353	0.106	0.247

Total Emissions	0.35	0.11	0.25

Fugitive Emissions Leak Rates for Process Equipment

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

2	Pump Seals	x	0.00115	lb/hr/pumpseal	=	0.0023	lb/hr VOC
148	Valves	x	0.00036	lb/hr/valve	=	0.0533	lb/hr VOC
45	Flanges	x	0.00018	lb/hr/flange	=	0.0081	lb/hr VOC
	Total VOC Emissions from Equipment Leaks				=	0.0637	lb/hr VOC

Total Annual Fugitive VOC Emissions:

0.0637 lb/hr VOC x 8760 hr/year = 557.84 lb VOC
0.2789 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.

$$\frac{557.8 \text{ lb VOC}}{} \Big| \frac{0.30 \text{ lb COF2}}{\text{lb VOC}} = \mathbf{167.35 \text{ lb COF2}}$$

$$\frac{557.8 \text{ lb VOC}}{} \Big| \frac{0.70 \text{ lb TAF}}{\text{lb VOC}} = \mathbf{390.49 \text{ lb TAF}}$$

See Page 3 for HF equivalents calculation:

$$\frac{557.8 \text{ lb VOC}}{} \Big| \frac{0.30 \text{ lb COF2}}{\text{lb VOC}} \Big| \frac{0.606 \text{ lb HF}}{\text{lb COF2}} = 101.42 \text{ lb HF}$$

$$\frac{557.8 \text{ lb VOC}}{} \Big| \frac{0.70 \text{ lb TAF}}{\text{lb VOC}} \Big| \frac{0.061 \text{ lb HF}}{\text{lb TAF}} = 23.666 \text{ lb HF}$$

101.42 lb HF + 23.666 lb HF = **125.1 lb HF**

Emission Summary

A. VOC Emissions by Compound and Source

Nafion® Compound	CAS Chemical Name	CAS No.	Stack Emissions (lbs)	Fugitive Emissions (lbs)	Total Emissions (lbs)
COF2	Carbonyl fluoride	116-14-3	0.11	167.4	167.5
TAF	Perfluoro-3,5,7, 9,11-pentaoxadodecanoyl fluoride	690-43-7	0.25	390.5	390.7
			Total VOC (lb)		**558.2**
			Total VOC (ton)		**0.28**

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	0.08	125.1	125.2

Yearly Emission Summary

A. VOC Compound Summary

NS-G SR/CR Resins Manufacturing Process			
Nafion® Compound	**CAS Chemical Name**	**CAS No.**	**Emission (lbs)**
PSEPVE	Perfluoro-2-(2-Fluorosulfonylethoxy) Propyl Vinyl Ether	16090-14-5	8,729
EVE	Propanoic Acid, 3-[1-[Difluoro[(Trifluoroethenyl)oxy]Methyl]-1,2,2,2-Tetrafluoroethoxy]-2,2,3,3-Tetrafluoro-Methyl Ester	63863-43-4	649
TFE	Tetrafluoroethylene	116-14-3	38,715
E-2	2H-Perfluoro(5-Methyl-3,6-Dioxanonane)	3330-14-1	6,610
MeOH	Methanol	67-56-1	519
		Total VOC Emissions (lbs)	**55,221**
		Total VOC Emissions (tons)	**27.6**

B. Toxic Air Pollutant Summary

NS-G SR/CR Resins Manufacturing Process			
Nafion® Compound	**CAS Chemical Name**	**CAS No.**	**Emission (lbs)**
F-113	Trichloro-1,2,2-trifluoro-1,1,2 Ethane	76-13-1	0
HF	Hydrogen Fluoride	7664-39-3	0.5
MeOH	Methanol	67-56-1	519
		Total VOC Emissions (lbs)	**520**
		Total VOC Emissions (tons)	**0.3**

Point Source Emission Determination

A. **HF**
Hydrogen Fluoride **CAS No. 7664-39-3**

HF Potential:

Some SR polymer is fluorinated with a mixture of 10% F2 90% N2.
Each mole of Fluorine (F2) reacts with one mole of SR polymer in the Fluorinator to produce 1 mole of HF.

$$R-CF_2-H+F_2 \rightarrow HF+R-CF_3$$

Quantity Released:

Vapor released to scrubber during initial fluorine charge:

F2 introduced during the initial fluorine charge to Fluorinator:

$$\frac{2.2\ lb\ F_2}{h}\ x\ 0.1\ F_2\ x\ 0.5\ hour = 0.11\ lb\ F_2$$

Estimate 75% of initial fluorine reacts with polymer during each batch:

$$0.75\ x\ 0.11\ lb\ F_2\ x\ \frac{1\ lbmol\ HF}{1\ lbmol\ F_2}\ x\ \frac{1\ lbmol\ F_2}{38\ lb\ F_2}\ x\ \frac{20\ lbHF}{1\ lbmol\ HF} = 0.0434\ lb\ HF$$

Vapors released to scrubber during initial fluorine charge: 0.0434 lb HF per batch

Vapor released to scrubber during remainder of fluorination cycle:

F2 feed :

$$0.88\ lb/h\ F_2\ x\ 0.10\ F_2\ x\ 12\ hours = 1.056\ lb\ F_2$$

Estimate 60% of fluorine reacts with polymer:

$$0.60\ x\ 1.056\ lb\ F_2\ x\ \frac{1\ lbmol\ HF}{1\ lbmol\ F_2}\ x\ \frac{1\ lbmol\ F_2}{38\ lb\ F_2}\ x\ \frac{20\ lbHF}{1\ lbmol\ HF} = 0.3335\ lb\ HF$$

Vapors released to scrubber during fluorination cycle: 0.3335 lb HF per batch

Unreacted Fluorine released to scrubber: 0.4499 lb F2 per batch

Vapor released to scrubber during Hydrolysis step of Chem Stable Process: 0.661 lb HF per batch

Total vapors to scrubber: 0.0434 + 0.3335 + 0.4499 = 0.8268 lb HF and F2 per fluorination batch

Emissions per batch utilizing 99% fluorine scrubber efficiency:

NOTE: 99% conversion based on studies of Washington Works' Fluorine Scrubbers

0.8268 lb HF and F2 per fluorination batch
x (1 - 0.99)
= 0.0083 lb HF and F2 per fluorination batch

0.6610 lb HF per hydrolysis batch
x (1 - 0.99)
= 0.0066 lb HF per hydrolysis batch

After-Control HF and F2 Emissions:

	# fluorinations	# hydrolysis	lb HF and F2 per fluorination batch	lb HF per hydrolysis batch	Total
1st Quarter	12	6	0.099216	0.03966	0.138876
2nd Quarter	18	9	0.148824	0.05949	0.208314
3rd Quarter	11	4	0.090948	0.02644	0.117388
4th Quarter	0	0	0	0	0
					0.464578

E. F-113
Trichloro-1,2,2-trifluoro-1,1,2 Ethane **CAS No. 76-13-1**

1. E2 Mass Balance:

	0 kg F-113 Beginning Inventory
+	0 kg F-113 Shipments
+	0 kg F-113 used with 3P in Polymerization
+	0 kg F-113 used with 3P in Semi-Works
-	0 kg F-113 waste sent off plant
-	0 kg F-113 Ending Inventory
	0 kg F-13 emission between SW & Polymerization

2. Division of Emissions between SW & Polymerization

0 kg F-113 Ending Inventory
0 kg F-113 Shipments
0 kg F-113 used with 3P in Semi-Works
0 kg F-113 used by Semi-Works

0 kg F-113 used with 3P in Polymerization
0 kg Refined by Polymerization in Recycle Still
0 kg F-113 used by Polymerization

Polymerization % = $\frac{\text{0 kg F-113 used by Polymerization}}{\text{0 kg F-113 Total}}$ x 100 = 0.0 %

3. E2 Emission from Polymerization: $\frac{0.0\ \%}{100}$ x 0 kg F-113 Emission = 0 kg F-113 emission from Polymerization
0 lb F-113 emission from Polymerization

December- Resins Monthly Emissions

Month	Date Entered	PSEPVE Emission (kg)	EVE Emission (kg)	TFE Emission (kg)	E-2 Emission (kg)	MeOH Emission (kg)	Total Emission (kg)	Total Emission (lbs)	Total Emission (tons)	12-month Sum (tons)
Jan-08	02/07/08	457	0	2276	806	26	3566	7861	3.9	33.3
Feb-08	03/13/08	187	1	1987	155	28	2358	5199	2.6	32.7
Mar-08	04/07/08	735	111	1984	71	25	2926	6450	3.2	34.3
Apr-08	05/08/08	41	0	2417	32	29	2520	5555	2.8	34.6
May-08	06/19/08	269	0	957	735	17	1977	4359	2.2	34.1
Jun-08	07/10/08	1121	87	1464	555	22	3249	7163	3.6	35.3
Jul-08	08/12/08	0	18	1184	53	19	1274	2809	1.4	33.8
Aug-08	09/13/08	265	73	1475	471	28	2312	5097	2.5	32.2
Sep-08	10/08/08	20	0	925	96	10	1051	2317	1.2	30.5
Oct-08	11/09/08	0	5	2195	1	26	2228	4911	2.5	30.0
Nov-08	12/10/08	864	0	696	16	7	1582	3488	1.7	29.4
Dec-08	01/13/09	0	0	0	7	0	7	15	0.0	27.6

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

DMSO Emissions yr	Units	2008	
Waste Shipped	lb/yr	0	data from Danny Melvin or replacement
Waste in storage tk yr end	gallons	616.8	=Waste% in Tank * Size of tank (5507 gal)
Waste in storage tk yr end	lb	6291	=gallons in tank* conversion of lb/gal of typical concentration of KOH/DMSO/water (10.2 lb/gal)
Waste % in storage tk yr end	%	10%	from IP-21, Y07403LG
DMSO Waste Content	wt%	11%	Per PR-70 average DMSO concentrations at highest limit, Lab analysis as support is available. Which indicates actual content is less then 11, Nafion® Products has decided to use the higher possible content to ensure fail safe position.
DMSO in Waste liquid	lb/yr	692	=(total lb. shipped offsite+total lb. stored onsite)*concentration of DMSO in tank (11%)
DMSO Shipped as Waste liquid	lb/yr	0	=(total lb. shipped offsite)*concentration of DMSO in tank (11%)
DMSO pumped to waste treatment	lb/yr	28885	Calc. from IP21 the number of days that we pumped to waste treatment, this rate is given at 5 gph (there is no flow meter at this time), use tank level changes IP21 Y07403LG to indicate tank level changes which means we are pumping. # days * *hr/day*gal/hr* Can also try using Y30529HS, which indicates if the pump is on
DMSO Inventory			
inv. Begin year	drums	20	from previous yr
inv. End year	drums	8	from Shipping and Material Coordinator (Autumn Arenivas)
DMSO Drums Rec	drums	88	from Shipping and Material Coordinator (Autumn Arenivas)
Wt/Drum	lb/drum	507	On shipping labels (from Shipping and Material Coordinator - Autumn Arenivas)
total DMSO consumed	lb	50700	=wt/drum*(dmso drum rec + inv. Begin year - inv. End year)
DMSO Emissions into air	lb/yr	21123	from total DMSO consumed - DMSO shipped as waste- DMSO pumped to waste treatment
DMSO Emissions into air	tons/yr	10.6	DMSO emissions into air/2000 lb. per ton
Acetic Acid Emissions air			
1st Quarter	hrs	99.1	from hydr run sheets, from quarterly acetic acid emissions report, completed by Hydrolyis ATO
2nd Quarter	hrs	108.9	from hydr run sheets, from quarterly acetic acid emissions report, completed by Hydrolyis ATO
3rd Quarter	hrs	52.38	from hydr run sheets, from quarterly acetic acid emissions report, completed by Hydrolyis ATO
4th Quarter	hrs	3.5	from hydr run sheets, from quarterly acetic acid emissions report, completed by Hydrolyis ATO
Total	hrs	263.9	
Acetic Acid Emissions Rate	lb/hr	0.727	from TA-NF-01-1240 study by Lee Ann Kessler in 1999
Acetic Acid HAP/TAP Emissions	lb/hr	*191.7*	=lb/hr * Total # of hours, brought to NS-H summary sheet
Acetic Acid HAP/TAP Emissions	**lb/yr**	192	Acetic Acid emissions

from TA-NF-01-1240 study by Lee Ann Kessler in 1999 the amount of HF produced per kg of polymer processed at various temperatures.
Use higher temp for extrusion.

kg/kg @ 200C	0.0003	5806.2	total operating schedule OS-19
kg/kg @ 200 C	0.0001		Seasonal % working schedule
kg/kg @ 275 C	0.000675		
kg/kg @ 275 C	0.000075		
kg/kg @ 300 C	0.00008		
kg/kg @ 300 C	0.00001		

Emission source/Operating Scenario Data

1. Emission Source ID No.

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
		2008	
Carbon Monoxide	CO	0	8
NOx	NOx	0	8
TSP	TSP	0	8
PM 2.5	PM-2.5	0	8
PM 10	PM-10	0	8
SO2	SO2	0	8
VOC	VOC	10.7	8

HAP/TAP pollutants	CAS #		8
Acetic Acid	64-19-7	192	8
Hydrogen Fluoride	7664-39-03	98	8

AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No.: NS-I MEMBRANE SPRAYBOOTH

Emission Source Description: Nafion® resin membrane spray booth treatment process

Process Description: OS-19 / Nafion® resin membrane spray booth treatment processes

The spray coating process supplies a thin uniform layer of coating (pigment & resin) solution to the surface of Nafion® membrane. This is accomplished in the following process Binder solution (Polymer and alcohol) is handled in 55 gallon drums and stored in an enclosed paint preparation room or temporarily on an outside pad prior to use. Pigment is received in 100 kg fiber packs and stored in the paint preparation area again prior to use.

The coating (or paint) solution is prepared by adding measured amounts of binder solution, a wetting agent, pigment and alcohol to an agitated premix tank. The coating solution is then tested per specification. If acceptable, the material is put into carboys. If not acceptable, the material is blended or processed though various equipment until tested within specifications. The acceptable coating solution is stored in carboys in the paint preparation area until needed for spray coating process.

In the spray coating process the resin membrane is feed continuously through the spray booth while the coating material is "sprayed" onto the membrane. An automatic transverse machine carries two air jet spray guns back and forth in front of the membrane and applies a thin coating.

The volatile paint alcohol is evaporated in the top section of the spray booth and in the exit enclosure behind the top section of the spray booth, leaving a dry pigment/binder coating on the membrane's surface.

The resin membrane spray coating and coating preparation process is contained in a enclosed room. All emissions are contained within the room and vent through emission control stacks. Air is supplied into the rooms and vented on a once through basis. The ventilation system is designed for 2 to 5 minute air exchange rate.

Basis and Assumptions:

- vent to atmosphere via stack
- No fugitive emissions due to all emissions vented through stack.
- Total Suspended Particles are pigment and larger than 10 micron PM.
- Maximum coating rate is 180cc/min per spray gun design basis with air pressure at max soc's. For these calculations the products area is using a 10% above factor to ensure emissions are not under reported. Thus 200 cc/min is basis for rate.
- Density of coating material is 7.928 lbs/gal average. This is soc aim. Actual lab analysis is performed with verifies this average over annual time frame. Thus basis of calculation assumes 7.928 SOC average vs lab reported average.
- Density of coating material is 7.928 lbs/gal average. This is soc aim. Actual lab analysis is performed with varifies this average over annual time frame. Thus basis of calculation assumes 7.928 SOC average vs lab reported average.

- Solution make up alcohol concentrations are soc specification averages. COA's verify actual concentrations are at soc averages. Thus basis of calculation assumes soc average for solution concentrations.

- Coating solution solid concentrations are soc specification averages. Lab analysis is performed and verifies this average over annual time frame. Thus the basis of calculation assumes 18% solids in coating batch.

- Paint applications emissions arrestor efficiency is 95% based on equipment design specification. 5% of total solids are lost as air emissions.

Information Inputs and Source of Inputs:

Information	Source
Paint batches made	Spray coating run sheets & lab numbering system for each batch made.
Gallons/batch	PR-81 process SOC
Paint batches remade	Spray coating run sheets & lab numbering system for each batch made. Note that the lab numbering system will indicate R for remade batches.
Gallons added/remade batch	PR-81 process SOC
Coating Density	PR-81 process SOC
Binder solution make up	PR-81 process SOC
% Ethanol	PR-81 process SOC
% Methanol	PR-81 process SOC
% 1-Propanol	PR-81 process SOC
Coating % solid pigment	PR-81 process SOC
Paint Arrestor efficiency	PR-81 process SOC
CA membrane Coated	Master Production Scheduler via SAP BW Reporting
Total hours of operation	Master Production Scheduler via SAP BW Reporting
% Hours operation per quarter	Master Production Scheduler via SAP BW Reporting

NS-I Membrane Spraybooth summary.

Coating Process yr		2008	
Max Spray Coat Rate	cc/min (2 guns)	400	
Max Process Rate	gal/hr	6.3	
Paint Batches	batch	248	from spraycoating paint & binder lab results
Gallons/batch	gals	25 or 50	
Gallons from Original batches	gals	7900	
Remade batches	batchs	0	from spraycoating paint & binder lab results NG first samples.
Gallons added/batch	gals	5	
Gallons added to remake batchs	gals	0	
Annual Process Throughput	gals/yr	7900	
Coating Density	lb/gal	7.928	
Coating Consumed	lbs/yr	62631	
VOC Emissions			
Ethanol	wt %	69%	
Methanol	wt %	1%	
1-Propanol	wt %	8%	
Annual VOC Emissions	lbs/yr	48852	
	tons/yr	24.4	
TSP Emissions			
Coating Solids	wt %	18%	
Paint Arrestor Effic	%	95%	
Solids Produced	lb/yr	11274	
Annual TSP Emissions	lbs/yr	563.7	
total suspended particles	tons/yr	0.28	

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

Criteria (NAAQS) pollutants	Pollutant code	Emissions-Criteria pollutants (tons/yr)
Carbon Monoxide	CO	0
NOx	NOx	0
TSP	TSP	0.28
PM 2.5	PM-2.5	0.28
PM 10	PM-10	0.28
SO2	SO2	0
VOC	VOC	24.4

2008 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. A typical batch is ~ 220 kgs of E fluids with the following composition (86% E2, 10% E1 and 4% E3).

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.

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)
E1	Propane, 1,1,1,2,2,3,3-heptafluoro-3-(1,2,2,2-tetrafluoroethoxy)-	3330-15-2	478.0	44.2	6.3	0	528.4
E2	2H-perfluoro(5-methyl-3,6-dioxanonane)	3330-14-1	365.0	33.3	54.2	0	452.5
E3	2H-perfluoro-5,8-dimethyl-3,6,9-trioxadodecane	3330-16-3	3.2	0.3	2.5	0	6.0
	Total for 2008		846.2	77.7	63.0	0	987.0
						Tons	**0.49**

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)

$$n = \frac{1.46 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{8.02 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.0020 \text{ lb-mol E1}$$

$$0.0020 \text{ lb-mol E1} \times \frac{286 \text{ lb E1}}{\text{lb-mol E1}} = \mathbf{0.57 \text{ lb E1/batch}}$$

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

$$n = \frac{0.70 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{8.02 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.0010 \text{ lb-mol E2}$$

$$0.0010 \text{ lb-mol E2} \times \frac{452 \text{ lb E2}}{\text{lb-mol E2}} = \mathbf{0.43 \text{ lb E2/batch}}$$

For E3: n = moles of E3 = (Partial pressure of E3) * (Volume) / (R) / (Temperature)

$$n = \frac{0.0047 \text{ psia}}{10.73 \text{ psia-ft}^3\text{/lb-mol/degR}} \times \frac{8.02 \text{ ft}^3}{545.69 \text{ degrees R}} = 0.000007 \text{ lb-mol E3}$$

$$0.000007 \text{ lb-mol E3} \times \frac{618 \text{ lb E3}}{\text{lb-mol E3}} = \mathbf{0.004 \text{ lb E3/batch}}$$

Total Fugitive Emissions from E2-Fluids process

Chemical	lb/batch	No. of batches	lbs
E1	0.57	77	44.2
E2	0.43	77	33.3
E3	0.004	77	0.3
Total			**77.7**

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 0 lb/hr VOC
Flange emissions:	20 flanges x 0.00018 lb/hr/flange =	0.0036 0 lb/hr VOC
Total equipment emission rate		0.0559 0 lb/hr VOC

VOC:		0.0559	lb/hr VOC
	x	1,128	operating hrs/year
	=	63.0	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%	63.0	6.3
E2	86%	63.0	54.2
E3	4%	63.0	2.5
Total			63.0

Where the **Chemical Emission Rate** equals the **Total Equipment Emission Rate** multiplied by the **Chemical Fraction**

Accidental Releases to Atmosphere

A.

Material Released: E1
Quantity Released: 0 lbs
specific gravity =

E1 is a VOC without the potential to form HF.

B. Date:

Material Released: E2
Quantity Released: 0 lbs

E2 is a VOC without the potential to form HF.

C. Date:

Material Released: E3
Quantity Released: 0 lbs

E3 is a VOC without the potential to form HF.

E. Total Emissions from Accidental Releases

Source		lb E1	lb E2	lb E3
A.		0.00	0.00	0.00
B.		0.00	0.00	0.00
C.		0.00	0.00	0.00
D.		0.00	0.00	0.00
	Total	0.00	0.00	0.00

Non-Point Source Emission Determination

A. TFE
Tetrafluoroethylene

CAS No. 116-14-3

Each mole of TFE/HCl distillate contains 1 mole of TFE and 2.1 moles of HCl, which calculates to:
0.566 Wt fraction TFE
0.434 Wt fraction HCL

Example of monthly calculation (by mass balance):

1. TFE Inventory Change:

Beginning Inventory	12791 kg TFE/HCl
TFE/HCl Distillate Shipment:	11948 kg TFE/HCl
Ending Inventory	7039 kg TFE/HCl
	17700 kg TFE/HCl

17700 kg TFE/HCl x (0.566 kg TFE / 1 kg TFE/HCl) = 10018 kg TFE

2. TFE Usage:

TFE to Polymerization	8542.09 kg TFE
TFE to Precursors	0 kg TFE
TFE to Semi-Works	336.3557471 kg TFE
	8878.445747 kg TFE

3. TFE Emission

TFE Inventory Change	10018 kg TFE
TFE Usage	8878.445747 kg TFE
	1140 kg TFE

Monthly & Yearly Calcuation

Month	TFE/HCl Ending Inventory	TFE/HCl Shipments	TFE to Polymerization	TFE to Precursors	TFE to Semi-Works	TFE Inventory Change (kg)	TFE Usage (kg)	TFE Emission (kg)	TFE Emission (lb)
Jan-08	12791	22218.76	6802.3	0	0	8917	6802	2114	4652
Feb-08	7039	11948.28	8542.09	0	336.35575	10018	8878	1140	2508
Mar-08	15165	24252.68	7810.1	0	1	9128	7811	1317	2897
Apr-08	0	0	7188.05	665	0	8583	7853	730	1607
May-08	4812	35185	5542.9	9094	0	17191	14637	2554	5619
Jun-08	1802	11567.92	5985.04	1028	0	8251	7013	1238	2724
Jul-08	15436	23644.32	4928	0	0	5666	4928	738	1623
Aug-08	17559	34603.88	9372.2	7457	92	18384	16921	1463	3219
Sep-08	19918	11831.24	3177.37	1433	9	5361	4619	742	1632
Oct-08	5754	0	7478	0	0	8017	7478	539	1185
Nov-08	13482	12735.68	2674	0	0	2834	2674	160	353
Dec-08	13482	0	0	0	0	0	0	0	0

TFE Emissions = **28018** lb TFE

RECEIVED
AUG 13 2009
DENR
FAYETTEVILLE REGIONAL OFFICE

B. Hydrogen Chloride (HCl)

CAS No. 76-470-10

Each mole of TFE/HCl distillate contains 1 mole of TFE and 2.1 moles of HCl, which calculates to:

0.566 Wt fraction TFE
0.434 Wt fraction HCL

0.767 kg HCl for is generated for each kg of TFE used.

$$1\ kg\ TFE\ x\ \frac{0.434\ kg\ HCl}{0.566\ kg\ TFE} = \frac{0.767\ kg\ HCl}{1\ kg\ TFE}$$

Example of monthly calculation (by mass balance):

1. HCl Inventory Change:

Beginning Inventory	12791 kg TFE/HCl				
TFE/HCl Distillate Shipment:	11948 kg TFE/HCl				
Ending Inventory	7039 kg TFE/HCl				
	17700 kg TFE/HCl	x	0.434 kg HCl / 1 kg TFE/HCl	=	7682 kg HCl

2. HCl generated from TFE usage:

TFE to Polymerization	8542.09 kg TFE				
TFE to Precursors	0 kg TFE				
TFE to Semi-Works	336.3557471 kg TFE				
	8878.445747 kg TFE	x	0.767 kg HCl / 1 kg TFE	=	6810 kg HCl

3. Before-Controlled HCl Emission

HCl Inventory Change	7682 kg HCl
HCl Usage	6810 kg HCl
	872 kg HCl

Monthly & Yearly Calcuation

Month	TFE/HCl Ending Inventory	TFE/HCl Shipments	TFE to Polymerization	TFE to Precursors	TFE to Semi-Works	Associated HCl produced by Polymerization	Associated HCl produced by Precursors	Associated HCl produced by Semi-Works	HCl Inventory Change (kg)	HCl Generation (Kg)	HCl to Scrubber		HCL Water Discharge	
Dec-07	6326	n/a	n/a	n/a	n/a									
Jan-08	12791	22218.76	6802.3	0	0	5217	0	0	6837	5217	1620		5211	
Feb-08	7039	11948.28	8542.09	0	336.35575	6552	0	258	7682	6810	872		6806	
Mar-08	15165	24252.68	7810.1	0	1	5990	0	1	6999	5991	1008		5987	
Apr-08	0	0	7188.05	665	0	5513	510	0	6582	6023	558		6021	
May-08	4812	35185	5542.9	9094	0	4251	6975	0	13182	11227	1955		11219	
Jun-08	1802	11567.92	5985.04	1028	0	4591	788	0	6327	5379	948		5375	
Jul-08	15436	23644.32	4928	0	0	3780	0	0	4344	3780	565		3778	
Aug-08	17559	34603.88	9372.2	7457	92	7188	5720	71	14097	12979	1118		12974	
Sep-08	19918	11831.24	3177.37	1433	9	2437	1099	7	4111	3543	568		3541	
Oct-08	5754	0	7478	0	0	5736	0	0	6147	5736	412		5734	
Nov-08	13482	12735.68	2674	0	0	2051	0	0	2173	2051	122		2050	
Dec-08	13482	0	0	0	0	0	0	0	0	0	0		0	
								Before-Controlled HCl Emission =			9746	kg HCl	68696	kg HCL
											21486	lb HCl	151447	lb HCL

4. After-Controlled HCl Emission

HCl is vented to the Waste Gas Scrubber (NCD-Hdr-1) utilizing 99.6% efficiency.

Waste Gas Scrubber	21,486	lb HCL before control
	x (100% - 99.6%)	Scrubber control efficiency
	= **85.9**	**lb HCl after control**

Emission Summary

A. VOC Compound Summary

NS-L TFE/HCl Separation Process			
Nafion® Compound	**CAS Chemical Name**	**CAS No.**	**Emission (lbs)**
TFE	Tetrafluoroethylene	116-14-3	28,018
		Total VOC Emissions (lb)	**28,018**
		Total VOC Emissions (tons)	**14.0**

B. Toxic Air Pollutant Summary

NS-L TFE/HCl Separation Process			
Nafion® Compound	**CAS Chemical Name**	**CAS No.**	**Emission (lbs)**
HCl	Hydrogen Chloride	76-470-10	85.9

2008 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.

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 = 2

VOC:

	0.005 lb/hr TFE FE
x	24 hours/day
x	2 days/year
=	**0.2 lb/yr VOC from EE**

CO2:

	0.005 lb/hr CO2 FE
x	24 hours/day
x	2 days/year
=	**0.2 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 = 2

VOC:

	0.0014 lb/hr TFE FE
x	24 hours/day
x	2 days/year
=	**0.1 lb/yr VOC from EE**

CO2:

	0.0014 lb/hr CO2 FE
x	24 hours/day
x	2 days/year
=	**0.1 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:	0.2
B. Fugitive Emissions From TFE/CO2 Vaporizer	0.1
Total for 2008	**0.3**

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:	0.2
B. Fugitive Emissions From TFE/CO2 Vaporizer	0.1
Total for 2008	**0.3**

Accidental Releases to Atmosphere

NOTE: Only accidental releases upstream of the TFE/CO2 flowmeter will be accounted for. on this sheet. All other accidental releases are accounted for in the system mass balance.

Incident Report 2008-174
TFE/CO2 Vaporizer RD Release

From the incident report, 130 kgs of TFE/CO2 was released from the process.
TFE/CO2 is a 50/50 wt% mixture of TFE and CO2.

130 kgs TFE/CO2

65 kgs TFE
143 lb. TFE

65 kgs CO2
143 lb. CO2

2008 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	404.5	0.3	143	547.8
			Total VOC Emissions (lb)			**547.8**
			Total VOC Emissions (tons)			**0.27**

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	0.7	0.3	143	144.0
			Total Emissions (lb)			**144.0**
			Total Emissions (tons)			**0.07**

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 2008

Container Type	Quantity of Containers	VOC per container (lb)	VOC Emissions (lb)
ISO Container	30	1,413	42,388
UNT Cylinder	48	83	3,989
1-Ton cylinder	333	63	21,035
3AA Cylinder	13	4	54
Total VOC Emission for All Containers			**67,466**

Total Containers Decontaminated	**424**

2008 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	67,466
		Total VOC Emissions (lb)	67,466
		Total VOC Emissions (tons)	33.73

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 and venting to the Waste Gas Scrubber (WGS).

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	0.02
PSEPVE	0.001
PPVE	0.03
EVE	0.01

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)
1 ton cylinder	200
4BW cylinder	57
4BA/3AA cylinder	15

Estimated emissions:

					Before Control	After Control
Dimer						
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
1 ton cylinder	4	X	0.016 lb	=	0.064 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	138	X	6.8 lb	=	938.4 lb
4BW cylinder	152	X	1.9 lb	=	294.6 lb
4BA/3AA cylinder	36	X	0.5 lb	=	18.36 lb
EVE					
1 ton cylinder	0	X	2.0 lb	=	0 lb
4BW cylinder	0	X	0.6 lb	=	0 lb
4BA/3AA cylinder	11	X	0.2 lb	=	1.65 lb

Year **2008**

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	0.1
PSEPVE	Perfluorinated Sulfonyl Vinyl Ether	16090-14-5	0.0
PPVE	Perfluoropropyl Vinyl Ether	1623-05-8	1,251
EVE	Ester Vinyl Ether	63863-43-4	1.7

Total VOC Emissions (lb.) 1,253

Total VOC Emissions (tons) 0.63

Prepared by: Debra Luttrell
6/17/2009

Emission Unit IDs: NS-P

Emission Source Description: Vinyl Ethers South 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 and venting to the Waste Gas Scrubber(WGS).

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 tank container volume is 4,480 gallons. One-ton cylinder 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

Container Emission Calculations for Year: 2008

Containers used to ship PMVE, PEVE and PPVE from the VE-S process

Container	Volume	
Iso container	4,480	gallons
1 ton cylinder	200	gallons
4BW cylinder	57	gallons
4BA/3AA cylinder	15	gallons

Product	Vapor Density(lb/ga @10°C
PMVE	0.2258
PEVE	0.0901
PPVE	0.0342

Product & Container Type	No. of containers decontaminated	lb. VOC emitted
PMVE ISO	7	7,081
PMVE 1 ton	157	7,090
PMVE 4BW	0	0
PMVE 4BA/3AA	24	81
Total PMVE emitted		**14,252**
PEVE 1 ton	118	2,126
PEVE 4BW	50	257
PEVE 4BA/3AA	15	20
Total PEVE emitted		**2,403**
PPVE 1 ton	0	0
PPVE 4BW	0	0
PPVE 4BA/3AA	0	0
Total PPVE emitted		**0**

Total Containers Decontaminated = **371**

* Information gotten from SAP via knowing the number of containers filled then shipped
Each container is decontaminated prior to filling

Year 2008

VE-South VOC Container Emission Summary:

Nafion® Compound	CAS Chemical Name	CAS No.	Total Emissions (TPY)
PMVE	Perfluoromethyl vinyl ether	1187-93-5	7.1
PEVE	Perfluoroethyl vinyl ether	10493-43-3	1.2
PPVE	Perfluoropropyl vinyl ether	1623-05-8	0.0

Actual TPY Emitted from Containers	**8.3**

Prepared by: Broderick Locklea

2008 Air Emmisions Inventory for SW-1 and SW-2 in pounds (lbs)

SW-1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
VOC's	0.0	1242.4	22.7	544.1	0.0	0.0	500.7	365.6	0.0	0.0	0.0	0.0	2675
F113	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AF's	0.0	7.4	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	8.2
HCl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Qtr's	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total
VOC's	1265.1	544.1	866.3	0.0	2675
F113	0.0	0.0	0.0	0.0	0.0
AF's	7.40	0.00	0.8	0.00	8.2
HCl	0.00	0.00	0.00	0.00	0.0

SW-2 (Only record emissions in support of SW polymerization operations)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
VOC's	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F113	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AF's	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000

Qtr's	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total
VOC's	0.0	0.0	0.0	0.0	0.0
F113	0.0	0.0	0.0	0.0	0.0
AF's	0.000	0.000	0.00	0.00	0.000

General explanation:

Semi-works is a research & development area that operates under a wide range of conditions. Emissions are calculated for each individual campaign. In all cases, material balances are used to determine emissions. Since all emissions occur within the semi-works facility, they are all assumed to be point source emissions via the process stack SW-1. The only emissions calculated for SW-2 are acid fluoride emissions associated with running melt flow samples under the lab hood.

Polymerization Campaign Emissions Determination:
The production and raw material information is entered for each campaign on a worksheet. The individual sheets in this workbook are copies of the completed worksheets for each campaign. Data in green fields is entered when applicable for the polymerization campaign. The other cells are calculated cells. The emissions for the campaign are calculated at the bottom of the worksheet. For the annual emissions calculations, the emissions from these campaigns are totaled onto a summary sheet. In this workbook, that is called "Campaign Summary". A summary by month is found on "Year End Summary".

*Example Mass Balance Calculations for polymerization campaigns: (using **5-SXF-1.1** worksheet for example)*
The emissions are determined by mass balance around the system. Data used in the calculation is obtained from production records and entered into the worksheet. The following is entered into the worksheet after each campaign:

1) Enter the starting material at the beginning of the campaign. This would include any material in the recovery tank and condensate tank. The composition of the material in each tank is determined by lab analysis and/or on-line GC.
2) Enter the amount of initiator added to the system, based on integrator on initiator feed. The concentration of initiator is determined by lab analysis.
3) Enter the amount of TFE added to the system, based on the integrator for TFE feed.
4) Enter the amounts of solvent (E2, F113) and monomer (PSEPVE) added to the system during the campaign. Drum weights before and after the campaign are used to determine this.

Enter starting and addition data as described in steps 1-4 above in the green shaded areas.
Spreadsheet sums all inputs for each component in right hand column (column M)....see embedded comments for details

Starting Material										
Item	Recovery Tank	Monomer Tank	Condensate Tank	Initiator Tank	Addition (TFE)	Addition (E2)	Addition (PS)	Addition (F113)		
Weight (Kg):	0.00	0.00	0.00	20.08	114.39	0.00	97.00	666.00	0.00	
Compositions:										
%E2	0.00%		94.00%	96.00%	0.00%	100.00%	0.00%	0.00%	0.00%	
%PSEPVE	8.00%		6.00%			0.00%	100.00%	0.00%	45.00%	
%TFE	0.00%		0.00%		100.00%	0.00%	0.00%	0.00%	0.00%	
%F113	92.00%		0.00%	0.00%		0.00%	0.00%	100.00%	55.00%	
%Inititiato	0.00%		0.00%	4.00%		0.00%	0.00%	0.00%	0.00%	**Totals**
Weights										
E2	0.00	0.00	0.00	19.28	0.00	0.00	0.00	0.00	0.00	19.3
PSEPVE	0.00	0.00	0.00	0.00	0.00	0.00	97.00	0.00	0.00	97.0
TFE	0.00	0.00	0.00	0.00	114.39	0.00	0.00	0.00	0.00	114.4
F113	0.00	0.00	0.00	0.00	0.00	0.00	0.00	666.00	0.00	666.0
Inititiator	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.8

5) Enter the amount and composition of material in the recovery tank, condensate tank, in collection drum, or held up in the system at the end of the campaign.
Spreadsheet sums all inputs for each component in right hand column (column M)....similar to above

Ending Material									
Item	Recovery Tank		Condensate Tank	E2 tank	Drained to drum	Holdup			
Tank level (jet off)									
Weight (Kg):	200.00		107.00		85.00	0.00	0.00		
Compositions									
%E2	3.89%		4.69%	100.00%	4.69%	72.00%			
%PSEPVE	7.50%		6.92%		6.92%	28.00%			
%TFE	0.00%				0.00%	0.00%			
%F113	87.79%		88.20%		88.20%	0.00%			
%Inititiato	0.00%				0.00%	0.00%			**Totals**
Weights									
E2	7.78	0.00	5.02	0.00	3.99	0.00	0.00		**16.8**
PSEPVE	15.00	0.00	7.40	0.00	5.88	0.00	0.00		**28.3**
TFE	0.00	0.00	0.00	0.00	0.00	0.00	0.00		**0.0**
F113	175.58	0.00	94.37	0.00	74.97	0.00	0.00		**344.9**
Inititiator	0.00	0.00	0.00	0.00	0.00	0.00	0.00		**0.0**

6) Enter total weight of polymer produced, and average EW.
7) Enter approximate weight (5 kg) of adhesions on vessel walls and in piping. The adhesions are assumed to be pTFE with an EW of 1700.
8) Enter amount and composition of slurry left over at the end of the campaign. The EW is assumed to be 1080 as a result of over saturation of initiator and limited TFE present during shutdown conditions.

Production

Item	Polymer	Adhesions	Slurry		Totals
Weight (Kg):	138.30	5.00	0.00		
Compositions					
EW	1470	1700	1000		
%Polymer	1	1	0.1		
%E2			0.72		
%PSEPVE			0.28		
%TFE			0		
%F113			0.79011		
Weights					
Polymer	138.30	5.00	0.00		143.3
E2	0.00	0.00	0.00		0.0
PSEPVE	41.96	1.31	0.00		43.3
TFE	96.34	3.69	0.00		100.0
F113	0.00	0.00	0.00		0.0
VE in Poly	41.96	1.31	0.00		

The total for each component added, remaining, and production output as calculated in column M for each section of the spreadsheet above is duplicated in the table below. Emissions are difference between amount consumed and amount in product.

Material Balance Summary

Compound	Added	Remaining	Used	Production	Other		*Totals*
E2	19.3	16.8	2.5	0.0			2.5
PSEPVE	97.0	28.3	68.7	43.3			25.4
TFE	114.4	0.0	114.4	100.0			14.4
F113	666.0	344.9	321.1	0.0			321.1
Inititiator	0.8	0.0	0.8	0.0			0.8

The final section of the spreadsheet summarizes the reportable emissions in pounds for SW-1. Refer to embedded comments for details.

Lbs of Emissions	
SW-1	
VOC's	**94.8 lbs**
F-113	**706.4 lbs**
AF's	**2.766 lbs**

9) Enter in the number of melt flow samples processed in the semi-works lab during the campaign. This is entered in the green box under SW-2. If all samples are sent to the mfg lab, this will be zero.

SW-2	
# of MF samples	**0**
grams emissions	**0 g**
lbs of emissions	**0.0000 lb**

Example Mass Balance Calculations for slurry reclaim campaigns:
The slurry reclaim process is used to recover valuable solvent and monomer from drums of polymer slurry. The semi-works flash dryer is used to flash off the solvent and monomer liquid into a vapor state, so that the solids can be collected in a bag filter. The vapors are then condensed back into liquid which can be reclaimed. Due to a high nitrogen (noncondensible) flow, some of the solvent and monomer escapes the condenser as vapor to the SW-1 stack. A mass balance approach is used to determine how much vapor has been lost, so that this can be included in annual air emissions summary.

Here is a summary of the material balance calculation.

1) Weight of drums processed through the system are recorded. The reported composition of the drums is used to determine VOC and F113 content. Solids and other non-recoverable waste are backed out, based on a material balance on solids (polymer and waste collected).
2) Any fresh E2 solution used for startup of the flash drying system is accounted for in the balance.
3) Outputs include weight of reclaimed liquid collected in drums, weight of solid polymer collected, and weight of solid waste in drums.

Example Mass Balance Calculations for TFESK campaigns:

The production of TFESK requires the use of TFE. TFE emissions and potential TFESK emissions are estimated based upon a material balance around the system. Data used in the calculation is obtained from production records for each campaign and entered into the worksheet. The following is entered into the worksheet after each campaign:

1) Enter the amount of TFE received; minus the amount required to produce the product.
2) Enter the number of bacthes dried during the month.
3) Enter the amount of TFESK solids removed from the oven.
4) Enter the average amount of dried TFESK collected per batch for the campaign being reported.

Outputs from the material balance include the estimated emissions of TFE and TFESK

A. Fluoroform (CF_3H) **CAS No. 75-46-7**

Freon® 23

Quantity Generated:

Before-control CF_3H generation per the process flowsheet (W1208078):

$$\frac{0.4\ kg\ CF_3H}{158.4\ kg\ fresh\ HFP}$$

Before-control CF_3H generation based on 2,117,586 kg of fresh HFP make-up:

$$\frac{0.4\text{ kg }CF_3H}{158.4\text{ kg fresh HFP}} \times 2{,}117{,}586\text{ kg fresh HFP} = 5{,}347\text{ kg }CF_3H$$

11,764 lb. CF_3H

5.88 ton CF_3H