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 is 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 $\frac{0.01\ kg\ C4s}{3.97\ kg\ Crude\ Receiver\ Vent}$

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 4,925 kg in the Condensation Reactor vent stream.
C4s vented based on 3,283 kg in the Crude Receiver vent stream.
C4s vented based on 1,032 kg in the Foreshots Receiver vent stream.
C4s vented based on 10,209 kg in the Stripper vent stream.

C4s vented from Condensation Reactor:

$\frac{0.00\ kg\ C4s}{2.35\ kg\ CndRx} \times 4{,}925\ kg\ CndRx = 0\ kg\ C4s$

C4s vented from Crude Receiver

$\frac{0.01\ kg\ C4s}{3.97\ kg\ CrRec} \times 3{,}283\ kg\ CrRec = 8\ kg\ C4s$

C4s vented from Foreshots Receiver

$\frac{0.15\ kg\ C4s}{1.06\ kg\ FsRec} \times 1{,}032\ kg\ FsRec = 145\ kg\ C4s$

C4s vented from Stripper

$\frac{0\ kg\ C4s}{100\ kg\ Strpr} \times 10{,}209\ kg\ Strpr = 0\ kg\ C4s$

VOC Emissions

	0 kg from Condensation Reactor		
+	8 kg from Crude Receiver		
+	145 kg from Foreshots Receiver		
+	0 kg from Stripper		
=	153 kg C4s	=	153 kg VOC
			337 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 perfluorobutenes 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 4,925 kg in the Condensation Reactor vent stream.
C5s vented based on 3,283 kg in the Crude Receiver vent stream.
C5s vented based on 1,032 kg in the Foreshots Receiver vent stream.
C5s vented based on 10,209 kg in the Stripper vent stream.

C5s vented from Condensation Reactor:

$$\frac{0.00\ kg\ C5s}{2.35\ kg\ CndRx} \times 4{,}925\ kg\ CndRx = 0\ kg\ C5s$$

C5s vented from Crude Receiver

$$\frac{0.00\ kg\ C5s}{3.97\ kg\ CrRec} \times 3{,}283\ kg\ CrRec = 0\ kg\ C5s$$

C5s vented from Foreshots Receiver

$$\frac{0.02\ kg\ C5s}{1.06\ kg\ FsRec} \times 1{,}032\ kg\ FsRec = 18\ kg\ C5s$$

C4s vented from Stripper

$$\frac{0\ kg\ C5s}{100\ kg\ Strpr} \times 10{,}209\ kg\ Strpr = 0\ kg\ C5s$$

VOC Emissions

0 kg from Condensation Reactor
\+ 0 kg from Crude Receiver
\+ 18 kg from Foreshots Receiver
\+ 0 kg from Stripper
= 18 kg C5s = 18 kg VOC
39 lb VOC

H. Carbon Monoxide (CO) **CAS No. 630-08-0**

HF Potential:
CO can not form HF

Quantity Released

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

CO 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 $\frac{0\ kg\ CO}{100\ kg\ Stripper\ Vent}$

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

CO vented from Condensation Reactor:

$$\frac{0.00\ kg\ CO}{2.35\ kg\ CndRx} \times 4{,}925\ kg\ CndRx = 0\ kg\ CO$$

CO vented from Crude Receiver

$$\frac{1.27\ kg\ CO}{3.97\ kg\ CrRec} \times 3{,}283\ kg\ CrRec = 1{,}053\ kg\ CO$$

CO vented from Foreshots Receiver

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

CO vented from Stripper

$$\frac{0\ kg\ CO}{100\ kg\ Strpr} \times 10{,}209\ kg\ Strpr = 0\ kg\ CO$$

CO Emissions

0 kg from Condensation Reactor
\+ 1,053 kg from Crude Receiver
\+ 0 kg from Foreshots Receiver
\+ 0 kg from Stripper
= 1,053 kg CO = **2,321 lb CO**

I. VOC Summary

Nafion Compound Name		Before Control Generated		After Control Stack Emissions	
		kg/yr	lb/yr	VOC lb/yr	HF lb/yr
A.	HFP	3,197	7,048	7,048	
B.	HFPO	6,363	14,028	14,028	
C.	PPF	5,498	12,120	48	5.8
D.	TFE	1,798	3,964	3,964	
E.	PPVE	1,273	2,806	2,806	
F.	C4	153	337	337	
G.	C5	18	39	39	
	Total	18,299	40,343	**28,271**	**5.8**

J. Point Source Summary

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	7,048	522.9	133.8	7,705
B.	HFPO	14,028	1,040.8	266.3	15,336
C.	PPF	48	3.6	0.9	53
D.	TFE	3,964	294.1	75.2	4,334
E.	PPVE	2,806	208.2	53.3	3,067
F.	C4	337	25.0	6.4	369
G.	C5	39	2.9	0.7	42
H.	CO	2,321	0.0	0.0	2,321
K.	AN	0	1,214.2	0.0	1,214
	Total	**30,592**	**2,098**	**537**	**33,226**

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

HF Equivalent Emissions

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
C.	PPF	5.8	0.43	0.11	6.36
	Total	**5.8**	**0.43**	**0.11**	**6.36**

The estimated HF equivalent emissions from Equipment Emissions were determined by multiplying the PPF HF Potential (0.12 lb. HF/lb. PPF) by the PPF Equipment Emissions (4.22 lb./yr) for the Compound

$$\frac{0.12 \text{ lb/yr HF}}{\text{lb/yr PPF}} \times 3.60 \text{ lb/yr Equipment PPF} = 0.432 \text{ lb/yr HF}$$

The estimated HF equivalent emissions from Maintenance Emissions were determined by multiplying the PPF HF Potential (0.12 lb. HF/lb. PPF) by the PPF Maintenance Emissions (0.13 lb./yr) for the Compoun

$$\frac{0.12 \text{ lb/yr HF}}{\text{lb/yr PPF}} \times 0.92 \text{ lb/yr Maintenance PPF} = 0.110 \text{ lb/yr HF}$$

2004 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.

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

Point Source Emission Determination

A. HFP **CAS No. 116-15-4**
Hexafluoropropylene

HF Potential:

HFP is a VOC without the potential to form HF

Quantity Released

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

HFP vented per the process flowsheet

Vented from the Condensation Reactor: $\frac{0.15\ kg\ HFP}{3.66\ kg\ CondRxVentFlow}$

Vented from the Crude Receiver $\frac{3.12\ kg\ HFP}{18.76\ kg\ Crude\ Receiver\ Vent}$

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

HFP vented based on 1,060 kg in the Condensation Reactor vent stream.
HFP vented based on 27,984 kg in the Crude Receiver vent stream.
HFP vented based on 19 kg in the Foreshots Receiver vent stream.

HFP vented from Condensation Reactor:

$$\frac{0.15\ kg\ HFP}{3.66\ kg\ CndRx} \times 1{,}060\ kg\ CndRx = 42\ kg\ HFP$$

HFP vented from Crude Receiver

$$\frac{3.12\ kg\ HFP}{18.76\ kg\ CrRec} \times 27{,}984\ kg\ CrRec = 4{,}651\ kg\ HFP$$

HFP vented from Foreshots Receiver

$$\frac{0.00\ kg\ HFP}{0.33\ kg\ FsRec} \times 19\ kg\ FsRec = 0\ kg\ HFP$$

VOC Emissions

42 kg from Condensation Reactor
\+ 4,651 kg from Crude Receiver
\+ 0 kg from Foreshots Receiver
= 4,693 kg HFP = 4,693 kg VOC
10,324 lb VOC

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

HF Potential:

HFPO is a VOC without the potential to form HF

Quantity Released

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

HFPO vented per the process flowsheet

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

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 1,060 kg in the Condensation Reactor vent stream.
HFPO vented based on 27,984 kg in the Crude Receiver vent stream.
HFPO vented based on 19 kg in the Foreshots Receiver vent stream.

HFPO vented from Condensation Reactor:

$$\frac{3.28\ kg\ HFPO}{3.66\ kg\ CndRx} \times 1{,}060\ kg\ CndRx = 950\ kg\ HFPO$$

HFPO vented from Crude Receiver

$$\frac{0.00\ kg\ HFPO}{18.76\ kg\ CrRec} \times 27{,}984\ kg\ CrRec = 0\ kg\ HFPO$$

HFPO vented from Foreshots Receiver

$$\frac{0.00\ kg\ HFPO}{0.33\ kg\ FsRec} \times 19\ kg\ FsRec = 0\ kg\ HFPO$$

VOC Emissions

950 kg from Condensation Reactor
\+ 0 kg from Crude Receiver
\+ 0 kg from Foreshots Receiver
= 950 kg HFPO = 950 kg VOC
2,090 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 PAF 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 1,060 kg in the Condensation Reactor vent stream.
PPF vented based on 27,984 kg in the Crude Receiver vent stream.
PPF vented based on 19 kg in the Foreshots Receiver vent stream.

Before control PPF vented from Condensation Reactor:

$\frac{0.20\ kg\ PPF}{3.66\ kg\ CndRx}$ x 1,060 kg CndRx = 59 kg PPF

PPF vented from Crude Receiver

$\frac{0.00\ kg\ PPF}{18.76\ kg\ CrRec}$ x 27,984 kg CrRec = 0 kg PPF

PPF vented from Foreshots Receiver

$\frac{0.00\ kg\ PPF}{0.33\ kg\ FsRec}$ x 19 kg FsRec = 0 kg PPF

Total before-control PPF vented = 59 kg PPF

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

VOC Emissions

Waste Gas Scrubber: 59 kg PPF x (100%-99.6%) Control Efficiency = 0.24 kg PAF = **0.24** kg VOC = **0.52** **lb. VOC**

HF Equivalent Emissions

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

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

HF Potential:

TFE is a VOC without the potential to form HF

Quantity Released

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

TFE vented per the process flowsheet

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

Vented from the Crude Receiver $\frac{0.01\ kg\ TFE}{18.76\ kg\ Crude\ Receiver\ Vent}$

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

TFE vented based on 1,060 kg in the Condensation Reactor vent stream.
TFE vented based on 27,984 kg in the Crude Receiver vent stream.
TFE vented based on 19 kg in the Foreshots Receiver vent stream.

TFE vented from Condensation Reactor:

$$\frac{0.00}{3.66\ \frac{kg\ TFE}{kg\ CndRx}} \times 1{,}060\ kg\ CndRx = 0\ kg\ TFE$$

TFE vented from Crude Receiver

$$\frac{0.01}{18.76\ \frac{kg\ TFE}{kg\ CrRec}} \times 27{,}984\ kg\ CrRec = 14\ kg\ TFE$$

TFE vented from Foreshots Receiver

$$\frac{0.00}{0.33\ \frac{kg\ TFE}{kg\ FsRec}} \times 19\ kg\ FsRec = 0\ kg\ TFE$$

VOC Emissions

0 kg from Condensation Reactor
\+ 14 kg from Crude Receiver
\+ 0 kg from Foreshots Receiver
= 14 kg TFE = 14 kg VOC
30 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 1,060 kg in the Condensation Reactor vent stream.
PSEPVE vented based on 27,984 kg in the Crude Receiver vent stream.
PSEPVE vented based on 19 kg in the Foreshots Receiver vent stream.

PSEPVE vented from Condensation Reactor:

$$\frac{0.00}{3.66\ \frac{kg\ PSEPVE}{kg\ CndRx}} \times 1{,}060\ kg\ CndRx = 0\ kg\ PSEPVE$$

PSEPVE vented from Crude Receiver

$$\frac{0.00}{18.76\ \frac{kg\ PSEPVE}{kg\ CrRec}} \times 27{,}984\ kg\ CrRec = 0\ kg\ PSEPVE$$

PSEPVE vented from Foreshots Receiver

$$\frac{0.07}{0.33\ \frac{kg\ PSEPVE}{kg\ FsRec}} \times 19\ kg\ FsRec = 3.97\ kg\ PSEPVE$$

VOC Emissions

0 kg from Condensation Reactor
\+ 0 kg from Crude Receiver
\+ 3.97 kg from Foreshots Receiver
= 3.97 kg PSEPVE = 3.97 kg VOC
8.74 lb VOC

F. C4
Perfluoro-2-butene

CAS No. 360-89-4

HF Potential:

C4s are VOCs without the potential to form HF

Quantity Released

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

C4s vented per the process flowsheet

Vented from the Condensation Reactor: $\frac{0\ kg\ C4}{3.66\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Crude Receiver $\frac{0.46\ kg\ C4}{18.76\ kg\ Crude\ Receiver\ Vent}$

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

C4s vented based on 1,060 kg in the Condensation Reactor vent stream.
C4s vented based on 27,984 kg in the Crude Receiver vent stream.
C4s vented based on 19 kg in the Foreshots Receiver vent stream.

C4s vented from Condensation Reactor:

$$\frac{0.00}{3.66\ \frac{kg\ C4s}{kg\ CndRx}} \times 1{,}060\ kg\ CndRx = 0\ kg\ C4s$$

C4s vented from Crude Receiver

$$\frac{0.46}{18.76\ \frac{kg\ C4s}{kg\ CrRec}} \times 27{,}984\ kg\ CrRec = 685\ kg\ C4s$$

C4s vented from Foreshots Receiver

$$\frac{0.10}{0.33\ \frac{kg\ C4s}{kg\ FsRec}} \times 19\ kg\ FsRec = 6\ kg\ C4s$$

VOC Emissions

0 kg from Condensation Reactor
\+ 685 kg from Crude Receiver
\+ 6 kg from Foreshots Receiver
= 690 kg C4s = 690 kg VOC
1,519 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 MA 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 1,060 kg in the Condensation Reactor vent stream.
HFPO Trimer vented based on 27,984 kg in the Crude Receiver vent stream.
HFPO Trimer vented based on 19 kg in the Foreshots Receiver vent stream.

Before control HFPO Trimer vented from Condensation Reactor:

$$\frac{0.00}{3.66\ \frac{kg\ HFPO\ Trimer}{kg\ CndRx}} \times 1{,}060\ kg\ CndRx = 0\ kg\ HFPO\ Trimer$$

HFPO Trimer vented from Crude Receiver

$$\frac{0.00}{18.76\ \frac{kg\ HFPO\ Trimer}{kg\ CrRec}} \times 27{,}984\ kg\ CrRec = 0\ kg\ HFPO\ Trimer$$

HFPO Trimer vented from Foreshots Receiver

$$\frac{0.01}{0.33\ \frac{kg\ HFPO\ Trimer}{kg\ FsRec}} \times 19\ kg\ FsRec = 0.79\ kg\ HFPO\ Trimer$$

Total before-control HFPO Trimer vented 0.79 kg VOC

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

VOC Emissions

Waste Gas Scrubber: 0.79 kg HFPO Trimer x (100%-99.6%) Control Efficiency = 0.0032 kg HFPO Trimer = 0.0032 kg VOC = **0.007 lb. VOC**

HF Equivalent Emissions

0.0032 kg HFPO Trimer x 0.040 kg HF/kg HFPO Trimer = 0.00013 kg HF **0.00028 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 1,060 kg in the Condensation Reactor vent stream.
MA vented based on 27,984 kg in the Crude Receiver vent stream.
MA vented based on 19 kg in the Foreshots Receiver vent stream.

Before control MA vented from Condensation Reactor:

$\frac{0.00\ kg\ MA}{3.66\ kg\ CndRx}$ x 1,060 kg CndRx = 0 kg MA

MA vented from Crude Receiver

$\frac{0.00\ kg\ MA}{18.76\ kg\ CrRec}$ x 27,984 kg CrRec = 0 kg MA

MA vented from Foreshots Receiver

$\frac{0.0045\ kg\ MA}{0.33\ kg\ FsRec}$ x 19 kg FsRec = 0.265 kg MA

Total before-control MA vented = 0.265 kg MA

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

VOC Emissions

Waste Gas Scrubber: 0.265 kg MA x (100%-99.6%) Control Efficiency
= 0.00106 kg MA = 0.00106 kg VOC
= **0.002 lb. VOC**

HF Equivalent Emissions

0.00106 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 1,060 kg in the Condensation Reactor vent stream.
DA vented based on 27,984 kg in the Crude Receiver vent stream.
DA vented based on 19 kg in the Foreshots Receiver vent stream.

Before control DA vented from Condensation Reactor:

$$\frac{0.00\ kg\ DA}{3.66\ kg\ CndRx} \times 1{,}060\ kg\ CndRx = 0\ kg\ DA$$

DA vented from Crude Receiver

$$\frac{0.00\ kg\ DA}{18.76\ kg\ CrRec} \times 27{,}984\ kg\ CrRec = 0\ kg\ DA$$

DA vented from Foreshots Receiver

$$\frac{0.13\ kg\ DA}{0.33\ kg\ FsRec} \times 19\ kg\ FsRec = 7.68\ kg\ DA$$

Total before-control DA vented = 7.68 kg DA

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

VOC Emissions

Waste Gas Scrubber: 7.68 kg DA × (100%-99.6%) Control Efficiency = 0.0307 kg DA = 0.031 kg VOC = **0.068 lb. VOC**

HF Equivalent Emissions

0.0307 kg DA × 0.039 kg HF/kg DA = 0.00120 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 1,060 kg in the Condensation Reactor vent stream.
Hydro-PSEPVE vented based on 27,984 kg in the Crude Receiver vent stream.
Hydro-PSEPVE vented based on 19 kg in the Foreshots Receiver vent stream.

Hydro-PSEPVE vented from Condensation Reactor:

$$\frac{0.00\ kg\ Hydro\text{-}PSEPVE}{3.66\ kg\ CndRx} \times 1{,}060\ kg\ CndRx = 0\ kg\ Hydro\text{-}PSEPVE$$

Hydro-PSEPVE vented from Crude Receiver

$$\frac{0.00\ kg\ Hydro\text{-}PSEPVE}{18.76\ kg\ CrRec} \times 27{,}984\ kg\ CrRec = 0\ kg\ Hydro\text{-}PSEPVE$$

Hydro-PSEPVE vented from Foreshots Receiver

$$\frac{0.0045\ kg\ Hydro\text{-}PSEPVE}{0.33\ kg\ FsRec} \times 19\ kg\ FsRec = 0.265\ kg\ Hydro\text{-}PSEPVE$$

VOC Emissions

0 kg from Condensation Reactor
\+ 0 kg from Crude Receiver
\+ 0.265 kg from Foreshots Receiver
= 0.265 kg Hydro-PSEPV = 0.265 kg VOC
0.583 lb VOC

K. Iso-PSEPVE
Perfluoro-1-Methyl-2-(2 Fluorosulfonyl Ethoxy) Ethyl Vinyl Ether **CAS No. 34805-58-8**

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 1,060 kg in the Condensation Reactor vent stream.
Iso-PSEPVE vented based on 27,984 kg in the Crude Receiver vent stream.
Iso-PSEPVE vented based on 19 kg in the Foreshots Receiver vent stream.

Iso-PSEPVE vented from Condensation Reactor:

$$\frac{0.00\ kg\ Iso\text{-}PSEPVE}{3.66\ kg\ CndRx} \times 1{,}060\ kg\ CndRx = 0\ kg\ Iso\text{-}PSEPVE$$

Iso-PSEPVE vented from Crude Receiver

$$\frac{0.00\ kg\ Iso\text{-}PSEPVE}{18.76\ kg\ CrRec} \times 27{,}984\ kg\ CrRec = 0\ kg\ Iso\text{-}PSEPVE$$

Iso-PSEPVE vented from Foreshots Receiver

$$\frac{0.014\ kg\ Iso\text{-}PSEPVE}{0.33\ kg\ FsRec} \times 19\ kg\ FsRec = 0.795\ kg\ Iso\text{-}PSEPVE$$

VOC Emissions

0 kg from Condensation Reactor
\+ 0 kg from Crude Receiver
\+ 0.795 kg from Foreshots Receiver
= 0.795 kg Iso-PSEPVE = 0.795 kg VOC
1.749 lb VOC

L. Glycol Ethers (GE) GLYET-Other

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

Quantity Released

=	2,600	kg GE introduced into processes
=	2,467	kg GE transferred to H/C waste tank
=	133	kg GE unaccounted for and assumed emitted
=	**294**	**lb. Glycol Ethers**

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

Therefore:

Emissions of glycol ether from PSEPVE = **294** **lb. Glycol Ethers**

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 $\frac{2.04\ kg\ SOF2}{18.76\ kg\ Crude\ Receiver\ Vent}$

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

SOF2 vented based on 1,060 kg in the Condensation Reactor vent stream.
SOF2 vented based on 27,984 kg in the Crude Receiver vent stream.
SOF2 vented based on 19 kg in the Foreshots Receiver vent stream.

Before control SOF2 vented from Condensation Reactor:

$$\frac{0.00\ kg\ SOF2}{3.66\ kg\ CndRx} \times 1{,}060\ kg\ CndRx = 0\ kg\ SOF2$$

SOF2 vented from Crude Receiver

$$\frac{2.04\ kg\ SOF2}{18.76\ kg\ CrRec} \times 27{,}984\ kg\ CrRec = 3{,}044\ kg\ SOF2$$

SOF2 vented from Foreshots Receiver

$$\frac{0.00\ kg\ SOF2}{0.33\ kg\ FsRec} \times 19\ kg\ FsRec = 0\ kg\ SOF2$$

Total before-control SOF2 vented = 3,044 kg SOF2

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

SOF2 Emissions

Waste Gas Scrubber: 3,044 kg SOF2 x (100%-99.6%) Control Efficiency = 12 kg SOF2 — 27 lb. SOF2

HF Equivalent Emissions

12 kg SOF2 x 0.465 kg HF/kg SOF2 = 5.66 kg HF — **12.48 lb. HF**

N. Carbon Monoxide (CO) **CAS No. 630-08-0**

CO is a criteria pollutant

Quantity Released

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

CO vented per the process flowsheet

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

Vented from the Crude Receiver $\frac{1.30\ kg\ CO}{18.76\ kg\ Crude\ Receiver\ Vent}$

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

CO vented based on 1,060 kg in the Condensation Reactor vent stream.
CO vented based on 27,984 kg in the Crude Receiver vent stream.
CO vented based on 19 kg in the Foreshots Receiver vent stream.

CO vented from Condensation Reactor:

$$\frac{0.00}{3.66\ \frac{kg\ CO}{kg\ CndRx}} \times 1{,}060\ kg\ CndRx = 0\ kg\ CO$$

CO vented from Crude Receiver

$$\frac{1.30}{18.76\ \frac{kg\ CO}{kg\ CrRec}} \times 27{,}984\ kg\ CrRec = 1{,}946\ kg\ CO$$

CO vented from Foreshots Receiver

$$\frac{0.00}{0.33\ \frac{kg\ CO}{kg\ FsRec}} \times 19\ kg\ FsRec = 0\ kg\ CO$$

CO Emissions

0 kg from Condensation Reactor
\+ 1,946 kg from Crude Receiver
\+ 0 kg from Foreshots Receiver
= 1,946 kg CO = **4,289 lb CO**

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	4,693	10,324	10,324	
B.	HFPO	950	2,090	2,090	
C.	PPF	59	130	0.52	0
D.	TFE	14	30	30	
E.	PSEPVE	4	9	9	
F.	C4	690	1,519	1,519	
G.	HFPO Trimer	0.79	1.75	0	0
H.	MA	0.26	0.58	0.00	0
I.	DA	7.68	16.94	0.07	0
J.	Hydro PSEPVE	0.26	0.58	0.58	
K.	Iso PSEPVE	0.79	1.75	1.75	
L.	Glycol Ethers	133	294	294	
	Total	**6,553**	**14,416**	**14,267**	**0**

P. Point Source Summary

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	10,324	766	196	11,286
B.	HFPO	2,090	155	40	2,284
C.	PPF	0.52	0.04	0.01	0.6
D.	TFE	30	2.2	0.6	33
E.	PSEPVE	8.74	0.65	0.17	9.6
F.	C4	1,519	113	29	1,660
G.	HFPO Trimer	0.007	0	0.000	0
H.	MA	0.002	0	0.000	0
I.	DA	0.068	0.005	0.0013	0.074
J.	Hydro-PSEPVE	0.583	0.043	0.011	0.64
K.	Iso-PSEPVE	1.749	0.13	0.033	1.9
L.	Glycol Ethers	294	21.81	5.579	321
M.	SOF2	27	2.0	0.51	29
N.	CO	4,289	0	0	4,289
	Total	18,584	1,061	271	**19,915**

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

HF Equivalent Emissions

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
C.	PPF	0.06	0.00	0.00	0.07
G.	HFPO Trimer	0.00	0.00	0.00	0.00
H.	MA	0.00	0.00	0.00	0.00
I.	DA	0.00	0.00	0.00	0.00
M.	SOF2	12.48	0.93	0.24	13.65
	Total	**12.55**	**0.93**	**0.24**	**13.72**

The estimated HF equivalent emissions from Equipment Emissions were determined by multiplying the PPF HF Potential (0.12 lb. HF/lb. PPF) by the PPF Equipment Emissions (0.04 lb./yr) for the Compound

$$\frac{0.12 \text{ lb/yr HF}}{\text{lb/yr PPF}} \times 0.04 \text{ lb/yr Equipment PPF} = 0.005 \text{ lb/yr HF}$$

The estimated HF equivalent emissions from Maintenance Emissions were determined by multiplying the PPF HF Potential (0.12 lb. HF/lb. PPF) by the PPF Maintenance Emissions (0.001 lb./yr) for the Compound

$$\frac{0.12 \text{ lb/yr HF}}{\text{lb/yr PPF}} \times 0.010 \text{ lb/yr Maintenance PPF} = 0.001 \text{ lb/yr HF}$$

2004 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

Assume that: 100% of process materials are VOCs ;
90% are acid fluorides that are emitted from the stack ;
10% are non-acid fluorides that are emitted from the stack.

Condensation Tower (vents to stack)

Valve emissions:	462	valves	×	valves	×	0.00039	lb/hr/valve	=	0.180	lb/hr VOC
Flange emissions:	924	flanges	×	flanges	×	0.00018	lb/hr/flange	=	0.166	lb/hr VOC
Pump emissions:	0	pumps	×	pumps	×	0.00115	lb/hr/pump	=	0.000	lb/hr VOC
							Total fugitive emission rate	=	0.347	lb/hr VOC

*Valve and Flange Factors can be found on Fugitive Emission Leak rates worksheet

Condensation Tower VOC

From Acid Fluorides:		0.347	lb/hr VOC from EE
	×	6,163	hours/year
	×	90%	fraction of EE that are acid fluorides
	=	1,922	lb VOC

From Non-Acid Fluorides:		0.347	lb/hr VOC from EE
	×	6,163	hours/year
	×	10%	fraction of EE that are non-acid fluorides
	=	214	lb VOC

Total Condensation Tower Equipment Emissions:

VOC:	1,922	lb VOC from acid fluorides	
	+ 214	lb VOC from non-acid fluorides	
	= **2,135**	**lb VOC**	

B. Equipment Emissions from Agitated Bed Reactor System

Assume that: 100% of process materials are VOCs ;
2% are acid fluorides that are emitted from the stack ;
98% are non-acid fluorides that are emitted from the stack.

Valve emissions:	85	valves	×	valves	×	0.00039	lb/hr/valve	=	0.033	lb/hr VOC
Flange emissions:	170	flanges	×	flanges	×	0.00018	lb/hr/flange	=	0.031	lb/hr VOC
Pump emissions:	0	pumps	×	pumps	×	0.00115	lb/hr/pump	=	0.000	lb/hr VOC
						Total fugitive emission rate		=	0.064	lb/hr VOC

Agitated Bed Reactor System VOC from Equipment Emissions

From Acid Fluorides:		0.064	lb/hr VOC from EE
	×	6,163	hours/year
	×	2%	fraction of EE that are acid fluorides
	=	8	lb VOC

From Non-Acid Fluorides:		0.064	lb/hr VOC from EE
	×	6,163	hours/year
	×	98%	fraction of EE that are non-acid fluorides
	=	385	lb VOC

Total Agitated Bed Reactor System Equipment Emissions:

VOC:		8	lb VOC from acid fluorides
	+	385	lb VOC from non-acid fluorides
	=	**393**	**lb VOC**

C. Equipment Emissions from Refining System

Assume that: 100% of process materials are VOCs ;
2% are acid fluorides that are emitted from the stack ;
98% are non-acid fluorides that are emitted from the stack.

Valve emissions:	162	valves	×	valves	×	0.00039	lb/hr/valve	=	0.063	lb/hr VOC
Flange emissions:	324	flanges	×	flanges	×	0.00018	lb/hr/flange	=	0.058	lb/hr VOC
Pump emissions:	0	pumps	×	pumps	×	0.00115	lb/hr/pump	=	0.000	lb/hr VOC
						Total fugitive emission rate		=	0.122	lb/hr VOC

Refining System VOC from Equipment Emissions

From Acid Fluorides:		0.122	lb/hr VOC from EE
	×	6,163	hours/year
	×	2%	fraction of EE that are acid fluorides
	=	15	lb VOC

From Non-Acid Fluorides:		0.122	lb/hr VOC from EE
	×	6,163	hours/year
	×	98%	fraction of EE that are non-acid fluorides
	=	734	lb VOC

Total Refining System Equipment Emissions:

VOC:		15	lb VOC from acid fluorides
	+	734	lb VOC from non-acid fluorides
	=	**749**	**lb VOC**

D. Total Equipment Emissions

Emission Source	Stack Emissions	Non-Stack Emissions	Total Emissions
	VOC lb	VOC lb	VOC lb
Condensation Tower	2,135		2,135
Agitated Bed Reactor	393		393
Refining		749	749
AN		1,214	1,214
ADN		287	287
Total	**2,528**	**2,250**	**4,779**

E. Speciated Equipment Emissions VOC Summary

Nafion® Compound	EVE Emissions (lbs)		PPVE Emissions (lbs)		PSEPVE Emissions (lbs)		Total Emissions (lbs)	
	Stack	Equip.	Stack	Equip.	Stack	Equip.	Stack	Equip.
HFP	663	49.2	7,048	522.9	10,324	766	18,035	1,338
HFPO	489	36.3	14,028	1040.8	2,090	155	16,607	1,232
HFPO-Dimer	0.77	0.1	0		0		1	0
EVE	0.13	0.0	0		0		0	0
PPVE	0		2,806	208.2	0		2,806	208
PSEPVE	0		0		8.74	1	9	1
PPF	0		48	3.6	0.52	0	49	4
TFE	423	31.4	3,964	294.1	30	2	4,417	328
SOF2	0		0		27	2	27	2
C4	0		337	25.0	1,519	113	1,856	138
C5	0		39	2.9	0.00		39	3
DA	0		0		0.068	0	0	0
Glycol Ethers	29	2.1	0		294	22	323	24
Hydro-PSEPVE	0		0		0.58	0	1	0
Iso-PSEPVE	0		0		1.749	0	2	0
AN	0		0	1,214	0.000	0.000	0	1,214
ADN	0	287	0		0.000	0.000	0	287
TOTAL	**1,605**	**406**	**28,271**	**3,312**	**14,294**	**1,061**	**44,170**	**4,779**

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. For example, the stack emission of HFP from the EVE process was 663 lb., with the total stack emission from the Vinyl Ethers North processes being 13,747 pounds. The total equipment emissions were 1,435 pounds (less ADN and AN since they are only emitted through equipment).

Therefore, the HFP equipment emissions from the EVE process were determined by:

$$663 \text{ lb. HFP} \times \frac{3{,}277 \text{ lb. total equip. emissions less ADN \& AN}}{44{,}170 \text{ lb. total stack emmisions}} = 49.2 \text{ lb. HFP}$$

2004 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 90% acid fluorides and 10% non-acid fluorides
(f) average molecular weight (MW) for acid fluoride component based on the average respective average acid fluoride MW for each campaign
Therfore the average molecular weight for VE-North is 392
(g) average MW for non-acid fluoride component = 156 (assumed to be HFP)
(h) number of deinventory events = 5

List of Process Vessels

Condensation Tower	Volume (ft^3)	Volume (gallons)
Reactor Decanter	5	41
Stripper Feed Decanter	7	51
Stripper Column	17	130
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	**105**	784

VOC Emissions

$n = PV/RT$, where $P = 14.7$ psia, $V = 105$ ft^3, $R = 10.73$ psia-ft^3/lb-mol degR, $T = 537$ degrees R

$$n = \frac{PV}{RT} = \frac{14.7 \text{ psia} \times 105 \text{ ft}^3}{10.73 \frac{\text{psia-ft}^3}{\text{lb-mol degR}} \times 537 \text{ deg R}} = 0.27 \frac{\text{lb-mol gas}}{\text{deinventory event}}$$

$$0.27 \frac{\text{lb-mol gas}}{\text{deinventory event}} \times 5 \frac{\text{deinventory events}}{\text{year}} = 1.34 \frac{\text{lb-mol gas}}{\text{year}}$$

$$1.34 \frac{\text{lb-mol gas}}{\text{year}} \times 10\% \text{ non-acid fluorides} \times 156 \frac{\text{lb non-A/F}}{\text{lb-mol gas}} = 20.8 \frac{\text{lb non-A/F}}{\text{year}}$$

Before-control A/F vented from Condensation:

$$1.34 \frac{\text{lb-mol gas}}{\text{year}} \times 90\% \text{ acid fluorides} \times 392 \frac{\text{lb A/F}}{\text{lb-mol gas}} = 471 \frac{\text{lb A/F}}{\text{year}}$$

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

$$471 \text{ lb/yr A/F VOC} \times \frac{(100\%-99.6\%) \text{ control efficiency}}{1.9 \text{ lb/yr A/F VOC}}$$

Total VOC: 20.8 lb/yr non-A/F VOC + 1.9 lb/yr A/F VOC = **22.7 lb/yr VOC**

D. Total Maintenance Emissions

Emission Source	Stack Emissions
	VOC lb
Condensation Tower	23
Agitated Bed Reactor & Refining	816
Total	**838**

E. Speciated Maintenance Emissions VOC Summary

Nafion® Compound	EVE Emissions (lbs)		PPVE Emissions (lbs)		PSEPVE Emissions (lbs)		Total Emissions (lbs)	
	Stack	Maint.	Stack	Maint.	Stack	Maint.	Stack	Maint.
HFP	663	12.6	7,048	133.8	10,324	196	18,035	342
HFPO	489	9.3	14,028	266.3	2,090	40	16,607	315
HFPO-Dimer	1	0.015	0		0		1	0
EVE	0	0.0	0		0		0	0
PPVE	0		2,806	53.3	0		2,806	53
PSEPVE	0		0		8.74	0.17	9	0
PPF	0		48	0.9	0.52	0.01	49	1
TFE	423	8.0	3,964	75.2	30	0.6	4,417	84
SOF2	0		0		27	0.5	27	1
C4	0		337	6.4	1,519	28.8	1,856	35
C5	0		39	0.7	0		39	1
DA	0		0		0.068	0.001	0	0
Glycol Ethers	29	0.5	0		294	5.579	323	6
Hydro-PSEPVE	0		0		0.583	0.011	1	0
Iso-PSEPVE	0		0		1.749	0.033	2	0
TOTAL	**1,605**	**30**	**28,271**	**537**	**14,294**	**271**	**44,170**	**838**

Note: Speciated maintenance emissions were estimated by assuming that each compound's emission concentration from maintenance activities was equal to that compound's stack emission fraction of the total stack emission. For example, the stack emission of HFP from the EVE process was 259 lb., with the total stack emission from the Vinyl Ethers North processes being 43,109 pounds. The total maintenance emissions were 141 pounds.

Therefore, the HFP maintenance emissions from the EVE process were determined by:

$$663 \text{ lb. HFP} \times \frac{838 \text{ lb. Total maintenance emissions}}{44{,}170 \text{ lb. Total stack emmisions}} = 12.6 \text{ lb. HFP}$$

2004 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

A. 2004-026 Date: **3/10/2004**

Material Released: **EVE**
Quantity Released: 5 kg
HF Potential:
EVE is a VOC without the potential to form HF

Total VOC 5 kg VOC
11 lbs VOC

B. Date:

C. Total Emissions from Accidental Releases

Source		lb EVE	lb	lb/yr VOC	lb/yr HF
A.	2004-026	11		11	
B.	0				
	Total	**11.000**	**0**	**11**	**0.0**

2004 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

A. VOC Emissions Summary

Nafion® Compound	CAS Chemical Name	CAS No.	EVE Process Emissions (lbs)	PPVE Process Emissions (lbs)	PSEPVE Process Emissions (lbs)	Accidental Releases (lbs)	Total Vinyl Ethers North Emissions (lbs)
HFP	Hexafluoroproplyene	116-15-4	725	7,705	11,286		19,716
HFPO	Hexafluoropropylene oxide	428-59-1	534	15,336	2,284		18,154
HFPO-Dimer	Perfluoro-2-Propoxy Propionyl Fluoride	2062-98-8	1	0	0		1
EVE	Propanoic Acid, 3-[1-[Difluoro [(Trifluoroethenyl oxy] Methyl]-1,2,2,2-Tetrafluoroethoxy] -2,2,3,3-Tetrafluoro , Methyl Ester	63863-43-4	0	0	0	11	11
PPVE	Perfluoropropyl vinyl ether	1623-05-8	0	3,067	0		3,067
PSEPVE	Perfluoro-2-(2-Fluorosulfonylethoxy) Propyl Vinyl Ether	16090-14-5	0	0	9.6		10
PPF	Perfluoropropionyl fluoride	422-61-7	0	53	0.6		54
TFE	Tetrafluoroethylene	116-14-3	462	4,334	33		4,828
C4	Perfluoro-2-butene	360-89-4	0	369	1,660		2,029
C5	Perfluoropentene	376-87-4	0	42	0		42
Glycol Ethers	Unlisted	GLYET	31	0	321		353
AN	Acetonitrile	75-05-8	0	1,214	0		1,214
ADN	Adiponitrile	111-69-3	287	0	0		287
DA	Tetrafluoro-2[Hexafluoro-2-(Tetrafluoro-2-{Fluorosulfonyl}Ethoxy) Propoxy Propionyl Fluoride	4089-58-1	0	0	0.074		0
Hydro-PSEPVE	Tetrafluoro-2-[Trifluoro-2-(1,2,2,2-Tetra-fluoroethoxy)-1-(Trifluoromethyl) Ethoxy]-Ethane Sulfonyl Fluoride	755-02-9	0	0	0.637		1
Iso-PSEPVE	Perfluoro-1-Methyl-2-(2 Fluorosulfonyl Ethoxy) Ethyl Vinyl Ether	34805-58-8	0	0	1.911		2
	Total VOC Emissions (lbs)		**2,042**	**32,119**	**15,597**	**11**	**49,769**
	Total VOC Emissions (tons)		**1.0**	**16.1**	**7.8**	**0.0**	**24.9**

Note: Actual Values for AN and Glycol ethers is not avialable until waste shipments are made, so these numbers can be positive or negative depending on what month the waste shipment went out. Full balance will be done at the end of the year.

B. VOC Control Device Efficiency

VOCs Generated				
Point Source Generated (lbs)	Equipment Emissions (lbs)	Maintanence Emissions (lbs)	Accidental Releases (lbs)	Total VOC Generated (lbs)
56,560	4,779	838	11	62,188

VOCs After Control
Total VOC Emitted (lbs)
48,555

62,188 lb VOC generated
48,555 lb VOC emitted
13,633 lb VOC removed in control device

13,633 lb VOC removed in control device
62,188 lb VOC generated
= **21.92% VOC control efficiency**

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

Nafion® Compound	CAS Chemical Name	CAS No.	EVE Process Emissions (lbs)	PPVE Process Emissions (lbs)	PSEPVE Process Emissions (lbs)	Accidental Releases (lbs)	Total Ethers Emissions (lbs)
HF	Hydrogen Fluoride	7664-39-3	0.05	6.4	13.7	0	20.13
Glycol Ethers	Unlisted- DiGlyme (only)	111-96-6			321		321
Acetonitrile	Acetonitrile	75-05-8		1,214			1,214

D. Carbon Monoxide (CO) Emissions Summary

Nafion® Compound	CAS Chemical Name	CAS No.	EVE Emissions (lbs)	PPVE Emissions (lbs)	PSEPVE Emissions (lbs)	Total Emissions (lbs)	Total Emissions (tons)
CO	Carbon Monoxide	630-08-0	1,426	2,321	4,289	8,036	4.0

Report Created By: Kristin D. Cecil
Report Created: 5/9/2005

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

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

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

1. Emission Source ID (from permit) or Emission Source Group ID NS–C

2. Emission Source Description: Nafion PEVE/PMVE and PPVE process

3. Operating Scenario ID/Description: OS – 13/Nafion PEVE/PMVE and PPVE process

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

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

6. Fuel Information (If fuel is used)

% Sulfur		% Ash		Heat Content (Btu/units)	

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

8. Control Device Information :

Order	CS–ID	CD ID (as listed in permit)	Control Device Description
1	CS–7	NCD–Hdr–2	Baffle plate–type tower waste gas scrubber

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

ERP ID	ERP Type	Height (in feet)	Diameter Circle (enter #): Rectangle (L x W) (in 0.1 feet)	Temperature (F)	Velocity (Feet/sec)	Volume Flow Rate (Acfm)	ERP Description
EP–NEP–Hdr2	VERTICAL STACK	81	2.3	75	46	11467.12	Nafion scrubber Hdr2

Operating Scenario: OS – 13 **Emission Source/Group ID:** NS–C

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

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

12. Seasonal Periods Percent Annual Throughput:

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

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

Criteria (NAAQS) Pollutants	Pollutant Code	Emissions– Criteria Pollutants (Tons/Year)	Emission Estimation Method Code (See Instructions)	Control Efficiency (Net after all controls)
		2004		
VOC	VOC	9.7	08	97
HAP/TAP Pollutants (In Alphabetical Order)	**CAS** (see instructions)	**Emissions HAP/TAPS** (Pounds/Year)	**Emission Estimation Method Code** (See Instructions)	**Control Efficiency** (Net after all controls)
		2004		
Acetonitrile	75–05–8	1645	08	0
Hydrogen fluoride (hydrofluoric acid as mass of HF– Component of Fluorides)	7664–39–3	1204	08	99.6
Methylene chloride	75–09–2	0	08	0

CONFIDENTIAL INFORMATION

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

2004 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No: NS-C

Emission Source Description: VE-South PEPM Manufacturing Process

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

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

Basis and Assumptions:

- The PEPM process flowsheet is the basis for relative concentrations of before-control emissions of gaseous wastes. The flowsheet is based on a 67:33 PAF/COF2 precursor feedratio. In 2004, the precursor feed ratio was 50:50 during a
- Split Campaign.
    - Accordingly, a flowsheet correction was made.

  PAF ratio is 0.50 COF2 Ratio is 0.50
- Calculations of point source emissions are based on actual vent flow totals taken from the IP21 Historian.
- All emission determination calculations are available on the EXCEL spreadsheet found at S:/Everyone/cecilkd/2004 Air Emissions/VES 2004 Emissions.xls.

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

HF Potential:

HFP is a VOC without the potential to form HF.

Quantity Released

HFP vented from Condensation Reactor (Cond Rx) per process flowsheet

$$\frac{0.15 \text{ kg HFP}}{1 \text{ kg Cond Rx Vent}}$$

HFP vented from Stripper Column per process flowsheet

$$\frac{0.15 \text{ kg HFP}}{1 \text{ kg Stripper Vent}}$$

HFP vented from Low Boiler Column (LBC) per process flowsheet

$$\frac{0.72 \text{ kg HFP}}{1 \text{ kg LBC Vent}}$$

Before-control HFP vented from Cond RX based o	5,399 kg
Before-control HFP vented from Stripper Column b	4,055 kg
Before-control HFP vented from LBC based on	2,583 kg

HFP vented from Cond Rx:

$$\frac{0.15 \text{ kg HFP}}{1 \text{ kg Cond Rx Vent}} \times 5{,}399 \text{ kg CondRx Vent} = 810 \text{ kg HFP}$$

HFP vented from Stripper Column:

$$\frac{0.15 \text{ kg HFP}}{1 \text{ kg Stripper Vent}} \times 4{,}055 \text{ kg Strip Vent} = 608 \text{ kg HFP}$$

HFP vented from LBC:

$$\frac{0.72 \text{ kg HFP}}{1 \text{ kg LBC Vent}} \times 2{,}583 \text{ kg LBC Vent} = 1{,}860 \text{ kg HFP}$$

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

VOC Emissions

	810 kg HFP from CondRx Vent			
+	608 kg HFP from Strip Vent			
+	1,860 kg HFP from LBC Vent			
	3,278 kg HFP	=	3,278	kg VOC
			7,211	**lb VOC**

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

HF Potential:

TFE is a VOC without the potential to form HF.

Quantity Released

TFE vented from Low Boiler Column (LBC) per process flowsheet

$$\frac{0.27 \text{ kg TFE}}{1 \text{ kg LBC Vent}}$$

Before-control TFE vented from LBC ba 2,583 kg vented from LBC

TFE vented from LBC:

$$\frac{0.27 \text{ kg TFE}}{1 \text{ kg LBC Vent}} \times 2{,}583 \text{ kg vented from LBC} = 697 \text{ kg TFE}$$

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

VOC Emissions

697 kg TFE = 697 kg VOC
1,534 lb VOC

I. VOC Summary

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	105,965	233,123	932	565
B.	PAF	20,586	45,289	181	31
C.	PMPF	21,491	47,280	189	16
D.	PEPF	90,263	198,578	794	56
E.	PMVE	0.25	1	0.5	
F.	PEVE	0	0	0	
G.	HFP	3,278	7,211	7,211	
H.	TFE	1,534	3,375	1,534	
	Total	243,117	534,857	**10,842**	**669**

J. Point Source Summary

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions (Note 1) lb/yr	Maintenance Emissions (Note 2) lb/yr	Total Emissions lb/yr
A.	COF2	932	321.6	8.0	1,262
B.	PAF	181	62.5	1.6	245
C.	PMPF	189	65.2	1.6	256
D.	PEPF	794	273.9	6.9	1,075
E.	PMVE	0.550	0.2	0.0	1
F.	PEVE	0	0.0	0.0	0
G.	HFP	7,211	2,486.7	62.2	9,760
H.	TFE	1,534	529.0	13.2	2,076
	Total	**10,842**	**3,739.2**	**94**	**14,675**

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

HF Equivalent Emissions

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
A.	COF2	565.15	194.898	4.877	764.92
B.	PAF	31.23	10.771	0.270	42.28
C.	PMPF	16.30	5.622	0.141	22.07
D.	PEPF	56	19.428	0.486	76.25
	Total	**669.02**	**230.719**	**5.773**	**905.51**

The estimated HF equivalent emissions from Equipment Emissions were determined by multiplying

the COF2 HF Potential (0.606 lb. HF/lb. COF2) by the COF2 Equipment Emissions for the Compound

$$\frac{0.606 \text{ lb/yr HF}}{\text{lb/yr COF2}} \times 321.58 \text{ lb/yr Equipment COF2} = 195 \text{ lb/yr HF}$$

The estimated HF equivalent emissions from Maintenance Emissions were determined by multiplying the COF2 HF Potential (0.606 lb. HF/lb. COF2) by the COF2 Maintenance Emissions for the Compound

$$\frac{0.606 \text{ lb/yr HF}}{\text{lb/yr COF2}} \times 8.05 \text{ lb/yr Maintenance COF2} = 5 \text{ lb/yr HF}$$

2004 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No: NS-C

Emission Source Description: VE-South PPVE Manufacturing Process

Process & Emission Description: The VE-South PPVE manufacturing process is a continuous chemical reaction. All emissions from the process are vented through the 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 PPVE process in VE-South emits compounds in the acid fluoride family. In the presence of water (such as in atmospheric moisture), these acid fluorides can eventually hydrolyze to hydrogen fluoride. For the purpose of this emissions inventory, a conservative approach will be taken and the acid fluorides will be reported bothas a VOC and as the equivalent quantity of hydrogen fluoride.

Basis and Assumptions:

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

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

- All emission determination calculations are available on the EXCEL spreadsheet found at S:/Everyone/cecilkd/Emissions/VES 2004 Emissions.xls.

Point Source Emission Determination

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

HF Potential:

HFP is a VOC without the potential to form HF

Quantity Released

HFP vented :

Vented from the Condensation Reactor per flowsheet: $\frac{0.05\ kg\ HFP}{2.35\ kg\ CondRxVentFlow}$

Vented from the Stripper Column per analytical data: $\frac{0.15\ kg\ HFP}{1.00\ kg\ Stripper\ Column\ Vent}$

Vented from the Low Boiler Column per flowsheet $\frac{0.01\ kg\ HFP}{1.06\ kg\ LowBoilerColumnVent}$

Before-control HFP vented from Cond RX based on	0
Before-control HFP vented from Stripper Column based on	0
Before-control HFP vented from LBC based on	0

HFP vented from Condensation Reactor:

$\frac{0.05\ kg\ HFP}{2.35\ kg\ CndRx}$ x 0 kg CndRx = 0 kg HFP

HFP vented from Stripper Column

$\frac{0.15\ kg\ HFP}{1.00\ kg\ CrRec}$ x 0 kg CrRec = 0 kg HFP

HFP vented from Low Boiler Column

$\frac{0.01\ kg\ HFP}{1.06\ kg\ FsRec}$ x 0 kg FsRec = 0 kg HFP

VOC Emissions

0 kg from Condensation Reactor
\+ 0 kg from Stripper Column
\+ 0 kg from Low Boiler Column
= 0 kg HFP = 0 kg VOC
0 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 vented:

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

Vented from the Stripper Column per analytical data: $\frac{0.62\ kg\ HFPO}{1.00\ kg\ Stripper\ Column\ Vent}$

Vented from the Low Boiler Column per flowsheet $\frac{0\ kg\ HFPO}{1.06\ kg\ Low\ Boiler\ Column\ Vent}$

HFPO vented based on 0 kg in the Condensation Reactor vent stream.
HFPO vented based on 0 kg in the Stripper Column vent stream.
HFPO vented based on 0 kg in the Low Boiler Column vent stream.

HFPO vented from Condensation Reactor:

$$\frac{0.11\ kg\ HFPO}{2.35\ kg\ CndRx} \times 0\ kg\ CndRx = 0\ kg\ HFPO$$

HFPO vented from Stripper Column

$$\frac{0.62\ kg\ HFPO}{1.00\ kg\ CrRec} \times 0\ kg\ CrRec = 0\ kg\ HFPO$$

HFPO vented from Low Boiler Column

$$\frac{0\ kg\ HFPO}{1.06\ kg\ FsRec} \times 0\ kg\ FsRec = 0\ kg\ HFPO$$

VOC Emissions

0 kg from Condensation Reactor
\+ 0 kg from Stripper Column
\+ 0 kg from Low Boiler Column
= 0 kg HFPO = 0 kg VOC
0 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 per flowsheet: $\frac{2.14\ kg\ PPF}{2.35\ kg\ Cond\ Rx\ Vent\ Flow}$

Vented from the Stripper Column per analytical data: $\frac{0.22\ kg\ PPF}{1.00\ kg\ Stripper\ Column\ Vent}$

Vented from the Low Boiler Column per flowsheet $\frac{0\ kg\ PPF}{1.06\ kg\ Low\ Boiler\ Column\ Vent}$

PPF vented based on 0 kg in the Condensation Reactor vent stream.
PPF vented based on 0 kg in the Stripper Column vent stream.
PPF vented based on 0 kg in the Low Boiler Column vent stream.

Before control PPF vented from Condensation Reactor:

$\frac{2.14\ kg\ PPF}{2.35\ kg\ CndRx}$ x 0 kg CndRx = 0 kg PPF

PPF vented from Stripper Column

$\frac{0.22\ kg\ PPF}{1.00\ kg\ CrRec}$ x 0 kg CrRec = 0 kg PPF

PPF vented from Low Boiler Column

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

Total before-control PPF vented = 0 kg PPF

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

VOC Emissions

Waste Gas Scrubber x $\frac{0\ kg\ PPF}{(100\%-99.6\%)}$
= $\frac{0\ kg\ PPF}{}$ = 0 kg VOC
= **0 lb. VOC**

HF Equivalent Emissions

x $\frac{0\ kg\ PPF}{0.120\ kg\ HF/kg\ PPF}$
= $\frac{0\ kg\ HF}{}$ = **0 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 vented per the process flowsheet

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

Vented from the Stripper Column per analytical data: $\frac{0\ kg\ TFE}{1.00\ kg\ Stripper\ Column\ Vent}$

Vented from the Low Boiler Column per flowsheet $\frac{0.0045\ kg\ TFE}{1.06\ kg\ Low\ Boiler\ Column\ Vent}$

TFE vented based on 0 kg in the Condensation Reactor vent stream.
TFE vented based on 0 kg in the Stripper Column vent stream.
TFE vented based on 0 kg in the Low Boiler Column vent stream.

TFE vented from Condensation Reactor:

$$\frac{0\ kg\ TFE}{2.35\ kg\ CndRx} \times 0\ kg\ CndRx = 0\ kg\ TFE$$

TFE vented from Stripper Column

$$\frac{0\ kg\ TFE}{1.00\ kg\ CrRec} \times 0\ kg\ CrRec = 0\ kg\ TFE$$

TFE vented from Low Boiler Column

$$\frac{0.0045\ kg\ TFE}{1.06\ kg\ FsRec} \times 0\ kg\ FsRec = 0\ kg\ TFE$$

VOC Emissions

0 kg from Condensation Reactor
\+ 0 kg from Stripper Column
\+ 0 kg from Low Boiler Column
= 0 kg TFE = 0 kg VOC
0 lb VOC

E. Perfluoropropyl vinyl ether (PPVE) **CAS No. 1623-05-8**

HF Potential:

PPVE is a VOC without the potential to form HF

Quantity Released

PPVE vented per the VE North process flowsheet. Note: There is not a PPVE flowsheet for VE-South

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

Vented from the Stripper Column per analytical data: $\frac{0\ kg\ PPVE}{1.00\ kg\ Stripper\ Column\ Vent}$

Vented from the Low Boiler Column per flowsheet $\frac{0.88\ kg\ PPVE}{1.06\ kg\ Low\ Boiler\ Column\ Vent}$

PPVE vented based on 0 kg in the Condensation Reactor vent stream.
PPVE vented based on 0 kg in the Stripper Column vent stream.
PPVE vented based on 0 kg in the Low Boiler Column vent stream.

PPVE vented from Condensation Reactor:

$$\frac{0\ kg\ PPVE}{2.35\ kg\ CndRx} \times 0\ kg\ CndRx = 0\ kg\ PPVE$$

PPVE vented from Stripper Column

$$\frac{0\ kg\ PPVE}{1.00\ kg\ CrRec} \times 0\ kg\ CrRec = 0\ kg\ PPVE$$

PPVE vented from Low Boiler Column

$$\frac{0.88\ kg\ PPVE}{1.06\ kg\ FsRec} \times 0\ kg\ FsRec = 0\ kg\ PPVE$$

VOC Emissions

0 kg from Condensation Reactor
\+ 0 kg from Stripper Column
\+ 0 kg from Low Boiler Column
= 0 kg PPVE = 0 kg VOC
0 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 vented per the process flowsheet

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

Vented from the Stripper Column per analytical data: $\frac{0\ kg\ C4s}{1.00\ kg\ Stripper\ Column\ Vent}$

Vented from the Low Boiler Column per flowsheet $\frac{0.15\ kg\ C4s}{1.06\ kg\ LowBoilerColumnVent}$

C4s vented based on 0 kg in the Condensation Reactor vent stream.
C4s vented based on 0 kg in the Stripper Column vent stream.
C4s vented based on 0 kg in the Low Boiler Column vent stream.

C4s vented from Condensation Reactor:

$$\frac{0\ kg\ C4s}{2.35\ kg\ CndRx} \times 0\ kg\ CndRx = 0\ kg\ C4s$$

C4s vented from Stripper Column

$$\frac{0\ kg\ C4s}{1.00\ kg\ CrRec} \times 0\ kg\ CrRec = 0\ kg\ C4s$$

C4s vented from Low Boiler Column

$$\frac{0.15\ kg\ C4s}{1.06\ kg\ FsRec} \times 0\ kg\ FsRec = 0\ kg\ C4s$$

VOC Emissions

0 kg from Condensation Reactor
\+ 0 kg from Stripper Column
\+ 0 kg from Low Boiler Column
= 0 kg C4s = 0 kg VOC
0 lb VOC

G. Perfluoropentene (C5) **CAS No. 376-87-4**

HF Potential:

C5s are VOCs without the potential to form HF

Quantity Released

C5s vented per the process flowsheet

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

Vented from the Stripper Column per analytical data: $\frac{0\ kg\ C5s}{1.00\ kg\ Stripper\ Column\ Vent}$

Vented from the Low Boiler Column per flowsheet $\frac{0.02\ kg\ C5s}{1.06\ kg\ Low\ Boiler\ Column\ Vent}$

C5s vented based on 0 kg in the Condensation Reactor vent stream.
C5s vented based on 0 kg in the Stripper Column vent stream.
C5s vented based on 0 kg in the Low Boiler Column vent stream.

C5s vented from Condensation Reactor:

$$\frac{0\ kg\ C5s}{2.35\ kg\ CndRx} \times 0\ kg\ CndRx = 0\ kg\ C5s$$

C5s vented from Stripper Column

$$\frac{0\ kg\ C5s}{1.00\ kg\ CrRec} \times 0\ kg\ CrRec = 0\ kg\ C5s$$

C5s vented from Low Boiler Column

$$\frac{0.02\ kg\ C5s}{1.06\ kg\ FsRec} \times 0\ kg\ FsRec = 0\ kg\ C5s$$

VOC Emissions

0 kg from Condensation Reactor
\+ 0 kg from Stripper Column
\+ 0 kg from Low Boiler Column
= 0 kg C5s = 0 kg VOC
0 lb VOC

H. VOC Summary

Nafion Compound Name		Before Control VOC Generated		After Control Stack Emissions	
		kg/yr VOC	lb/yr VOC	lb/yr VOC	lb/yr HF
A.	HFP	0	0	0	
B.	HFPO	0	0	0	
C.	PPF	0	0	0	0
D.	TFE	0	0	0	
E.	PPVE	0	0	0	
F.	C4	0	0	0	
G.	C5	0	0	0	
	Total	0	0	**0**	**0**

I. Point Source Summary

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
A.	HFP	0	0.0	0.0	0
B.	HFPO	0	0.0	0.0	0
C.	PPF	0	0.0	0.0	0
D.	TFE	0	0.0	0.0	0
E.	PPVE	0	0.0	0.0	0
F.	C4	0	0.0	0.0	0
G.	C5	0	0.0	0.0	0
	Total	**0**	**0**	**0**	**0**

HF Equivalent Emissions

Nafion Compound Name		Stack Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
C.	PPF	0.00	0.000	0.000	0.00
	Total	**0.00**	**0.000**	**0.000**	**0.00**

The estimated HF equivalent emissions from Equipment Emissions were determined by multiplying the PPF HF Potential (0. lb. HF/lb. PPF) by the PPF Equipment Emissions for the Compound.

$$\frac{0.12 \text{ lb/yr HF}}{\text{lb/yr PPF}} \times 0.00 \text{ lb/yr Equipment PPF} = 0 \text{ lb/yr HF}$$

The estimated HF equivalent emissions from Maintenance Emissions were determined by multiplying the PPF HF Potential (0. lb. HF/lb. PPF) by the PPF Maintenance Emissions for the Compound.

$$\frac{0.12 \text{ lb/yr HF}}{\text{lb/yr PPF}} \times 0.00 \text{ lb/yr Maintenance PPF} = 0 \text{ lb/yr HF}$$

2004 AIR EMISSIONS INVENTORY SUPPORTING DOCUMENTATION

Emission Source ID No: NS-C

Emission Source Description: VE-South PMVE Only Manufacturing Process

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

Basis and Assumptions:

- The PMVE Only process flowsheet is the basis for relative concentrations of before-control emissions of gaseous wastes.
- The flowsheet is based on a 67:33 PAF/COF2 precursor feed ratio. In 2004, the precursor feed ratio was 100% COF2 during a PMVE Only Campaign.
  - Accordingly, a flowsheet correction was made.
    PAF ratio is 0.00 COF2 Ratio is 1.00
- Calculations of point source emissions are based on actual vent flow totals taken from the IP21 Historian. All emission determination calculations are available on the EXCEL spreadsheet found at
- S:/Everyone/cecilkd/Emissions/2004/VES 2004 Emissions.xls.

E. Perfluoromethyl vinyl ether (PMVE) **CAS No. 1187-93-5**

HF Potential:

PMVE is a VOC without the potential to form HF.

Quantity Released

Before-control PMVE per the process flowsheet:

Before-control PMVE vented based on 226.56 kg HFPO

PMVE Vented from Low Boiler Column:

$$\frac{0.006 \text{ kg PMVE}}{62 \text{ kg HFPO}} \times 226.56 \text{ kg HFPO} = 0.0219 \text{ kg PMVE}$$

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

VOC Emissions = **0.0219 kg VOC**
0.048 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

VOC Emissions = **0 kg VOC**

G. Hexafluoropropylene (HFP)

CAS No. 116-15-4

HF Potential:

HFP is a VOC without the potential to form HF.

Quantity Released

HFP vented from Condensation Reactor (Cond Rx) per process flowsheet

$$\frac{0.15 \text{ kg HFP}}{1 \text{ kg Cond Rx Vent}}$$

HFP vented from Stripper Column per process flowsheet

$$\frac{0.15 \text{ kg HFP}}{1 \text{ kg Stripper Vent}}$$

HFP vented from Low Boiler Column (LBC) per process flowsheet

$$\frac{0.72 \text{ kg HFP}}{1 \text{ kg LBC Vent}}$$

Before-control HFP vented from Cond RX based on	833 kg
Before-control HFP vented from Stripper Column based on	1,900 kg
Before-control HFP vented from LBC based on	227 kg

HFP vented from Cond Rx:

$$\frac{0.15 \text{ kg HFP}}{1 \text{ kg Cond Rx Vent}} \times 833 \text{ kg CondRx Vent} = 125 \text{ kg HFP}$$

HFP vented from Stripper Column:

$$\frac{0.15 \text{ kg HFP}}{1 \text{ kg Stripper Vent}} \times 1{,}900 \text{ kg Strip Vent} = 285 \text{ kg HFP}$$

HFP vented from LBC:

$$\frac{0.72 \text{ kg HFP}}{1 \text{ kg LBC Vent}} \times 227 \text{ kg LBC Vent} = 163 \text{ kg HFP}$$

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

VOC Emissions

	125	kg HFP from CondRx Vent		
+	285	kg HFP from Strip Vent		
+	163	kg HFP from LBC Vent		
	573	kg HFP	=	573 kg VOC
				1,261 lb VOC

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

HF Potential:

TFE is a VOC without the potential to form HF.

Quantity Released

TFE vented from Low Boiler Column (LBC) per process flowsheet

0.27 kg TFE / 1 kg LBC Vent

Before-control TFE vented from LBC based on 227 kg vented from LBC

TFE vented from LBC:

0.27 kg TFE / 1 kg LBC Vent x 227 kg vented from LBC = 61 kg TFE

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

VOC Emissions

61 kg TFE = 61 kg VOC
135 lb VOC

I. VOC Summary

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	27,889	61,357	245	149
B.	PAF	28,165	61,963	248	43
C.	PMPF	37,332	82,131	329	28
D.	PEPF	0	0	0	0
E.	PMVE	0.02	0.05	0.05	
F.	PEVE	0	0	0	
G.	HFP	573	1,261	1,261	
H.	TFE	135	296	135	
	Total	94,095	207,009	**2,217**	220

J. Point Source Summary

	Nafion Compound Name	Stack Emissions lb/yr	Equipment Emissions (Note 1) lb/yr	Maintenance Emissions (Note 2) lb/yr	Total Emissions lb/yr
A.	COF2	245	84.6	2.1	332
B.	PAF	248	85.5	2.1	335
C.	PMPF	329	113.3	2.8	445
D.	PEPF	0	0.0	0.0	0
E.	PMVE	0	0.0	0.0	0
F.	PEVE	0	0.0	0.0	0
G.	HFP	1,261	434.8	10.9	1,707
H.	TFE	135	46.4	1.2	182
	Total	**2,217**	**765**	**19**	**3,001**

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

HF Equivalent Emissions

	Nafion Compound Name	Stack Emissions lb/yr	Equipment Emissions lb/yr	Maintenance Emissions lb/yr	Total Emissions lb/yr
A.	COF2	148.74	51	1.284	201.32
B.	PAF	42.73	14.737	0.369	57.84
C.	PMPF	28.32	9.767	0.244	38.33
D.	PEPF	0	0.000	0.000	0.00
	Total	**219.80**	**75.800**	**1.897**	**297.50**

The estimated HF equivalent emissions from Equipment Emissions were determined by multiplying the COF2 HF Potential (0.606 lb. HF/lb. COF2) by the COF2 Equipment Emissions for the Compound

$$\frac{0.606 \text{ lb/yr HF}}{\text{lb/yr COF2}} \times 84.64 \text{ lb/yr Equipment COF2} = 51 \text{ lb/yr HF}$$

The estimated HF equivalent emissions from Maintenance Emissions were determined by multiplying the COF2 HF Potential (0.606 lb. HF/lb. COF2) by the COF2 Maintenance Emissions for the Compound

$$\frac{0.606 \text{ lb/yr HF}}{\text{lb/yr COF2}} \times 2.12 \text{ lb/yr Maintenance COF2} = 1 \text{ lb/yr HF}$$

2004 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

Assume that: 100% of process materials are VOCs ;
90% are acid fluorides that are emitted from the stack ;
10% are non-acid fluorides that are emitted from the stack.

Condensation Tower (vents to stack)

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

Condensation Tower VOC

From Acid Fluorides:	0.248	lb/hr FE
x	6,638	Operating hr/yr
x	90%	
=	1,484	lb FE

From Non-Acid Fluorides:	0.248	lb/hr FE
x	6,638	Operating hr/yr
x	10%	
=	165	lb FE

Total Condensation Fugitive Emissions:

VOC	1,484	
+	165	
=	**1,649**	**lb FE**

B. Fugitive Emissions from Agitated Bed Reactor System & Refining

Assume that: 100% of process materials are VOCs ;
2% are acid fluorides that are emitted from the stack ;
98% are non-acid fluorides that are emitted from the stack.

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

From Acid Fluorides:

	0.43	lb/hr FE
x	6,638	Operating hr/yr
x	2%	
=	57	lb FE

From Non-Acid Fluorides:

	0.430	lb/hr FE
x	6,638	Operating hr/yr
x	98%	
=	2,798	lb FE

Total ABR & Refining Fugitive Emissions:

VOC	57	
+	2,798	
=	**2,855**	**lb FE**