

APPENDIX C

SUPPORTING CALCULATIONS FOR
EASTMAN CHEMICAL CO. AGREED ORDER 2000-0033-AIR

REGIONAL STRATEGY

APRIL 2000 REVISION

Attachment 1

Building 75

Coal Fired Boilers

No. 13 and No. 14

<u>Coal Fired Boilers</u>		<u>Fuel Usage</u> <u>Units/Yr</u>	<u>Emission Factors, lb/Unit</u>								
<u>FIN</u>	<u>EPN</u>		<u>PM</u>	<u>NMVOG</u>	<u>NOx</u>	<u>N2O</u>	<u>SOx</u>	<u>CO</u>	<u>HCl</u>	<u>HF</u>	<u>HCOH</u>
<u>UD047B13</u>	<u>047B13</u>										
Coal	MBtu	3,580,570	0.021	0.00284	0.417	0.00227	0.402	0.028	0.0227	0.00568	1.336E-05
Natural Gas	MSCF	539	3	1.411	0.417	2.2	0.402	40	-	-	-
<u>UD047B14</u>	<u>047B14</u>										
Coal	MBtu	3,580,570	0.021	0.00284	0.232	0.00227	0.212	0.028	0.0227	0.00568	1.336E-05
Natural Gas	MSCF	539	3	1.411	0.232	2.2	0.212	40	-	-	-

		<u>Actual Emissions, Tons/Yr</u>									
<u>UD047B13</u>	<u>047B13</u>										
Coal	MBtu		37.5960	5.0844	746.5489	4.0639	719.6947	50.8441	40.6395	10.1688	0.0239
Natural Gas	MSCF		0.8081	0.3801	0.1123	0.5926	0.1083	10.7745	0.0000	0.0000	0.0000
	<u>Total</u>		<u>38.4041</u>	<u>5.4645</u>	<u>746.6613</u>	<u>4.6565</u>	<u>719.8029</u>	<u>61.6186</u>	<u>40.6395</u>	<u>10.1688</u>	<u>0.0239</u>
<u>UD047B14</u>	<u>047B14</u>										
Coal	MBtu		37.5960	5.0844	415.3462	4.0639	379.5405	50.8441	40.6395	10.1688	0.0239
Natural Gas	MSCF		0.8081	0.3801	0.0625	0.5926	0.0571	10.7745	0.0000	0.0000	0.0000
	<u>Total</u>		<u>38.4041</u>	<u>5.4645</u>	<u>415.4087</u>	<u>4.6565</u>	<u>379.5976</u>	<u>61.6186</u>	<u>40.6395</u>	<u>10.1688</u>	<u>0.0239</u>

162.0699

1099.4005

Fuel value of coal is 17.6 MBtu per ton.

Coal combustion PM emission factor of 0.021 lb/MBtu is from Metco stack test 80-98 (attached).

NMVOG emission factor of 0.00284 lb/MBtu (0.05/17.6) is from AP-42, Table 1.1-18 (10/96).

PM, NMVOG, SOx, N2O and CO emission factors for Natural Gas combustion are from AP-42, Tables 1.4-1 through 1.4-3 (10/96).

NOx emission factor is from in-line stack monitor and includes both coal and natural gas fuels.

SOx emission factor is from in-line stack monitor and includes both coal and natural gas fuels.

HCl emission factor based on coal analysis of 0.02% chlorine.

HF emission factor based on coal analysis of 50 ppm fluorine.

HCOH (Formaldehyde) emissions factor from AP-42, Table 1.1-13 (10/96)

Coal combustion CO emission factor is from AP-42 Table 1.1-3 (10/96)

Coal combustion N2O emission factor is from AP-42 Table 1.1-18 (10/96).

FACTORS FOR BOILERS:

NO_x=140lb/MSCF
SO₂=0.6 lb/MSCF
CO=35 lb/MSCF
CO₂=120000 lb/MSCF
TOC=5.8lb/MSCF
Part=13.7 lb/MSCF

EP009B1

Total Fuel Consumption = 278.778 MSCF/year, so emissions are:

NO_x=19.5 ton/year
SO₂=0.0836 ton/year
CO=4.879 ton/year
CO₂=16728 ton/year
TOC=0.8085 ton/year
Part=1.910 ton/year

EP009B2

Total Fuel Consumption = 308.585 MSCF/year, so emissions are:

NO_x=26.64 ton/year
SO₂=0.1142 ton/year
CO=6.660 ton/year
CO₂=22835 ton/year
TOC=1.104 ton/year
Part=2.607 ton/year

EP009B3

Total Fuel Consumption = 298.938 MSCF/year, so emissions are:

NO_x=20.926 ton/year
SO₂=0.0897 ton/year
CO=5.231 ton/year
CO₂=17936 ton/year
TOC=0.8667 ton/year
Part=2.048 ton/year

EP009C1A, EP009C1B, EP009C1C

Natural Gas Usage = 21640.3 MBTU/year/compressor

Factors for:

NO_x = 2.9 lb/MBTU

CO=0.410 lb/MBTU

NMVOC=0.11 lb/MBTU

SO₂=0.00057 lb/MBTU

So for each compressor listed above the emissions are:

NO_x=31.38 ton/year

CO=4.437 ton/year

NMVOC= 1.19 ton/year

SO₂=0.006 ton/year

EP009C4A, EP009C4B

Natural Gas Usage = 20197.6 MBTU/year/compressor

Use same factors as above.

So for each compressor listed above the emissions are:

NO_x=29.29 ton/year

CO=4.141 ton/year

NMVOC= 1.111 ton/year

SO₂=0.006 ton/year

Oxo Aldehydes AEI 1997 Report

P-OX-01-01 FACTORS USED FROM TNRCC LATEST PUBLICATION; 1996 AEI CALCULATIONS

Total Compressor Fuel Usage:				707,681	MBTu									
FIN	EPN	Compressor	Hp Contribution	Fract. On Line(95)	Usage Factor	Fuel Used MBtu	Fuel Used MSCF	NOX TPY	CO TPY	CO2 TPY	Methane TPY	TNMOC TPY	SO2 TPY	SO2 TPY
OX062C7	062C7	C7	0.138	0.143	0.138	97724	93.07	132	19	5326	68	5.37	0.00	0.03
OX062C9	062C9	C9	0.128	0.137	0.123	87120	82.97	118	17	4748	61	4.79	0.00	0.02
OX062C16	062C16	C16	0.147	0.143	0.148	104407	99.44	141	20	5690	73	5.74	0.00	0.03

Comp. ID	Hp	% On-Line	Hp Contr. X Fract. On-line	normalized factor
C7	1550	0.990	0.019740041	0.13809
C9	1440	0.950	0.01759816	0.12
C16	1656	0.990	0.021090005	0.147534

OBTAINED FACTORS FROM TNRCC TABLES 3.2-1 AND 3.2-5 (10/96 Edition)

NOX FACTOR= 2.7 LBNOX/MMBTU
 CO FACTOR= 0.38 LB CO/MMBTU
 CO2 FAC.= 109 LBCO2/MMBTU
 CH4 FACTOR= 1.4 LBCH4/MMBTU
 TNMOC FAC.= 0.11 LB TNMOC/MMBTU
 SO2 FAC.= 0

Note: SO2 factor is zero because natural gas is desulfurized.

Utilities Division Cooling Tower Drives

Natural Gas Engines

PIN	FIN	EPN	Size Hp	Hours	Hp-Hr	Emission Factors, lb/hp-hr (1)					Actual Emissions, TPY				
						PM10	NM VOC	NOx	SOx (2)	CO	PM10	NM VOC	NOx	SOx	CO
P-UD-02-01	UD009PE1	009PE1	400	8760	3,504,000	-	0.000309	0.022	0.0000291	0.019	0.0000	0.5414	38.5440	0.0510	33.2880
P-UD-02-01	UD009PE2	009PE2	400	8760	3,504,000	-	0.000309	0.022	0.0000291	0.019	0.0000	0.5414	38.5440	0.0510	33.2880
P-UD-02-03	UD063PE3	063PE3	1,200	8760	10,512,000	-	0.000309	0.022	0.0000291	0.019	0.0000	1.6241	115.6320	0.1529	99.8640
P-UD-02-02	UD040PE3	040PE3	1,200	8760	10,512,000	-	0.000309	0.022	0.0000291	0.019	0.0000	1.6241	115.6320	0.1529	99.8640

Notes

1. Natural gas engine emission factors from AP-42 Table 3.2-1 (10/96).
2. SOx factor based on 2 grains/100 SCF S in Natural Gas, 50% engine efficiency

Emission Reductions Summary

VOC Reductions

Project	Reduction
Polyethylene Vents to Flare	321 TPY VOC
Equalization Basin Cover	1 TPY VOC
Tank Car Flare	Not Conducted
Off-gas Routing Control	227 TPY VOC
Total Reductions From Above	549 TPY VOC
Original FAR Agreement Total	386 TPY VOC

NO_x Reductions

Project	Reduction
Cooling Tower Natural Gas Engine Replacement	116 TPY NO _x
Clean Burn Technology on a Compressor Engine	185 TPY NO _x
Total Reductions From Above	301 TPY NO_x

State Implementation Plan Commitments

Original FAR Agreement VOC Reductions	386 TPY
NO_x Reductions From Above Projects	301 TPY
Total SIP Reductions	687 TPY

Table 2

<u>FUGITIVE EMISSION SOURCE</u>	<u>NO. OF SOURCES</u>	<u>SOCMI EMISSION FACTOR (lb/hr) (1)</u>	<u>SOCMI EMISSIONS</u>	<u>% RED.</u>	<u>EMISSIONS</u>
PUMP SEALS					
LIGHT LIQUID	0 *	0.1440 =	0.00 *	0 =	0.00
HEAVY LIQUID	0 *	0.0046 =	0.00 *	0 =	0.00
VALVES					
GAS	0 *	0.0258 =	0.00 *	0 =	0.00
LIGHT LIQUID	0 *	0.0459 =	0.00 *	0 =	0.00
HEAVY LIQUID	0 *	0.0005 =	0.00	0 =	0.00
GAS SAFETY-RELIEF VALVES	79 *	0.2293 =	18.11 *	0 =	18.11
OPEN ENDED LINES	145 *	0.0075 =	1.09 *	0 =	1.09
FLANGES (2)	0 *	0.0053 =	0.00 *	0.30 =	0.00
COMPRESSOR SEALS	0 *	0.5027 =	0.00 *	0 =	0.00
TOTAL EMISSIONS FROM ALL SOURCES =			19.2 LB/HR		19.2 LB/HR 461 LBS/DAY 42,053 LBS/QTR 84.11 TPY

Total Reduction 321 TPY

**Calculations of Reductions Associated with
Installation of Piping and Equipment for Tank Cars
Depressurizing to Flare**

This project was not undertaken due to safety concerns of residual oxygen in the tank cars. The amount represented in the estimate for depressurizing residual organic from the tank cars at the wash rack to a flare was 10 tons/ year.

Calculations not provided.

Project abandoned
Total reduction 0 TPY

Calculations:

Plant 1 Off-Air Emission Reductions

1998 Days In Service =	322.5 Days	On stream factor	88%
1998 Average Flow rate =	29,613 lb/hr		
Conversion factor from ppmv to ppmw =	1.583		
HAc concentration before =	200 ppmv		
HAc concentration after improvements =	50 ppmv		

Calculation

$$\frac{322.5 \text{ day}}{\text{yr}} \times \frac{24 \text{ hrs}}{\text{day}} \times \frac{29,613 \text{ lb}}{\text{hr}} \times \frac{(200 - 50) \text{ ppmv}}{1,000,000} \times \frac{1.583 \text{ ppmw}}{\text{ppmv}} =$$

**54,425 Lbs/yr
Reduction**

**27.21 Tons/yr
Reduction**

Plant 2 Off-Gas Emission Reduction Calculations

1997 Days In Service =	316.2 Days	1997 Days venting =	39.1	% time toHCl/Incin	86
1998 Days In Service =	278.9 Days	1998 Days venting =	13.4		95
1997 Average Flow rate =	804 lb/hr				
1998 Average Flow rate =	912 lb/hr				
HCl/Incinerator efficiency =	99.9% Removal				

	1997 Wt%	1998 Wt%
Acetaldehyde	0.092	0.073
Chloromethane	0.748	0.851
Chloroethane	1.869	1.929
Ethylene	4.631	4.113
Chloroform	0.004	0.004
Dichloromethane	0.003	0.003
WT % VOC	7.347	6.971

1997 reduction 196.22 TPY VOC
1998 reduction 202.35 TPY VOC

Average over two year period was 199.3 for Plant 2

Two Projects Combined provide:

Total Reduction $199.3 + 27.2 = 226.5$ TPY VOC