TABLE C-1
POINT SOURCE EXHAUST PARAMETERS - SULFUR RECOVERY UNIT THERMAL OXIDIZERS
MICHIGAN REFINING DIVISION

Point Source Description	Emission Unit ID	Aermod Input ID	Stack Orientation	Stack Coordinate (UTM) Easting	Stack Coordinate (UTM) Northing	Stack Height (feet)	Stack Height (meters)	Exit Temperature (F)	Exit Temperature (K)	Volumetric Flow Rate (acfm)	Exit Velocity (f/s)	Exit Velocity (m/s)	Inside Diameter (inches)	Inside Diameter (meters)
PROCESS STACKS/VENTS														
SRU Thermal Oxidizer	EU42-43SULRECOV-S1	SRUTO42	Vertical	322123.9	4683147.3	199.5	60.81	1,296	975.4	45,100	76.37	23.28	42.5	1.079
SRU/TGU Thermal Oxidizer	EU72-SULRBLOCK2-S1	SRUTO72	Vertical	322086.0	4683770.4	195.0	59.44	621	600.4	38,500	12.77	3.89	96	2.438
					ROP Limit	150.0	45.72							

Source	AERMOD Source ID	Contents	Emissions (g/s)	Hatch Height (ft)	Hatch Height (m)	Hatch Diameter (ft)	Hatch Diameter (m)	Hatch Area (m2)	Side Length (m)	Emissions (g/s/m2)	Southwest Corner (m) Easting	Southwest Corner (m) Northing
72 Railcar Loading	RAILLD72	H2S	1.00000	12	3.66	3	0.91	0.7	0.8104	1.52E+00	322126.0	4683660.2

TABLE C-2
MODELED EMISSION RATES - SULFUR CAP OPTIMIZATION PROJECT
MICHIGAN REFINING DIVISION

Point Source Description	Emission Unit ID	Aermod Input ID	SO2 Emission Rate						
			ROP Limits		Emission Factor	Short-term PTE		Annual PTE	
			Monthly (LT/day)	Annual (LT/day)	(lbs/LT)	(lb/hr)	(g/s)	(lb/hr)	(g/s)
EMISSIONS BASED ON CURRENT ROP LIMITS									
SRU Thermal Oxidizer	EU42-43SULRECOV-S1	SRUTO42	145	130	1.981	12.0	1.5080	10.7	1.3520
SRU/TGU Thermal Oxidizer	EU72-SULRBLOCK2-S1	SRUTO72	-	260	0.409	4.4	0.5583	4.4	0.5583
EMISSIONS BASED ON PROPOSED ROP LIMITS									
SRU Thermal Oxidizer	EU42-43SULRECOV-S1	SRUTO42	-	-	-	-	-	-	-
SRU/TGU Thermal Oxidizer	EU72-SULRBLOCK2-S1	SRUTO72	-	390	0.459	7.5	0.9392	7.5	0.9392

Notes:
1. Emission factors based on actual 2018 - 2020 production and SO2 emissions.

TABLE C-3
SUMMARY OF MODELED IMPACTS ASSOCIATED WITH THE SULFUR CAP OPTIMIZATION PROJECT
MICHIGAN REFINING DIVISION

Regulated Pollutant	Modeling Scenario	Averaging Period	Modeled Concentration (ug/m^3)	Significant Impact Level (ug/m^3)	PSD Increment (ug/m^3)	NAAQS (ug/m^3)
SO_2	Combined impact of SRU 42 and SRU 72 based on current permit-allowable ROP elemental sulfur production limits	1-Hour	4.3	7.9	-	196
		3-Hour	4.0	25	512	1,300
		24-Hour	1.5	5	91.0	-
		Annual	0.2	1	20	-
	Combined impact of SRU 42 and SRU 72 based on proposed elemental sulfur production limits	1-Hour	3.4	7.9	-	196
		3-Hour	3.1	25	512	1,300
		24-Hour	1.1	5	91.0	-
		Annual	0.1	1	20	-
	Reduction in modeled impact due to the project	1-Hour	-0.9			
		3-Hour	-0.9			
		24-Hour	-0.4			
		Annual	-0.1			

Notes
1. Model runs conducted using AERMOD (Version 21112) over a five year meteorological database (Detroit City Airport, 2016 - 2020).

TABLE C-4
RULE 227(1)(A) ANALYSIS FOR AIR TOXICS ASSOCIATED WITH THE SULFUR CAP OPTIMIZATION PROJECT
MICHIGAN REFINING DIVISION

North SRU Maximum Firing Rate: 50.0 MMBTU/hr ROP allowable heat input for Unit 72

Facility Name:										Facility Address:														Hours of operation per year:				8,760		
				Screening Level						Allowable Emission Rate (AER)						Proposed Emission Rate (ER)							Is Proposed Emission Rate less than AER?						
										1st ITSL		2nd ITSL		IRSL / SRSL																
Chemical Name	CAS No.	CAS No.	Emission Factor (lb/MMscf)	1st ITSL µg/m³	1st ITSL Avg Time	2nd ITSL µg/m³	2nd ITSL Avg Time	IRSL / SRSL µg/m³ (annual Avg)	AQD Footnote(s)	Max lbs per hour	lbs per month, 24-hr, 8-hr or 1-hr	Max lbs per hour	lbs per month, 24-hr, 8-hr or 1-hr	Max lbs per hour	lbs per month	Max Hourly ER lbs/hour	Rate (1st ITSL)	1st ITSL Rate Units	Rate (2nd ITSL)	2nd ITSL Rate Units	Rate (IRSL)	IRSL / SRSL Rate Units	1st ITSL Max Hourly Rate	1st ITSL ER	2nd ITSL Max Hourly Rate	2nd ITSL ER	IRSL Max Hourly Rate	IRSL ER	Notes
2-methylnaphthalene	91-57-6	91576	2.40E-05	10	annual					5.4	400					1.20E-06	0.000876	lbs/month					yes	yes					
3-methylcholanthrene	56-49-5	56495	1.80E-06						5							0.00000009													
7,12-dimethylbenz(a)anthracene	57-97-6	57976	1.60E-05						5							0.0000008													
acenaphthene	83-32-9	83329	1.80E-06	210	annual					113.4	8400					0.00000009	6.57E-05	lbs/month					yes	yes					
acenaphthylene	208-96-8	208968	1.80E-06	35	annual					18.9	1400					0.00000009	6.57E-05	lbs/month					yes	yes					
anthracene	120-12-7	120127	2.40E-06	1000	annual					540	40000					0.00000012	8.76E-05	lbs/month					yes	yes					
arsenic	7440-38-2	7440382	2.00E-04					0.0002						0.0001	0.008	1.00E-05					0.0073	lbs/month					yes	yes	
barium and soluble barium compounds	7440-39-3	7440393	4.40E-03	5	8 hr				35	0.1	0.1					2.20E-04	0.00176	lbs/8-hr					yes	yes					
benzene	71-43-2	71432	2.10E-03	30	annual	30	24 hr	0.1		16.2	1200	1.5	3.6	0.054	4	1.05E-04	0.07665	lbs/month	0.00252	lbs/24-h	0.07665	lbs/month	yes	yes	yes	yes	yes	yes	
benz(a)anthracene	56-55-3	56553	1.80E-06						5							0.00000009													
benzo(a)pyrene	50-32-8	50328	1.20E-06	0.002	24 hr			0.001	5	0.0001	0.0002			0.0005	0.04	0.00000006	1.44E-06	lbs/24-hr			4.38E-05	lbs/month	yes	yes			yes	yes	
Benzo(b)fluoranthene	205-99-2	205992	1.80E-06						5							0.00000009													
benzo(g,h,i)perylene	191-24-2	191242	1.20E-06	13	annual					7.02	520					0.00000006	4.38E-05	lbs/month					yes	yes					
benzo(j)fluoranthene	205-82-3	205823	1.80E-06						5							0.00000009													
beryllium	7440-41-7	7440417	1.20E-05	0.02	24 hr			0.0004		0.001	0.0024			0.0002	0.016	0.0000006	1.44E-05	lbs/24-hr			0.000438	lbs/month	yes	yes			yes	yes	
butane	106-97-8	106978	2.10E+00	23800	8 hr				22	476	476					0.11	0.84	lbs/8-hr					yes	yes					
cadmium	7440-43-9	7440439	1.10E-03					0.0006						0.0003	0.024	5.50E-05					0.04015	lbs/month					yes	no	
Chromium, trivalent	16065-83-1	16065831	1.40E-03	5	8 hr					0.1	0.1					7.00E-05	0.00056	lbs/8-hr					yes	yes					(3)
chrysene	218-01-9	218019	1.80E-06						5							0.00000009													
cobalt and cobalt compounds that release cobalt ions	7440-48-4	7440484	8.40E-05	0.2	8 hr			0.00013	42	0.004	0.004			7E-05	0.0052	0.0000042	3.36E-05	lbs/8-hr			0.003066	lbs/month	yes	yes			yes	yes	
copper	7440-50-8	7440508	8.50E-04	2	8 hr					0.04	0.04					4.25E-05	0.00034	lbs/8-hr					yes	yes					
dibenz(a,h)anthracene	53-70-3	53703	1.20E-06						5							0.00000006													
dichlorobenzene	25321-22-6	541731	1.20E-03	3	annual					1.62	120					6.00E-05	0.0438	lbs/month					yes	yes					(2)
fluoranthene	206-44-0	206440	3.00E-06	140	annual					75.6	5600					0.00000015	0.00011	lbs/month					yes	yes					
fluorene	86-73-7	86737	2.80E-06	140	annual					75.6	5600					0.00000014	0.000102	lbs/month					yes	yes					
formaldehyde	50-00-0	50000	7.50E-02	30	24 hr			0.08		1.5	3.6			0.0432	3.2	3.75E-03	0.09	lbs/24-hr			2.7375	lbs/month	yes	yes			yes	yes	
n-hexane	110-54-3	110543	1.80E+00	700	annual					378	28000					0.09	65.7	lbs/month					yes	yes					
hydrogen sulfide	7783-06-4	7783064		10	annual	100	24 hr			5.4	400	5	12			0.38	278.276	lbs/month	9.1488	lbs/24-h			yes	yes	yes	yes			
Indeno(1,2,3-cd)pyrene	193-39-5	193395	1.80E-06						5							0.00000009													
manganese and manganese compounds	7439-96-5	7439965	3.80E-04	0.3	annual				29	0.162	12					1.90E-05	0.01387	lbs/month					yes	yes					
mercury and mercury compounds	7439-97-6	7439976	2.60E-04	0.3	annual	1	24 hr		7	0.162	12	0.05	0.12			1.54E-04	0.112684	lbs/month	0.003705	lbs/24-h			yes	yes	yes	yes			(5)
molybdenum	7439-98-7	7439987	1.10E-03	30	8 hr					0.6	0.6					5.50E-05	0.00044	lbs/8-hr					yes	yes					
molybdenum trioxide	1313-27-5	1313275	1.10E-03	5	8 hr			0.12		0.1	0.1			0.0648	4.8	5.50E-05	0.00044	lbs/8-hr			0.04015	lbs/month	yes	yes			yes	yes	
naphthalene	91-20-3	91203	6.10E-04	3	annual	520	8 hr	0.08		1.62	120	10.4	10.4	0.0432	3.2	3.05E-05	0.022265	lbs/month	0.000244	lbs/8-hr	0.022265	lbs/month	yes	yes	yes	yes	yes	yes	
nickel	7440-02-0	7440020	2.10E-03					0.006						0.0032	0.24	1.05E-04					0.07665	lbs/month					yes	yes	
pentane	109-66-0	109660	2.60E+00	17700	8 hr					354	354					0.13	1.04	lbs/8-hr					yes	yes					
phenanthrene	85-01-8	85018	1.70E-05	0.1	annual					0.054	4					0.00000085	0.000621	lbs/month					yes	yes					
pyrene	129-00-0	129000	5.00E-06	100	annual					54	4000					2.50E-07	0.000183	lbs/month					yes	yes					
selenium and inorganic selenium compounds	7782-49-2	7782492	2.40E-05	2	8 hr				34	0.04	0.04					0.0000012	9.6E-06	lbs/8-hr					yes	yes					
sulfuric acid	7664-93-9	7664939	-	1	annual	120	1 hr		9,13	0.54	40	0.12	0.12			1.40	1020.463	lbs/month	1.397895	lbs/hr			no	no	no	no			
toluene	108-88-3	108883	3.40E-03	5000	24 hr					250	600					1.70E-04	0.00408	lbs/24-hr					yes	yes					
vanadium	7440-62-2	1314621	2.30E-03	0.5	1 hr					0.0005	0.0005					1.15E-04	0.000115	lbs/hr					yes	yes					(1)
zinc	7440-66-6	1314132	2.90E-02	20	8 hr					0.4	0.4					1.45E-03	0.0116	lbs/8-hr					yes	yes					(4)
PAHs as benzo(a)pyrene	50-32-8	50328	-					0.001	5					0.0005	0.04	5.27E-05					0.038453	lbs/month					yes	yes	

yellow columns = must enter information

Links:

Toxics Screening Level Query Footnotes

Procedure for the Carcinogenic PAHs of Footnote No. 5 - See PAHs worksheet

Notes:

Natural gas factors listed in AP-42 Tables 1.4-3 and 1.4-4 (7/98).

1. Screening level is that of vanadium pentoxide, which is the biologically active form of the chemical.
2. Screening level is for 1,3-Dichlorobenzene (541-73-1).
3. There is no published screening level for Chromium; therefore, the screening level for Chromium, trivalent (16065-83-1) was used.
4. Screening level is for zinx oxide (1314-13-2).
5. Includes emissions from 72 SRU railcar loading.

TABLE C-5
PAH EQUIVALENT EVALUATION
MICHIGAN REFINING DIVISION

Potency Factors for TACs with AQD Footnote 5.

Procedure for the Carcinogenic PAHs of Footnote No. 5

Table 1. PAH Potency Equivalency Factors (PEFs)

CHEMICAL NAME	CAS NO.	PEF	Emission Rate (lb/hr)
Dibenz(a,h)anthracene	53-70-3	1.1	6.00E-08
3-Methylcholanthrene	56-49-5	5.7	9.00E-08
7,12-Dimethylbenz(a)anthracene	57-97-6	65	8.00E-07
Chrysene	218-01-9	0.01	9.00E-08
Indeno(1,2,3-cd)pyrene	193-39-5	0.1	9.00E-08
Benzo(a)anthracene	56-55-3	0.1	9.00E-08
Benzo(b)fluoranthene	205-99-2	0.1	9.00E-08
Benzo(k)fluoranthene	207-08-9	0.1	
Benzo(j)fluoranthene	205-82-3	0.1	9.00E-08
5-Methylchrysene	3697-24-3	1	
Benzo(a)pyrene	50-32-8	1	6.00E-08
Dibenzo(a,e)pyrene	192-65-4	1	
Dibenzo(a,h)pyrene	189-64-0	10	
Dibenzo(a,i)pyrene	189-55-9	10	
Dibenzo(a,l)pyrene	191-30-0	10	
Equivalent Emission Rate of benzo(a)pyrene (lb/hr)			5.27E-05

yellow columns = must enter information

Instructions: In the table for Rule 227(1)(a) enter in CAS Numbers and emission rates for each PAH that is emitted. The table above will calculate the "equivalent emission rate of benzo(a)pyrene." Next, you need to compare this to the IRSL (or SRSL) for benzo(a)pyrene.

In the table for Rule 227(1)(a), (b), or (c), enter the CAS No. for benzo(a)pyrene (50-32-8) into Column B, **and change the Chemical Name in Column A from "benzo(a)pyrene" to "*PAHs as benzo(a)pyrene*."** Changing the name will prevent the table above from double-counting the benzo(a)pyrene emissions. Then enter the equivalent emission rate of benzo(a)pyrene into the appropriate column.

TABLE 6
RULE 227(1)(C) ANALYSIS FOR AIR TOXICS ASSOCIATED WITH THE SULFUR CAP OPTIMIZATION PROJECT
MICHIGAN REFINING DIVISION

		Thermal Oxidizer		
		Emission Rate (lb/hr)	Modeled Impact µg/m³	Avg Time
Cadmium	7440439	5.5E-05	8.0E-07	Annual
Sulfuric Acid	7664939	1.4E+00	2.0E-02	Annual
Sulfuric Acid	7664939	1.4E+00	6.2E-01	1-Hour

Thermal Oxidizer at 1 g/s Unit Emission rate Impact µg/m³	
1 hr	3.55
8 hr	2.32
24 hr	1.08
Annual	0.12

		Combined TAC Impacts Facility		Screening Level					
Chemical Name	CAS No.	Modeled Impact µg/m³	Avg Time	ITSL µg/m³	ITSL Avg Time	IRSL µg/m³	SRSL µg/m³	Is PAI less than the ITSL?	Is PAI less than IRSL or SRSL?
Cadmium	7440439	8.0E-07	Annual	-	-	0.0006	0.006	-	YES
Sulfuric Acid	7664939	2.0E-02	Annual	1	Annual	-	-	YES	-
Sulfuric Acid	7664940	6.2E-01	1-Hour	120	1-Hour	-	-	YES	-

Notes
1. Model runs conducted using AERMOD (Version 21112) over a one year meteorological database (Detroit City Airport, 2020).