Air Quality Modeling Analysis

Air Quality Modeling Update for the Final Environmental Impact Statement for the Mandan, Hidatsa, and Arikara Nation's Proposed Clean Fuels Refinery Project

June 6, 2011

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Chapter 1 - Introduction

The purpose of this report is to update the air quality air quality impacts associated with the proposed Mandan, Hidatsa, and Arikara Nation's Proposed Clean Fuels Refinery Project (MHA Refinery). The proposed refinery will be located on the Fort Berthold Indian Reservation in western North Dakota. The original Air Quality Technical Report for this proposed refinery was submitted to EPA Region 8 in December, 2007.

This evaluation was done using existing monitoring data available for the MHA Refinery proposed location and surrounding areas, projections of criteria air pollutants from the proposed refinery, and air quality modeling. The report also identifies the federal air regulatory requirements for air emissions from the proposed refinery.

A Vacuum Crude Heater and two Decant Oil Tank Heaters have been added to this analysis since the December 2007 Air Quality Technical Report.

The air quality modeling conducted was compared concentrations of criteria air pollutants to the National Ambient Air Quality Standards (NAAQS). This addresses air quality impacts from emissions of oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter with nominal aerodynamic diameters of 10 microns and 2.5 microns (PM_{10} and $PM_{2.5}$ respectively) from the sources at the MHA Refinery.

Chapter 2 - Air Quality Standards

EPA has established NAAQS for NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$ have been developed to protect public health and welfare with an adequate margin of safety. The NAAQS for these pollutants are presented in Table 2 as well as the State of North Dakota's ambient air quality standards. These are the regulatory limits that concentrations of pollutants must not exceed during the specific averaging period for an area to be considered in attainment for air quality.

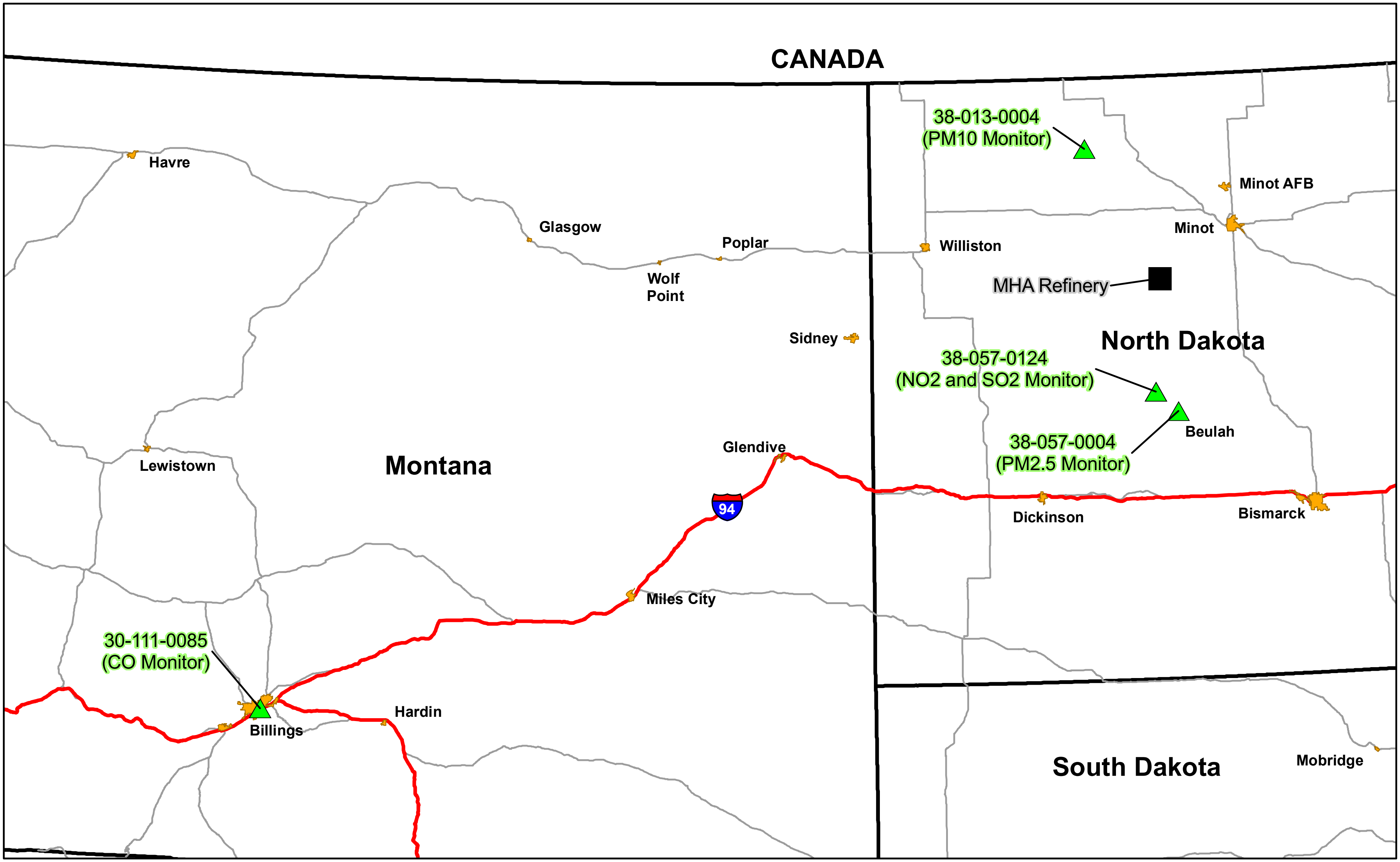
Table 1 Summary of Regulatory Ambient Air Quality Concentrations (µg/m3)[1]

Pollutant	Averaging Time	NAAQS[2] (µg/m³)	Increment Class II (µg/m³)
NO_2	1-Hour	188[3]	NS
	Annual	100	100
CO	1-Hour	40,000	40,000
	8-Hour	10,000	10,000
PM_{10}	24-Hour	150	150
$PM_{2.5}$	24-Hour	35[3]	NS
	Annual	15	NS
SO_2	1-hour	196[4]	715
	24-Hour	365	260
	Annual	80	60

1. µg/m³ = micrograms per cubic meter
2. National Ambient Air Quality Standards (40 CFR 50)
3. 98th Percentile
4. 99th Percentile

Existing Ambient Air Quality

Ambient air quality data were selected from EPA ambient air monitoring stations that would be considered representative of the air quality at the project site. Figure 2-1 Ambient Air Quality Monitoring Stations shows the locations of the selected monitoring stations.



Legend

- MHA Refinery
- Monitoring Stations
- Interstate Highway
- U.S. Highway
- City
- State Boundary

0 25 50 100 Miles

FORT BERTHOLD REFINERY EIS

FIGURE 2-1
AMBIENT AIR QUALITY MONITORING STATIONS

ANALYSIS AREA: MOUNTRAIL AND WARD COUNTIES, N. DAKOTA	
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Table 2 summarizes the data for these monitoring sites. These data represent maximums and averages for the years 2005 through 2009.

Table 2 Monitoring Data Summary

Pollutant	Averaging Period	EPA Station ID	Location	Calculated Ambient Concentration (µg/m³)	Calculation Method[1]
NO2	1-hour	38-057-0124	Beulah, ND	41	8H Average
	Annual	38-057-0124	Beulah, ND	4	Maximum
CO	1-hour	30-111-0085	Billings, MT	7,980	1H Average
	8-hour	30-111-0085	Billings, MT	3,124	1H Average
PM10	24-hour	38-013-0004	Kenmare, ND	45	1H Average
PM2.5	24-hour	38-057-0004	Mercer Co., ND	16	2H Average
	Annual	38-057-0004	Mercer Co., ND	6	Maximum
SO2	1-hour	38-057-0124	Beulah, ND	96	4H Average
	24-hour	38-057-0124	Beulah, ND	21	1H Average
	Annual	38-057-0124	Beulah, ND	3	Max Average

1. NH represents the Nth High (ex. 8H is the Eighth High for that averaging period)

Table 3 presents the monitoring data summary for each year.

Table 3 Monitoring Data Summary by Year (µg/m³) for the Stations Listed in Table 2

	NO_2		CO		PM_{10}	$PM_{2.5}$		SO_2		
Year	**8th High 1-Hour**	**Annual**	**Max 1-Hour**	**Max 8-Hour**	**Max 24-Hour**	**2nd High 24-Hour**	**Annual**	**4th High 1-Hour**	**Max 24-Hour**	**Annual**
2005	43	4	15,276	4,218	34	19	6	99	21	2
2006	47	4	6,726	3,078	52	19	6	94	26	2
2007	39	3	5,130	2,736	76	14	6	99	21	3
2008	36	4	5,472	2,622	32	13	6	112	21	2
2009	41	4	7,296	2,964	30	14	5	73	16	2

Chapter 3 — Air Quality Impact Analysis

The air quality modeling analysis used the same plant, source, and receptor configurations that were used in the 2007 modeling analysis. Since the previous modeling was conducted using the ISCST3 dispersion model, the analysis was updated using the AERMOD dispersion modeling system which is now the EPA preferred model for this application.

Air Quality Modeling Methodology

Model Selection

The EPA recommended AERMOD dispersion modeling system was used to evaluate Class II air quality impacts. The AERMOD model (Version 11103) is the latest generation of the EPA's AERMOD model, which is recommended for predicting impacts from industrial point sources as well as area and volume sources. The model combines simple and complex terrain algorithms, and includes the PRIME algorithms to account for building downwash and cavity zone impacts.

The complete AERMOD modeling system is comprised of three parts—the AERMET pre-processor, the AERMAP pre-processor, and the AERMOD model. The AERMET (Version 11059) pre-processor compiles the surface and upper-air meteorological data and formats the data for AERMOD input. The AERMAP (Version 11103) pre-processor is used to obtain elevation and controlling hill heights for AERMOD input.

BEEST for Windows (Version 9.83) was used to compile and generate the AERMOD model runs.

AERMET Meteorological Data Processing

Land Use Analysis

Land use analysis for use by AERMET was processed using the AERSURFACE processor. National Land Cover Data for North Dakota were downloaded from the U.S. Geological Survey (USGS) webpage (http://edcftp.cr.usgs.gov/pub/data/landcover/states). Precipitation data for each of the modeling years (2005 through 2009) were compared against a normal precipitation summary for Minot, ND to determine whether precipitation for each year was dry (below the 30th percentile), average (30th to 70th percentile), or wet (above the 70th percentile).

Selection of the Meteorological Database

Surface data collected at Minot Airport (WBAN 24013) and upper air data collected at Bismarck, ND (WBAN 24011) for the years 2005 through 2009 were used in this analysis.

Meteorological Data Processing

The surface and upper air data were processed with AERMET along with the output from the AERSURFACE processing.

The preparation of the meteorological data files using AERMET was a two-step process. The first step was the extraction of raw hourly surface observations and upper air soundings. The extracted files were checked by AERMET module for consistency and any missing or calm hours were identified.

The second step was to read the meteorological data and estimate the boundary layer parameters required by AERMOD using land use surface parameters unique to the area surrounding the project site.

AERMOD Processing

The AERMOD model was used with regulatory default options as recommended in the EPA Guideline on Air Quality Models as listed as follows:

- Use stack-tip downwash
- Model accounts for elevated terrain effects
- Use calms processing
- Use sequential meteorological date checking
- Use of the PRIME algorithm for sources influenced by building downwash
- Use Missing Data Processing routine
- No exponential decay calculated

Building Downwash

Building wake effects were assessed with the Building Profile Input Program with Plume Rise Enhancements (BPIP-PRIME, dated 04274). BPIP-PRIME was also be used to analyze Good Engineering Practice (GEP) stack heights for the point sources. Table 4 presents the dimensions of the buildings to be used in this analysis.

Table 4 Dimensions of Buildings at the MHA Nation's Proposed Clean Fuels Refinery

Building/Structure	Length 1 (m)[1]	Length 2 (m)	Height (m)
Office Building	71	55	12.2
Utility Building	28	33	12.2
Control Building	49	15	12.2

1. m = meter

Treatment of Chemical Transformations (for example, NO to NO2, parameterizations)

100 percent of the NOx emissions were assumed to be NO_2. No other chemical transformations were used.

Pollutant Averaging Periods

The following air pollutants were modeled for the corresponding averaging periods:

- NO_x – 1-hour and annual
- CO – 1-hour and 8-hour
- SO_2 – 1-hour, 24-hour, and annual
- PM_{10} – 24-hour
- $PM_{2.5}$ – 24-hour and annual

MHA Refinery Modeled Emission Rates

Estimated emissions for refinery sources included NO_x, CO, PM_{10}, and SO_2 were presented in air quality technical report presented to EPA on March 9, 2011 (MHA 2011). Except for the soybean and soybean meal handling, $PM_{2.5}$ emissions were assumed to be equivalent to PM_{10}.

For the soybean and soybean meal handling $PM_{2.5}$ emission rates were assumed to be 17% of PM_{10} emission rates based on information provided in EPA's AP-24 on Table 9.9.1-1. Particulate Emission Factors for Grain Elevators (USEPA 2011a). These sources include:

- Soybean Loadout
- Meal Loadout 1
- Meal Loadout 2

For all other sources $PM_{2.5}$ emission rates were assumed to be equivalent to PM_{10} emission rates.

For the 1-hour NO_2 modeling, the emergency generator and fire pump engine were excluded from the modeling analysis. This is recommended in recent EPA guidance for modeling 1-hour NO_2 with intermittent sources (USEPA 2011b).

For the 1-hour and 24-hour SO_2 modeling, annual average emissions (that include elevated emission events) were used. Although higher short-term SO_2 emissions were estimated for this source, these would be intermittent emissions associated with the shutdown of both Sulfur Recovery Units (SRUs), therefore the recommendations from EPA's 1-hour NO_2 modeling guidance should be appropriate for SO_2 modeling.

According to the EPA 1-hour NO_2 guidance (USEPA 2011b, page 8):

> "...the intermittent nature of the actual emissions associated with emergency generators and startup/shutdown in many cases, when coupled with the probabilistic form of the standard, could result in modeled impacts being significantly higher than actual impacts would realistically be expected to be for these emission scenarios."

Elevated flaring emissions would be similar to startup/shutdown events since these are based on the low probability of a shutdown of both SRUs. One SRU will normally be shutdown and will be used as a backup should a shutdown be required for the other SRU. This design has been developed to create an extremely low probability for the elevated flaring events. Therefore the elevated flare emissions would not likely coincide with worst-case meteorological conditions and maximum background concentrations.

Although the potential elevated SO_2 emissions from the flare have been estimated to occur 100 hours per year, this is an extremely conservative assumption. The SRU units will be monitored and maintained with a goal of having far fewer - if any - events over the period of a year.

Summaries of the modeled emission rates and source exhaust parameters are presented in Appendix A.

Receptor Network

The same receptor grid as was used in the original ISCST3 modeling analysis was used in this analysis. The elevations for these receptors were revised using current data and the AERMAP receptor elevation processor.

Receptor Elevations

The AERMOD pre-processor AERMAP was used to generate receptor elevations and controlling terrain elevations.

The elevation data used to generate receptor elevations and controlling terrain elevations were obtained from the United States Geological Survey (USGS) in a National Elevation Data (NED) GEOTIFF format. These data were obtained from the USGS Seamless Data Warehouse (http://seamless.usgs.gov/index.php).

Background Concentrations

Ambient air quality monitoring data for the various criteria pollutants were used to establish background concentrations in the refinery project area. The data presented above on Table 2 were used to represent ambient background for the modeling analysis. The monitored values reflect the impacts from existing regional sources such as power plants and mobile sources as well as transported pollutants from neighboring states.

Class II NAAQS Analysis Results

The refinery project and surrounding area is classified as a Class II area. The total cumulative air quality impacts are shown in Table 5. The maximum ambient cumulative impacts associated with the proposed refinery are below all NAAQS.

Table 5 Results of Class II Modeling Analysis

Pollutant	Averaging Period	Modeled Impact (µg/m³)	Background (µg/m³)	Total (µg/m³)	NAAQS (µg/m³)	Percent of NAAQS
NO_2	1-Hour[1]	33	41	74	188	39.5%
	Annual[2]	1	4	5	100	5.0%
CO	1-Hour[2]	56	7,980	8,036	40000	20.1%
	8-Hour[2]	38	3,124	3,162	10000	31.6%
PM_{10}	24-Hour[2]	51	45	96	150	63.9%
$PM_{2.5}$	24-Hour[1]	8	16	24	35	68.4%
	Annual[2]	1	6	7	15	49.6%
SO_2	1-Hour[1]	63	96	159	196	81.0%
	24-Hour[2]	16	21	37	365	10.1%
	Annual[2]	1	3	4	78	4.8%

1. Modeled impact is High 1st High, 5 year average
2. Modeled impact is 5 year maximum

Chapter 6 — References

MHA 2011. Addendum, Air Quality Technical Report for the Final Environmental Impact Statement for the Mandan, Hidatsa, and Arikara Nation's Proposed Clean Fuels Refinery Project. March 9, 2011

U.S. EPA 2011a. Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I: Stationary Point and Area Sources. AP42, Volume I, Supplements A, B, C, D, E, F, Updates 2001, 2002, 2003, and 2004 [Web Page] Located at: hhtp://epa.gov/ttn/chief/ap42/index.html. Accessed: May 15, 2011.

U.S. EPA 2011b. Memorandum, Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard.

U.S. EPA 2007. Air Quality Technical Report for the Final Environmental Impact Statement for the Mandan, Hidatsa, and Arikara Nation's Proposed Clean Fuels Refinery Project.

Appendix A - Source Emission Rates and Exhaust Parameters

Table A-1 Source Parameters for MHA Nation's Proposed Clean Fuels Refinery

Model ID	Source Description	UTM X (m)	UTM-Y (m)	Elev (m)	Stack Height (m)	Exhaust Temp (K)	Exhaust Velocity (m/s)	Stack Diameter (m)
00001	Crude Heater	286096.00	5317510.00	632	30.50	483	0.75	3.050
00002	Reformer Heater 1	286268.00	5317440.00	636	30.50	483	0.72	0.910
00003	Reformer Heater 2	286268.00	5317450.00	636	30.50	483	0.72	0.910
00004	Reformer Heater 3	286268.00	5317460.00	636	30.50	483	1.92	0.910
00005	Reformer Heater 4	286239.00	5317440.00	635	30.50	483	1.44	0.910
00006	Reformer Heater 5	286239.00	5317450.00	635	30.50	483	0.36	0.910
00007	Hydrocracker 1	286212.00	5317300.00	632	30.50	483	1.44	0.910
00008	Hydrocracker 2	286212.00	5317310.00	632	30.50	483	1.68	0.910
00009	Hydrocracker 3	286212.00	5317320.00	633	30.50	483	2.40	0.910
00010	Hydrocracker 4	286212.00	5317330.00	633	30.50	483	1.68	0.910
00011	Olefin	286088.00	5317440.00	631	30.50	483	7.19	0.910
00012	Hydrogen	286272.00	5317500.00	636	30.50	483	11.98	0.910
00013	Boiler 1	286018.00	5317470.00	631	30.50	483	4.79	0.910
00014	Boiler 2	286018.00	5317460.00	631	30.50	483	4.79	0.910
00015	Boiler 3	286018.00	5317450.00	631	30.50	483	4.79	0.910
00016	Flare	286186.00	5317070.00	631	54.90	1273	40.30	0.840
00017	Sulfur Incinerator	286090.00	5317380.00	631	36.60	311	0.03	3.050
00018	Standby Generator	286021.28	5317373.97	631	6.10	797	50.29	0.300
00019	Fire Pump	285913.66	5317224.77	631	6.10	730	9.74	0.300
00020	Soybean Loadout	286295.23	5317621.01	637	11.60	294	6.47	0.300
00021	Meal Loadout 1	286295.23	5317596.55	637	11.60	294	6.47	0.300
00022	Meal Loadout 2	286327.03	5317596.55	637	11.60	294	6.47	0.300
00023	Vacuum Crude Heater	286096.00	5317510.00	632	30.50	483	0.75	3.050
00024	Decant Oil Tank Heater 1	286096.00	5317510.00	632	30.50	483	4.79	0.910
00025	Decant Oil Tank Heater 2	286096.00	5317510.00	632	30.50	483	4.79	0.910

Table A-2 Source Emission Rates (gm/s) for MHA Nation's Proposed Clean Fuels Refinery

Model ID	Source Description	NOx		CO		PM10	PM2.5		SO2		
		1-hour	Annual	1-hour	8-hour	24-hour	24-hour	Annual	1-hour	24-hour	Annual
00001	Crude Heater	0.4820	0.1991	0.6464	0.6464	0.0403	0.0403	0.0401	0.1395	0.1395	0.0615
00002	Reformer Heater 1	0.0413	0.0171	0.0554	0.0554	0.0035	0.0035	0.0034	0.0120	0.0120	0.0053
00003	Reformer Heater 2	0.0413	0.0171	0.0554	0.0554	0.0035	0.0035	0.0034	0.0120	0.0120	0.0053
00004	Reformer Heater 3	0.1102	0.0455	0.1478	0.1478	0.0092	0.0092	0.0092	0.0319	0.0319	0.0141
00005	Reformer Heater 4	0.0826	0.0341	0.1108	0.1108	0.0069	0.0069	0.0069	0.0239	0.0239	0.0105
00006	Reformer Heater 5	0.0207	0.0085	0.0277	0.0277	0.0017	0.0017	0.0017	0.0060	0.0060	0.0026
00007	Hydrocracker 1	0.0826	0.0341	0.1108	0.1108	0.0069	0.0069	0.0069	0.0239	0.0239	0.0105
00008	Hydrocracker 2	0.0964	0.0398	0.1293	0.1293	0.0081	0.0081	0.0080	0.0279	0.0279	0.0123
00009	Hydrocracker 3	0.1377	0.0569	0.1847	0.1847	0.0115	0.0115	0.0115	0.0399	0.0399	0.0176
00010	Hydrocracker 4	0.0964	0.0398	0.1293	0.1293	0.0081	0.0081	0.0080	0.0279	0.0279	0.0123
00011	Olefin	0.4131	0.1706	0.5541	0.5541	0.0345	0.0345	0.0344	0.1196	0.1196	0.0527
00012	Hydrogen	0.6885	0.2844	0.9235	0.9235	0.0576	0.0576	0.0573	0.1993	0.1993	0.0879
00013	Boiler 1	0.2754	0.1015	0.3694	0.3694	0.0230	0.0230	0.0229	0.0797	0.0797	0.0352
00014	Boiler 2	0.2754	0.1015	0.3694	0.3694	0.0230	0.0230	0.0229	0.0797	0.0797	0.0352
00015	Boiler 3	0.2754	0.1015	0.3694	0.3694	0.0230	0.0230	0.0229	0.0797	0.0797	0.0352
00016	Flare	0.0857	0.0857	0.4662	0.4662	0.0115	0.0115	0.0115	0.8193	0.8193	0.8193
00017	Sulfur Incinerator	0.0000	0.0000	0.6000	0.6000	0.0000	0.0000	0.0000	1.0698	1.0698	1.0577
00018	Standby Generator	2.4809	0.1412	0.1814	0.1814	0.0202	0.0202	0.0011	0.0617	0.0617	0.0035
00019	Fire Pump	0.4586	0.0261	0.0202	0.0202	0.0050	0.0050	0.0003	0.0126	0.0126	0.0007
00020	Soybean Loadout	0.0000	0.0000	0.0000	0.0000	0.1184	0.0201	0.0201	0.0000	0.0000	0.0000
00021	Meal Loadout 1	0.0000	0.0000	0.0000	0.0000	0.0680	0.0116	0.0115	0.0000	0.0000	0.0000
00022	Meal Loadout 2	0.0000	0.0000	0.0000	0.0000	0.0580	0.0099	0.0098	0.0000	0.0000	0.0000
00023	Vacuum Crude Heater	0.2066	0.0853	0.2770	0.2770	0.0173	0.0173	0.0172	0.0598	0.0598	0.0264
00024	Decant Oil Tank Heater 1	0.0138	0.0057	0.0185	0.0185	0.0012	0.0012	0.0011	0.0040	0.0040	0.0018
00025	Decant Oil Tank Heater 2	0.0138	0.0057	0.0185	0.0185	0.0012	0.0012	0.0011	0.0040	0.0040	0.0018