Antelope Valley Station and Great Plains Synfuels Plant - SO2 DRR Modeling Report

Basin Electric Power Cooperative

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1. Introduction

The United States Environmental Protection Agency (EPA) is implementing the 2010 1-hour SO_2 National Ambient Air Quality Standard (NAAQS)[1] in an approach that involves either a dispersion modeling or monitoring approach to characterize local SO_2 concentrations near isolated emission sources. In August 2015, the U.S. Environmental Protection Agency (EPA) issued the SO_2 Data Requirements Rule (DRR; 80 FR 51052; August 21, 2015), which directs state and tribal air agencies in “an orderly process” to identify maximum ambient air 1-hour SO_2 concentrations in areas with large sources of SO_2 emissions.

The purpose of the DRR is to identify large SO_2-emitting sources, generally those with annual emissions greater than 2,000 tons for the most recent year for which emissions data are available and to characterize SO_2 concentrations in the vicinity of these sources. The affected sources are those that have not been previously captured as part of the initial non-attainment area designations for the 1-hour SO_2 National Ambient Air Quality Standard (NAAQS) in August 2013, or with the sources identified by the March 2015 Consent Decree between the EPA and the Sierra Club and National Resources Defense Council. According to the DRR, the method of characterizing the SO_2 concentrations around each source can be done by either:

1) installing and operating an ambient air monitoring network; or
2) performing an air dispersion modeling study to characterize the SO_2 concentration pattern in areas beyond the secured industrial boundary where monitors could be placed.

Alternatively, instead of a source characterization, each identified source can modify its air operating permit prior to January 13, 2017 such that the DRR-identified source either:

3) limits annual SO_2 emissions to less than 2,000 tons, or
4) limits short-term (1-hour) and/or longer-term (up to 30-day average) SO_2 emissions that, based on the results of an air dispersion modeling study, demonstrate that the area surrounding the source is in attainment with the SO_2 NAAQS, allowing the state air agency to provide a recommendation for a designation of attainment with the NAAQS.

The affected DRR sources evaluated in this report to implement Option 2 as noted above are Basin Electric Power Cooperative’s (Basin Electric) Antelope Valley Station (AVS), Dakota Gasification Company’s (DGC) Great Plains Synfuels Plant (GPSP) and Otter Tail Power’s Coyote Station (Coyote). Coyote was included in this analysis due to its proximity to AVS and GPSP. Figure 1-1 shows a map of the source locations and terrain in the vicinity.

To assist sources selecting the Option 2 modeling pathway, the North Dakota Department of Health (NDDH) issued the “Protocol for Modeling Analyses Used to Address EPA’s Data Requirements Rule (DRR) for 1-hour SO_2 NAAQS Designations in North Dakota” in December 2016 that outlined the DRR option selected by each facility subject to the rule, as well as general guidance as to how to conduct the Option 2 modeling analyses. EPA Region 8 requested a supplemental modeling protocol for each modeling analysis to be conducted as shown in their June 2016 comments in Appendix A to this report. As part of the supplemental protocol, EPA requested the following site-specific information:

- Building downwash assumptions for building dimensions;
- Receptor networks and fenceline receptors;
- AERSURFACE configuration options; and
- Background concentrations.

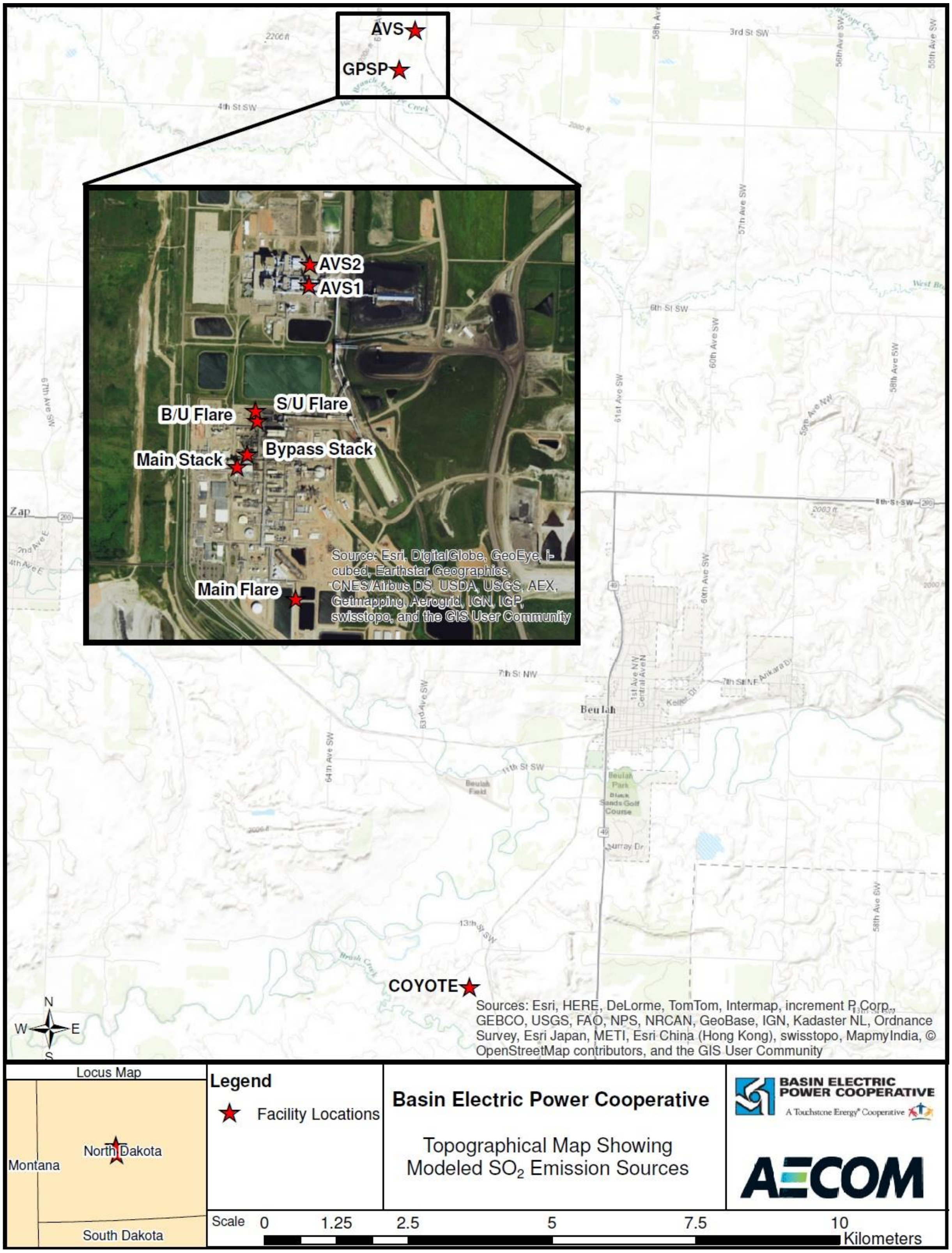
[1] 75 FR 35571 is the final rule for the 2010 SO_2 NAAQS.

Basin Electric provided the facility-specific information requested by NDDH and EPA in a supplemental protocol dated December 13, 2016.

1.1 Report Organization

Section 2 of this report describes the emission sources that were modeled (AVS, GPSP and Coyote). This section shows that there are no other nearby sources (i.e., within 10-20 km) that would interact with these three emission sources to cause a significant concentration gradient near either of AVS or GPSP. This section also describes the source of regional monitoring data that was used to represent distant source impacts not being modeled. Section 3 describes the dispersion model approaches that were used in this study, including the receptor networks and building downwash assumptions. Section 4 of the report presents the SO_2 characterization modeling results.

Figure 1-1: Topographical Map Showing Modeled SO_2 Emission Sources



2. Description of Modeled Emission Sources

2.1 Antelope Valley Station

AVS, owned by Basin Electric, consists of two coal-fired units: Unit 1 and Unit 2, each rated at 450 megawatts (with a heat rate input of 6,275 MMBtu/hr for each unit). The emissions from the two boilers are each exhausted into 600-foot stacks, as shown in Figure 2-1. The station is located seven miles south of Lake Sakakawea reservoir in Mercer County and situated northwest of the community of Beulah, North Dakota. The area surrounding AVS is considered rural with mostly flat to gently rolling terrain, with some sharper valleys by the nearby Knife River.

For the modeling analysis, we used 2013-2015 actual hourly SO_2 emissions, temperature and velocity data collected by the Continuous Emissions Monitoring (CEMs) equipment at each unit. Table 2-1 summarizes the emissions and stack parameters that were used in the AERMOD modeling.

Figure 2-1: Antelope Valley Station Photograph

Photograph source: Basin Electric https://www.basinelectric.com/Facilities/Antelope-Valley/

Table 2-1: Antelope Valley Station Emissions and Exhaust Parameters

Parameter	Unit 1	Unit 2
SO_2 Emissions	2013-2015 actual hourly-variable	2013-2015 actual hourly-variable
Stack Height	182.9 m	182.9 m
Exit Temperature	2013-2015 actual hourly-variable	2013-2015 actual hourly-variable
Exit Velocity	2013-2015 actual hourly-variable	2013-2015 actual hourly-variable
Diameter	7.0 m	7.0 m
Base Elevation	588.3 m	588.3 m
Coordinates (UTM Zone 14)	285920.18 m E, 5250189.31 m N	285923.89 m E, 5250293.40 m N

2.2 Great Plains Synfuels Plant

Dakota Gasification Company, a subsidiary of Basin Electric, operates the Great Plains Synfuels Plant, which is a coal gasification plant. The gasification plant is located to the south of and immediately adjacent to AVS. SO_2 emission sources from this plant include the main stack, bypass stack, one main flare, a startup flare and a backup flare. Figure 2-2 shows the 393-foot main stack, the 402-foot bypass stack, the 250-foot main flare stack, the 100-foot backup flare stack and the 225-foot startup flare stack. For the modeling analysis, we used 2013-2015 actual hourly SO_2 emissions, temperature and velocity data from the continuous emissions monitoring systems (CEMS) for the main stack and bypass stack. Hourly flare emissions provided by GPSP were calculated on a daily basis accounting for the various plant-wide streams that can be routed to each flare. Flare emissions were calculated on both 15-minute and hourly bases for each day. An hourly summary of total calculated flare emissions from each flare is routinely saved in a spreadsheet for each day of plant operations. While NOx, CO, VOC, and PM emission rates are calculated using AP-42 factors, SO_2 emissions are calculated using mass balances based on the measured or parameterized concentrations of H_2S in the flared gases and the measured or designed flow rates of streams that could be routed to the flares. DGC conservatively assumes that all H_2S is converted to SO_2 using the ideal gas constant and the molecular weights of H_2S and SO_2.

2.2.1 Main Stack and Bypass Stack

GPSP utilizes three Riley boilers (rated at 763 MMBtu/hr each) and two steam superheaters (rated 169 MMBtu/hr each) to provide the bulk of steam needed for the facility. The Riley boilers and superheaters are capable of combusting a wide range of plant-produced liquid and gaseous fuels. The flue gases from each boiler and superheater can be individually routed to one of two stacks: the main stack or the bypass stack. Each stack has separate CEMS instrumentation for SO_2.

Flue gas from the Riley boilers that has been routed to the main stack is scrubbed via a flue gas desulfurization (FGD) process to control SO_2 emissions; flue gas from the Riley boilers that is routed to the bypass stack is uncontrolled. The flue gas from the superheaters is uncontrolled regardless of which stack the gases are routed to.

Each of the Riley boilers and superheaters have individually permitted SO_2 emission limits. Additionally, both the main and bypass stacks each have separate emission limits for SO_2 for the combined flue gas discharge for all of the boilers and superheaters routed to the respective stack. The SO_2 CEMS instrumentation on each stack, as well as additional SO_2 CEMS instrumentation on the inlet to the FGD and on the ductwork for the two superheaters, provides the continuous emissions data for which the facility demonstrates compliance with both individual boiler and superheater emission limits and individual stack emissions limits for SO_2. In general, the flue gases from the Riley boilers and the superheaters are all routed together to either the main stack or the bypass stack; however, there are specific instances when both stacks are receiving flue gases and, subsequently, can have CEMS instrumentation simultaneously recording SO_2 emissions on each stack. Any flue gas routed to one stack would, of necessity, be removed from the other stack, since it is the individual boilers and/or superheaters producing the flue gases, not the stacks themselves. Therefore, it would be physically impossible for both stacks to be operating simultaneously at full capacity.

Flue gases from the boilers and superheaters are routed to the main stack during the majority of facility operating time. Flue gases from these emission units are routed to the bypass stack when individual boilers and/or superheaters are starting up or shutting down. This can result in SO_2 emissions from both stacks simultaneously. In practice, GPSP starts up or shuts down the Riley boilers and superheaters on synthetic natural gas (SNG) only, which minimizes SO_2 emissions to the bypass stack.

The bypass stack is also used during outage periods of routine FGD maintenance and during periods of FGD malfunction. Since the SO_2 CEMS data is recorded and reported on an hourly basis, there is the potential for some overlap of SO_2 emissions between the two stacks within a given 60-minute period during the time periods when flue gases are switched back and forth between the two stacks during an FGD outage. The total number of hours that the facility was operating with both stacks simultaneously during the three-year period of modeled emissions data is shown in Table 2-2.

2.2.2 Startup Flare

The startup flare is used primarily to control emissions from gasification startup, shutdown, and malfunction. Under normal operation, the fourteen facility gasifiers batch process lignite coal into a raw gas stream, which undergoes further processing within the plant. While the gasifiers are starting up, however, the raw gas stream is not of sufficient composition for further processing and the gas is flared instead of processed in downstream units. The raw gas is also flared if downstream processing units are shut down.

The startup flare also controls for lock gas recovery on the gasifiers. Normally, lock gas (gasification gases that escape through the top of the gasifiers each time the unit batch cycles) is captured from the gasifier locks and sent to on-site facility boilers for combustion, as the gases have a residual fuel value; however, in cases where facility boilers are not operating or there is some issue with the routing of the lock gas, the lock gas is sent to the startup flare instead to be combusted. The startup flare can also be used occasionally to control emissions from other plant processes and areas, but this is rare and would be accounted for on an individualized basis.

The startup flare is equipped with a flow meter, though high flow rates have caused unreliable flowmeter readings and the design process flow has conservatively been substituted in the past. The flow rate is corrected to temperature and moisture in the gas. The H_2S concentration is measured by the gasifier spectrum analyzer. If the analyzer is not operating, the value from the daily combined gasifier outlet sample is used. The outlet sample is based on all then-currently operating gasifiers, so offset values are used to account for the different gasifier startup conditions. For example, when a gasifier is in the oxygen startup condition, the H_2S concentration off-set value is calculated to be 87% of the daily gasification outlet sample. These offset values were determined using multiple bag samples during a controlled startup of the three startup conditions: steam heat up, air/steam mix, and oxygen.

2.2.3 Main Flare

The main plant flare is used to control emissions from various plant processes during startup, shutdown, or malfunction of those processes. Each area of the plant that can be routed to the Main Flare has unique calculations associated with it based on a variety of factors, such as typical gas composition analyses, valve positioning, design or measured stream flow rates, spike gas flow rates, and/or the addition of known quantities of nitrogen gas. While the calculations in the flare spreadsheet account for the main plant processes that can be routed to the flare, there are hundreds of additional areas designed to be routed to the flare in an emergency or that could potentially “leak” emissions to the flare.

To account for these areas that are not calculated on a daily basis within the flare spreadsheet, at least once per month, DGC takes flare samples at the base of the flare (past the final point where all the flare streams are routed together) for laboratory analysis (called a “leak check”). Once a month while the plant is under normal operating conditions (all units in operation and no process streams vented), a bag sample is taken directly from the Main Flare. This sample is analyzed by the lab, and an SO_2 pounds per hour rate is calculated. These flare “leakage” emissions are then conservatively added into the spreadsheet on an hourly basis, providing a baseline of flare emissions even when no plant processes are ostensibly being routed to the flare. This leakage rate is applied until the next monthly sample is taken; typically this leakage rate accounts for the majority of the SO_2 emissions from the Main Flare. The main plant flare is also continuously monitored and recorded by camera as well, with periodic visual emission checks, to ensure no unusual and/or unaccountable flaring activity is occurring. Should such unusual or unaccountable flaring activity be detected, or plant processes malfunction in such a way that a leak to the main flare is suspected, leak checks are performed more frequently as appropriate to ensure accountability for all main flare emissions.

The Main Flare flow rates are determined through valve position, the amount of gas sent to the flare, and which process the gas is routed from. The flow rate is corrected based on moisture data gathered through Method 4 test methods. There are two daily samples that are used for the Main Flare calculation, the gasification outlet sample and the CO_2 product gas sample. Much like the startup flare, each process that is vented to the Main Flare has an offset applied based on these daily samples. For example, both the high pressure and low pressure lock gases have an H_2S concentration equal to 75% of the daily gasifier outlet sample, while the different rectisol process gases range between 14% to 107% of the daily CO_2 product gas sample. All of the H_2S offsets for the different process streams were determined using bag samples, and then correlated to the daily gasification and/or CO_2 product samples.

2.2.4 Backup Flare

The backup flare is used primarily to control emissions from gasification startup, shutdown, or malfunction should the startup flare be unavailable. Should the backup flare be utilized, the same calculations as for the startup flare are used to calculate flow rate and concentrations.

The stack parameters for the flares are based on the source parameter table in the NDDH December 2016 modeling protocol. Table 2-3 summarizes the emissions and stack parameters that were used in the AERMOD modeling.

An example emissions calculation for the flares is included in Appendix B. The number of hours each unit operated in 2013 through 2015 is summarized in Table 2-2.

Table 2-2 GPSP Hours of Operation

Source	2013	2014	2015
Main Stack	8038	8590	8590
Bypass Stack	198	1004	623
Main and Bypass Stacks Operating Simultaneously During a Given Hour	80	834	453
Main Flare	8243	8760	8760
Backup Flare	3858	444	1132
Startup Flare	7434	8714	8597

Figure 2-2: Great Plains Synfuels Plant Photograph

Photograph source: Dakota Gasification Company http://www.dakotagas.com/

Table 2-3: Great Plains Synfuels Plant Emissions and Exhaust Parameters

Parameter	Main Stack	Bypass Stack	Main Flare	Backup Flare	Startup Flare
SO_2 Emissions	2013-2015 actual hourly-variable	2013-2015 actual hourly-variable	2013-2015 actual hourly-variable	2013-2015 actual hourly-variable	2013-2015 actual hourly-variable
Stack Height	119.8 m	122.5 m	76.2 m	30.5 m	68.6 m
Exit Temperature	2013-2015 actual hourly-variable	2013-2015 actual hourly-variable	1,000 K	1,000 K	1,000 K
Exit Velocity	2013-2015 actual hourly-variable	2013-2015 actual hourly-variable	100.5 m/s	102.1 m/s	98.4 m/s
Diameter	7.0 m	4.9 m	1.0 m	0.50 m	0.50 m
Base Elevation	588.3 m	588.3 m	588.3 m	588.3 m	588.3 m
Coordinates (UTM Zone 14)	285551.77 m E, 5249268.12 m N	285603.00 m E, 5249333.40 m N	285849.68 m E, 5248599.59 m N	285653.42 m E, 5249501.86 m N	285647.84 m E, 5249552.90 m N

2.3 Coyote Station

Coyote Station is owned by Otter Tail Power Company and is located approximately 16 km south of AVS and GPSP in Mercer County and situated southwest of the community of Beulah, North Dakota. The plant has one coal-fired boiler rated at 427 megawatts. Emissions from the boiler are exhausted through a single 498-foot stack, as shown on Figure 2-3.

Although Coyote Station has already met the requirements of the SO_2 Consent Decree, it was modeled here because of its proximity to AVS and GPSP and due to the recommendations of the North Dakota Department of Health (NDDH) in their December 2016 SO_2 Data Requirements Rule protocol that has been accepted by EPA. Similar to those two facilities, the area surrounding Coyote Station is rural with mostly flat terrain and gently rolling hills.

For the modeling analysis, we used 2013-2015 actual hourly SO_2 emissions, temperature and velocity data collected using CEMs for the single stack at the facility. Table 2-4 summarizes the emissions and stack parameters that were used in the AERMOD modeling.

Figure 2-3: Coyote Station Photograph

Photograph source: Otter Tail Power https://www.otpco.com/about-us/company-history/

Table 2-4: Coyote Station Emissions and Exhaust Parameters

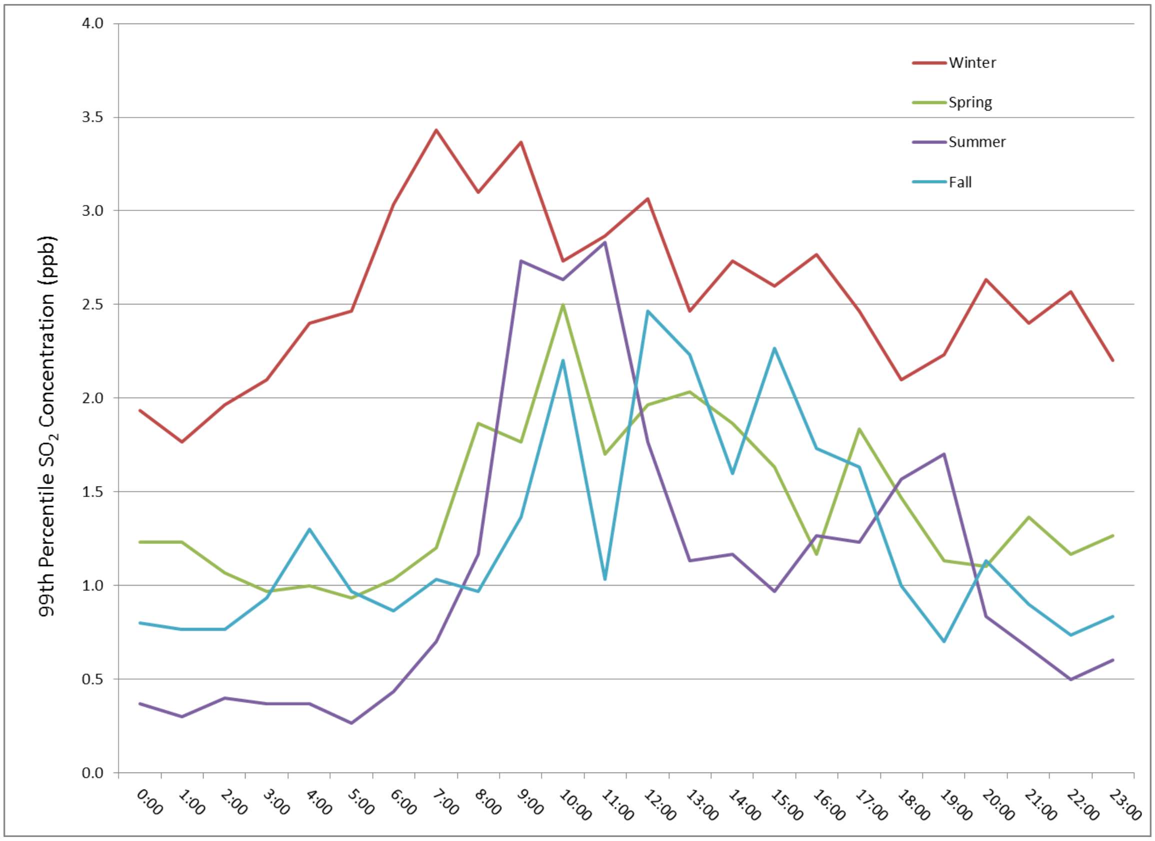
Parameter	Coyote
SO_2 Emissions	2013-2015 actual hourly-variable
Stack Height	151.79 m
Exit Temperature	2013-2015 actual hourly-variable
Exit Velocity	2013-2015 actual hourly-variable
Diameter	6.4 m
Base Elevation	590.52 m
Coordinates (UTM Zone 14)	286869.20 m E, 5233589.00 m N

2.4 Regional Background

As stated in the December 2016 NDDH modeling protocol, the only other significant source of SO_2 emissions within 30 km of AVS and GPSP is Coyote Station. Therefore, for this 1-hour SO_2 NAAQS analysis, Coyote Station was the only background source considered in this modeling. The total concentration for 1-hour SO_2 NAAQS compliance was computed by adding the AVS, GPSP, and Coyote predicted concentrations to the regional background concentrations from the NDDH-approved Dunn Center monitor (location shown in Figure 3-5).

The background concentrations were calculated as a 3-year (2013-2015) average of the 99th percentile by season and hour-of-day and added internally for each modeled hour in AERMOD to the AERMOD-predicted concentration for comparison with the 1-hour SO_2 National Ambient Air Quality Standard (NAAQS) of196.5 $\mu g/m^3$. The Dunn Center seasonal SO_2 concentrations are displayed in Figure 2-4.

Figure 2-4: 2013-2015 Average 99th Percentile Concentration at Dunn Center SO_2 Monitor



3. Dispersion Modeling Approach

The suitability of an air quality dispersion model for a particular application is dependent upon several factors. The following selection criteria have been evaluated in selecting the model for this project:

- stack height relative to nearby structures;
- dispersion environment;
- local terrain; and
- representative meteorological data.

The EPA Guideline on Air Quality Models (Appendix W[2]) prescribes a set of approved models for regulatory applications for a wide range of source types and dispersion environments. Based on a review of the factors discussed below and the recommended modeling approach in the December 2016 NDDH modeling guidance, the version of AERMOD specified in the approved NDDH protocol (version 15181) was used to assess air quality impacts for AVS, GPSP and Coyote. Since AVS and GPSP are located adjacent to each other, they were modeled in the same model run within the same domain and receptor grid centered at the two plants, as suggested by the Modeling Technical Assistance Document (TAD) and December 2016 NDDH modeling protocol. The Coyote emissions were also modeled for this same modeling domain and receptor coverage.

In a proposed rulemaking published in the July 29, 2015 Federal Register (80 FR 45340), the EPA released a revised version of AERMOD (15181), which replaced the previous version of AERMOD dated 14134. As this report describes, the dispersion modeling analysis was conducted using the regulatory defaults associated with AERMOD version 15181.

3.1 Good Engineering Practice Stack Height Analysis

Good engineering practice (GEP) stack height is defined as the stack height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutant as a result of atmospheric downwash, wakes, or eddy effects created by the source, nearby structures, or terrain features.

A GEP stack height analysis was performed for the stacks at AVS, GPSP and Coyote Stations with the EPA's Building Profile Input Program (BPIP). BPIP was used to develop the building/structural information required for input to AERMOD to simulate building downwash in the dispersion modeling. BPIP input and output files are provided in the modeling archive.

The locations of the buildings/structures relative to the stack locations for AVS, GPSP and Coyote are shown in Figures 3-1, 3-2, and 3-3, respectively. Since EPA's Technical Assistance Document for modeling[3] specifies that actual stack heights should be used in this modeling characterization of SO_2 concentrations, the GEP analysis was used to provide input of building dimensions to AERMOD, but not to change the stack height input from the actual value for input to the modeling. Per NDDH's DRR protocol, building downwash was not included for the flares at GPSP.

3.2 Dispersion Environment

The application of AERMOD requires characterization of the local (within 3 kilometers) dispersion environment as either urban or rural, based on an EPA-recommended procedure that characterizes an area by prevalent land use. This land use approach classifies an area according to 12 land use types. In this scheme, areas of industrial, commercial, and compact residential land use are designated urban. According to EPA modeling guidelines, if more than 50% of an area within a 3-km radius of the facility is

[2] http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf.
[3] http://www.epa.gov/airquality/sulfurdioxide/pdfs/SO2ModelingTAD.pdf.

classified as rural, then rural dispersion coefficients are to be used in the dispersion modeling analysis. Conversely, if more than 50% of the area is urban, urban dispersion coefficients are used. As shown in Figure 3-4, the 3-km area surrounding each of the stations is rural. Therefore, rural dispersion was assumed for each of the plants being modeled.

3.3 Model Receptor Grid and Terrain

The latest version of AERMAP (version 11103), the AERMOD terrain preprocessor program, was used to generate modeling receptors. A Cartesian receptor grid was used as an input to AERMOD with the following spacing:

- 25 meters spacing along the fenceline;
- 0 km to 2.3 km with 50 meters spacing;
- 2.3 km to 5 km with 100 meters spacing;
- 5 km to 10 km with 250 meters spacing;
- 10 km to 20 km with 500 meters spacing;
- 20 km to 50 km with 1,000 meters spacing.

The grid is centered on the area between the Antelope Valley Station and Great Plains Synfuels Plant facilities. For conservatism, no areas beyond the fence line were excluded from the modeling analysis. For each facility, receptors were added on their property to model impacts from the other facility using 25-meter spacing. The modeling was done in three parts: all receptors outside of both properties, receptors within Antelope Valley Station (for Great Plains Synfuels Plant and Coyote impacts), and receptors within Great Plains Synfuels Plant (for Antelope Valley Station and Coyote impacts).

Terrain elevations from 10-meter National Elevation Data (NED) from USGS were processed with AERMAP to develop the receptor terrain elevations required by AERMOD. Figure 3-5 shows the receptor network used in the modeling and Figure 3-6 shows the near-field receptor grid.

3.4 Meteorological Data for Modeling

Meteorological data required for AERMOD include hourly values of wind speed, wind direction, and ambient temperature. Since the AERMOD dispersion algorithms are based on atmospheric boundary layer dispersion theory, additional boundary layer variables are derived by parameterization formulas, which are computed by the AERMOD meteorological preprocessor, AERMET. These parameters include sensible heat flux, surface friction velocity, convective velocity scale, vertical potential temperature gradient, convective and mechanical mixing heights, Monin-Obukhov length, surface roughness length, Bowen ratio, and albedo.

Hourly averaged surface observations were processed from the state-operated meteorological station in Beulah, ND. Sub-hourly (1-minute) wind data (used as backup to Beulah) were processed from nearby Garrison Municipal Airport in Garrison, ND. Cloud cover observations were available from the regional observing stations at Hazen and Bismarck, ND. Concurrent upper air data were obtained from the closest or most representative National Weather Service site, which was determined to be Bismarck, ND. Additional details are provided in the following sections.

3.4.1 Available Offsite Meteorological Data and NWS Upper Air Data

The hourly meteorological data for Beulah was processed with the latest version of AERMET (Version 15181). AERMET was run utilizing three concurrent years (2013-2015) of hourly surface observations from the Beulah station along with concurrent upper air data from Bismarck, ND. Sub-hourly observations were obtained from Garrison Municipal Airport for 2013-2015 as backup to the observations at Beulah. Since cloud cover data is not recorded from the Beulah meteorological station, cloud cover observations were taken from nearby Mercer County Airport in Hazen, ND. For periods (such as in portions of 2015) when cloud cover observations from the Mercer County Airport were missing, cloud cover data from the

Bismarck Airport were substituted. This approach led to hourly observations to have at least 94% data capture, as shown in Table 3-1. Missing upper air data from Bismarck, ND were substituted with data from Glasgow, MT[4]. Figure 3-7 shows the locations of the meteorological stations in relation to the modeled facilities, as well as the SO_2 background station discussed below.

The AERMET inputs were based on surface meteorological data from the NDDH database along with 1-minute Automated Surface Observing System (ASOS) data. The latest version of AERMINUTE (version 15272) was used to process this data. The upper air data input to AERMET were downloaded from the NOAA/ESRL/GSD - RAOB database (http://esrl.noaa.gov/raobs/). A wind rose for the Beulah station for the years 2013-2015 is shown in Figure 3-8.

Table 3-2 gives the site location and information on the meteorological datasets. The surface wind data are measured 10 meters above ground level. The temperature and relative humidity are measured 2 meters above ground level.

Table 3-1: Data Capture (%) by Meteorological Parameter and Level

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average	EPA Threshold
2013	99.21%	99.31%	98.91%	99.64%	99.27%	90.00%
2014	99.63%	99.82%	98.91%	99.18%	99.39%	90.00%
2015	100.00%	99.08%	94.84%	97.37%	97.82%	90.00%

Table 3-2: Meteorological Data Used in AERMET

Met Site	Latitude	Longitude	Base Elevation (m)	Data Source	Data Format
Beulah, ND	47.229	-101.767	630	NDDH	TEXT
Garrison Municipal Airport – Garrison, ND	47.646	-101.439	583	NCDC	1 min ASOS
Mercer County Airport – Hazen, ND[1]	47.287	-101.557	553	NCDC	ISHD
Bismarck Airport – Bismarck, ND[1]	46.774	-100.748	506	NCDC	ISHD
Bismarck, ND	46.774	-100.748	506	FSL	FSL
Glasgow, MT	48.200	-106.620	693	FSL	FSL

[1] Sites used to obtain cloud cover data for AERMET processing.

3.4.2 AERSURFACE Analysis – Meteorological Site Land Use Characteristics

AERMET requires specification of site characteristics including surface roughness, Bowen ratio, and albedo. These parameters were developed according to the guidance provided by EPA in the most recent revision of the AERMOD Implementation Guide (AIG)[5].

The revised AIG provides the following recommendations for determining the site characteristics:

1. The determination of the surface roughness length should be based on an inverse distance weighted geometric mean for a default upwind distance of 1 kilometer relative to the

[4] A total of 19 days over the 3 years to be modeled were substituted.
[5] US EPA 2015. AERMOD Implementation Guide (AIG). Office of Air Quality Planning and Standards, Research Triangle Park, NC. August. http://www.epa.gov/ttn/scram/7thconf/aermod/aermod_implmtn_guide_3August2015.pdf

measurement site. Surface roughness length may be varied by sector to account for variations in land cover near the measurement site; however, the sector widths should be no smaller than 30 degrees.

2. The determination of the Bowen ratio should be based on a simple un-weighted geometric mean (i.e., no direction or distance dependency) for a representative domain, with a default domain defined by a 10-km by 10-km region centered on the measurement site.
3. The determination of the albedo should be based on a simple un-weighted arithmetic mean (i.e., no direction or distance dependency) for the same representative domain as defined for Bowen ratio, with a default domain defined by a 10-km by 10-km region centered on the measurement site.

The AIG recommends that the surface characteristics be determined based on digitized land cover data. EPA has developed a tool called AERSURFACE[6] that can be used to determine the site characteristics based on digitized land cover data in accordance with the recommendations from the AIG discussed above. AERSURFACE incorporates look-up tables of representative surface characteristic values by land cover category and seasonal category. The latest version of AERSURFACE (13016) version was applied with the instructions provided in the AERSURFACE User's Guide.

The current version of AERSURFACE supports the use of land cover data from the USGS National Land Cover Data 1992 archives[7] (NLCD92). The NLCD92 archive provides data at a spatial resolution of 30 meters based upon a 21-category classification scheme applied over the continental U.S. The AIG recommends that the surface characteristics be determined based on the land use surrounding the site where the surface meteorological data were collected.

Recommended AERSURFACE inputs[8] provided by NDDH were used for this SO_2 DRR modeling demonstration. This includes using a 1-km radius circular area, which was divided into twelve sectors for surface roughness determination as shown in Figure 3-9. The recently revised AERMOD Implementation Guide (AIG)[9] issued by the US Environmental Protection Agency recommends this circular area be centered at the meteorological station site. Since the meteorological site is at a state-operated meteorological monitor site, the AERSURFACE input was not marked as an airport. A secondary set of surface characteristics for the twelve sectors was developed around the backup NWS Hazen airport. Due to some missing cloud cover data at Hazen in 2015, a secondary backup set of surface characteristics for the twelve sectors was developed around the Bismarck airport. In AERMET Stage 3, the primary set of characteristics were applied for those hours in which the onsite data are used and the secondary set were applied for those hours in which the NWS surface file or 1-minute ASOS wind data are substituted for missing or calm onsite data. Additional details on the seasonal classification and surface moisture determination are provided in the following sub-sections.

3.4.2.1 Surface Moisture Determination

For Bowen ratio, the land use values are linked to three categories of surface moisture corresponding to average, wet and dry conditions. The surface moisture condition for the site may vary depending on the meteorological data period for which the surface characteristics will be applied. AERSURFACE applies the surface moisture condition for the entire data period. Therefore, if the surface moisture condition varies significantly across the data period, then AERSURFACE can be applied multiple times to account for those variations. As recommended in the AERSURFACE User's Guide, the surface moisture condition for each season was determined by comparing precipitation for the period of data to be processed to a recent 30-year record at Garrison airport (for 2013-2014) and Bismarck airport (for 2015) precipitation records. This procedure selected "wet" conditions if precipitation was in the upper 30th percentile, "dry" conditions if precipitation was in the lower 30th percentile, and "average" conditions if precipitation was in

[6] Available at http://www3.epa.gov/ttn/scram/dispersion_related.htm#aersurface.
[7] Available at http://edcftp.cr.usgs.gov/pub/data/landcover/states/.
[8] Available at https://www.ndhealth.gov/AQ/Policy/AERSURFACE%20Inputs.pdf.
[9] Available at http://www3.epa.gov/ttn/scram/7thconf/aermod/aermod_implmtn_guide_3August2015.pdf.

the middle 40th percentile. Surface moisture data for this analysis is provided in Appendix C. The monthly designations of surface moisture input to AERSURFACE are summarized in Table 3-3.

Table 3-3: AERSURFACE Bowen Ratio Condition Designations

Month	Bowen Ratio Category		
	2013	2014	2015
January	Dry	Average	Wet
February	Average	Average	Average
March	Average	Average	Dry
April	Wet	Wet	Dry
May	Wet	Wet	Wet
June	Wet	Average	Wet
July	Average	Dry	Dry
August	Wet	Wet	Average
September	Wet	Average	Dry
October	Wet	Average	Average
November	Average	Wet	Average
December	Wet	Dry	Wet

3.4.2.2 Seasonal Classification

The AERSURFACE seasonal categories by month were developed for each modeled year and applied for the primary (Beulah site) and secondary (Hazen airport in 2013-2014; Bismarck airport in 2015) sites, as shown in Table 3-4. A month was selected as a "winter with continuous snow on the ground" if a month had at least half of the days with recorded snow on the ground. Daily snow cover records were obtained for the Garrison and Bismarck airports from the National Climatic Data Center (NCDC)[10].

Table 3-4: Selected Seasonal Categories for AERSURFACE

Season Description	2013	2014	2015
Late autumn after frost and harvest, or winter with no snow	3,4	3	11, 2, 3
Winter with continuous snow on the ground	12,1,2	11, 12, 1, 2	12, 1
Transitional spring	5	4, 5	4, 5
Midsummer with lush vegetation	6,7,8	6,7,8	6,7,8
Autumn with unharvested cropland	9,10,11	9,10	9,10

3.4.3 AERMET Data Processing

AERMET (Version 15181) and AERMINUTE (Version 15272) were used to process data required for input to AERMOD. Boundary layer parameters used by AERMOD, which also are required as input to the AERMET processor, include albedo, Bowen ratio, and surface roughness. The land classifications and associated boundary layer parameters were determined following procedures outlined below. In running AERMET, the observed airport hourly wind directions (if used to substitute for missing AERMINUTE data) were randomized based on guidance from EPA's March 8, 2013 Use of ASOS Meteorological Data in AERMOD Dispersion Modeling memo[11] using the "WIND_DIR RANDOM" keyword in AERMET. The randomization method addresses the lack of precision in the NWS wind direction observations, which are reported to the nearest 10 degrees. If the randomization method is not used, the potential exists for overly conservative model impacts to occur.

[10] http://www.ncdc.noaa.gov/cdo-web/search
[11] Available at https://www3.epa.gov/scram001/guidance/clarification/20130308_Met_Data_Clarification.pdf

AERMET was applied to create two meteorological data files required for input to AERMOD:

SURFACE: A file with boundary layer parameters such as sensible heat flux, surface friction velocity, convective velocity scale, vertical potential temperature gradient in the 500-meter layer above the planetary boundary layer, and convective and mechanical mixing heights. Also provided are values of Monin-Obukhov length, surface roughness, albedo, Bowen ratio, wind speed, wind direction, temperature, and heights at which measurements were taken.

PROFILE: A file containing multi-level meteorological data with wind speed, wind direction, temperature, sigma-theta (σ_θ) and sigma-w (σ_w) when such data are available. For AVS/GPSP, the profile file contains a single level of wind data (10 meters) and the temperature data only, corresponding to the Beulah tower observation.

Figure 3-1: Stacks and Buildings in the GEP Analysis for Antelope Valley Station

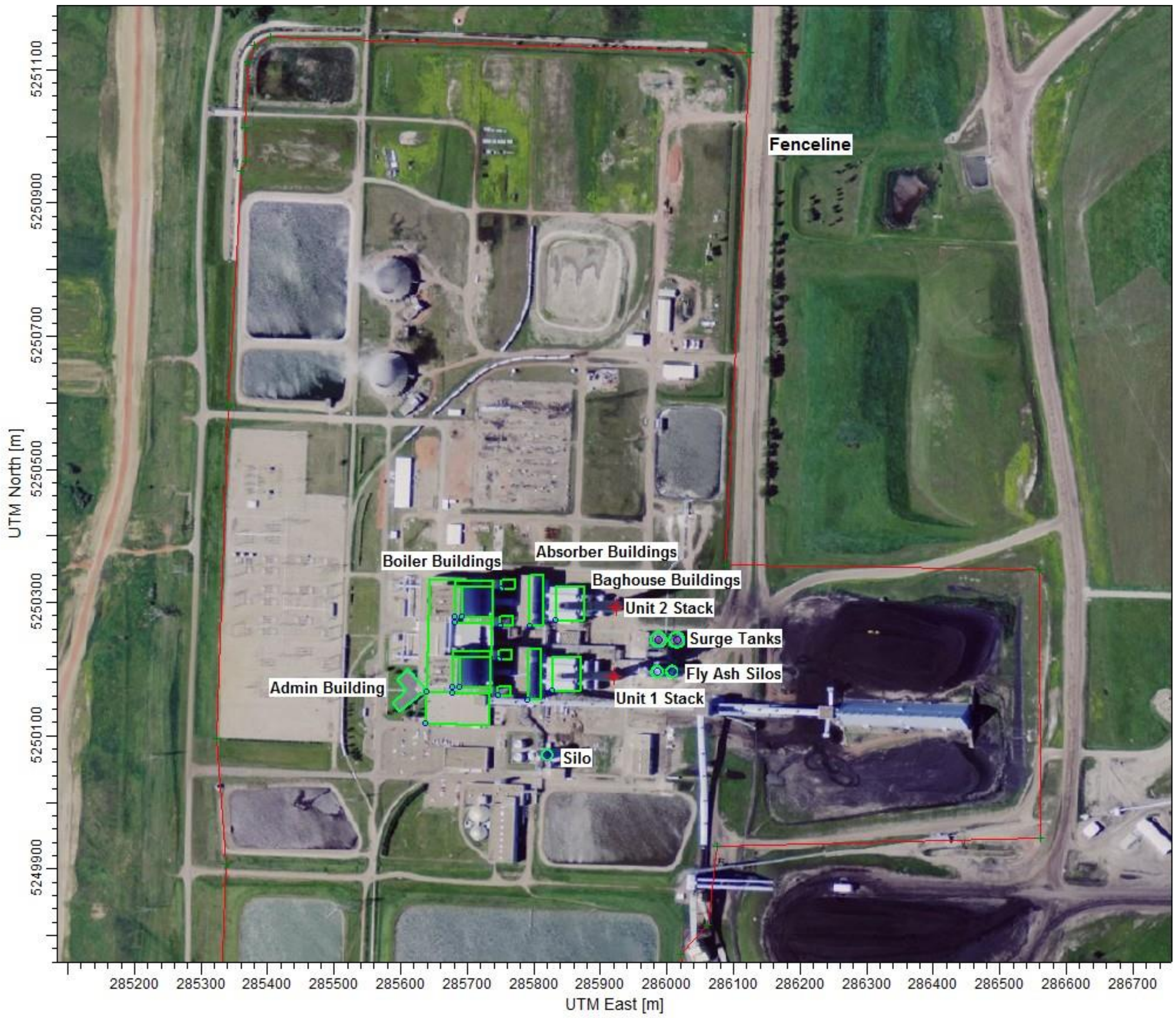


Figure 3-2: Stacks and Buildings Used in the GEP Analysis for Great Plains Synfuels Plant

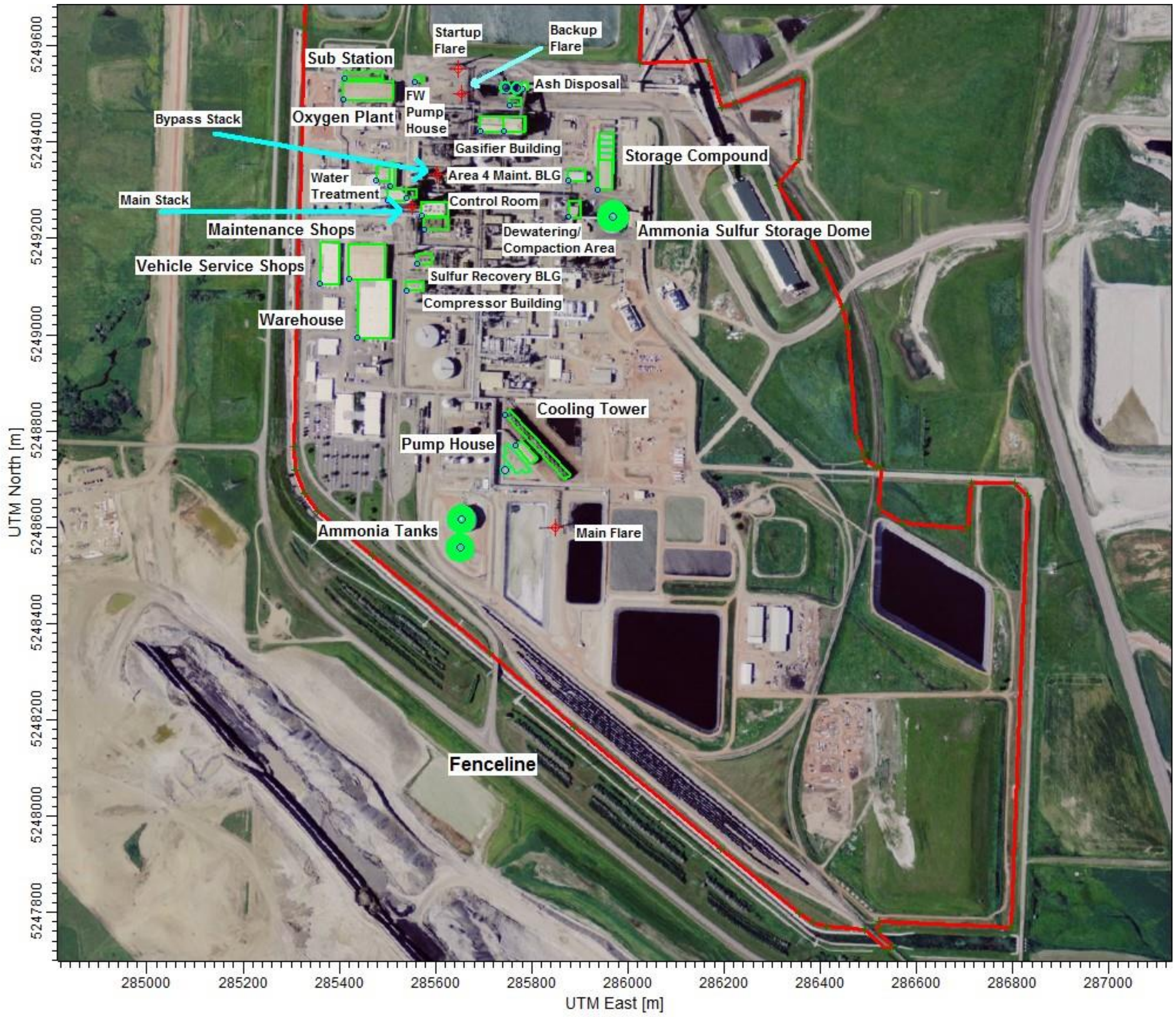


Figure 3-3: Stacks and Buildings Used in the GEP Analysis for Coyote Station

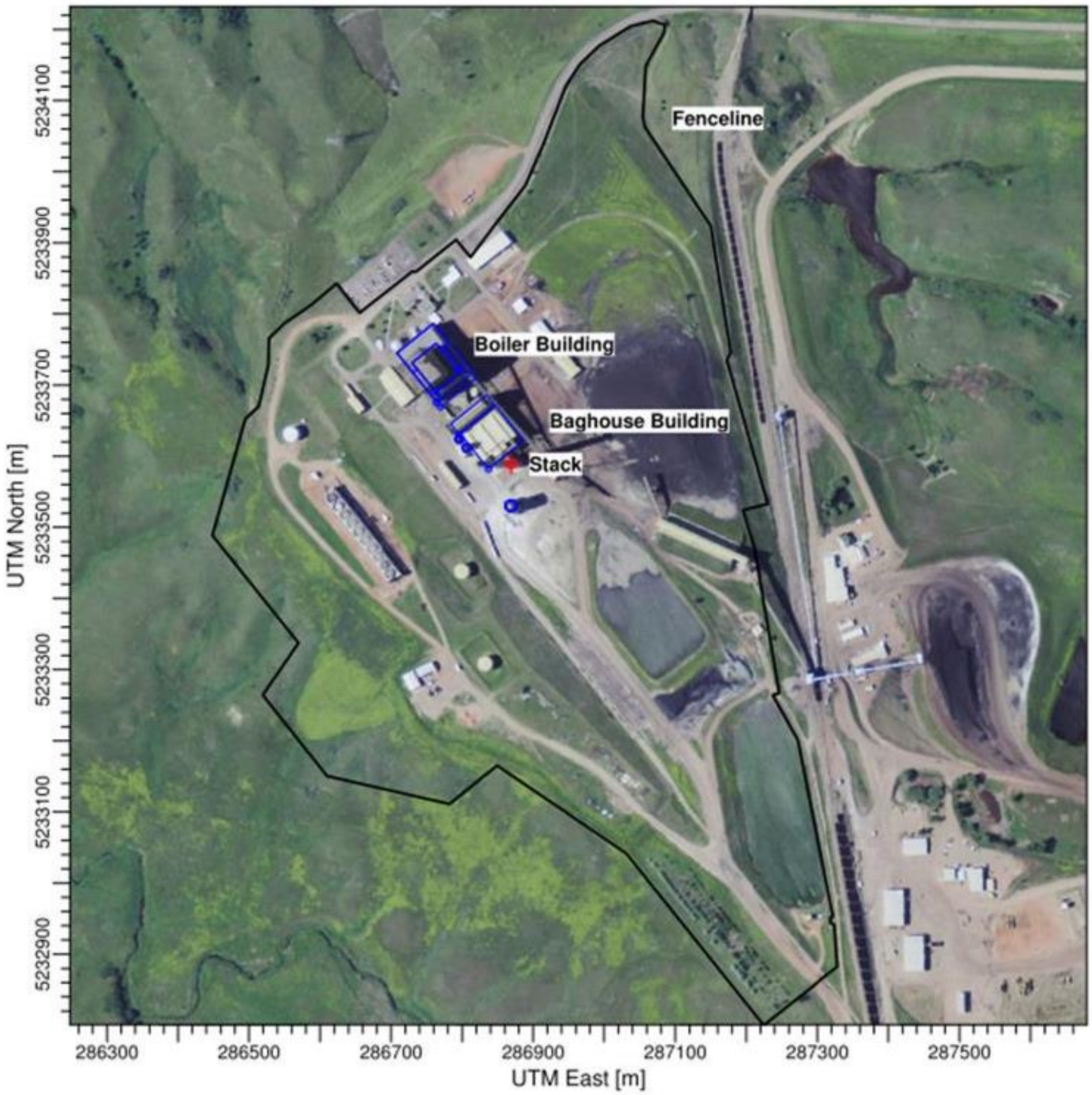


Figure 3-4: Land Use Within 3-kilometers of AVS/GPSP

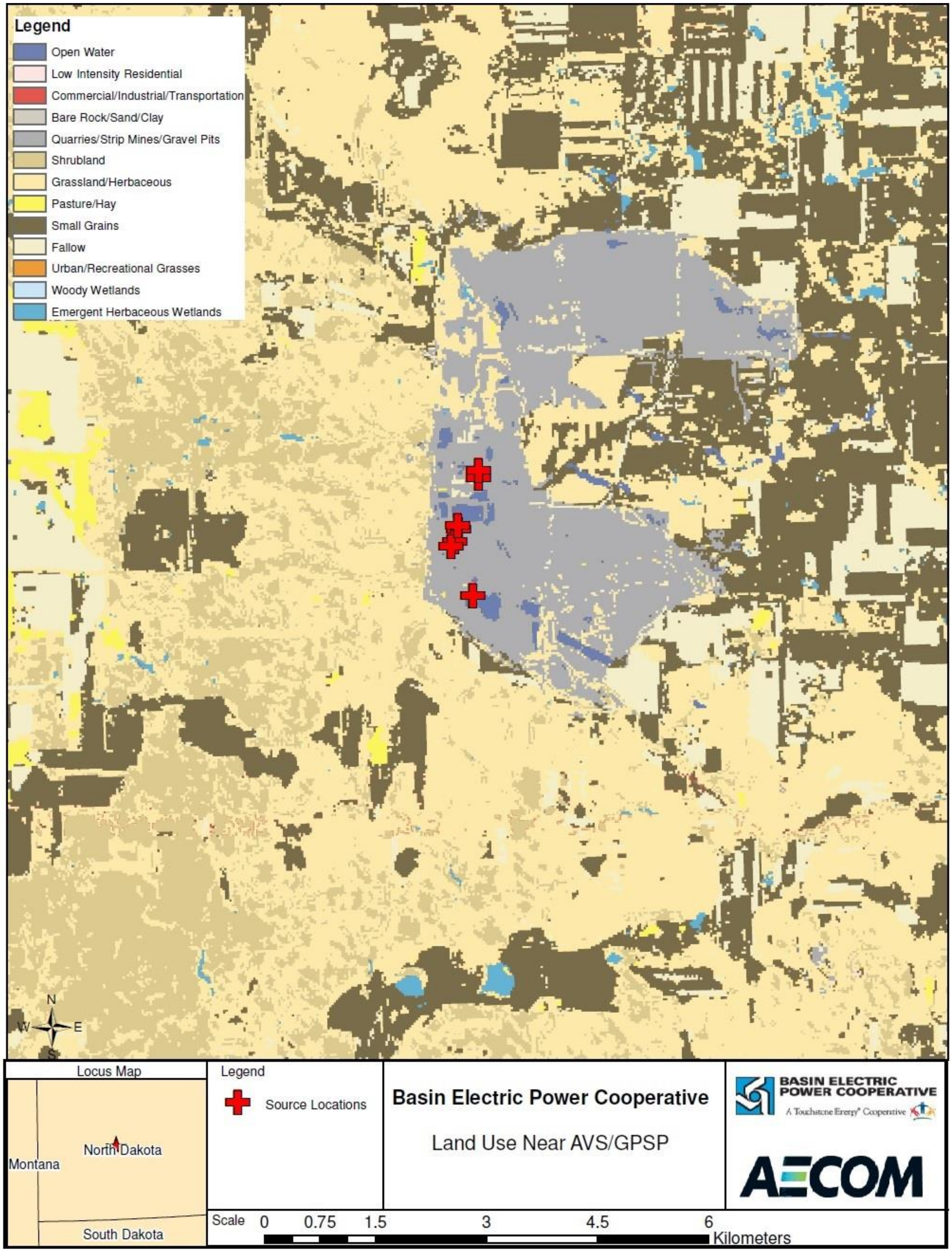


Figure 3-5: Modeling Receptor Grid (Far-Field View)

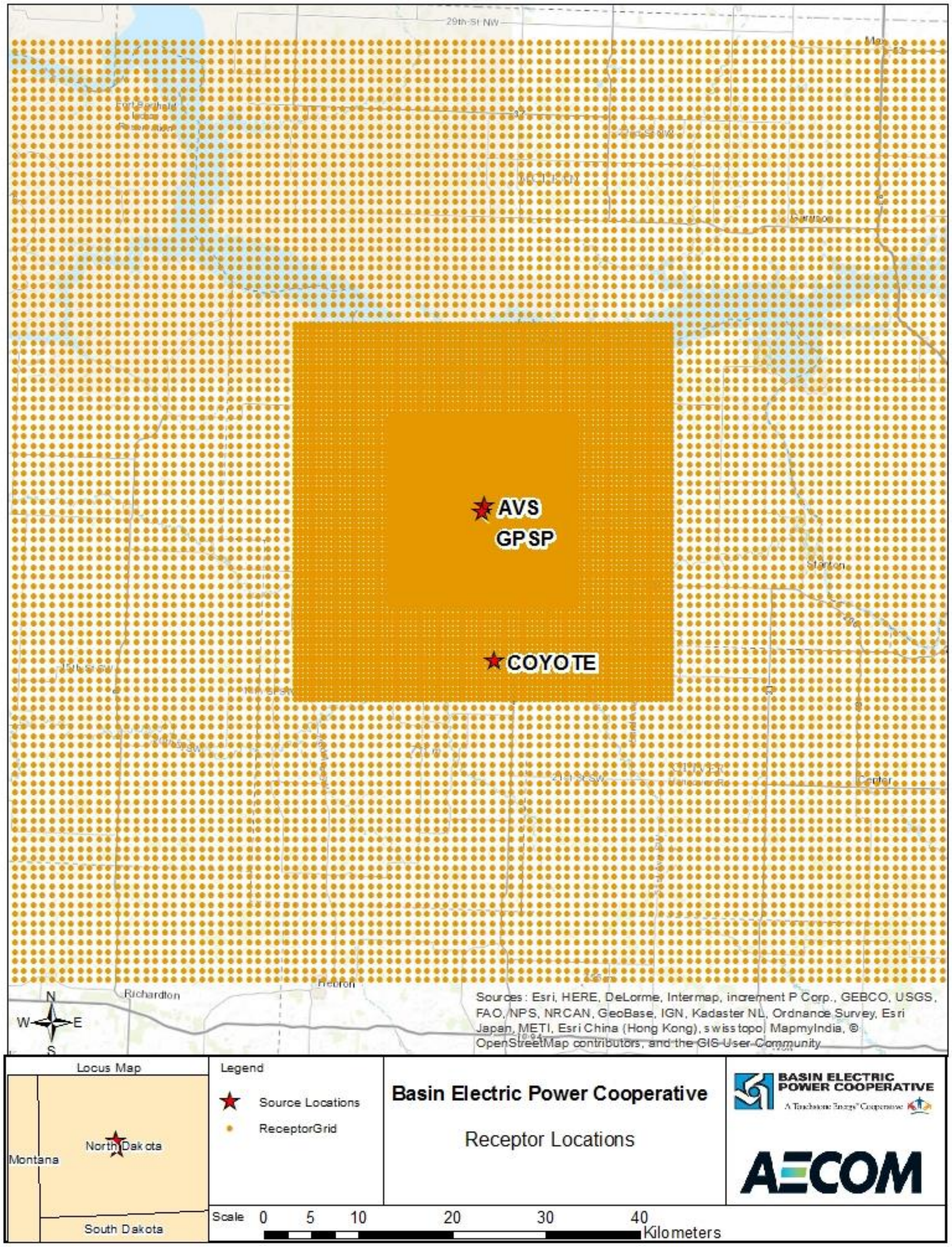


Figure 3-6: Modeling Receptor Grid (Near-Field View)

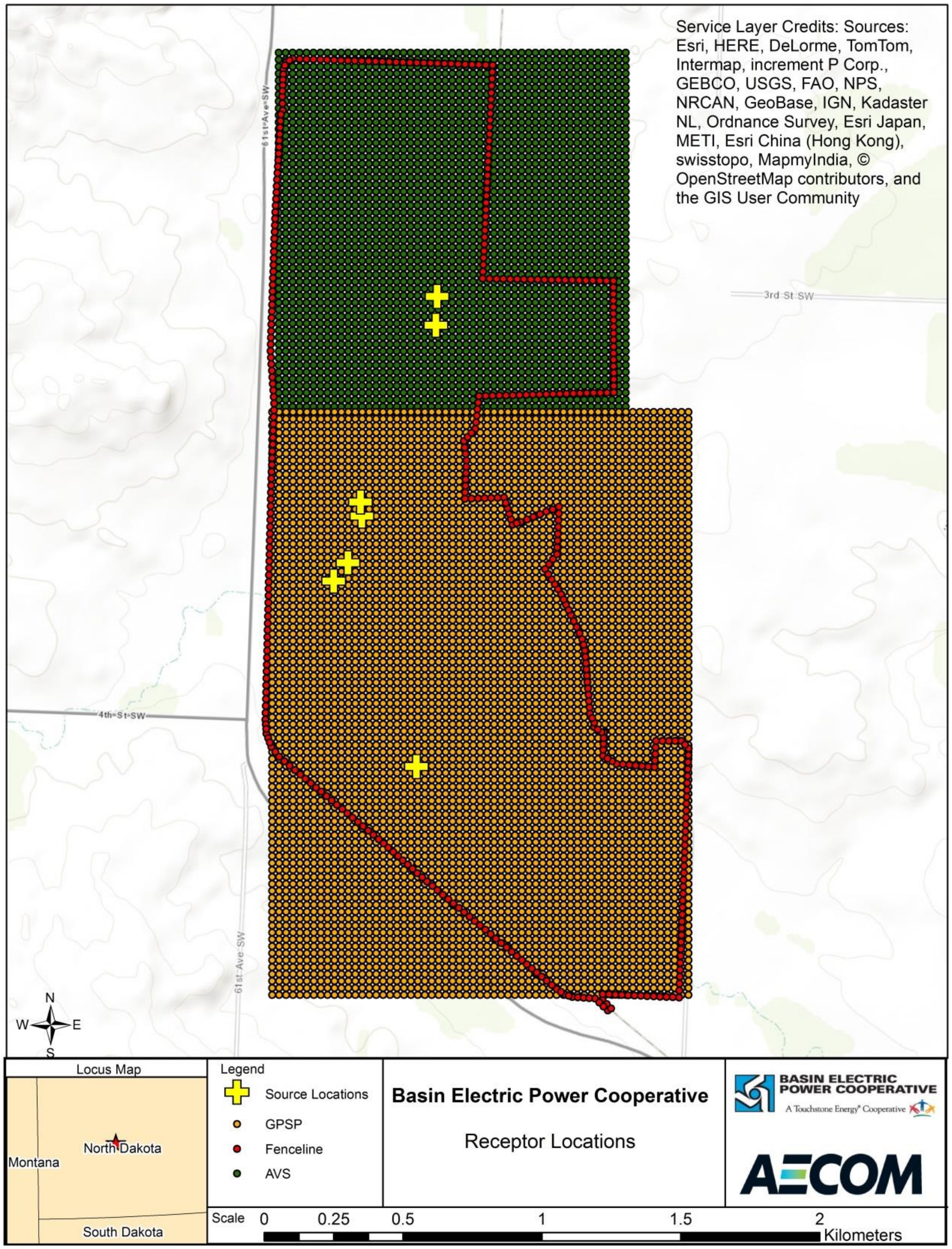


Figure 3-7: Location of Meteorological Stations and SO_2 Monitor Relative to the Modeled Sources

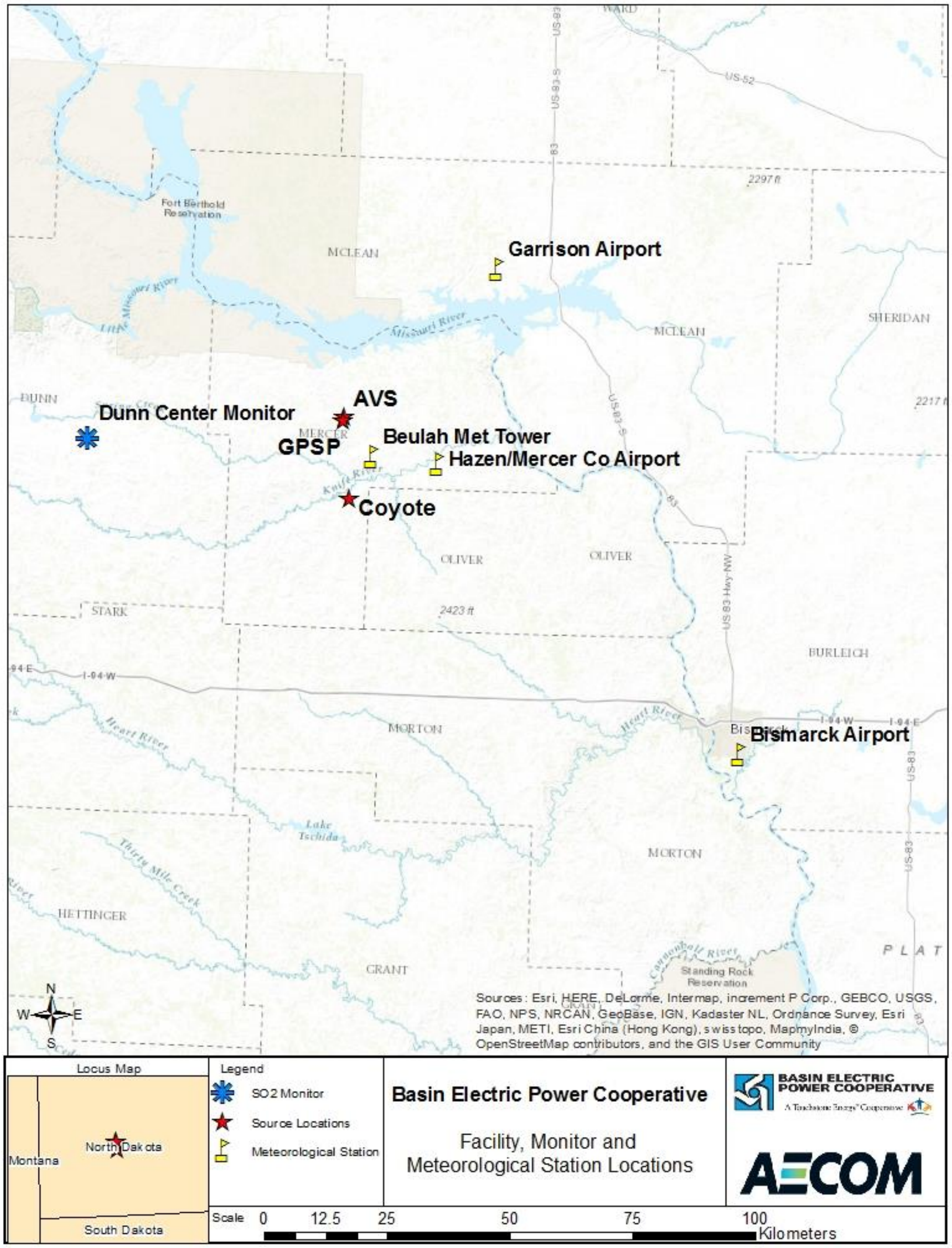
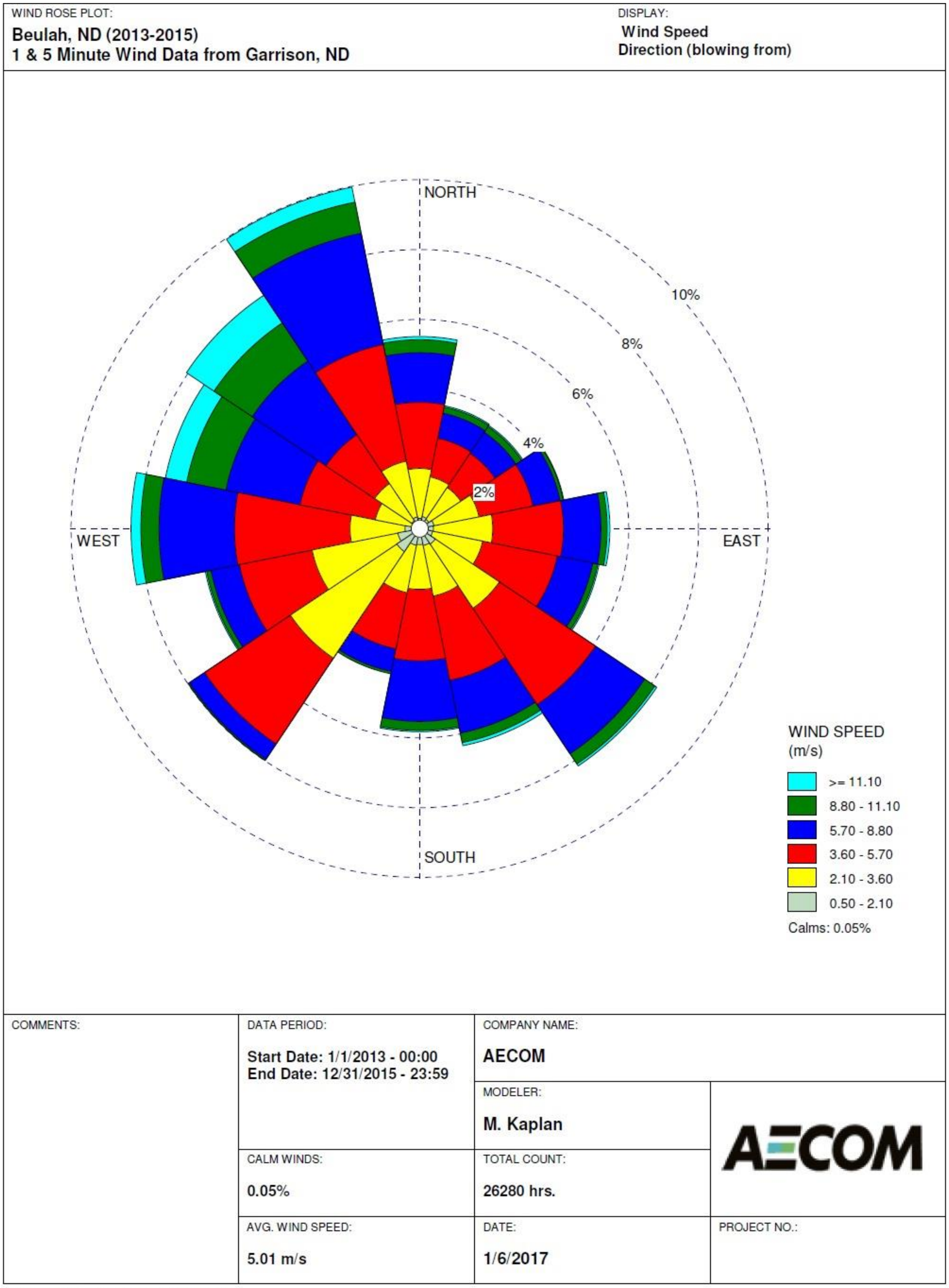
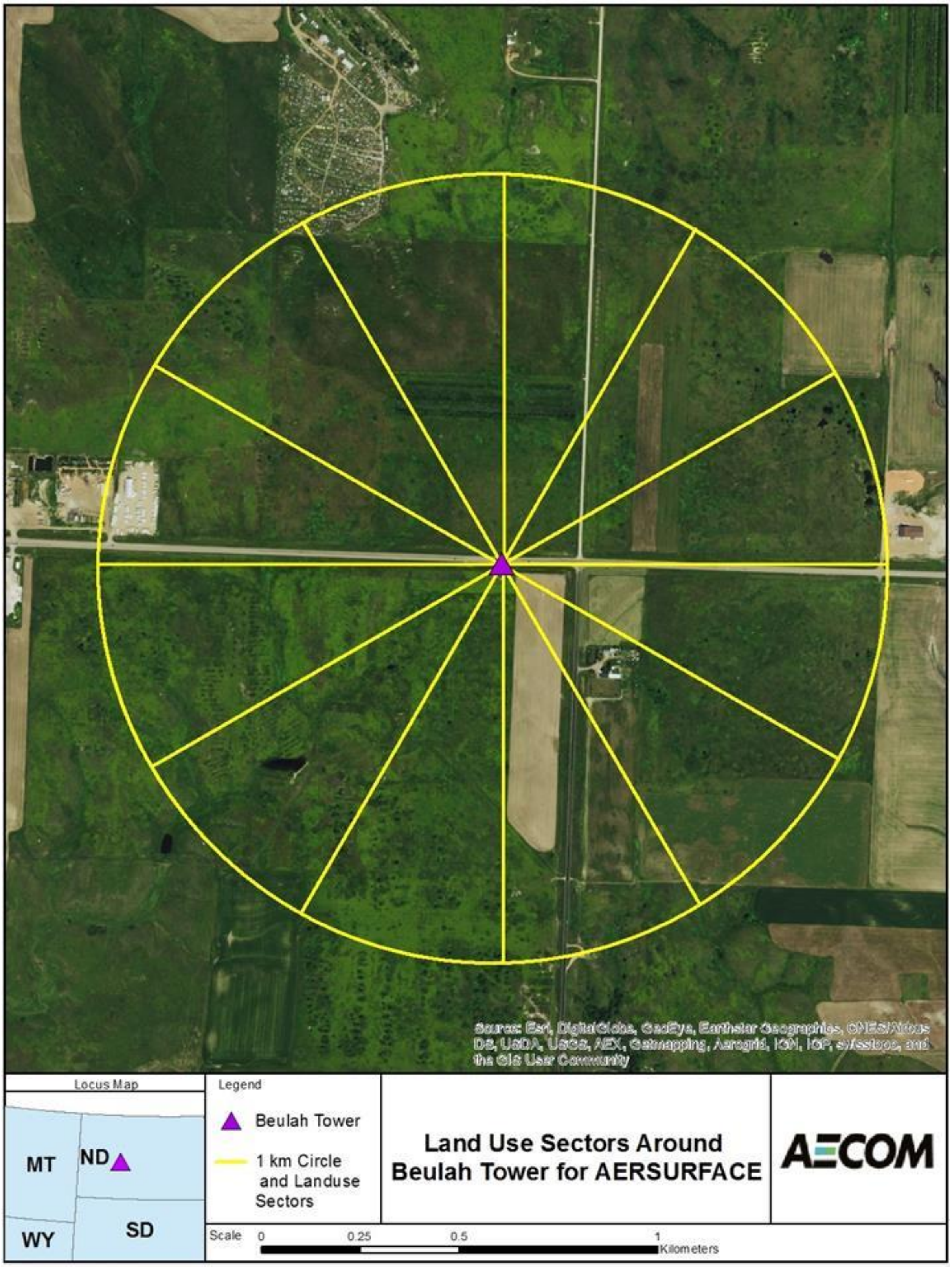


Figure 3-8: Beulah Wind Rose (2013-2015)



WRPLOT View - Lakes Environmental Software

Figure 3-9: Land Use Sectors Around Beulah Tower for AERSURFACE



4. SO_2 Characterization Modeling Results

The 1-hour SO2 characterization modeling for AVS, GPSP and Coyote adheres to the following guidance documents (where applicable): (1) the August 2016 "SO2 NAAQS Designations Modeling Technical Assistance Document" (TAD) issued in draft form by the EPA, (2) the final DRR for the 2010 1-hour SO_2 primary NAAQS, (3) the final NDDH modeling protocol (December 1, 2016), and (4) direction received from the NDDH Modeling Staff.

The modeling was conducted with the EPA regulatory default option with seasonal hourly background from the Dunn Center monitor and the concentration isopleths are plotted in Figure 4 1. The figure indicates that there is a peak area northeast of AVS and another area southeast of GPSP. Both areas of peak impact occur on relatively flat terrain in close proximity to the fenceline.

Table 4-1 shows the design concentration due to each source separately (at different locations), without background concentration added. AVS and GPSP have the highest localized impacts and Coyote Station is predicted to have the smallest impact. The highest impacts from AVS and GPSP do not occur during the same period or location.

Table 4-2 shows the NAAQS compliance modeling results of the three facilities and monitoring background combined. The peak design concentration occurs in flat terrain about 1 kilometer to the northeast of AVS. The results show compliance with the 1-hour SO_2 NAAQS by a comfortable margin. Modeling of GPSP sources on AVS property and modeling of AVS sources on GPSP property are shown in Table 4-3.

This modeling analysis supports the designation of the area in the vicinity of AVS, GPSP and Coyote as being in attainment of the 1-hour SO_2 NAAQS. AVS, GPSP and Coyote will continue to report emissions from its continuous emission monitors and daily flare calculations, such that NDDH can continue to track emission trends to determine if there are any significant emissions increases in the future.

Table 4-1: AERMOD Modeled Peak Design SO_2 Concentrations[(1)] from Each Modeled Facility

Modeling Option	AVS Modeled Design Concentration ($\mu g/m^3$)	GPSP Modeled Design Concentration ($\mu g/m^3$)	Coyote Station Modeled Design Concentration ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
Default	82.0	119.6	80.4	196.5

(1) The "design concentration" is the 99th percentile peak daily 1-hour maximum concentration, averaged over the 3 years

Table 4-2: AERMOD Modeled Design SO_2 Concentrations[1] from All Facilities Combined (including Background Concentrations)

Modeling Option	AVS, GPSP, Coyote Facilities Modeled Design Concentration (μg/m³)	Background Design Concentration from Dunn Center (μg/m³)	Total Design Concentration (μg/m³)	NAAQS (μg/m³)
Default	130.99[2]	5.65	136.64	196.5

(1) The "design concentration" is the 99th percentile peak daily 1-hour maximum concentration, averaged over the 3 years

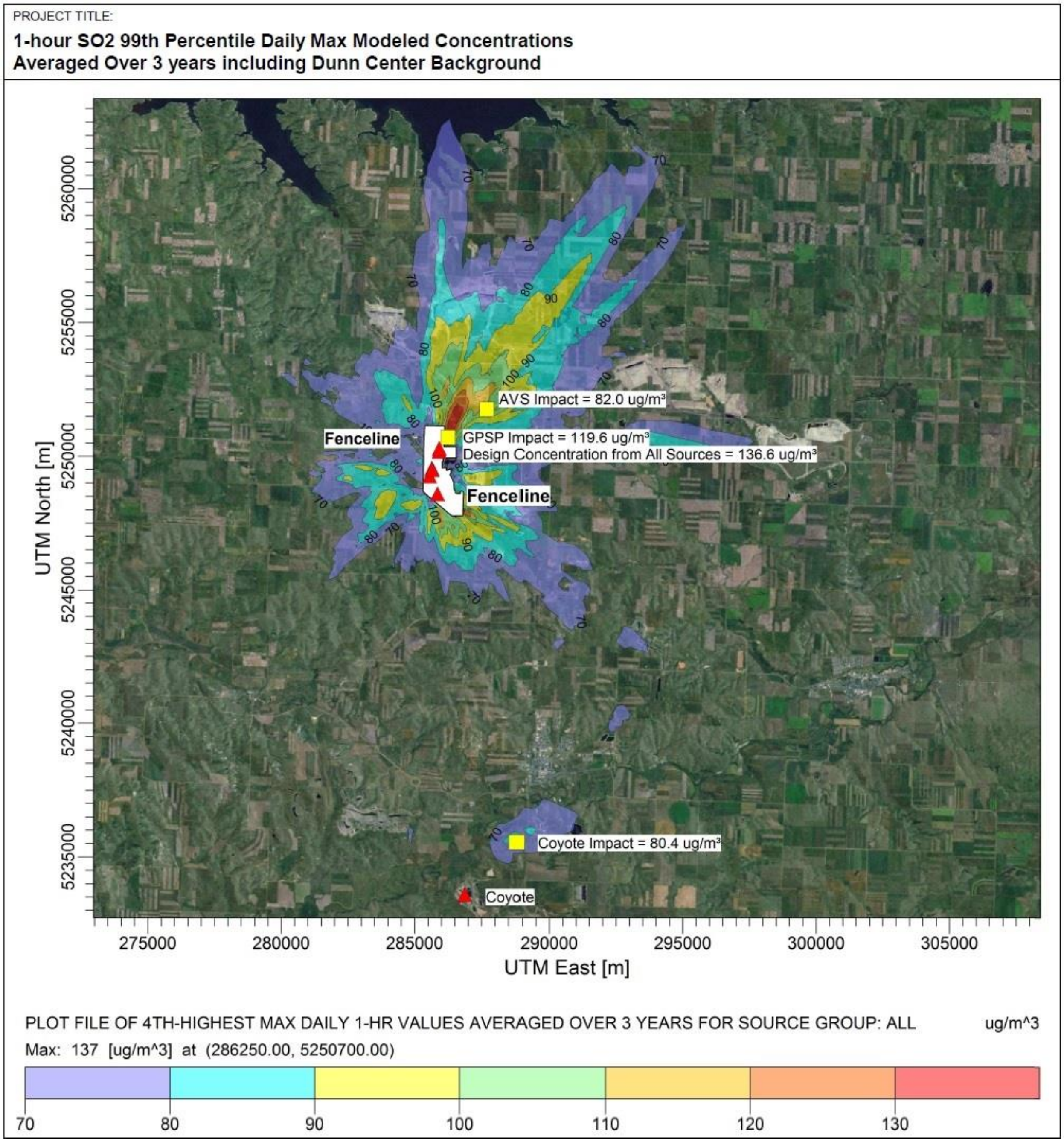
(2) GPSP contributes 106.29 μg/m³, AVS contributes 5.93 μg/m³, and Coyote contributes 18.84 μg/m³

Table 4-3: AERMOD Modeled Design SO_2 Concentrations[1] from Each Facility on Adjoining Facility Property (including Background Concentrations)

Modeling Option	AVS/Coyote Modeled Design Concentration (μg/m³)	GPSP/Coyote Modeled Design Concentration (μg/m³)	NAAQS (μg/m³)
GPSP Receptors Only	60.7	N/A	196.5
AVS Receptors Only	N/A	113.5	

(1) The "design concentration" is the 99th percentile peak daily 1-hour maximum concentration, averaged over the 3 years

Figure 4-1: 99th Percentile 3-Year Average 1-hour SO_2 Concentration Isopleths with Default Option



Appendix A

EPA Region 8 Correspondence

Kaplan, Mary

From: Cris Miller <cmiller@bepc.com>
Sent: Wednesday, January 04, 2017 12:31 PM
To: Paine, Bob; Kaplan, Mary
Cc: Anine Lambert; Daniel Whitley
Subject: Updated Supplement and Requested Modeling Files--for AVS & GPSP

Please insert this e-mail string approving the Modeling Protocol as an appendix in the final Modeling Report.

Cris Miller
Senior Environmental Project Specialist
Basin Electric Power Cooperative
1717 E Interstate Avenue | Bismarck, ND 58503
Direct: 701.557.5635 | Cell: 701.202.6972 | Fax: 701.557.5338
cmiller@bepc.com | basinelectric.com

BASIN ELECTRIC POWER COOPERATIVE
A Touchstone Energy® Cooperative

From: O'Clair, Terry L. [mailto:toclair@nd.gov]
Sent: Wednesday, January 04, 2017 10:37 AM
To: Cris Miller <cmiller@bepc.com>
Cc: White, Rob J. <rwhite@nd.gov>
Subject: [External] FW: Updated Supplement and Requested Modeling Files--for AVS & GPSP

External Email - Use caution clicking links or opening attachments

Cris,

I am forwarding you a message we received from EPA Region 8. It shows you have the green light to move forward with the modeling based upon the protocol.

Terry

From: Matichuk, Rebecca [mailto:Matichuk.Rebecca@epa.gov]
Sent: Wednesday, January 04, 2017 10:33 AM
To: White, Rob J.; Clark, Adam
Cc: O'Clair, Terry L.
Subject: RE: Updated Supplement and Requested Modeling Files--for AVS & GPSP

CAUTION: This email originated from an outside source. Do not click links or open attachments unless you know they are safe.

Hi Terry and Rob,

Thank you for providing the supplemental documents for AVS and GPSP. Based on our review of the additional information, the approach to conducting the dispersion modeling for EPA's SO2 DRR aligns with EPA's guidance, and sufficient information has been provided to EPA Region 8 for the DRR sources to proceed with the dispersion modeling using the methodology outlined in these documents. Please keep us informed of any changes to current methodology.

We have also sent an email with the questions discussed yesterday to our HQ folks. We will let you know when we receive responses.

Again, we appreciate the time taken to coordinate your efforts with us. Please let us know if you have any questions, or if any issues occur during the modeling efforts that you would like to discuss.

Thanks,
Rebecca
303-312-6867

From: White, Rob J. [mailto:rwhite@nd.gov]
Sent: Thursday, December 29, 2016 1:27 PM
To: Clark, Adam <Clark.Adam@epa.gov>; Matichuk, Rebecca <Matichuk.Rebecca@epa.gov>
Cc: O'Clair, Terry L. <toclair@nd.gov>
Subject: FW: Updated Supplement and Requested Modeling Files--for AVS & GPSP

Rebecca and Adam,

I am forwarding to you an email with links to the requested Supplemental Document and related computer files for the last two ND DRR sources, namely AVS and GPSP. Since the two plants are adjacent to each other, they will be modeled in the same analysis and their supplemental information was included together in one document and one set of computer files. We did get an earlier submittal, but there was one aspect of the analysis that we felt needed more explanation, so we asked them to expand the explanation there. Their original submittal included a hardcopy document and a CD. To speed up the process, we suggested, and they provided, links for an ftp-type internet transfer (as MDU did recently), which they included in this email. The links are for the Supplemental Document and all of the computer files.

After quickly checking this submittal over, this submittal looks pretty good and complete, with the requested discussion added, so we are sending it to you now for your review as you requested. We thought we should make a few comments as well, one of which is longer than the others.

The subject of our request for more information was an additional source included in the Supplemental Document without enough explanation. The additional SO2 source was the Bypass Stack at the GPSP. I have heard of a Bypass Stack at GPSP now and then over the years, but I've never seen it included in a modeling analysis, so I assumed it was part of an alternate operating scenario that normally isn't modeled because it is much less frequent than normal operations or has a lower impact than normal operations.

I haven't worked closely on modeling for GPSP over the years, it was normally handled by Steve Weber (who has retired), so I don't have complete knowledge of all modeling for GPSP done over the years. The analyses I've seen most often were for SO2 Class I increments, which I was very involved with. I had files with information on our most recent modeling analysis for SO2 Class I increment consumption, which included information from many sources including for GPSP. In any Class I increment analyses I recall seeing, as well as any other SO2 modeling analyses, we typically included only the four SO2 sources at GPSP that were included in our Table 4-1: the Main Stack, Main Flare, Startup Flare, and Backup Flare. I don't recall seeing a table in a modeling-related document including the Bypass Stack or an input file that included the Bypass Stack, so I didn't include it in our Protocol. From past experience with GPSP, I don't think we were expecting to see the Bypass Stack in a modeling analysis, so when DGC included it in their Supplemental Document, we had to request more information from the company to explain how this source operates.

Since Tom Bachman is back in the office, I asked Tom what his understanding was of the purpose for the Bypass Stack at GPSP. From what Tom told me, it sounded like the Bypass Stack was for an alternate operating scenario involving the Main Stack being down, which was pretty infrequent. In addition, the Bypass Stack has similar stack parameters and the processes should be the same that vent to the Main Stack, and there is no good reason we are aware of for emissions to vent from both stacks at the same time since one stack operates in place of the other, so it sounded like that was the reason why the Bypass Stack isn't normally modeled. The two stacks are more or less equivalent, but the Main Stack is part of normal operations, whereas the Bypass Stack operates when the Main Stack or processes that vent to it are down, so it is used infrequently.

One other aspect of these analyses is important to mention too. Any modeling analysis for GPSP that I've ever seen included sources modeled with constant emission rates, probably allowable, permitted, or some type of maximum emission rates. I don't recall seeing GPSP being modeled with anything other than constant emission rates. My understanding was that these two sources don't typically operate at the same time, because one source operates in place of the other, so including both of them using constant maximum emission rates would duplicate emissions and be unrealistically conservative.

This is consistent with Tom's understanding of these sources. He thought that maybe including them both in the same analysis might be okay if both were modeled using hourly emissions, as we are doing in this DRR SO2 modeling analysis. In this case, from my understanding, an analysis using hourly emissions data at GPSP could include both stacks, but during any given hour only one source or the other would be emitting, so in an hourly analysis there would be no duplication of emissions, such as in a more typical analysis at constant maximum emissions.

I ran this explanation past DGC and asked them if this was more or less correct, if they could confirm that, and asked if they could give us a more complete explanation of how the Main Stack and Bypass Stack operate, especially if they are both included in the same modeling analysis. In the Supplemental Document accessed by the links in this email (below), DGC gave a much better explanation of the purposes for the Main Stack and Bypass Stack and how they operate, which affects how they might be modeled. I think DGC more or less confirmed our general understanding, but they gave many more details, which illustrates the potential complexity of the operations of these two sources. You can read it for yourself in their Section 2.2.1 on pp. 2-2 and 2-3 for the details.

In brief, their discussion states that five separate processes all operate independently and can vent to either the Main Stack or Bypass Stack individually. Emissions vent to the Bypass Stack when any of the five processes start up or shut down, as well as during outages involving scrubber maintenance or malfunction. Since the five processes operate independently, some combination of emissions from the five processes may vent to either stack at any time, so there is a possibility of emissions from both stacks at the same time, but one process can vent to only one stack at a time, so maximum emissions from both stacks would be impossible.

This explains why a typical modeling analysis for GPSP under normal operations could include just the Main Stack using its maximum emissions without the Bypass Stack. Since now we are modeling using hourly emissions data and both the Main Stack and Bypass Stack collect CEMS data, we can model the most refined analysis for GPSP using hourly emissions data including both the Main Stack and the Bypass Stack. This is the explanation for why an additional source was included in the Supplemental Document for GPSP beyond what was included in Table 4-1 in our Protocol.

Thus, you will find the additional source and its source data in their table of source data, in their Table 2-3. Otherwise, our stack parameters from our Table 4-1 match pretty well. As with the other sources, the companies can provide the most refined and accurate UTM coordinates for their sources, somewhat different from those in our last modeling analysis for these sources. Their UTM coordinates are pretty close to ours and off similarly to the difference between values from NAD83 vs. NAD27, so the different datum may be the main reason for the difference in coordinates.

We could mention that there appears to be a mistake in reporting the version from one of the programs in the analysis. In their Section 3.3, they report using the latest version of AERMAP, which was reported to be Version 15181. The latest version of AERMAP, which was to be used in the DRR modeling analyses, is Version 11103, which didn't change with the recent AERMOD update. Since the last version of AERMOD was Version 15181, it seems likely they accidentally transposed the version number of AERMAP with that of AERMOD in this case. There is no newer version of AERMAP, such as 15181, that could accidentally be used, and an older version probably wouldn't work with most of the software anyway, so it seems pretty certain that they were planning to use the current version of AERMAP, but just reported the wrong version number.

Otherwise, the link to the requested computer files includes the same selection of computer files as in the other supplemental documents so far. In particular, the folder with emissions data looks to be pretty complete, with available CEMS data, calculated GPSP flare emissions data, and AERMOD hourly input data, for all sources including the nearby source Coyote Station. Thus, as I said before, I think this submittal is pretty good and complete, but you can review it for yourselves.

The links were created with an expiration date of 12-29-2016, which is today, so we should ask Cris Miller if he could make the links available for another week, as we did with MDU's links. I have downloaded the files using the links below and they all worked and the zip files unzipped correctly. If Adam gets this email soon enough, he may be able to download the files from these links and make them available to Rebecca, but this is cutting it very close to the links' expiration date, so we will request that the links' expiration dates be extended another week.

I will let you know if the expiration date of the links is extended. At least Adam may get a chance to start review using these links.

Rob

Rob White
Division of Air Quality
ND Dept. of Health

918 E. Divide Ave., 2nd floor
Bismarck, ND 58501
701-328-5181
rwhite@nd.gov

From: Cris Miller [mailto:cmiller@bepc.com]
Sent: Thursday, December 22, 2016 3:36 PM
To: O'Clair, Terry L.
Cc: White, Rob J.
Subject: Updated Supplement and Requested Modeling Files

Terry

As requested, attached are the electronic files of updated Modeling Protocol and Modeling input files.

Will be submitted in letter form and CD as well.

Call if questions/comments…..Cris

Cris Miller
Senior Environmental Project Specialist
Basin Electric Power Cooperative
1717 E Interstate Avenue | Bismarck, ND 58503
Direct: 701.557.5635 | Cell: 701.202.6972 | Fax: 701.557.5338
cmiller@bepc.com | basinelectric.com

BASIN ELECTRIC POWER COOPERATIVE
A Touchstone Energy® Cooperative

Mary Kaplan has sent you 2 files using AECOM's File Transfer System.

Mary Kaplan says:

Updated Supplement and Modeling Files

These files will be available for download until 12/29/2016

File	Description	Size
AVS-GPSP - Supplemental Information to NDDH - SO2 DRR Modeling Protocol_122216_.pdf		4,023KB
AVSGPSPCoyote_Model Inputs.zip		96,569KB

Download all files (.zip)

If you are having trouble accessing the links in this email, you can view this message as a web page by copying the following link and pasting it into your browser:

https://sendfiles.aecom.com/message.aspx?msgId=72707697-b719-45c1-86a3-3e4fce4a148f

If you have any questions, please contact your project manager.

Protocol for Modeling Analyses Used to Address EPA's Data Requirements Rule (DRR) for 1-hour SO_2 NAAQS Designations in North Dakota
North Dakota Department of Health
Dated: March 2016
Received: May 10, 2016

EPA Region 8 – Air Program Comments
06/15/2016

We appreciate the opportunity to review and provide comments on the North Dakota Department of Health (NDDH) modeling protocol for the 1-hour Sulfur Dioxide (SO_2) Data Requirements Rule (DRR). We have outlined some questions and recommendations for consideration. Addressing these areas during the modeling protocol stage will assist us in determining whether all components of the analysis align with EPA guidance for the SO_2 DRR modeling analysis. We look forward to continuing our discussions related to these areas and determining a path forward that works for all groups.

1. **Applicable Sources [pages 2, 10 – 20]:** According to the draft protocol, the current assumption will be that the five facilities listed in Table 1 below will be pursuing the modeling option so that the modeling protocol will address all five facilities in Table 1. The protocol also notes that it is expected that the companies owning the subject DRR sources will want to perform their own SO_2 modeling analyses. Therefore, this modeling protocol informs the companies of the modeling methodology expected by EPA and the State.

   We agree that the five facilities listed in Table 1 should be considered for the remaining 1-hour SO_2 DRR obligations. Note that EPA also agrees with NDDH in that the Coyote, Stanton, and Coal Creek Stations have been addressed under the Consent Decree rule, and that additional modeling is not needed.

   Table 1: Sources to be addressed for the DRR and Covered by the NDDH Modeling Protocol.

Facility	Company
Antelope Valley Station, Units 1 & 2	Basin Electric Power Coop.
Milton R. Young Station, Units 1 & 2	Minnkota Power Coop.
R. M. Heskett Station, Units 1 & 2	Montana Dakota Utilities, Co.
Great Plains Synfuels Plant	Dakota Gasification Company
Tioga Gas Plant	Hess Corporation

   In an email from Rob White (Division of Air Quality, NDDH) on May 27, 2016, Rob provided EPA Region 8 information on the facilities pursing the modeling pathway (instead of the monitoring pathway) and whether any of the facilities will be requesting the approval to use non-regulatory default options. Based on the information provided by Rob, the Tioga Gas Plant may be pursuing the monitoring pathway instead of the modeling, and the R.M. Heskett Station may be the only facility pursuing non-regulatory default options. The Environmental Director of the Montana-Dakota Utilities (Abbie Krebsbach) also sent an email to EPA on June 3, 2016 informing EPA that the R.M. Heskett Station may also consider the monitoring pathway.

   EPA appreciates the update provided by Rob White and the Montana-Dakota Utilities Director. However, EPA recommends that NDDH determines the analysis pathway that each facility plans to pursue by July 1, 2016 and updates the modeling protocol to reflect the decisions. As required by the DRR and codified at 40 CFR 51.1203(b), the State must notify EPA by July 1, 2016 as to whether it will characterize its DRR sources through monitoring, modeling **OR** establishing an emissions limit of less than 2,000 tpy SO_2 (DRR Final Rule at 80 FR 51087, 8/21/15). A modeling **AND** monitoring protocol cannot be submitted to EPA for review, or a facility cannot pursue both the modeling and monitoring pathways after July 1, 2016. Therefore, EPA will assume that the Tioga Gas Plant and R.M. Heskett Station will be modeling if it remains in the NDDH modeling protocol after July 1, 2016.

2. **Specific Model Input Assumptions and Configuration Options for Each DRR Source:** The protocol provides a substantial amount of information related to the characteristics and conditions of each facility throughout the document, and outlines input assumptions and configurations that are expected to be utilized in the modeling analyses for each facility. The protocol also provides options for some of the model input assumptions and configuration options, and notes that some options will be determined by or based on the facility. For instance, the areas that have options or will be determined by facility, include:
    a. Non-regulatory default options;
    b. AERSURFACE configuration options;
    c. Building downwash assumptions for building dimensions;
    d. Receptor networks and fenceline receptors; and
    e. Background concentrations.

   To ensure that these areas or the areas that have options align with EPA air quality modeling guidance, we recommend determining the options, and associated details/input assumptions, that each facility will use in their modeling analysis during the modeling protocol phase. In particular, EPA would like to review maps of the receptor network and source locations, the input assumptions and building dimensions used for building downwash, and (if possible) the hourly emissions, varying stack velocities, and temperatures at the modeling protocol stage. These details should be provided in the modeling protocol by the January 13, 2017 deadline.

   Given the modeling protocol approach taken by NDDH, it is not clear whether these details should be determined and explicitly stated in the NDDH modeling protocol, or if it would be more efficient to have the individual facilities submit an additional modeling protocol or supplemental document that outlines the options selected and deviations from the NDDH modeling protocol. In any case, the details and options should be obtained and agreed upon before finalizing the modeling protocol and before the final modeling is performed for each source. This ensures that no disparities occur during the modeling efforts.

3. **Receptor Network [page 46]:** We recommend providing spatial maps of the receptor networks to better understand the receptor locations and their positions relative to the sources, the fence line, or other important features. We recommend providing this information with the modeling protocol to assist in better understanding the receptor layout and ensuring that a proper receptor network is used for the modeling analysis.

4. **Fenceline Receptors [page 48]:** The protocol states that fenceline receptors, with 25-meter spacing, will generally be required for the modeling. However, the protocol notes that it may be acceptable to omit the fence-line receptors if the facility includes only tall-stack sources and no short-stack sources or surface releases. We recommend including fenceline receptors for all facilities/sources, and omitting the text allowing for the exclusion of fenceline receptors.

5. **Background Concentrations [page 57]:** The protocol notes that a constant 1-hour SO_2 background concentration could be assumed for the air quality modeling analysis. However, the protocol does not provide details on the formulation of this value. Therefore, we recommend providing the details and methodology to support the constant value, including the number of years, which years, how the value is representative, how the methodology aligns with EPA guidance, etc.

6. **Analysis of Model Results and Documentation [page 72]:** The protocol states that a report will be submitted to the NDDH and EPA for each DRR source. The reports will contain a summary of the relevant information provided in the protocol, including the modeling procedures followed, and a summary and analysis of the modeling results. We recommend adding details to this section to explain the specific analyses, calculations, graphical displays that NDDH expects to be completed for the DRR modeling. In particular, we recommend requesting the following analyses and graphical displays:
   - total predicted design concentrations,
   - wind rose plots of the meteorological conditions, and
   - spatial contour plots of the modeled concentrations.

   These calculations and graphical displays assist in the interpretation of the results.

   While the protocol notes that State's modeling to support the 1-hour SO_2 NAAQS designation process will use EPA's Guideline model AERMOD (i.e., utilization of AERMOD default options), the State or the owner of the DDR source may obtain approval for use of a non-regulatory default option in AERMOD or AERMET and that this approval should be obtained before the final modeling is performed. EPA agrees with the approval process and procedures outlined in the protocol for the use of non-regulatory default options. However, it is not clear whether NDDH will require the facilities to complete simulations using the default options AND non-regulatory default options. We recommend that NDDH clarifies whether the sources will need to conduct a simulation with the default options and another simulation with the non-regulatory default options in this section of the protocol, and specify which model results will be summarized in the final report. NDDH may also want to include this information in section 3.3 (Possible Use of Non-Regulatory Default Beta Options) of the modeling protocol.

Appendix B

Example Flare Calculations

Main Flare:

The following is an explanation of the columns and rows of the spreadsheet titled “Main” and a discussion of the equations within this spreadsheet. The following columns and rows are general to the discussion of the individual flare streams used for calculating sulfur dioxide (SO_2) emissions from the Main Flare:

- Column A is a date/time stamp indicating the ending time of process.
- Columns B and C are the daily lab samples copied from the “Startup” flare spreadsheet, in percent H_2S, as discussed in the Startup Flare discussion. Some process streams routed to the flare are normalized to the daily flare samples for the raw gas and CO2 gas streams.
- Calculations in rows 7 through 38 are daily averages of the hourly data for each day The values in these rows are saved as part of the permanent record for the flare; each month, a new spreadsheet is generated while the prior month’s is saved.
- Calculations in rows 47 through 76 are hourly averages. Each days’ hourly averages are overwritten for each new day, A separate annual log of the summed emissions for each hour of each day is saved, an excerpt for the year 2016 is included as “Daily Flare” (note: the individual values and calculations for each hour are not saved in this annual log, only the final summed hourly SO_2 emissions).
- Calculations in rows 101 through 196 are 15-minute averages. These values are also overwritten each day.

Rectisol:

Columns D through L are used for calculating emissions from Rectisol off-gases. Typically these gases are sent directly to the boilers. In extreme circumstances these gases may need to be flared. Columns D, F, H, and J pull the flow rates from the process tags for the various Rectisol streams. Columns E, G, I, and K calculate SO_2 lb/hr for each Rectisol stream using the below equation. Column L sums together columns E, G, I, and K for the total Rectisol off-gas emission that could occur if routed to the Main Flare. In rare cases where the Rectisol gases are flared instead of sent to facility boilers, the summed value in column L is manually added into the total flare emissions calculation in column BC.

$$Flow\ rate\ x\ 1000\ x\ \frac{\%H2S}{100} x \frac{100-\%H2O}{100} x \frac{64}{379} = \mathrm{pphSO2}$$

Flow rate of flared Rectisol gas (from columns D, F, H, or J): as expressed in MSCFH

1000: conversion from MSCFH to SCFH

%H_2S: the standard measured percentage of H_2S in each individual gas stream based on previous testing, standard values are located in row 42

%H_2O: the standard measured percentage of H_2O in each individual gas stream based on previous testing, standard values are located in row 41

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Phosam:

Columns M through U are used for calculating emissions from Phosam off-gases. Columns M through P provide flow rates for specific Phosam streams from process tags. Columns R through U are the process values for plant valves related to the Phosam streams (only the valve in column U is used for calculations herein; the rest provide back-up verification). These valves indicate if Phosam gases are being sent to facility boilers or are flared in the Main Flare.

Column M is a process value, the sum of both Phosam overhead train flows. Column N is a calculation determining the amount of gas from column M that is actually flared by multiplying column M by column U.

Columns O and P are the individual trains from 4600 overheads. These columns are not used in any flare calculations but are present to confirm if Column M is summing correctly.

Column Q calculates the possible SO_2 pounds per hour (lb/hr) using the following equation if Phosam gases are sent to the Main Flare:

$$Flow\ rate\ x\ 1000\ x\ \frac{\%H2S}{100}\ x\ \frac{100-\%H2O}{100}\ x\ \frac{64}{379} = \mathrm{pphSO2}$$

Flow rate (column M): as expressed in MSCFH

1000: conversion from MSCFH to SCFH

%H_2S: the standard measured percentage of H_2S in each individual gas stream based on previous testing, standard values are located in row 42

%H_2O: the standard measured percentage of H_2O in each individual gas stream based on previous testing, standard values are located in row 41

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Column V calculates the actual amount of SO_2 in lb/hr sent to the main flare, and is calculated by multiplying together columns Q and U. Column V is the value that gets summed into the total flare emissions calculation in column BC.

Main Flare Dry Header:

Columns W through AO are calculations for several different process streams that can be routed to the main flare dry header.

Columns W, Y, and AA are flared gas flows in MMSCFH from specific process streams. Columns X, Z, and AB calculates SO_2 lb/hr using the following equation:

$$Flow\ rate\ x\ 1000000\ x\ \frac{CO2\ \%H2S}{100}\ x\ \%\ of\ CO2\ x\frac{64}{379} = \text{pphSO2}$$

Flow rate (from column W, Y, or AA): as expressed in MMSCFH

1000000: conversion from MMSCFH to SCFH

CO_2 %H_2S (column C): percentage of flared gas daily lab sample of CO_2 product gas measuring % H_2S; the actual flared gas is normalized to the daily value with the correction discussed below

% of CO_2 (row 42): a standard value based off previous lab data, correlating %H_2S flared to %H_2S in daily CO_2 product sample; located in row 42 (note: not a really a %, so not divided by 100)

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Columns AC and AE are flared gas flows in MSCFH for specific process streams. There was an issue with these process tags giving negative numbers. Originally an offset was used in cell AC3 and AE3, this was replaced by using an Excel Max function in the calculation columns AD and AF to replace negative numbers with zeroes. Columns AD and AF calculate SO_2 lb/hr using the following equation:

$$Flow\ rate\ x\ 1000\ x\ \frac{CO2\ \%H2S}{100} x\ \%\ of\ CO2\ x\frac{64}{379} = \text{pphSO2}$$

Flow rate (from column AC or AE): as expressed in MSCFH

1000: conversion from MSCFH to SCFH

CO_2 %H_2S (column C): percentage of flared gas daily lab sample of CO_2 product gas measuring % H_2S; the actual flared gas is normalized to the daily value with the correction discussed below

% of CO_2 (row 42): a standard value based off previous lab data, correlating %H_2S flared to %H_2S in daily CO_2 product sample; located in row 42 (note: not a really a %, so not divided by 100)

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Columns AG, AH, and AI are flared gas flows in MMSCFH for specific process streams associated with the CO2 gas compressors. Column AJ calculates SO_2 lb/hr using the following equation for the summed process streams from the CO2 gas compressors:

$$Flow\ rate\ x\ 1000000\ x\ \frac{CO2\ \%\ H2S}{100}\ x\ \frac{64}{379} = \text{pphSO2}$$

Flow rate (columns AG+AH+AI): as expressed in MMSCFH, flow rate is the sum of the flows in column AG, AH, and AI

1000000: conversion from MMSCFH to SCFH

CO_2 % H_2S (column C): daily lab sample of CO_2 product gas measuring % H_2S

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Column AK is flared gas flows in SCFH. Column AL calculates SO_2 lb/hr using the following equation:

$$Flow\ rate\ x\ \frac{CO2\ \%H2S}{100}\ x\ \%\ of\ CO2\ x\ \frac{64}{379} = \text{pphSO2}$$

Flow rate (column AK): as expressed in MSCFH

CO_2 %H_2S (column C): percentage of flared gas daily lab sample of CO_2 product gas measuring % H_2S; the actual flared gas is normalized to the daily value with the correction discussed below

% of CO_2 (row 42): a standard value based off previous lab data, correlating %H_2S flared to %H_2S in daily CO_2 product sample; located in row 42 (note: not a really a %, so not divided by 100)

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Column AM sums the total of columns X, Z, AB, AD, AF, AJ, and AL. This is the total SO_2 flared from the Dry Gas Header.

Columns AN and AO are process flows of SNG. These gases do not contribute to SO_2 emissions. The data is collected for use in the emission inventory and NO_X PAL.

Main Flare Wet Header:

Columns AQ through BA are calculations for several different process streams that can be routed to the main flare wet header.

Columns AQ and AR are process flows of SNG for specific process streams. These gases do not contribute to SO_2 emissions. The data is collected for use in the emission inventory and NO_X PAL.

Column AS is flared gas flow in MSCFH. Column AT calculates SO_2 lb/hr using the following equation (an Excel Max function is used to prevent negative numbers):

$$Flow\ rate\ x\ 1000\ x\ \frac{Raw\ gas\ \%\ H2S}{100}\ x\frac{64}{379} = \mathrm{pphSO2}$$

Flow rate (column AS): as expressed in MSCFH

1000: conversion from MSCFH to SCFH

Raw gas % H_2S (column B): daily lab sample of raw gas measuring % H_2S

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Column AU and AV is flared gas flow in MSCFH. Column AW calculates SO_2 lb/hr using the following equation (an Excel Max function is used to prevent negative numbers):

$$Flow\ rate\ x\ 1000\ x\ \frac{Raw\ gas\ \%\ H2S}{100}\ x\ 0.72\ x\frac{64}{379} = \mathrm{pphSO2}$$

Flow rate (columns AU + AV): as expressed in MSCFH, combined flow from column AU and AV

1000: conversion from MSCFH to SCFH

Raw gas % H_2S (column B): daily lab sample of Raw gas measuring % H_2S

0.72: a correction for % moisture in this flared gas stream

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Column AX is flared gas flow in MSCFH. Column AY calculates SO_2 lb/hr using the following equation:

$$Flow\ rate\ x\ 1000\ x\ (1 - 0.15)\ x\ 0.75\ x\ \frac{Raw\ gas\ \%\ H2S}{100}\ x\frac{64}{379} = \mathrm{pphSO2}$$

Flow rate (column AX): as expressed in MSCFH

1000: conversion from MSCFH to SCFH

(1-0.15): subtracts out 15 percent moisture in the gas stream; based on previous testing

0.75: a standard value based off previous lab data, correlating %H_2S flared to %H_2S in daily raw gas product sample

Raw gas % H_2S: daily lab sample of Raw gas measuring % H_2S

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Column AZ is flared gas flow in MSCFH. Column BA calculates SO_2 lbs/hr using the following equation, a Max function is used to prevent negative numbers.

$$Flow\ rate\ x\ 1000\ x\ (1 - 0.15)\ x\ 0.75\ x\ \frac{Raw\ gas\ \%\ H2S}{100}\ x\frac{64}{379} = \mathrm{pphSO2}$$

Flow rate (column BA): as expressed in MSCFH

1000: conversion from MSCFH to SCFH

(1-0.15): subtracts out 15 percent moisture in the gas stream; based on previous testing

0.75: a standard value based off previous lab data, correlating %H_2S flared to %H_2S in daily Raw gas product sample

Raw gas % H_2S: daily lab sample of raw gas measuring % H_2S

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Total Flare SO_2 and Leakage Calculations:

Column BB is process flow of SNG. This gas does not contribute to SO_2 emissions. The data is collected for use in the emission inventory and NO_X PAL.

Column BC is total SO_2 flared from all monitored sources. This column sums emissions calculated from columns V (Phosam), AM (Main Flare Dry Header), AT, AW, AY, and BA (Main Flare Wet Header).

Column BD is total SO_2 flared from all monitored sources, plus SO_2 from leakage, discussed below.

Column BE is the leakage or background level of SO_2 emissions to the Main Flare. Background level is defined by DGC's PAL monitoring program as follows: "*The background levels of SO_2 in the Main Flare are calculated periodically by taking at least one valid sample of the flare system each calendar month that the plant is under normal operation. That sample is then analyzed for H_2S. Bag samples that have less than 1% oxygen in them are considered valid if no known sources of H_2S were already being added to the flare at the time of the sample. Baseline levels are added to the calculated values for SO_2 when determining emissions from the Main Flare.*"

Leakage is calculated using the following equation. This a manual entry that is updated after the monthly sample is taken. Cell BD2 contains the manual entry that is used for the hourly calculation.

$$Flow\ rate\ x\ \frac{\%\ H2S}{100}\ x\frac{64}{379.4} = \text{pphSO2}$$

Flow rate: flow rate calculated during time of bag sample in SCFH

% H_2S: bag sample % H_2S

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

	A	B	C	D	E	F	G	H	I	J	K	L
1				**A-Train**		**B-Train**		**Rectisol OFF GASES**				
2				PC14026.OP		PC14526.OP				**DA1408**	**6.5**	**MEOH Scrubber Off Gas**
3				FI14034.PV		FI14534.PV		PC14111.OP		PC14057.OP		**Azeotrope Waste Gas**
4				Hot Regen		Hot Regen		CFI14862.PV		CFI14863.PV	**Total**	**Naphtha Stripper**
5		Raw Gas	CO2	MEOH Scrubber Off Gas		MEOH Scrubber Off Gas		Azeotrope Waste Gas		Naphtha Stripper		**TOTAL AD,AF,AH**
6		%H2S	%H2S	MSCFH	**SO2 lbs**	MSCFH	**SO2 lbs**	MSCFH	**SO2 lbs**	MSCFH	**SO2 Lb/Hr**	**SO2 Lb/Hr**
7	11/1/2016 0:00	0.52	1.40	**111.60**	**306.24**	**145.15**	**392.16**	**232.46**	**433.37**	**0.36**	**11.46**	**1143**
8	11/2/2016 0:00	0.41	1.30	**115.33**	**316.46**	**147.23**	**397.79**	**216.56**	**403.74**	**0.36**	**11.46**	**1129**
9	11/3/2016 0:00	0.43	1.30	**106.43**	**292.04**	**144.79**	**391.19**	**246.55**	**459.63**	**0.36**	**11.46**	**1154**
10	11/4/2016 0:00	0.51	1.40	**110.61**	**303.52**	**139.45**	**376.78**	**252.78**	**471.25**	**0.34**	**10.80**	**1162**
11	11/5/2016 0:00	0.51	1.40	**101.24**	**277.82**	**139.76**	**377.61**	**377.33**	**703.44**	**0.36**	**11.43**	**1370**
12	11/6/2016 0:00	0.47	1.50	**106.17**	**291.34**	**145.60**	**393.40**	**359.96**	**671.06**	**0.36**	**11.48**	**1367**
13	11/7/2016 0:00	0.47	1.10	**105.51**	**289.52**	**121.16**	**327.34**	**194.90**	**363.35**	**0.32**	**10.23**	**990**
14	11/8/2016 0:00	0.45	1.30	**114.41**	**313.96**	**143.38**	**387.39**	**383.35**	**714.67**	**0.36**	**11.44**	**1427**
15	11/9/2016 0:00	0.24	1.30	**104.24**	**286.03**	**142.85**	**385.97**	**370.33**	**690.40**	**0.36**	**11.47**	**1374**
16	11/10/2016 0:00	0.50	1.20	**119.37**	**327.56**	**143.92**	**388.86**	**305.37**	**569.30**	**0.36**	**11.47**	**1297**
17	11/11/2016 0:00	0.51	1.40	**119.75**	**328.60**	**145.16**	**392.20**	**319.51**	**595.66**	**0.36**	**11.47**	**1328**
18	11/12/2016 0:00	0.44	1.50	**103.49**	**284.00**	**145.75**	**393.79**	**338.19**	**630.48**	**0.36**	**11.47**	**1320**
19	11/13/2016 0:00	0.48	1.50	**124.17**	**340.74**	**146.07**	**394.66**	**337.51**	**629.21**	**0.36**	**11.47**	**1376**
20	11/14/2016 0:00	0.00	1.50	**116.84**	**320.61**	**149.71**	**404.49**	**325.28**	**606.41**	**0.36**	**11.47**	**1343**
21	11/15/2016 0:00	0.51	1.40	**124.00**	**340.26**	**149.16**	**403.02**	**285.80**	**532.81**	**0.36**	**11.47**	**1288**
22	11/16/2016 0:00	0.43	1.40	**121.92**	**334.56**	**146.36**	**395.44**	**334.69**	**623.96**	**0.36**	**11.47**	**1365**
23	11/17/2016 0:00	0.43	1.50	**105.25**	**288.81**	**118.16**	**319.26**	**209.54**	**390.65**	**0.32**	**10.37**	**1009**
24	11/18/2016 0:00	0.43	1.40	**59.94**	**164.48**	**118.84**	**321.08**	**253.47**	**472.53**	**0.25**	**7.97**	**966**
25	11/19/2016 0:00	0.43	1.30	**83.58**	**229.34**	**111.30**	**300.71**	**284.94**	**531.21**	**0.25**	**8.11**	**1069**
26	11/20/2016 0:00	0.51	1.40	**109.41**	**300.22**	**151.58**	**409.55**	**295.20**	**550.33**	**0.36**	**11.34**	**1271**
27	11/21/2016 0:00	0.43	1.50	**108.59**	**297.96**	**149.80**	**404.75**	**203.77**	**379.89**	**0.36**	**11.47**	**1094**
28	11/22/2016 0:00	0.54	1.60	**110.32**	**302.74**	**152.48**	**411.97**	**245.20**	**457.13**	**0.36**	**11.47**	**1183**
29	11/23/2016 0:00	0.47	1.50	**113.26**	**310.80**	**152.61**	**412.32**	**224.20**	**417.96**	**0.36**	**11.47**	**1153**
30	11/24/2016 0:00	0.48	1.60	**111.62**	**306.29**	**152.29**	**411.46**	**121.02**	**225.62**	**0.36**	**11.47**	**955**
31	11/25/2016 0:00	0.46	1.40	**111.00**	**304.60**	**152.23**	**411.31**	**295.10**	**550.15**	**0.36**	**11.47**	**1278**
32	11/26/2016 0:00	0.46	1.40	**100.53**	**275.85**	**151.57**	**409.53**	**285.08**	**531.47**	**0.36**	**11.47**	**1228**
33	11/27/2016 0:00	0.39	1.40	**113.39**	**311.14**	**153.83**	**415.62**	**252.97**	**471.60**	**0.36**	**11.47**	**1210**
34	11/28/2016 0:00	0.39	1.40	**115.77**	**317.68**	**153.45**	**414.61**	**314.31**	**585.96**	**0.36**	**11.47**	**1330**
35	11/29/2016 0:00	0.36	1.30	**114.63**	**314.56**	**154.09**	**416.32**	**234.57**	**437.30**	**0.36**	**11.47**	**1180**
36	11/30/2016 0:00	0.41	1.30	**111.84**	**306.88**	**153.44**	**414.56**	**121.89**	**227.23**	**0.36**	**11.47**	**960**
37	12/1/2016 0:00	0.00	0.00	**110.63**	**303.59**	**152.88**	**413.06**	**95.01**	**177.13**	**0.35**	**11.30**	**905**
38	12/2/2016 0:00	0.00	0.00									
39	Average			109.19		144.32		268.29		0.35	**12.53**	893437.91
40												
41				**35**	**H2O%**	**20.0**	**H2O%**	**31**	**H2O%**	**0**	**H2O%**	**H2O%**
42				**2.5**	**H2S%**	**2.0**	**H2S%**	**1.6**	**H2S%**	**18.90**	**Tot S**	**H2S%**
43												
44												

	A	B	C	D	E	F	G	H	I	J	K	L
45				5.60							Typical PFD	
46											Benzene 0.9 pph	
47	**11/30/16**										SO2 18.9 pph	
48	11/29/2016 21:00	0.4099	1.30									**0**
49	11/29/2016 22:00										**18.9**	**19**
50	11/29/2016 23:00			**114.24**	**313.49**	**153.91**	**415.83**	**256.76**	**478.66**	**0.36**	0.00	**1208**
51	11/30/2016 0:00			**114.27**	**313.57**	**153.81**	**415.58**	**274.30**	**511.38**	**0.36**	0.00	**1241**
52	11/30/2016 1:00			**114.55**	**314.32**	**154.14**	**416.47**	**282.74**	**527.10**	**0.36**	0.00	**1258**
53	11/30/2016 2:00			**114.15**	**313.24**	**153.56**	**414.90**	**215.87**	**402.45**	**0.36**	0.00	**1131**
54	11/30/2016 3:00			**113.51**	**311.47**	**153.10**	**413.64**	**192.45**	**358.77**	**0.36**	0.00	**1084**
55	11/30/2016 4:00			**112.95**	**309.93**	**152.56**	**412.20**	**154.64**	**288.29**	**0.36**	0.00	**1010**
56	11/30/2016 5:00			**112.44**	**308.54**	**152.80**	**412.84**	**119.66**	**223.08**	**0.36**	0.00	**944**
57	11/30/2016 6:00			**111.82**	**306.85**	**152.81**	**412.86**	**86.00**	**160.34**	**0.36**	0.00	**880**
58	11/30/2016 7:00			**111.65**	**306.37**	**152.52**	**412.09**	**64.40**	**120.05**	**0.36**	0.00	**839**
59	11/30/2016 8:00			**111.82**	**306.85**	**151.70**	**409.86**	**35.91**	**66.94**	**0.36**	0.00	**784**
60	11/30/2016 9:00			**112.25**	**308.01**	**153.32**	**414.25**	**137.93**	**257.14**	**0.36**	0.00	**979**
61	11/30/2016 10:00			**111.87**	**306.97**	**154.16**	**416.51**	**190.52**	**355.19**	**0.36**	0.00	**1079**
62	11/30/2016 11:00			**111.71**	**306.54**	**154.68**	**417.92**	**192.41**	**358.71**	**0.36**	0.00	**1083**
63	11/30/2016 12:00			**111.89**	**307.02**	**154.28**	**416.85**	**202.75**	**377.98**	**0.36**	0.00	**1102**
64	11/30/2016 13:00			**111.45**	**305.83**	**152.81**	**412.86**	**157.71**	**294.02**	**0.36**	0.00	**1013**
65	11/30/2016 14:00			**111.56**	**306.12**	**152.83**	**412.92**	**149.89**	**279.44**	**0.36**	0.00	**998**
66	11/30/2016 15:00			**111.74**	**306.62**	**153.14**	**413.77**	**173.89**	**324.19**	**0.36**	0.00	**1045**
67	11/30/2016 16:00			**111.52**	**306.01**	**152.95**	**413.25**	**184.44**	**343.86**	**0.36**	0.00	**1063**
68	11/30/2016 17:00			**110.30**	**302.68**	**152.72**	**412.63**	**140.67**	**262.24**	**0.36**	0.00	**978**
69	11/30/2016 18:00			**110.22**	**302.46**	**152.67**	**412.50**	**56.23**	**104.84**	**0.36**	0.00	**820**
70	11/30/2016 19:00			**110.73**	**303.86**	**152.94**	**413.22**	**12.94**	**24.12**	**0.36**	0.00	**741**
71	11/30/2016 20:00			**111.12**	**304.93**	**153.32**	**414.25**	**46.62**	**86.91**	**0.36**	0.00	**806**
72	11/30/2016 21:00			**111.07**	**304.79**	**155.13**	**419.15**	**68.25**	**127.23**	**0.36**	0.00	**851**
73	11/30/2016 22:00			**112.04**	**307.43**	**155.40**	**419.86**	**76.06**	**141.79**	**0.36**	0.00	**869**
74	11/30/2016 23:00			**111.16**	**305.04**	**154.78**	**418.19**	**-2.89**	**-5.40**	**0.36**	0.00	**718**
75	12/1/2016 0:00			**110.65**	**303.64**	**154.24**	**416.73**	**-6.56**	**-12.24**	**0.36**	0.00	**708**
76	12/1/2016 1:00			**109.12**	**299.43**	**154.65**	**417.85**	**7.35**	**13.71**	**0.36**	0.00	**731**
77	12/1/2016 2:00			**109.36**		**154.02**		**-6.59**		**0.36**		
78	Average			111.84		153.44		122.19		0.36		
79												
80				120.00	**306.87**	120.00	**414.74**	120.00	**230.47**		**0.00**	**940.53**
81												
82												
83												
84											**11**	
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98												
99												
100	0:15											
101	**11/30/16**			114.7041987		154.170953		303.1705724		0.359344631		
102	11/30/2016 0:00	11/30/2016 0:15		114.5720282		154.4911416		300.2210827		0.359344631		
103	11/30/2016 0:15	11/30/2016 0:30		114.5425252		153.7901012		277.73557		0.359344631		
104	11/30/2016 0:30	11/30/2016 0:45		114.3645095		154.1245836		249.8234089		0.359344631		
105	11/30/2016 0:45	11/30/2016 1:00		114.785253		154.2375007		238.4475111		0.359344631		
106	11/30/2016 1:00	11/30/2016 1:15		114.2440633		153.4090385		220.2547241		0.359344631		
107	11/30/2016 1:15	11/30/2016 1:30		113.7496076		152.6863949		199.6683108		0.359344631		
108	11/30/2016 1:30	11/30/2016 1:45		113.8346144		153.9080201		205.128292		0.359344631		
109	11/30/2016 1:45	11/30/2016 2:00		113.650911		153.4237349		206.693326		0.359344631		
110	11/30/2016 2:00	11/30/2016 2:15		113.3578977		153.2747378		200.728568		0.359344631		
111	11/30/2016 2:15	11/30/2016 2:30		113.395702		152.6628976		184.7389928		0.359344631		
112	11/30/2016 2:30	11/30/2016 2:45		113.6202845		153.0239795		177.6266821		0.359344631		
113	11/30/2016 2:45	11/30/2016 3:00		112.7181931		152.0899181		172.0939131		0.359344631		
114	11/30/2016 3:00	11/30/2016 3:15		113.3190933		153.2324868		157.3519885		0.359344631		
115	11/30/2016 3:15	11/30/2016 3:30		113.1921988		152.2129952		151.2514011		0.359344631		
116	11/30/2016 3:30	11/30/2016 3:45		112.5525942		152.7205786		137.8533254		0.359344631		
117	11/30/2016 3:45	11/30/2016 4:00		112.7604076		152.4861904		129.9930984		0.359344631		
118	11/30/2016 4:00	11/30/2016 4:15		112.792328		152.9655091		116.7266626		0.359344631		
119	11/30/2016 4:15	11/30/2016 4:30		112.2113099		153.4311909		118.0020061		0.359344631		
120	11/30/2016 4:30	11/30/2016 4:45		111.9991504		152.3199534		113.9263897		0.359344631		
121	11/30/2016 4:45	11/30/2016 5:00		111.8670494		152.7094679		115.1211504		0.359344631		
122	11/30/2016 5:00	11/30/2016 5:15		111.8478075		153.5743105		96.44331172		0.359344631		
123	11/30/2016 5:15	11/30/2016 5:30		111.8896822		152.7473857		73.87490273		0.359344631		
124	11/30/2016 5:30	11/30/2016 5:45		111.6895142		152.1911915		58.57893751		0.359344631		
125	11/30/2016 5:45	11/30/2016 6:00		111.4795194		152.9741892		56.96752109		0.359344631		
126	11/30/2016 6:00	11/30/2016 6:15		111.8163618		152.1576518		59.68781645		0.359344631		
127	11/30/2016 6:15	11/30/2016 6:30		111.6391313		152.2422459		70.60513339		0.359344631		
128	11/30/2016 6:30	11/30/2016 6:45		111.6614135		152.7120495		70.32132755		0.359344631		
129	11/30/2016 6:45	11/30/2016 7:00		112.0455615		152.8770127		56.79677922		0.359344631		
130	11/30/2016 7:00	11/30/2016 7:15		111.660285		150.7178001		34.67576		0.359344631		
131	11/30/2016 7:15	11/30/2016 7:30		111.7995931		151.8546184		23.37972172		0.359344631		
132	11/30/2016 7:30	11/30/2016 7:45		111.7925435		151.3368999		28.78410013		0.359344631		
133	11/30/2016 7:45	11/30/2016 8:00		111.9215612		152.8614654		65.0760449		0.359344631		
134	11/30/2016 8:00	11/30/2016 8:15		112.3910814		153.5282386		115.4474895		0.359344631		
135	11/30/2016 8:15	11/30/2016 8:30		112.3732185		153.6427008		173.3133752		0.359344631		
136	11/30/2016 8:30	11/30/2016 8:45		112.298005		153.2584462		197.890688		0.359344631		
137	11/30/2016 8:45	11/30/2016 9:00		111.4129435		153.7675284		197.1905254		0.359344631		
138	11/30/2016 9:00	11/30/2016 9:15		111.8215336		153.941459		194.9463032		0.359344631		
139	11/30/2016 9:15	11/30/2016 9:30		111.8401758		154.267304		195.8514756		0.359344631		
140	11/30/2016 9:30	11/30/2016 9:45		112.3998126		154.6540847		174.1001353		0.359344631		
141	11/30/2016 9:45	11/30/2016 10:00		111.4696845		154.1213317		176.205785		0.359344631		
142	11/30/2016 10:00	11/30/2016 10:15		111.9517378		155.0365335		189.9714225		0.359344631		
143	11/30/2016 10:15	11/30/2016 10:30		111.8272628		154.8936172		202.4526166		0.359344631		
144	11/30/2016 10:30	11/30/2016 10:45		111.5858732		154.6594735		201.0270122		0.359344631		
145	11/30/2016 10:45	11/30/2016 11:00		111.5026717		155.1803902		199.7649557		0.359344631		
146	11/30/2016 11:00	11/30/2016 11:15		112.1394422		155.3035728		197.0397668		0.359344631		
147	11/30/2016 11:15	11/30/2016 11:30		112.1538404		153.0975801		204.7223614		0.359344631		
148	11/30/2016 11:30	11/30/2016 11:45		111.7496756		153.5471738		209.4663831		0.359344631		
149	11/30/2016 11:45	11/30/2016 12:00		111.8300208		153.1513186		191.0679853		0.359344631		
150	11/30/2016 12:00	11/30/2016 12:15		111.2439543		152.4251068		171.3977233		0.359344631		
151	11/30/2016 12:15	11/30/2016 12:30		111.4972115		153.3910219		141.8755283		0.359344631		
152	11/30/2016 12:30	11/30/2016 12:45		111.2354793		152.2605972		126.5107913		0.359344631		
153	11/30/2016 12:45	11/30/2016 13:00		111.4187935		152.7555312		129.3568507		0.359344631		

	A	B	C	D	E	F	G	H	I	J	K	L
154	11/30/2016 13:00	11/30/2016 13:15		111.3976036		153.1564958		144.14852		0.359344631		
155	11/30/2016 13:15	11/30/2016 13:30		111.8210906		152.7337899		154.9967206		0.359344631		
156	11/30/2016 13:30	11/30/2016 13:45		111.591628		152.668631		171.0715426		0.359344631		
157	11/30/2016 13:45	11/30/2016 14:00		111.8641582		153.7238434		178.2596376		0.359344631		
158	11/30/2016 14:00	11/30/2016 14:15		111.7924026		152.9052216		170.9640543		0.359344631		
159	11/30/2016 14:15	11/30/2016 14:30		111.577987		152.4432598		171.9391572		0.359344631		
160	11/30/2016 14:30	11/30/2016 14:45		111.7261117		153.5048307		174.4139314		0.359344631		
161	11/30/2016 14:45	11/30/2016 15:00		112.1391572		152.5613638		190.3240891		0.359344631		
162	11/30/2016 15:00	11/30/2016 15:15		111.5652668		153.4771078		206.1844596		0.359344631		
163	11/30/2016 15:15	11/30/2016 15:30		111.2599057		153.0001792		176.526981		0.359344631		
164	11/30/2016 15:30	11/30/2016 15:45		111.1049496		152.7724396		164.742792		0.359344631		
165	11/30/2016 15:45	11/30/2016 16:00		110.7629495		152.5000441		159.8361546		0.359344631		
166	11/30/2016 16:00	11/30/2016 16:15		110.5764712		153.1601051		154.179885		0.359344631		
167	11/30/2016 16:15	11/30/2016 16:30		109.5247702		151.897176		128.0857435		0.359344631		
168	11/30/2016 16:30	11/30/2016 16:45		110.34315		153.3216123		120.5592585		0.359344631		
169	11/30/2016 16:45	11/30/2016 17:00		110.2091253		153.3048069		98.19823331		0.359344631		
170	11/30/2016 17:00	11/30/2016 17:15		110.5400777		151.983264		68.11873196		0.359344631		
171	11/30/2016 17:15	11/30/2016 17:30		110.1402556		152.733187		35.91243751		0.359344631		
172	11/30/2016 17:30	11/30/2016 17:45		109.9982952		152.6682656		22.70824071		0.359344631		
173	11/30/2016 17:45	11/30/2016 18:00		110.7414996		152.585342		5.832466492		0.359344631		
174	11/30/2016 18:00	11/30/2016 18:15		110.3297707		153.0698531		10.34483182		0.359344631		
175	11/30/2016 18:15	11/30/2016 18:30		110.4784765		153.0331281		13.79409175		0.359344631		
176	11/30/2016 18:30	11/30/2016 18:45		111.3887007		153.0649578		21.76999976		0.359344631		
177	11/30/2016 18:45	11/30/2016 19:00		110.7408796		152.9314155		39.57606846		0.359344631		
178	11/30/2016 19:00	11/30/2016 19:15		111.3623381		153.8984408		47.13673355		0.359344631		
179	11/30/2016 19:15	11/30/2016 19:30		111.1057696		153.4748008		56.69717082		0.359344631		
180	11/30/2016 19:30	11/30/2016 19:45		111.2798439		152.978638		43.05521132		0.359344631		
181	11/30/2016 19:45	11/30/2016 20:00		111.6014445		153.7403459		47.3135793		0.359344631		
182	11/30/2016 20:00	11/30/2016 20:15		110.8385657		153.2999554		62.71285646		0.359344631		
183	11/30/2016 20:15	11/30/2016 20:30		110.9250145		154.2197706		75.81591676		0.359344631		
184	11/30/2016 20:30	11/30/2016 20:45		110.9311968		159.2758017		87.15097329		0.359344631		
185	11/30/2016 20:45	11/30/2016 21:00		110.661425		155.7081519		89.55528868		0.359344631		
186	11/30/2016 21:00	11/30/2016 21:15		112.4948981		156.4573426		95.02915927		0.359344631		
187	11/30/2016 21:15	11/30/2016 21:30		112.5967527		155.2870467		71.40077157		0.359344631		
188	11/30/2016 21:30	11/30/2016 21:45		112.3877877		154.1386989		48.23547564		0.359344631		
189	11/30/2016 21:45	11/30/2016 22:00		111.8231702		156.0549345		11.77959735		0.359344631		
190	11/30/2016 22:00	11/30/2016 22:15		111.0555869		155.2373621		-7.356077796		0.359344631		
191	11/30/2016 22:15	11/30/2016 22:30		110.9233581		154.0399439		-8		0.359344631		
192	11/30/2016 22:30	11/30/2016 22:45		110.847783		153.7804663		-8		0.359344631		
193	11/30/2016 22:45	11/30/2016 23:00		110.5925515		153.6764166		-7.733792669		0.359344631		
194	11/30/2016 23:00	11/30/2016 23:15		110.8967387		154.700379		-7.932710501		0.359344631		
195	11/30/2016 23:15	11/30/2016 23:30		110.2699479		154.4917534		-7.241296344		0.359344631		
196	11/30/2016 23:30	11/30/2016 23:45		110.8506823		154.0894101		-3.350261998		0.359344631		
197	11/30/2016 23:45	12/1/2016 0:00		109.7951082		153.284261		-2.884160002		0.359344631		
198	12/1/2016 0:00	12/1/2016 0:15		109.5474715		155.2302081		16.73732827		0.359344631		
199	12/1/2016 0:15	12/1/2016 0:30										
200	12/1/2016 0:30	12/1/2016 0:45										
201	12/1/2016 0:45	12/1/2016 1:00										
202	12/1/2016 1:00	12/1/2016 1:15										
203	12/1/2016 1:15	12/1/2016 1:30										

Cell: D5
Comment: a2471:
Whenever 1400 C-train is offline, columns AC and AE are sent to the Main Flare, as the high methanol content changes the fuel characteristics and is a safety concern. Since these are manual valves and are not represented on Process Explorer, Operator logs and verbal confirmation are necessary to get the start/stop times for these events. Modify the calcs in AD/AF as needed and copy results to AK for the affected hours.

Cell: A7
Comment: rch:
This version is using 2% H2S for the 4600 SSOHds concentration;
the old version is using 0.55%

Cell: A43
Comment: rch:
This version is using 2% H2S for the 4600 SSOHds concentration;
the old version is using 0.55%

	A	M	N	O	P	Q	R	S	T	U	V
1											
2		PC46003.op					XZSC46046A.PV	XZSC46046B.PV	XZSC46045A.PV	XZSC46045B.PV	Only if manual valves open
3		**Phosam OHds**	**Phosam OHds**	**Phosam OHds**	**Phosam OHds**						SU/SD once in a while
4		CFI46400.PV	Actual	CFI46400A.PV	CFI46400B.PV		These are indicators of the block valves from				Remarks
5		SUM of trains	SUM of trains	1600 A train	1600 B train		SSOH, yellow = flared				
6		MSCFH	MSCFH	MSCFH	MSCFH	**SO2 Lb/Hr**					
7	11/1/2016 0:00	132	0	50	81	**266**	1	1	0	0	**0**
8	11/2/2016 0:00	131	0	88	42	**265**	1	1	0	0	**0**
9	11/3/2016 0:00	122	0	43	79	**248**	1	1	0	0	**0**
10	11/4/2016 0:00	113	0	43	69	**228**	1	1	0	0	**0**
11	11/5/2016 0:00	123	0	44	79	**250**	1	1	0	0	**0**
12	11/6/2016 0:00	125	0	45	79	**252**	1	1	0	0	**0**
13	11/7/2016 0:00	77	0	25	52	**157**	1	1	0	0	**0**
14	11/8/2016 0:00	114	0	39	74	**230**	1	1	0	0	**0**
15	11/9/2016 0:00	133	0	62	71	**270**	1	1	0	0	**0**
16	11/10/2016 0:00	137	0	70	67	**277**	1	1	0	0	**0**
17	11/11/2016 0:00	131	0	70	61	**265**	1	1	0	0	**0**
18	11/12/2016 0:00	139	0	71	68	**281**	1	1	0	0	**0**
19	11/13/2016 0:00	144	0	71	73	**292**	1	1	0	0	**0**
20	11/14/2016 0:00	137	0	70	68	**278**	1	1	0	0	**0**
21	11/15/2016 0:00	137	0	70	67	**277**	1	1	0	0	**0**
22	11/16/2016 0:00	132	0	68	65	**268**	1	1	0	0	**0**
23	11/17/2016 0:00	119	0	64	55	**242**	1	1	0	0	**0**
24	11/18/2016 0:00	96	0	55	41	**194**	1	1	0	0	**0**
25	11/19/2016 0:00	99	0	56	43	**201**	1	1	0	0	**0**
26	11/20/2016 0:00	135	0	64	71	**273**	1	1	0	0	**0**
27	11/21/2016 0:00	133	0	60	72	**269**	1	1	0	0	**0**
28	11/22/2016 0:00	135	0	62	73	**275**	1	1	0	0	**0**
29	11/23/2016 0:00	135	1	61	74	**274**	1	1	0	0	**3**
30	11/24/2016 0:00	110	110	56	54	**222**	0	0	1	1	**222**
31	11/25/2016 0:00	129	37	59	70	**261**	1	1	0	0	**74**
32	11/26/2016 0:00	137	0	61	76	**277**	1	1	0	0	**0**
33	11/27/2016 0:00	140	0	62	79	**284**	1	1	0	0	**0**
34	11/28/2016 0:00	138	0	60	78	**280**	1	1	0	0	**0**
35	11/29/2016 0:00	139	0	60	79	**282**	1	1	0	0	**0**
36	11/30/2016 0:00	139	0	59	80	**282**	1	1	0	0	**0**
37	12/1/2016 0:00	138	0	60	79		1	1	0	0	**0**
38	12/2/2016 0:00										
39	Average	127.39		58.95	68.42	**257.40**					
40											**7178.44**
41		**40**									
42		**2.000**			**3.5**	MMSCF					
43											
44											

	A	M	N	O	P	Q	R	S	T	U	V
45		0.55									
46											
47	**11/30/16**										
48	11/29/2016 21:00					**0**					**0**
49	11/29/2016 22:00			59	80	**281**	1	1	0	0	**0**
50	11/29/2016 23:00	139		59	79	**281**	1	1	0	0	**0**
51	11/30/2016 0:00	139		59	79	**281**	1	1	0	0	**0**
52	11/30/2016 1:00	139		59	80	**282**	1	1	0	0	**0**
53	11/30/2016 2:00	139		59	80	**283**	1	1	0	0	**0**
54	11/30/2016 3:00	140		60	79	**281**	1	1	0	0	**0**
55	11/30/2016 4:00	139		59	78	**279**	1	1	0	0	**0**
56	11/30/2016 5:00	138		59	80	**280**	1	1	0	0	**0**
57	11/30/2016 6:00	138		60	79	**283**	1	1	0	0	**0**
58	11/30/2016 7:00	139		59	78	**276**	1	1	0	0	**0**
59	11/30/2016 8:00	136		60	80	**284**	1	1	0	0	**0**
60	11/30/2016 9:00	140		59	80	**284**	1	1	0	0	**0**
61	11/30/2016 10:00	140		60	80	**283**	1	1	0	0	**0**
62	11/30/2016 11:00	140		60	80	**282**	1	1	0	0	**0**
63	11/30/2016 12:00	139		60	79	**282**	1	1	0	0	**0**
64	11/30/2016 13:00	139		59	80	**283**	1	1	0	0	**0**
65	11/30/2016 14:00	139		59	81	**283**	1	1	0	0	**0**
66	11/30/2016 15:00	140		60	80	**285**	1	1	0	0	**0**
67	11/30/2016 16:00	140		59	79	**278**	1	1	0	0	**0**
68	11/30/2016 17:00	137		60	80	**282**	1	1	0	0	**0**
69	11/30/2016 18:00	139		59	80	**281**	1	1	0	0	**0**
70	11/30/2016 19:00	139		59	80	**281**	1	1	0	0	**0**
71	11/30/2016 20:00	139		60	79	**281**	1	1	0	0	**0**
72	11/30/2016 21:00	139		60	78	**279**	1	1	0	0	**0**
73	11/30/2016 22:00	138		58	80	**282**	1	1	0	0	**0**
74	11/30/2016 23:00	139		58	81	**283**	1	1	0	0	**0**
75	12/1/2016 0:00	140		59	80		1	1	0	0	
76	12/1/2016 1:00	140									
77	12/1/2016 2:00			59.34	79.62	281.62	1.00	1.00	0.00	0.00	0.00
78	Average	138.98				**0.0**					Original calculation
79						0.00					0.00
80											0.00
81											
82											
83											
84						565.09					
85						23.55					
86											
87											
88											
89											
90											
91											
92											
93											
94											
95											
96											
97											

	A	M	N	O	P	Q	R	S	T	U	V
98											
99											
100	0:15					**0**					FALSE
101	**11/30/16**	136.0545257		58.75433602	76.27642984	**155**	1	1	0	0	0
102	11/30/2016 0:00	145.2903471		60.57245359	82.22334107	**167**	1	1	0	0	0
103	11/30/2016 0:15	139.2676674		59.11307108	78.38918587	**159**	1	1	0	0	0
104	11/30/2016 0:30	138.9744579		59.08712829	79.0619536	**160**	1	1	0	0	0
105	11/30/2016 0:45	138.973246		58.99108981	79.76310023	**162**	1	1	0	0	0
106	11/30/2016 1:00	137.9262276		59.06283796	79.43895361	**161**	1	1	0	0	0
107	11/30/2016 1:15	137.8111267		58.38831647	80.43401046	**163**	1	1	0	0	0
108	11/30/2016 1:30	139.4751843		58.82434927	80.74116175	**164**	1	1	0	0	0
109	11/30/2016 1:45	138.8648594		58.75186929	80.5430679	**163**	1	1	0	0	0
110	11/30/2016 2:00	140.8923187		58.90638666	80.21930912	**163**	1	1	0	0	0
111	11/30/2016 2:15	140.8923187		59.20073017	80.72102245	**164**	1	1	0	0	0
112	11/30/2016 2:30	140.8923187		60.58795864	79.8046104	**162**	1	1	0	0	0
113	11/30/2016 2:45	138.8321013		60.48864881	79.10485324	**160**	1	1	0	0	0
114	11/30/2016 3:00	138.2952789		59.77945665	78.42271723	**159**	1	1	0	0	0
115	11/30/2016 3:15	135.2729028		58.3613639	77.68342678	**157**	1	1	0	0	0
116	11/30/2016 3:30	142.5281568		61.60010013	80.97107039	**164**	1	1	0	0	0
117	11/30/2016 3:45	136.124232		58.79120469	78.05931534	**158**	1	1	0	0	0
118	11/30/2016 4:00	138.1870268		59.55716884	78.64840178	**159**	1	1	0	0	0
119	11/30/2016 4:15	137.7076416		59.69769478	78.49582922	**159**	1	1	0	0	0
120	11/30/2016 4:30	137.7076416		59.7053919	78.00492	**158**	1	1	0	0	0
121	11/30/2016 4:45	137.7076416		59.2168287	79.73308184	**162**	1	1	0	0	0
122	11/30/2016 5:00	137.6938317		58.98337819	79.43579338	**161**	1	1	0	0	0
123	11/30/2016 5:15	137.6874847		58.66586218	79.28507207	**161**	1	1	0	0	0
124	11/30/2016 5:30	138.6017704		59.16381937	80.53391435	**163**	1	1	0	0	0
125	11/30/2016 5:45	139.3464508		59.37398057	79.37848841	**161**	1	1	0	0	0
126	11/30/2016 6:00	139.3464508		59.41811364	78.82249139	**160**	1	1	0	0	0
127	11/30/2016 6:15	139.3464508		59.69657344	79.20878249	**161**	1	1	0	0	0
128	11/30/2016 6:30	139.5055483		59.85091122	79.500554	**161**	1	1	0	0	0
129	11/30/2016 6:45	139.6044769		60.11780843	78.42649634	**159**	1	1	0	0	0
130	11/30/2016 7:00	139.6044769		60.25092973	78.29771034	**159**	1	1	0	0	0
131	11/30/2016 7:15	139.5656775		60.29212799	79.10794154	**160**	1	1	0	0	0
132	11/30/2016 7:30	132.7879998		56.62913626	74.38008649	**151**	1	1	0	0	0
133	11/30/2016 7:45	146.6159574		62.28247315	85.22218788	**173**	1	1	0	0	0
134	11/30/2016 8:00	134.3444138		59.49707436	75.66176066	**153**	1	1	0	0	0
135	11/30/2016 8:15	139.1377325		60.27059369	79.13448281	**160**	1	1	0	0	0
136	11/30/2016 8:30	138.642334		59.6379136	79.75195713	**162**	1	1	0	0	0
137	11/30/2016 8:45	138.642334		58.92374333	79.45064493	**161**	1	1	0	0	0
138	11/30/2016 9:00	138.642334		59.09828241	79.8114936	**162**	1	1	0	0	0
139	11/30/2016 9:15	140.4404611		59.55979589	80.75800731	**164**	1	1	0	0	0
140	11/30/2016 9:30	138.9492645		59.09238412	80.70366849	**164**	1	1	0	0	0
141	11/30/2016 9:45	138.9492645		59.24068086	79.69569352	**161**	1	1	0	0	0
142	11/30/2016 10:00	140.0202059		59.34323329	80.994479	**164**	1	1	0	0	0
143	11/30/2016 10:15	139.9181246		59.63193386	80.31277877	**163**	1	1	0	0	0
144	11/30/2016 10:30	139.2177421		59.95168641	79.11418863	**160**	1	1	0	0	0
145	11/30/2016 10:45	139.7025614		60.27704354	80.27405432	**163**	1	1	0	0	0
146	11/30/2016 11:00	139.7929077		60.2783407	80.05809964	**162**	1	1	0	0	0
147	11/30/2016 11:15	139.7929077		60.30400347	79.12853598	**160**	1	1	0	0	0
148	11/30/2016 11:30	139.7814261		60.44221569	79.4332613	**161**	1	1	0	0	0
149	11/30/2016 11:45	140.5147868		60.57519318	79.67074309	**161**	1	1	0	0	0
150	11/30/2016 12:00	136.0864074		57.06690789	76.12125073	**154**	1	1	0	0	0
151	11/30/2016 12:15	140.593256		61.8100661	84.60587835	**171**	1	1	0	0	0

	A	M	N	O	P	Q	R	S	T	U	V
152	11/30/2016 12:30	139.37093		60.37398594	76.55908426	**155**	1	1	0	0	0
153	11/30/2016 12:45	140.9494853		59.91238949	80.79485884	**164**	1	1	0	0	0
154	11/30/2016 13:00	138.6898836		58.87667746	79.6737584	**161**	1	1	0	0	0
155	11/30/2016 13:15	138.3188661		58.91058368	79.44757238	**161**	1	1	0	0	0
156	11/30/2016 13:30	139.9312993		59.16499631	80.65174968	**163**	1	1	0	0	0
157	11/30/2016 13:45	140.27948		58.91475026	80.73156583	**164**	1	1	0	0	0
158	11/30/2016 14:00	140.27948		58.54532926	81.12974655	**164**	1	1	0	0	0
159	11/30/2016 14:15	140.27948		59.01804491	80.85011555	**164**	1	1	0	0	0
160	11/30/2016 14:30	140.9122569		59.30487855	81.87458266	**166**	1	1	0	0	0
161	11/30/2016 14:45	139.471622		59.49997887	79.74480856	**162**	1	1	0	0	0
162	11/30/2016 15:00	139.3134918		59.70189937	80.25268113	**163**	1	1	0	0	0
163	11/30/2016 15:15	139.3134918		59.98362497	80.61981609	**163**	1	1	0	0	0
164	11/30/2016 15:30	140.0720131		60.13216892	80.07458514	**162**	1	1	0	0	0
165	11/30/2016 15:45	140.2505412		60.65133471	79.13381927	**160**	1	1	0	0	0
166	11/30/2016 16:00	138.7849274		60.43533613	79.6645398	**161**	1	1	0	0	0
167	11/30/2016 16:15	138.5523198		59.3412764	78.87666792	**160**	1	1	0	0	0
168	11/30/2016 16:30	133.3380684		56.91770037	78.03902666	**158**	1	1	0	0	0
169	11/30/2016 16:45	144.1287783		63.17193018	80.58080967	**163**	1	1	0	0	0
170	11/30/2016 17:00	136.5859589		58.09131111	79.78492426	**162**	1	1	0	0	0
171	11/30/2016 17:15	138.5366398		58.72962244	78.83050206	**160**	1	1	0	0	0
172	11/30/2016 17:30	137.5213776		58.50205844	79.71361489	**162**	1	1	0	0	0
173	11/30/2016 17:45	137.5213776		58.43513135	78.72249917	**160**	1	1	0	0	0
174	11/30/2016 18:00	137.5213776		58.58163721	79.94398296	**162**	1	1	0	0	0
175	11/30/2016 18:15	138.4543702		58.8284196	79.74387543	**162**	1	1	0	0	0
176	11/30/2016 18:30	137.9730101		58.11939261	79.93635777	**162**	1	1	0	0	0
177	11/30/2016 18:45	139.7416754		58.75213891	80.76570551	**164**	1	1	0	0	0
178	11/30/2016 19:00	138.4582062		58.53117895	80.5278356	**163**	1	1	0	0	0
179	11/30/2016 19:15	138.4582062		59.08749766	79.67120024	**161**	1	1	0	0	0
180	11/30/2016 19:30	138.4582062		59.21318703	80.49087417	**163**	1	1	0	0	0
181	11/30/2016 19:45	138.762546		59.36436791	79.55169029	**161**	1	1	0	0	0
182	11/30/2016 20:00	139.2199402		59.92966221	78.82031021	**160**	1	1	0	0	0
183	11/30/2016 20:15	139.2199402		59.67634425	80.38331522	**163**	1	1	0	0	0
184	11/30/2016 20:30	139.2199402		59.91198792	78.68385257	**159**	1	1	0	0	0
185	11/30/2016 20:45	138.7210114		60.15671734	78.56605238	**159**	1	1	0	0	0
186	11/30/2016 21:00	136.2810866		59.5956838	76.60991006	**155**	1	1	0	0	0
187	11/30/2016 21:15	135.4374643		58.90189076	78.98511361	**160**	1	1	0	0	0
188	11/30/2016 21:30	141.1623211		60.61426719	79.55282312	**161**	1	1	0	0	0
189	11/30/2016 21:45	138.2258611		58.22908557	80.51239813	**163**	1	1	0	0	0
190	11/30/2016 22:00	138.6489535		57.84315621	79.06519527	**160**	1	1	0	0	0
191	11/30/2016 22:15	138.3757629		58.1648038	80.71291182	**164**	1	1	0	0	0
192	11/30/2016 22:30	138.3757629		57.90750279	80.02465521	**162**	1	1	0	0	0
193	11/30/2016 22:45	138.3757629		58.32108491	80.39502253	**163**	1	1	0	0	0
194	11/30/2016 23:00	140.0752382		57.80212738	81.05131107	**164**	1	1	0	0	0
195	11/30/2016 23:15	140.2054291		58.08201151	80.83868635	**164**	1	1	0	0	0
196	11/30/2016 23:30	140.2054291		58.83972427	80.5863492	**163**	1	1	0	0	0
197	11/30/2016 23:45	140.2054291		58.7360702	80.82783094	**164**	1	1	0	0	0
198	12/1/2016 0:00	138.2018478		59.07863437	80.02849799						
199	12/1/2016 0:15										
200	12/1/2016 0:30										
201	12/1/2016 0:45										
202	12/1/2016 1:00										
203	12/1/2016 1:15										

Cell: V7
Comment: A6408:
N2 Purge

Cell: T38
Comment: These are block valves from FA4606 to either the Main Flare or DA4011

If cells in AP and AQ are OPEN (0, red)
and AR and AS are CLOSED (1, red)
then the Superstill overheads are being sent to the main flare;

	A	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
1												**Main Flare DRY header**								
2						GB1451					GB1341									PC14503.OP
3		PC14999.OP		PC14009.OP		PC14509.OP		PC14005.OP		PC14505.OP		**---------------- CO2 from 5900 ----------------**				**HC13005.op**			PC14003.OP	CFI14869.PV
4		**CFI14999.PV**		**CFI14864.PV**		**CFI14865.PV**		**CFI14866.PV**		**CFI14867.PV**		**CFI59187.PV**	**CFI59487.PV**	**CFI59787.PV**		**CFI13005.PV**		**Total CO2**	CFI14868.PV	CFI14869.PV
5		B-stage flash (A&B trains)		A Train C-F Stages		B Train C-F Stages		A Train A-Flash Off Gas		B Train A-Flash Off Gas		GB5905	GB5925	GB5945	**CO2**	**GB1341 flash gas compressor**		**and Flash gas**	A SYN Spike Gas	B SYN Spike Gas
6		**MMSCFH**	**Lb/Hr SO2**	**MMSCFH**	**Lb/Hr SO2**	**MMSCFH**	**Lb/Hr SO2**	**MSCFH**	**Lb/Hr SO2**	**MSCFH**	**Lb/Hr SO2**	MMCFH	MMCFH	MMCFH	**Lb/Hr SO2**	**SCFH**	**Lb/Hr SO2**	**Lb/Hr SO2**	MSCFH	MSCFH
7	11/1/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	0	0
8	11/2/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	0	0
9	11/3/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	0	0
10	11/4/2016 0:00	0	0.00	0	608.30	0	511.36	0	0.03	0	0.00	0	0	0	7	16344	5.4	1132.02	4	1865
11	11/5/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	0	0
12	11/6/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	6	1
13	11/7/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	47	23
14	11/8/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	8	0
15	11/9/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	5	0
16	11/10/2016 0:00	0	0.00	0	70.59	0	40.04	0	0.00	0	0.00	0	0	0	1	0	0.0	111.78	4	0
17	11/11/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	6	0
18	11/12/2016 0:00	0	0.00	0	4.14	0	2.47	0	0.00	0	0.00	0	0	0	1	0	0.0	7.22	2	0
19	11/13/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	3	1
20	11/14/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	19	7
21	11/15/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	5	2
22	11/16/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	8	3
23	11/17/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	4	3
24	11/18/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.02	0	0.00	0	0	0	0	926	0.3	0.33	625	28
25	11/19/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	28	23
26	11/20/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	2	0
27	11/21/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	12	4
28	11/22/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	2	0
29	11/23/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	1	0
30	11/24/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	3	0
31	11/25/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	12	0
32	11/26/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	0	0
33	11/27/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	1	0
34	11/28/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	1	0
35	11/29/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	0	0
36	11/30/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	0	0
37	12/1/2016 0:00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0	0	0	0	0.0	0.00	0	0
38	12/2/2016 0:00																			
39	Average	0	0	0	22	0	18	0	0	0	0	0	0	0	0		0	40	26	63
40		0.000	0.00	6.702	16392.75	5.368	13292.95	3.618	1.19	0.000	0.00	0.01	0.05	0.040993675	208.07	0.41	137.18		19.4	47.0
41																			MMSCF	MMSCF
42		% of CO2	0.87	% of CO2	1.07	% of CO2	1.07	% of CO2	0.14	% of CO2	0.14		0.10			% of CO2	0.14			
43		%H2S	1.13	%H2S	1.39	%H2S	1.39	%H2S	0.18	%H2S	0.18					%H2S	0.18			66.4
44		Old %H2S	0.85	Old %H2S	1.06	Old %H2S	1.06	Old %H2S	1.06	Old %H2S	1.06					Old %H2S	1.06			

	A	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
45																				
46															0	**0.00**	**0.00**	**0**		
47	**11/30/16**															**0**	**0**			
48	11/29/2016 21:00								**0.00**							**0**	**0**	**0**		
49	11/29/2016 22:00	0.000	**0.0**	0.00	**0.00**	0.00	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
50	11/29/2016 23:00	0.000	**0.0**	0.00	**0.00**	0.00	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
51	11/30/2016 0:00	0.000	**0.0**	0.00	**0.00**	0.00	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
52	11/30/2016 1:00	0.000	**0.0**	0.00	**0.00**	0.00	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
53	11/30/2016 2:00	0.000	**0.0**	0.00	**0.00**	0.00	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
54	11/30/2016 3:00	0.000	**0.0**	0.00	**0.00**	0.00	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
55	11/30/2016 4:00	0.000	**0.0**	0.00	**0.00**	0.00	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
56	11/30/2016 5:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
57	11/30/2016 6:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
58	11/30/2016 7:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
59	11/30/2016 8:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
60	11/30/2016 9:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
61	11/30/2016 10:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
62	11/30/2016 11:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
63	11/30/2016 12:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
64	11/30/2016 13:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
65	11/30/2016 14:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
66	11/30/2016 15:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
67	11/30/2016 16:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
68	11/30/2016 17:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
69	11/30/2016 18:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
70	11/30/2016 19:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
71	11/30/2016 20:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
72	11/30/2016 21:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
73	11/30/2016 22:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
74	11/30/2016 23:00	0.000	**0.0**	0.00	**0.00**	0.000	**0.00**	0	**0.00**	0	**0.00**	0.00	0.00	0.00	**0**	**0**	**0**	**0**	**0**	**0**
75	12/1/2016 0:00	0.000		0.00		0.000		0		0		0.00	0.00	0.00		**0**			**0**	**0**
76	12/1/2016 1:00																			
77	12/1/2016 2:00	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000000	0.00	0.00	0.00	0.000	0.00		0.0	**0.00**	0	0.00
78	Average																			
79																				
80																				
81																				
82																				
83																				
84				CFI14864.PV		CFI14865.PV		PC14009.OP		PC14509.OP								**Total CO2**	**Total CO2**	
85		PC14999.OP	SO2 lb/min	TR A C-F Stg	SO2 lb/min	TR B C-F Stg	SO2 lb/min	TR A C-F Stg	SO2 lb/min	TR B C-F Stg	SO2 lb/min	MMCFH	MMCFH	MMCFH	**CO2**			**and Flash gas**	**and Flash gas**	
86				MMSCFH		MMSCFH									**Lb/min SO2**			**Lb/min SO2**	**Lb/min H2S**	
87																				
88																				
89																				
90																				
91																				
92																				
93																				
94																				
95																				
96																				
97																				

	A	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
98																				
99			15-min avg																	
100	0:15		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**									
101	**11/30/16**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
102	11/30/2016 0:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
103	11/30/2016 0:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
104	11/30/2016 0:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
105	11/30/2016 0:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
106	11/30/2016 1:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
107	11/30/2016 1:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
108	11/30/2016 1:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
109	11/30/2016 1:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
110	11/30/2016 2:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
111	11/30/2016 2:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
112	11/30/2016 2:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
113	11/30/2016 2:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
114	11/30/2016 3:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
115	11/30/2016 3:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
116	11/30/2016 3:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
117	11/30/2016 3:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
118	11/30/2016 4:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
119	11/30/2016 4:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
120	11/30/2016 4:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
121	11/30/2016 4:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
122	11/30/2016 5:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
123	11/30/2016 5:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
124	11/30/2016 5:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
125	11/30/2016 5:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
126	11/30/2016 6:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
127	11/30/2016 6:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0.00
128	11/30/2016 6:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
129	11/30/2016 6:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
130	11/30/2016 7:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
131	11/30/2016 7:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
132	11/30/2016 7:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
133	11/30/2016 7:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
134	11/30/2016 8:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
135	11/30/2016 8:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
136	11/30/2016 8:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
137	11/30/2016 8:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
138	11/30/2016 9:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
139	11/30/2016 9:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
140	11/30/2016 9:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
141	11/30/2016 9:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
142	11/30/2016 10:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
143	11/30/2016 10:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
144	11/30/2016 10:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
145	11/30/2016 10:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
146	11/30/2016 11:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
147	11/30/2016 11:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
148	11/30/2016 11:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
149	11/30/2016 11:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
150	11/30/2016 12:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
151	11/30/2016 12:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0

	A	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
152	11/30/2016 12:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
153	11/30/2016 12:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
154	11/30/2016 13:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
155	11/30/2016 13:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
156	11/30/2016 13:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
157	11/30/2016 13:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
158	11/30/2016 14:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
159	11/30/2016 14:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
160	11/30/2016 14:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
161	11/30/2016 14:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
162	11/30/2016 15:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
163	11/30/2016 15:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
164	11/30/2016 15:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
165	11/30/2016 15:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
166	11/30/2016 16:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
167	11/30/2016 16:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
168	11/30/2016 16:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
169	11/30/2016 16:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
170	11/30/2016 17:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
171	11/30/2016 17:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
172	11/30/2016 17:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
173	11/30/2016 17:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
174	11/30/2016 18:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
175	11/30/2016 18:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
176	11/30/2016 18:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
177	11/30/2016 18:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
178	11/30/2016 19:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
179	11/30/2016 19:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
180	11/30/2016 19:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
181	11/30/2016 19:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
182	11/30/2016 20:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
183	11/30/2016 20:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
184	11/30/2016 20:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
185	11/30/2016 20:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
186	11/30/2016 21:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
187	11/30/2016 21:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
188	11/30/2016 21:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
189	11/30/2016 21:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
190	11/30/2016 22:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
191	11/30/2016 22:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
192	11/30/2016 22:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
193	11/30/2016 22:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
194	11/30/2016 23:00	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
195	11/30/2016 23:15	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
196	11/30/2016 23:30	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
197	11/30/2016 23:45	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	**0.00**	0	0	0	**0**	0	**0**	**0**	0	0
198	12/1/2016 0:00	0		0		0		0		0		0	0	0		0			0	0
199	12/1/2016 0:15																0.00			
200	12/1/2016 0:30																			
201	12/1/2016 0:45																			
202	12/1/2016 1:00																			
203	12/1/2016 1:15																			

Cell: X1
Comment: M.O.C. 1164 March 10,2009 to correct calculation

Cell: AA1
Comment: M.O.C. 1164 March 10,2009 to correct calculation

Cell: X42
Comment: rch:
Typical sample = 87% of Daily CO2 %H2S

changed 10/20/09

Cell: Z42
Comment: rch:
Typical sample = 116% (D-F stages) and 87% (C-stage) of daily CO2 sample %H2S

changed 10/20/09

Cell: AB42
Comment: rch:
Typical sample = 116% (D-F stages) and 87% (C-stage) of daily CO2 sample %H2S

changed 10/20/09

Cell: AD42
Comment: rch:
Typical sample = 14% of daily CO2 %H2S sample

changed 10/20/09

Cell: AF42
Comment: rch:
Typical sample = 14% of daily CO2 %H2S sample

changed 10/20/09

Cell: AL42
Comment: rch:
Typical sample = 14% of daily CO2 %H2S sample

changed 10/20/09

	A	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE
1								Main Flare WET header								Leakage lb SO2/hr	
2							GB-1351	1200A/B-Train		PC11802B.OP		PC11830B.op				32	
3			PC17021.OP	PC17221.OP	PC13008.OP		PC13508.OP	PC12007.OP		CFI11601.PV		CFI11600.pv		FC83003.pv			
4			CFI17405.PV	CFI17406.PV	CFI13400.PV		CFI13401.PV	CFI12400.pv	Shift Conv Gas		75% Raw gas,15% water		75% Raw gas,15% wate	FC83005.pv	Main Flare	Total SO2 Lb/Hr	
5			SNG Train A Flare Fuel	SNG Train B Flare Fuel	Cooled Raw Gas	Cooled Raw Gas	Shifted/Cooled Gas	Shifted Gas	28% water	HP Lock Gas	HP Lock Gas	LP Lock Gas	LP Lock Gas	Spike gas to flare	Total SO2 Lb/Hr	With	
6			MSCFH	MSCFH	MSCFH	Lb/Hr SO2	MSCFH	MSCFH	Lb/Hr SO2	MSCFH	Lb/Hr SO2	MSCFH	SO2	MSCFH	24 hr Avg	Leakage	Leakage
7	11/1/2016 0:00		-169	-169	2	2.0	0	0	0.00	0	0.1	0	0.08	45	2.13	37.13	35
8	11/2/2016 0:00		-169	-169	0	0.2	0	0	0.00	0	0.0	0	0.00	44	0.28	35.28	35
9	11/3/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.1	0	0.12	45	0.18	32.18	32
10	11/4/2016 0:00		-169	-169	0	0.0	0	0	0.00	3	1.5	0	0.15	73	1133.70	1165.70	32
11	11/5/2016 0:00		-169	-169	0	0.2	0	0	0.00	0	0.0	0	0.01	46	0.22	32.22	32
12	11/6/2016 0:00		-169	-169	1	0.8	0	0	0.00	0	0.0	0	0.13	45	0.96	32.96	32
13	11/7/2016 0:00		-150	-162	0	0.1	0	0	0.00	4	2.1	0	0.08	45	2.26	34.26	32
14	11/8/2016 0:00		-169	-169	1	0.6	0	0	0.00	1	0.6	1	0.26	46	1.45	33.45	32
15	11/9/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.0	0	0.00	45	0.03	32.03	32
16	11/10/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.1	0	0.00	57	111.84	143.84	32
17	11/11/2016 0:00		-169	-169	0	0.0	0	0	0.00	1	0.4	0	0.00	46	0.36	32.36	32
18	11/12/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.0	0	0.01	45	7.23	39.23	32
19	11/13/2016 0:00		-169	-169	0	0.2	0	0	0.00	0	0.0	0	0.02	45	0.24	32.24	32
20	11/14/2016 0:00		-169	-169	1	0.0	0	0	0.00	0	0.0	0	0.00	46	0.00	32.00	32
21	11/15/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.0	0	0.00	46	0.02	32.02	32
22	11/16/2016 0:00		-165	-167	0	0.0	0	0	0.00	0	0.1	0	0.00	46	0.07	32.07	32
23	11/17/2016 0:00		-169	-169	0	0.0	0	0	0.00	1	0.2	0	0.01	85	0.26	32.26	32
24	11/18/2016 0:00		-169	-169	6	4.6	9	0	4.44	2	0.7	0	0.00	46	10.08	42.08	32
25	11/19/2016 0:00		-163	-168	1	0.6	0	0	0.00	3	1.3	0	0.04	98	1.91	33.91	32
26	11/20/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.0	0	0.02	70	0.05	32.05	32
27	11/21/2016 0:00		-78	-96	1	0.8	0	0	0.00	1	0.3	0	0.00	42	1.12	33.12	32
28	11/22/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.0	0	0.03	46	0.03	32.03	32
29	11/23/2016 0:00		-169	-169	1	1.2	0	0	0.00	0	0.0	0	0.02	47	4.00	36.00	32
30	11/24/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.0	0	0.00	48	222.26	254.26	32
31	11/25/2016 0:00		-169	-169	3	2.5	0	0	0.00	0	0.0	0	0.04	34	76.57	108.57	32
32	11/26/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.0	0	0.04	40	0.04	32.04	32
33	11/27/2016 0:00		-169	-169	1	0.9	0	0	0.00	0	0.0	0	0.00	49	0.90	32.90	32
34	11/28/2016 0:00		-169	-169	3	1.8	0	0	0.00	0	0.0	0	0.05	80	1.80	33.80	32
35	11/29/2016 0:00		-169	-169	1	0.5	0	0	0.00	0	0.0	0	0.00	72	0.51	32.51	32
36	11/30/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.0	0	0.10	79	0.10	32.10	32
37	12/1/2016 0:00		-169	-169	0	0.0	0	0	0.00	0	0.0	0	0.00	54	0.00	32.00	32
38	12/2/2016 0:00																
39	Average	Hours	-165	-166	1	1	0	0	0	0	0		0	53.28	51.0	84.9	
40		720								1000	0.0						
41			-164.69	-166	0.5	406.24	0.2	0.00	106.63	0.4	181.84	0.1	29.48	39.6		61119	Total Pounds
42		Total Monthly	3.8	2.6071438078974	MMSCF	Pounds	MSCF	MSCF	Pounds	MMSCF	Pounds	MMSCF	Pounds	MMSCF			
43		SNG MMSCF	MMSCF	MMSCF			0.2048184006139									82.15	23184
44		71.062	2.7	1.9			SUM				0				0		Leakage lbs

	A	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE
45																	
46															1-Hour Avg		
47	**11/30/16**		4.6			**0.0**			**0**		**0**		**0**		**w/o leakage**	**1 Hour Avg**	**1 Hr Average**
48	11/29/2016 21:00					**0.0**			**0**		**0**		**0**			**With leakage**	
49	11/29/2016 22:00				0	**0.0**	0	0	**0**	0	**0**	0	**0**		**0.0**	Limit 805 lb/hr	**EPCRA Lbs**
50	11/29/2016 23:00				0	**0.0**	0	0	**0**	0	**0**	0	**0**		**0.0**	**32**	
51	11/30/2016 0:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	78	**0.0**	**32**	**0**
52	11/30/2016 1:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
53	11/30/2016 2:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
54	11/30/2016 3:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	80	**0.0**	**32**	**0**
55	11/30/2016 4:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	80	**0.0**	**32**	**0**
56	11/30/2016 5:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	80	**0.0**	**32**	**0**
57	11/30/2016 6:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	78	**0.0**	**32**	**0**
58	11/30/2016 7:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
59	11/30/2016 8:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
60	11/30/2016 9:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
61	11/30/2016 10:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
62	11/30/2016 11:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
63	11/30/2016 12:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
64	11/30/2016 13:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**1.6**	**32**	**0**
65	11/30/2016 14:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	4	**2**	79	**0.0**	**34**	**0**
66	11/30/2016 15:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
67	11/30/2016 16:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
68	11/30/2016 17:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.0**	**32**	**0**
69	11/30/2016 18:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	79	**0.3**	**32**	**0**
70	11/30/2016 19:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	1	**0**	79	**0.0**	**32**	**0**
71	11/30/2016 20:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	78	**0.0**	**32**	**0**
72	11/30/2016 21:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	76	**0.0**	**32**	**0**
73	11/30/2016 22:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	0	**0**	76	**0.5**	**32**	**0**
74	11/30/2016 23:00		-169	-169	0	**0.0**	0	0	**0**	0	**0**	1	**1**	76		**33**	**0**
75	12/1/2016 0:00		-169	-169	0		0	0	**0**	0		1		76			
76	12/1/2016 1:00		-169	-169	0		0	0		0					**0.1**		
77	12/1/2016 2:00		-169	-169	0.00	0.00	0	0.0	**0.0**	0.00	**0.00**	0.23	**0.10**	78.55		**32.10**	**0.00**
78	Average														**0**		
79													**Normal**	**Normal**			LHV calc
80															0.1		
81				-3876													
82															0.1		
83			**Wet Flare**						**PC Calc**	0.00							
84			CFI17405.PV	CFI17406.PV	CFI13400.PV					PC11830B @ 20% =72MCFH							12021
85			SNG Train A Flare Fuel	SNG Train B Flare Fuel	P/T Comp Raw Gas						NOTE: See FlareCalcs.xls for estimating flows for PC11802B.op data				**H2S-lb/min**		
86			MSCFH	MSCFH	MSCFH	**H2S-lb/min**			**H2S-lb/min**		**H2S-lb/min**					**SO2 lb/hr**	
87																	
88																	
89																	
90																	
91																	
92																	
93																	
94																	
95																	
96																	
97																	

	A	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE
98															**15-minute Avgs**		
99																	
100	0:15								**0.0**		**0**		**0.00**		**0.0**		Max
101	**11/30/16**		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	77.17551335	**0.0**	**32.0**	
102	11/30/2016 0:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	77.37399874	**0.0**	**32.0**	32.00
103	11/30/2016 0:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	78.21146658	**0.0**	**32.0**	
104	11/30/2016 0:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	78.8194853	**0.0**	**32.0**	
105	11/30/2016 0:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.0707304	**0.0**	**32.0**	
106	11/30/2016 1:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.08418716	**0.0**	**32.0**	32.00
107	11/30/2016 1:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.03799622	**0.0**	**32.0**	
108	11/30/2016 1:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.03364864	**0.0**	**32.0**	
109	11/30/2016 1:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.01343597	**0.0**	**32.0**	
110	11/30/2016 2:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.04365429	**0.0**	**32.0**	32.00
111	11/30/2016 2:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.04605617	**0.0**	**32.0**	
112	11/30/2016 2:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	78.68297958	**0.0**	**32.0**	
113	11/30/2016 2:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	78.73485578	**0.0**	**32.0**	
114	11/30/2016 3:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.81308195	**0.0**	**32.0**	32.00
115	11/30/2016 3:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.82681913	**0.0**	**32.0**	
116	11/30/2016 3:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.81301891	**0.0**	**32.0**	
117	11/30/2016 3:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.80060864	**0.0**	**32.0**	
118	11/30/2016 4:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.80020835	**0.0**	**32.0**	32.00
119	11/30/2016 4:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.80862396	**0.0**	**32.0**	
120	11/30/2016 4:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.81597092	**0.0**	**32.0**	
121	11/30/2016 4:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.82518305	**0.0**	**32.0**	
122	11/30/2016 5:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.82356625	**0.0**	**32.0**	32.00
123	11/30/2016 5:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.84142748	**0.0**	**32.0**	
124	11/30/2016 5:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.81913746	**0.0**	**32.0**	
125	11/30/2016 5:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	78.43596796	**0.0**	**32.0**	
126	11/30/2016 6:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	78.91725907	**0.0**	**32.0**	32.00
127	11/30/2016 6:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	77.74970498	**0.0**	**32.0**	
128	11/30/2016 6:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	78.61223238	**0.0**	**32.0**	
129	11/30/2016 6:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.12908625	**0.0**	**32.0**	
130	11/30/2016 7:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.1076362	**0.0**	**32.0**	32.00
131	11/30/2016 7:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.09544302	**0.0**	**32.0**	
132	11/30/2016 7:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.07163252	**0.0**	**32.0**	
133	11/30/2016 7:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.03822723	**0.0**	**32.0**	
134	11/30/2016 8:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.06253324	**0.0**	**32.0**	32.00
135	11/30/2016 8:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.02794428	**0.0**	**32.0**	
136	11/30/2016 8:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.02553719	**0.0**	**32.0**	
137	11/30/2016 8:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.01596245	**0.0**	**32.0**	
138	11/30/2016 9:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.01383098	**0.0**	**32.0**	32.00
139	11/30/2016 9:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	78.99513483	**0.0**	**32.0**	
140	11/30/2016 9:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.0125737	**0.0**	**32.0**	
141	11/30/2016 9:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.01516559	**0.0**	**32.0**	
142	11/30/2016 10:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.01717975	**0.0**	**32.0**	32.00
143	11/30/2016 10:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.01696018	**0.0**	**32.0**	
144	11/30/2016 10:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	78.99978689	**0.0**	**32.0**	
145	11/30/2016 10:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.02191794	**0.0**	**32.0**	
146	11/30/2016 11:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.02271792	**0.0**	**32.0**	32.00
147	11/30/2016 11:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.04255936	**0.0**	**32.0**	
148	11/30/2016 11:30		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.05911057	**0.0**	**32.0**	
149	11/30/2016 11:45		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.01333477	**0.0**	**32.0**	
150	11/30/2016 12:00		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.02141438	**0.0**	**32.0**	32.00
151	11/30/2016 12:15		-169	-169	0	**0**	**0.0**	**0.0**	**0.0**	0	**0**	0	**0.00**	79.0524493	**0.0**	**32.0**	

	A	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE
152	11/30/2016 12:30		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	79.0441225	0.0	32.0	
153	11/30/2016 12:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	79.04267219	0.0	32.0	
154	11/30/2016 13:00		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	79.02877018	0.0	32.0	32.00
155	11/30/2016 13:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	79.03800063	0.0	32.0	
156	11/30/2016 13:30		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	79.04100705	0.0	32.0	
157	11/30/2016 13:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	79.0614473	0.0	32.0	
158	11/30/2016 14:00		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	79.06273721	0.0	32.0	38.37
159	11/30/2016 14:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	79.04608713	6.4	32.0	
160	11/30/2016 14:30		-169	-169	0	0	0.0	0.0	0.0	0	0	14.43015805	6.37	79.03475013	0.0	38.4	
161	11/30/2016 14:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	79.03373873	0.0	32.0	
162	11/30/2016 15:00		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	79.00146673	0.0	32.0	32.00
163	11/30/2016 15:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.97912758	0.0	32.0	
164	11/30/2016 15:30		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.99461212	0.0	32.0	
165	11/30/2016 15:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.98887154	0.0	32.0	
166	11/30/2016 16:00		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.96959773	0.0	32.0	32.00
167	11/30/2016 16:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.96646142	0.0	32.0	
168	11/30/2016 16:30		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.94197209	0.0	32.0	
169	11/30/2016 16:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.95158841	0.0	32.0	
170	11/30/2016 17:00		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.96147666	0.0	32.0	32.00
171	11/30/2016 17:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.96099209	0.0	32.0	
172	11/30/2016 17:30		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.97590835	0.0	32.0	
173	11/30/2016 17:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.98210206	0.0	32.0	
174	11/30/2016 18:00		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.96029028	0.0	32.0	32.00
175	11/30/2016 18:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.95741864	0.0	32.0	
176	11/30/2016 18:30		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.94238227	0.0	32.0	
177	11/30/2016 18:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.950328	1.1	32.0	
178	11/30/2016 19:00		-169	-169	0	0	0.0	0.0	0.0	0	0	2.572543411	1.14	78.9549714	0.0	33.1	33.14
179	11/30/2016 19:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.93581432	0.0	32.0	
180	11/30/2016 19:30		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.96716455	0.0	32.0	
181	11/30/2016 19:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.94719856	0.0	32.0	
182	11/30/2016 20:00		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	78.9490521	0.0	32.0	32.00
183	11/30/2016 20:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	76.93126227	0.0	32.0	
184	11/30/2016 20:30		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.57100258	0.0	32.0	
185	11/30/2016 20:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.57798586	0.0	32.0	
186	11/30/2016 21:00		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.60990791	0.0	32.0	32.00
187	11/30/2016 21:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.60174871	0.0	32.0	
188	11/30/2016 21:30		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.59942327	0.0	32.0	
189	11/30/2016 21:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.58485015	0.0	32.0	
190	11/30/2016 22:00		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.60812985	0.0	32.0	32.00
191	11/30/2016 22:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.61345936	0.0	32.0	
192	11/30/2016 22:30		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.62139113	0.0	32.0	
193	11/30/2016 22:45		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.62794147	0.0	32.0	
194	11/30/2016 23:00		-169	-169	0	0	0.0	0.0	0.0	0	0	0	0.00	75.63731775	0.3	32.0	33.76
195	11/30/2016 23:15		-169	-169	0	0	0.0	0.0	0.0	0	0	0.614702698	0.27	75.62308908	1.8	32.3	
196	11/30/2016 23:30		-169	-169	0	0	0.0	0.0	0.0	0	0	3.988171211	1.76	75.63809327	1.1	33.8	
197	11/30/2016 23:45		-169	-169	0	0	0.0	0.0	0.0	0	0	2.470471691	1.09	75.64138767		33.1	
198	12/1/2016 0:00		-169	-169	0	0	0.0	0.0		0		2.625189125		75.65910335			
199	12/1/2016 0:15					0											
200	12/1/2016 0:30					0											
201	12/1/2016 0:45					0											
202	12/1/2016 1:00					0											
203	12/1/2016 1:15																

Cell: AP40
Comment: Needed for A/B SNG from 1700

Cell: AQ44
Comment: Make sure hours are correct

Cell: BE47
Comment: 7/2/13 changed from 3-hour rolling average to 1-hour average

Cell: BC78
Comment: Total SO2 lb/hr (NORMAL CONDITIONS) =
1400 Flash Gas SO2 lb/hr +
1310 Cooled Raw Gas SO2 lb/hr +
1200 Shifted Raw Gas SO2 lb/hr +
1180 Lock Gas SO2 lb/hr

=Ar76+Ay76+Bb76+Bf76

Cell: AX83
Comment: PC Calc =
Column BB PC11802B Valve Position percent / 100 *
1280 (from Engineering data sheet?)

=BB75/100*1280

Change array in BB47:BB72 to look at BB2 tag, change calc
"BB75" to "BB74" - change back when done - don't want to include in normal calculation

Cell: BC85
Comment: Total H2S lb/minute =
Rectisol Off Gas H2S lb/min +
Phosam Overheads H2S lb/min +
Rectisol Flash Gas H2S lb/min +
Raw Gas H2S lb/min *
1/2 +
Raw Gas H2S lb/min +
Lock Gas H2S lb/min +
1.125????

=AF84+AJ84+AQ84+AX84/2+BA84+BE84+1.125

Cell: AW86
Comment: Basis Raw Gas H2S lb/min =
(1300 Converted gas MSCFH + 1200 Converted gas MSCFH) *
1000 *
Raw Gas analysis percent H2S / 100 *
(100%-28%)/100 H2O correction = 0.72 *
1 hour / 60 minutes *
34 lbs H2S / lb-mol *
1 lb-mol / 379 SCF

=(AY84+AZ84)*1000*$A$44/100*0.72*1/60*34/379

Cell: AY86
Comment: Basis Lock Gas H2S lb/min =
HP Lock gas to flare MSCFH *
1000 *
1 hour / 60 minutes *
Raw Gas analysis percent H2S / 100 *
34 lbs H2S / lb-mol *
1 lb-mol / 379 SCF *
60% of Raw Gas H2S in HP Lock gas

=BB84*1000*1/60*$A$44/100*34/379*0.6

Cell: BD86
Comment: SO2 lb/hr =
Total H2S lb/min *
64 lb SO2 / 34 lb H2S *
60 minutes / hour

=BG84*64/34*60

Startup Flare:

The following is an explanation of the columns and rows of the spreadsheet titled “Startup” and a discussion of the equations within it. The following columns and rows are the ones most utilized to track sulfur dioxide (SO_2) emissions from the Startup Flare:

- Column A is a date/time stamp indicating the ending time of process.
- Columns B and C are the daily lab samples, in percent H_2S, of the raw gas and the CO_2 product gas streams, which are used for both the startup flare and main flare calculations.
- Column D is the process flow data from the flow meter for flared waste gas.
- Column E calculates pounds per hour (pph) of SO_2 released from the Startup Flare using the equation discussed in the **Operation During Malfunction** section below. This column is replaced with equations also described below depending on if the gasifiers are in startup (**Steam Heat Up**; **Air/Steam Mix Heatup**; **Oxygen Startup**) or shutting down (**Shutdown**).
- Column L is used to calculate the total SO_2 emitted from the Startup Flare, and is the sum of columns E and K.
- Calculations in rows 7 through 38 are daily averages for the hourly data calculated for each day. The values in these rows are saved as part of the permanent record for the flare; each month, a new spreadsheet is generated while the prior month’s is saved.
- Calculations in rows 47 through 76 are hourly averages. Each days’ hourly averages are overwritten for each new day, except under special circumstances (days on which gasification startup and/or shutdown occur), as discussed in further detail below. A separate annual log of the summed emissions for each hour of each day is saved, an excerpt for the year 2016 is included as “Sheet1” (note: the individual values and calculations for each hour are not saved in this annual log, only the final summed hourly SO_2 emissions).
- Calculations in rows 98 through 194 are 15-minute averages. These values are also overwritten each day.

The following columns are either used only rarely under special circumstances or are no longer in use, or are used solely for tracking purposes for other emission units, requirements, and/or programs:

- Column F is the low pressure lock gas that can be routed to the startup flare.
- Column G is the SNG (Synthetic Natural Gas) spike gas to the flare.
- Column H is not in use at this time.
- Columns I, J, and K are not normally used; these columns are used if streams normally routed to the main flare are routed instead to the startup flare.

- Column M is just used for tracking purposes; it provides the total SO2 released during each day (column L multiplied by 24 hours in a day).

- Columns N and O are used to separate sulfur emissions into SO_2 and H_2S.

- Columns P and Q are not used for the Startup Flare at all; these columns are used to monitor an off-site pipeline flare.

- Columns U through Z are also not used for the Startup Flare; these columns are for tracking the Backup flare. The Backup Flare is used as backup for the Startup Flare. The calculations are therefore identical to those of the Startup Flare discussed herein.

- Column AC is not in use at this time.

The Startup Flare generally utilizes two categories of operation with differing calculation methodologies associated with them: broadly categorized as **Operation During Malfunction** and gasifier startup/shutdown. The broad category of gasifier startup/shutdown is broken down into four distinct categories, depending on whether the gasifier is starting up (which itself consists of three distinct startup phases) or shutting down (which has just one phase associated with it).

Gasifier startup moves sequentially through three phases of distinct emission profiles: first, steam is injected into the gasifier to begin heating the gasifier (the emissions calculation for which is discussed under the heading **Steam Heatup**). Second, once a certain temperature is achieved, air is added to the steam for an air/steam mix (the emissions calculation for which is discussed under the heading **Air/Steam Mix Heatup**). Third, as the gasifier achieves normal gasification temperatures, the air is switched out for pure oxygen, resulting in the normal gasification oxygen/steam mixture (the emissions calculation for which is discussed under the heading **Oxygen Startup**). The gas being produced from startup is then switched over from being flared in the Startup Flare to the raw gas header for further downstream gas processing. Shutdown of a gasifier only has one emissions regime associated with it (the emissions calculation for which is discussed under the heading **Shutdown**).

The **Operation During Malfunction** equation discussed below is the default equation utilized on an hourly basis as calculated in rows 48 through 76. When the gasifiers are in startup or shutdown mode, the equations associated with that type of operation are used to overwrite the hourly equations, as discussed in further detail below. When the default **Operation During Malfunction** equation is overwritten, a separate hourly log for that day is copied into rows at the bottom of the spreadsheet, since different equations are possibly utilized for different hours of that day.

Operation During Malfunction:

For operations not involving gasification startup, the Startup Flare emissions on a pound per hour (pph) basis are calculated in column E. This can occur when gasifiers are operating but downstream chemical processes are not able to accept raw gas. The following equation is used during operation of the Startup Flare during malfunction (an Excel Max Function is used to prevent negative numbers).

$$\left(Flow\ rate \cdot 1000 \cdot \frac{Raw\ gas\ \%H2S}{100} \cdot 0.75 \cdot \frac{64}{379} \cdot (1-0.15)\right) = pph\ SO2$$

Flow rate of flared gas (column D): The flow rate is expressed in MSCFH

1000: conversion from MSCFH to SCFH

Raw gas %H_2S (column B): from measured daily lab results

0.75: a standard value based off previous lab data correlating the lock gas that is actually flared to the raw gas that is monitored on a daily basis based upon the measured reduction due to pre-flared scrubbing

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

(1-0.15): subtracts out 15 percent moisture in the gas stream; based on previous testing

Shutdown:

The following equation is used during a gasifier shutdown. When the gasifier shutdown calculation is used, the output of the below calculation occurs to cell L82, which is then used to copy over the normal **Operation During Malfunction** hourly output equation in column E (hourly calculation rows 48 through 76) for the specific hours for which gasifier(s) are on shutdown. The calculation in column E now utilizes the below shutdown calculation rather than the **Operation During Malfunction** calculation normally utilized for that individual hour for which the gasifier was determined to be in shutdown mode.

$$Flow\ rate \cdot 1000 \cdot \frac{Wet\ \%H2S}{100} \cdot \frac{\%Raw\ Gas}{100} \cdot \frac{64}{379} = pph\ SO2$$

Flow rate of flared gas (column D): The flow rate is expressed in MSCFH

1000: conversion from MSCFH to SCFH

Wet %H_2S (cell J82): a moisture-corrected value from the daily raw gas sample using percent moisture from cell I82 (column B x (100% - cell I82)/100%); the percent moisture is determined through testing of gasifiers while in shutdown

%Raw Gas (cell K82): percentage of flared gas concentration in shutdown mode that correlates to the raw gas concentration of the daily sample, determined through correlation testing of gasifiers while in shutdown

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Steam Heat Up:

The following equation is used during the steam heat up portion of gasifier startup. When the gasifier steam heat up calculation is used, the output of the below calculation occurs to cell L81, which is then used to copy over the normal **Operation During Malfunction** hourly output equation in column E (hourly calculation rows 48 through 76) for the specific hours for which gasifier(s) are on steam heat up. The calculation in column E now utilizes the below steam heat up calculation rather than the **Operation During Malfunction** calculation normally utilized for that individual hour for which the gasifier was determined to be in steam heat up mode.

$$Flow\ rate \cdot 1000 \cdot \frac{Wet\ \%H2S}{100} \cdot \frac{\%Raw\ Gas}{100} \cdot \frac{64}{379} = pph\ SO2$$

Flow rate of flared gas (column D): The flow rate is expressed in MSCFH

1000: conversion from MSCFH to SCFH

Wet %H_2S (cell J81): a moisture-corrected value from the daily raw gas sample using percent moisture from cell I81 (column B x (100% - cell I81)/100%); the percent moisture is determined through testing of gasifiers while in steam heat up

%Raw Gas (cell K81): percentage of flared gas concentration in steam heat up mode that correlates to the raw gas concentration of the daily sample, determined through correlation testing of gasifiers while in steam heat up

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Air/Steam Mix Heat Up:

The following equation is used during the air/steam mix heat up portion of gasifier startup. When the gasifier steam air/steam mix heat up calculation is used, the output of the below calculation occurs to cell L80, which is then used to copy over the normal **Operation During Malfunction** hourly output equation in column E (hourly calculation rows 48 through 76) for the specific hours for which gasifier(s) are on air/steam mix heat up. The calculation in column E now utilizes the below air/steam mix heat up calculation rather than the **Operation During Malfunction** calculation normally utilized for that individual hour for which the gasifier was determined to be in air/steam mix heat up mode.

$$Flow\ rate \cdot 1000 \cdot \frac{Wet\ \%H2S}{100} \cdot \frac{\%Raw\ Gas}{100} \cdot \frac{64}{379} = pph\ SO2$$

Flow rate of flared gas (column D): The flow rate is expressed in MSCFH

1000: conversion from MSCFH to SCFH

Wet %H_2S (cell J80): a moisture-corrected value from the daily raw gas sample using percent moisture from cell I80 (column B x (100% - cell I80)/100%); the percent moisture is determined through testing of gasifiers while in air/steam mix heat up

%Raw Gas (cell K80): percentage of flared gas concentration in air/steam mix heat up mode that correlates to the raw gas concentration of the daily sample, determined through correlation testing of gasifiers while in air/steam mix heat up

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

Oxygen Startup:

The following equation is used during the oxygen startup portion of gasifier startup. When the gasifier oxygen startup calculation is used, the output of the below calculation occurs to cell L79, which is then used to copy over the normal **Operation During Malfunction** hourly output equation in column E (hourly calculation rows 48 through 76) for the specific hours for which gasifier(s) are on oxygen startup. The calculation in column E now utilizes the below oxygen startup calculation rather than the **Operation During Malfunction** calculation normally utilized for that individual hour for which the gasifier was determined to be in oxygen startup mode.

$$Flow\ rate \cdot 1000 \cdot \frac{Wet\ \%H2S}{100} \cdot \frac{\%Raw\ Gas}{100} \cdot \frac{64}{379} = pph\ SO2$$

Flow rate of flared gas (column D): The flow rate is expressed in MSCFH

1000: conversion from MSCFH to SCFH

Wet %H_2S (cell J79): a moisture-corrected value from the daily raw gas sample using percent moisture from cell I79 (column B x (100% - cell I79)/100%); the percent moisture is determined through testing of gasifiers while in oxygen startup

%Raw Gas (cell K79): percentage of flared gas concentration in oxygen startup mode that correlates to the raw gas concentration of the daily sample, determined through correlation testing of gasifiers while in oxygen startup

64: the molecular weight of SO_2

379: standard conversion from cubic feet to mol-lb

	A	B	C	D	E	F	G	H	I	J	K	L
1					**Start-up Flare**						0.64	
2								PC11939.pv				
3				FI11932.PV				PC11939.op	Expansion gas	Expansion gas	Expansion gas	
4					**0.00**	pc11803.op	FC11933.PV	Startup Scrubber			**0.89% H2S**	**Total**
5		Raw Gas	CO2	WGAS To S.U. Flare		LP Lockgas	Spike Gas	Outlet	Est Exp gas	Hours	**50% water**	**Daily Avg**
6		%H2S	%H2S	MSCFH	Lb/hr	PCT	MSCFH	PCT	MMCFH	Flared	**SO2 Lb/Hr**	**SO2 Lb/Hr**
7	11/1/2016 0:00	0.5222	1.40	0.0000	**0.0**	0.012751609	24.39148328	0.006983121	**0.0**	0.0	**0.0**	**0.0**
8	11/2/2016 0:00	0.4109	1.30	0.0000	**0.0**	0	24.366533	0	**0.0**	0.0	**0.0**	**0.0**
9	11/3/2016 0:00	0.4297	1.30	0.0000	**0.0**	0.004885631	24.34141113	0	**0.0**	0.0	**0.0**	**0.0**
10	11/4/2016 0:00	0.5120	1.40	0.2295	**0.1**	0.013524875	24.32481071	0.157121185	**0.0**	0.0	**0.0**	**0.1**
11	11/5/2016 0:00	0.4740	1.40	0.0000	**0.0**	0	24.12375578	1.1304432	**0.0**	0.0	**0.0**	**0.0**
12	11/6/2016 0:00	0.4700	1.50	0.0871	**0.0**	0.04287354	24.11730741	0.440468622	**0.0**	0.0	**0.0**	**0.0**
13	11/7/2016 0:00	0.44	1.10	0.0000	**0.0**	0.02317495	24.0761714	0.03921541	**0.0**	0.0	**0.0**	**0.0**
14	11/8/2016 0:00	0.38	1.30	0.0541	**0.0**	0.025592197	24.12643869	0.136092846	**0.0**	0.0	**0.0**	**0.0**
15	11/9/2016 0:00	0.5200	1.40	0.0000	**0.0**	0	24.15147172	0.151343301	**0.0**	0.0	**0.0**	**0.0**
16	11/10/2016 0:00	0.4969	1.20	5.1565	**2.8**	0	24.03924014	1.853296618	**0.0**	0.0	**0.0**	**2.8**
17	11/11/2016 0:00	0.5102	1.40	0.0000	**0.0**	0	24.13856728	0	**0.0**	0.0	**0.0**	**0.0**
18	11/12/2016 0:00	0.4400	1.50	0.0000	**0.0**	0	23.92412994	0.017997173	**0.0**	0.0	**0.0**	**0.0**
19	11/13/2016 0:00	0.4800	1.50	0.0000	**0.0**	0.009101117	23.81874758	2	**0.0**	0.0	**0.0**	**0.0**
20	11/14/2016 0:00	0.5100	1.50	0.0000	**0.0**	0	24.0335988	0.053064418	**0.0**	0.0	**0.0**	**0.0**
21	11/15/2016 0:00	0.5100	1.40	0.2874	**0.2**	0	24.02854494	0.170848386	**0.0**	0.0	**0.0**	**0.2**
22	11/16/2016 0:00	0.4282	1.40	0.1635	**0.1**	0.000165294	23.98686016	2.375424634	**0.0**	0.0	**0.0**	**0.1**
23	11/17/2016 0:00	0.4282	1.50	3.0599	**1.4**	0.000950959	24.02658212	0.457071679	**0.0**	0.0	**0.0**	**1.4**
24	11/18/2016 0:00	0.4282	1.40	0.0000	**0.0**	0	24.06521143	0	**0.0**	0.0	**0.0**	**0.0**
25	11/19/2016 0:00	0.4282	1.30	0.0000	**0.0**	0.010003095	24.18503047	0.03960017	**0.0**	0.0	**0.0**	**0.0**
26	11/20/2016 0:00	0.5100	1.40	0.0021	**0.0**	0.075311343	24.07599512	0	**0.0**	0.0	**0.0**	**0.0**
27	11/21/2016 0:00	0.4300	1.50	14.1910	**6.6**	0.072409144	33.67789376	2.073828404	**0.0**	0.0	**0.0**	**6.6**
28	11/22/2016 0:00	0.5400	1.60	0.0000	**0.0**	0	23.93334556	0.080431945	**0.0**	0.0	**0.0**	**0.0**
29	11/23/2016 0:00	0.47	1.50	0.0000	**0.0**	0	23.93719992	0.015705733	**0.0**	0.0	**0.0**	**0.0**
30	11/24/2016 0:00	0.4773	1.60	15.2646	**7.8**	0	25.53031947	0	**0.0**	0.0	**0.0**	**7.8**
31	11/25/2016 0:00	0.4625	1.40	0.0000	**0.0**	0	23.73664906	0	**0.0**	0.0	**0.0**	**0.0**
32	11/26/2016 0:00	0.4245	1.20	0.0000	**0.0**	0.001377879	23.70368774	0	**0.0**	0.0	**0.0**	**0.0**
33	11/27/2016 0:00	0.3900	1.40	0.0000	**0.0**	0	23.71038755	0	**0.0**	0.0	**0.0**	**0.0**
34	11/28/2016 0:00	0.3900	1.40	0.0000	**0.0**	0.000418628	23.73616547	0	**0.0**	0.0	**0.0**	**0.0**
35	11/29/2016 0:00	0.3600	1.30	0.0000	**0.0**	0	23.75690383	0	**0.0**	0.0	**0.0**	**0.0**
36	11/30/2016 0:00	0.4099	1.30	0.0000	**0.0**	0.016333308	23.88979416	0	**0.0**	0.0	**0.0**	**0.0**
37	12/1/2016 0:00			0.0000	**0.0**	0.025263217	23.91665624	0	**0.0**	0.0	**0.0**	**0.0**
38	12/2/2016 0:00											
39	Average			1.24	**0.61**	0.01	24.38	0.36	**0.00**		**0.00**	**0.61**
40										0.00		
41				**0.9**	**456**		**18.1**					
42				**Waste Gas**	**Total Pounds**		**SNG MMSCF**					
43				**MMSCF**	0.61							
44	**42694.00**											
45					0.00				**0.000**			

	A	M	N	O	P	Q	R	S	T	U	V	W
1			494 pph limit 7/2/13									
2								Expansion Gas				
3-6		Total SO2 lbs	Total SO2 lbs 0.99	Total H2S lbs 0.01	TIOGA Flare Temp Deg F TI74054.PV	TIOGA Flare Low Temp Alarm TAL74054.PV		Daily Expansion gas Exp gas MCFH	Exp gas SO2 Lb/hr	XZAO11815.PV	FI11808.PV WGAS Flow MSCFH	FI11809A.PV SNG Flow MSCFH
7	11/1/2016 0:00	0	0	0	1396.664192	0		461	520	1	8.752830678	0
8	11/2/2016 0:00	0	0	0	1396.653371	0		461	520	1	23.68783703	0
9	11/3/2016 0:00	0	0	0	1396.696668	0		461	520	1	26.93234271	0
10	11/4/2016 0:00	3	3	0	1396.657537	0		400	450	1	24.48211651	0
11	11/5/2016 0:00	0	0	0	1396.759942	0		465	524	1	19.24433236	0
12	11/6/2016 0:00	1	1	0	1396.585637	0		463	521	1	9.214323223	0
13	11/7/2016 0:00	0	0	0	1396.472993	0		338	380	1	27.75427191	0
14	11/8/2016 0:00	1	1	0	1396.529766	0		458	516	1	29.71315962	0
15	11/9/2016 0:00	0	0	0	1396.598945	0		460	518	1	18.32554903	0
16	11/10/2016 0:00	66	66	0	1396.438722	0		446	503	1	28.12978925	0
17	11/11/2016 0:00	0	0	0	1396.312788	0		431	485	1	28.89487444	0
18	11/12/2016 0:00	0	0	0	1396.581443	0		459	518	1	10.28133541	0
19	11/13/2016 0:00	0	0	0	1396.389367	0		467	527	1	9.786281144	0
20	11/14/2016 0:00	0	0	0	1396.683253	0		458	517	1	10.67384968	0
21	11/15/2016 0:00	4	4	0	1396.357621	0		462	521	1	12.0394445	0
22	11/16/2016 0:00	2	2	0	1396.323642	0		445	502	1	2.689559639	0
23	11/17/2016 0:00	34	34	0	463.4364116	0.621598843		361	407	1	25.8342094	0
24	11/18/2016 0:00	0	0	0	766.0309312	0.432234005		295	333	1	30.44639969	0
25	11/19/2016 0:00	0	0	0	1396.028608	0		329	371	1	30.44639969	0
26	11/20/2016 0:00	0	0	0	1396.235571	0		468	527	1	26.75725415	0
27	11/21/2016 0:00	158	156	1	1396.419981	0		445	502	1	14.57003297	0
28	11/22/2016 0:00	0	0	0	1396.457411	0		463	522	1	22.01513091	0
29	11/23/2016 0:00	0	0	0	1396.542843	0		468	527	1	29.29943258	0
30	11/24/2016 0:00	188	186	1	1396.535725	0		458	516	1	29.44300922	0
31	11/25/2016 0:00	0	0	0	1396.365181	0		467	526	1	24.98098565	0
32	11/26/2016 0:00	0	0	0	1396.315453	0		468	527	1	19.57435191	0
33	11/27/2016 0:00	0	0	0	1396.338778	0		467	527	1	2.131573156	0
34	11/28/2016 0:00	0	0	0	1396.111156	0		467	527	1	0	0
35	11/29/2016 0:00	0	0	0	1395.938396	0		469	528	1	2.813519397	0
36	11/30/2016 0:00	0	0	0	1396.013604	0		470	530	1	19.27322041	0
37	12/1/2016 0:00	0	0	0	1396.461384	0				1	25.96953215	0
38	12/2/2016 0:00											
39	Average				1346.00			**440.99**	**497.08**		14.26	0.00
40												
41												
42												**529.52**
43												
44	**42694.00**											
45												

	A	X	Y	Z	AA	AB	AC
1		**Backup Flare**					
2							
3							
4		FI11809B.PV		Gaifier SU			CFS11606.PV
5		FUELGAS		Air/Stm/O2			Gasifier capacity
6		MSCFH	Value used	Lb/hr SO2 daily avg	3 Hr Rolling Avg		Eq
7	11/1/2016 0:00	6.769181382	0.00	**0.00**			13.78923136
8	11/2/2016 0:00	8.704786172	0.00	**0.00**			13.79838309
9	11/3/2016 0:00	11.2384474	0.00	**0.00**			13.79801057
10	11/4/2016 0:00	14.10218157	0.00	**0.00**			11.95199749
11	11/5/2016 0:00	13.19618434	0.00	**0.00**			13.90075993
12	11/6/2016 0:00	13.63872892	0.00	**0.00**			13.83707013
13	11/7/2016 0:00	3.643959348	0.00	**0.00**			10.09653478
14	11/8/2016 0:00	8.508792153	0.00	**0.00**			13.69452649
15	11/9/2016 0:00	17.03746512	0.00	**0.00**			13.75499255
16	11/10/2016 0:00	10.05385872	0.00	**0.00**			13.34984009
17	11/11/2016 0:00	9.990159892	0.00	**0.00**			12.88109962
18	11/12/2016 0:00	20.48783121	0.00	**0.00**			13.73874896
19	11/13/2016 0:00	18.12098208	0.00	**0.00**			13.97319313
20	11/14/2016 0:00	17.82969389	0.00	**0.00**			13.71326007
21	11/15/2016 0:00	17.26783909	0.00	**0.00**			13.83475969
22	11/16/2016 0:00	16.25477844	0.00	**0.00**			13.31964625
23	11/17/2016 0:00	2.511658958	0.00	**0.00**			10.81041336
24	11/18/2016 0:00	-0.167015519	0.00	**0.00**			8.824682737
25	11/19/2016 0:00	6.224204223	0.00	**0.00**			9.847922049
26	11/20/2016 0:00	13.48743977	0.00	**0.00**			13.99745623
27	11/21/2016 0:00	18.76573663	0.00	**0.00**			13.31862286
28	11/22/2016 0:00	19.35858359	0.00	**0.00**			13.8471602
29	11/23/2016 0:00	18.79225999	0.00	**0.00**			13.98800364
30	11/24/2016 0:00	17.9629099	0.00	**0.00**			13.68618847
31	11/25/2016 0:00	22.12921791	0.00	**0.00**			13.97293874
32	11/26/2016 0:00	27.15127439	0.00	**0.00**			13.9977764
33	11/27/2016 0:00	26.17241357	0.00	**0.00**			13.97911796
34	11/28/2016 0:00	20.25997973	0.00	**0.00**			13.97656989
35	11/29/2016 0:00	19.34196638	0.00	**0.00**			14.01499916
36	11/30/2016 0:00	17.95186566	0.00	**0.00**			14.06841694
37	12/1/2016 0:00	20.21835403	0.00	**0.00**			13.69251765
38	12/2/2016 0:00						
39	Average	14.74	0.00	**0.00**			13.21
40							
41		**10.97**					
42							
43							
44	**42694.00**						
45							

	A	B	C	D	E	F	G	H	I	J	K	L
46						Daily RG				Hours	0.89% H2S	
47	**11/30/16**	0.4099	1.30			LP Lockgas			Est	Flared	50% water	**1-Hr Avg**
48	11/29/2016 22:00		20.5	FI11932.PV	**Lb/hr**	pc11803.op	FC11933.PV	PC11939.pv	MMCFH	Exp gas	SO2 Lb/Hr	**SO2 Lb/Hr**
49	11/29/2016 23:00		20.5	0.000	**0**	0	23.913908	4.703933468	**0.0**	0.00	**0.00**	**0**
50	11/30/2016 0:00		20.5	0.000	**0**	0	23.913908	4.818603347	**0.0**	0.00	**0.00**	**0**
51	11/30/2016 1:00		20.5	0.000	**0**	0	23.913908	4.773258148	**0.0**	0.00	**0.00**	**0**
52	11/30/2016 2:00		20.5	0.000	**0**	0	23.91380126	4.695591203	**0.0**	0.00	**0.00**	**0**
53	11/30/2016 3:00		20.5	0.000	**0**	0	23.93997915	4.591167826	**0.0**	0.00	**0.00**	**0**
54	11/30/2016 4:00		20.5	0.000	**0**	0	23.87672034	4.57788792	**0.0**	0.00	**0.00**	**0**
55	11/30/2016 5:00		20.5	0.000	**0**	0	23.913908	4.622071911	**0.0**	0.00	**0.00**	**0**
56	11/30/2016 6:00		20.5	0.000	**0**	0	23.94728106	4.516107565	**0.0**	0.00	**0.00**	**0**
57	11/30/2016 7:00		20.5	0.000	**0**	0	24.04422951	4.49348762	**0.0**	0.00	**0.00**	**0**
58	11/30/2016 8:00		20.5	0.000	**0**	0	23.94141464	4.761380292	**0.0**	0.00	**0.00**	**0**
59	11/30/2016 9:00		20.5	0.000	**0**	0	23.80838443	4.697203529	**0.0**	0.00	**0.00**	**0**
60	11/30/2016 10:00		20.5	0.000	**0**	0	23.88398522	4.732516636	**0.0**	0.00	**0.00**	**0**
61	11/30/2016 11:00		20.5	0.000	**0**	0	23.913908	4.59971077	**0.0**	0.00	**0.00**	**0**
62	11/30/2016 12:00		20.5	0.000	**0**	0	23.913908	4.472375252	**0.0**	0.00	**0.00**	**0**
63	11/30/2016 13:00		20.5	0.000	**0**	0	23.94265584	4.639561572	**0.0**	0.00	**0.00**	**0**
64	11/30/2016 14:00		20.5	0.000	**0**	0.166095406	23.985103	4.683470111	**0.0**	0.00	**0.00**	**0**
65	11/30/2016 15:00		20.5	0.000	**0**	0.002068229	23.913908	4.643657573	**0.0**	0.00	**0.00**	**0**
66	11/30/2016 16:00		20.5	0.000	**0**	0	23.85017049	4.661059975	**0.0**	0.00	**0.00**	**0**
67	11/30/2016 17:00		20.5	0.000	**0**	0	23.88152311	4.52665543	**0.0**	0.00	**0.00**	**0**
68	11/30/2016 18:00		20.5	0.000	**0**	0	23.913908	4.639229975	**0.0**	0.00	**0.00**	**0**
69	11/30/2016 19:00		20.5	0.000	**0**	0	23.81097077	4.571175401	**0.0**	0.00	**0.00**	**0**
70	11/30/2016 20:00		20.5	0.000	**0**	0	23.78287125	4.58217293	**0.0**	0.00	**0.00**	**0**
71	11/30/2016 21:00		20.5	0.000	**0**	0	23.78287125	4.394924866	**0.0**	0.00	**0.00**	**0**
72	11/30/2016 22:00		20.5	0.000	**0**	0	23.78287125	4.379103759	**0.0**	0.00	**0.00**	**0**
73	11/30/2016 23:00		20.5	0.000	**0**	0.223835755	23.78287125	4.47945816	**0.0**	0.00	**0.00**	**0**
74	12/1/2016 0:00		20.5	0.000	**0**	0.250759432	23.78287125	4.468005583	**0.0**	0.00	**0.00**	**0**
75	12/1/2016 1:00		20.5	0.000	**0**	0	23.78287125	4.596336152	**0.0**	0.00	**0.00**	**0**
76	12/1/2016 2:00											
77	Average		Startup	0.00	0.0	0.03	23.88	4.59	**0.000**	0.00	**0.00**	**0.00**
78			Sequence	Typical flows					%Moisture	Wet %H2S	% of Raw Gas	NEW Calc
79			Last	1200.00	**498.4**		**SU gasifier O2 (testing of 1-9/10-01)**		**76.8**	**0.095**	**87.0**	**167.7**
80			Second	500.00			**Air/steam SU**		**78.5**	**0.088**	**47**	**35.0**
81			First	180.00			**Steam heatup (Sept/Oct 09)**		**13.3**	**0.355**	**32**	**34.6**
82				266.00			**Gasifier Shutdown**		**9.0**	**0.37**	**60**	**100.5**
83					**0.0**		**Expansion gas**					
84					**0.0**		**Lock gas calc**					
85				80.00	**53.7**		**Raw gas, Orsat gas, Vent gas, SD**		8.00			
86					**0.0**		**FA-1302 breakthrough**					
87												
88												
89												
90												

	A	M	N	O	P	Q	R	S	T	U	V	W
46									5/2		106.08	23.33
47	**11/30/16**		**1-Hr Avg**	**TIOGA Flare**	**TIOGA Flare**							
48	11/29/2016 22:00		Pounds over 494 pph	**Temp Deg F**	**Low Temp Alarm**		Exp gas MCFH	Exp gas Lb/hr		BU flare Flows		
49	11/29/2016 23:00			1395.733793	0		**468**	**352**		w/gas	14.33455178	0
50	11/30/2016 0:00			1395.748109	0		**468**	**352**		0.00	15.42101116	0
51	11/30/2016 1:00		0	1397.165657	0		**468**	**352**		0.00	15.93700411	0
52	11/30/2016 2:00		0	1394.536729	0		**468**	**352**		0.00	16.69230461	0
53	11/30/2016 3:00		0	1396.809585	0		**468**	**352**		0.00	17.06062533	0
54	11/30/2016 4:00		0	1395.917855	0		**468**	**352**		0.00	17.12091448	0
55	11/30/2016 5:00		0	1394.727963	0		**468**	**352**		0.00	17.58076376	0
56	11/30/2016 6:00		0	1395.654031	0		**468**	**352**		0.00	18.08634625	0
57	11/30/2016 7:00		0	1395.700645	0		**470**	**353**		0.00	18.55876514	0
58	11/30/2016 8:00		0	1396.832965	0		**471**	**354**		0.00	18.83225126	0
59	11/30/2016 9:00		0	1395.744473	0		**471**	**354**		0.00	18.96528453	0
60	11/30/2016 10:00		0	1396.203768	0		**471**	**354**		0.00	19.33298595	0
61	11/30/2016 11:00		0	1395.844387	0		**471**	**354**		0.00	18.85291288	0
62	11/30/2016 12:00		0	1395.55088	0		**471**	**354**		0.00	18.52807932	0
63	11/30/2016 13:00		0	1396.243804	0		**471**	**354**		0.00	18.32871484	0
64	11/30/2016 14:00		0	1397.117238	0		**471**	**354**		0.00	18.55762601	0
65	11/30/2016 15:00		0	1396.384089	0		**471**	**354**		0.00	19.60777453	0
66	11/30/2016 16:00		0	1396.325696	0		**471**	**354**		0.00	20.49346418	0
67	11/30/2016 17:00		0	1395.27548	0		**471**	**354**		0.00	21.03954825	0
68	11/30/2016 18:00		0	1396.793592	0		**471**	**354**		0.00	21.63639517	0
69	11/30/2016 19:00		0	1396.550591	0		**471**	**354**		0.00	22.05524395	0
70	11/30/2016 20:00		0	1396.225976	0		**471**	**354**		0.00	22.21980275	0
71	11/30/2016 21:00		0	1395.603762	0		**471**	**354**		0.00	22.1679888	0
72	11/30/2016 22:00		0	1396.068335	0		**471**	**354**		0.00	22.55749515	0
73	11/30/2016 23:00		0	1395.300895	0		**471**	**354**		0.00	22.92398741	0
74	12/1/2016 0:00		0	1397.328856	0		**471**	**354**			23.0846349	0
75	12/1/2016 1:00		0	1395.66288	0						23.44292534	0
76	12/1/2016 2:00		0.00									
77	Average			1396			**470**	**354**			19.59	0.00
78		Typical SU/SD pounds										
79		503										
80		245										
81		69										0.000
82		294										
83												0.000
84		816.89										
85		68.07										
86												
87												
88												
89												
90												

	A	X		Y	Z	AA	AB	AC
46		17.88		170.75	145.44	**Permit dev**		
47	**11/30/16**			**0.00**	**0.00**	**3 Hr Roll Avg**		
48	11/29/2016 22:00				**0.00**	**SO2 Lb/Hr**		
49	11/29/2016 23:00		17.7800482	**18**	**7.85**			
50	11/30/2016 0:00		17.51547047	**18**	**7.73**			13.99444693
51	11/30/2016 1:00		17.29468391	**17**	**7.63**	**7.74**		13.99882302
52	11/30/2016 2:00		17.11524424	**17**	**7.55**	**7.64**		13.99485164
53	11/30/2016 3:00		17.06719931	**17**	**7.53**	**7.57**		14.00208878
54	11/30/2016 4:00		16.86721928	**17**	**7.44**	**7.51**		13.99485389
55	11/30/2016 5:00		16.68983701	**17**	**7.36**	**7.45**		13.99856831
56	11/30/2016 6:00		16.65352284	**17**	**7.35**	**7.39**		13.99939544
57	11/30/2016 7:00		16.81228237	**17**	**7.42**	**7.38**		13.99940919
58	11/30/2016 8:00		17.14154421	**17**	**7.56**	**7.44**		14.07127993
59	11/30/2016 9:00		17.31806789	**17**	**7.64**	**7.54**		14.10347698
60	11/30/2016 10:00		17.80219164	**18**	**7.86**	**7.69**		14.09559591
61	11/30/2016 11:00		18.49645309	**18**	**8.16**	**7.89**		14.09727763
62	11/30/2016 12:00		19.02286588	**19**	**8.39**	**8.14**		14.1000095
63	11/30/2016 13:00		19.25649013	**19**	**8.50**	**8.35**		14.09733426
64	11/30/2016 14:00		18.99657536	**19**	**8.38**	**8.42**		14.09966879
65	11/30/2016 15:00		18.67460125	**19**	**8.24**	**8.37**		14.1017937
66	11/30/2016 16:00		18.4707913	**18**	**8.15**	**8.26**		14.09599281
67	11/30/2016 17:00		18.31059711	**18**	**8.08**	**8.16**		14.0997207
68	11/30/2016 18:00		18.40612554	**18**	**8.12**	**8.12**		14.09829915
69	11/30/2016 19:00		18.56262415	**19**	**8.19**	**8.13**		14.09779332
70	11/30/2016 20:00		18.62462221	**19**	**8.22**	**8.18**		14.0986842
71	11/30/2016 21:00		18.70276692	**19**	**8.25**	**8.22**		14.09746317
72	11/30/2016 22:00		18.5259011	**19**	**8.17**	**8.22**		14.10211726
73	11/30/2016 23:00		18.51709868	**19**	**8.17**	**8.20**		14.10088547
74	12/1/2016 0:00		18.74537701	**19**	**8.27**	**8.21**		14.09662347
75	12/1/2016 1:00		18.66185366					14.1002653
76	12/1/2016 2:00							14.09587098
77	Average	18.00		17.98	7.92			
78								14.07
79								
80								
81		SU gasifier O2 (testing of 1-9/10-01)						
82								
83		Air/steam calc SU/SD			0.00	Normal calc		
84					0.00	Exp gas 808 < 460		
85					0.000	Total if FI> 460		
86								
87								
88								
89								
90								

Cell: F3
Comment:
PC11803 is a split-range valving arrangement;
0 - 50% output is using the B valve
50 - 100% output is using A valve

Cell: D6
Comment: a6958:
When Column B gets over 1000 it is an indication gasifier is on O2.

Cell: F6
Comment: a6958:
If this column is positive it is an indication of Lock gas going to SU flare.

Cell: Z39
Comment: Terrence Kizer:
These are the Backup flare numbers for the PAL sheet

Cell: U50
Comment: GRH:
manual flows for the BU flares. As per mitch olsen

Cell: I78
Comment: rch:
As of 10/16/09, this moisture is based on testing that was done on 10/1/09 only

Cell: H79
Comment: SO2 lb/hr during startup procedure, ON OXYGEN =
Waste gas to flare MSCFH * 1000 *
Daily Raw Gas Sample H2S analysis mole pct / 100 *
64 lb SO2 / lb-mol *
1 lb-mol / 379 SCF *
100% - 40% / 100 H20 correction

=B76*1000*$A$43/100*64/379*(1-0.4)

From PFD, one gasifier on O2 will contribute 307 lbs/hr of SO2,
and 1,215,388 scfh
plus the ORSAT gas/Vent gas of 32 lbs/hr,
totalling at least 339 lbs/hr of SO2

Typical flow 1200 MSCFH, 3 hours typical duration

Cell: D80
Comment: During a gasifier startup or shutdown the 1810 expansion gases BYPASS the Startup Scrubber - routed directly to the BOILERS (Normal route is through startup scrubber to boilers)

A N2 purge of ~85 MSCFH and the ORSAT gas (32 lb/hr) streams are started early in the startup process; will use the Air/Steam startup calculation until O2 is introduced to the gasifier, at which point we will assume the SU Gasifier O2 calculation.

The N_2 purge is used also in the shutdown process; to date, we use the Raw gas calc

Cell: W81
Comment: Backup Flare SO_2 lb/hr (during Gasifier Start-Up, on O_2)=
Q77 Waste Gas flow MSCFH *
1000 *
Raw Gas H_2S analysis mole percent /100 *
64 lbs SO_2 / lb-mol *
1 lb-mol / 379 SCF
(100% - 40%) / 100 H_2O correction *

=Q77*1000*$A$44/100*64/379*(1-0.4)

Cell: W83
Comment: Backup Flare SO_2 lb/hr during Gasifier Start-Up, on AIR/STEAM =
Waste Gas flow MSCFH *
1000 *
Raw Gas H_2S analysis mole percent /100 *
0.1
64 lbs SO_2 / lb-mol *
1 lb-mol / 379 SCF
(100% - 40%) / 100 H_2O correction *

=Q78*1000*$A$44/100*0.1*64/379*(1-0.4)

Cell: Z83
Comment: Backup Flare SO_2 lb/hr =
=IF(Q47<S47,S47,Q47) MSCFH *
1000 *
Raw Gas H_2S analysis mole percent /100 *
(100% - 40%) / 100 H_2O correction *
0.85 *
64 lbs SO_2 / lb-mol *
1 lb-mol / 379 SCF

=(T78)*1000*$A$44/100*0.6*0.85*64/379

Cell: Z84
Comment: Backup Flare SO_2 lb/hr =
=IF(Q47<S47,S47,Q47) MSCFH *
1000 *
0.89% %H2S in Gas
0.5% % Water in Gas
64 lbs SO_2 / lb-mol *
1 lb-mol / 379 SCF

=(T79)*1000*0.0089*0.5*64/379

Cell: Z85
Comment: Backup Flare SO2 lb/hr (if FI11809B > 460 MSCFH) =
(Value used column T - (Gasifier capacity / 14) * 0.468) *
1000 *
Raw Gas H2S analysis mole percent /100 *
0.4 *
64 lbs SO2 / 379 SCF *
(100% - 15%) / 100 H2O correction *
Expansion Gas SO2 lb/hr

=(T80-(BN80/14*468))*1000*$A$44/100*0.4*64/379*(1-0.15)+O80

	A	B	C	D	E	F
95						Max
96	0:15				15 min avg	15 min avg
97	11/30/16				0.0	
98	11/30/16 0:00		20.54577812	0	0.0	
99	11/30/16 0:15		20.54577812	0	0.0	0.00
100	11/30/16 0:30		20.54577812	0	0.0	
101	11/30/16 0:45		20.54577812	0	0.0	
102	11/30/16 1:00		20.54577812	0	0.0	
103	11/30/16 1:15		20.54577812	0	0.0	0.00
104	11/30/16 1:30		20.54577812	0	0.0	
105	11/30/16 1:45		20.54577812	0	0.0	
106	11/30/16 2:00		20.54577812	0	0.0	
107	11/30/16 2:15		20.54577812	0	0.0	0.00
108	11/30/16 2:30		20.54577812	0	0.0	
109	11/30/16 2:45		20.54577812	0	0.0	
110	11/30/16 3:00		20.54577812	0	0.0	
111	11/30/16 3:15		20.54577812	0	0.0	0.00
112	11/30/16 3:30		20.54577812	0	0.0	
113	11/30/16 3:45		20.54577812	0	0.0	
114	11/30/16 4:00		20.54577812	0	0.0	
115	11/30/16 4:15		20.54577812	0	0.0	0.00
116	11/30/16 4:30		20.54577812	0	0.0	
117	11/30/16 4:45		20.54577812	0	0.0	
118	11/30/16 5:00		20.54577812	0	0.0	
119	11/30/16 5:15		20.54577812	0	0.0	0.00
120	11/30/16 5:30		20.54577812	0	0.0	
121	11/30/16 5:45		20.54577812	0	0.0	
122	11/30/16 6:00		20.54577812	0	0.0	
123	11/30/16 6:15		20.54577812	0	0.0	0.00
124	11/30/16 6:30		20.54577812	0	0.0	
125	11/30/16 6:45		20.54577812	0	0.0	
126	11/30/16 7:00		20.54577812	0	0.0	
127	11/30/16 7:15		20.54577812	0	0.0	0.00
128	11/30/16 7:30		20.54577812	0	0.0	
129	11/30/16 7:45		20.54577812	0	0.0	
130	11/30/16 8:00		20.54577812	0	0.0	
131	11/30/16 8:15		20.54577812	0	0.0	0.00
132	11/30/16 8:30		20.54577812	0	0.0	
133	11/30/16 8:45		20.54577812	0	0.0	
134	11/30/16 9:00		20.54577812	0	0.0	
135	11/30/16 9:15		20.54577812	0	0.0	0.00
136	11/30/16 9:30		20.54577812	0	0.0	
137	11/30/16 9:45		20.54577812	0	0.0	
138	11/30/16 10:00		20.54577812	0	0.0	
139	11/30/16 10:15		20.54577812	0	0.0	0.00
140	11/30/16 10:30		20.54577812	0	0.0	
141	11/30/16 10:45		20.54577812	0	0.0	
142	11/30/16 11:00		20.54577812	0	0.0	
143	11/30/16 11:15		20.54577812	0	0.0	0.00
144	11/30/16 11:30		20.54577812	0	0.0	
145	11/30/16 11:45		20.54577812	0	0.0	
146	11/30/16 12:00		20.54577812	0	0.0	
147	11/30/16 12:15		20.54577812	0	0.0	0.00
148	11/30/16 12:30		20.54577812	0	0.0	
149	11/30/16 12:45		20.54577812	0	0.0	
150	11/30/16 13:00		20.54577812	0	0.0	
151	11/30/16 13:15		20.54577812	0	0.0	0.00
152	11/30/16 13:30		20.54577812	0	0.0	
153	11/30/16 13:45		20.54577812	0	0.0	
154	11/30/16 14:00		20.54577812	0	0.0	
155	11/30/16 14:15		20.54577812	0	0.0	0.00
156	11/30/16 14:30		20.54577812	0	0.0	
157	11/30/16 14:45		20.54577812	0	0.0	
158	11/30/16 15:00		20.54577812	0	0.0	
159	11/30/16 15:15		20.54577812	0	0.0	0.00
160	11/30/16 15:30		20.54577812	0	0.0	
161	11/30/16 15:45		20.54577812	0	0.0	
162	11/30/16 16:00		20.54577812	0	0.0	
163	11/30/16 16:15		20.54577812	0	0.0	0.00

	A	B	C	D	E	F
164	11/30/16 16:30		20.54577812	0	**0.0**	
165	11/30/16 16:45		20.54577812	0	**0.0**	
166	11/30/16 17:00		20.54577812	0	**0.0**	
167	11/30/16 17:15		20.54577812	0	**0.0**	0.00
168	11/30/16 17:30		20.54577812	0	**0.0**	
169	11/30/16 17:45		20.54577812	0	**0.0**	
170	11/30/16 18:00		20.54577812	0	**0.0**	
171	11/30/16 18:15		20.54577812	0	**0.0**	0.00
172	11/30/16 18:30		20.54577812	0	**0.0**	
173	11/30/16 18:45		20.54577812	0	**0.0**	
174	11/30/16 19:00		20.54577812	0	**0.0**	
175	11/30/16 19:15		20.54577812	0	**0.0**	0.00
176	11/30/16 19:30		20.54577812	0	**0.0**	
177	11/30/16 19:45		20.54577812	0	**0.0**	
178	11/30/16 20:00		20.54577812	0	**0.0**	
179	11/30/16 20:15		20.54577812	0	**0.0**	0.00
180	11/30/16 20:30		20.54577812	0	**0.0**	
181	11/30/16 20:45		20.54577812	0	**0.0**	
182	11/30/16 21:00		20.54577812	0	**0.0**	
183	11/30/16 21:15		20.54577812	0	**0.0**	0.00
184	11/30/16 21:30		20.54577812	0	**0.0**	
185	11/30/16 21:45		20.54577812	0	**0.0**	
186	11/30/16 22:00		20.54577812	0	**0.0**	
187	11/30/16 22:15		20.54577812	0	**0.0**	0.00
188	11/30/16 22:30		20.54577812	0	**0.0**	
189	11/30/16 22:45		20.54577812	0	**0.0**	
190	11/30/16 23:00		20.54577812	0	**0.0**	
191	11/30/16 23:15		20.54577812	0	**0.0**	0.00
192	11/30/16 23:30		20.54577812	0	**0.0**	
193	11/30/16 23:45		20.54577812	0	**0.0**	
194	12/1/16 0:00		20.54577812	0	**0.0**	
195	12/1/16 0:15			0		
196	12/1/16 0:30			0		
197	12/1/16 0:45			0		
198	12/1/16 1:00					

	A	V	W	X	Y	Z	AA	AB	AC
96	0:15	Back Up Flare					15 min avg		
97	11/30/16								
98	11/30/16 0:00	15.13450866	0	17.615497		**0.00**			14.00106227
99	11/30/16 0:15	15.32059956	0	17.60969925		**0.00**	0.00		14.01895554
100	11/30/16 0:30	15.32059956	0	17.60969925		**0.00**			13.97851156
101	11/30/16 0:45	15.32059956	0	17.51789429		**0.00**			13.99972818
102	11/30/16 1:00	15.52232483	0	17.44720078		**0.00**			13.99491448
103	11/30/16 1:15	15.52970028	0	17.44720078		**0.00**	0.00		13.99745317
104	11/30/16 1:30	15.52970028	0	17.3364518		**0.00**			13.9890349
105	11/30/16 1:45	15.55440663	0	17.28840065		**0.00**			14.00160652
106	11/30/16 2:00	16.34530067	0	17.17837725		**0.00**			13.99509276
107	11/30/16 2:15	16.34530067	0	17.11380005		**0.00**	0.00		14.01076131
108	11/30/16 2:30	16.34530067	0	17.11380005		**0.00**			13.99297996
109	11/30/16 2:45	16.40972203	0	17.11380005		**0.00**			14.01564759
110	11/30/16 3:00	17.01810074	0	17.11380005		**0.00**			13.98663868
111	11/30/16 3:15	17.01810074	0	17.11380005		**0.00**	0.00		13.99449036
112	11/30/16 3:30	17.01810074	0	17.11380005		**0.00**			13.99864038
113	11/30/16 3:45	17.03097715	0	17.11380005		**0.00**			13.99935551
114	11/30/16 4:00	17.09799957	0	17.03206498		**0.00**			14.00829962
115	11/30/16 4:15	17.09799957	0	17.00639915		**0.00**	0.00		13.98822005
116	11/30/16 4:30	17.09799957	0	16.84600622		**0.00**			14.00915122
117	11/30/16 4:45	17.10695195	0	16.83939934		**0.00**			13.99687904
118	11/30/16 5:00	17.13750076	0	16.83939934		**0.00**			14.01566558
119	11/30/16 5:15	17.13750076	0	16.83516734		**0.00**	0.00		13.99724581
120	11/30/16 5:30	17.13750076	0	16.67609978		**0.00**			13.98455037
121	11/30/16 5:45	17.36697226	0	16.67609978		**0.00**			14.00041484
122	11/30/16 6:00	17.92320061	0	16.67609978		**0.00**			13.99655516
123	11/30/16 6:15	17.92320061	0	16.6715576		**0.00**	0.00		14.00374082
124	11/30/16 6:30	17.92320061	0	16.62639999		**0.00**			14.00196569
125	11/30/16 6:45	18.02249545	0	16.62639999		**0.00**			13.99528717
126	11/30/16 7:00	18.20100021	0	16.62639999		**0.00**			13.99477903
127	11/30/16 7:15	18.20100021	0	16.65050219		**0.00**	0.00		14.08682231
128	11/30/16 7:30	18.20100021	0	16.78019905		**0.00**			14.10396951
129	11/30/16 7:45	18.45570892	0	16.8063202		**0.00**			14.09066884
130	11/30/16 8:00	18.80340004	0	16.94759941		**0.00**			14.10748206
131	11/30/16 8:15	18.80340004	0	16.94759941		**0.00**	0.00		14.10672406
132	11/30/16 8:30	18.80340004	0	16.9734658		**0.00**			14.10583935
133	11/30/16 8:45	18.82546901	0	17.23999977		**0.00**			14.09678055
134	11/30/16 9:00	18.84860039	0	17.23999977		**0.00**			14.09202521
135	11/30/16 9:15	18.84860039	0	17.23999977		**0.00**	0.00		14.10458531
136	11/30/16 9:30	18.84860039	0	17.25041548		**0.00**			14.09442334
137	11/30/16 9:45	18.94803679	0	17.33354027		**0.00**			14.09485066
138	11/30/16 10:00	19.02820015	0	17.47599983		**0.00**			14.09527044
139	11/30/16 10:15	19.02820015	0	17.55489508		**0.00**	0.00		14.09741639
140	11/30/16 10:30	19.02820015	0	17.7498172		**0.00**			14.09701881
141	11/30/16 10:45	19.33678435	0	17.95470047		**0.00**			14.10374221
142	11/30/16 11:00	19.52659988	0	18.16509155		**0.00**			14.09035943
143	11/30/16 11:15	19.52659988	0	18.31057844		**0.00**	0.00		14.11188255
144	11/30/16 11:30	19.52659988	0	18.39595054		**0.00**			14.08967589
145	11/30/16 11:45	18.81679376	0	18.70375774		**0.00**			14.10985231
146	11/30/16 12:00	18.48990059	0	18.81559944		**0.00**			14.09963886

	A	V	W	X	Y	Z	AA	AB	AC
147	11/30/16 12:15	18.48990059	0	18.86166685		**0.00**	0.00		14.09586854
148	11/30/16 12:30	18.48990059	0	18.97780037		**0.00**			14.09136543
149	11/30/16 12:45	18.54008968	0	19.08848925		**0.00**			14.10504939
150	11/30/16 13:00	18.55680084	0	19.17900085		**0.00**			14.09672116
151	11/30/16 13:15	18.55680084	0	19.22418791		**0.00**	0.00		14.10863021
152	11/30/16 13:30	18.55680084	0	19.33880043		**0.00**			14.0848367
153	11/30/16 13:45	18.27057664	0	19.27994265		**0.00**			14.10852895
154	11/30/16 14:00	18.20590019	0	19.17009926		**0.00**			14.10031282
155	11/30/16 14:15	18.20590019	0	19.17009926		**0.00**	0.00		14.11091018
156	11/30/16 14:30	18.20590019	0	19.06320097		**0.00**			14.09473458
157	11/30/16 14:45	18.61333355	0	18.86947871		**0.00**			14.10273311
158	11/30/16 15:00	18.66830063	0	18.82981158		**0.00**			14.0923053
159	11/30/16 15:15	18.66830063	0	18.7159996		**0.00**	0.00		14.09688421
160	11/30/16 15:30	18.66830063	0	18.7159996		**0.00**			14.09948185
161	11/30/16 15:45	19.9050335	0	18.7159996		**0.00**			14.10595384
162	11/30/16 16:00	19.97470093	0	18.67526124		**0.00**			14.09278307
163	11/30/16 16:15	19.97470093	0	18.57019997		**0.00**	0.00		14.09287363
164	11/30/16 16:30	19.98317014	0	18.57019997		**0.00**			14.08940115
165	11/30/16 16:45	20.67779922	0	18.46702911		**0.00**			14.08991743
166	11/30/16 17:00	20.67779922	0	18.35460091		**0.00**			14.09758534
167	11/30/16 17:15	20.67779922	0	18.35460091		**0.00**	0.00		14.10903808
168	11/30/16 17:30	20.71376275	0	18.35460091		**0.00**			14.0936988
169	11/30/16 17:45	21.14139938	0	18.31439598		**0.00**			14.09129598
170	11/30/16 18:00	21.14139938	0	18.28070068		**0.00**			14.10805349
171	11/30/16 18:15	21.14139938	0	18.28070068		**0.00**	0.00		14.08614736
172	11/30/16 18:30	21.23417179	0	18.30507306		**0.00**			14.10304924
173	11/30/16 18:45	21.79039955	0	18.45120049		**0.00**			14.09101243
174	11/30/16 19:00	21.79039955	0	18.45120049		**0.00**			14.11413256
175	11/30/16 19:15	21.79039955	0	18.45120049		**0.00**	0.00		14.10379475
176	11/30/16 19:30	21.86216571	0	18.48169863		**0.00**			14.09298624
177	11/30/16 19:45	22.13489914	0	18.59760094		**0.00**			14.08563866
178	11/30/16 20:00	22.13489914	0	18.59760094		**0.00**			14.11137503
179	11/30/16 20:15	22.13489914	0	18.59760094		**0.00**	0.00		14.08405829
180	11/30/16 20:30	22.16818042	0	18.60509985		**0.00**			14.10978517
181	11/30/16 20:45	22.25650024	0	18.625		**0.00**			14.08724931
182	11/30/16 21:00	22.25650024	0	18.625		**0.00**			14.11673564
183	11/30/16 21:15	22.25650024	0	18.625		**0.00**	0.00		14.08611856
184	11/30/16 21:30	22.20396846	0	18.66508579		**0.00**			14.10618802
185	11/30/16 21:45	22.10160065	0	18.7432003		**0.00**			14.10038787
186	11/30/16 22:00	22.10160065	0	18.7432003		**0.00**			14.10273136
187	11/30/16 22:15	22.10160065	0	18.65007345		**0.00**	0.00		14.10763225
188	11/30/16 22:30	22.32562439	0	18.57019997		**0.00**			14.09074198
189	11/30/16 22:45	22.65530014	0	18.57019997		**0.00**			14.10365545
190	11/30/16 23:00	22.65530014	0	18.40424365		**0.00**			14.09707416
191	11/30/16 23:15	22.65530014	0	18.36380005		**0.00**	0.00		14.08809302
192	11/30/16 23:30	22.81047019	0	18.43233599		**0.00**			14.11648364
193	11/30/16 23:45	22.98539925	0	18.53370094		**0.00**			14.08340339
194	12/1/16 0:00	22.98539925	0	18.76310553		**0.00**			14.12251369
195	12/1/16 0:15	22.98539925	0	18.79750061					14.08467674
196	12/1/16 0:30	23.02995124	0	18.79750061					14.11256501
197	12/1/16 0:45	23.0685997	0	18.79750061					14.08943373

Appendix C

30-Year Monthly Precipitation Data Listing

30 Years of Precipitation Data (Inches) For Garrison, ND

Year #	YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1	1982	0.84	0.22	0.70	0.37	1.90	4.39	2.26	2.70	0.79	4.40	0.29	0.65	19.52
2	1983	0.52	0.17	1.74	0.65	1.27	2.84	2.37	1.17	1.45	0.53	0.47	0.54	13.72
3	1984	0.72	0.06	1.00	4.17	0.27	2.90	1.06	2.87	0.87				13.92
4	1985						2.88	1.31	1.77	1.93	1.01	0.03		8.93
5	1986			0.00	3.13	2.60	0.90	6.21	1.72	2.08	0.58	1.28	0.00	18.50
6	1987	0.09	0.47	1.95	0.20	2.21	2.17	8.43	2.33	0.54	0.01	0.03	0.00	18.45
7	1988	0.45	0.06	0.76	0.00	1.40	0.85	1.42	0.68	1.36	0.16	0.60	0.68	8.42
8	1989	0.63	0.08	0.54	1.67	2.62	3.21	1.42	1.98	1.06	0.56	0.32	0.18	14.28
9	1990	0.00	0.00	0.31	0.79	2.65	6.98	5.03	0.70	1.34	0.87	0.12	0.23	19.03
10	1991	0.02	0.02	0.20	1.95	3.09	5.82	1.16	2.63	2.57	0.77	0.25	0.00	18.48
11	1992	0.06	0.05	0.90	0.30	0.85	1.58	2.17	1.22	0.33	0.15	0.78	0.28	8.66
12	1993	0.39	0.18	0.19	1.57	2.11	3.33	8.78	0.47	0.18	0.24	1.19	0.04	18.69
13	1994	0.52	0.22	0.05	0.50	1.94	2.81	1.11	0.44	0.59	6.48	0.62	0.14	15.44
14	1995	0.30	0.04	0.84	0.68	2.43	1.39	3.56	0.72	0.56	0.44	0.56	0.49	12.02
15	1996	0.73	0.46	1.02	0.77	2.15	2.58	1.33	0.95	1.00	0.69	1.01	0.70	13.40
16	1997	0.42	0.10	0.56	1.10	0.55	3.79	3.99	0.48	0.41	0.85	0.31	0.00	12.56
17	1998	0.28	2.42	0.14	0.34	1.78	3.82	1.41	2.96	0.95	3.52	0.82	0.38	18.81
18	1999	0.88	0.20	0.10	0.61	5.16	6.22	1.29	6.37	1.46	0.26	0.04	0.07	22.66
19	2000	0.26	0.55	0.30	2.29	4.22	3.70	2.04	4.93	1.56	1.37	1.87	0.20	23.29
20	2001	0.25	0.15	0.00	1.18	1.48	3.88	2.42	0.23	1.20	0.31	0.14	0.21	11.46
21	2002	0.60	0.05	0.82	1.91	1.06	4.30	2.29	5.21	0.42	0.82	0.02	0.42	17.92
22	2003	0.28	0.28	0.51	0.79		2.98	3.51	1.37	2.34	0.49	0.41	0.45	13.42
23	2004	0.93	0.43	1.07	0.62	2.39	1.00	2.52	3.31	0.52	1.40	0.13	0.26	14.58
24	2005			0.83	0.32	4.16	11.86	1.13	1.75	1.28	1.19	1.21	0.27	24.00
25	2006	0.04	0.27	0.33	1.63	1.20	1.43	2.24	2.94	1.38	0.78	0.06	0.55	12.85
26	2007	0.21	0.48	1.17	1.09	7.83	4.42	1.56	2.09	1.31	0.14	0.14	0.17	20.60
27	2008	0.47	0.26	0.00	0.33	1.42	3.41	0.91	1.60	1.88	1.47	2.20	1.82	15.79
28	2009	1.14	1.32	0.94	0.92	2.79	2.80	3.18	1.23	1.91	1.11	0.00	0.63	17.97
29	2010	0.73	0.02	1.18	1.63	3.80	6.22	5.50	3.09	4.27	0.43	0.17	0.67	27.72
30	2011	0.60	0.23	1.93	1.40	3.76	2.46	2.11	1.69	2.00	1.09	0.02	0.26	17.55
31	2012	0.22	0.44	0.46	3.22	2.09	3.32	2.17	1.13	0.11	2.54	0.83	0.61	17.14
32	2013	0.06	0.21	0.73	1.82	5.56	5.96	3.17	2.72	3.13	3.65	0.39	0.66	28.06
33	2014	0.32	0.12	0.47	2.24	2.90	3.48	1.12	7.04	0.99	0.74	0.63	0.02	20.07
34	2015	0.41	0.34	0.66	0.76	3.71	4.69	3.55	0.72	1.43	1.45	0.26	0.32	18.30

30-Years of Precipitation Data (Inches) For Bismarck, ND														
Year #	**YEAR(S)**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**ANN**
1	1986	0.37	0.26	0.26	3.60	3.11	3.96	4.25	1.61	4.41	0.35	2.09	0.02	24.30
2	1987	0.14	1.65	1.34	0.13	4.19	1.52	4.59	3.03	0.29	0.10	0.02	0.13	17.15
3	1988	0.69	0.40	0.92	0.12	1.17	2.18	0.56	2.20	0.63	0.15	0.48	0.72	10.21
4	1989	0.60	0.22	0.29	1.87	1.93	0.70	1.76	1.62	1.23	0.21	0.64	0.30	11.37
5	1990	0.26	0.24	0.56	0.31	1.65	4.73	1.53	1.37	1.25	0.29	0.00	0.50	12.70
6	1991	0.17	0.24	0.62	1.62	3.34	2.64	0.65	1.78	2.50	2.33	0.75	0.16	16.79
7	1992	0.31	0.41	0.62	0.22	1.12	3.64	2.46	0.98	1.29	0.39	0.81	0.48	12.73
8	1993	0.29	0.33	0.39	1.26	2.37	4.57	13.75	1.89	0.26	0.02	1.04	0.84	27.02
9	1994	0.59	0.45	0.67	1.06	0.54	3.35	1.76	0.33	5.02	3.41	1.50	0.30	18.98
10	1995	0.42	0.33	1.67	1.00	4.15	1.39	5.00	1.99	0.80	1.12	0.52	0.56	18.94
11	1996	0.94	0.66	1.19	0.52	1.61	2.92	2.73	2.99	2.80	1.73	1.84	0.69	20.63
12	1997	0.85	0.59	0.97	3.26	0.32	1.24	2.20	1.08	1.73	2.29	0.31	0.09	14.94
13	1998	0.09	1.68	0.39	0.67	1.10	2.91	1.89	9.29	0.98	3.09	1.40	0.24	23.73
14	1999	1.13	0.39	0.25	1.61	6.96	3.61	2.52	7.91	1.31	0.43	0.10	0.23	26.47
15	2000	0.39	1.74	1.28	1.52	2.73	5.11	4.03	1.00	0.98	2.48	1.53	0.24	23.03
16	2001	0.46	0.44	0.24	1.88	2.00	6.92	7.31	0.00	1.07	0.85	0.06	0.13	21.38
17	2002	0.33	0.13	0.80	1.15	0.52	1.53	2.61	2.40	0.63	0.79	0.13	0.33	11.35
18	2003	0.27	0.23	0.43	0.85	5.26	2.11	1.36	0.26	1.77	0.63	0.43	0.48	14.09
19	2004	0.59	0.32	1.25	0.78	1.39	3.17	2.83	2.29	2.07	1.09	0.14	0.19	16.14
20	2005	0.36	0.11	0.54	1.04	2.37	6.23	2.65	2.87	0.26	1.21	0.74	0.85	19.24
21	2006	0.19	0.21	0.55	0.74	1.77	0.84	0.58	2.50	1.74	1.11	0.09	0.83	11.15
22	2007	0.14	0.75	1.18	0.80	5.43	3.32	1.25	3.26	1.78	0.83	0.14	0.23	19.11
23	2008	0.11	0.41	0.45	0.73	1.28	3.93	2.85	1.13	2.46	1.73	2.25	1.41	18.74
24	2009	0.83	0.78	2.73	0.70	2.02	7.94	3.14	0.58	1.24	2.21	0.04	0.91	23.13
25	2010	0.70	0.63	1.06	3.09	3.05	2.48	3.01	2.74	3.61	0.68	0.76	1.40	23.22
26	2011	1.14	0.58	1.56	2.35	2.32	3.19	5.24	4.02	0.97	1.35	0.06	0.47	23.26
27	2012	0.30	0.48	0.54	1.71	1.99	2.15	2.65	2.33	0.05	1.03	1.07	0.64	14.94
28	2013	0.26	0.35	0.84	1.81	7.37	2.70	1.63	1.37	4.36	4.73	0.09	1.27	26.78
29	2014	0.39	0.19	0.82	1.95	0.86	3.03	0.73	4.76	0.37	0.15	0.61	0.11	13.97
30	2015	0.76	0.40	0.45	0.37	5.31	4.98	1.50	1.41	0.37	1.07	0.21	0.91	17.75

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