Permit to Install Application
For
A Circulating Fluidized Bed (CFB) Boiler

at

Northern Michigan University

Marquette, Michigan

[SRN: M3792]

February 5, 2007

Prepared By:
NTH Consultants, Ltd.
608 S. Washington Avenue
Lansing, MI 48933
(517) 484-6900
NTH Project No. 16-060504

Background Concentrations

To analyze impacts relative to NAAQS, estimates of background pollutant concentrations are needed. Background concentrations are obtained from ambient air quality monitors and include contributions from other sources in the area and may include contributions from natural sources, anthropogenic sources too distant to be included in the modeling inventory, small area sources, and/or other unidentified sources.

For this study, background concentrations of CO, SO_2, PM_{10}, and NO_x were obtained from the MDEQ-AQD via email on August 21, 2006. However, as will be discussed in the results section, only SO2 requires a full dispersion modeling analysis to demonstrate compliance with the applicable NAAQS. Therefore, only the background concentration of SO2 is needed for the NMU modeling analysis. Table 6-8 summarizes the background concentrations that have been used in the NAAQS analysis for SO_2. Monitor selection and background concentrations are presented in Appendix C, along with the background concentrations of the other pollutants.

Table 6-8. Background Concentrations for NAAQS Modeling

Pollutant	Averaging Period	Concentration ($\mu g/m^3$)
SO2	Annual	2.7
	24-Hour	13.3
	3-Hour	45.2

The following sections will present the results of the criteria pollutant and TAC dispersion modeling analyses.

6.5 CRITERIA POLLUTANT MODELING RESULTS

The U.S. EPA AERMOD (with PRIME) dispersion model was used for the refined modeling analyses for the facility, utilizing the most current 5-years of NWS meteorology (2001-2005) available from MDEQ. The results of the CO, SO_2, PM_{10}, and NO_x modeling analyses are contained in the following subsections.

6.5.1 CO Significant Impact Level (SIL) Modeling Results

The maximum CO emission rate from the proposed CFB boiler has been included in an air quality dispersion modeling analysis. In addition, for conservatism, the maximum hourly emission rate of CO from the existing boilers was also included in this analysis. The CO emission rates presented in Tables 6-4 and 6-5 for the two exhaust stacks were modeled to determine the maximum ground level concentration (GLC) for both stacks emitting simultaneously. Consistent with the ambient standards for CO, both the maximum 1-hour and 8-hour highest second high GLCs (over the five year set of meteorological data) have been determined.

Criteria pollutant modeling is typically conducted in discrete phases. The first phase consisting of determining the maximum GLCs for the sources that are being permitted based upon the most recent single year of meteorological data and first highest value or a five-year set of meteorological data and the highest of the second high values. The resulting GLCs are then compared to SILs that have been established for the various criteria pollutants and associated averaging periods. If the results of the first step in the analysis indicate that the GLCs are less than the applicable SILs, then further modeling is not required and the source(s) are assumed to be in compliance with the federal standards (NAAQS for CO). However, if the first step in the analysis indicates an exceedance of an applicable SIL, further modeling is conducted.

Per the preceding discussion, the CO combined impacts from the two stacks have been determined for comparison with the applicable SILs of 2,000 $\mu g/m^3$ on a 1-hour basis and 500 $\mu g/m^3$ on an 8-hour basis. The results of this analysis are presented in Table 6-9.

As shown in Table 6-9, the maximum CO emission rates for both the proposed new CFB boiler and the existing boiler stack result in maximum combined GLCs of 85.3 $\mu g/m^3$ on a 1-hour basis and 27.2 $\mu g/m^3$ on an 8-hour basis. These GLCs are approximately 4.3% and 5.4% of the 1-hour and 8-hour significant impact levels, respectively. Due to the fact that impacts from the proposed new boiler and existing boilers are less than the applicable SILs for CO, the impacts are considered insignificant and no further modeling is required to demonstrate compliance with the CO NAAQS for this project.

Table 6-9. Results of the NMU CO SIL Modeling Analysis (01-05 SAW MET)

Averaging Period	NMU Maximum Impact [1] (μg/m³)	Year of Maximum Impact	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Significant Impact Level (μg/m³)	Impact As % Of SIL
1-hour	85.30	2002	466,860.8	5,151,904.0	2000	4.27%
8-hour	27.18	2003	469,210.8	5,156,254.0	500	5.44%

[1] Consistent with how the standards are applied, the maximum impacts are based upon the highest of the 2nd High impacts determined using five discrete years of meteorological data (2001 through 2005).

6.5.2 SO_2 PSD Increment Modeling Results

The SO_2 PSD Increment modeling analysis also considered all of the NMU sources, both existing and the new proposed CFB boiler as it was determined that the SO_2 impacts from the CFB boiler alone would be greater than the applicable SILs for SO_2. As the existing boilers were installed and/or modified after the SO_2 PSD baseline date of February 8, 1980 (AQCR 126), it has been assumed that all existing boilers are sources of SO_2 for PSD Increment consumption purposes.

The analysis has a tiered approach for compliance demonstration. The first tier is used to show that the proposed project, together with the existing facility sources, will not consume more than 80% of the allowed U.S. EPA PSD Increment for each averaging period (i.e., for SO_2 – annual, 24-hour, and 3-hour periods). The second tier is to show that the NMU PSD Increment consuming sources and all off-site Increment consuming sources, modeled simultaneously, will comply with 100% of the applicable PSD Increment for each averaging period. However, as discussed in Section 6.4, the AQD has indicated that there are no PSD Increment consuming sources to be considered in the PSD analysis, and therefore, the 100% PSD Increment analysis is based solely on the impacts from NMU.

Table 6-10 presents the results of the modeling analysis conducted to demonstrate compliance with 80% and 100% of the SO_2 PSD Increments (as NMU is the only source included in the 100% analysis). The NMU SO_2 emission sources modeled for the PSD Increment analysis include all sources of SO_2 emissions – both existing boilers and the new CFB boiler. The NMU SO_2

emission rates were previously listed in Table 6-4 for the new CFB boiler and in Table 6-5 for the existing NMU boilers.

Table 6-10. Results of NMU SO_2 80% and 100% Increment Modeling (01-05 SAW MET)

Averaging Period	NMU & PSD Maximum Impact [1] ($\mu g/m^3$)	Impact UTM Easting (meters)	Impact UTM Northing (meters)	100% of PSD Class II Increment ($\mu g/m^3$)	80% of PSD Class II Increment ($\mu g/m^3$)	Maximum NMU & PSD Impact As % of PSD Class II Increment
Annual	6.06	468,660.8	5,156,254.0	20	16	30.28%
24-hour	60.86	469,110.8	5,156,354.0	91	72.8	66.87%
3-hour	119.08	469,110.8	5,156,404.0	512	409.6	23.26%

[1] Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1st high impacts determined using five discrete years of meteorological data (2001 through 2005), while the 24-hour and 3-hour maximum impacts are based upon the highest of the 2nd high impacts from the same five year set of meteorological data.

As shown in Table 6-10, the PSD Increment consuming SO_2 emission rates for NMU sources, including those associated with the proposed project and currently existing, do not result in impacts that are greater than 80% (and consequently, 100%) of the applicable SO_2 PSD Increments. The annual impact is predicted to be approximately 30% of the PSD Increment, while the 24-hour and 3-hour impacts are about 67% and 23% of their applicable PSD Increment, respectively.

6.5.3 SO_2 NAAQS Modeling Results

After having demonstrated compliance with the PSD Class II Increments, the last step in the SO_2 modeling analysis is a demonstration of compliance with the annual, 24-hour, and 3-hour SO_2 NAAQS.

Unlike PSD Increments, which are designed to prevent the air quality in a given region from significantly deteriorating beyond the conditions that existed at a stipulated baseline date, the NAAQS are designed to ensure the protection of human health and the environment. Therefore, the NAAQS modeling analysis includes all pertinent sources of emissions near the source of interest (at their maximum allowable emission rates), regardless of their installation date. In addition, NAAQS modeling analyses also include a background concentration, which represents the natural background concentrations from local sources in the area of interest (anthropogenic sources) and biogenic sources (concentrations presented in Table 6-9).

The SO_2 NAAQS consist of primary and secondary standards. The primary standards have been developed to protect public health, including the health of sensitive portions of the general population (i.e., asthmatics, children, elderly, etc.). The secondary standards are designed to protect public welfare, including decreased visibility in a region and damage to animals, crops, vegetation, and buildings. In the case of SO_2, the primary standards are for the annual and 24-hour averaging periods, while the 3-hour averaging period is a secondary standard.

Similar to the PSD Increments, the SO_2 NAAQS are applicable over the annual, 24-hour, and 3-hour averaging periods. The NAAQS modeling analysis includes all SO_2 emission sources – all NMU SO_2 emission sources and all off-site SO_2 emission sources (sources listed for SO_2 emissions in Table 6-8) – at their allowable (or proposed allowable) emission rates. The background concentrations were then added to the concentrations predicted by the dispersion model in order to determine the overall maximum concentrations. The results of the SO_2 NAAQS modeling analysis are presented in Table 6-11.

Table 6-11. Results of the NMU SO_2 NAAQS Modeling Analysis (01-05 SAW MET)

Averaging Period	Maximum Impact [1] (μg/m³)	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Primary NAAQS (μg/m³)	Background Concen-tration (μg/m³)	Total NAAQS Impact (μg/m³)	Total Impact As % Of NAAQS
Annual	30.56	469,260.8	5,157,204.0	80	2.7	33.26	41.57%
24-Hour	217.39	469,410.8	5,157,104.0	365	13.3	230.69	63.20%
3-Hour	520.24	465,360.8	5,151,654.0	1300	45.2	565.44	43.50%

[1] Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1st high impacts determined using five discrete years of meteorological data (2001 through 2005), while the 24-hour and 3-hour maximum impacts are based upon the highest of the 2nd high impacts from the same five year set of meteorological data.

As shown in Table 6-11, the SO_2 NAAQS modeling analysis shows that the proposed project will not cause a violation of the SO_2 3-hour, 24-hour, or annual NAAQS when the model predicted maximum impacts are added to the background concentrations.

6.5.4 PM_{10} Significant Impact Level (SIL) Modeling Results

The PM_{10} PSD Increment modeling analysis considered all NMU boilers, both existing and the newly proposed boiler. Similar to CO, the PM_{10} impacts were initially determined for the newly proposed boiler and the existing boilers in order to compare the results to SILs that have been established for the various PM_{10} standards and averaging periods. If the results of this initial analysis indicate that the ambient impacts are less than the applicable SILs, then further modeling is not required to demonstrate compliance with the federal standards (PSD Increment and NAAQS for PM_{10}).

Per the preceding discussion, the PM_{10} combined impacts from the two stacks have been determined for comparison with the applicable SILs of 5 $\mu g/m^3$ on a 24-hour basis and 1 $\mu g/m^3$ on an annual basis. The full 5-year meteorological data set was utilized, and the results of this analysis are presented in Table 6-12.

As shown in Table 6-12, the maximum PM_{10} emission rates for both the proposed new CFB boiler and the existing boiler stack result in maximum combined ambient impacts of 3.23 $\mu g/m^3$ on a 24-hour basis and 0.35 $\mu g/m^3$ on an annual basis. These impacts are approximately 65% and 35% of the 24-hour and annual significant impact levels, respectively. Due to the fact that impacts from the proposed new boiler and existing boilers are less than the applicable SILs for PM_{10}, the impacts are considered insignificant and no further modeling is required to demonstrate compliance with the PM_{10} PSD Increment standards and NAAQS for this project.

Table 6-12. Results of the NMU PM_{10} SIL Modeling Analysis (01-05 SAW MET)

Averaging Period	NMU Maximum Impact [1] (µg/m^3)	Year of Maximum Impact	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Significant Impact Level (µg/m^3)	NMU Impact As % Of SIL
Annual	0.35	2003	468,660.8	5,156,254.0	1	35.20%
24-hour	3.23	2004	469,160.8	5,156,304.0	5	64.60%

[1] Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1st high impacts determined using five discrete years of meteorological data (2001 through 2005), while the 24-hour maximum impacts are based upon the highest of the 2nd high impacts from the same five year set of meteorological data.

6.5.5 NO_x Significant Impact Level (SIL) Modeling Results

The NO_x significant impact level modeling analysis considered all NMU boilers, both existing and the newly proposed boiler. Similar to CO and PM_{10}, the NO_x impacts were initially determined for the newly proposed boiler and the existing boilers in order to compare the results to SIL that has been established for the NO_x annual standard. Had the results of this initial analysis indicated that the ambient impacts were greater than the applicable SILs, then further modeling would have been required to demonstrate compliance with the federal standards (PSD Increment and NAAQS for NO_x). However, the results predicted that the NO_x impacts would be below the applicable SIL.

Per the preceding discussion, the NO_x combined impacts from the two stacks have been determined for comparison with the applicable SIL of 1 µg/m^3 on an annual basis. The full 5-year meteorological data set was utilized, and the results of this analysis are presented in Table 6-13.

As shown in Table 6-13, the maximum NO_x emission rates for both the proposed new CFB boiler and the existing boiler stack result in a maximum combined ambient impact of 0.97 µg/m^3 on an annual basis. This maximum impact is below the annual significant impact level, and therefore, the NOx impact from the NMU boilers is considered insignificant and no further modeling is required to demonstrate compliance with the NO_x PSD Increment standard and NAAQS.

Table 6-13. Results of the NMU NO_x SIL Modeling Analysis (01-05 SAW MET)

Averaging Period	NMU Maximum Impact [1] (μg/m³)	Year of Maximum Impact	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Significant Impact Level (μg/m³)	NMU Impact As % Of SIL
Annual	0.974	2005	468,960.8	5,157,154.0	1	97.40%

[1] Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1st high impacts determined using five discrete years of meteorological data (2001 through 2005).

6.6 TAC MODELING ANALYSIS RESULTS

In addition to the criteria pollutant modeling analyses, a TAC modeling analysis has been conducted to demonstrate that the emissions of TACs from the new CFB boiler (Unit #10) will be in compliance with the Michigan AQD's air toxics regulations. Refined modeling for TACs was performed to determine the ambient, off-property impact from trace metals and organic compounds emitted from the new boiler.

Modeling was performed in accordance with the same methodology used for the criteria pollutant modeling and followed all regulations, guidelines and policies established by U.S. EPA and MDEQ, and again utilized the ISC-AERMOD (PRIME) model Version 04300. Michigan Rule 225 states that emissions from the new or modified source shall not cause a violation of the Initial Threshold Screening Level (ITSL) for non-carcinogens or Initial Risk Screening Level (IRSL) for carcinogenic compounds.

The results were determined by scaling the emission rate for each TAC by model predicted impacts based on a 1.0 gram/second model run for the averaging period associated with each TAC's applicable screening. Using this methodology, it is possible to determine the ambient impacts for multiple pollutants based on one model run instead of running a model for each TAC individually.

The emission rate of each TAC was determined by taking the maximum short term emission rate of each compound for the various fuel types that could potentially be used in the proposed CFB boiler. Table B-2 of Appendix B shows the maximum short term emission rates on a compound-