Northern Michigan University

Facilities Department
Facilities Specialist/Planner
1401 Presque Isle Avenue
Marquette, MI 49855-5301
906 227-2025
FAX: 906 227-2467

February 5, 2007

Michigan Dept of Environmental Quality
Attn: Ms. Mary Ann Dolehanty, Supervisor
AQD – Thermal Process Unit
P.O. Box 30260
Lansing, MI 48909

RECEIVED
FEB 0 5 2007
AIR QUALITY DIV.

**SUBJECT: Permit to Install Application for a New Circulating Fluidized Bed Boiler
Northern Michigan University – Ripley Heating Plant**

Dear Ms. Dolehanty:

Enclosed is a Permit to Install Application for the proposed installation of a new solid fuel-fired circulating fluidized bed (CFB) boiler at the Northern Michigan University (NMU) – Ripley Heating Plant. In support of the Governor's 21st Century Energy Plan, this project will be designed to allow operation on Renewable Resources (specifically wood chips) up to 100% of the total heat input, with the capability to operate on sub-bituminous coal, and natural gas if the Renewable Resource fuel is unavailable or not economically feasible. The application requests that all fuels be allowed up to a possible 100% of the total heat input into the boiler. It is anticipated that NMU may blend these solid fuels as needed, to support the heat input required with the Renewable Resource fuel given preference whenever feasible. Natural gas is only intended to be used for startup, shutdown, and backup purposes.

NMU recently received PTI 126-05 for two (2) new oil/gas fired boilers. Since NMU is proposing to install the new solid fuel boiler within the contemporaneous period, we have included these boilers in the analysis for the new CFB. Based on our analysis, the facility will continue to comply with all applicable standards. In addition, we have provided correspondence from the U.S. Fish & Wildlife Service regarding the impacts to endangered species.

We authorize Mr. Jeffrey P. Jaros of NTH Consultants, Ltd., to serve as our agent in responding to your questions concerning this application and to negotiate the conditions for the revised permit. Should you have any questions concerning the application, please contact Mr. Jaros at (517) 484-6900.

Sincerely yours,
NORTHERN MICHIGAN UNIVERSITY

Michael G. Hellman,
Facilities Specialist/Planner

MGH:kag

cc: Jeff Jaros, NTH Consultants, Ltd.
Randy Russell, P.E., Cummins & Barnard, Inc.
Carl S. Pace, Assoc. VP Facilities & Business Services – NMU
Kathy Richards, Director of Engineering & Planning – NMU
Robert Ryan, Project Manager - NMU

Exhibit 4

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

Northern Michigan University

Facilities Department
Facilities Specialist / Planner
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Robert Ryan, Project Manager - NMU

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY - AIR QUALITY DIVISION

DEQ

PERMIT TO INSTALL APPLICATION

For authority to install, construct, reconstruct, relocate, or modify process, fuel-burning or refuse burning equipment and/or control equipment. Permits to install are required by administrative rules pursuant to Section 5505 of 1994 PA 451, as amended.

FOR DEQ USE
APPLICATION NUMBER

Please type or print clearly. The "Application Instructions" and "Information Required for an Administratively Complete Permit to Install Application" are available on the AQD Permit Web Page at http://www.deq.state.mi.us/aps, or contact the Air Quality Division at 517-373-7023.

copy for file

1. FACILITY CODES: State Registration Number (SRN) and North American Industry Classification System (NAICS)
SRN M 3 7 9 2 NAICS 2 2 1 1 1 2

2. APPLICANT NAME: (Business License Name of Corporation, Partnership, Individual Owner, Government Agency)
Northern Michigan University - Ripley Heating Plant

3. APPLICANT ADDRESS: (Number and Street)
1401 Presque Isle Avenue
MAIL CODE:

CITY: (City, Village or Township) Marquette
STATE: MI
ZIP CODE: 49855

4. EQUIPMENT OR PROCESS LOCATION: (Number and Street – if different than Item 3)

CITY: (City, Village or Township)
ZIP CODE:
COUNTY: Marquette

5. GENERAL NATURE OF BUSINESS:
Combined Heat and Power

6. EQUIPMENT OR PROCESS DESCRIPTION: (A Description MUST Be Provided Here. Include Emission Unit IDs. Attach additional sheets if necessary.)
Northern Michigan University is proposing to install a new 185/205 MMBtu (7 MW) circulating fluidized bed (CFB) boiler capable of firing solid fuels, including coal and wood. In 2005, NMU received PTI 126-05 to install two (2) new fuel oil/natural gas fired boilers to replace 2 existing boilers that were decommissioned and reviewed. Since this project is within the contemporaneous period, NMU is submitting the enclosed application to include both the new solid fuel CFB and two new oil/gas boilers.

7. REASON FOR APPLICATION: (Check all that apply.)
- [x] INSTALLATION / CONSTRUCTION OF NEW EQUIPMENT OR PROCESS
- [ ] RECONSTRUCTION / MODIFICATION / RELOCATION OF EXISTING EQUIPMENT OR PROCESS – DATE INSTALLED:
- [ ] OTHER – DESCRIBE

8. IF THE EQUIPMENT OR PROCESS THAT WILL BE COVERED BY THIS PERMIT TO INSTALL (PTI) IS CURRENTLY COVERED BY ANY ACTIVE PERMITS, LIST THE PTI NUMBER(S): **126-05**

9. DOES THIS FACILITY HAVE AN EXISTING RENEWABLE OPERATING PERMIT (ROP)? [x] NOT APPLICABLE [ ] PENDING APPLICATION [ ] YES

PENDING APPLICATION OR ROP NUMBER **MI-ROP-B2357-2006**

10. AUTHORIZED EMPLOYEE: Michael Hellman
TITLE: Facilities Planner
PHONE NUMBER: (Include Area Code) 906-227-2120
SIGNATURE: Michael Hellman
DATE: February 1, 2007
E-MAIL ADDRESS: mhellman@nmu.edu

11. CONTACT: (If different than Authorized Employee. The person to contact with questions regarding this application)
Jeffrey P. Jaros
PHONE NUMBER: (Include Area Code) 517-484-6900
CONTACT AFFILIATION: NTH Consultants, Ltd.
E-MAIL ADDRESS: jjaros@nthconsultants.com

12. IS THE CONTACT PERSON AUTHORIZED TO NEGOTIATE THE TERMS AND CONDITIONS OF THE PERMIT TO INSTALL? [x] YES [ ] NO

FOR DEQ USE ONLY - DO NOT WRITE BELOW

DATE OF RECEIPT OF ALL INFORMATION REQUIRED BY RULE 203:

DATE PERMIT TO INSTALL APPROVED:	SIGNATURE:
DATE APPLICATION VOIDED:	SIGNATURE:
DATE APPLICATION DENIED:	SIGNATURE:

A PERMIT CERTIFICATE WILL BE ISSUED UPON APPROVAL OF A PERMIT TO INSTALL

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

Northern Michigan University (NMU) is submitting the attached permit to install application for the construction of a circulating fluidized bed (CFB) boiler capable of firing coal and wood. The CFB boiler will have a maximum heat input capacity of 185 million Btu per hour (MMBtu/hr) for 100 percent coal firing and 205 MMBtu/hr for 100 percent wood firing. The existing NMU power plant consists of three (3) 84 MMBtu/hr natural gas/No. 2 oil fired boilers, covered by Permit No. 126-05. The facility is located at 1401 Presque Isle Avenue, Marquette, Michigan [SRN: M3792].

NMU is currently not considered a major source because its potential to emit of any criteria pollutant is limited to 99.9 tons per year (tpy) by federally enforceable conditions in Permit No. 126-05. The existing facility is also not a major source of hazardous air pollutants (HAP) because it does not have the potential to emit 10 tpy of any single HAP, or 25 tpy of any combination of HAPs. The facility, however, will become a major source as defined in Michigan Rule 211(1)(a) upon initial startup of the CFB boiler, as the CFB boiler has the potential to emit 100 tpy or more of any criteria pollutant. NMU will remain a minor source of HAPs after issuance of this permit, as NMU requests federally enforceable permit conditions limiting the facility's potential emissions to less than 10 tpy for a single HAP, and less than 25 tpy of all HAPs combined.

As a major source of new source review regulated air contaminants, the CFB boiler will be subject to the federal Prevention of Significant Deterioration (PSD) regulations at 40 CFR Part 52.21. The CFB boiler will also be subject to the federal New Source Performance Standards (NSPS) for Industrial-Commercial-Institutional Steam Generating Units at 40 CFR Part 60, Subparts A and Db. As NMU will be a minor, or area, source of HAPs after issuance of the permit, the facility's boilers will not be subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Industrial, Commercial, Institutional Boilers and Process Heaters, 40 CFR Parts A and DDDDD. In addition to the federal air quality requirements, the CFB boiler will be subject to the Michigan air toxics requirements under Rules 224-232.

The process description and boiler specifications are provided in Section 2.0. A regulatory analysis is provided in Section 3.0, and provides a summary of pertinent federal and state air quality requirements that are applicable to the proposed CFB boiler and the NMU facility. Emission estimates for this application are provided in Section 4.0, and include estimates for criteria pollutants, hazardous air pollutants (HAP), and toxic air contaminants (TAC) from the new CFB boiler. The best available control technology (BACT) analysis has been conducted for particulate matter (PM/PM_{10}), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon monoxide (CO) and is presented in Section 5.0, and also includes Michigan's requirements for BACT for VOC and toxic air contaminants. Section 6.0 presents an air quality modeling analysis that demonstrates compliance with state and federal ambient air quality standards. Additional impact analyses as required by the PSD rules [40 CFR 52.21(o)] are provided in Section 7.0. A site map is provided in Appendix A, and additional permit to install application supporting information is attached as Appendices B through G.

2.0 PROCESS DESCRIPTION

NMU is proposing to install and operate a cogeneration (combined heat and power (CHP)) 185 MMBtu/hr coal/wood/natural gas fired circulating fluidized bed (CFB) boiler that will include a 10 MW gross electrical output generator, and be capable of producing 120,000 pounds of steam per hour. The new boiler will be located next to NMU's existing Ripley Heating Plant, which is located on the north end of NMU's campus.

2.1 CIRCULATING FLUIDIZED BED BOILER AND STEAM TURBINE

The CFB technology that will be employed by NMU is a non-reheat steam generator that will provide steam to an electrical turbine generator, and supply steam for the NMU campus. At this time, NMU has not decided upon the vendor for this equipment. There will also be a new wet-dry mechanical draft-cooling tower to accommodate additional heat rejection from the system.

The new CFB plant cycle consists of a turbine generator with four (4) feedwater heaters, including a deaerator to remove dissolved gases from the process feedwater. Dissolved gases, including oxygen and carbon dioxide, increase the corrosiveness of the water by lowering pH levels, which leads to boiler tube failures. The nominal steam flow of the CFB generator will be 120,000 pounds per hour at average ambient conditions. The boiler will be designed to accommodate bituminous and subbituminous Powder River Basin (PRB) coals, virgin wood, and natural gas. Natural gas will be used primarily for boiler startup, and any other times when solid fuel firing may not be available; i.e., as a back-up fuel source and for initial startup. Coal will come from either the Marquette Board of Light & Power, or the nearby WE Energy Presque Isle Power Plant. Virgin wood fuel will be supplied from independent wood suppliers and natural gas will be pipeline quality gas from NMU's supplier of natural gas.

Coal and limestone sorbent are fed into the bottom of the CFB at a molar ratio of calcium to sulfur of approximately 4:1. Primary and secondary air for combustion is forced into the furnace approximately one-third from the bottom of the boiler. Flue gas exiting the boiler passes through a mechanical collector (cyclone) and the removed particulate (unburned carbon or loss on ignition) is recycled back into the bottom of the furnace. Bottom ash from the combustion of fuels empties through the bottom of the CFB and is removed. Once the flue gas passes through the cyclone it enters the convection pass, superheater and economizer surfaces where heat is transferred to water tubes to produce steam. Finally, the flue gas passes through the SNCR and fabric filter at an estimated maximum rate of 108,700 actual cubic feet per minute (ACFM), which is while firing 100% wood fuel. The plot plan for the campus, showing the location of the new boiler and stack, is included in Appendix A.

Steam produced from the CFB boiler will be used to feed the steam turbine to produce electricity, and will supply steam for use on the campus; mostly for on-site campus heating, hot water for bathrooms, and for laundry equipment.

2.2 COAL & WOOD HANDLING

Bulk deliveries of coal and wood will be received via trucks. The trucks delivering the bulk solid fuels will be unloaded inside dedicated areas that have a 3-sided enclosure to reduce wind effects and will minimize fugitive emissions. The site has the capacity to store up to a 3-day supply of coal and wood in dedicated silos controlled by vent filters. Unloading of the solid fuels will be done in a fashion to minimize fugitive emissions.

Coal and wood fuels will be supplied to the CFB boiler from the silos. Coal received will already be sized correctly, so that there will be no coal processing performed on-site. Wood will be received chipped, and there will not be wood chipping performed on-site. Coal and wood fuels will be delivered to the CFB boiler inside enclosed transfer equipment. The fuel silos can hold an approximate 3-day supply of fuel, which will allow boiler operation through weekends and holidays. Finally, from the fuel silos, fuel is gravity fed onto a screw conveyor system that feeds the CFB for combustion.

2.2.1 Fugitive Emissions

Emissions of particulate as a result of coal/wood handling and storing are expected from 3 sources; truck unloading and receiving, fuel, ash, and limestone storage silos, and the conveyance of solid fuels and limestone to the CFB boiler. On average, NMU will receive a shipment every day, except on weekends. A typical shipment will consist of 40 tons of coal and/or 40 tons of wood. The annual maximum delivery of each fuel would equate to approximately 68,669 tons of bituminous coal, 95,329 tons of PRB coal, and 199,533 tons of wood. However, due to reduced capacity factors as a result of startup, shutdown, and maintenance activities, the shipments will be lower.

The coal and wood will be unloaded directly from the delivery trucks into 3-sided enclosures to minimize fugitive emissions. Transfer from the silos to the boiler will be done in enclosed conveyance systems. Dust from coal or wood transfer points will be controlled with fabric filters. Once the coal and wood is received, it will be stored in dedicated silos, and each silo will be controlled with a vent filter.

2.3 ASH HANDLING & STORAGE

Ash removed from the CFB will be stored in a dedicated silo with vent filter. Ash will be loaded out of the ash silo periodically, and placed in covered trucks for final disposal off-site of the NMU campus. The final plans for this activity have not yet been finalized.

2.4 LIMESTONE HANDLING & STORAGE

Limestone will be received via trucks and pneumatically transferred to a silo with a vent filter. Limestone will then be removed from the silo on an as-needed basis for co-firing into the bed of the CFB boiler.

2.5 ALTERNATIVE TECHNOLOGY REVIEW

The control technology analysis presented in Section 5 does not include a detailed technical evaluation of other potential fossil-fueled power generation technologies for this project such as Integrated Gasification Combined Cycle (IGCC) or Pulverized Coal boilers (PC). These are other power plant design technologies that are not appropriate and rejected for the reasons identified in this Alternative Technology Review. There are sound reasons for not including the analysis of these technologies into the BACT analysis included with this application. Primarily, there are no IGCC units that are cogeneration or combined heat and power units.

Second, as stated in the U.S. Environmental Protection Agency's (EPA's) New Source Review (NSR) Manual, "Historically, EPA has not considered the BACT requirement as a means to redefine the design of the source when considering available control alternatives. For example, applicants proposing to construct a coal-fired electric generator have not been required by EPA as part of a BACT analysis to consider building a natural gas-fired electric turbine, although the turbine may be inherently less polluting per unit product (in this case electricity)." (NSR Manual Page B.13). While the NSR Manual notes that there may be instances where, in a permit authority's judgment, alternative production processes may be required to be analyzed, this does not apply to cases where such a process would fundamentally change the project design, as would the case of IGCC or super critical pulverized coal (SCPC) boilers. EPA's Environmental Appeals Board has consistently upheld state permitting agency decisions to not require consideration of fundamentally different designs as part of the BACT analysis (In the Matter of Pennsauken County 2 E.A.D. 667 [1998] [firing municipal waste in a power plant rather than in the proposed MSW combustor]; In the Matter of Hawaiian Commercial & Sugar Co., 4 E.A.D. 95 [1992] [combined cycle or oil fired plant rather than CFB boiler fired with coal, fuel oil, or bagasse]; In re: Kendall New Century Development, 2003 EPA APP. LEXIS 26 [constructing a facility with larger units or operating as a combined cycle plant rather than a smaller simple cycle peaking unit as proposed]).

The process of review under the PSD requirements of the Clean Air Act (CAA) is focused on a single media (i.e., air quality) and must be kept in perspective with other governmental policy and permit reviews. Under the CAA the applicant must show that the proposed project will meet an emission limitation based upon the BACT and will not significantly impact air quality. However, the applicant must consider a myriad of other factors, including capital and operating costs, fuel diversification, availability, economic risks and costs to the applicant and electricity consumers, and ability to secure financing when designing its project proposal. These decisions may be influenced by state and federal agencies responsible for the energy policy and by local land use agencies concerned with the broad public health and welfare. But they are not germane to an evaluation under the CAA of the best available means to <u>control</u>, not redesign, the source proposed by the applicant. Note that the statute does not require an emission limitation based upon the "Best Available <u>Design</u> Technology." Therefore, NMU believes that MDEQ does not have the discretion to require treatment of alternative designs in the analysis of alternative control technologies that are germane to the satisfaction of BACT analysis requirements. This position has been reaffirmed by the position taken by U.S. EPA's Stephen Page, Director of the Office of Air Quality, Planning and Standards in his December 13, 2005, letter regarding the consideration of IGCC as an element of BACT or LAER when considering coal fueled power generation projects. In Mr. Page's letter (copy attached), EPA clearly stated that IGCC is not to be considered an element of BACT or LAER, but rather an Alternative Technology.

NMU recognizes that there is public interest in alternative means of producing electricity. . Therefore, it has included an assessment of the design alternatives of IGCC and PC for informational purposes and separate from the BACT analysis. The alternative technology analysis clearly demonstrates that IGCC and PC are fundamentally different source designs than proposed by NMU and for a variety of cost, availability, and other factors, were not appropriate designs for the proposed project. NMU proposes to construct, own and operate a solid fuel-fired cogeneration, or combined heat and power, facility to provide reliable and cost efficient electric power and steam for its campus.

During the initial planning stages of any cogeneration project, it is necessary to define the project objectives and criteria including, among other things: requisite electrical and steam generating capacity, capital and operating costs, reliability, availability, fuel price, fuel price volatility, fuel availability, site characteristics, safety factors and potential environmental impacts. Based on a review of technical, financial and practical considerations, NMU determined the appropriate design for the proposed power plant is a unit capable of firing a range of fuels. Based on a technical review of the potentially available solid fuel stream and electricity-generating configurations (e.g., Integrated Gasification Combined Cycle, Sub-Critical or Super-Critical Pulverized Coal), NMU concluded that the most appropriate fuel conversion technology for a project of this size is a CFB boiler.

CFB technology was selected based upon its satisfying the following project criteria:

1) CFB technology is readily available in single unit size of generating 7 to 10 MW of electricity and 120,000 pounds per hour of steam;
2) CFB technology is part of DOE's Clean Energy Program;
3) CFB technology has proven experience utilizing the range of fuels selected for this project;
4) CFB technology is highly cost competitive, both in terms of initial capital cost and operating and maintenance costs for a unit of this size;

5) CFB technology can be operated with a high level (i.e., ≥90 percent) of availability and reliability;
6) The commercial risk of CFB technology relating to capital cost, operating cost, environmental performance, reliability and availability is considered low;
7) CFB technology is well suited for the required electrical output needed; and
8) CFB has a solid record of demonstrated environmental performance.

The following paragraphs discuss alternate technologies for fuel conversion, which NMU does not consider appropriate for the needs of its campus.

2.5.1 Integrated Gasification Combined Cycle (IGCC)

IGCC is not structurally similar in design or capacity to CFB boilers or electrical generation of the size required to serve the needs of NMU. IGCC is not based on coal combustion but on coal gasification; the two processes are fundamentally different. IGCC is not a "control technology" such as baghouses, electrostatic precipitators (ESPs), SCR, etc. Instead, IGCC would constitute a redefinition of a coal-fired power plant. Furthermore, there are no IGCC units for cogeneration, or combined heat and power, needs.

IGCC power systems use a gasifier to convert coal (or other carbon-based solids) into a synthesis gas (syngas) consisting of a mixture of carbon monoxide (CO), hydrogen (H_2), carbon dioxide (CO_2) and traces of other gases. Syngas from the gasifier is filtered and scrubbed to reduce particulates, sulfur and other contaminants prior to being combusted in a gas-fired combustion turbine. Heat from the turbine exhaust gas is extracted in a heat recovery steam generator (HRSG) to produce steam to drive a steam turbine generator.

Gasification processes require an oxidant to react with the coal and maintain the temperature required for gasification. The oxidant reacts with coal to produce syngas. The typical air separation unit (ASU) cryogenically separates ambient air into its major constituents, oxygen (O_2) and nitrogen (N_2). Most of the O_2 is needed in the gasification plant for the production of syngas. A small percentage of the O_2 is used separately in a sulfuric acid plant. Most of the N_2 goes to the power plant's combustion turbine to dilute the fuel gas for NO_x abatement. This diluent N_2 also increases the combustion turbine's power production as it expands through the turbine.

The gasification process uses one-fifth to one-third of the theoretical oxygen (sub-stoiciometeric) to partially oxidize the combustible constituents of the feedstock. The major combustible products of gasification are CO and H_2, with a small fraction of the carbon completely oxidized to CO_2, and a small amount of methane (CH_4) may also be present.

The minor and trace components of coal are also transformed in the gasification reactor. Under the sub-stoiciometeric reducing conditions of gasification, most of the fuel's sulfur converts to hydrogen sulfide (H_2S), but some also converts to carbonyl sulfide (COS). Nitrogen bound in the fuel generally converts to gaseous nitrogen and ammonia (NH_3) and a small amount of hydrogen cyanide (HCN). Most of the chlorine in the fuel converts to hydrogen chloride (HCl) gas. Trace elements associated with both organic and inorganic components of the coal, such as mercury and arsenic, are released during gasification and partition between the ash fractions and gaseous emissions.

Syngas exiting a gasifier contains ash particulate that must be removed prior to combustion in the combustion turbine. Particulate matter can be removed by hot barrier filters (located upstream of the high-temperature heat recovery devices) or warm gas water scrubbers located downstream of the heat recovery system. Warm gas particulate removal by wet scrubbing is typically employed. In water scrubbers, the particulate is removed as slurry, which must be dewatered. Particulate-laden water is sent to a water-handling system, which separates the solids for recycle to the gasifier for disposal.

The gasifier's raw gas also contains COS and H_2S, both of which must be removed for the combustion turbine to achieve a low SO_2 limit. COS is not readily removed unless it is first converted to H_2S by hydrolysis. A hydrolysis unit reacts COS with water in the presence of a catalyst to form CO_2 and H_2S. The cooled syngas is then sent through an acid gas removal process to remove most of the H_2S and some of the CO_2.

Acid gas removal processes treat the syngas by contact with chemical or physical solvents to capture the H_2S. Amine solvents, such as methyldiethanolamine (MDEA), react to form a chemical bond between the acid gas and the solvent. The rich amine from the absorber is sent to a stripper where it is stripped of acid gas. The amine can be recycled and the recovered acid gases sent to a sulfur recovery process for conversion into sulfuric acid or elemental sulfur.

The cleaned syngas is used to fuel a combustion turbine. The combustion turbine drives an electric generator and produces heat (exhaust) to generate steam in a heat recovery steam generator (HRSG) for a steam turbine. The low-Btu syngas produced by gasification requires modifications to the typical natural gas combustion turbine's burners.

IGCC Operations

There are currently three IGCC power generation plants operating in the United States designed specifically to generate electricity from gasified bituminous coal and/or petroleum coke - Polk Power Station, Wabash River Generation Station and Delaware Star Refinery Station. The U.S. Department of Energy's (DOE's) Clean Coal Technology (CCT) Demonstration Project co-funded the construction and initial operation of Tampa Electric's Polk Power Station and PSI Energy's Wabash River Generation Station. The rated outputs for these facilities are 250 MW, 262 MW and 180 MW for the Polk Power Station, Wabash River Generation Station and the Delaware Star Refinery Station, respectively. Based on available information, other plants have not been able to demonstrate syngas availability greater than 80 percent, and none of the plants identified herein has ever operated at an annual capacity factor higher than 77 percent, including periods when they operated on oil or natural gas with no attempt to use coal.

As stated previously, the plant proposed by NMU is to be a moderate capacity power generation facility. With the demonstrated limited availability and reliability of these existing IGCC plants, IGCC technology would not be technically and commercially feasible to satisfy the requirements of NMU's needs to supply its campus with electricity and steam. Additionally, IGCC technology has been developed around the use of 300 MW power generation blocks, which is far beyond the 10 MW capacity proposed for the project. The high capital cost of IGCC, which is a factor that the technology struggles with even at the 300 or 600 MW power increment, would be drastically exacerbated when scaled down to the 10 MW generation capacity needed by NMU.

The Public Service Commission of Wisconsin has determined that while "ICGG technology is still promising, [it] is still expensive and requires more maturation." (Public Service Commission of Wisconsin, Final Decision on Application for Elm Road Generating Station, page 26). More recently, the State of Wisconsin Division of Hearings and Appeals rendered an opinion in the permitting of the Elm Road Generating Station that the Wisconsin Department of Natural Resources did not err in excluding IGCC from its BACT/LAER analysis of the proposed PC-fired units based on the substantial differences in the process technology (Wisconsin Division of Hearings and Appeals, Findings of Fact, Conclusions of Law and Order dated February 3, 2005). Therefore, as an alternative technology consideration for the project, it was concluded that IGCC is currently a developmental technology that does not meet the following project-specific selection criteria:

1) IGCC is not commercially proven;
2) IGCC does not have proven availability experience consistent with the performance achieved by conventional coal fired power plant technologies, such as CFB or pulverized coal (PC). The best known IGCC operating availability is in the range of 70 percent versus an expectation of 90+ percent for NMU's needs;
3) Commercial risk of IGCC technology is currently considered higher than that of CFB or PC technology;
4) Current capital, operating and maintenance costs of IGCC technology are higher than for CFB technologies;
5) There are no known vendors or suppliers of IGCC technology that can offer the type of commercial package necessary to satisfy the requirements of NMU and its costs of power needs; and
6) The required footprint far exceeds the available site limitations.

2.5.2 Pulverized Coal (PC)

Pulverized coal fired boiler technology has been used by the utility industry and major industrial steam users as an efficient means of generating steam for direct thermal uses and/or electrical power generation over a long period of time. A further development of the technology in the later 20^{th} century up to present day is the use of super-critical pulverized coal combustion, which further enhances the combustion efficiency of the process. Sub-critical pulverized coal boilers commonly operate in pressure ranges of 1,800 to 2,400 psia and steam temperatures of 950 F to

1,050 F. The more recent super-critical PC boiler technology pushes pressures in the range of 3,700 psia to over 4,000 psia and steam temperatures to 1,100 F and above.

PC technology has a long track record and is well proven over a wide range of unit capacities. The current trend toward super-critical cycles has been driven by the need to maximize cycle efficiencies, thus driving operating costs down and lowering emissions on a per MW basis. The development of super-critical technology has primarily focused on unit sizes in the 500 MW+ size ranges, which is well beyond the unit capacity needed by NMU. Although efficient, a super-critical cycle applied to a 10 MW power plant would be significantly higher in capital and operating costs than the CFB technology chosen.

Sub-critical PC technology has been used over a long period of time for steam and power generation greater than the size range needed for NMU's project. For years, it was the default technology of choice for coal-fired generation. The successful development of CFB combustion technology coupled with increasingly stringent environmental standards has led over the past 20 years to a situation where CFB, although marginally less efficient, has become the standard approach for unit capacities in the 250 MW and lower size range.

Another factor that separates CFB from sub-critical PC is fuel flexibility. PC units are designed to burn purely coal. A CFB unit can accommodate coal plus a range of opportunity fuels such as wood.

The selective use of opportunity fuels such as wood was a consideration in the selection of CFB combustion technology. The use of PC technology would not allow for this degree of fuel flexibility.

Therefore, as an alternative technology consideration for the project, it was concluded that neither sub-critical nor super-critical PC technology is appropriate to meet this Projects' selection criteria because:

1) Super-critical PC cycles are a good choice for major generating units at the 500-MW unit size and larger, but are not appropriate due to high capital and operating costs for a unit size of 10 MW.
2) For the 10 MW unit size planned, CFB has largely replaced sub-critical PC design as the technology of choice.
3) PC based combustion technology does not offer the fuel flexibility desired by NMU for this project.

3.0 SUMMARY OF APPLICABLE REQUIREMENTS

A new "major" stationary source of air pollution or a major modification at an existing major source is required to obtain an air permit through the new source review (NSR) process. Prevention of Significant Deterioration (PSD) new source review is required for sources located in attainment and unclassified areas. Non-attainment new source review (NANSR) is required in areas where monitoring data show that certain pollutant(s) are not meeting the applicable ambient air quality standard. These areas are referred to as non-attainment areas. A new source, or modification at an existing source, can be subject to both PSD and NANSR if the area in which the source is located is attainment for one or more pollutants and non-attainment for other pollutants, and the source is considered "major" for both the attainment and non-attainment pollutants.

3.1 FEDERAL REQUIREMENTS

Northern Michigan University is currently not a major stationary source as defined in the PSD regulations at 40 CFR 52.21, because the NMU facility's potential to emit of any regulated pollutant is limited to less than the major source threshold of 100 tons per year (tpy) by federally enforceable conditions of Permit No. 126-05. This permit was approved on July 21, 2005, and includes three (3) 70,000 lbs steam/hour; natural gas/No. 2 oil fired boilers and miscellaneous exempt equipment. Neither is the existing NMU facility a major source of hazardous air pollutants as defined in 40 CFR 63.2.

The existing facility is located approximately 60 miles from the nearest Class I area (Seney National Wildlife Refuge), which is located in Schoolcraft County. NMU's campus is located on the north side of the City of Marquette, Michigan, and is designated as an attainment/unclassified area for all pollutants subject to a National Ambient Air Quality Standard (NAAQS) under the Clean Air Act (CAA).

3.1.1 Prevention of Significant Deterioration (PSD)

The federal PSD regulations are codified in 40 CFR §52.21 and require that all major new or modified stationary sources located within an attainment area and emitting any pollutant regulated under the Clean Air Act (CAA) in excess of the applicable significance level be reviewed by the U.S. EPA, or the state agency, provided the state has an approved program. Michigan is a delegated state under PSD NSR and NANSR and issues permits on behalf of the U.S. EPA. A ***major stationary source*** is defined as any one of 28 listed source categories that have the potential to emit 100 tpy or more, or any other stationary source that has the potential to emit 250 tpy or more, of any criteria pollutant regulated under the Clean Air Act.

PSD review is used to determine whether significant air quality deterioration will result from the new or modified source. As part of the PSD review process, major sources are required to address the following items prior to issuance of a permit:

- Control technology review (BACT)
- Air quality analysis (monitoring)
- Ambient impact analysis
- Source information
- Additional impact analysis

The control technology review includes a determination of Best Available Control Technology (BACT) for the proposed project and equipment subject to PSD. The air quality analysis (pre-construction monitoring) requires that the source collect ambient air monitoring data in the impact area for at least one year prior to the start of construction. MDEQ has historically waived this requirement since air monitoring stations are currently being operated by the State and sufficient data exists. The ambient impact analysis requires a demonstration of compliance with federal and state air quality standards and allowable PSD Increments using computational models. Impacts on non-attainment areas may also be required if the source is expected to contribute to violations of any applicable air quality standard. Source information, including process design parameters and control equipment information, must be submitted with the permit application to the reviewing agency. Finally, an additional impact analysis of the proposed source on soils, vegetation, wildlife and visibility, especially on Class I PSD areas, may be required if requested by the state agency or any Federal Land Manager (FLM), as well as analysis of impacts due to increases in emissions and industrial growth in the community associated with the proposed source.

The CFB boiler is subject to a BACT review for $PM/PM_{10}/PM_{2.5}$, SO_2, NO_x, and CO under the PSD rules at 40 CFR 52.21(j), as the potential emission rates of SO_2 and CO will be greater than the major threshold of 100 tpy and $PM/PM_{10}/PM_{2.5}$ and NO_x are greater than their corresponding significant emission rate thresholds. The BACT analysis is provided in Section 5.0.

PSD review also requires a source impact analysis [40 CFR 52.21(k)] and additional impact analyses [40 CFR 52.21(o)]. The source impact analysis is presented in Section 6.0. This analysis demonstrates that the proposed facility will not cause or contribute to any violation of the applicable federal ambient air quality standards. Additional impact analyses are presented in Section 7.0, demonstrating that the proposed boiler will not adversely impact the Class I areas and will not impose any additional impacts.

3.1.2 New Source Performance Standards (NSPS)

U.S. EPA has promulgated a new source performance standard for industrial, commercial, institutional boilers at 40 CFR Part 60 Subpart Db. The General Provisions contained in Subpart A apply to all sources specified in the rest of the NSPS. These general requirements include, but are not limited to:

- Monitoring and reporting to assure that the particular source is in compliance with the applicable NSPS rules;
- Initial compliance testing to verify that the source meets the applicable limits specified in the applicable NSPS Subpart;
- Notification and recordkeeping.

Subpart Db – Industrial-Commercial-Institutional Steam Generating Units

Subpart Db applies to each steam generating unit ("boiler") that commences construction, modification or reconstruction after June 19, 1984, and that has a heat input capacity from fuels combusted in the boiler of greater than 100 MMBtu/hr. This subpart has been revised and the final rule amendments became effective on February 27, 2006.

Subpart Db contains emissions limits, compliance determination methods and procedures, and recordkeeping and reporting requirements. Specifically, it contains emissions standards for sulfur dioxide, particulate matter, and nitrogen oxides. These standards are as follows:

- 60.42b – Standard for Sulfur Dioxide: 0.20 lb/MMBtu or 90% Reduction
- 60.43b – Standard for Particulate Matter: 0.10 lb/MMBtu
- 60.44b – Standard for Nitrogen Oxides: 0.60 lb/MMBtu

3.1.3 National Emission Standards for Hazardous Air Pollutants (NESHAP)

Modified facilities, such as NMU, may be subject to the federal requirements for Hazardous Air Pollutants (HAPs) by either of two ways. The first step in determining applicability is to review the pollutant- and source-specific regulations promulgated in 40 C.F.R. §§61 and 63. These regulations are collectively known as the National Emission Standards for Hazardous Air Pollutants (NESHAPs). The second step for determining applicability is to evaluate whether the modification will be a major source of HAPs and, therefore, subject to the case-by-case Maximum Achievable Control Technology (MACT) requirements pursuant to Section 112(g) of the federal Clean Air Act should a federal NESHAP not exist.

Prior to the Clean Air Act Amendments of 1990, the U.S. EPA regulated a relatively small number of chemicals known as Hazardous Air Pollutants (HAPs). The initial list of HAPs included asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides and vinyl chloride. The regulations promulgated to control emissions of these chemicals are found at 40 C.F.R. §61. With the passage of the 1990 Clean Air Act Amendments, a list of 189 HAPs was adopted into law. A ***major source*** of Hazardous Air Pollutants is defined in Section 112 of the Clean Air Act, in part, as a stationary source that has the potential to emit 10 tons per year or more of any listed hazardous air pollutant or 25 tons per year of any combination of listed hazardous air pollutants subject to regulation under the Clean Air Act. The U.S. EPA was required to develop a listing of major source categories and area sources of HAPs and to promulgate regulations to control the emissions of HAPs from those sources. These regulations are found at 40 C.F.R. §63. U.S. EPA has not promulgated a NESHAP for utility boilers.

Case-By-Case MACT

Effective June 1998, a requirement for a case-by-case determination of the MACT applies to all new and reconstructed major sources of HAPs pursuant to Section 112(g) of the federal Clean Air Act and 40 C.F.R. §§63.40 to 63.44. The NESHAP for Industrial, Commercial, and Institutional Boilers and Process Heaters, 40 CFR Part 63, Subpart DDDDD became effective on September 13, 2004. This subpart applies to an industrial, commercial, and institutional boiler or process heater as defined in 63.7575, that is located at, or is part of a major source of HAP as defined in 63.2.

NMU is currently not a major source of HAP, and will remain an area (minor) source of HAPs after issuance of the air use permit. The maximum single HAP is estimated at 5.3 tons per year (HCl), and the maximum potential combined HAP emissions for NMU (new boiler plus existing boilers) will be 23.4 tons per year. These emission rates are based on full-year operation at 8760 hours per year. Therefore, the NESHAP requirements under 40 CFR Part 63, Subparts A and DDDDD will not apply to the proposed boiler, or the natural gas/No. 2 fuel oil boilers.

3.1.4 Prevention of Accidental Release

Section 112(r) of the Clean Air Act Amendments of 1990 directed the EPA to establish requirements in order to prevent the accidental release of a hazardous air pollutant. Due to the storage of bulk chemicals (e.g., anhydrous ammonia) for use in varied industries, EPA promulgated regulations that require facilities that store certain chemicals in amounts greater than the respective threshold quantity to prepare a Risk Management Plan (RMP) in order address how the chemicals will be stored and measures used to prevent their accidental release to the surrounding environment. The requirements governing accidental releases can be found in 40 C.F.R. Part 68 – Chemical Accident Prevention Provisions. These regulations are found in 40 CFR Part 68.

At this time, NMU is not proposing any storage tanks or vessels that would be subject to these regulations.

3.1.5 Compliance Assurance Monitoring

The Compliance Assurance Monitoring (CAM) rule (40 CFR Part 64) establishes criteria for monitoring certain air pollution control devices to provide reasonable assurance of compliance with emission limits and standards. As specified in 40 CFR 64.2(a), the CAM rule applies, on a pollutant specific basis, to each emission unit at a source that is a major source and is required to obtain a Michigan Renewable Operating Permit (Title V of the 1990 federal Clean Air Act) that meets all of the following:

- The unit is subject to an emission limitation or standard for the pollutant;
- The unit uses a control device to achieve compliance with the limit or standard; and
- Potential uncontrolled emissions of the pollutant are equal to, or greater than, part 70 major source thresholds for that pollutant (100 tpy of a criteria pollutant, 10 tpy of a single HAP, or 25 tpy of all HAPs combined).

Additionally, 40 CFR 64.2(b)(1)(i) specifies an exemption from the CAM rule that is applicable to this analysis. This section exempts emission units (on a pollutant specific basis) subject to the emission limitations or standards proposed by the EPA after November 15, 1990 pursuant to section 111 or 112 of the Act.

Since the proposed boiler is subject to the amended NSPS, 40 CFR 60, Subpart Db (effective date, February 27, 2006), it is exempt from the CAM rule for particulate matter and sulfur dioxide, pursuant to 64.2(b)(1)(i). No add-on control is being proposed for CO.

3.1.6 Federal Acid Rain Program

The proposed boiler is not a "utility boiler", as defined in section 402 of the Clean Air Act. Therefore, the boiler will not be subject to the Acid Rain Program Regulations under 40 CFR Parts 72 to 78.

3.2 MICHIGAN-SPECIFIC REQUIREMENTS

Michigan has developed regulations in order to both implement and supplement the federal requirements. Specifically, MDEQ has promulgated rules and regulations under the Natural Resources and Environmental Protection Act (Act 451 of 1994, As Amended) and Section 336 of the Michigan Compiled Law (MCL) for the control of air pollution.

Air Use Permit (Permit-to-Install) Overview

The State of Michigan requires that all sources of air pollution must obtain a Permit-to-Install prior to construction. Federal rules for Prevention of Significant Deterioration (PSD), 40 C.F.R. 52.21, also require a major modification of a major stationary source to obtain approval prior to beginning on-site construction of the major modification(s). Issuance of a State of Michigan Permit-to-Install will satisfy the federal requirement to obtain approval prior to constructing the modification. The State of Michigan is a federally delegated state for issuing PSD permits.

Prior to obtaining approval of a Permit-to-Install in Michigan, the source must demonstrate compliance with all applicable federal and state rules and regulations. This includes a public participation process, with an option for a public hearing, to allow all interested people the opportunity to make comments on the proposed modification.

The Permit-to-Install will include conditions covering the installation and operation of the equipment until a Renewable Operating Permit (ROP) is issued or modified to allow long-term operation of the modified source, assuming that the applicant has submitted an administratively complete application for a ROP within the time frame for obtaining a permit shield.

The Permit-to-Install conditions include some or all of the following: emission limits; equipment restrictions; design parameters; operating requirements; testing and sampling requirements; monitoring, recordkeeping and reporting. These are required to ensure that the source will continuously comply with the state and federal requirements applicable to the project.

Toxic Air Contaminants (TACs) Discussion

MDEQ Rules 224 to 232 (R 336.1224 to R 336.1232) regulate the emission of Toxic Air Contaminants (TACs) from new and modified emission units. The substantive requirements are contained in Rules 224 and 225, T-BACT Requirements for New and Modified Sources and Health-Based Screening Level Requirement for New and Modified Sources, respectively. The proposed project will be subject to Michigan Air Toxics requirements pursuant to Rules 224 and 225.

3.2.1 Best Available Control Technology for Toxics (T-BACT)

Michigan Rule 224 (R 336.1224) specifies that new or modified emission units cannot emit toxic air contaminants in excess of the maximum allowable emission rate based upon the application of best available control technology for toxics (T-BACT). However, Rule 224(2)(a)(iii) states that the requirement for T-BACT does not apply to "other toxic air contaminants that are particulate matter, if the standard promulgated under section 112(d) of the clean air act or the determination made under section 112(g) or 112(j) of the clean air act controls similar compounds that are also particulate matter." In this instance, EPA has promulgated a mercury emission limit under NESHAP for Industrial, Commercial, Institutional boilers equal to 3.0 E-06 lb/MMBtu heat input. Consequently, NMU is required to ensure that the emissions of Hg meet a limit representative of T-BACT. NMU is proposing to meet the NESHAP limit, which is considered the "MACT Floor" and equivalent to T-BACT for this project.

3.2.2 Health Based Screening Levels for Air Toxics

Michigan Rule 225 (R 336.1225) requires that the ambient concentrations ($\mu g/m^3$) produced by the emissions of toxic air contaminants (TACs) from the new or modified source be less than or equal to the screening levels that are established by the MDEQ – Air Quality Division (AQD). Screening levels for non-carcinogenic compounds are referred to as Initial Threshold Screening Levels (ITSLs), while screening levels for carcinogenic compounds are referred to as Initial Risk Screening Levels (IRSLs). Rule 226 (R 336.1226) contains exemptions from the requirements contained in Rule 225 and Rule 227 (R336.1227) and specifies methods for demonstrating compliance with the state air toxics rules, including methodologies for establishing screening levels.

The TAC emissions from the installation of the new CFB will consist of some trace metal compounds and HAPs. The potential TAC emission rates are presented in Appendix B and the ambient impacts of these TAC emissions have been shown to be in compliance with all of the applicable screening levels using the air quality modeling procedures contained in R 336.1240 and R 336.1241.

3.2.3 Requirement for Lower Emission Rate than Required by T-BACT

Rule 228 allows the department to determine, on a case-by-case basis, that the maximum allowable emission rate determined in Rules 224 or 225 may not provide adequate protection of human health or the environment. During a pre-application meeting with MDEQ on June 29, 2006, staff from MDEQ – Toxics Unit indicated that the emissions from the proposed facility are not at a level of concern to warrant any additional analysis to determine an emission rate lower than T-BACT.

3.2.4 Standards for Density of Emissions

Under Michigan Rule 301 (R 336.1301), visible emissions from processes and process equipment are limited to 20 percent opacity on a 6-minute average, with an allowance that one 6-minute average per hour may exceed 20 percent opacity provided it does not exceed 27 percent opacity. However, certain operations at the facility are subject to specific requirements contained in Michigan's Part 3 rules.

The level of particulate emissions proposed by NMU in this application are at or lower than the applicable PM and/or opacity standards for fuel burning equipment contained in Part 3 of the Michigan Air Pollution Control Rules. No other source specific criteria pollutant standards apply.

3.2.5 Emission Limitations and Prohibitions – Sulfur-Bearing Compounds

Michigan has adopted specific rules to limit the emissions of SO_2 from power plants. Specifically, Rule 401 limits the sulfur content in fuel for power plants to 1.0% for units capable of producing greater than 500,000 lbs of steam per hour. However, Rule 401 allows for an exemption from the sulfur in-fuel requirement if the facility is subject to a federal emission standard and requires only that the unit meet an emission rate based on the sulfur content in the fuel. Since the unit will be subject to a federal emission standard for SO_2 contained in 40 C.F.R. Part 60 (NSPS) and this emission limit is lower than that contained in Table 42 of Rule 401, the unit will be compliance with the Michigan Part 4 rules.

3.2.6 Emission Limitations and Prohibitions – New Sources of VOC Emissions

Michigan's Part 7 Rules require new sources of VOC not allow emissions in excess of the lowest maximum allowable emission rate, otherwise known as VOC BACT. The total net emissions of VOC will be less than significant emission threshold of 40 tpy. In addition, the CFB boiler will employ good combustion techniques in order to reduce the emission of volatile compounds from the unit and is considered BACT for VOC.

3.2.7 Emission Limitations and Prohibitions – Oxides of Nitrogen

Michigan's Part 8 Rules govern the level of emissions allowed by both SIP call and non-SIP call stationary sources and requires that units larger than 250 MMBtu/hr meet certain limits based on the season. Additionally, MDEQ is drafting new rules in order to implement the provisions of the Clean Air Interstate Rule (CAIR), which will augment the existing Part 8 rules.

NMU is proposing to meet an emission limit lower than the NSPS limit of 0.6 lb/MMBtu for emissions of NO_x from the new CFB.

4.0 SUMMARY OF EMISSION ESTIMATES

This section presents the emission estimates for the CFB unit and coal handling equipment as a result of installing the new boiler.

4.1 CIRCULATING FLUIDIZED BED BOILER EMISSION CALCULATIONS

The proposed CFB boiler is nominally rated at 185 MMBtu/hr heat input for coal firing and 205 MMBtu/hr heat input for 100% wood firing. The boiler will combust coal, wood, or a mixture of coal and wood and utilize limestone to control sulfur dioxide (SO_2), hydrogen chloride (HCl) and other acid gas (inorganic HAP) emissions (e.g. H_2SO_4 acid mist, HF, chlorine, etc.). In addition, a fabric filter (baghouse) will be installed to control particulate matter ($PM/PM_{10}/PM_{2.5}$), lead (Pb), and non-volatile metallic HAPs; a selective non-catalytic reduction (SNCR) system will be installed to control nitrogen oxides (NO_x) emissions; and good combustion controls and operating practices will be used to control emissions of carbon monoxide (CO), volatile organic compounds (VOC), and volatile organic HAPs (VOHAP).

The CFB boiler will use a mixture of fuels to produce a maximum gross heat input of approximately 185 MMBtu/hr. The primary pollutants that will be emitted from the CFB boiler will consist of particulate matter ($PM_{10}/PM_{2.5}$), SO_2, NO_x, and CO.

The emissions have been calculated on both a short-term (lb/hr) and long-term (tpy) basis. All annual calculations are based on continuous operation at 8,760 hours per year. The potential emissions of regulated pollutants and toxic air contaminants (TAC), including hazardous air pollutants (HAP) from the CFB boiler are summarized below and detailed in the attached Appendix B.

The potential emission rates of regulated pollutants from the proposed CFB boiler are listed in Table 4-1.

Table 4-1 Potential PSD-Regulated Pollutant Emission Rates from the CFB Boiler

Pollutant	Emission Rates			Basis
	lb/MM Btu	lb/hr	tpy	
PM/PM_{10} (filterable)	0.025	5.1	22.4	PSD-BACT
PM_{10} (filterable & condensable	0.03	6.2	26.9	PSD-BACT
SO_2 (1)	0.48	88.8	388.9	PSD-BACT
NO_x	0.10	20.5	89.8	PSD-BACT
CO	0.17	34.9	152.6	PSD-BACT
VOC (as Propane)	0.02	4.0	18.0	R702-BACT
Lead	1.34E-05	0.0025	0.011	(2)
H_2SO_4 Mist	6.1E-03	1.1	4.9	(3)
Fluorides (as HF)	0.01	0.2	0.7	T-BACT
Total Reduced Sulfur (including H_2S)(4)	NA	NA	NA	NA

Notes:

(1) SO_2 emission rates are based on 3.5 percent (average max.) sulfur coal and 92 percent reduction requirement per NSPS. The limits are also based on a 30-day rolling average.

(2) The lead estimated emission rates represents the maximum of PRB, bituminous, & wood fuels, and are based on a statistical analysis of respective typical coals, with a 99% control efficiency of the baghouse collector, with wood emissions being based on the AP-42 emission factor.

(3) Based on a BACT determination regarding the Plum Point Energy permit for an 800-MW pulverized coal fired utility boiler, located in Arkansas. The limit should be based on a 24-hour average.

(4) Due to the oxidation of fuels in the boiler, sulfur-bearing compounds will be oxidized to SO_2. Therefore, total reduced sulfur and reduced sulfur compounds, including H_2S are not likely to be formed and thus, will not be emitted.

4.1.1 Particulate Matter ($PM/PM_{10}/PM_{2.5}$)

PM - 10 PM - 2.5

The "significant net increase" threshold for $PM_{10}/PM_{2.5}$ emissions is 15 tpy. Recent EPA guidance for $PM_{2.5}$ requires that in the interim period between the dates of the $PM_{2.5}$ NAAQS designations and when EPA promulgates regulations to implement NANSR for the $PM_{2.5}$ NAAQS, states should use PM_{10} as the surrogate for determining whether a facility or modification is considered major for $PM_{2.5}$ under PSD. Therefore states and facilities should use projected PM_{10} emissions and net emissions increases (and decreases) as a surrogate for $PM_{2.5}$. The particulate emissions will primarily consist of flyash. A CFB boiler is specifically designed to reduce the amount of particulate emissions by utilizing a high temperature cyclone to capture the unburned portion of the ash and return it to the primary combustion chamber.

The boiler will be equipped with a cyclone and baghouse to control particulate matter (PM) emissions, including PM_{10} and $PM_{2.5}$. The baghouse will be designed to meet a PM/PM_{10} emission rate of 0.030 lb/MMBtu heat input (filterable and condensable) when firing coal, wood, or a mixture of coal and wood and is more stringent than the NSPS (Subpart Db) limit of 0.10 lb/MMBtu heat input (for coal and mixtures of coal with other fuels provided the annual capacity factor greater for other fuels is 10% or greater, by heat input), and the State Implementation Plan (SIP) – R 336.1331 PM limit of 0.30 lb/1,000 lbs exhaust gas, corrected to 50% excess air. The boiler will comply with the opacity limit established pursuant to R 336.1301(Rule 301(1)).

The short-term and long-term maximum potential emission rates for PM_{10} been calculated using the following equations:

$$\boldsymbol{PM_{10}\ Emissions} = \frac{0.03\ lb}{MMBtu} \times \frac{205\ MMBtu}{hr} \times = \frac{6.15\ lb}{hr}$$

$$\boldsymbol{PM_{10}\ Emissions} = \frac{6.15\ lb}{hr} \times \frac{8760\ hr}{yr} \times \frac{1\ ton}{2000\ lb} = \frac{26.94\ ton}{yr}$$

Compliance with the PM/PM_{10} emission limits will be determined by conducting the performance tests required under the NSPS, Subparts A and Db. The facility will install, operate, certify and maintain a continuous opacity monitoring system (COMS) to demonstrate continuous compliance with the PM/PM_{10} and opacity limits.

4.1.2 Sulfur Dioxide (SO_2)

Sulfur dioxide emissions are proportional to the sulfur content of the coal. In order to minimize the SO_2 emissions, the boiler will be fired with bituminous coal with maximum sulfur content not to exceed 3.5 percent by weight and co-fired with limestone and wood, as available. The potential sulfur dioxide (SO_2) emissions will be reduced by the use of limestone, which will be mixed with the coal. Wood, as defined in 40 CFR 60.41b, will also be used as fuel and will be fired alone or co-fired with coal. The firing of wood alone or in combination with coal will reduce the potential SO_2 emissions from the boiler because wood contains very little sulfur. The boiler will be designed to meet the NSPS SO_2 emission limit of 0.20 lb/MM Btu heat input, or 8 percent (0.08) of the potential SO_2 emission rate (92 percent reduction) and 1.2 lb/MMBtu heat input, based on a 30-day rolling average. Based on the maximum 3.5 weight percent coal and 92 percent reduction requirement, the allowable SO_2 emission rate will be 0.48 lb/MMBtu.

$$SO_2\ Emissions = \frac{0.48\ lb}{MMBtu} \times \frac{185\ MMBtu}{hr} \times = \frac{88.80\ lb}{hr}$$

$$SO_2\ Emissions = \frac{88.80\ lb}{hr} \times \frac{8760\ hr}{yr} \times \frac{1\ ton}{2000\ lb} = \frac{388.94\ ton}{yr}$$

The facility will install, calibrate, maintain, and operate a continuous emission monitoring system (CEMS) for measuring SO_2 concentrations, with either oxygen (O_2) or carbon dioxide (CO_2) concentrations, and will record the output of the system as required in 60.47b(a). Initial and continuous compliance with the SO_2 emission limits and percent reduction requirements will be determined using the CEMS. The initial performance test will be conducted over 30 consecutive operating days of the boiler. The first operating day included in the initial performance test will be scheduled within 60 days after achieving the maximum production rate at which the boiler will be operated, but not later than 180 days after initial startup of the boiler. Compliance with the SO_2 emission limit and percent reduction requirements will be determined using a 30-day rolling average at the end of each steam generating unit operating day.

4.1.3 Nitrogen Oxides (NO_x)

Nitrogen oxides (NO_x) are present in the flue gas in two forms: thermal NO_x and fuel NO_x. Thermal NO_x forms when nitrogen and oxygen molecules in the combustion air are disassociated at peak flame temperatures and recombined into oxides of nitrogen (primarily NO). Fuel NO_x is formed when the nitrogen in the fuel (fuel-bound nitrogen) is combined with oxygen in the combustion air form nitrogen oxides. When firing natural gas, or other gaseous fuels, thermal NO_x is the primary mechanism through which NO_x is formed since the concentration of nitrogen in natural gas is negligible. However, when firing solid fuel (i.e., coal) or liquid (i.e., distillate or waste oils) fuels in the boiler, a greater percentage of the total NO_x formed is due to the release of fuel-bound nitrogen in the fuel. Through proper design and good combustion practices the formation of NO_x can be limited by controlling the peak combustion temperature, gas residence time at peak temperature, and the air-to-fuel ratio. CFB's have been specifically designed to burn at temperatures that are lower than the prime temperatures in which NO_x is formed.

The boiler will be equipped with SNCR to reduce the nitrogen oxides emissions. The CFB boiler and SNCR system will be designed to achieve a NO_x emission rate of 0.10 lb/MMBtu heat input when firing coal, wood, or a mixture of coal and wood. This limit is based on BACT determinations pursuant to 40 CFR 52.21(j). The limit is based on a 30-day rolling average and is more stringent than the applicable NSPS limit of 0.60 lb/MMBtu heat input.

$$\boldsymbol{NO_x\ Emissions} = \frac{0.10\ lb}{MMBtu} \times \frac{205\ MMBtu}{hr} \times = \frac{20.50\ lb}{hr}$$

$$\boldsymbol{SO_2\ Emissions} = \frac{20.50\ lb}{hr} \times \frac{8760\ hr}{yr} \times \frac{1\ ton}{2000\ lb} = \frac{89.79\ ton}{yr}$$

The facility will install, calibrate, maintain, and operate continuous emission monitoring systems (CEMS) for measuring NO_2 concentrations, with either O_2 or carbon dioxide CO_2 concentrations, and will record the output of the systems. Initial and continuous compliance with the NO_x emission limit will be determined using the CEMS.

4.1.4 Carbon Monoxide (CO)

CO is an intermediate combustion product that is formed when the reaction of CO to CO_2 cannot proceed to completion. These emissions typically occur when there is a lack of available oxygen, if the combustion gas temperature is too low, if the residence time is too short, if there is not sufficient turbulence (or mixing) of the combustion gases or if there will be a combination of these conditions in the combustion chamber.

Based on the experience of Cummins & Barnard, Inc. (C&B) and review of the RACT/BACT/LAER Clearinghouse (RBLC), an emission factor of 0.17 lb/MMBtu heat input was used to evaluate the emissions from the CFB boiler. It was determined that the CO emissions will be 34.85 pph for all fuels firing represents BACT. The limit is based on a 30-day rolling average.

$$CO\ Emissions = \frac{0.17\ lb}{MMBtu} \times \frac{205\ MMBtu}{hr} \times = \frac{34.85\ lb}{hr}$$

$$CO\ Emissions = \frac{34.85\ lb}{hr} \times \frac{8760\ hr}{yr} \times \frac{1\ ton}{2000\ lb} = \frac{152.64\ ton}{yr}$$

4.1.5 Volatile Organic Compounds (VOC)

Hydrocarbons, or VOCs, are emitted due to incomplete combustion occurring in the boiler. Due to the efficiency of the CFB boiler, the emissions of VOCs are expected to be low. Based on the experience of C&B and a review of RBLC, an emission factor of 0.02 lb/MMBtu (measured as propane) was utilized to estimate the potential VOC emissions. This equates to approximately 4.0 pph, and 17.6 tpy. These emission rates are representative of BACT pursuant to the requirements of Michigan Rule 702(a).

$$VOC\ Emissions = \frac{0.02\ lb}{MMBtu} \times \frac{205\ MMBtu}{hr} \times = \frac{4.10\ lb}{hr}$$

$$VOC\ Emissions = \frac{4.10\ lb}{hr} \times \frac{8760\ hr}{yr} \times \frac{1\ ton}{2000\ lb} = \frac{17.96\ ton}{yr}$$

4.1.6 Lead (Pb)

The emissions of lead are dependent upon the lead content of the fuel and the removal efficiency of the particulate collection device. Information and data obtained from industry and EPA, as well as sampling data from other NTH Consultants, Ltd. projects, indicates that over 99% of the Pb is emitted in particulate form (particle-phase). Consequently, a well-performing particulate control device, such as a fabric filter, can be expected to capture nearly all of the potential Pb emissions.

NMU is planning to use a blend of subbituminous coal and wood. NTH and C&B have reviewed analytical data from proposed coal sources and performed a statistical analysis of the lead content in these coals, which resulted in a maximum, estimated lead emission rate of 1.34E-05 lb/MMBtu heat input that includes 99% control efficiency for the baghouse. This yields an emission rate of 0.0025 pph and 0.011 tpy, which is equivalent to approximately 22 lbs/year. This is below the Pb significant emission rate threshold of 0.6 tpy.

$$\textbf{Pb Emissions} = \frac{1.34\ E\text{-}05\ lb}{MMBtu} \times \frac{185\ MMBtu}{hr} \times = \frac{0.0025\ lb}{hr}$$

$$\textbf{Pb Emissions} = \frac{0.0025\ lb}{hr} \times \frac{8760\ hr}{yr} \times \frac{1\ ton}{2000\ lb} = \frac{0.011\ ton}{yr}$$

4.1.7 Mercury Emissions T-BACT

Emissions of mercury are dependent upon the mercury content of the fuel, chlorine content of the coal, unburned carbon or loss on ignition (LOI) within the boiler, type of burner design and the removal efficiency of the add-on control technology. Information and data obtained from industry and EPA suggest that removal efficiencies of at least 80% are readily obtained in CFB boilers firing bituminous and subbituminous coals and utilizing a fabric filter and/or other technology for the control of SO_2 and NO_x.

Even though the new boiler is not subject to the Industrial, Commercial, and Institutional Boiler MACT requirements, NMU is proposing to accept a mercury emission limit equivalent to the MACT level of 3.0E-06 lb/MMBtu heat input. The U.S. EPA did not consider carbon injection to be a MACT floor control technology for industrial, commercial, institutional boilers and process heaters. Data from electric utility boilers indicate that fabric filters are the most effective control technology for reducing potential mercury emissions. The MACT floor emissions level based on mercury test data from solid fuel fired units with a fabric filter is 3.0E-06 lb/MMBtu heat input. The proposed CFB boiler will be equipped with a fabric filter (or baghouse).

$$Hg\ Emissions = \frac{3.0\ E\text{-}06\ lb}{MMBtu} \times \frac{185\ MMBtu}{hr} \times = \frac{5.55\ E\text{-}04\ lb}{hr}$$

$$Hg\ Emissions = \frac{5.50\ E\text{-}06\ lb}{hr} \times \frac{8760\ hr}{yr} = \frac{4.86\ lb}{yr}$$

4.1.8 Sulfuric Acid Mist (H_2SO_4) and Fluorides (as HF)

The sulfuric acid mist emission estimate and proposed limit is based on a permit issued to Plum Point Energy, which is located in Arkansas, while the fluorides (as HF) emission factor is based on EPA's AP-42 emission database and includes a 15% increase as a safety factor. The potential H_2SO_4 emission rate of 4.9 tpy is less than the PSD significant emission rate threshold of 7 tpy, and the potential HF (hydrogen fluoride) emission rate of 0.7 tpy is well below the PSD significant emission rate threshold of 3 tpy for fluorides. Therefore, these pollutants are not subject to PSD review. However, the use of limestone and baghouse systems will minimize the emissions of these pollutants, and represents T-BACT for this proposed CFB boiler.

4.1.9 Total Reduced Sulfur (TRS), including Hydrogen Sulfide (H2S)

Due to the oxidation of fuels in the boiler and the use of good combustion controls, the sulfur-bearing compounds will be oxidized to SO_2 rather than reduced to form total reduced sulfur (TRS) and reduced sulfur compounds (RSC), including H_2S.

4.2 SUMMARY OF HAP AND TAC EMISSIONS

The proposed CFB boiler will emit toxic air contaminants, including some of the HAPs listed in Section 112(b)(1) of the Clean Air Act (CAA). All HAPs are considered as TACs under the State of Michigan Air Toxics rules. The potential HAP/TAC emission factors for coal (bituminous and PRB coal) and wood-fired industrial boilers have been reviewed and a worst-case emission factor for each HAP/TAC was used to calculate the maximum hourly and annual emission rates from the CFB boiler. The worst-case emission factors and mass emission rates are listed in Appendix B. The emission factors were obtained from the U.S. EPA AP-42 document, stack test results and permits for other similar coal/wood-fired boilers, and other published articles and technical bulletins on coal/wood combustion in boilers. Data from EPA's AP-42 and stack testing results were increased by 15% as a safety factor. The values listed in Appendix B represent the maximum from either coal, natural gas or wood fuels. See Appendix B for a complete list of compounds for which data was available.

The HAP/TAC emissions can be divided into the following four common categories: mercury, metallic HAP/TAC, inorganic HAP/TAC, and organic HAP/TAC. Mercury was discussed previously. The compounds in each pollutant category and emission control techniques used for each category are discussed below.

Metallic HAP/TAC Emissions

The groups of compounds included under this pollutant category are: antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, phosphorus, selenium, vanadium, and zinc. Most of these non-mercury metallic HAP/TAC compounds appear in the flue gas flyash, which is emitted as particulate matter (PM). Therefore, the same control techniques that would be used to control the flyash PM will control non-mercury metallic HAP/TAC emissions.

The proposed CFB boiler is subject to BACT for PM emissions, and a baghouse will be utilized to control PM emissions from the boiler. Since the non-mercury metallic HAP/TAC will be emitted as part of PM emissions, the baghouse will also control the non-mercury metallic HAP/TAC emissions. Therefore, the proposed baghouse is considered to represent T-BACT for these compounds. The maximum controlled HAP/TAC emission rates are used in the dispersion modeling analysis to demonstrate compliance with the Michigan air toxics requirements under Rules 225-232. The modeling analysis is presented in Section 6.0.

Inorganic HAP/TAC Emissions

The primary inorganic HAP/TAC emitted from boilers are acid gases, such as hydrogen chloride (HCl), chlorine, hydrogen fluoride (HF), and sulfuric acid mist (H_2SO_4), with HCl present in the largest amounts. Therefore, control technologies that would reduce HCl emissions would also control other inorganic compounds that are acidic gases.

The proposed CFB boiler will use limestone in the bed of the boiler to control emissions of SO_2 and other acid gases. An HCl emission limit of 0.0065 lb/MMBtu is based on the EPA's AP-42 emission factor found at Table 1.1-15, Chapter 1.1, dated 9/98, with a 15% safety factor, and using 92% control efficiency due to the use of limestone in the boiler bed. Thus, the addition of limestone to the CFB in the boiler is considered T-BACT for HCl and other acid gases, and the corresponding maximum controlled emission rates of inorganic HAP/TAC listed in Table 4-2 will result in ambient concentrations that are less than the screening levels established pursuant to the air toxics requirements of Michigan Rules 225-232.

Organic HAP/TAC Emissions

Although numerous organic HAP/TAC may be emitted from industrial boilers, only a few account for essentially all of the mass of organic HAP/TAC. These organic HAP/TAC are: Formaldehyde, benzene, hexane, toluene, and acetaldehyde. All other organic HAP/TAC, including polynuclear aromatic hydrocarbons (PAH), and dioxins and furans are emitted in trace amounts.

Organic HAP/TAC and carbon monoxide (CO) emissions would occur due to incomplete combustion of fuels. In establishing MACT standards for industrial boilers and process heaters, EPA used CO as a surrogate to represent the variety of organic compounds, including dioxins and furans, emitted from the various fuels burned in the boilers and process heaters. As CO is a good indicator of incomplete combustion, there is a direct correlation between CO emissions and the formation of organic HAP emissions. Therefore, minimizing CO emissions will result in minimizing organic HAP/TAC emissions.

The proposed CFB boiler is subject to BACT for CO. NMU is proposing an emission limit of 0.17 lb/MMBtu heat input for BACT, based on a 30-day rolling time period. This limit represents complete combustion and BACT under the PSD rules (*40 CFR 52.21(j)*) and T-BACT under the Michigan Air Toxics rules (Rule 224) for VOC and organic toxic air contaminants. The worst-case organic HAP/TAC emission rates from the CFB boiler have been calculated from the U.S. EPA AP-42 document and used in the modeling analysis presented in Section 6.0. The results of the modeling analysis indicate that the proposed boiler will comply with the Michigan Air Toxics Rules.

5.0 CONTROL TECHNOLOGY REVIEW

The proposed project is considered a "major modification" as defined in the PSD regulations at 40 CFR 52.21 because there will be a significant net increase in PM, $PM_{10}/PM_{2.5}$, SO_2, NO_x, and CO emissions as a result of installing the new CFB boiler. Therefore, the requirements for best available control technology (BACT) of 40 CFR 52.21(j) will be applicable to control emissions of PM, $PM_{10}/PM_{2.5}$, SO_2, NO_x, and CO from the proposed CFB boiler. Further, Rules 224 and 702 of the Michigan Air Pollution Control Rules require an analysis of BACT for toxic air contaminants and VOCs, respectively. The BACT analyses contained in this application were performed in accordance with the U.S. EPA's recommended top-down procedure outlined in the New Source Review Workshop Manual and set forth in Section 165(a)(4) of the federal Clean Air Act (CAA) as well as the MDEQ – Air Quality Division Operational Memorandum No. 20.

5.1 BACT PROCEDURE

The BACT analyses required under both the state and federal rules follow the MDEQ-AQD's Operational Memorandum No. 20 (Op Memo 20) for BACT determinations. Op Memo 20 identifies four (4) levels of review and closely reflects the intention of EPA's methodology for performing BACT analyses for PSD purposes. As described below, the procedure takes advantage of BACT determinations that have been made for other similar equipment across the country over the past several years. This allows for a more streamlined analysis by circumventing the rigorous approach set forth in the NSR Workshop Manual.

LEVEL 1

Level 1 is the first step and identifies the most stringent form of control described as the lowest achievable emission rate (LAER). Any proposed BACT analysis that selects to achieve LAER will be accepted without additional review. If LAER is not chosen, the applicant proceeds to a Level 2 analysis.

LEVEL 2

Level 2 identifies the types of control technologies that have been approved as BACT for similar source types nation-wide. Emission limitations accepted as BACT in recent permits throughout the country for similar processes or industries are acceptable unless new technical developments have been made that indicate additional emission reductions can be achieved in practice. In general, approved limits for BACT over the previous 5-year period are reviewed and compared against the proposed BACT limits in the current application.

If the proposed emission limits are less stringent than those accepted as BACT in recent permits or when few recent BACT determinations exist for the process or industry, and new technical developments have not occurred over the preceding 5-years, the BACT evaluation proceeds to Level 3.

LEVEL 3

A Level 3 BACT evaluation involves consideration of controls that have been accepted as BACT in recent permits for similar air emission streams from different processes or industry types. Level 3 also allows consideration, where appropriate, of older BACT determinations. Control technologies or techniques (i.e., materials, methods or equipment) that have not been demonstrated within the process or industry type under review may be evaluated for use if they are shown to be both available and applicable to the process or industry type for which the application is being prepared.

In the case of materials or methods, consideration is given on the basis of their use in manufacturing identical or similar products from identical or similar raw materials. In the case of add-on control equipment, consideration is made on the basis of the physical and chemical characteristics of the pollutant-bearing streams for which the controls have been applied and compared with those from the process or industry type of the proposed source(s). In Level 3, determining whether energy, environmental, or economic impacts are appropriate is primarily based on current and historical determinations.

If the proposed emission limit is less stringent than those accepted for the same process and industry, the BACT evaluation proceeds to Level 4.

LEVEL 4

The Level 4 BACT evaluation involves a detailed, top-down technical and quantitative analysis for all emission reduction options available for the proposed process and equipment. This analysis mirrors U.S. EPA's 5-step, top-down procedure identified previously and is described below.

Step 1

The first step in the top down procedure is to identify all control technologies and emission reduction options. NMU is employing CFB technology for the new boiler. Inherently in the design of the CFB, reductions of many criteria and toxic pollutants are naturally reduced due to boiler design and residence time. In order to identify additional control technologies, the following sources of information would be referenced:

- U.S. EPA RACT/BACT/LAER Clearinghouse (RBLC)
- U.S. EPA Control Technology Center (CTC)
- Recent Permit Actions by MDEQ and other States
- Vendor Information
- Project Experience from all parties associated with this project, including NTH Consultants, Ltd., Cummins & Barnard, Inc., and Northern Michigan University

Step 2

The second step in performing the top-down BACT analysis is to eliminate all technically infeasible options. The determination that a control technology is technically infeasible is source-specific and based upon physical, chemical, and engineering principles.

Step 3

The third step in the top-down BACT analysis is to rank all remaining control technologies with respect to control effectiveness. The control technologies are ranked in order of control effectiveness and are pollutant-specific. Information including control efficiency, anticipated emission rate, expected emissions reduction, and economic, environmental and energy impacts are to be considered.

Step 4

If the top-ranked control technology option is chosen, the BACT analysis is complete and no further information regarding economic, environmental, and energy impacts are required. However, if the top-ranked option is not chosen, an assessment of economic, environmental, and energy impacts are performed to evaluate the most effective controls in Step 4. In this step, an analysis is performed on each remaining control technology in order to determine whether the economic and energy impacts to the applicant do not provide sufficient incremental environmental benefits. Those technologies that do not provide a sufficient environmental benefit, given energy and economic impacts, can be eliminated.

Step 5

The fifth, and final, step is selection of the BACT emission limit corresponding to the most stringent, and technically feasible technology that was not eliminated based upon adverse economic, environmental, and energy impacts.

The economic analysis is performed in accordance with the procedures found in U.S. EPA's Air Pollution Control Cost Manual published in January 2002 (EPA/452/B-02-001). This document provides capital and annual operating cost factors for use in determining the economic impact of each control technology.

Finally, pursuant to 40 CFR 52.21(b)(12), the chosen BACT emission limit must not be less stringent than any applicable federal New Source Performance Standard (NSPS), National Emission Standard for Hazardous Air Pollutants (NESHAP), or state-specific emission standard.

NMU has chosen, as BACT, emission limits identified in the Level 2 analysis by reviewing all of the national BACT determinations using the EPA's RACT/BACT/LAER (RBLC) Clearinghouse. The BACT emission limits chosen for this project are at least as stringent as applicable federal or state standards and within the range of recent BACT determinations for similar processes as found in the RBLC database. Specifically, a NSPS has been promulgated for PM_{10}, SO_2, and NO_x, pursuant to 40 CFR Part 60, Subpart Db. This application is consistent with the proposed revision. A copy of the RBLC Clearinghouse database review is attached in Appendix E.

5.2 PARTICULATE MATTER ($PM/PM_{10}/PM_{2.5}$)

Particulate Matter, including PM, PM_{10}, and $PM_{2.5}$, results from both the combustion and storage of fuel, as well as limestone and ash handling and storage. In this instance, solid fuels, limestone, and ash will be stored in enclosed silos with appropriate vent filters. Particulate is formed in boilers during the combustion process and is present as unburned carbon and fly ash. In order to minimize the amount of particulate entering the flue gas stream and maximize the combustion of all carbon, the unburned carbon is re-circulated back to the CFB for further combustion.

Particulate matter may be emitted as a solid, or it can be emitted as a condensable material. Solid particulate is measured using EPA's Method 5 sampling procedure, which are commonly referred to as "front half" emissions. The condensable particulate emissions are measured using EPA's Method 202 procedure and commonly referred to as "back half" emissions.

Currently accepted control technologies for particulate matter include both fabric filters (baghouse) and electrostatic precipitators (ESP). Both of these technologies represent the most efficient and cost-effective method for controlling PM emissions from many sources, including commercial, industrial, and institutional boilers. While other control technologies exist, including mechanical collectors and wet scrubbers, neither has been proven as an effective control technology due to efficiency and energy impacts.

Fabric Filter (Baghouse)

A fabric filter system consists of a structure containing fabric bags arranged in numerous rows where the exhaust flue gas passes through the bags to capture particles in the gas stream prior to exiting to an exhaust stack. Particles are "cleaned", or filtered, from the exhaust gas by various mechanisms, including inertial impaction and impingement, as the gas passes through the fabric bags. Accumulated particulate (or dust cake) is periodically removed using mechanical, sonic or pneumatic means.

Fabric filters achieve high removal efficiencies by designing the system such that the air-to-cloth ratio ensures that the exhaust gas stream passes through the bags at a low enough velocity to allow the dust to accumulate on the surface of the bag. This build up of dust on the surface effectively increases the removal efficiency of the bags by decreasing the sieve size of the filter media (bags).

Typical collection efficiencies for a fabric filter system are on the order of 99+ percent for particles smaller than 10-microns in size.

Electrostatic Precipitators (ESP)

Electrostatic precipitators remove particles from a gas stream through the use of electrical currents and forces. Dust laden gases are pushed or pulled through the precipitator box with the assistance of a fan. The airflow is channeled into lanes formed by collection plates. Discharge electrodes are centered between each collection plate to provide a negative charge to the surrounding dust particles. The collection plates are positively grounded and act as a magnet for the negatively charged dust particles. The collected dust is transported down the collection plates and electrode with the assistance of a rapper or vibrator system into a collection hopper.

Electrostatic precipitation is typically a dry process, but spraying moisture to the incoming air flow helps collect the exceptionally fine particulates, and helps reduce the electrical resistance of the incoming dry material to make the process more effective for some processes. Where condensenable organic emissions are significant, such as in the wood products industry, wet ESP's are used to reduce VOC emissions in addition to the PM emissions. The flow of liquid by gravity down the plate continually removes the collected contaminants. Since the contaminants are part of a liquid matrix, water treatment facilities must also be included as part of the overall control system.

Mechanical Collectors (Pre-cleaners)

Collectively, mechanical collectors are known as pre-cleaners as these systems are not usually the primary collection device for particulate. These systems are primarily used to reduce the inlet loading of the particulate matter of the flue gas to downstream collection devices, such as fabric filters and ESPs.

Mechanical collectors operate on the principal of inertia to remove larger particles. The collector (usually a cyclone) imparts a centrifugal force on the gas stream that is used to separate the larger particles. These particles then fall out from the collector and accumulate in a hopper. Typical collection efficiencies for mechanical collectors are less than 90 percent for particles less than 10-microns in size.

Wet Scrubber

Wet scrubbers remove particles from gas streams principally through inertial impaction of the particle onto a water droplet. Particles are wetted through spray nozzles whereas the gas stream flows counter to the direction of the water spray. In venturi-type scrubbers, the gas stream passes through the scrubber and is constricted in the throat section causing the gas stream to accelerate. As it passes through the throat, it enters a larger cyclone and experiences a pressure drop across the system. The entrained water droplets are then removed by means of a cyclone separator or impingement scrubber section. Typical collection efficiencies for packed-bed and venturi scrubbers are less than 90 percent for particles sizes less than 10 microns.

5.2.1 Proposed BACT Emission Limit

NMU will be utilizing a new fabric filter, with mechanical pre-cleaner, to control total particulate (front half + back half) emissions from the combustion of solid fuels, including western and eastern coals, and virgin wood, in the new CFB boiler. The proposed use of a baghouse is considered BACT for this process.

A review of the BACT limits contained in the RBLC Clearinghouse for similar sized boilers indicated a range of 0.02 – 0.25 pound per million Btu heat input. Most of the limits are in the range of 0.02 – 0.048 pound per million Btu heat input. The PM emission limit as contained in the Industrial-Commercial-Institutional NSPS requirements, at 40 CFR 60.43b(2), is 0.10 pound per million Btu heat input, which is measured using EPA's Method 5, and is "front half" particulate. This emission limit in the NSPS does not include condensable particulate. Nonetheless, NMU is proposing a total particulate (filterable and condensable) limit of 0.030 pound per million Btus heat input.

This level of emissions is considered to be BACT for this process and meets the limit established in the NSPS. The emission limit of 0.030 pound per million Btus heat input results in potential emissions of 6.2 lb/hr and 26.9 ton/year while firing 100% wood due to higher heat input. Because NMU has chosen an emission limit per the Level 2 procedure of Op Memo 20, and that there are sufficient determinations in EPA's RACT/BACT/LAER Clearinghouse, no further analysis for PM BACT is necessary.

5.3 SULFUR DIOXIDE (SO_2)

SO_2 is emitted as a result of the presence of sulfur in the fuel being combusted. Typically, sulfur is present in fuels, including natural gas, wood, coal, lignite, waste materials, etc, but in varying degrees. As an example, pipeline quality natural gas and wood are lower in sulfur content than coal fuels, and some ranks of coal have lower sulfur contents than other coal fuel ranks.

The sulfur present in the fuel is released during the combustion process and combines with oxygen at the temperatures present in the combustion zone to form sulfur oxides. The sulfur oxides are primarily SO_2, with some SO_3.

Boilers that are required to control SO_2 emissions will do so using one of three primary methods. These methods consist of post-combustion and in-situ dry flue gas desulfurization utilizing adiabatic injection of lime slurry in a scrubber down-stream of the combustion zone where the exhaust gases do not become saturated, a wet process utilizing post-combustion and post PM control that incorporates a saturated system where the exhaust gases are cooled below the saturation point, and injection of limestone into the bed of a boiler that utilizes either a bubbling or fluidized bed where combustion is on-going. A more detailed description of these types of control is provided in the next three paragraphs.

Dry Scrubber – Flue Gas Desulfurization

SO_2 emissions control using dry scrubber control prior to a PM control device consists of a tower where a certain amount of slacked limestone (hydrated calcium oxide) is injected into the tower. The amount of injection is controlled such that the exhaust gases do not become saturated (adiabatic cooling). The SO_2 reacts with the lime slurry to produce calcium sulfate, also known as gypsum. Saturation of the exhaust gases prior to the fabric filter would plug up the fabric filter, which is unacceptable. Control efficiencies with this type of control range from 70 to 95%, depending on the concentration of SO_2 in the exhaust gas and ratio of slurry to SO_2.

Wet Scrubber – Flue Gas Desulfurization

Another process uses a saturated method of controlling SO_2. This type of control is typically located downstream of the PM control device such that the saturated exhaust gas does not interfere with the effectiveness of the PM control device, such as the fabric filter proposed for NMU's CFB boiler. These types of control use a packed tower while voluminous quantities of alkaline slurry are pumped into the tower. The SO_2 reacts with the hydrated calcium oxide and produces calcium sulfate, which is commonly referred to as gypsum. The resulting gypsum then can be sold or recycled to produce wallboard for the construction industry. These wet type SO_2 control devices typically result in 80 to 99% control of the potential SO_2 emissions, depending on the concentration of SO_2 in the exhaust gas, and ratio of slurry to SO_2.

Limestone – Co-Firing

A third type of control uses limestone added to the fluidized bed of the CFB boiler. Limestone, which is calcium carbonate, is added to the bed of the CFB boiler at a particular ratio depending on the required control necessary. At the temperature of the boiler, the limestone is calcined and converted to calcium oxide because the carbon dioxide that is driven off of the calcium carbonate. The SO_2 then reacts with the calcium oxide. Using this type of control removes the SO_2 from the exhaust gas stream beginning with the fluidized bed, and allows more residence time for the lime and calcium to react together prior to the PM control device. This method achieves 80 to 95% control of the potential SO_2 emissions. The resulting calcium sulfate is removed from the fluidized bed periodically.

The proposed SO_2 emissions will meet the requirements of NSPS Subpart Db for a control efficiency of 92% of the potential SO_2 emissions from higher sulfur bituminous coal, and 90% of the potential SO2 emissions from lower sulfur western coal, with a maximum allowed limit of 1.2 pound per MM Btus heat input.

5.3.1 Proposed BACT Emission Limit

NMU will be utilizing limestone injection into the CFB to control SO_2 emissions from the combustion of solid fuels, including western and eastern coals. The proposed use of limestone injection is considered BACT for this process.

The nation-wide BACT range of emission limits for SO_2 is 0.09 - 1.6 lb/MMBtu heat input. Most of the limits are in the range of 0.13 - 0.5 lb/MMBtu heat input. The NSPS Subpart Db limits SO_2 emissions to no more than 0.20 lb/MMBtu, or achieve a control efficiency of at least 92% with an emission limit of no more than 1.2 lb/MM Btu. Both of these requirements are based on a 30-day rolling average.

NMU is proposing a maximum SO_2 emission limit of 0.475 pound per million Btu heat input, and this is within the nation-wide range of accepted SO_2 emissions that represent BACT. This limit represents using solid fuel with a maximum sulfur content of 3.5%, by weight, and using limestone added to the bed of the CFB boiler.

This emission limit is equivalent to potential emissions of 87.8 lb/hr and 384.5 ton/year. Because NMU has chosen to use Level 2 of Op Memo 20, and that there are sufficient determinations in EPA's RACT/BACT/LAER Clearinghouse, no further analysis for SO_2 BACT is necessary.

5.4 NITROGEN OXIDES (NO_x)

NO_x is emitted as a result of nitrogen in the fuel being burned (referred to as fuel NO_x), and nitrogen and oxygen in the combustion air that forms NO_x due to disassociation of diatomic nitrogen and oxygen in the air at the flame temperature (referred to as thermal NO_x). The nitrogen oxides are primarily emitted as nitrogen oxide (NO).

NO_x is controlled by using several techniques; either alone, or in conjunction with both internal and external technologies. New boilers implement modern state-of-the-art combustion techniques that minimize both flame temperature and available nitrogen in the combustion air. Add-on control techniques include the use of injecting ammonia or urea into the exhaust gases at the correct exhaust gas temperature, which is known as selective non-catalytic reduction (SNCR). Technology has also been developed to include a catalytic converter in the exhaust gases downstream of the ammonia/urea injection system that further reduces NO_x from the exhaust gas stream. This is known as selective catalytic reduction (SCR). NMU is proposing to use SNCR in addition to the CFB, where low combustion temperatures inherently limit the formation of NO_x, as BACT for NO_x.

5.4.1 Proposed BACT Emission Limit

From the RBLC, the nation-wide BACT range of emission limits for NO_x is 0.15 - 0.7 lb/MMBtu heat input. Most of the limits are in the range of 0.15 - 0.35 lb/MMBtu heat input. The NSPS Subpart Db limits NO_x emissions to no more than 0.6 lb/MMBtu. The NSPS emission limit is based on a 30-day rolling average.

NMU is proposing a NO_x emission limit of 0.10 lb/MMBtu heat input. This is more stringent than the nation-wide range of NO_x emissions that represent BACT for the proposed size boiler, as contained in the RBLC.

5.5 CARBON MONOXIDE (CO)

Carbon monoxide is emitted from the CFB boiler as a result of incomplete combustion. Factors affecting the formation of CO include the oxygen-to-fuel ratio, combustion temperature, residence time, and turbulence (or mixing) of the combustion gases. In addition to the formation of CO, incomplete combustion also leads to increased emissions of particulate matter, including particulate metals, volatile organic compounds, and hazardous air pollutants. Therefore, methods employed to reduce or control emissions of CO tend to reduce emissions of other pollutants as well.

There are two available control technologies for controlling CO emissions from a CFB boiler: (1) catalytic oxidation and, (2) efficient combustion. Catalytic oxidation is a post-combustion CO reduction technique that uses a catalyst to convert CO to CO_2. Efficient combustion is a direct result of the design and operation of a boiler.

Catalytic Oxidation

Catalytic oxidizers treat exhaust gas from a combustion device utilizing a catalyst bed, typically a media-supported film of precious metals, such as platinum/rhodium, where oxidation of CO to CO_2 takes place. Depending on catalyst formation, the reaction can occur over a temperature range of approximately 450 to 1200° F. The amount of CO oxidation (or conversion) will depend on several factors, including operating temperature, gas composition, and pressure drop across the catalyst bed.

To date, oxidation catalysts have not been used for coal-fired boilers. Catalytic oxidation has several serious technical problems related to the use of coal firing, including:

- Catalyst fouling and poisoning by sulfur, flyash and lime.
- Low excess oxygen levels in the flue gas.
- Low temperature levels of the flue gas.

Typically, vendors are not willing to offer catalytic oxidizers due to the issues stated above. Furthermore, catalytic oxidizers are nonselective and will oxidize other compounds. The presence of sulfur oxides will result in the formation of SO_3, which will in turn combine with moisture in the gas stream to form H_2SO_4 mist.

Lastly, the short catalyst life caused by fouling and poisoning would result in a significant and ongoing generation of catalyst waste that would most likely be classified as a hazardous waste. For these reasons, and because oxidation catalysts have never been used or demonstrated in practice on coal-fired boilers, catalytic oxidation is not considered a technically feasible control option for CO for the proposed CFB boiler.

Efficient Combustion

Because CO emissions are a function of combustion operating conditions; the most direct approach for reducing these emissions is to maximize combustion efficiency. Maximizing combustion efficiency must be balanced with the potential increase of NO_x emissions that could occur when combustion efficiency is associated with high chamber temperatures. Modern combustion controls are able to balance this anomaly; i.e., reduce CO with a minimal resulting NO_x emission increase.

5.5.1 Proposed BACT Emission Limit

The nation-wide BACT range of emission limits for CO is 0.022 - 1.8 lb/MMBtu heat input. Most of the limits are in the range of 0.18 - 0.44 lb/MMBtu heat input. There is no emission limit for CO in any Michigan or federal air pollution control rules or regulations that would apply to the proposed solid fuel fired boiler.

NMU is proposing a CO emission limit of 0.17 pound per million Btu heat input, and this is within the nation-wide range of accepted CO emissions that represent BACT. This emission limit will be achieved through the use of modern combustion control technology.

5.6 VOLATILE ORGANIC COMPOUNDS (VOC)

Although the proposed CFB boiler is not subject to the requirement of BACT pursuant to the PSD regulations, Michigan's Rule 702(a) requires implementing BACT for VOC emissions from new or modified sources of VOC.

The new CFB boiler will employ state-of-the-art combustion techniques that will limit the potential emission of organic compounds. Organic compounds consist of many forms, and are primarily generated from incomplete combustion.

Installations of add-on control devices such as a thermal oxidizer or catalytic oxidizer are not considered to be acceptable control alternatives based on economic, environmental and energy purposes. Furthermore, these types of control have not been added to control organic and CO emissions from solid fuel fired boilers.

Boilers control potential organic compound emissions by implementing good combustion practices that include proper temperature, adequate mixture of organics with oxygen in the combustion air, and enough residence time to achieve oxidation of the organics inside the furnace. Therefore, the use of state-of-the-art combustion controls represents BACT for VOCs.

The VOC emissions from the proposed CFB boiler are not subject to the BACT requirements of the PSD regulations. The VOC emissions are required to be controlled using BACT pursuant to the requirement in Michigan's Rule 702(a). NMU is proposing a Rule 702(a) BACT limit of 4.0 lb/hr and 17.6 ton/yr.

5.7 TOXIC AIR CONTAMINANTS (TACs)

Rule 224 of Michigan's Rules for Air Pollution Control requires Best Available Control Technology for Toxics (T-BACT) for compounds identified as toxic air contaminants (TACs). TAC's also include hazardous air pollutants (or HAPs) that, for boilers subject to the MACT for industrial, commercial, and institutional boilers, are regulated by the MACT standards of 40 CFR Part 63. The proposed boiler is not subject to these requirements because NMU is a minor source of HAPs.

The majority of the TACs emitted will be in the form of solids (such as metals), and some toxics will likely be emitted as a gas. The gaseous emissions would consist of both organic and acidic compounds with some vapor phase mercury.

Following are discussions regarding T-BACT for the various forms (or groupings) of TACs.

5.7.1 Metals (Except Mercury)

Metals are emitted as a result of their presence in the fuel(s). The metals are contained in the ash from the solid fuel, and are in particulate form. Some of the ash is carried out of the boiler in the form of flyash, and some remains in the bottom of the boiler known as bottom ash. Some of the ash remains at the bottom of the boiler and is removed when the fluidized bed is circulated out of the boiler. The flyash remains in the exhaust gas stream and is removed with a downstream particulate control device. NMU will be installing a baghouse (or fabric filter), which will clean the exhaust gases of the particulate matter. The PSD BACT analysis for PM was addressed in Section 5.1 above.

Baghouses and electrostatic precipitators are considered the best method of removing PM from solid fuel fired boiler exhaust gas streams, and are generally considered to be the best available control technology for removing suspended TACs in the form of PM. See Section 5.1 above for a description regarding PM control devices used by solid fuel fired boilers.

The use of a fabric filter represents BACT for PM emissions, and Rule 224 of Michigan's Rules for Air Pollution Control state that the use of PM BACT represents T-BACT for TACs as PM.

5.7.2 Organic Compounds

The new CFB boiler will employ state-of-the-art combustion techniques that will limit the potential emission of organic compounds. Organic compounds consist of many forms, and are primarily generated from incomplete combustion.

Installations of add-on control devices such as a thermal oxidizer or catalytic oxidizer are not considered to be acceptable control alternatives based on economic, environmental and energy purposes. Furthermore, these types of control have not been added to control organic and CO emissions from solid fuel fired boilers.

Boilers control potential organic compound emissions by implementing good combustion practices that include proper temperature, adequate mixture of organics with oxygen in the combustion air, and enough residence time to achieve oxidation of the organics inside the boiler's furnace box. Therefore, the use of state-of-the-art combustion controls represents T-BACT for organic TACs.

The use of state-of-the-art combustion techniques represents BACT for VOC emissions, and Rule 224 of Michigan's Rules for Air Pollution Control state that the use of VOC BACT represents T-BACT for organic TACs in the form of VOC.

5.7.3 Acid Gas Emissions

Acid gases result from the presence of chlorine, sulfur and fluorine in the fuels combusted. These emissions are primarily hydrogen chloride (HCl), hydrogen fluoride (HF) and sulfuric acid mist (H_2SO_4).

Control of these pollutants will be accomplished through the use of limestone addition to the CFB boiler bed, which is a proven control technique for controlling acid gases from CFB boilers. Sulfuric acid mist, HCl and HF are captured by reacting with the limestone (which is converted to calcium oxide at the temperature of the bed in the CFB boiler), prior to becoming airborne in the exhaust gases.

Therefore, the use of limestone in the CFB boiler bed represents T-BACT for controlling potential acid gas emissions.

5.7.4 Mercury (Hg)

Emissions of Hg from the proposed CFB boiler are subject to the Michigan-specific requirements for T-BACT. MDEQ rules governing T-BACT require a thorough control technology analysis for TACs with respect to energy, environmental, and economic impacts.

Many existing technologies and systems used for control of PM, SO_2, and NO_x have been demonstrated to have significant co-benefits for control of mercury emissions. Specifically, use of flue gas desulfurization (FGD), fabric filters, and selective (and non-selective) catalytic reduction. In addition, certain grades of coal have been shown to inherently reduce emissions of Hg due to the constituents within the coal. Recent information available from EPA reports indicates that bituminous coals tend to have significantly lower mercury emissions in the flue gas due to the presence of chlorine in the coal ash. Studies have shown that the mercury has an affinity to combine with the chlorine in bituminous coal to form mercuric chlorides that are then captured in the downstream particulate collection device. The only demonstrated and commercially available add-on control technology specifically designated for control of Hg from combustion of coal is activated carbon injection (ACI).

NMU will be utilizing a blend of subbituminous and bituminous grade coals and virgin wood with desulfurization occurring inside the furnace through co-firing of limestone while firing coal fuel, and add-on controls consisting of SNCR and fabric filter. EPA has stated in both the preamble to 40 C.F.R. Part 60 Subparts Da and HHHH, and summary to the reconsideration of the clean air mercury rule (CAMR) that the best demonstrated technology for mercury control while firing bituminous coal is a fabric filter, flue gas desulfurization, and, to a lesser extent, selective non-catalytic reduction. Several test studies have shown that removal efficiencies for Hg of at least 80% are readily achieved through such a configuration. In this instance, the proposed limit of 3.0 E-6 lb/MMBtu represents approximately 70% Hg removal when considering a maximum Hg content in coal of 0.1 ppmw on a wet basis.

Nationwide Existing Controls

Some of the gaseous (vapor) mercury present in the exhaust gas stream will adsorb to fly ash and other PM and will be removed by the PM control device. While removal efficiencies range from 0 to 98 percent, data from plants burning only bituminous or a blend of subbituminous and bituminous coals have a much higher removal of mercury. In this project, the PM control device will be a fabric filter.

In addition, divalent mercury (Hg^{2+}) compounds (sometimes referred to as reactive gas mercury or RGM) have been shown to be reduced through the use of FGD devices, including both wet and dry systems, especially for plants firing bituminous coals. The reasons stem from the presence of chlorine in the coal, and the higher concentration of chlorine in bituminous coals. Bituminous coals tend to have higher levels of chlorine and unburned carbon available for removal of Hg. In this scenario, elemental Hg (Hg^{o}) is oxidized to form Hg^{2+} due the presence of HCl, which can then be captured by the baghouse.

Finally, the use of SNCR for control of NO_x has been proven to reduce Hg in the flue gas stream as well, since a portion of the elemental Hg is catalytically oxidized to divalent mercury as it passes through the SNCR unit. The uses of these three technologies in field tests have shown that mercury levels can be reduced by 80% – 90%.

Activated Carbon Injection (ACI)

In ACI systems, powdered activated carbon (PAC) sorbent is injected into the flue gas upstream of the PM control device. Activated carbon is a specially treated carbon that has been exposed to temperatures of 800 – 900 degrees Celsius. It becomes "activated" such that the carbon is very porous and has a high surface area. The pores allow vapor-phase mercury to adsorb to the carbon, which is then collected in the downstream PM control device.

The performance of activated carbon is related to physical properties including surface area, pore size, and particle size distribution. Mercury capture is increased with increased pore size and surface area. A large drawback to the use of ACI is the "poisoning" of the fly ash and reduced ability to sell the ash to other industries. To minimize the impact on the fly ash, one option is to install a TOXECON® system. In this system, PAC is injected downstream of the primary PM collection device, which is used to collect the fly ash, but upstream of a polishing baghouse that vents to the ambient air. The polishing baghouse or Compact Hybrid Particulate Collector (COHPAC) installed downstream of the sorbent injection is specifically designed to capture the mercury contaminated particulate.

Proposed Hg BACT Emission Limit

The facility is proposing a Hg emission limit of 3.0E-06 lb/MMBtu, which, coincidentally, is equal to the Boiler MACT limit. To date, the use of ACI has not been proven to significantly increase the Hg removal beyond what NMU is currently proposing.

Instead, the Hg limit of 3.0E-06 lb/MMBtu is consistent with the level of control currently being achieved in some CFBs burning bituminous coals. This level of emissions is considered the T-BACT limit for this process and exceeds many recently issued permits for coal-fired boilers issued in the past several years.

Instead, the Hg limit of 3.0E-06 lb/MMBtu is consistent with the level of control currently being achieved in some CFBs burning bituminous coals. This level of emissions is considered the T-BACT limit for this process and exceeds many recently issued permits for coal-fired boilers issued in the past several years.

6.0 AMBIENT IMPACT ANALYSIS

As discussed in Sections 1 through 5, Northern Michigan University (NMU) is proposing to install a new coal/wood fired boiler at the main campus power facility in Marquette, Michigan. NMU is currently not a major source because its potential to emit of any criteria pollutant is limited to 99.9 tons per year (tpy) by federally enforceable conditions of Permit No. 126-05. The facility, however, will become a major source for PSD purposes upon initial startup of the new CFB boiler, as the CFB boiler has the potential to emit 100 tpy or more of any criteria pollutants and 10 tpy or more of a single HAP. This section presents an air quality modeling analysis, which demonstrates that the emissions from the power facility (including CFB boiler emissions) will comply with the applicable state and federal ambient air quality standards.

The power facility will be subject to the federal PSD regulations because the new CFB boiler is considered a major stationary source under 40 CFR Part 52.21. The potential emissions of SO_2 and CO exceed the PSD major source thresholds, and the potential emissions of PM_{10} and NO_x exceed the significant emission rates defined in the PSD regulations. As required by the PSD regulations and MDEQ-AQD, the emissions of SO_2, PM_{10}, CO and NO_x must be included in a compliance demonstration analysis to show that the emissions of these pollutants will not cause or contribute significantly to the deterioration of the ambient air.

Criteria pollutant modeling was conducted for SO_2, PM_{10}, and NO_x in order to demonstrate compliance with the applicable PSD Class II Increments and National Ambient Air Quality Standards (NAAQS). In addition, modeling has been conducted for SO_2, PM_{10}, and NO_x to demonstrate compliance with 80% of the applicable PSD Class II Increments per MDEQ-AQD policy that no single facility is allowed to consume more than 80% of the applicable Increment standards, in order to allow future industrial growth. Modeling has been conducted for CO in order to demonstrate compliance with the applicable NAAQS. As CO does not have any established PSD Increment standards, Increment modeling is not required for CO emissions.

The ambient impact analysis for criteria pollutants was initially conducted by modeling the potential emission increases from the affected sources under the proposed modification in order to determine the corresponding impacts. These impacts were determined for the pollutants with emissions greater than the PSD significant emission rates (i.e., SO_2, PM_{10}, CO and NO_x), and were compared to the appropriate significance impact levels (SIL) as stipulated by the U.S. EPA.

The results of the initial modeling indicate that the CO, PM_{10}, and NO_x emissions from the NMU power facility will not result in maximum ambient impacts greater than the appropriate SILs, while the SO_2 emissions from the NMU power facility will result in maximum ambient impacts that are greater than the appropriate SILs. Therefore, a more detailed modeling analysis has only been conducted to demonstrate that the SO_2 emissions from the proposed modification will not violate the applicable PSD Class II Increments and NAAQS. This analysis includes all of the NMU power facility sources and off-site sources, as appropriate for each analysis. Because the results of the initial modeling for CO, PM_{10}, and NO_x for the proposed modification indicated that these emissions will not result in maximum ambient impacts that are greater than the appropriate SIL, more detailed modeling is not required for CO, PM_{10}, and NO_x.

The results of the criteria pollutant modeling analyses demonstrate that the SO_2, PM_{10}, and NO_x emissions from the modification and existing facility are in compliance with the PSD Increment and NAAQS and that the CO emissions from the facility are in compliance with the NAAQS.

Based upon AP-42 and other emission factor sources, the new CFB boiler is expected to emit toxic air contaminants (TACs) that consist of various trace metals and organic and inorganic compounds. These TAC emissions have been included in a modeling analysis to demonstrate that the proposed installation of the CFB boiler at the NMU power facility will comply with the ambient impact levels of TACs established pursuant to Michigan's air toxics regulations. These regulations are codified as Michigan Rules 225 through 232 and establish, on a compound-by-compound basis, the maximum ambient concentration that emissions from a proposed modification or facility may produce off the source's secured property.

The predicted ground level concentrations of the TAC emissions have been compared to the appropriate health based screening levels of Michigan Rule 225. The results of this analysis indicate that the emissions TACs will comply with Michigan Rule 225.

Section 6.1 describes the modeling methodology utilized in the criteria pollutant (i.e. CO, SO_2, PM_{10} and NO_x) and TAC ambient impact analyses, and Section 6.2 describes the NMU power facility (both the existing and the newly proposed expansion) and pertinent modeling parameters. Section 6.3 presents the modeled emission rates of CO, SO_2, PM_{10}, NO_x, and TACs, and the results of the air quality impact analysis are presented in Sections 6.5 and 6.6.

6.1 MODELING METHODOLOGY

The primary objective of any air quality analysis is to demonstrate compliance with all applicable state and federal air quality standards. The federal standards include: (1) The National Ambient Air Quality Standards (NAAQS), and (2) Prevention of Significant Deterioration (PSD) Increments – both of which pertain to criteria pollutant emissions. The MDEQ has further incorporated a policy whereas no single source may consume greater than 80% of the PSD Increment standards applicable to any criteria pollutant. Additionally, the MDEQ has rules pertaining to the impacts of toxic air contaminant (TAC) emissions.

Tables 6-1 through 6-3 list the U.S. EPA CO, SO_2, PM_{10}, and NO_x impact standards – Significant Impact Levels, PSD Allowable Increment, and NAAQS, respectively. In addition to the modeling discussed in this section, a visibility analysis was done for Class I areas since the facility is within 200 km from the nearest PSD Class I areas (Seney National Wildlife Refuge). The visibility modeling is discussed in Section 7. The criteria pollutant modeling was conducted in order to demonstrate that the proposed project at the NMU powerhouse would comply with the allowable ambient impact concentrations listed in Tables 6-1 through 6-3.

Table 6-1. Significant Impact Levels for Criteria Pollutants

Pollutant	Averaging Period	Concentration (µg/m³)
CO	8-Hour	500
	1-Hour	2,000
SO_2	Annual	1
	24-Hour	5
	3-Hour	25
PM_{10}	Annual	1
	24-Hour	5
NO_x	Annual	1

Table 6-2. PSD Allowable Increments (µg/m³)

Pollutant	Averaging Period	PSD Increment Standards (µg/m³)	
		Class I	Class II
SO_2	Annual [2]	2	20
	24-Hour [1]	5	91
	3-Hour [1]	25	512
PM_{10}	Annual [2]	4	17
	24-Hour [1]	8	30
NO_x	Annual	2.5	25

[1] High 2nd High over a five-year period.
[2] Annual arithmetic mean.

Table 6-3. National Ambient Air Quality Standards (NAAQS)

Pollutant	Averaging Period	National Ambient Standards ($\mu g/m^3$)	
		Primary	Secondary
CO	8-Hour [1]	10,000	n/a
	1-Hour [1]	40,000	n/a
SO_2	Annual [2]	80	n/a
	24-Hour [1]	365	n/a
	3-Hour [1]	n/a	1,300
PM_{10}	Annual [2]	50	50
	24-Hour [3]	150	150
NO_x	Annual [2]	100	100

[1] High 2nd High.
[2] Annual arithmetic mean.
[3] High 6th High over a five-year period.

6.1.1 Modeling Background

In promulgating the 1977 Clean Air Act Amendments (CAAA), Congress specified that certain increases, or *increments*, in ambient air quality pollutant concentrations above an air quality baseline concentration level for TSP would constitute significant deterioration. The magnitude of the increment that cannot be exceeded depends on the classification of the area in which a new source (or modification to an existing source) will have an ambient air impact. Three classifications were designated based on criteria established in the CAAA. Initially, Congress promulgated areas as Class I (international parks, national wilderness areas, memorial parks larger than 2,024 hectares [ha] [5,000 acres], and national parks larger than 2,428 ha [6,000 acres]) or Class II (all other areas not designated as Class I). No Class III areas, which would be allowed greater deterioration than Class II areas, were designated. However, the states were given the authority to re-designate any Class II area to Class III status provided certain requirements were met. The U.S. EPA then promulgated, as regulations, the requirements for classifications and area designations.

The approach to these analyses generally begins by determining the impacts of the proposed facility or modification alone. If the impacts of the proposed facility or modification are below specified significance levels, no further study of that pollutant-averaging time combination is needed. These "significant impact levels" or SILs were presented in Table 6-1. If the impacts of the proposed facility or modification are found to be significant (i.e. greater than the SILs), further analysis considering all existing facility sources, other nearby facilities, and natural background concentrations is required for the compliance demonstration.

To accomplish these objectives, air quality impact modeling analyses were conducted for the proposed modification. All modeling analyses were conducted in a manner consistent with U.S. EPA guidance and standard practices. Guidance contained in EPA manuals and user's guides was followed. This includes the use of regulatory default options for the selected model.

On November 9, 2005, the U.S. Environmental Protection Agency promulgated the use of the AMS/EPA Regulatory Model Improvement Committee (AERMIC) Model (AERMOD) for all regulatory applications requiring an ambient impact demonstration. As part of the regulation, the U.S. EPA has granted sources a 12-month grace period to facilitate the transition from the use of ISCST3 to AERMOD. As this grace period concluded on November 9, 2006, AERMOD has been used to predict environmental impacts from the emissions of both criteria pollutants and toxic air contaminants (TACs).

AERMOD is a steady-state Gaussian model capable of handling multiple source inputs and producing both concentration and deposition impacts from point, area, volume, and open-pit sources. AERMOD is also capable of handling numerous source configurations, building inputs, receptor grids and elevated terrain.

6.2 MODEL SELECTION AND MODELING PARAMETERS

As stated, the AERMOD dispersion model (U.S. EPA source code version 04300) was used for all dispersion modeling to obtain refined impact predictions for both short-term and long-term ambient air concentrations. Procedures applicable to the AERMOD dispersion model specified in the U.S. EPA's GAQM were followed in conducting the refined dispersion modeling. The

GAQM is codified in Appendix W of Chapter 40, Code of Federal Regulations (CFR) Part 51 (updated as of November 9, 2005 to include the promulgation of AERMOD).

A description of the various modeling parameters and concerns is presented in the remainder of this section.

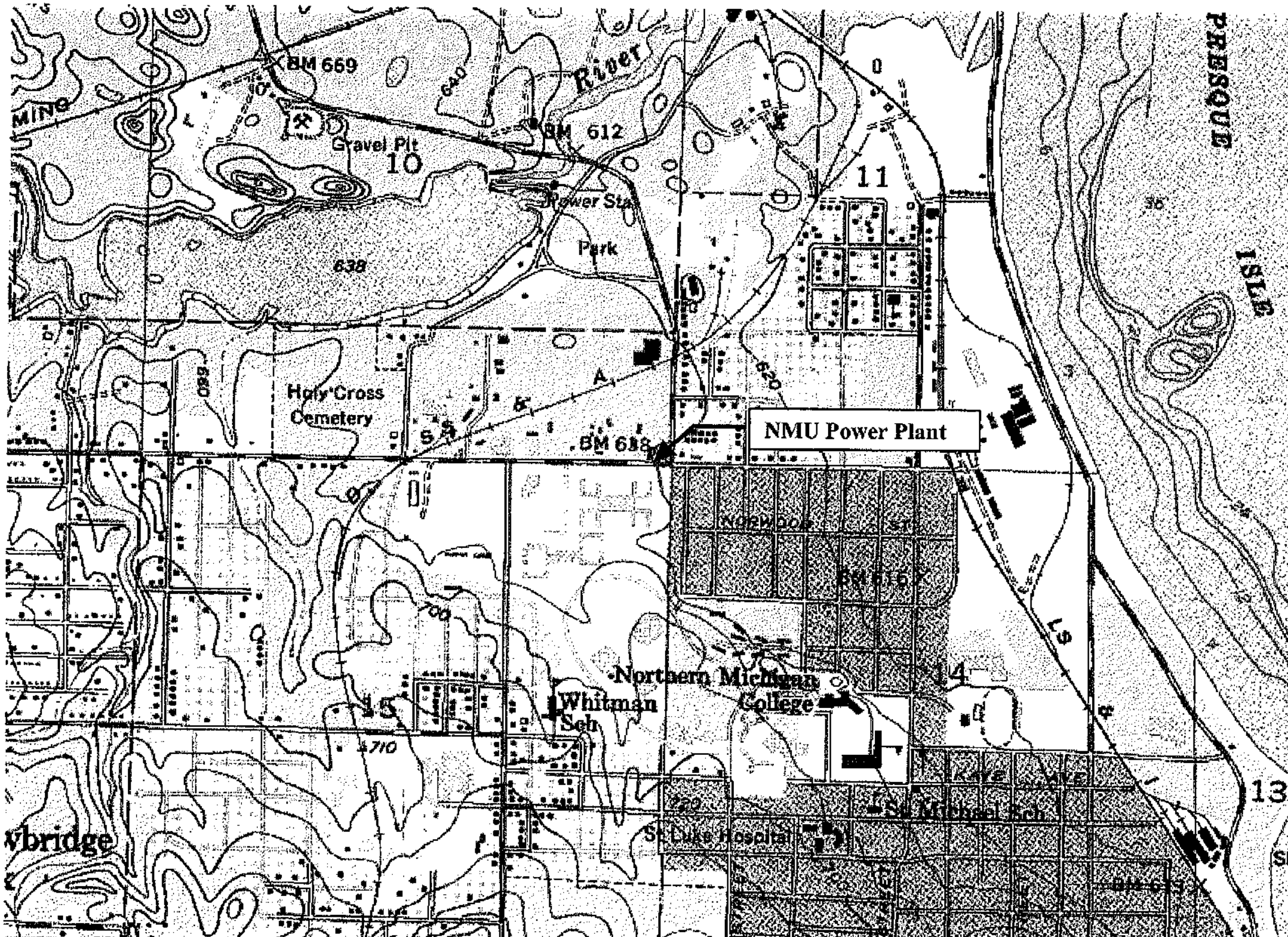
Source Description

The existing powerhouse operations (Ripley Heating Plant) are located toward the northern part of the Northern Michigan University campus, to the northwest of the intersection of Wright Street and Sugar Loaf Avenue, in Marquette, Marquette County, Michigan 49036. The existing facility operates as SRN M3792, under PTI No. 126-05.

The existing facility, as permitted under PTI No. 126-05 is nearing completion of construction to install and operate a total of 3 boilers capable of firing both natural gas and No. 2 fuel oil. The existing powerhouse operations will all be contained within one primary structure, the Ripley Heating Plant building.

The new CFB boiler and steam turbine will be contained within a new building that will be constructed adjacent to the Ripley Heating Plant, directly to the west. The site maps of Appendix A provide an overall view of the NMU campus, and provide detailed drawings of the new equipment and power plant area. The new boiler and turbine building will be rectangular in shape and measure approximately 64 feet east to west, and approximately 155 feet north to south. In addition to the new boiler housing, fuel handling operations and a baghouse structure will also be constructed as a part of the new project.

All existing and new building structures have been incorporated into the modeling analysis. Figure 6-1 presents the power plant and NMU campus location on a topographic map excerpt (Marquette 7.5-Minute Quadrangle). In regards to overall site topography, NMU is located in an area that has some significant changes in elevations, largely due the campus be located near Lake Superior. The general terrain increases to the south and west, with sharp increases in elevations to the southwest within about 1.5 km of the power plant. The terrain gently increases to the north and remains relatively flat to the east, with a gently decreasing slope towards Lake Superior.



Note: The topographic excerpt is from the Marquette 7.5-min. U.S.G.S. quadrangle. The scale of the map is 1.0" = 1,414 ft (431 m).

Figure 6-1. Northern Michigan University Campus Power Plant Site Map

Prevailing elevations are about 640 feet above sea level in the vicinity of the NMU power plant, and fall to about 620 feet to the east of the facility and rise quickly to about 900 feet within about 3.5 km in the southwest direction.

***Terrain Considerations* (AERMAP)**

AERMOD requires the use of an elevated terrain data file for use in establishing elevations for all sources, buildings and receptors. The AERMAP pre-processor is used to process digital elevation maps with location points for all sources, structures, and receptors. 7.5-minute digitized topographic files for the area surrounding the facility were used as input to the AERMAP pre-processor to obtain elevations and hill heights, which were then imported into the AERMOD model. The following North American Datum 1927 (NAD27) based Digital Elevation Models (DEMs) were incorporated into the AERMOD model via the AERMAP pre-processor:

- Marquette
- Marquette OE East

The elevated terrain option was employed for all model runs for the ambient impact analysis. Electronic copies of the DEM files are included in Appendix C for informational purposes.

Land Use Analysis

Another important modeling parameter is the land use classification (rural or urban). A technique was developed by Irwin (1978) to classify a site area as either rural or urban for purpose of using rural or urban dispersion coefficients [refer to Section 8.2.3 of 40 CFR Part 51, Appendix W]. The classification can be based on either average heat flux, land use, or population density within a 3 km radius from a plant site. The rural/urban classification based on land use is as follows:

> Using the land use typing scheme established by Auer, an urban classification of the site area requires more than 50 percent of the following land use types: heavy industrial, light/ moderate industrial, commercial, and compact residential (single and multi-family). Otherwise, the site area is considered rural.

The NMU campus is located in the northern section of the city of Marquette in the mid-eastern portion of Marquette County. While the area within 3 kilometers of NMU does contain some commercial operations and residential areas, the overall surrounding area is predominantly rural in nature and has not historically been considered by the Michigan AQD to be classified as urban. Therefore, the land use has been treated as rural and all modeling has been conducted with rural dispersion coefficients.

Meteorological Data

This modeling analysis has been conducted to demonstrate compliance with the applicable federal ambient standards for CO, SO_2, PM_{10} and NO_x, and the applicable Michigan AQD health based screening levels (Rule 225) for the TACs that may be emitted from the new boiler and existing operations. Actual surface meteorological (MET) data is required for use in the AERMOD modeling system. Raw meteorological data obtained in the SAMSON format can be readily obtained from a number of sources.

Prior to use with the model, the meteorological data must be processed through the AERMET pre-processor with certain site characteristics, including vegetative cover, friction velocity, etc. As part of processing the MET files, the user must specify certain site-specific surface features and characteristics and can, therefore, tailor any MET file to the site-specific conditions at the facility site. The AQD has determined representative surface characteristics and has prepared pre-processed "AERMOD-ready" MET data for use in AERMOD modeling.

The AQD prepared and supplied pre-processed, "AERMOD-ready" MET data (i.e. data processed using AERMET) the Sawyer International Airport (Station # 94836) located in Gwinn, MI. The 5-year data set utilized in this modeling analysis covers the years 2001 through 2005, and the main surface station height is given as 372 meters above Mean Sea Level (MSL). The upper air station processed with this data is Green Bay (Station # 14898) for the years 2001-2005.

The full five-year data set (2001-2005) was utilized for criteria pollutant modeling, while only the most recent year of data (2005) was required for the TAC modeling analysis.

Building Downwash

Prior to performing the dispersion analysis, the new and existing facility baghouse exhaust stack heights were compared to their Good Engineering Practice (GEP) heights. A GEP stack height is the stack height at which building downwash no longer occurs. Dispersion models use different calculation methods depending upon whether a given stack is GEP height or higher. The GEP value is defined as the building height (H_b) plus 1.5 times the lesser (L) of the building height and the maximum projected width (MPW) of the building.

The building layout of the existing Ripley Heating Plant facility and the new power plant consists of multiple structures of varying dimensions. The two predominant structures that influence what is considered GEP for all of the facility stacks are the new boiler building and the existing Ripley Heating Plant. The Ripley Heating Plant is 79 feet tall, and the new boiler building will be approximately 110 feet tall. GEP has been determined through the Lakes Environmental AERMODView software and indicates that all of the facility stacks are lower than their respective GEP stack heights, therefore the effects of building downwash must be addressed within the modeling analysis.

The U.S. EPA's Building Profile Input Program has been used to determine the downwash effects associated with the various buildings. The modeling building layout diagram included with the modeling support information in Appendix C identifies all structures included in the modeling analysis and their associated heights. In addition, it should be noted that the AERMOD model incorporates BPIP PRIME downwash, which provides more accurate downwash parameters than the former BPIP program provided in the ISCST3 model.

Cavity Calculations

Pursuant to current Michigan AQD modeling guidance, all modeling studies must address the cavity region and any associated pollutant concentrations for all of the stacks being modeled. The cavity region occurs immediately downwind from a given structure, and the dimensions are typically three times the lesser of the building height or projected width of a given structure. The Michigan AQD requires that the cavity region be addressed due to the greater turbulence and higher pollutant concentrations that are often encountered in these regions.

The AERMOD model has been used to conduct the modeling analysis, which employs PRIME downwash and calculates all pollutant concentrations occurring within the cavity region associated with a given stack/building configuration. Therefore, all pollutant concentrations occurring within any potential cavity regions have been addressed within the modeling analysis.

Modeling Analysis Receptor Grid

The southwest corner of the existing Ripley Heating Plant building **(refer to the Plot Plan of Appendix A)** has been designated as the internal Cartesian grid ordinate (0,0). As elevated terrain has been incorporated into the modeling analysis through the use of the AERMAP pre-processing program, and all coordinates were translated from an internal site coordinate system (based on the designated site ordinate) to NAD27 based Universal Transverse Meridian (UTM) coordinates to facilitate the incorporation of DEM terrain data.

The designated site ordinate has a UTM coordinate of Zone 16, Easting = 468,874.0 meters, and Northing = 5,156,608.0 meters.

As was indicated in the Modeling Protocol for this permit application (dated August 16, 2006), which has been reviewed and approved by the AQD, the following receptor grid configuration has been utilized for the dispersion modeling analysis:

- Fence Line Receptors: No fence line
- Near-field Cartesian Receptor Grid: Receptors were placed at 50 meter spacing outward to 1,500 m from the center of the facility sources (468,860.85 Easting; 5,156,653.92 Northing).
- Mid-field Cartesian Receptor Grid: Receptors were placed at 100 meter spacing from the boundary of the Near-field grid out to 3 km from the center point.
- Far-field Cartesian Receptor Grid: Receptors were placed at 250 meter spacing from the boundary of the Mid-field grid outward to 5 km. As a result, the overall grid occupies a 10.0 km by 10.0 km area. The southwest corner of the far-field grid in UTMs is (463,860.85 Easting, 5,151,653.92 Northing).

The combination of these receptor grids provides a more dense (50 m) grid close to the facility, while expanding the grid out 5 km in each direction from the facility center with wider receptor spacing (up to 250-m spacing). The use of this receptor grid configuration contains a total of 7,537 receptors. A graphical representation of the facility layout and the receptor grid used in the modeling analysis are contained in Appendix C.

Modeling Options

The modeling options employed during the CO, SO_2, PM_{10}, and NO_x, and TAC modeling analyses were elevated terrain, rural dispersion coefficients, and the AERMOD model's regulatory default options. The regulatory default options include the following model settings:

- Use stack-tip downwash (except for Schulman-Scire downwash)
- Incorporate the effects of elevated terrain
- Use the calms processing routine
- Use missing data processing routine
- Use upper-bound concentration estimates for sources influenced by building downwash from super-squat buildings
- Use a 4-hour half life for exponential decay of SO_2 for urban sources

6.3 NMU EMISSION RATES AND EXHAUST PARAMETERS

The following sections will present the modeled emission rates for the equipment associated with the new powerhouse and the existing Ripley Heating Plant, and present the source parameters for each NMU modeled emission source.

New Powerhouse Sources

Section 3 summarizes the CO, SO_2, PM_{10}, NO_x, and TAC emission rates from the proposed new powerhouse emission sources. CO, SO_2, NO_x and TACs will only be discharged from the new baghouse stack associated with this modification. PM_{10} will be emitted from the new CFB, along with some minor material handling and storage silos. Fugitive emissions resulting from coaling handling operations will be contained and controlled by limiting the on-hand supply of coal and through the use of a three-walled containment structure, and as such, fugitive PM_{10} is expected to be less than 1 tpy. Therefore, as the new CFB boiler baghouse stack is the only significant source of hourly PM_{10} emissions, it is the only new source of PM_{10} considered in the PM_{10} modeling analysis.

Table 6-4 presents the new CFB boiler baghouse stack modeled emission rates for each criteria pollutant in terms of the maximum pound per hour and the corresponding gram per second emission rates. The maximum emission rates have been determined on a worse case basis considering each type of fuel source (i.e., highest lb/hour rate from wood, coal, natural gas). The following calculation procedure was used to convert lb/hour emission rate to gram/second emission rates.

$$Emission\ Rate(g/sec) = \frac{Emission\ Rate,\ lb}{hour} \times \frac{hour}{3{,}600\ seconds} \times \frac{453.59\ grams}{lb}$$

For each pollutant with standards that have an annual averaging period, it was conservatively assumed that the maximum hourly emission rate would occur continuously (i.e. 24 hours per day and 365 days per year).

In addition to criteria pollutants, maximum hourly TAC emission rates were determined for each of the types of fuel that may be used in the new CFB boiler. The maximum hourly emission rates are presented in Table B-2 of Appendix B, and have been converted to gram per second emission rates for use in the TAC modeling analysis.

Table 6-4. New CFB Boiler Criteria Pollutant Emission Rates [1]

Pollutant	Maximum Hourly Emission Rate (lb/hour)	Modeled Emission Rate (gram/sec)
CO	34.85	4.39
SO_2	87.80	11.06
PM_{10}	6.15	7.75E-01
NO_x	20.50	2.58

[1] Based on worst-case emissions per fuel type.

Existing Ripley Heating Plant Sources

In order to conduct the PSD and NAAQS modeling analysis for the various criteria pollutants, emissions from existing sources at the NMU facility need to be quantified and accounted for as appropriate. The existing sources for the NMU facility consists solely of the equipment (3 fuel oil/natural gas fired boilers) installed at the Ripley Heating Plant.

In order to determine the past actual emissions (for use in determining PSD Increment modeling rates), reported emissions of the existing boilers were utilized and assumed to occur evenly over 8,760 hours per year. However, a PSD emission rate (in other words, a "net" emission rate calculated as future potential minus past actual) was only determined and modeled for PM_{10} emissions. For all other criteria pollutants, the future potential emission rates were used because they were either very similar to the "net" hourly emission rates or the pollutant impact from NMU was fairly low and modeling the future potential is conservative.

In order to determine maximum hourly emissions for NAAQS modeling purposes, a determination of maximum hourly emission rates was made by analyzing the expected operation of the existing boilers on either fuel oil or natural gas. For NAAQS modeling purposes, it was assumed that only 2 boilers would operate at any given time (at maximum capacity) and that the third boiler would only operate when the new CFB boiler was not in operation. Therefore, for NAAQS purposes, the existing boiler emission rates are based on only 2 boilers operating simultaneously with the new CFB boiler.

Table 6-5 presents the modeled emission rates for the existing Ripley Heating Plant boilers, which all exhaust from a common stack.

Table 6-5. Existing Ripley Heating Plant Criteria Pollutant Emission Rates [1]

Pollutant	Maximum Hourly Emission Rate (lb/hour)	Modeled Emission Rate (gram/sec)
CO	24.90	3.14
SO_2	86.18	10.86
PM_{10} – PSD Increment Rate	4.44	0.56
PM_{10} – NAAQS Rate	4.79	0.60
NO_x [2]	10.24	1.29

[1] All boilers exhaust from a single common stack. Except for PM_{10}, the emission rates presented represent the future potential maximum hourly emissions based on two of the three existing boilers operating simultaneously.

[2] The NOx emission rate has been determined based on the annual average emissions assuming that the existing equipment would be limited to 99.9 tpy of SO_2. At this limit, the boilers would have limited operation on fuel oil, with the balance of operation on natural gas. Therefore, annual NOx emissions would also be limited to approximately 44.9 tpy, which results in an annual average NOx emission rate of 10.2 lb/hr.

Stack Parameters – NMU Emission Sources

Table 6-6 presents the baghouse exhaust stack characteristics for both the new CFB boiler stack and for the existing Ripley Heating Plant stack, and includes: stack locations (based upon UTM coordinates) and parameters such as flow rate, temperature, and stack height and diameter. Both of these exhaust stacks will discharge unobstructed vertically to the ambient air.

Note that the exhaust stack diameter and height for the stack that exhausts the 3 boilers at the Ripley Heating Plant will be modified from the stack requirements in PTI No. 126-05.

Table 6-6. New CFB Boiler and Existing Boiler Exhaust Stack Characteristics

Baghouse Exhaust Stack	UTM Easting [1] (meters)	UTM Northing [1] (meters)	Stack Height (feet)	Exhaust Temp (°F)	Flow Rate [2] (ACFM)	Exit Velocity (m/s)	Diam (inches)
New CFB Boiler	468,853.5	5,156,684.2	165	325	86,300	15.51	72
Existing Stack [2]	468,868.2	5,156,623.6	160	300	47,234	12.22	60

1 For reference, the southwest corner of the Ripley Heating Plant building was taken as the site ordinate, and is located at the following UTM coordinate: Easting = 468,874 m, Northing = 5,156,608 m.

2 The existing stack currently has a diameter of 108 inches and a height of 150 feet. Upon installation of the new boiler, the stack will be modified to a diameter of 60 inches and a height of 160 feet.

6.4 OFFSITE SOURCES AND BACKGROUND CONCENTRATIONS

The CO, SO_2, PM_{10}, and NO_x modeling analyses have been conducted to demonstrate compliance with the applicable PSD Increments and NAAQS. Therefore, the PSD modeling must include appropriate off-site PSD Increment consuming sources, and the NAAQS modeling analyses must include all sources that the MDEQ-AQD considers to have significant impact areas (SIAs) that interact with the SIAs produced by the NMU sources. However, since only the emissions of SO_2 from NMU boilers result in ambient impacts greater than the applicable significant impact levels (SILs), conducting a detailed modeling analysis that includes off-site sources was only necessary to demonstrate compliance with the SO_2 standards.

MDEQ-AQD modeling personnel were consulted to provide a list of appropriate off-site sources for use in the PSD Increment and NAAQS modeling analyses. The off-site inventories were e-mailed to NTH Consultants on August 18, 2006. The listing supplied by the AQD indicated that there were no off-site sources for purposes of PSD Increment modeling for any of the pollutants (i.e. there are no PSD Increment consuming sources in the area near NMU, other than NMU itself), and therefore only provided sources that needed to be included in the NAAQS modeling analyses. Table 6-7 presents the off-site sources included in the SO_2 NAAQS modeling analysis. The information in this table includes the source SRN and modeling ID, the company name and source description, the emission rates, and pertinent exhaust characteristics for the various NAAQS analyses.

Table 6-7. List of Off-Site Sources for the NMU SO_2 NAAQS Modeling Analysis

SRN	Source Name	UTM Easting (meters)	UTM Northing (meters)	Facility/Source Emission Rates		Source Distance from NMU (km)	Stack Information [2]				
				(pph)	(g/sec)		Height (ft)	Diam (inch)	Temp. (deg F)	Flow (ACFM)	Velocity (m/s)
SO_2 NAAQS Increment Modeling Sources/Parameters											
B1827	Empire Iron Mining Partner	453,954	5,143,680	1,211.4	152.64	19.9	133.80	122.2	289.23	401,171	24.96
B1833	Marquette Board of Light & Power	469,900	5,153,000	315.4	39.74	4.0	280.27	95.4	252.54	185,172	19.16
B4261	Wisconsin Electric Power Co	469,745	5,158,290	10,102.0	1,272.85	1.7	402.70	117.4	339.19	338,115	22.84
B4885	Tilden Mining Company L.C.	449,950	5,142,850	1,211.2	152.61	23.5	191.62	193.8	330.91	661,860	16.08

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/m^3)	Year of Maximum Impact	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Significant Impact Level (μg/m^3)	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/m^3)	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Primary NAAQS (µg/m^3)	Background Concen-tration (µg/m^3)	Total NAAQS Impact (µg/m^3)	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] ($\mu g/m^3$)	Year of Maximum Impact	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Significant Impact Level ($\mu g/m^3$)	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 $\mu g/m^3$ on an annual basis. The full 5-year meteorological data set was utilized, and the results of this analysis are presented in Table 6-13.

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 $\mu g/m^3$ 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-by-compound basis, which were then converted into gram/second emission rates for scaling purposes. The emission rates and calculated ambient impacts for all TACs (which includes HAPs) are presented in Table C-1 of Appendix C.

The following is a brief description of the procedure for using the gram per second modeled impacts to determine a specific pollutant's maximum ground level concentration.

Worst Case Acetaldehyde Impact, 24-Hour Averaging Period

CFB Boiler Stack Acetaldehyde Emission Rate = 2.47E-02 gram/sec

Gram/Second Modeled Impact for 24-hour averaging period = 1.589 (μg/m³)/(g/sec)

$$Acetaldehyde\ Impact = \frac{1.589\ (\mu g/m^3)}{(1\ gram/second)} \times \frac{2.47E\text{-}02\ grams}{second}$$

$$Acetaldehyde\ Impact = \frac{0.0392\ \mu g\ Acetaldehyde}{m^3}$$

As shown in the preceding calculations, the acetaldehyde emissions from the new CFB boiler exhaust stack results in a 24-hour impact of 0.0392 $\mu g/m^3$, which is approximately 0.44% of the acetaldehyde screening level of 9 $\mu g/m^3$ on a 24-hour basis.

The modeled impacts associated with the annual, 1-hour, 8-hour, and 24-hour modeled averaging periods for the new CFB boiler exhaust stack are presented in Table 6-14.

Table 6-14. 1.0 Gram Per Second Modeled Impacts for the New CFB Boiler

Averaging Period	Modeled Impact ($\mu g/m^3$)/(g/sec)	X (East) Impact Location [1] (meters)	Y (North) Impact Location [1] (meters)	Receptor Elevation (meters)
Annual	0.211	468,960.8	5,157,204.0	193.79
24-Hour	1.589	468,760.8	5,156,254.0	201.88
8-Hour	2.712	466,860.8	5,151,904.0	283.74
1-Hour	15.779	466,860.8	5,151,904.0	283.74

[1] These distances are referenced from the site ordinate (UTM coordinate Easting = 468,874.0 meters, and Northing = 5,156,608.0 meters).

Table C-1 of Appendix C presents the results of applying the modeled impacts of Table 6-14 to the maximum TAC emission rates. Table C-1 shows that the TAC emitted at the highest hourly rate, hydrochloric acid (HCl), results in an ambient impact of 0.24 $\mu g/m^3$ when scaled by the 24-hour modeled impact. This impact is approximately 1.2% of the allowable screening level (SL) of 20 $\mu g/m^3$ on a 24-hour averaging period basis. Similarly, the TAC that is expected to have the highest ambient impacts versus its screening level is formaldehyde, which has been predicted to result in a maximum annual ambient impact of 0.028 $\mu g/m^3$ - approximately 34% of the allowable screening level (SL) of 0.08 $\mu g/m^3$ on an annual averaging period basis. (Note that although the impact for chromium VI is predicted to be approximately 26% of its screening level, the emission rate quantified for Cr VI is uncontrolled and is expected to be much less than the rate presented in Table C-1, and thus result in a much lower impact after considering control efficiency of the baghouse).

Overall, the results presented in Table C-1 show that all TACs will comply with the applicable screening levels at the maximum predicted emission rates and thus comply with the Michigan AQD air toxics rules.

It should be noted that although the Michigan AQD ITSL for lead (Pb) has a 3-month averaging period, a 24-hour ambient impact has been determined and compared to the ITSL of 1.5 $\mu g/m^3$ on a 3-month basis. This represents a conservative approach because it over predicts the ambient impact that would occur on a 3-month basis.

In conclusion, the proposed operation of the NMU facility expansion will be in compliance with all applicable federal and state ambient air quality standards for both criteria pollutants and TAC emissions.

6.7 DISPERSION MODELING FILES

Table 6-15 lists the ISC AERMOD files that have been included in Appendix C on compact disc. These include the complete Lakes Environmental project files for all modeling runs. The Marquette OE East and Marquette 7.5-minute DEM files utilized in determining elevated terrain through AERMAP are also included electronically.

Table 6-18. Summary of the NMU Modeling Files

ISC AERMOD View Files	File Description	Meteorological Data
NMU01_CO through NMU05_CO	CO SIL Models	2001-2005
NMUPM_P1 through NMUPM_P5	PM_{10} SIL Models	2001-2005
NMU01SO2 through NMU05SO2	SO_2 PSD and NAAQS Models	2001-2005
NMU_NOx1 through NMU_NOx5	NO_x SIL Models	2001-2005
NMU_GPS2	TAC modeling Gram/Second Model	2005

7.0 SECONDARY IMPACT ANALYSIS

An additional impact analysis is required for major new sources or major modifications at existing major sources pursuant to 40 CFR Part 52.21(o). In addition, Section 7(a) of the Endangered Species Act (ESA) requires review of threatened and endangered species in the area surrounding the proposed projects. Therefore, the additional impact analysis is necessary to evaluate the impacts from the proposed project on:

- Associated growth
- Soils, vegetation, and wildlife
- Visibility impairment
- Threatened and Endangered Species

The proposed project is considered a major modification and will result in emissions of particulate matter ($PM_{10}/PM_{2.5}$), nitrogen oxides (NO_x), sulfur dioxide (SO_2) and carbon monoxide (CO) greater than the major source significant level. Consequently, an additional impact analysis addressing the effects of PM, NO_x, SO_2, and CO in these areas is required.

Additionally, MDEQ has requested a quantitative analysis regarding the impact of the 7 MW cooling tower on fogging and icing. Fogging occurs as a result of evaporative moisture from the cooling tower and result in reduced visibility and increased humidity directly adjacent to the cooling tower. Icing when the ambient temperature is below freezing the cooling tower fog freezes on road surfaces.

7.1 ASSOCIATED GROWTH

The purpose of the growth impact analysis is to quantify the impact from growth resulting from the construction and operation of the proposed project and to assess air quality impacts that would result from that growth. Impacts on the ambient air and surrounding community resulting from the installation of the new CFB will be minor.

Northern Michigan University will be receiving solid fuels for the new boiler via 40 ton trucks delivered approximately once per day, Monday through Friday. While an increase in vehicle traffic as a result of fuel truck delivery will increase, both Sugarloaf and Wright Avenues are currently major transportation routes. Specifically, Sugarloaf Avenue is currently heavily traveled by logging trucks delivering fibers to facilities from processing plants north and west of Marquette. Consequently, the increase in truck traffic as a result of the new solid fuel boiler will be relatively insignificant.

NMU is proposing to construct and install a new CFB boiler and steam turbine in response to increased demand for power and steam at the Marquette campus. The proposed project also includes construction of a new boiler building. Due to abundant supplies of solid fuel, including coal and wood waste, the project is not expected to affect the fuel supply or impact the fuel markets within the upper peninsula of Michigan or the Midwest.

7.2 SOILS, VEGETATION, AND WILDLIFE

Additional increases in pollutant levels resulting from a specific emission source can have an impact on air quality-related values (AQRVs). However, it is important to evaluate the level of the expected increase. AQRVs can include visibility, odor, flora, fauna, and geographic resources; archeological, historical, and other cultural resources; and soil and water resources.

NMU has performed a modeling demonstration for $PM_{10}/PM_{2.5}$, NO_x, SO_2, and CO emissions resulting from the installation of the new CFB boiler. This ambient impact analysis addressed emissions from the all units at NMU, including the three (3) existing natural gas/oil-fired boilers, and compared the model results with both the primary and secondary National Ambient Air Quality Standards. Note that the primary and secondary standards for PM_{10}, NO_x, SO_2, and CO have the same NAAQS and that the impacts associated with the proposed project will be minor.

The highest predicted NO_x concentration increases resulting from the proposed project at NMU are less than the ambient health standards allowed in the NAAQS. Specifically, AERMOD predicted the following PM_{10} impacts from the facility as a result of future potential emissions:

- Annual concentration of 0.97 $^{\mu g}/_{m^3}$ (primary NAAQS is 100 $^{\mu g}/_{m^3}$)

The highest predicted SO_2 concentration increases resulting from the proposed project at NMU are less than the ambient health standards allowed in the NAAQS. Specifically, AERMOD predicted the following PM_{10} impacts from the facility as a result of future potential emissions:

- 3-hour concentration of 520.24 $^{\mu g}/_{m}{}^3$ (primary NAAQS is 1,300 $^{\mu g}/_{m}{}^3$)
- 24-hour concentration of 217.39 $^{\mu g}/_{m}{}^3$ (primary NAAQS is 365 $^{\mu g}/_{m}{}^3$)
- Annual concentration of 30.56 $^{\mu g}/_{m}{}^3$ (primary NAAQS is 80 $^{\mu g}/_{m}{}^3$)

Modeling was also performed for PM_{10} and CO emissions. This modeling showed that the impacts from both PM_{10} and CO as a result of the proposed project are less than the federal significant impact levels of 1 and 5 $^{\mu g}/_{m}{}^3$, and 500 and 2,000 $^{\mu g}/_{m}{}^3$, respectively.

Based on the modeling results presented above, no impact on soils, vegetation, or wildlife can be expected. Further, these small concentration increases are not likely to have an adverse effect on AQRVs within the vicinity of the facility.

7.3 VISIBILITY

NMU is located within 50 km from the Seney National Wildlife Refuge (Seney) Class I area. As such, a visibility analysis using the CALPUFF model was performed to determine whether the emissions from the new CFB will cause a degradation of visibility due to increased relative humidity within Seney.

The visibility modeling demonstration was performed according the modeling protocol submitted to MDEQ on August 18, 2006 and approved via e-mail on August 21, 2006. The results confirm that the potential emissions from the new CFB will not result in visibility impairment at Seney.

While sulfates are a subset of the $PM_{2.5}$ and known to contribute to regional haze problems, the small incremental increase in sulfates from the proposed project are considered to be negligible in comparison to the region's current quality index and have not been quantified. Therefore, no adverse effect on regional haze is expected from the proposed new boiler.

7.4 THREATENED AND ENDANGERED SPECIES

A request for review of threatened and endangered species in the area surrounding the NMU facility was submitted to the Michigan Department of Natural Resources (MDNR) was submitted by NTH Consultants, Ltd. A review by the MDNR – Wildlife Division determined that "the project should have no impact on rare or unique natural features …" and a copy of the letter from Ms. Lori Sargent, Endangered Species Specialist, is included in Appendix E.

Additionally, a request for review for threatened and endangered species by the U.S. Fish and Wildlife Service was requested as well. Per the letter included in Appendix E, the U.S. Fish and Wildlife Service confirms that no threatened and endangered species are present in the area impacted by the project and no additional review is necessary.

7.5 COOLING TOWER IMPACTS

As requested by MDEQ, a quantitative analysis for impacts of fogging and icing from the proposed 7 MW cooling tower was performed using the Seasonal/Annual Cooling Tower Impact (SACTI) model. This analysis confirmed that impairments to the surrounding community as a result of fogging and icing is not expected. The electronic input and output files from this analysis is included in Appendix C on compact disc, with hardcopy output in Appendix F.

APPENDIX C

Dispersion Modeling
Support Information

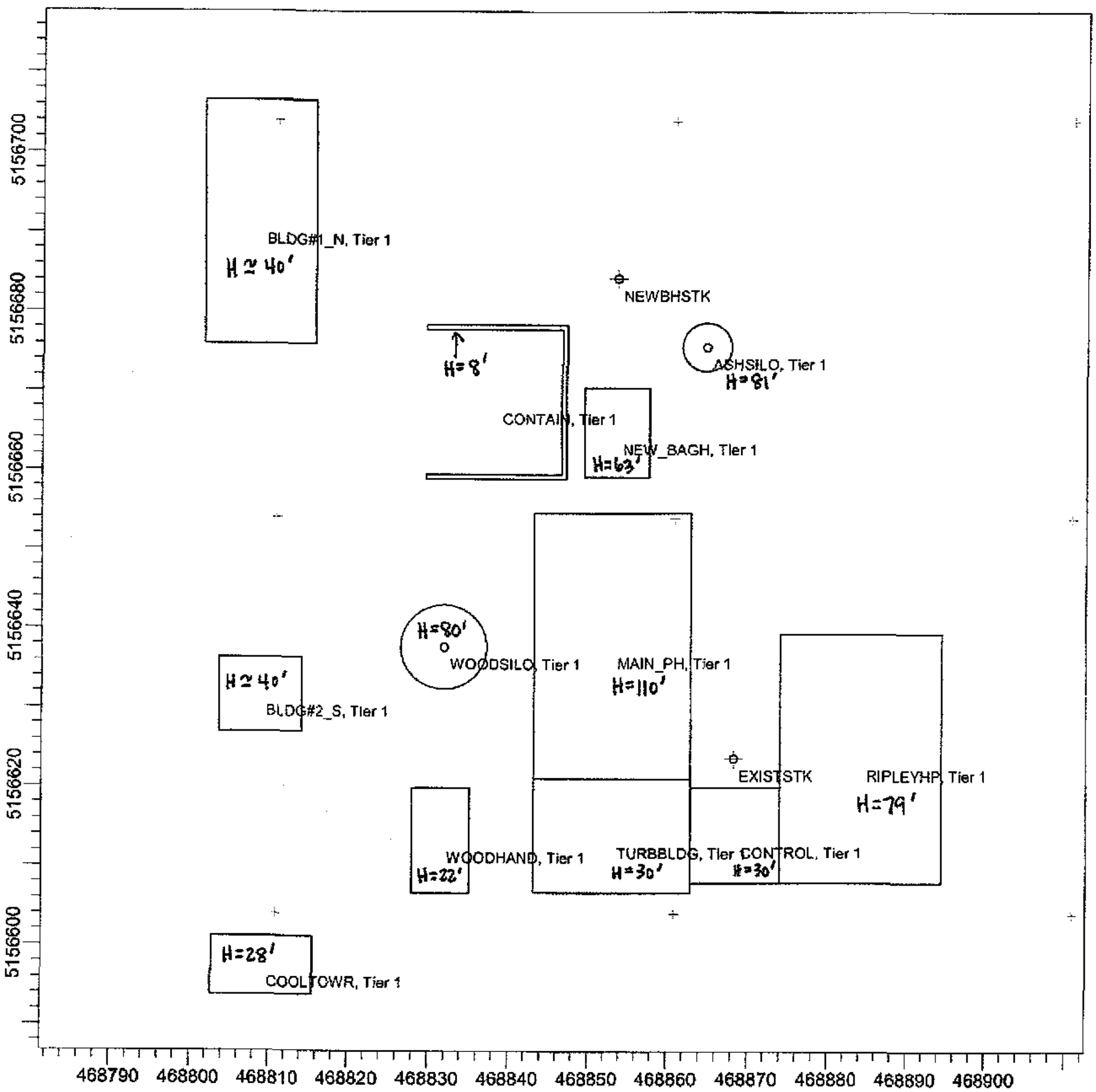
NMU Campus

Modeling Building Layouts

(with Building Heights)

PROJECT TITLE:

Northern Michigan University - Powerhouse Modification PTI
Building Layout



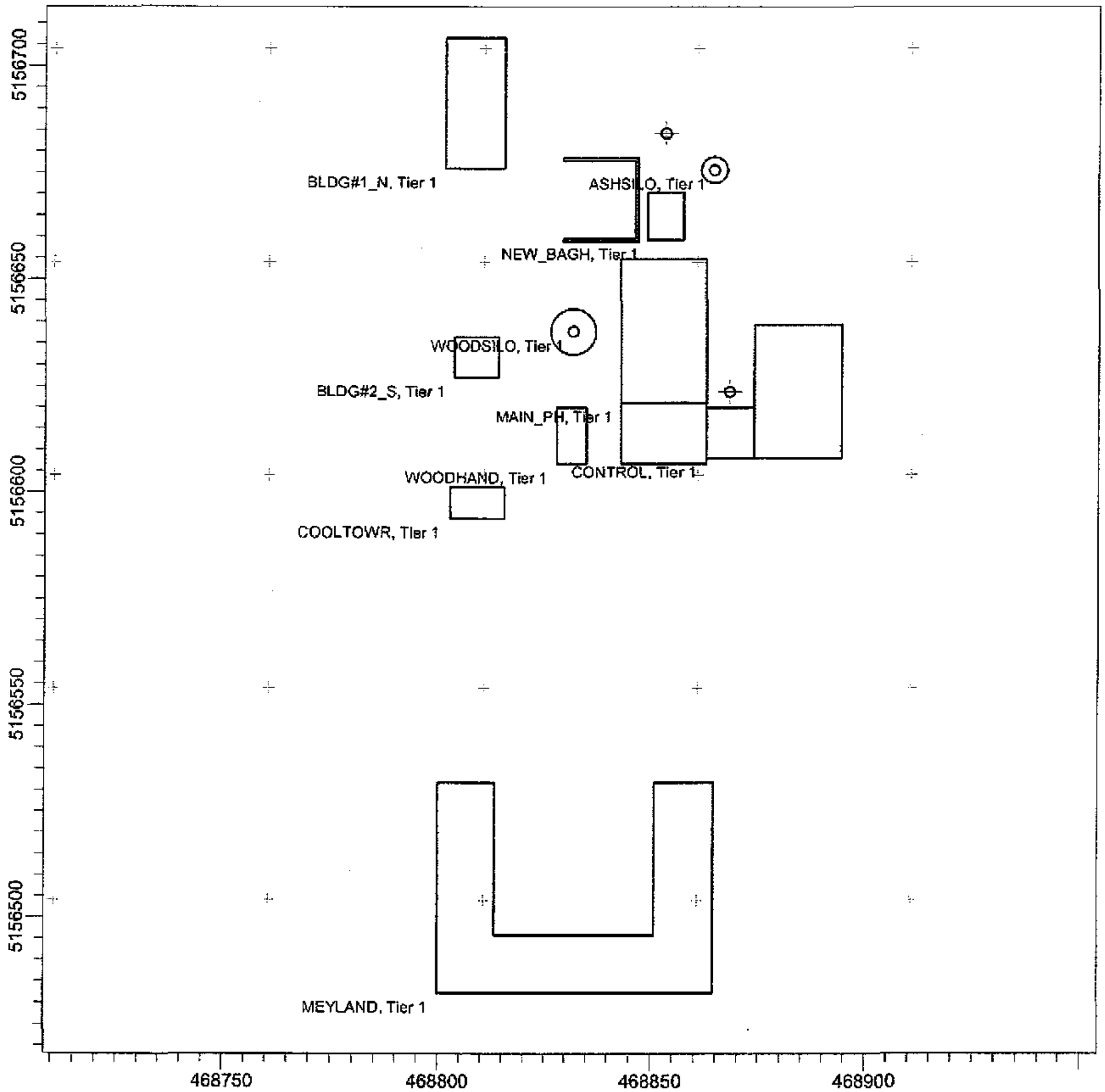
COMMENTS:	SOURCES:	COMPANY NAME:	
NMU Power Plant	2	**NTH Consultants, Ltd**	
Building Layout:	RECEPTORS: 7537	MODELER: **Edward Bishop, Asst Project Engineer**	
		SCALE: 1:800 (0 — 0.02 km)	
		DATE: **1/25/2007**	PROJECT NO.: **16-060504**

ISC-AERMOD View - Lakes Environmental Software

C:\Northern Michigan U Modeling\NMU_GPS\NMU_GPS2.isc

PROJECT TITLE:

Northern Michigan University - Powerhouse Modification PTI
Building Layout



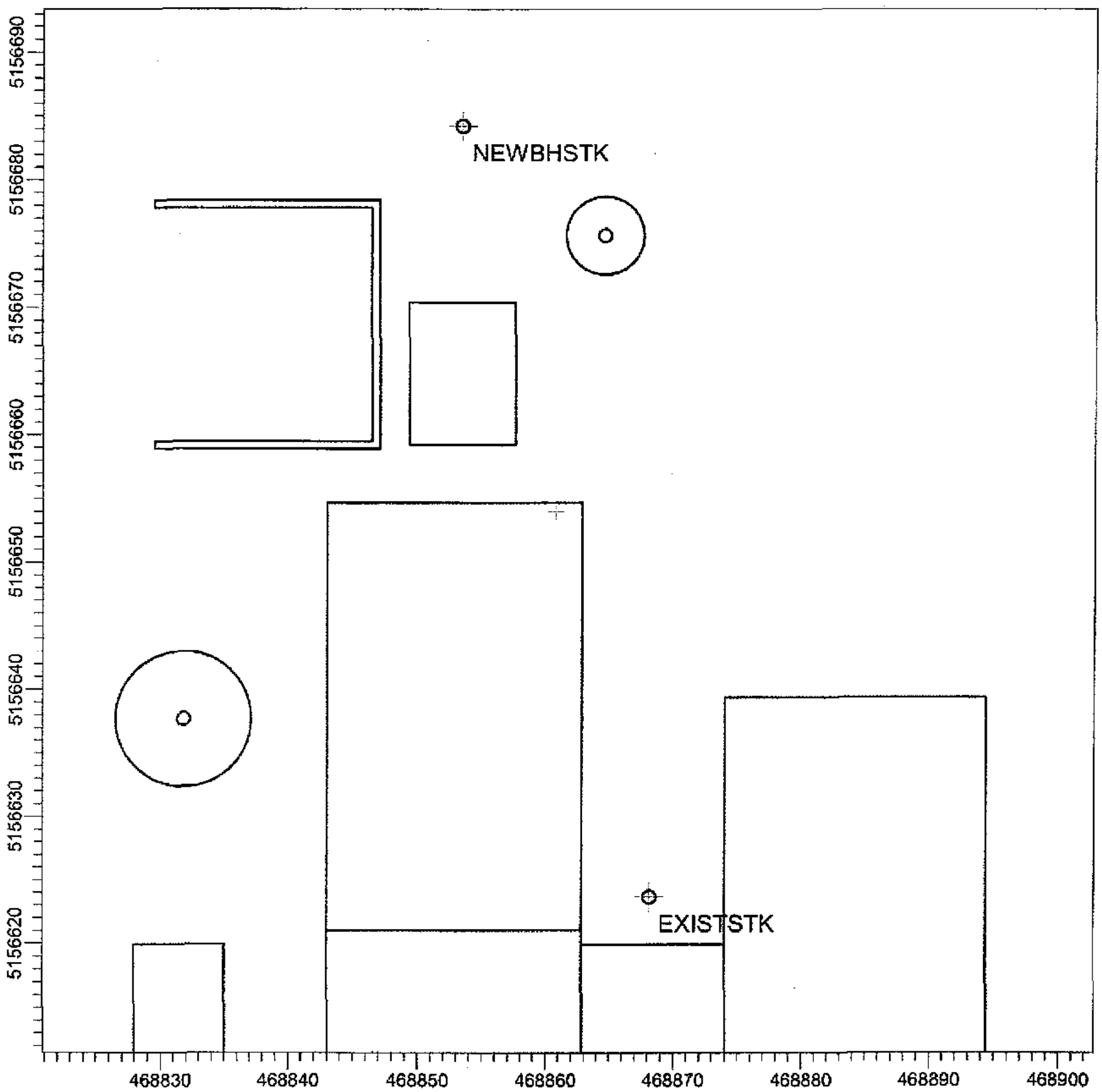
COMMENTS:	SOURCES:	COMPANY NAME:	
NMU Power Plant	2	**NTH Consultants, Ltd**	
Building Layout:	RECEPTORS: 7537	MODELER: **Edward Bishop, Asst Project Engineer**	
		SCALE: 1:1,500 — 0 to 0.05 km	
		DATE: **1/25/2007**	PROJECT NO.: **16-060504**

ISC-AERMOD View - Lakes Environmental Software

C:\Northern Michigan U Modeling\NMU_GPS\NMU_GPS2.isc

PROJECT TITLE:

Northern Michigan University - Powerhouse Modification PTI
Stack Identification Layout



COMMENTS:	SOURCES:	COMPANY NAME:	
NMU Power Plant	**2**	**NTH Consultants, Ltd**	
Building Layout:	RECEPTORS: **7537**	MODELER: **Edward Bishop, Asst Project Engineer**	
		SCALE: 1:500 0 ——— 0.01 km	
		DATE: **1/25/2007**	PROJECT NO.: **16-060504**

Existing Facility, New Structures, and Stack Coordinates

(Internal Coordinates)

Northern Michigan University - Modeling Analysis Layout for Proposed Boiler Project

Coordinate System Layout for Northern Michigan University Located in Marquette, MI
The Southwest Corner of the Existing Ripley Heating Plant Bldg Equals Site Coordinate (0,0)

Building	Corner I.D.	Coordinates (feet) X (E)	Coordinates (feet) Y (N)	Height (feet)	Coordinates (meters) X (E)	Coordinates (meters) Y (N)	Height (meters)
Ripley Heating Plant	A1	0.00	0.00	79.00	0.00	0.00	24.08
	A2	0.00	102.92	79.00	0.00	31.37	24.08
	A3	66.92	102.92	79.00	20.40	31.37	24.08
	A4	66.92	0.00	79.00	20.40	0.00	24.08
	A5	0.00	0.00	79.00	0.00	0.00	24.08
New Boiler Main Building	B1	-101.53	42.82	110.00	-30.95	13.05	33.53
	B2	-101.53	153.12	110.00	-30.95	46.67	33.53
	B3	-36.53	153.12	110.00	-11.14	46.67	33.53
	B4	-36.53	42.82	110.00	-11.14	13.05	33.53
	B5	-101.53	42.82	110.00	-30.95	13.05	33.53
New Steam Turbine Bldg	C1	-101.53	-4.19	30.00	-30.95	-1.28	9.14
	C2	-101.53	42.82	30.00	-30.95	13.05	9.14
	C3	-36.53	42.82	30.00	-11.14	13.05	9.14
	C4	-36.53	-4.19	30.00	-11.14	-1.28	9.14
	C5	-101.53	-4.19	30.00	-30.95	-1.28	9.14
New Control Room	D1	-36.53	0.00	30.00	-11.14	0.00	9.14
	D2	-36.53	39.13	30.00	-11.14	11.93	9.14
	D3	0.00	39.13	30.00	0.00	11.93	9.14
	D4	0.00	0.00	30.00	0.00	0.00	9.14
	D5	-36.53	0.00	30.00	-11.14	0.00	9.14
Coal Containment Structure	E1	-145.96	167.00	8.00	-44.49	50.90	2.44
	E2	-145.96	169.00	8.00	-44.49	51.51	2.44
	E3	-90.29	169.00	8.00	-27.52	51.51	2.44
	E4	-90.29	229.00	8.00	-27.52	69.80	2.44
	E5	-145.96	229.00	8.00	-44.49	69.80	2.44
	E6	-145.96	231.00	8.00	-44.49	70.41	2.44
	E7	-88.29	231.00	8.00	-26.91	70.41	2.44
	E8	-88.29	167.00	8.00	-26.91	50.90	2.44
	E9	-145.96	167.00	8.00	-44.49	50.90	2.44
Wood Handling Building	F1	-151.12	-4.43	22.00	-46.06	-1.35	6.71
	F2	-151.12	39.14	22.00	-46.06	11.93	6.71
	F3	-127.87	39.14	22.00	-38.98	11.93	6.71
	F4	-127.87	-4.43	22.00	-38.98	-1.35	6.71
	F5	-151.12	-4.43	22.00	-46.06	-1.35	6.71
New Baghouse Structure	G1	-80.76	168.12	63.00	-24.62	51.24	19.20
	G2	-80.76	204.76	63.00	-24.62	62.41	19.20
	G3	-53.75	204.76	63.00	-16.38	62.41	19.20
	G4	-53.75	168.12	63.00	-16.38	51.24	19.20
	G5	-80.76	168.12	63.00	-24.62	51.24	19.20
Cooling Tower Structure	H1	-233.86	-46.48	28.00	-71.28	-14.17	8.53
	H2	-233.86	-22.48	28.00	-71.28	-6.85	8.53
	H3	-191.86	-22.48	28.00	-58.48	-6.85	8.53
	H4	-191.86	-46.48	28.00	-58.48	-14.17	8.53
	H5	-233.86	-46.48	28.00	-71.28	-14.17	8.53
Existing Nearby Bldg #1	I1	-237.56	222.84	40.00	-72.41	67.92	12.19
	I2	-237.56	323.23	40.00	-72.41	98.52	12.19
	I3	-191.52	323.23	40.00	-58.37	98.52	12.19
	I4	-191.52	222.84	40.00	-58.37	67.92	12.19
	I5	-237.56	222.84	40.00	-72.41	67.92	12.19
Existing Nearby Bldg #2	J1	-230.95	62.16	40.00	-70.39	18.95	12.19
	J2	-230.95	93.06	40.00	-70.39	28.37	12.19
	J3	-196.64	93.06	40.00	-59.94	28.37	12.19
	J4	-196.64	62.16	40.00	-59.94	18.95	12.19
	J5	-230.95	62.16	40.00	-70.39	18.95	12.19
Gunther C. Meyland Hall	K1	-242.84	-412.65	120.00	-74.02	-125.78	36.58
(NE Section of Quad 2)	K2	-242.84	-250.26	120.00	-74.02	-76.28	36.58
	K3	-198.80	-250.26	120.00	-60.59	-76.28	36.58
	K4	-198.80	-368.41	120.00	-60.59	-112.29	36.58
	K5	-75.38	-368.41	120.00	-22.98	-112.29	36.58
	K6	-75.38	-250.26	120.00	-22.98	-76.28	36.58
	K7	-30.78	-250.26	120.00	-9.38	-76.28	36.58
	K8	-30.78	-412.65	120.00	-9.38	-125.78	36.58
	K9	-242.84	-412.65	120.00	-74.02	-125.78	36.58

Circular Strutures	Center I.D.	Coordinates (feet) X (E)	Coordinates (feet) Y (N)	Height (feet)	Coordinates (meters) X (E)	Coordinates (meters) Y (N)	Diameter (meters)	Height (meters)
New Ash Silo	O1	-30.54	221.91	81.00	-9.31	67.64	6.10	24.69
Wood Silo	P1	-138.44	97.43	80.00	-42.19	29.70	10.65	24.38

Stacks	I.D.	Coordinates (feet) X (E)	Coordinates (feet) Y (N)	Height (feet)	Coordinates (meters) X (E)	Coordinates (meters) Y (N)	Diameter (meters)	Height (meters)
New Baghouse Stack	NewBHStk	-67.25	250.08	165.00	-20.50	76.22	1.83	50.29
Existing Boiler Stack	ExistStk	-19.02	51.28	150.00	-5.80	15.63	1.52	45.72

Existing Facility, New

Structures, and Stack Coordinates

(UTM Coordinates)

Northern Michigan University - Modeling Analysis Layout for Proposed Boiler Project

Coordinate System Layout for Northern Michigan University Located in Marquette, MI
The Southwest Corner of the Ripley Heating Plant Bldg Equals UTM Coordinate (468,874 E; 5,156,608 N)

Building	Corner I.D.	Coordinates (meters) X (E)	Coordinates (meters) Y (N)	Height (feet)	UTM Coordinates (meters) Easting	UTM Coordinates (meters) Northing	Elevation (meters)
Ripley Heating Plant	A1	0.00	0.00	79.00	468874.00	5156608.00	195.38
	A2	0.00	31.37	79.00	468874.00	5156639.37	195.38
	A3	20.40	31.37	79.00	468894.40	5156639.37	195.38
	A4	20.40	0.00	79.00	468894.40	5156608.00	195.38
	A5	0.00	0.00	79.00	468874.00	5156608.00	195.38
New Boiler Main Building	B1	-30.95	13.05	110.00	468843.05	5156621.05	195.38
	B2	-30.95	46.67	110.00	468843.05	5156654.67	195.38
	B3	-11.14	46.67	110.00	468862.86	5156654.67	195.38
	B4	-11.14	13.05	110.00	468862.86	5156621.05	195.38
	B5	-30.95	13.05	110.00	468843.05	5156621.05	195.38
New Steam Turbine Bldg	C1	-30.95	-1.28	30.00	468843.05	5156606.72	195.38
	C2	-30.95	13.05	30.00	468843.05	5156621.05	195.38
	C3	-11.14	13.05	30.00	468862.86	5156621.05	195.38
	C4	-11.14	-1.28	30.00	468862.86	5156606.72	195.38
	C5	-30.95	-1.28	30.00	468843.05	5156606.72	195.38
New Control Room	D1	-11.14	0.00	30.00	468862.86	5156608.00	195.38
	D2	-11.14	11.93	30.00	468862.86	5156619.93	195.38
	D3	0.00	11.93	30.00	468874.00	5156619.93	195.38
	D4	0.00	0.00	30.00	468874.00	5156608.00	195.38
	D5	-11.14	0.00	30.00	468862.86	5156608.00	195.38
Coal Contaiment Structure	E1	-44.49	50.90	8.00	468829.51	5156658.90	195.38
	E2	-44.49	51.51	8.00	468829.51	5156659.51	195.38
	E3	-27.52	51.51	8.00	468846.48	5156659.51	195.38
	E4	-27.52	69.80	8.00	468846.48	5156677.80	195.38
	E5	-44.49	69.80	8.00	468829.51	5156677.80	195.38
	E6	-44.49	70.41	8.00	468829.51	5156678.41	195.38
	E7	-26.91	70.41	8.00	468847.09	5156678.41	195.38
	E8	-26.91	50.90	8.00	468847.09	5156658.90	195.38
	E9	-44.49	50.90	8.00	468829.51	5156658.90	195.38
Wood Handling Building	F1	-46.06	-1.35	22.00	468827.94	5156606.65	195.38
	F2	-46.06	11.93	22.00	468827.94	5156619.93	195.38
	F3	-38.98	11.93	22.00	468835.02	5156619.93	195.38
	F4	-38.98	-1.35	22.00	468835.02	5156606.65	195.38
	F5	-46.06	-1.35	22.00	468827.94	5156606.65	195.38
New Baghouse Structure	G1	-24.62	51.24	63.00	468849.38	5156659.24	195.38
	G2	-24.62	62.41	63.00	468849.38	5156670.41	195.38
	G3	-16.38	62.41	63.00	468857.62	5156670.41	195.38
	G4	-16.38	51.24	63.00	468857.62	5156659.24	195.38
	G5	-24.62	51.24	63.00	468849.38	5156659.24	195.38
Cooling Tower Structure	H1	-71.28	-14.17	28.00	468802.72	5156593.83	195.38
	H2	-71.28	-6.85	28.00	468802.72	5156601.15	195.38
	H3	-58.48	-6.85	28.00	468815.52	5156601.15	195.38
	H4	-58.48	-14.17	28.00	468815.52	5156593.83	195.38
	H5	-71.28	-14.17	28.00	468802.72	5156593.83	195.38
Existing Nearby Bldg #1	I1	-72.41	67.92	40.00	468801.59	5156675.92	196.90
	I2	-72.41	98.52	40.00	468801.59	5156706.52	196.90
	I3	-58.37	98.52	40.00	468815.63	5156706.52	196.90
	I4	-58.37	67.92	40.00	468815.63	5156675.92	196.90
	I5	-72.41	67.92	40.00	468801.59	5156675.92	196.90
Existing Nearby Bldg #2	J1	-70.39	18.95	40.00	468803.61	5156626.95	195.38
	J2	-70.39	28.37	40.00	468803.61	5156636.37	195.38
	J3	-59.94	28.37	40.00	468814.06	5156636.37	195.38
	J4	-59.94	18.95	40.00	468814.06	5156626.95	195.38
	J5	-70.39	18.95	40.00	468803.61	5156626.95	195.38
Gunther C. Meyland Hall	K1	-74.02	-125.78	120.00	468799.98	5156482.22	195.38
(NE Section of Quad 2)	K2	-74.02	-76.28	120.00	468799.98	5156531.72	195.38
	K3	-60.59	-76.28	120.00	468813.41	5156531.72	195.38
	K4	-60.59	-112.29	120.00	468813.41	5156495.71	195.38
	K5	-22.98	-112.29	120.00	468851.02	5156495.71	195.38
	K6	-22.98	-76.28	120.00	468851.02	5156531.72	195.38
	K7	-9.38	-76.28	120.00	468864.62	5156531.72	195.38
	K8	-9.38	-125.78	120.00	468864.62	5156482.22	195.38
	K9	-74.02	-125.78	120.00	468799.98	5156482.22	195.38

Northern Michigan University - Modeling Analysis Layout for Proposed Boiler Project

Coordinate System Layout for Northern Michigan University Located in Marquette, MI
The Southwest Corner of the Ripley Heating Plant Bldg Equals UTM Coordinate (468,874 E; 5,156,608 N)

Building	Corner I.D.	Coordinates (meters)		Height	UTM Coordinates (meters)		Elevation
		X (E)	Y (N)	(feet)	Easting	Northing	(meters)

Circular Strutures	Center I.D.	Coordinates (feet)		Height	UTM Coordinates (meters)		Diameter	Height
		X (E)	Y (N)	(feet)	UTM Easting	UTM Northing	(meters)	(meters)
New Ash Silo	O1	-9.31	67.64	81.00	468864.69	5156675.64	6.10	24.69
Wood Silo	P1	-42.19	29.70	80.00	468831.81	5156637.70	10.65	24.38

Stacks	I.D.	Coordinates (feet)		Height	UTM Coordinates (meters)		Diameter	Height
		X (E)	Y (N)	(feet)	UTM Easting	UTM Northing	(meters)	(meters)
New Baghouse Stack	NewBHStk	-20.50	76.22	165.00	468853.50	5156684.22	1.83	50.29
Existing Boiler Stack	ExistStk	-5.80	15.63	150.00	468868.20	5156623.63	1.52	45.72

160'

60"

Used in modeling inputs

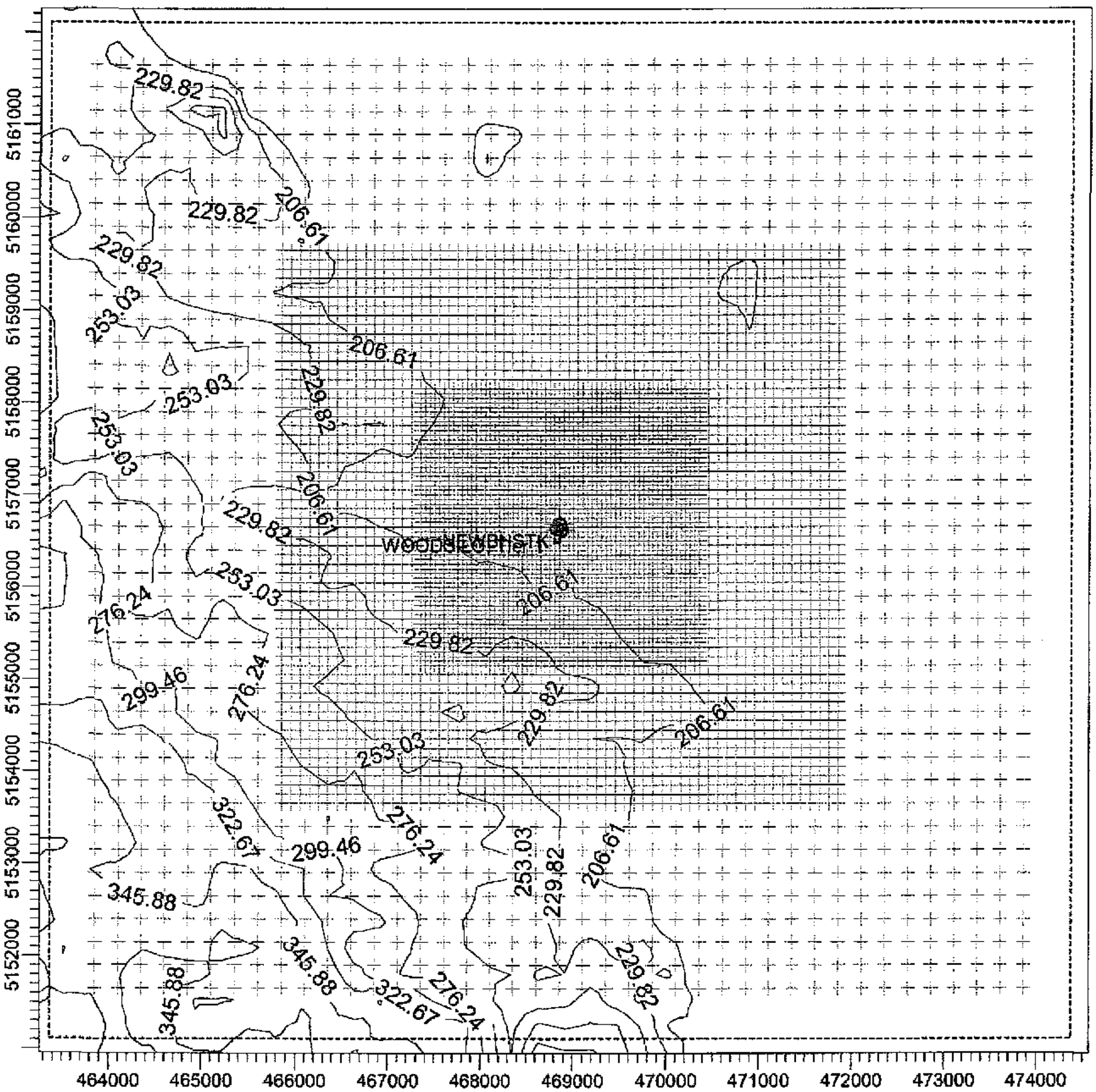
File: NMU Modeling Setup Tab: UTM Coords

Printed 1/25/2007 11:54 AM

Receptor Grid Layout Diagrams

PROJECT TITLE:

Northern Michigan University - Powerhouse Modification PTI
Receptor Grid Layout



COMMENTS:

NMU Receptor Grid Layout:

Inner Grid: 1 km x 1 km
50-m spacing
Middle Grid: 3 km x 3 km
100-m spacing
Outer Grid: 5 km x 5 km
250-m spacing

SOURCES:
2

RECEPTORS:
7537

COMPANY NAME:
NTH Consultants, Ltd

MODELER:
Edward Bishop, Asst Project Engineer

SCALE: 1:69,000

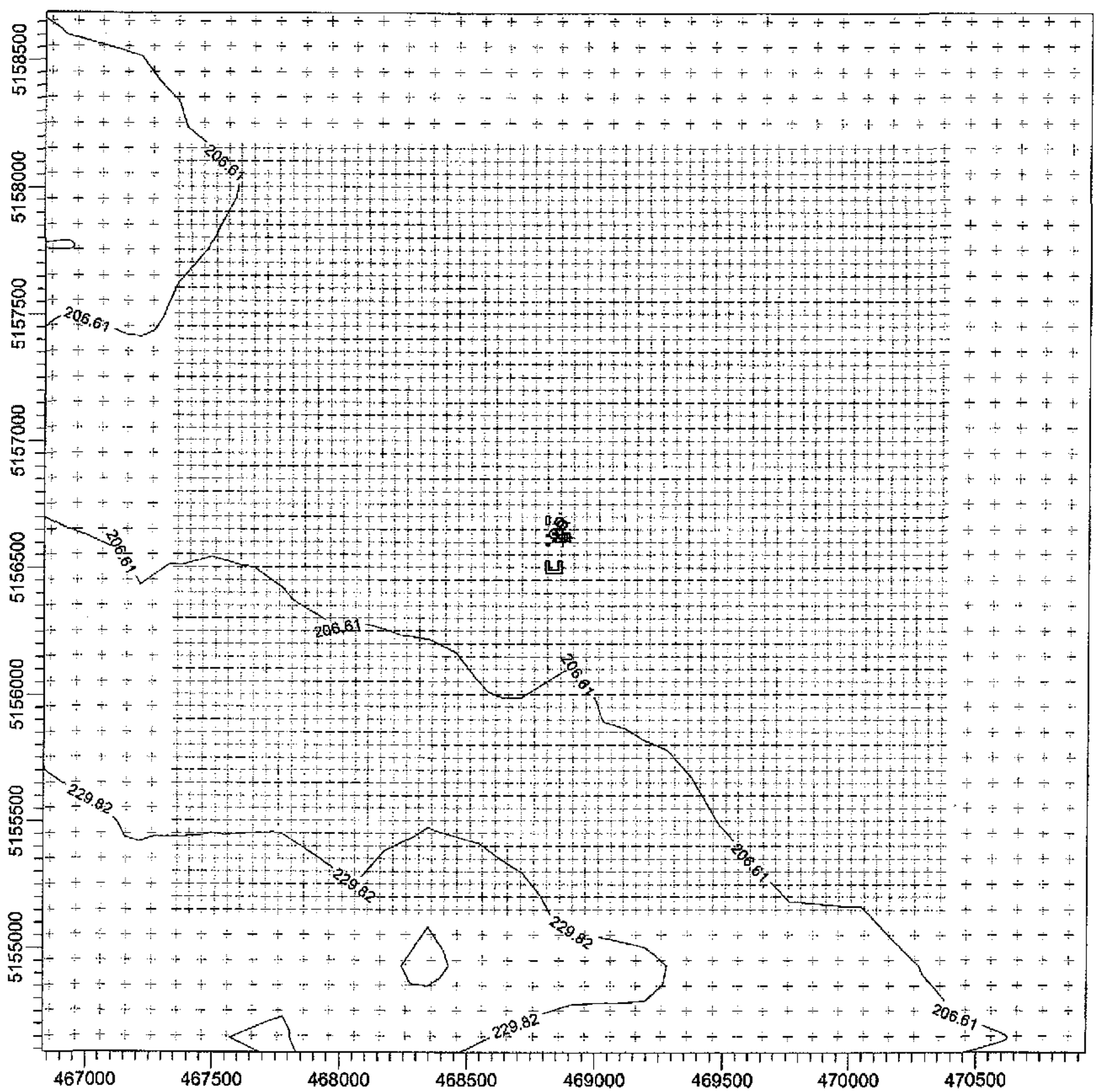
0 ——— 2 km

DATE:
1/25/2007

PROJECT NO.:
16-060504

PROJECT TITLE:

Northern Michigan University - Powerhouse Modification PTI
Receptor Grid Layout - Zoomed



COMMENTS:	SOURCES:	COMPANY NAME:	
NMU Receptor Grid Layout: Inner Grid: 1 km x 1 km 50-m spacing Middle Grid: 3 km x 3 km 100-m spacing	2	**NTH Consultants, Ltd**	
	RECEPTORS:	MODELER:	
	7537	**Edward Bishop, Asst Project Engineer**	
		SCALE: 1:25,000 0 ___ 0.5 km	
		DATE:	PROJECT NO.:
		1/25/2007	**16-060504**

Existing Source Emission Rates

NMU Boiler Project - Existing Source Emission Rates

Pre Permit 126-05 Emission Estimates

Basis: 1,020 Btu/scf nat gas
135,000 Btu/gallon fuel oil

Year	Nat Gas (MM scf)	Fuel Oil (gal)	Heat Input Nat Gas (MM Btu)	Heat Input Fuel Oil (MM Btu)	Heat Input Total (MM Btu)
2000	358.057	1313	365218	177.3	365,395
2001	363.933	363	371212	49.0	371,261
2002	401.341	0	409368	0.0	409,368
2003	377.819	22471	385375	3033.6	388,409
2004	384.185	25896	391869	3496.0	395,365

Potential Fuel Oil Capacity
(MM gal/year)
10,356,267

0.0025 Max Actual Capacity Factor
21.90 Equiv Hrs using Fuel Oil/year

Past Actual - Estimated Annual Emissions

Pollutant	NOx	CO	PM	SO2	VOC
	Tons/Year				
2000	17.92	15.04	1.36	0.16	0.98
2001	18.20	15.29	1.38	0.12	1.00
2002	**20.07**	**16.86**	**1.53**	0.12	**1.10**
2003	19.12	15.92	1.48	0.93	1.04
2004	19.47	16.20	1.51	**1.06**	1.06
Maximum	**20.07**	**16.86**	**1.53**	**1.06**	**1.10**
lb/hour	**4.582**	**3.848**	**0.348**	**0.242**	**0.252**

annual average lb/hour

AP42 Factors

	Nat Gas (lb/mmscf)	Fuel Oil (lb/mmBtu)
NOx	100	0.148
CO	84	0.037
PM	7.6	0.03
SO2	0.6	0.54
VOC	5.5	0.002

Permit 126-05 Equipment - Potential Emissions (Based on Two Boilers @ Rated Capacities)

	2 Boilers Capacity (MM Btu/hr)	Nat Gas (MM scf/hr)	Nat Gas (MM scf/yr)	Fuel Oil (gal/hr)	Fuel Oil (gal/year)
Nat Gas	167.2	0.1639	1,057.14		
Fuel Oil	159.6			1,182.22	2,732,040

Annual Operation With Fuel Type
(hour/year)
6449.1 Nat Gas
2310.9 Fuel Oil

Pollutant	NOx	CO	PM	SO2	VOC
	Potential Emissions (Tons/Year)				
Nat Gas	26.43	44.40	4.02	0.32	2.91
Fuel Oil	18.44	28.77	5.53	99.58	0.37
Maximum	n/a	n/a	n/a	n/a	n/a
Totals	44.87	73.17	9.55	99.90	3.28

Low NOx/AP42 Factors

	Nat Gas (lb/mmscf)	Fuel Oil (lb/mmBtu)
NOx	50	0.100
CO	84	0.156
PM	7.6	0.03
SO2	0.6	0.54
VOC	5.5	0.002

0.5 Wt-% Sulfur in Fuel Oil

		NOx	CO	PM	SO2	VOC
Nat Gas only	lb/hour	8.196	13.769	1.246	0.098	**0.902**
Oil Only (max hourly)	lb/hour	15.960	**24.898**	**4.788**	**86.184**	0.319
Limited Oil Use (annual ave hourly)	lb/hr (annual)	**10.244**	16.705	2.180	22.808	0.748

Note: red bold = maximum emission rate used for future potential modeling purposes

Modeled Emission Rates for Existing Boilers (based on two operating at maximum capacity)

	NOx	CO	PM	SO2
PSD Increment	0.714		0.559	10.829
NAAQS	1.291	3.137	0.603	10.859
	Emission rates above given in units of gram/second			

Summary of TAC Analysis Results

Background Concentrations

BACKGROUND CONCENTRATIONS

	CITY	ADDRESS	TYPE	YEAR	Distance	3-HR	24-HR	ANNUAL
SO2	Escanaba	County Road 414	Rural	2003	65.3 km	45.2	13.3	2.7
SO2	Escanaba	County Road 414	Rural	2004	65.3 km	34.6	10.6	2.7
SO2		Seney Nat'L Wildlife Refuge, Hcr2,	Rural	2005	158.5 km	29.3	13.3	2.7
						45.2	13.3	2.7

	CITY	ADDRESS	TYPE	YEAR	Distance	ANNUAL
NO2		Harrington Beach State Park, 531 Hw	Rural	2003	225.4 km	11.5
NO2	Two Rivers	Manitowoc/Woodlnd Dunes, 2315 Goodw	Rural	2004	176.5 km	5.7
NO2	Two Rivers	Manitowoc/Woodlnd Dunes, 2315 Goodw	Rural	2005	176.5 km	5.7
						11.5

	CITY	ADDRESS	TYPE	YEAR	Distance	24-HR	ANNUAL
PM10	Green Bay	Prangeway, 1300 N Quincy Street	Urban	2003	160.8 km	----	19.0
PM10	Green Bay	Prangeway, 1300 N Quincy Street	Urban	2004	160.8 km	----	15.0
PM10	Green Bay	Prangeway, 1300 N Quincy Street	Urban	2005	160.8 km	----	22.0
						48.0 4th High	22.0

	CITY	ADDRESS	TYPE	YEAR	Distance	1-HR	8-HR
CO	Milwaukee	Dnr Ser Hdqrts, 2300 N M. L. King J	Urban	2003	258.5 km	4408	3016
CO	Milwaukee	Dnr Ser Hdqrts, 2300 N M. L. King J	Urban	2004	258.5 km	4524	3480
CO		Seney Nat'L Wildlife Refuge, Hcr2,	Rural	2005	158.5 km	812	464
						4524	3480

	CITY	ADDRESS	TYPE	YEAR	Distance	QUARTER
Pb	Milwaukee	Health Center, 1337 So 16th St	Urban	2003	262.1 km	0.03
Pb		Mayville, Near N6705 Madison Rd	Rural	2004	256.2 km	0.01
Pb		1769 S Jeffs Rd	Rural	2005	316.5 km	0.01
						0.03

APPENDIX D

RACT/BACT/LAER Clearinghouse Results

RBLCID	FACILITY NAME	STATE	PERMIT No.	PERMIT DATE	DESCRIPTION	PROCESS NAME	FUEL	THRUPUT	UNIT	PROCESS NOTES	POLLUTANT	EMIS LIMIT	UNIT	AVG TIME	BASIS
MN-0058	VIRGINIA DEPARTMENT OF PUBLIC UTILITIES	MN	13700028-005	6/30/2005		BOILER, WOOD FIRED	WOOD	230	mmbtu/h		Particulate Matter (PM)	0.025	LB/MMBTU	3-HR TEST	BACT-PSD
MN-0058	VIRGINIA DEPARTMENT OF PUBLIC UTILITIES	MN	13700028-005	6/30/2005		BOILER, WOOD FIRED	WOOD	230	mmbtu/h		Particulate Matter < 10 µ (PM10)	0.025	LB/MMBTU	3-HR TEST	BACT-PSD
MN-0058	VIRGINIA DEPARTMENT OF PUBLIC UTILITIES	MN	13700028-005	6/30/2005		BOILER, WOOD FIRED	WOOD	230	mmbtu/h		Carbon Monoxide	0.3	LB/MMBTU	4-HOUR BLOCK AVERAGE	BACT-PSD
MN-0058	VIRGINIA DEPARTMENT OF PUBLIC UTILITIES	MN	13700028-005	6/30/2005	WOOD FIRED BOILER, 230 MMBTU/H HEAT INPUT, SPREADER STOKER	BOILER, WOOD FIRED	WOOD	230	mmbtu/h		Nitrogen Oxides (NOx)	0.15	LB/MMBTU	30 DAY AVERAGE	BACT-PSD
MN-0059	HIBBING PUBLIC UTILITIES	MN	13700027-003	6/30/2005		BOILER, WOOD FIRED	WOOD	230	mmbtu/h		Particulate Matter < 10 µ (PM10)	0.025	LB/MMBTU	3-HR TEST	BACT-PSD
MN-0059	HIBBING PUBLIC UTILITIES	MN	13700027-003	6/30/2005		BOILER, WOOD FIRED	WOOD	230	mmbtu/h		Particulate Matter (PM)	0.025	LB/MMBTU	3-H TEST	BACT-PSD
MN-0059	HIBBING PUBLIC UTILITIES	MN	13700027-003	6/30/2005		BOILER, WOOD FIRED	WOOD	230	mmbtu/h		Carbon Monoxide	0.3	LB/MMBTU	4-HOUR BLOCK AVERAGE	BACT-PSD
MN-0059	HIBBING PUBLIC UTILITIES	MN	13700027-003	6/30/2005		BOILER, WOOD FIRED	WOOD	230	mmbtu/h		Nitrogen Oxides (NOx)	0.15	LB/MMBTU	30-DAY ROLING AVERAGE	BACT-PSD
ND-0020	RICHARDTON PLANT	ND	4004	8/4/2004		BOILER, COAL-FIRED	LIGNITE	250	MMBTU/H		Particulate Matter < 10 µ (PM10)	0.02	LB/MMBTU	3-HOUR AVERAGE	BACT-PSD
ND-0020	RICHARDTON PLANT	ND	4004	8/4/2004		BOILER, COAL-FIRED	LIGNITE	250	MMBTU/H		Sulfur Oxides (SOx)	0.09	LB/MMBTU	30 DAY ROLLING AVG.	BACT-PSD
ND-0020	RICHARDTON PLANT	ND	4004	8/4/2004		BOILER, COAL-FIRED	LIGNITE	250	MMBTU/H		Nitrogen Oxides (NOx)	0.1	LB/MMBTU	30 DAY ROLLING AVERAGE	BACT-PSD
ND-0020	RICHARDTON PLANT	ND	4004	8/4/2004		BOILER, COAL-FIRED	LIGNITE	250	MMBTU/H		Carbon Monoxide	0.11	LB/MMBTU	3 HOUR ROLLING AVERAGE	BACT-PSD
ND-0020	RICHARDTON PLANT	ND	4004	8/4/2004	ETHANOL PRODUCTION PLANT RATED AT 65 MILLION GALLONS PER YEAR.	BOILER, COAL-FIRED	LIGNITE	250	MMBTU/H	BOILER ACTS AS A CONTROL DEVICE FOR THE DISTILLER'S GRAIN DRYERS , DISTILLATION COLUMNS AND BIOMETHANATOR (I.E. GASES FROM THESE PROCESSES ARE ROUTED TO THE BOILER FOR COMBUSTION).	Particulate Matter (PM)	0.048	LB/MMBTU	3 HOUR AVERAGE	BACT-PSD
ND-0020	RICHARDTON PLANT	ND	4004	8/4/2004		DDGS COOLING		22	T/H		Particulate Matter < 10 µ (PM10)	0.004	GR/DSCF	3 HOUR AVERAGE	BACT-PSD
ND-0020	RICHARDTON PLANT	ND	4004	8/4/2004		GRAIN RECEIVING		420	T/H		Particulate Matter < 10 µ (PM10)	0.004	GR/DSCF	3 HOUR AVERAGE	BACT-PSD
ND-0020	RICHARDTON PLANT	ND	4004	8/4/2004		HAMMERMILLING		76	T/H		Particulate Matter < 10 µ (PM10)	0.004	GR/DSCF	3 HOUR AVERAGE	BACT-PSD
ND-0020	RICHARDTON PLANT	ND	4004	8/4/2004		DDGS LOADOUT		420	T/H		Particulate Matter < 10 µ (PM10)	0.004	GR/DSCF	3 HOUR AVERAGE	BACT-PSD
ND-0020	RICHARDTON PLANT	ND	4004	8/4/2004		COAL HANDLING		27	T/H		Particulate Matter < 10 µ (PM10)	0.004	GR/DSCF	3 HOUR AVERAGE	BACT-PSD

RBLCID	FACILITY NAME	STATE	PERMIT No.	PERMIT DATE	DESCRIPTION	PROCESS NAME	FUEL	THRUPUT	UNIT	PROCESS NOTES	POLLUTANT	EMIS LIMIT	UNIT	AVG TIME	BASIS
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004	THIS FACILITY BREWS AND PACKAGES BEER. EACH BOILER NOT TO EXCEED 180,000 LB STEAM/H OR 238 MMBTU/H. BOTH BOILERS TOGETHER NOT TO EXCEED 125,682 TONS COAL/ROLLING 12-MONTHS. THIS PTI, 14-05515, IS A MODIFICATION TO PTI #14-05143 ISSUED 11/15/01 FOR THE ADDITION OF AN 8.5 MW STEAM TURBINE GENERATOR TO AN EXISTING COAL FIRED BOILER (THERE WERE NO EMISSIONS FROM THE STEAM TURBINE ITSELF). THIS MODIFICATION WAS TO INCREASE THE HCL HOURLY AND T/YR LIMITS AND SO2/MMBTU LIMIT. THE T/YR FACILITYWIDE LIMITS HAVE NOT CHANGED, EXCEPT FOR HCL WHICH HAS INCREASE BY 46.1 T/YR IN THIS NEW PERMIT.	BOILER (2), COAL FIRED	COAL	238	MMBTU/H	TWO BOILERS, CAPABLE OF BURNING AND WITH LIMITS FOR COAL, NATURAL GAS, NUMBERS 2 AND 6 FUEL OILS. POUND PER HOUR LIMITS ARE FOR EACH BOILER; AND EXCEPT FOR VOC AND CO, ALL T/YR LIMITS ARE FOR BOTH BOILERS COMBINED. COAL USAGE FOR BOTH BOILERS TOGETHER NOT TO EXCEED 125,682 TONS/ROLLING 12 MONTHS. THESE LIMITS FOR THE COAL.	Nitrogen Oxides (NOx)	0.7	LB/MMBTU		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), COAL FIRED	COAL	238	MMBTU/H		Carbon Monoxide	5.2	LB/H	EACH BOILER	BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), COAL FIRED	COAL	238	MMBTU/H		Sulfur Dioxide (SO2)	1.6	LB/MMBTU		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	6/27/2004		BOILER (2), COAL FIRED	COAL	238	MMBTU/H		Particulate Matter < 10 µ (PM10)	0.01	GR/ACF		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NO. 6 FUEL OIL	NO. 6 FUEL OIL	238	MMBTU/H		Particulate Matter < 10 µ (PM10)	0.01	GR/ACF		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NO. 6 FUEL OIL	NO. 6 FUEL OIL	238	MMBTU/H		Nitrogen Oxides (NOx)	0.7	LB/MMBTU		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NO. 6 FUEL OIL	NO. 6 FUEL OIL	238	MMBTU/H		Carbon Monoxide	8.15	LB/H	EACH BOILER	BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NO. 6 FUEL OIL	NO. 6 FUEL OIL	238	MMBTU/H		Sulfur Dioxide (SO2)	1.6	LB/MMBTU		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NO. 2 FUEL OIL	NO. 2 FUEL OIL	238	MMBTU/H		Particulate Matter < 10 µ (PM10)	0.01	GR/ACF		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	6/27/2004		BOILER (2), NO. 2 FUEL OIL	NO. 2 FUEL OIL	238	MMBTU/H		Nitrogen Oxides (NOx)	0.7	LB/MMBTU		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NO. 2 FUEL OIL	NO. 2 FUEL OIL	238	MMBTU/H		Volatile Organic Compounds (VOC)	0.38	LB/H	EACH BOILER	BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NO. 2 FUEL OIL	NO. 2 FUEL OIL	238	MMBTU/H		Carbon Monoxide	8.5	LB/H	EACH BOILER	BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NO. 2 FUEL OIL	NO. 2 FUEL OIL	238	MMBTU/H		Sulfur Dioxide (SO2)	1.6	LB/MMBTU		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NATURAL GAS	NATURAL GAS	238	MMBTU/H		Particulate Matter < 10 µ (PM10)	0.01	GR/ACF		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NATURAL GAS	NATURAL GAS	238	MMBTU/H		Nitrogen Oxides (NOx)	0.7	LB/MMBTU		BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NATURAL GAS	NATURAL GAS	238	MMBTU/H		Carbon Monoxide	20	LB/H	EACH BOILER	BACT-PSD
OH-0241	MILLER BREWING COMPANY - TRENTON	OH	14-05515	5/27/2004		BOILER (2), NATURAL GAS	NATURAL GAS	238	MMBTU/H		Sulfur Dioxide (SO2)	1.6	LB/MMBTU		BACT-PSD

RBLCID	FACILITY NAME	STATE	PERMIT No.	PERMIT DATE	DESCRIPTION	PROCESS NAME	FUEL	THRUPUT	UNIT	PROCESS NOTES	POLLUTANT	EMIS LIMIT	UNIT	AVG TIME	BASIS
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		WOOD FIRED BOILERS (7)	WOOD	175	MMBTU/H		Particulate Matter < 10 µ (PM10)	3.97	LB/H		BACT-PSD
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		WOOD FIRED BOILERS (7)	WOOD	175	MMBTU/H		Nitrogen Oxides (NOx)	27.98	LB/H		N/A
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		WOOD FIRED BOILERS (7)	WOOD	175	MMBTU/H		Carbon Monoxide	31.8	LB/H		BACT-PSD
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		WOOD FIRED BOILERS (7)	WOOD	175	MMBTU/H		Sulfur Dioxide (SO2)	22.13	LB/H		N/A
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		WOOD HANDLING SYSTEM		130495	ACFM		Particulate Matter < 10 µ (PM10)	6.71	LB/H		BACT-PSD
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		AUXILIARY BOILER	FUEL OIL #2	227	MMBTU/H		Nitrogen Oxides (NOx)	43.13	LB/H	ON FUEL OIL	N/A
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		AUXILIARY BOILER	FUEL OIL #2	227	MMBTU/H		Carbon Monoxide	27.24	LB/H	WITH FUEL OIL	BACT-PSD
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004	SEVEN BOILERS PURCHASED FROM AN ETHANOL PLANT, REBUILDING TO BURN WOOD AND TO GENERATE POWER, USING WOOD WASTE	AUXILIARY BOILER	FUEL OIL #2	227	MMBTU/H	Oxidation catalyst, selective catalytic reduction, sodium bicarbonate injection, reverse air baghouse w/98% control.	Particulate Matter < 10 µ (PM10)	9.08	LB/H	WITH FUEL OIL	BACT-PSD
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		AUXILIARY BOILER	FUEL OIL #2	227	MMBTU/H		Sulfur Dioxide (SO2)	2.84	LB/H	FOR FUEL OIL	N/A
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		AUXILIARY BOILER	NATURAL GAS	247	MMBTU/H		Nitrogen Oxides (NOx)	14.82	LB/H	WITH NATURAL GAS	N/A
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		AUXILIARY BOILER	NATURAL GAS	247	MMBTU/H		Carbon Monoxide	27.17	LB/H	WITH NATURAL GAS	BACT-PSD
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		AUXILIARY BOILER	NATURAL GAS	247	MMBTU/H		Particulate Matter < 10 µ (PM10)	1.73	LB/H	WITH NATURAL GAS	BACT-PSD

RBLCID	FACILITY NAME	STATE	PERMIT No.	PERMIT DATE	DESCRIPTION	PROCESS NAME	FUEL	THRUPUT	UNIT	PROCESS NOTES	POLLUTANT	EMIS LIMIT	UNIT	AVG TIME	BASIS
*OH-0269	BIOMASS ENERGY, LLC-SOUTH POINT POWER	OH	07-00534	1/5/2004		AUXILIARY BOILER	NATURAL GAS	247	MMBTU/H		Sulfur Dioxide (SO2)	0.15	LB/H	WITH NATURAL GAS	N/A
LA-0126	JOYCE MILL	LA	PSD-LA-679	4/24/2002	JOYCE MILL PRODUCES LUMBER AND WOOD WASTES, SUCH AS WOOD CHIPS, SHAVINGS, SAWDUST AND BARK. THE WOOD WASTE IS USED FOR FUEL IN THE BOILERS TO PRODUCE STEAM FOR THE MILL.	KIPPER BOILERS NO.1 AND NO.2 (EACH)	WOOD WASTE	58.3	MMBTU/H EACH	EMISSION POINTS 74A (NO.1) AND 74B (NO.2)	Carbon Monoxide	105.5	LB/H	EACH	Other Case-by-Case
LA-0126	JOYCE MILL	LA	PSD-LA-679	4/24/2002		MCBURNEY BOILER NO.4	WOOD WASTE	154.2	MMBTU/H	EMISSION POINT 75A.	Carbon Monoxide	279.1	LB/H		Other Case-by-Case
VA-0268	THERMAL VENTURES	VA	30529	2/15/2002	STEAM PRODUCTION FACILITY	BOILER, STEAM	WOOD	120	MMBTU/H	Wood limit 70% Mixture. Wood/Bark excluding any wood which contains chemical treatments or has affixed thereto paint and/or finishing materials or paper or plastic laminates: Average annual heat content: 5,000 Btu/lb HHV	Particulate Matter (PM)	0.15	LB/MMBTU		Other Case-by-Case
VA-0268	THERMAL VENTURES	VA	30529	2/15/2002		BOILER, STEAM	WOOD	120	MMBTU/H		Particulate Matter < 10 µ (PM10)	0.14	LB/MMBTU		Other Case-by-Case
VA-0268	THERMAL VENTURES	VA	30529	2/15/2002		BOILER, STEAM	WOOD	120	MMBTU/H		Sulfur Dioxide (SO2)	0.47	LB/MMBTU		Other Case-by-Case
VA-0268	THERMAL VENTURES	VA	30529	2/15/2002		BOILER, STEAM	WOOD	120	MMBTU/H		Nitrogen Dioxide (NO2)	0.4	LB/MMBTU		Other Case-by-Case
VA-0268	THERMAL VENTURES	VA	30529	2/15/2002		BOILER, STEAM	WOOD	120	MMBTU/H		Carbon Monoxide	0.44	LB/MMBTU		Other Case-by-Case
VA-0268	THERMAL VENTURES	VA	30529	2/15/2002		BOILER, STEAM	COAL	120	MMBTU/H	In order to meet the annual emission limitations included in this permit, the wood/coal mixture shall not exceed 30% coal by BTU content on an annual basis.	Particulate Matter (PM)	0.15	LB/MMBTU		Other Case-by-Case

RBLCID	FACILITY NAME	STATE	PERMIT No.	PERMIT DATE	DESCRIPTION	PROCESS NAME	FUEL	THRUPUT	UNIT	PROCESS NOTES	POLLUTANT	EMIS LIMIT	UNIT	AVG TIME	BASIS
VA-0268	THERMAL VENTURES	VA	30529	2/15/2002		BOILER, STEAM	COAL	120	MMBTU/H	Average annual heat content 13,000 Btu/lb HHV. Average sulfur content per shipment 0.9% and average ash content per shipment 7%.	Particulate Matter < 10 µ (PM10)	0.14	LB/MMBTU		Other Case-by-Case
VA-0268	THERMAL VENTURES	VA	30529	2/15/2002	STEAM PRODUCTION FACILITY	BOILER, STEAM	COAL	120	MMBTU/H	In order to meet the annual emission limitations included in this permit, the wood/coal mixture shall not exceed 30% coal by BTU content on an annual basis. Average annual heat content 13,000 Btu/lb HHV. Average sulfur content per shipment 0.9% and average ash content per shipment 7%.	Sulfur Dioxide (SO2)	0.47	LB/MMBTU		Other Case-by-Case
VA-0268	THERMAL VENTURES	VA	30529	2/15/2002		BOILER, STEAM	COAL	120	MMBTU/H		Nitrogen Oxides (NOx)	0.4	LB/MMBTU		Other Case-by-Case
VA-0268	THERMAL VENTURES	VA	30529	2/15/2002		BOILER, STEAM	COAL	120	MMBTU/H		Carbon Monoxide	0.44	LB/MMBTU		Other Case-by-Case
LA-0125	WILLAMETTE INDUSTRIES, INC.	LA	PSD-LA-627 (M-1)	1/7/2002	WILLAMETTE INDUSTRIES REQUESTED A PSD MODIFICATION TO INSTALL A REGENERATIVE THERMAL OXIDIZER OR CATALYTIC OXIDIZER (RTO/RCO), REMOVE THE PRODUCTION LIMIT IMPOSED BY PART 70 OPERATING PERMIT NO. 3240-00010-V2, AND MODERNIZE THE PLYWOOD MANUFACTURING PROCESS AT THE DODSON DIVISION.	WOOD FIRED BOILER	WOOD	233	MMBTU/H	EIQ NO. 017. NO PHYSICAL MODIFICATION TO THE BOILERS WILL BE NEEDED (FIRING RATES WILL BE INCREASED) SO BACT IS NOT REQUIRED FOR EMISSIONS FROM BOILERS.	Nitrogen Oxides (NOx)	47.91	LB/H		Other Case-by-Case
LA-0125	WILLAMETTE INDUSTRIES, INC.	LA	PSD-LA-627 (M-1)	1/7/2002		WOOD FIRED BOILER	WOOD	233	MMBTU/H		Carbon Monoxide	191.58	LB/H		Other Case-by-Case
LA-0125	WILLAMETTE INDUSTRIES, INC.	LA	PSD-LA-627 (M-1)	1/7/2002		VENNER DRYER NO.1 COOLING ZONE	NATURAL GAS			EIQ NO. 028. SCC FOR GAS VENEER DYER, PINES. NO THROUGHPUT GIVEN.	Nitrogen Oxides (NOx)	0.37	LB/H		BACT-PSD
LA-0125	WILLAMETTE INDUSTRIES, INC.	LA	PSD-LA-627 (M-1)	1/7/2002		VENNER DRYER NO.1 COOLING ZONE	NATURAL GAS				Carbon Monoxide	0.09	LB/H		BACT-PSD
LA-0125	WILLAMETTE INDUSTRIES, INC.	LA	PSD-LA-627 (M-1)	1/7/2002		VENNER DRYER NO.2 COOLING ZONE	NATURAL GAS			EIQ NO. 029. SCC FOR GAS VENEER DYER, PINES. NO THROUGHPUT GIVEN.	Nitrogen Oxides (NOx)	0.88	LB/H		BACT-PSD
LA-0125	WILLAMETTE INDUSTRIES, INC.	LA	PSD-LA-627 (M-1)	1/7/2002		VENNER DRYER NO.2 COOLING ZONE	NATURAL GAS				Carbon Monoxide	0.22	LB/H		BACT-PSD
LA-0125	WILLAMETTE INDUSTRIES, INC.	LA	PSD-LA-627 (M-1)	1/7/2002		VENEER DRYERS, HOT ZONES	NATURAL GAS			EMISSIONS INFORMATION IN THE PERMIT IS ORGANIZED UNDER THE REGENERATIVE THERMAL OXIDIZER OR	Nitrogen Oxides (NOx)	10.27	LB/H		BACT-PSD
LA-0125	WILLAMETTE INDUSTRIES, INC.	LA	PSD-LA-627 (M-1)	1/7/2002		VENEER DRYERS, HOT ZONES	NATURAL GAS				Carbon Monoxide	9.31	LB/H		BACT-PSD

RBLCID	FACILITY NAME	STATE	PERMIT No.	PERMIT DATE	DESCRIPTION	PROCESS NAME	FUEL	THRUPUT	UNIT	PROCESS NOTES	POLLUTANT	EMIS LIMIT	UNIT	AVG TIME	BASIS
VA-0267	VPI POWER STATION	VA	20124	8/30/2001		BOILER, OVERFEED STOKER	COAL	146.7	MMBTU/H		Particulate Matter < 10 µ (PM10)	2.9	LB/H		BACT-PSD
VA-0267	VPI POWER STATION	VA	20124	8/30/2001		BOILER, OVERFEED STOKER	COAL	146.7	MMBTU/H		Sulfur Dioxide (SO2)	6.16 23.6	LB/H		BACT-PSD
VA-0267	VPI POWER STATION	VA	20124	8/30/2001	Steam generation for electricity.	BOILER, OVERFEED STOKER	COAL	146.7	MMBTU/H	No. 11 boiler. Boiler produces steam for generation of electricity.	Nitrogen Dioxide (NO2)	36.1	LB/H		BACT-PSD
VA-0267	VPI POWER STATION	VA	20124	8/30/2001		BOILER, OVERFEED STOKER	COAL	146.7	MMBTU/H		Carbon Monoxide	33.2	LB/H		BACT-PSD
VA-0267	VPI POWER STATION	VA	20124	8/30/2001		BOILER, OVERFEED STOKER	COAL	146.7	MMBTU/H		Particulate Matter (PM)	2.9	LB/H		BACT-PSD
AR-0045	COLUMBIAN CHEMICALS - EL DORADO	AR	906-AOP-R1 (70-0014)	8/9/2001	This plant makes carbon black using the oil furnance process. This determination is a modification. Emission Increases of SO2 and NOx will exceed the PSD significance levels. Increases of PM10 emissions are less than the PSD threshold. Other pollutants' proposed emissions are lower than the past actual emissions because of the addition of new control equipment. Pollutant Emissions (T/yr) Carbon Disulfide 87.75 Carbonyl sulfide 13.46 Hydrogen 117.76 TRS 219.04	COAL-FIRED BOILERS (2)	SUB-BITUMINOUS COAL	8700	MMBTU/H FOR EACH	CO catalyst technology used with a coal fired source was deemed technically infeasible. Due to position in ductwork, the catalyst is exposed to a substantial amount of fly ash in the flue gas stream. No physical modification was made for this process under this determination, but permitted emission rates for ppm emissions of CO change due to the use of new emission factors.	Carbon Monoxide	100	PPM	24 hr. average	Other Case-by-Case
AR-0045	COLUMBIAN CHEMICALS - EL DORADO	AR	906-AOP-R1 (70-0014)	8/9/2001		CARBON BLACK MFG, UNIT D STACK & VENT	NATURAL GAS				Sulfur Dioxide (SO2)	0.2	LB/H		BACT-PSD
AR-0045	COLUMBIAN CHEMICALS - EL DORADO	AR	906-AOP-R1 (70-0014)	8/9/2001		CARBON BLACK MFG, UNIT D STACK & VENT	NATURAL GAS			Throughput is confidential. This carbon black mfg process is being added. New stacks: SN-31, SN-48, SN-49. BACT determination for SO2 and NOx only.	Nitrogen Oxides (NOx)	7.7	LB/H		BACT-PSD
AR-0045	COLUMBIAN CHEMICALS - EL DORADO	AR	906-AOP-R1 (70-0014)	8/9/2001		CARBON BLACK MFG., UNITS A, B, & C	FEEDSTOCK OIL				Sulfur Dioxide (SO2)	2530	LB/H	combined	BACT-PSD
AR-0045	COLUMBIAN CHEMICALS - EL DORADO	AR	906-AOP-R1 (70-0014)	8/8/2001		CARBON BLACK MFG., UNITS A, B, & C	FEEDSTOCK OIL				Nitrogen Oxides (NOx)	246	LB/H	combined	BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		BOILER, POWER, COAL-FIRED	COAL	249	MMBTU/H		Particulate Matter (PM)	0.16	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001	MODIFICATION FOR INSTALLATION OF NEW EQUIPMENT TO INCREASE PRODUCTION CAPACITY.	BOILER, POWER, COAL-FIRED	COAL	249	MMBTU/H	POWER BOILER CAN FIRE COAL, NO. 6 FUEL OIL, OR BARK/WOOD FIBER SLUDGE.	Sulfur Dioxide (SO2)	0.8	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		BOILER, POWER, COAL-FIRED	COAL	249	MMBTU/H		Nitrogen Oxides (NOx)	0.4	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		BOILER, POWER, COAL-FIRED	COAL	249	MMBTU/H		Carbon Monoxide	0.208	LB/MMBTU		BACT-PSD

RBLCID	FACILITY NAME	STATE	PERMIT No.	PERMIT DATE	DESCRIPTION	PROCESS NAME	FUEL	THRUPUT	UNIT	PROCESS NOTES	POLLUTANT	EMIS LIMIT	UNIT	AVG TIME	BASIS
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		BOILER, POWER, OIL-FIRED	NO. 6 FUEL OIL	249	MMBTU/H		Particulate Matter (PM)	0.0562	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		BOILER, POWER, OIL-FIRED	NO. 6 FUEL OIL	249	MMBTU/H		Sulfur Dioxide (SO2)	0.8	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		BOILER, POWER, OIL-FIRED	NO. 6 FUEL OIL	249	MMBTU/H		Nitrogen Oxides (NOx)	0.367	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		BOILER, POWER, OIL-FIRED	NO. 6 FUEL OIL	249	MMBTU/H		Carbon Monoxide	0.033	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		BOILER, POWER, WOODWASTE-FIRED	WOODWASTE	600	MMBTU/H	POWER BOILER CAN FIRE COAL, NO. 6 FUEL OIL, OR BARK/WOOD FIBER SLUDGE.	Particulate Matter (PM)	0.25	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		BOILER, POWER, WOODWASTE-FIRED	WOODWASTE	600	MMBTU/H		Sulfur Dioxide (SO2)	0.024	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001	MODIFICATION FOR INSTALLATION OF NEW EQUIPMENT TO INCREASE PRODUCTION CAPACITY.	BOILER, POWER, WOODWASTE-FIRED	WOODWASTE	600	MMBTU/H		Nitrogen Oxides (NOx)	0.35	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		BOILER, POWER, WOODWASTE-FIRED	WOODWASTE	600	MMBTU/H		Carbon Monoxide	0.5	LB/MMBTU		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		RECOVERY BOILER	NO. 6 FUEL OIL	557	MMBTU/H		Sulfur Dioxide (SO2)	979.2	LB/H		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		RECOVERY BOILER	NO. 6 FUEL OIL	557	MMBTU/H		Nitrogen Dioxide (NO2)	586.5	LB/H		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		RECOVERY BOILER	NO. 6 FUEL OIL	557	MMBTU/H		Carbon Monoxide	357.1	LB/H		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		RECOVERY BOILER	NO. 6 FUEL OIL	557	MMBTU/H		Particulate Matter (PM)	0.044	GR/DSCF @ 8% O2		N/A
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		SMELT TANKS				BOILER FIRES AN AVERAGE OF 5.59 MILLION POUNDS OF BLACK LIQUOR SOLIDS PER DAY.	Sulfur Dioxide (SO2)	6.2	LB/H		BACT-PSD
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		LIME KILN	NO.6 FUEL OIL	212	LB/MMBTU		Particulate Matter (PM)	0.13	GR/DSCF @ 10% O2		N/A
NC-0092	RIEGELWOOD MILL	NC	03138R16	5/10/2001		LIME KILN	NO.6 FUEL OIL	212	LB/MMBTU		Total Reduced Sulfur	8	PPM @ 10% O2		N/A

APPENDIX E

ESA Documentation

STATE OF MICHIGAN

JENNIFER M. GRANHOLM
GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
LANSING

REBECCA A. HUMPHRIES
DIRECTOR

August 8, 2006

Mr. Jeffrey Jaros
NTH Consultants, Ltd.
608 S. Washington
Lansing, MI 48933

RE: **Two proposed air permit locations in Holland and Marquette, Michigan submitted to DNR Endangered Species Assessment web application**

Dear Mr. Jaros:

The location of the proposed projects were checked against known localities for rare species and unique natural features, which are recorded in a statewide database. This continuously updated database is a comprehensive source of existing data on Michigan's endangered, threatened, or otherwise significant plant and animal species, natural plant communities, and other natural features. Records in the database indicate that a qualified observer has documented the presence of special natural features at a site. The absence of records in the database for a particular site may mean that the site has not been surveyed. Records are not always up-to-date, and may require verification. In some cases, the only way to obtain a definitive statement on the status of natural features is to have a competent biologist perform a complete field survey.

Under Act 451 of 1994, the Natural Resources and Environmental Protection Act, Part 365, Endangered Species Protection, "a person shall not take, possess, transport, ...fish, plants, and wildlife indigenous to the state and determined to be endangered or threatened," unless first receiving an Endangered Species Permit from the Department of Natural Resources, Wildlife Division. *Responsibility to protect endangered and threatened species is not limited to the list below. Other species may be present that have not been recorded in the database.*

The presence of threatened or endangered species does not preclude activities or development, but may require alterations in the project plan. Special concern species are not protected under endangered species legislation, but recommendations regarding their protection may be provided. Protection of special concern species will help prevent them from declining to the point of being listed as threatened or endangered in the future.

The following is a summary of the results for the project in Ottawa County, City of Holland, T5N R16W section 36 **and** Marquette County, City of Marquette, T48N R25W section 11:

> The project should have no impact on rare or unique natural features at the location specified above *if it* proceeds according to the plans provided. Please contact me for an evaluation if the project plans are changed.

Thank you in for your coordination in addressing the protection of Michigan's natural resource heritage. Responses and correspondence can be sent to: Michigan Department of Natural Resources, Wildlife Division – Natural Heritage Program, PO Box 30180, Lansing, MI 48909. If you have further questions, please call me at 517-373-1263 or e-mail at SargenL2@michigan.gov .

Sincerely,

Lori A Sargent

Lori G. Sargent
Endangered Species Specialist
Wildlife Division

STEVENS T. MASON BUILDING • P.O. BOX 30028 • LANSING, MICHIGAN 48909-7528
www.michigan.gov/dnr • (517) 373-2329

United States Department of the Interior

FISH AND WILDLIFE SERVICE
East Lansing Field Office (ES)
2651 Coolidge Road, Suite 101
East Lansing, Michigan 48823-6316

IN REPLY REFER TO:

November 24, 2006

Mr. Jeffrey P. Jaros
NTH Consultants, Ltd.
608 S. Washington Avenue
Lansing, MI 48933

Re: Endangered Species List Request, Proposed Construction of Solid Fuel Fired Boiler, Northern Michigan University, Marquette, Marquette County, Michigan

Dear Mr. Jaros:

Thank you for your October 24, 2006 request for information regarding federally listed and proposed threatened and endangered species, candidate species, or critical habitat near your proposed project. Your request and this response are made pursuant to the Endangered Species Act of 1973, as amended (Act). Under this project, Northern Michigan University proposes to install a cogeneration of coal/wood/natural gas fired circulating fluidized bed boiler on the north end of its campus, next to the existing Ripley Heating Plant.

Our records do not indicate the presence of federally listed species or critical habitat near your proposed project. This precludes the need for further action on this project as required by the Act. If, however, more than six months pass, project plans change, or new information becomes available that indicates listed species or proposed species may be affected, you should conduct further consultation with this office.

We appreciate your concern for endangered and threatened species. Any questions can be directed to Tameka Dandridge of this office at Tameka_Dandridge@fws.gov or 517/351-8315.

Sincerely,

Craig A. Czarnecki
Field Supervisor

cc: MDNR-Wildlife Division, Lansing, MI (Attn: Lori Sargent)

s: admin/archives/nov06/se list/NTH-NMU-solidfuel.tnd.doc

APPENDIX F

Cooling Tower Modeling Output

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****************************************************************************************************************************
  EPRI PLUME AND DRIFT ANALYSIS SYSTEM PREPROCESSOR CODE, PRE-RELEASE VERSION 09-01-90
  CASE STUDY: Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)

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INPUT INFORMATION

SURFACE TAPE TYPE:	CD144
TOWER TYPE:	LINEAR MECHANICAL DRAFT
TOWER HEIGHT (M):	12.50
TOWER DIAMETER (M):	47.03
TOWER HEAT (KW):	7000.00
TOWER AIR FLOW (KG/S):	679.50
SITE LATITUDE:	46.60
SITE LONGITUDE:	87.40
SITE TIME ZONE:	EASTERN
ROUGHNESS HEIGHT (CM):	0.07
REFERENCE HEIGHT (M):	10.00
RECORD STOPPING SWITCH:	8760
RECORD SKIPPING FACTOR:	1
HOURLY RECORD PRINT LOG:	NOT SELECTED
BI-DAILY MIXING HEIGHT TAPE:	SELECTED
MIXING HEIGHT TYPE:	RURAL
FOGGING/ICING OPTION:	SELECTED
DRIFT OPTION:	SELECTED

MONTHLY CLEARNESS INDEX

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
.460	.490	.520	.490	.530	.550	.560	.550	.530	.500	.420	.420

TOTAL DAILY SOLAR ENERGY DEPOSITION
(LONG-TERM AVERAGE FOR MONTH)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5.74	8.79	13.10	16.08	20.47	22.69	22.52	19.34	14.78	10.05	5.82	4.60

```
1            ****************************************WIND SPEED FREQUENCY
TABLE****************************************
             Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)
  WIND       **************************************************WIND
FROM**************************************************
  SPEED         N    NNE    NE    ENE    E    ESE    SE    SSE    S    SSW    SW    WSW    W
WNW   NW    NNW
  RANGE      **************************************************WIND
HEADED**************************************************
  (M/S)         S    SSW    SW    WSW    W    WNW    NW    NNW    N    NNE    NE    ENE    E
ESE   SE    SSE   SUM

  0  TO   1  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  1  TO   2  0.009 0.003 0.003 0.003 0.004 0.002 0.003 0.004 0.008 0.009 0.008 0.005 0.007
0.003 0.004 0.005 0.081
```

```
   2  TO    3  0.017 0.009 0.011 0.007 0.009 0.004 0.007 0.010 0.022 0.017 0.012 0.015 0.022
0.011 0.009 0.010 0.192
   3  TO    4  0.016 0.015 0.012 0.006 0.007 0.003 0.006 0.012 0.026 0.021 0.015 0.007 0.019
0.013 0.015 0.009 0.202
   4  TO    5  0.014 0.019 0.015 0.005 0.002 0.002 0.007 0.010 0.031 0.016 0.013 0.008 0.011
0.012 0.011 0.008 0.183
   5  TO    6  0.012 0.012 0.010 0.002 0.001 0.001 0.006 0.008 0.030 0.016 0.007 0.007 0.006
0.006 0.007 0.008 0.139
   6  TO    7  0.012 0.006 0.004 0.001 0.000 0.001 0.002 0.005 0.017 0.007 0.004 0.003 0.004
0.004 0.006 0.005 0.083
   7  TO    8  0.008 0.006 0.001 0.000 0.000 0.000 0.001 0.003 0.013 0.006 0.002 0.002 0.002
0.003 0.005 0.002 0.056
   8  TO    9  0.005 0.003 0.000 0.000 0.000 0.000 0.000 0.001 0.005 0.003 0.002 0.001 0.001
0.001 0.002 0.002 0.025
   9  TO   10  0.006 0.002 0.000 0.000 0.000 0.000 0.000 0.001 0.003 0.003 0.001 0.001 0.001
0.000 0.002 0.001 0.019
  10  TO   11  0.005 0.002 0.000 0.000 0.000 0.000 0.000 0.001 0.001 0.000 0.000 0.001 0.000
0.000 0.000 0.000 0.011
  11  TO   12  0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.000
0.000 0.000 0.000 0.005
  12  TO   13  0.001 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.003
  13  TO   14  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.001
  14  TO   15  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.001
  15  TO   20  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  20  TO   25  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  25  TO   30  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  30  TO OVER 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000


**********************************************************************************************
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 AVERAGE     4.47699      VARIANCE   4.52228      STD DEV     2.12657
 STD ERR     0.02459      SKEWNESS   1.31718      KURTOSIS    2.01213

**********************************************************************************************
************************************
1              **********************************RELATIVE HUMIDITY FREQUENCY
TABLE**********************************
               Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)
   RELATIVE    **********************************************WIND
FROM*********************************************
   HUMIDITY        N     NNE    NE     ENE     E     ESE    SE     SSE     S     SSW    SW     WSW    W
WNW   NW    NNW
   RANGE(%)    *********************************************WIND
HEADED*********************************************
                   S     SSW    SW     WSW     W     WNW    NW     NNW     N     NNE    NE     ENE    E
ESE   SE    SSE   SUM

   0  TO   10  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  10  TO   20  0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.000 0.001 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.003
  20  TO   30  0.000 0.001 0.000 0.000 0.000 0.001 0.002 0.003 0.003 0.001 0.001 0.001 0.001
0.000 0.000 0.000 0.015
  30  TO   40  0.001 0.003 0.004 0.002 0.002 0.002 0.004 0.005 0.007 0.004 0.004 0.004 0.004
0.003 0.001 0.001 0.050
  40  TO   50  0.002 0.005 0.007 0.002 0.001 0.000 0.002 0.005 0.013 0.007 0.007 0.004 0.005
0.003 0.002 0.002 0.066
  50  TO   60  0.008 0.008 0.008 0.004 0.001 0.001 0.001 0.005 0.020 0.011 0.008 0.006 0.008
0.005 0.005 0.004 0.103
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  60   TO  70   0.014 0.010 0.009 0.003 0.003 0.001 0.002 0.007 0.018 0.012 0.008 0.007 0.010
0.009 0.011 0.006 0.130
  70   TO  80   0.015 0.012 0.008 0.003 0.002 0.001 0.003 0.006 0.026 0.016 0.009 0.010 0.014
0.014 0.013 0.012 0.162
  80   TO  90   0.029 0.014 0.009 0.006 0.006 0.003 0.005 0.009 0.026 0.020 0.016 0.010 0.022
0.014 0.018 0.014 0.221
  90   TO 100   0.027 0.016 0.009 0.004 0.004 0.004 0.007 0.009 0.029 0.020 0.009 0.007 0.007
0.005 0.010 0.009 0.175
 100   TO OVER 0.012 0.009 0.003 0.002 0.002 0.001 0.004 0.005 0.011 0.008 0.004 0.002 0.003
0.001 0.003 0.003 0.074


*********************************************************************************************
************************************
 AVERAGE    74.66025      VARIANCE 402.23911      STD DEV    20.05590
 STD ERR     0.23196      SKEWNESS    1.08593      KURTOSIS    1.22048

*********************************************************************************************
************************************
1              *********************************DEW POINT TEMPERATURE FREQUENCY
TABLE*********************************
               Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)
   DEW POINT   ***********************************************WIND
FROM*********************************************
   TEMP           N     NNE    NE     ENE     E     ESE    SE     SSE     S     SSW    SW     WSW     W
WNW   NW    NNW
   RANGE (C)   **********************************************WIND
HEADED********************************************
                  S     SSW    SW     WSW     W     WNW    NW     NNW     N     NNE    NE     ENE     E
ESE    SE     SSE    SUM

 -45   TO -40   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 -40   TO -35   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 -35   TO -30   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001
0.000 0.000 0.000 0.001
 -30   TO -25   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.002 0.001 0.004
0.002 0.000 0.000 0.010
 -25   TO -30   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.000 0.000 0.002 0.003
0.001 0.001 0.001 0.010
 -20   TO -15   0.001 0.000 0.001 0.000 0.001 0.001 0.000 0.000 0.003 0.004 0.004 0.005 0.009
0.006 0.008 0.004 0.047
 -15   TO -10   0.016 0.007 0.003 0.001 0.002 0.002 0.004 0.003 0.005 0.011 0.008 0.006 0.011
0.008 0.015 0.010 0.111
 -10   TO  -5   0.016 0.012 0.008 0.003 0.001 0.002 0.007 0.007 0.013 0.007 0.005 0.003 0.005
0.006 0.008 0.005 0.108
  -5   TO   0   0.021 0.015 0.009 0.004 0.005 0.005 0.005 0.007 0.025 0.014 0.011 0.006 0.009
0.006 0.008 0.007 0.158
   0   TO   5   0.018 0.014 0.008 0.004 0.003 0.001 0.004 0.007 0.019 0.012 0.004 0.003 0.009
0.007 0.010 0.012 0.138
   5   TO  10   0.021 0.015 0.013 0.004 0.004 0.002 0.004 0.010 0.024 0.013 0.007 0.007 0.008
0.006 0.006 0.007 0.150
  10   TO  15   0.014 0.010 0.012 0.004 0.003 0.001 0.004 0.012 0.030 0.014 0.011 0.008 0.012
0.009 0.004 0.003 0.151
  15   TO  20   0.003 0.004 0.003 0.003 0.002 0.001 0.002 0.007 0.033 0.021 0.012 0.007 0.003
0.002 0.002 0.001 0.106
  20   TO  25   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.003 0.002 0.001 0.001 0.001
0.001 0.000 0.000 0.010
  25   TO  30   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  30   TO  35   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  35   TO  40   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  40   TO  45   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
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45 TO OVER 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000

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AVERAGE	1.50883	VARIANCE	120.84354	STD DEV	10.99289
STD ERR	0.12714	SKEWNESS	0.12920	KURTOSIS	2.21745

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1 *******************************DRY BULB TEMPERATURE FREQUENCY
TABLE********************************

Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)

DRY BULB TEMP RANGE (C) / WIND FROM	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
WIND HEADED	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	SUM
-45 TO -40	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-40 TO -35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-35 TO -30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-30 TO -25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-25 TO -20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.003	0.002	0.000	0.000	0.008
-20 TO -15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.003	0.006	0.003	0.002	0.000	0.018
-15 TO -10	0.004	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.007	0.004	0.005	0.013	0.006	0.011	0.008	0.069
-10 TO -5	0.017	0.008	0.006	0.003	0.001	0.001	0.003	0.004	0.008	0.011	0.009	0.006	0.007	0.008	0.017	0.008	0.118
-5 TO 0	0.023	0.013	0.008	0.002	0.003	0.004	0.005	0.005	0.012	0.009	0.007	0.003	0.006	0.006	0.006	0.006	0.119
0 TO 5	0.020	0.017	0.007	0.005	0.005	0.002	0.005	0.005	0.020	0.013	0.007	0.005	0.010	0.008	0.012	0.011	0.151
5 TO 10	0.012	0.010	0.006	0.002	0.002	0.001	0.004	0.005	0.018	0.007	0.004	0.004	0.007	0.003	0.004	0.006	0.097
10 TO 15	0.017	0.011	0.009	0.003	0.003	0.002	0.005	0.009	0.025	0.015	0.004	0.004	0.006	0.005	0.006	0.007	0.131
15 TO 20	0.011	0.008	0.009	0.003	0.003	0.001	0.003	0.008	0.025	0.012	0.008	0.005	0.005	0.005	0.003	0.002	0.112
20 TO 25	0.004	0.008	0.011	0.005	0.003	0.001	0.003	0.012	0.029	0.013	0.010	0.008	0.008	0.006	0.002	0.002	0.126
25 TO 30	0.000	0.001	0.001	0.001	0.001	0.000	0.001	0.002	0.009	0.007	0.005	0.003	0.003	0.002	0.000	0.000	0.037
30 TO 35	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.003	0.003	0.003	0.002	0.001	0.000	0.000	0.000	0.014
35 TO 40	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40 TO 45	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45 TO OVER	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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AVERAGE	6.44997	VARIANCE	154.27522	STD DEV	12.42076
STD ERR	0.14365	SKEWNESS	1.16754	KURTOSIS	2.32720

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1              ***********************************STABILITY CLASS FREQUENCY
TABLE************************************
               Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)
   STABILITY   **********************************************WIND
FROM*******************************************************
   CLASS           N     NNE    NE     ENE     E     ESE    SE     SSE     S     SSW    SW     WSW     W
WNW    NW     NNW
               ********************************************WIND
HEADED*************************************************
                   S     SSW    SW     WSW     W     WNW    NW     NNW     N     NNE    NE     ENE     E
ESE    SE     SSE    SUM

         1     0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.002
         2     0.003 0.003 0.004 0.003 0.002 0.002 0.002 0.003 0.003 0.003 0.002 0.002 0.003
0.001 0.001 0.001 0.037
         3     0.007 0.011 0.016 0.005 0.002 0.001 0.003 0.005 0.016 0.009 0.009 0.008 0.007
0.005 0.004 0.003 0.113
         4     0.072 0.053 0.028 0.010 0.010 0.006 0.017 0.029 0.085 0.049 0.029 0.024 0.032
0.030 0.041 0.030 0.545
         5     0.015 0.007 0.007 0.005 0.006 0.004 0.006 0.011 0.035 0.019 0.012 0.009 0.014
0.011 0.011 0.009 0.180
         6     0.009 0.002 0.002 0.001 0.002 0.001 0.002 0.004 0.014 0.015 0.009 0.005 0.016
0.006 0.005 0.006 0.102
         7     0.003 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.003 0.002 0.003 0.002 0.003
0.001 0.001 0.001 0.021


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 AVERAGE     4.25201      VARIANCE    0.99227      STD DEV     0.99613
 STD ERR     0.01152      SKEWNESS    1.07871      KURTOSIS    1.21936

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1              ******************************************K FREQUENCY
TABLE******************************************
               Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)
    K          **********************************************WIND
FROM*******************************************************
  (UA/VE)          N     NNE    NE     ENE     E     ESE    SE     SSE     S     SSW    SW     WSW     W
WNW    NW     NNW
   RANGE       **********************************************WIND
HEADED*************************************************
                   S     SSW    SW     WSW     W     WNW    NW     NNW     N     NNE    NE     ENE     E
ESE    SE     SSE    SUM

 0.0  TO 0.1   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 0.1  TO 0.2   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 0.2  TO 0.3   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 0.3  TO 0.4   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 0.4  TO 0.5   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 0.5  TO 0.6   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 0.6  TO 0.7   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 0.7  TO 0.8   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 0.8  TO 0.9   0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
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0.000 0.000 0.000 0.000
 0.9  TO 1.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 1.0  TO 1.2  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 1.2  TO 1.4  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 1.4  TO 1.6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 1.6  TO 1.8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 1.8  TO 2.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.0  TO 2.5  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.5  TO 3.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 3.0  TO OVER 0.110 0.078 0.058 0.024 0.022 0.014 0.031 0.054 0.155 0.098 0.064 0.050 0.075
0.054 0.062 0.051 1.000


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 AVERAGE    3.50000     VARIANCE   0.00000     STD DEV    0.00000
 STD ERR    0.00000     SKEWNESS   1.00000     KURTOSIS   1.00000

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1             ****************************************VSTAR FREQUENCY
TABLE*****************************************
              Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)
              **********************************************WIND
FROM*******************************************
   VSTAR         N     NNE   NE    ENE    E    ESE   SE    SSE    S    SSW   SW    WSW    W
WNW   NW     NNW
   RANGE      ********************************************WIND
HEADED*******************************************
               S     SSW   SW    WSW    W    WNW   NW    NNW    N    NNE   NE    ENE    E
ESE   SE     SSE   SUM

   0  TO   1  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
   1  TO   2  0.093 0.067 0.054 0.023 0.020 0.011 0.026 0.048 0.141 0.087 0.058 0.047 0.070
0.052 0.056 0.045 0.895
   2  TO   3  0.003 0.002 0.001 0.000 0.000 0.001 0.001 0.000 0.002 0.002 0.001 0.001 0.001
0.001 0.001 0.002 0.020
   3  TO   4  0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.000 0.001 0.000 0.000
0.000 0.000 0.000 0.004
   4  TO   5  0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.000 0.000 0.000 0.001
0.000 0.001 0.001 0.007
   5  TO   6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.001
   6  TO   7  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
   7  TO   8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
   8  TO   9  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
   9  TO  10  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  10  TO  11  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  11  TO  12  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  12  TO  13  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
  13  TO  14  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
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0.000 0.000 0.000 0.000
14 TO 15 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
15 TO 20 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
20 TO 25 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
25 TO 30 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
30 TO OVER 0.012 0.009 0.003 0.002 0.002 0.001 0.004 0.005 0.011 0.008 0.004 0.002 0.003
0.001 0.003 0.003 0.074

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AVERAGE 4.03170 VARIANCE 76.75311 STD DEV 8.76089
STD ERR 0.10132 SKEWNESS 3.54087 KURTOSIS 12.83027

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1 ********************************PLUME LENGTH PARAMETER FREQUENCY
TABLE********************************
Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)
PLUME ***WIND
FROM**
LENGTH N NNE NE ENE E ESE SE SSE S SSW SW WSW W
WNW NW NNW
RANGE (M) ***WIND
HEADED***
S SSW SW WSW W WNW NW NNW N NNE NE ENE E
ESE SE SSE SUM

0.0 TO 0.2 0.099 0.071 0.054 0.023 0.020 0.012 0.027 0.049 0.145 0.091 0.060 0.048 0.072
0.053 0.059 0.047 0.931
0.2 TO 0.4 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
0.4 TO 0.6 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
0.6 TO 0.8 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
0.8 TO 1.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
1.0 TO 1.2 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
1.2 TO 1.4 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
1.4 TO 1.6 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
1.6 TO 1.8 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
1.8 TO 2.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
2.0 TO 2.2 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
2.2 TO 2.4 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
2.4 TO 2.6 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
2.6 TO 2.8 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
2.8 TO 3.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
3.0 TO 3.2 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
3.2 TO 3.4 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
3.4 TO 3.6 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

0.000 0.000 0.000 0.000
3.6 TO 3.8 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
3.8 TO 4.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
4.0 TO 4.2 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.001
4.2 TO 4.4 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
4.4 TO 4.6 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
4.6 TO 4.8 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
4.8 TO 5.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
5.0 TO 5.2 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
5.2 TO 5.4 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
5.4 TO 5.6 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
5.6 TO 5.8 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
5.8 TO 6.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
6.0 TO 6.2 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.001
6.2 TO 6.4 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
6.4 TO 6.6 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
6.6 TO 6.8 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
6.8 TO 7.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
7.0 TO 7.2 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
7.2 TO 7.4 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
7.4 TO 7.6 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
7.6 TO 7.8 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
7.8 TO 8.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
8.0 TO 8.2 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
8.2 TO 8.4 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
8.4 TO 8.6 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
8.6 TO 8.8 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
8.8 TO 9.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
9.0 TO 9.2 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
9.2 TO 9.4 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
9.4 TO 9.6 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
9.6 TO 9.8 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
9.8 TO 10.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
1 ********************************PLUME LENGTH PARAMETER FREQUENCY
TABLE**********************************

Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)

PLUME LENGTH RANGE (M)	WIND FROM N / WIND HEADED S	NNE / SSW	NE / SW	ENE / WSW	E / W	ESE / WNW	SE / NW	SSE / NNW	S / N	SSW / NNE	SW / NE	WSW / ENE	W / E	WNW / ESE	NW / SE	NNW / SSE	SUM
10.0 TO 10.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10.4 TO 10.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10.8 TO 11.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
11.2 TO 11.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
11.6 TO 12.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
12.0 TO 12.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.4 TO 12.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.8 TO 13.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
13.2 TO 13.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
13.6 TO 14.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.0 TO 14.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.4 TO 14.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.8 TO 15.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.2 TO 15.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
15.6 TO 16.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
16.0 TO 16.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
16.4 TO 16.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
16.8 TO 17.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
17.2 TO 17.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.6 TO 18.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.003
18.0 TO 18.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
18.4 TO 18.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
18.8 TO 19.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
19.2 TO 19.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
19.6 TO 20.0	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.004
20.0 TO 21.0	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
21.0 TO 22.0	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.004
22.0 TO 23.0	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.004
23.0 TO 24.0	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000				

0.000 0.000 0.000 0.003
24.0 TO 25.0 0.002 0.001 0.000 0.000 0.000 0.000 0.001 0.000 0.001 0.000 0.000 0.000 0.000
0.000 0.000 0.001 0.006
25.0 TO 26.0 0.001 0.000 0.000 0.000 0.000 0.000 0.001 0.000 0.001 0.001 0.000 0.000 0.000
0.000 0.000 0.000 0.005
26.0 TO 27.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.000 0.000 0.000 0.000
0.000 0.001 0.000 0.004
27.0 TO 28.0 0.000 0.001 0.001 0.000 0.000 0.000 0.000 0.000 0.001 0.001 0.000 0.000 0.000
0.000 0.000 0.000 0.004
28.0 TO 29.0 0.000 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.001 0.000 0.000 0.000
0.000 0.000 0.000 0.003
29.0 TO 30.0 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.000 0.001 0.000 0.000
0.000 0.000 0.000 0.004
30.0 TO 31.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.001
31.0 TO 32.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
32.0 TO 33.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.001
33.0 TO 34.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
34.0 TO 35.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
35.0 TO 36.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
36.0 TO 37.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
37.0 TO 38.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
38.0 TO 39.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
39.0 TO 40.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
40.0 TO OVER 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000

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****
AVERAGE 1.55888 VARIANCE 31.63983 STD DEV 5.62493
STD ERR 0.06506 SKEWNESS 4.17934 KURTOSIS 18.08287

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1 ********************************PLUME HEIGHT PARAMETER FREQUENCY
TABLE********************************
Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)
PLUME ***WIND
FROM***
HEIGHT N NNE NE ENE E ESE SE SSE S SSW SW WSW W
WNW NW NNW
RANGE (M) ***WIND
HEADED***
S SSW SW WSW W WNW NW NNW N NNE NE ENE E
ESE SE SSE SUM

0.0 TO 0.1 0.100 0.071 0.055 0.023 0.020 0.012 0.027 0.049 0.147 0.091 0.061 0.048 0.072
0.053 0.060 0.048 0.937
0.1 TO 0.2 0.001 0.001 0.000 0.000 0.001 0.000 0.000 0.001 0.001 0.000 0.000 0.000 0.001
0.001 0.000 0.000 0.007
0.2 TO 0.3 0.001 0.001 0.000 0.000 0.000 0.000 0.001 0.001 0.001 0.001 0.000 0.000 0.001
0.000 0.001 0.000 0.008
0.3 TO 0.4 0.001 0.001 0.001 0.000 0.000 0.000 0.000 0.000 0.002 0.001 0.000 0.000 0.000
0.000 0.000 0.000 0.007
0.4 TO 0.5 0.001 0.001 0.000 0.001 0.000 0.000 0.001 0.001 0.002 0.001 0.000 0.000 0.000
0.000 0.000 0.000 0.008
0.5 TO 0.6 0.001 0.001 0.000 0.000 0.000 0.000 0.001 0.000 0.001 0.001 0.001 0.000 0.000

```
0.000 0.000 0.000 0.007
 0.6  TO 0.7  0.001 0.001 0.001 0.000 0.000 0.000 0.001 0.000 0.001 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.006
 0.7  TO 0.8  0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.001 0.000 0.000 0.000
0.000 0.000 0.000 0.004
 0.8  TO 0.9  0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.000 0.000 0.000
0.000 0.000 0.001 0.005
 0.9  TO 1.0  0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.003
 1.0  TO 1.1  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.001 0.000 0.000 0.000
0.000 0.000 0.000 0.003
 1.1  TO 1.2  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.001
 1.2  TO 1.3  0.000 0.000 0.000 0.000 0.001 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.002
 1.3  TO 1.4  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.001
 1.4  TO 1.5  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 1.5  TO 1.6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 1.6  TO 1.7  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 1.7  TO 1.8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 1.8  TO 1.9  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 1.9  TO 2.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.0  TO 2.1  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.1  TO 2.2  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.2  TO 2.3  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.3  TO 2.4  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.4  TO 2.5  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.5  TO 2.6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.6  TO 2.7  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.7  TO 2.8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.8  TO 2.9  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 2.9  TO 3.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 3.0  TO 3.1  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 3.1  TO 3.2  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 3.2  TO 3.3  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 3.3  TO 3.4  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 3.4  TO 3.5  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 3.5  TO 3.6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 3.6  TO 3.7  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 3.7  TO 3.8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 3.8  TO 3.9  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
```

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 3.9  TO 4.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 4.0  TO 4.1  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 4.1  TO 4.2  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 4.2  TO 4.3  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 4.3  TO 4.4  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 4.4  TO 4.5  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 4.5  TO 4.6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 4.6  TO 4.7  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 4.7  TO 4.8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 4.8  TO 4.9  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 4.9  TO 5.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
1             *******************************PLUME HEIGHT PARAMETER FREQUENCY
TABLE********************************
              Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)
   PLUME      **********************************************WIND
FROM**********************************************
   HEIGHT        N     NNE    NE    ENE     E    ESE    SE    SSE     S    SSW    SW    WSW     W
WNW   NW    NNW
   RANGE (M)  *********************************************WIND
HEADED*********************************************
                 S     SSW    SW    WSW     W    WNW    NW    NNW     N    NNE    NE    ENE     E
ESE   SE    SSE   SUM

 5.0  TO 5.2  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 5.2  TO 5.4  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 5.4  TO 5.6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 5.6  TO 5.8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 5.8  TO 6.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 6.0  TO 6.2  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 6.2  TO 6.4  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 6.4  TO 6.6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 6.6  TO 6.8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 6.8  TO 7.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 7.0  TO 7.2  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 7.2  TO 7.4  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 7.4  TO 7.6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 7.6  TO 7.8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 7.8  TO 8.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 8.0  TO 8.2  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 8.2  TO 8.4  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
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0.000 0.000 0.000 0.000
 8.4  TO 8.6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 8.6  TO 8.8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 8.8  TO 9.0  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 9.0  TO 9.2  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 9.2  TO 9.4  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 9.4  TO 9.6  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 9.6  TO 9.8  0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 9.8  TO 10.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 10.0 TO 10.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 10.5 TO 11.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 11.0 TO 11.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 11.5 TO 12.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 12.0 TO 12.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 12.5 TO 13.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 13.0 TO 13.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 13.5 TO 14.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 14.0 TO 14.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 14.5 TO 15.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 15.0 TO 15.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 15.5 TO 16.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 16.0 TO 16.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 16.5 TO 17.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 17.0 TO 17.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 17.5 TO 18.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 18.0 TO 18.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 18.5 TO 19.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 19.0 TO 19.5 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 19.5 TO 20.0 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000
 20.0 TO OVER 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000


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 AVERAGE     0.08216     VARIANCE    0.02140     STD DEV     0.14628
 STD ERR     0.00169     SKEWNESS    4.76015     KURTOSIS   27.32819

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1 ******************************PLUME LENGTH-K-STABILITY FREQUENCY TABLE*******************************

Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)

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PLUME LENGTH RANGE (M)	STABILITY CATEGORY 1			STABILITY CATEGORY 2			STABILITY CATEGORY 3		
	K1	K2	K3	K1	K2	K3	K1	K2	K3
0.0 TO 0.2	0.000	0.000	0.152	0.000	0.000	0.668	0.000	0.000	0.112
0.2 TO 0.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.4 TO 0.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.6 TO 0.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.8 TO 1.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.0 TO 1.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.2 TO 1.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.4 TO 1.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.6 TO 1.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.8 TO 2.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.0 TO 2.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.2 TO 2.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.4 TO 2.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.6 TO 2.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.8 TO 3.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.0 TO 3.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.2 TO 3.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.4 TO 3.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.6 TO 3.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.8 TO 4.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.0 TO 4.2	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
4.2 TO 4.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.4 TO 4.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.6 TO 4.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.8 TO 5.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

prep

5.0 TO 5.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.2 TO 5.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.4 TO 5.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.6 TO 5.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.8 TO 6.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.0 TO 6.2	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
6.2 TO 6.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.4 TO 6.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.6 TO 6.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.8 TO 7.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.0 TO 7.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.2 TO 7.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.4 TO 7.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.6 TO 7.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.8 TO 8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.0 TO 8.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.2 TO 8.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.4 TO 8.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.6 TO 8.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.8 TO 9.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9.0 TO 9.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9.2 TO 9.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9.4 TO 9.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9.6 TO 9.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9.8 TO 10.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

1 *****************************PLUME LENGTH-K-STABILITY FREQUENCY TABLE******************************

Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)

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PLUME LENGTH RANGE (M)	STABILITY CATEGORY 1			STABILITY CATEGORY 2			STABILITY CATEGORY 3		
	K1	K2	K3	K1	K2	K3	K1	K2	K3
10.0 TO 10.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

								0.000	0.000
10.4 TO 10.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10.8 TO 11.2	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
11.2 TO 11.6	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
11.6 TO 12.0	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
12.0 TO 12.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.4 TO 12.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12.8 TO 13.2	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
13.2 TO 13.6	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
13.6 TO 14.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.0 TO 14.4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.4 TO 14.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.8 TO 15.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.2 TO 15.6	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
15.6 TO 16.0	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
16.0 TO 16.4	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000
16.4 TO 16.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.8 TO 17.2	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
17.2 TO 17.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.6 TO 18.0	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000
18.0 TO 18.4	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
18.4 TO 18.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
18.8 TO 19.2	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
19.2 TO 19.6	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
19.6 TO 20.0	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.001
20.0 TO 21.0	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000
21.0 TO 22.0	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.003
22.0 TO 23.0	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.001
23.0 TO 24.0	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.002
24.0 TO 25.0	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.001
25.0 TO 26.0	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000
26.0 TO 27.0	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000
27.0 TO 28.0	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000
28.0 TO 29.0	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000

29.0 TO 30.0	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000
30.0 TO 31.0	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
31.0 TO 32.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32.0 TO 33.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33.0 TO 34.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34.0 TO 35.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35.0 TO 36.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36.0 TO 37.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37.0 TO 38.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38.0 TO 39.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39.0 TO 40.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.0 TO OVER	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

1 CAT NUM TYPE UH WX DBT DTDZ DPT VE TE MXHT PLGT FREQ REFERENCE HEIGHT= 10. M

CAT NUM	TYPE	UH	WX	DBT	DTDZ	DPT	VE	TE	MXHT	PLGT	FREQ
1	FOG	10.0	0.25	263.1	-0.010	262.6	0.3	270.1	500.	6.24	0.0012
2	FOG	15.0	0.25	263.1	-0.010	262.6	0.3	270.1	500.	0.00	0.0004
3	FOG	12.0	0.25	263.1	-0.010	261.1	0.3	269.8	500.	0.00	0.0037
4	FOG	17.0	0.25	263.1	-0.010	261.1	0.3	269.8	500.	0.00	0.0004
5	FOG	15.0	0.25	263.1	-0.010	258.6	0.3	269.4	500.	0.00	0.0003
6	FOG	12.5	0.25	273.1	-0.010	272.4	0.3	278.5	500.	0.00	0.0036
7	FOG	16.5	0.25	273.1	-0.010	269.4	0.3	277.6	500.	0.00	0.0009
8	FOG	15.0	0.25	283.1	-0.010	282.4	0.3	286.9	500.	0.00	0.0007
9	FOG	16.5	0.25	283.1	-0.010	279.4	0.3	285.6	500.	0.00	0.0001
10	FOG	15.5	0.25	293.1	-0.010	291.1	0.3	294.9	500.	0.00	0.0001
11	PLUME	3.9	0.15	289.6	-0.018	279.4	0.3	288.1	868.	0.00	0.1517
12	PLUME	4.9	0.25	278.5	-0.010	273.9	0.3	281.5	850.	9.48	0.6676
13	PLUME	2.2	0.30	277.0	0.030	273.7	0.3	280.8	950.	18.88	0.1118
14	PLUME	8.7	0.25	271.0	-0.010	270.9	0.3	276.9	632.	0.00	0.0001
15	PLUME	7.7	0.25	275.4	-0.010	275.3	0.3	280.6	1120.	1.17	0.0001
16	PLUME	4.6	0.25	292.1	-0.010	292.0	0.3	295.1	996.	1.73	0.0003
17	PLUME	5.7	0.25	285.4	-0.010	285.3	0.3	289.2	730.	2.58	0.0003
18	PLUME	7.7	0.25	274.3	-0.010	274.2	0.3	279.7	984.	3.38	0.0005
19	PLUME	5.7	0.25	285.1	-0.010	285.0	0.3	288.9	620.	3.20	

0.0004											
	20	PLUME	4.6	0.25	290.4	-0.010	290.3	0.3	293.6	426.	4.17
0.0001											
	21	PLUME	5.8	0.25	283.4	-0.010	283.3	0.3	287.4	671.	4.44
0.0004											
	22	PLUME	7.2	0.25	276.0	-0.010	275.9	0.3	281.1	689.	5.10
0.0001											
	23	PLUME	4.6	0.25	285.4	-0.010	285.3	0.3	289.2	800.	11.31
0.0001											
	24	PLUME	6.2	0.25	281.0	-0.010	280.9	0.3	285.4	782.	5.47
0.0005											
	25	PLUME	3.6	0.25	292.1	-0.010	292.0	0.3	295.1	923.	10.12
0.0001											
	26	PLUME	4.9	0.25	287.6	-0.010	287.5	0.3	291.1	836.	6.03
0.0003											
	27	PLUME	5.1	0.25	285.4	-0.010	285.3	0.3	289.2	904.	7.21
0.0003											
	28	PLUME	7.7	0.25	272.1	-0.010	272.0	0.3	277.8	766.	7.69
0.0001											
	29	PLUME	4.1	0.25	291.0	-0.010	290.9	0.3	294.1	496.	7.72
0.0001											
	30	PLUME	5.7	0.25	282.1	-0.010	282.0	0.3	286.3	1046.	8.15
0.0004											
	31	PLUME	6.2	0.25	279.3	-0.010	279.2	0.3	283.9	771.	8.39
0.0001											
	32	PLUME	4.9	0.25	285.7	-0.010	285.6	0.3	289.4	784.	8.93
0.0003											
	33	PLUME	4.1	0.25	286.0	-0.010	285.9	0.3	289.7	11.	14.07
0.0001											
	34	PLUME	5.7	0.25	281.0	-0.010	280.9	0.3	285.4	1028.	9.97
0.0001											
	35	PLUME	5.4	0.25	281.2	-0.010	281.1	0.3	285.5	726.	12.08
0.0007											
	36	PLUME	5.7	0.25	280.8	-0.010	280.7	0.3	285.2	631.	10.33
0.0007											
	37	PLUME	4.2	0.25	287.6	-0.010	287.5	0.3	291.1	830.	11.12
0.0005											
	38	PLUME	3.6	0.25	289.6	-0.010	289.5	0.3	292.8	902.	12.95
0.0003											
	39	PLUME	4.6	0.25	284.3	-0.010	284.2	0.3	288.2	767.	12.85
0.0004											
	40	PLUME	5.1	0.25	282.1	-0.010	282.0	0.3	286.3	676.	12.29
0.0005											
	41	PLUME	5.9	0.25	278.1	-0.010	278.0	0.3	282.9	610.	12.64
0.0005											
	42	PLUME	3.1	0.25	292.1	-0.010	292.0	0.3	295.1	603.	13.13
0.0003											
	43	PLUME	3.6	0.25	283.9	-0.010	283.8	0.3	287.9	701.	18.87
0.0127											
	44	PLUME	2.9	0.25	277.5	-0.010	277.4	0.3	282.4	604.	24.83
0.0298											
	45	PLUME	3.3	0.25	271.6	-0.010	271.6	0.3	277.4	605.	29.10
0.0174											

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MET RECORDS READ :       8760
RECORDS DISCARDED:          0
CALM RECORDS:            1284
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TOTAL TO NEW FILE:       8760
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APPENDIX G

Visibility Modeling Support Information

Northern Michigan University
Marquette, MI
CFB Boiler Project

Proposed Circulating Fluidized Bed Boiler
Potential Emissions

Boiler Parameters	Specification
Boiler Type	Circulating Fluidized Bed
Maximum Rated Heat Input (MMBtu/hr)	185
Gross Output (MW/hr)	10

(Approximate; nominally 1)

Material	Sulfur Content	Material Usage (%)	Heat Input (MM BTU/hr)	Heating Value (BTU/lb)	Material Throughput (lb/hr)	Material Throughput (t/hr)	Material Throughput (tpy)	Natural Gas Maximum Usage Rate MMscf/hr
Coal, Bituminous	1.50%	100.0%	185	12,500	14,800	7.40	64,824	0.1914
Coal, PRB	0.80%	100.0%	185	8,500	21,765	10.88	95,328	
Natural Gas	0.06%	100.0%	185	23,200	7,974	3.99	34,927	
Virgin Wood	0.00%	100.0%	205	4,500	45,556	22.78	199,533	

TABLE B-1. EMISSION RATES OF CRITERIA POLLUTANTS, HAPS, AND TACS FROM THE NEW BOILER ON A PER-FUEL BASIS

Compound	CAS Reference Number	Coal, Bituminous				Coal, PRB				Natural Gas				Waste Wood			
		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates	
		Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)
Carbon tetrachloride	56235													5.16E-05	lb/MMBtu	1.06E-02	4.65E-02
Chlorine	7782505													8.09E-04	lb/MMBtu	1.66E-01	7.26E-01
2-Chloroacetophenone	532274	8.00E-06	lb/ton	5.92E-05	2.61E-04	8.00E-06	lb/ton	8.76E-05	3.84E-04					2.76E-09	lb/MMBtu	5.66E-07	2.48E-06
Chlorobenzene	108907	2.53E-05	lb/ton	1.87E-04	8.20E-04	2.53E-05	lb/ton	2.75E-04	1.21E-03					3.80E-05	lb/MMBtu	7.78E-03	3.41E-02
Chloroform	67663	6.79E-05	lb/ton	5.02E-04	2.20E-03	6.79E-05	lb/ton	7.38E-04	3.23E-03					3.22E-05	lb/MMBtu	6.60E-03	2.89E-02
2-Chloronaphthalene	91587													2.76E-09	lb/MMBtu	5.66E-07	2.48E-06
2-Chlorophenol	95578													2.76E-08	lb/MMBtu	5.66E-06	2.48E-05
Cumene	98828	6.10E-06	lb/ton	4.51E-05	1.98E-04	6.10E-06	lb/ton	6.63E-05	2.91E-04								
Cyanide	74908	2.88E-03	lb/ton	2.13E-02	9.33E-02	2.88E-03	lb/ton	3.13E-02	1.37E-01								
1,4-Dichlorobenzene	106467									1.38E-03	lb/MMscf	2.58E-04	1.10E-03				
2,4-Dinitrotoluene	121142	3.22E-07	lb/ton	2.38E-06	1.04E-05	3.22E-07	lb/ton	3.50E-06	1.53E-05								
Dimethyl sulfate	77781	5.52E-05	lb/ton	4.08E-04	1.79E-03	5.52E-05	lb/ton	6.01E-04	2.63E-03								
2,4-Dinitrophenol	51285													2.07E-07	lb/MMBtu	4.24E-05	1.86E-04
Ethylbenzene	100414	1.08E-04	lb/ton	8.00E-04	3.50E-03	1.08E-04	lb/ton	1.18E-03	5.16E-03					3.57E-05	lb/MMBtu	7.31E-03	3.20E-02
Ethyl chloride	75003	4.83E-05	lb/ton	3.57E-04	1.57E-03	4.83E-05	lb/ton	5.26E-04	2.30E-03								
Ethylene dichloride	107062	4.60E-05	lb/ton	3.40E-04	1.49E-03	4.60E-05	lb/ton	5.01E-04	2.19E-03								
Ethylene dibromide	106934	1.38E-06	lb/ton	1.02E-05	4.47E-05	1.38E-06	lb/ton	1.50E-05	6.58E-05								
Formaldehyde	50000	2.76E-04	lb/ton	2.04E-03	8.95E-03	2.76E-04	lb/ton	3.00E-03	1.32E-02	8.03E-02	lb/MMscf	1.56E-02	6.83E-02	5.06E-03	lb/MMBtu	1.04E+00	4.54E+00
Heptachlorobiphenyl	28655712													7.69E-11	lb/MMBtu	1.58E-08	6.92E-08
Hexachlorobiphenyl	26601649													8.33E-10	lb/MMBtu	1.50E-07	6.66E-07
Hexanal	66251													8.06E-06	lb/MMBtu	1.65E-03	7.23E-03
Hexane	110543	7.71E-05	lb/ton	5.70E-04	2.50E-03	7.71E-05	lb/ton	8.39E-04	3.67E-03	2.07E+00	lb/MMscf	3.75E-01	1.64E+00				
Isobutyraldehyde	78842													1.38E-05	lb/MMBtu	2.83E-03	1.24E-02
Isophorone	78591	6.67E-04	lb/ton	4.94E-03	2.16E-02	6.67E-04	lb/ton	7.26E-03	3.18E-02								
2-Methylnaphthalene	91576									2.70E-05	lb/MMscf	5.01E-06	2.19E-05	1.84E-07	lb/MMBtu	3.77E-05	1.65E-04
3-Methylcholanthrene										2.07E-06	lb/MMscf	3.75E-07	1.64E-06				
Monochlorobiphenyl														2.53E-10	lb/MMBtu	5.19E-08	2.27E-07
Methyl bromide (bromomethane)	74839	1.84E-04	lb/ton	1.36E-03	5.96E-03	1.84E-04	lb/ton	2.00E-03	8.77E-03					1.78E-05	lb/MMBtu	3.64E-03	1.59E-02
Methyl chloride	74873	6.10E-04	lb/ton	4.51E-03	1.98E-02	6.10E-04	lb/ton	6.63E-03	2.91E-02					2.65E-05	lb/MMBtu	5.43E-03	2.37E-02
Methyl ethyl ketone	78933	4.49E-04	lb/ton	3.32E-03	1.45E-02	4.49E-04	lb/ton	4.88E-03	2.14E-02					6.21E-06	lb/MMBtu	1.27E-03	5.56E-03
Methyl hydrazine	60344	1.96E-04	lb/ton	1.45E-03	6.34E-03	1.96E-04	lb/ton	2.13E-03	9.33E-03								
Methyl methacrylate	80626	2.30E-05	lb/ton	1.70E-04	7.45E-04	2.30E-05	lb/ton	2.50E-04	1.10E-03								
Methyl tert butyl ether	1634044	4.03E-05	lb/ton	2.98E-04	1.30E-03	4.03E-05	lb/ton	4.38E-04	1.92E-03								
Methylene chloride (Dichloromethane)	75092	3.34E-04	lb/ton	2.47E-03	1.08E-02	3.34E-04	lb/ton	3.63E-03	1.59E-02					3.34E-04	lb/MMBtu	6.84E-02	2.99E-01
2-Nitrophenol	88755													2.76E-07	lb/MMBtu	5.66E-05	2.48E-04
4-Nitrophenol	100027													1.27E-07	lb/MMBtu	2.59E-05	1.14E-04
Pentachlorobiphenyl	25429292													1.38E-09	lb/MMBtu	2.83E-07	1.24E-06
Pentachlorophenol	87865													5.87E-09	lb/MMBtu	1.20E-06	5.27E-06
Perylene	198550													5.96E-10	lb/MMBtu	1.23E-07	5.37E-07
Phenol	108952	1.84E-05	lb/ton	1.36E-04	5.96E-04	1.84E-05	lb/ton	2.00E-04	8.77E-04					5.87E-05	lb/MMBtu	1.20E-02	5.27E-02
Propionaldehyde	123386	4.37E-04	lb/ton	3.23E-03	1.42E-02	4.37E-04	lb/ton	4.75E-03	2.08E-02					7.02E-05	lb/MMBtu	1.44E-02	6.30E-02
Propanal	123386													3.68E-06	lb/MMBtu	7.54E-04	3.30E-03
Styrene	100425	2.88E-05	lb/ton	2.13E-04	9.33E-04	2.88E-05	lb/ton	3.13E-04	1.37E-03					2.19E-03	lb/MMBtu	4.48E-01	1.96E+00
Tetrachlorobiphenyl	26914330													2.88E-09	lb/MMBtu	5.89E-07	2.58E-06
Tetrachloroethylene	127184	4.95E-05	lb/ton	3.66E-04	1.60E-03	4.95E-05	lb/ton	5.38E-04	2.36E-03					4.37E-05	lb/MMBtu	8.95E-03	3.92E-02
Toluene	108883	2.76E-04	lb/ton	2.04E-03	8.95E-03	2.76E-04	lb/ton	3.00E-03	1.32E-02	3.91E-03	lb/MMscf	7.00E-04	3.11E-03	1.06E-03	lb/MMBtu	2.17E-01	9.50E-01
o-Tolualdehyde	529204													8.28E-06	lb/MMBtu	1.70E-03	7.43E-03
p-Tolualdehyde	104870													1.27E-05	lb/MMBtu	2.60E-03	1.14E-02
Trichlorobiphenyl														2.99E-09	lb/MMBtu	6.13E-07	2.68E-06

TABLE B-2. MAXIMUM EMISSION RATES

Compound	Maximum Emission Rates		Fuel	Emission Factor
	(lb/hr)	(tpy)		lb/MMBtu
Carbon tetrachloride	1.06E-02	4.65E-02	Wood	5.16E-05
Chlorine	1.66E-01	7.26E-01	Wood	8.09E-04
2-Chloroacetophenone	8.76E-05	3.84E-04	PRB Coal	4.74E-07
Chlorobenzene	7.78E-03	3.41E-02	Wood	3.80E-05
Chloroform	6.60E-03	2.89E-02	Wood	3.22E-05
2-Chloronaphthalene	5.66E-07	2.48E-06	Wood	2.76E-09
2-Chlorophenol	5.65E-06	2.48E-05	Wood	2.76E-08
Cumene	6.63E-05	2.91E-04	PRB Coal	3.58E-07
Cyanide	3.13E-02	1.37E-01	PRB Coal	1.69E-04
1,4-Dichlorobenzene	2.60E-04	1.10E-03	Nat Gas	1.35E-06
2,4-Dinitrotoluene	3.50E-06	1.53E-05	PRB Coal	1.89E-08
Dimethyl sulfate	6.01E-04	2.63E-03	PRB Coal	3.25E-06
2,4-Dinitrophenol	4.24E-05	1.86E-04	Wood	2.07E-07
Ethylbenzene	7.31E-03	3.20E-02	Wood	3.57E-05
Ethylchloride	5.26E-04	2.30E-03	PRB Coal	2.84E-06
Ethylene dichloride	5.01E-04	2.19E-03	PRB Coal	2.71E-06
Ethylene dibromide	1.50E-05	6.58E-05	PRB Coal	8.12E-08
Formaldehyde	1.04E+00	4.54E+00	Wood	5.06E-03
Heptachlorobiphenyl	1.58E-08	6.92E-08	Wood	7.69E-11
Hexachlorobiphenyl	1.50E-07	6.66E-07	Wood	8.33E-10
Hexanal	1.65E-03	7.23E-03	Wood	8.06E-06
Hexane	3.75E-01	1.64E+00	Nat Gas	2.03E-03
Isobutyraldehyde	2.83E-03	1.24E-02	Wood	1.38E-05
Isophorone	7.26E-03	3.18E-02	PRB Coal	3.92E-05
2-Methylnaphthalene	3.77E-05	1.65E-04	Wood	1.84E-07
3-Methylcholanthrene	3.75E-07	1.64E-06	Nat Gas	2.03E-09
Monochlorobiphenyl	5.19E-08	2.27E-07	Wood	2.53E-10
Methyl bromide	3.64E-03	1.59E-02	Wood	1.78E-05
Methyl chloride	6.63E-03	2.91E-02	PRB Coal	3.58E-05
Methyl ethyl ketone	4.88E-03	2.14E-02	PRB Coal	2.64E-05
Methyl hydrazine	2.13E-03	9.32E-03	PRB Coal	1.15E-05
Methyl methacrylate	2.50E-04	1.10E-03	PRB Coal	1.35E-06
Methyl tert butyl ether	4.38E-04	1.92E-03	PRB Coal	2.37E-06
Methylene chloride	6.84E-02	2.99E-01	Wood	3.34E-04
2-Nitrophenol	5.66E-05	2.48E-04	Wood	2.76E-07
4-Nitrophenol	2.59E-05	1.14E-04	Wood	1.27E-07
Pentachlorobiphenyl	2.83E-07	1.24E-06	Wood	1.38E-09
Pentachlorophenol	1.20E-06	5.27E-06	Wood	5.87E-09
Perylene	1.23E-07	5.37E-07	Wood	5.96E-10
Phenol	1.20E-02	5.27E-02	Wood	5.87E-05
Propionaldehyde	1.44E-02	6.30E-02	Wood	7.02E-05
Propanal	7.54E-04	3.30E-03	Wood	3.68E-06
Styrene	4.48E-01	1.96E+00	Wood	2.19E-03
Tetrachlorobiphenyl	5.89E-07	2.58E-06	Wood	2.88E-09
Tetrachloroethylene	8.95E-03	3.92E-02	Wood	4.37E-05
Toluene	2.17E-01	9.50E-01	Wood	1.06E-03
o-Tolualdehyde	1.70E-03	7.43E-03	Wood	8.28E-06
p-Tolualdehyde	2.60E-03	1.14E-02	Wood	1.27E-05
Trichlorobiphenyl	6.13E-07	2.68E-06	Wood	2.99E-09

Prepared by NTH Consultants, Ltd.

Northern Michigan University
Marquette, MI
CFB Boiler Project

Proposed Circulating Fluidized Bed Boiler
Potential Emissions

Boiler Parameters	Specification
Boiler Type	Circulating Fluidized Bed
Maximum Rated Heat Input (MM Btu/hr)	185
Gross Output (MWe)	10 (Approximately; nominally [illegible])

Material	Sulfur Content	Material Usage (%)	Heat Input (MM BTU/hr)	Heating Value (BTU/lb)	Material Throughput (lb/hr)	Material Throughput (tph)	Material Throughput (tpy)	Natural Gas Maximum Usage Rate MMscf/hr
Coal, Bituminous	1.50%	100.0%	185	12,500	14,800	7.40	64,824	0.1814
Coal, PRB	0.80%	100.0%	185	8,500	21,765	10.88	95,329	
Natural Gas	0.00%	100.0%	185	23,200	7,974	3.99	34,927	
Virgin Wood	0.00%	100.0%	205	4,500	45,556	22.78	199,533	

TABLE B-1. EMISSION RATES OF CRITERIA POLLUTANTS, HAPS, AND TACS FROM THE NEW BOILER ON A PER-FUEL BASIS

Compound	CAS Reference Number	Coal, Bituminous Emission Factors Value	Units	Emission Rates (lb/hr)	(tpy)	Coal, PRB Emission Factors Value	Units	Emission Rates (lb/hr)	(tpy)	Natural Gas Emission Factors Value	Units	Emission Rates (lb/hr)	(tpy)	Waste Wood Emission Factors Value	Units	Emission Rates (lb/hr)	(tpy)
Trichlorofluoromethane	75694													4.77E-05	lb/MMBtu	9.87E-03	4.23E-02
Trichloroethene	79016													3.45E-05	lb/MMBtu	7.07E-03	3.10E-02
1,1,1-Trichloroethane	71556	2.30E-06	lb/ton	1.70E-04	7.45E-04	2.30E-06	lb/ton	2.50E-04	1.10E-03					3.57E-05	lb/MMBtu	7.31E-03	3.20E-02
2,4,6-Trichlorophenol	88062													2.53E-08	lb/MMBtu	5.19E-06	2.27E-05
Vinyl acetate	108054	8.74E-05	lb/ton	6.47E-04	2.83E-03	8.74E-05	lb/ton	9.51E-04	4.17E-03								
Vinyl Chloride	75014													2.07E-05	lb/MMBtu	4.24E-03	1.86E-02
Xylenes	1330207	4.26E-05	lb/ton	3.15E-04	1.38E-03	4.26E-05	lb/ton	4.63E-04	2.03E-03								
o-Xylene	95476													2.63E-05	lb/MMBtu	5.39E-03	2.36E-02
Polynuclear Aromatic Hydrocarbons (PAH)																	
Acenaphthene	83329	5.87E-07	lb/ton	4.34E-06	1.90E-05	5.87E-07	lb/ton	6.39E-06	2.80E-05	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	1.06E-06	lb/MMBtu	2.19E-04	9.40E-04
Acenaphthylene	208968	2.88E-07	lb/ton	2.13E-06	9.32E-06	2.88E-07	lb/ton	3.13E-06	1.37E-05	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	5.76E-06	lb/MMBtu	1.18E-03	5.16E-03
Acetone	67641													2.18E-04	lb/MMBtu	4.46E-02	1.96E-01
Anthracene	120127	2.42E-07	lb/ton	1.79E-06	7.85E-06	2.42E-07	lb/ton	2.63E-06	1.15E-05	2.76E-06	lb/MMscf	5.01E-07	2.19E-06	3.45E-06	lb/MMBtu	7.07E-04	3.10E-03
Benzaldehyde	100527													9.76E-07	lb/MMBtu	2.00E-04	8.76E-04
Benzo(a)anthracene	56553	9.20E-08	lb/ton	6.81E-07	2.98E-06	9.20E-08	lb/ton	1.00E-06	4.39E-06	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	7.48E-08	lb/MMBtu	1.53E-05	6.71E-05
Benzo(a)pyrene	50328	4.37E-08	lb/ton	3.23E-07	1.42E-06	4.37E-08	lb/ton	4.75E-07	2.08E-06	1.38E-06	lb/MMscf	2.50E-07	1.10E-06	2.99E-06	lb/MMBtu	6.13E-04	2.68E-03
Benzo(e)pyrene	192972									1.38E-06	lb/MMscf	2.50E-07	1.10E-06	2.99E-09	lb/MMBtu	6.13E-07	2.68E-06
Benzo(b)fluoranthene	205992									2.07E-06	lb/MMscf	3.75E-07	1.64E-06	1.16E-07	lb/MMBtu	2.38E-05	1.04E-04
Benzo(j,k)fluoranthene	206440													1.84E-07	lb/MMBtu	3.77E-05	1.65E-04
Benzo(k)fluoranthene	205823									2.07E-06	lb/MMscf	3.75E-07	1.64E-06	4.14E-08	lb/MMBtu	8.49E-06	3.72E-05
Benzo(g,h,i)fluoranthene		1.27E-07	lb/ton	9.35E-07	4.10E-06	1.27E-07	lb/ton	1.38E-06	6.03E-06					1.15E-07	lb/MMBtu	2.36E-05	1.03E-04
Benzo(g,h,i)perylene	191242	3.11E-08	lb/ton	2.30E-07	1.01E-06	3.11E-08	lb/ton	3.38E-07	1.48E-06	1.38E-06	lb/MMscf	2.50E-07	1.10E-06	1.07E-07	lb/MMBtu	2.19E-05	9.60E-05
Biphenyl	92524	1.96E-06	lb/ton	1.45E-05	6.34E-05	1.96E-06	lb/ton	2.13E-05	9.33E-05								
Chrysene	218019	1.15E-07	lb/ton	8.51E-07	3.73E-06	1.15E-07	lb/ton	1.25E-06	5.48E-06	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	4.37E-08	lb/MMBtu	8.96E-06	3.92E-05
Crotonaldehyde	4170303													1.14E-05	lb/MMBtu	2.33E-03	1.02E-02
Decachlorobiphenyl	2051243													3.11E-10	lb/MMBtu	6.37E-08	2.79E-07
Dibenzo(a,h)anthracene	53703									1.38E-06	lb/MMscf	2.50E-07	1.10E-06	1.05E-08	lb/MMBtu	2.15E-06	9.40E-06
1,2-Dibromoethene	540498													6.33E-06	lb/MMBtu	1.30E-03	5.68E-03
Dichlorobiphenyl	2050682													8.51E-10	lb/MMBtu	1.74E-07	7.64E-07
1,2-Dichloroethane	107062													3.34E-05	lb/MMBtu	6.84E-03	2.99E-02
1,2-Dichloropropane	78875													3.80E-05	lb/MMBtu	7.78E-03	3.41E-02
7,12-Dimethylbenz(a)anthracene	57976									1.84E-05	lb/MMscf	3.34E-06	1.46E-05				
Fluoranthene	206440	8.17E-07	lb/ton	6.04E-06	2.65E-05	8.17E-07	lb/ton	8.89E-06	3.89E-05	3.45E-06	lb/MMscf	6.26E-07	2.74E-06	1.84E-06	lb/MMBtu	3.77E-04	1.65E-03
Fluorene	86737	1.05E-06	lb/ton	7.74E-06	3.39E-05	1.05E-06	lb/ton	1.14E-05	4.99E-05	3.22E-06	lb/MMscf	5.84E-07	2.56E-06	3.91E-06	lb/MMBtu	8.02E-04	3.51E-03
Indeno(1,2,3,c,d)pyrene	193395	7.02E-08	lb/ton	5.19E-07	2.27E-06	7.02E-08	lb/ton	7.64E-07	3.34E-06	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	1.00E-07	lb/MMBtu	2.05E-05	8.98E-05
Naphthalene	91203	1.50E-05	lb/ton	1.11E-04	4.86E-04	1.50E-05	lb/ton	1.63E-04	7.13E-04	7.02E-04	lb/MMscf	1.27E-04	5.57E-04	1.12E-04	lb/MMBtu	2.29E-02	1.00E-01
Phenanthrene	85018	3.11E-06	lb/ton	2.30E-05	1.01E-04	3.11E-06	lb/ton	3.38E-05	1.48E-04	1.96E-05	lb/MMscf	3.56E-06	1.56E-05	8.05E-06	lb/MMBtu	1.65E-03	7.23E-03
Pyrene	129000	3.80E-07	lb/ton	2.81E-06	1.23E-05	3.80E-07	lb/ton	4.13E-06	1.81E-05	5.75E-06	lb/MMscf	1.04E-06	4.57E-06	4.26E-06	lb/MMBtu	8.72E-04	3.82E-03
5-Methyl chrysene	3697243	2.53E-08	lb/ton	1.87E-07	8.20E-07	2.53E-08	lb/ton	2.75E-07	1.21E-06					9.89E-12	lb/MMBtu	2.03E-09	8.88E-09

CFB Boiler Maximum Single HAP Emission Rate (HCl) = 6.3 tpy

CFB Boiler Maximum Combined Total HAP Emission Rate = [illegible] 22.7 tpy

TABLE B-2. MAXIMUM EMISSION RATES

Compound	Maximum Emission Rates (lb/hr)	(tpy)	Fuel	Emission Factor lb/MMBtu
Trichlorofluoromethane	9.87E-03	4.23E-02	Wood	4.77E-05
Trichloroethene	7.07E-03	3.10E-02	Wood	3.45E-05
1,1,1-Trichloroethane	7.31E-03	3.20E-02	Wood	3.57E-05
2,4,6-Trichlorophenol	5.19E-06	2.27E-05	Wood	2.53E-08
Vinyl acetate	9.51E-04	4.17E-03	PRB Coal	5.14E-06
Vinyl Chloride	4.24E-03	1.86E-02	Wood	2.07E-05
Xylenes	4.63E-04	2.03E-03	PRB Coal	2.50E-06
o-Xylene	5.39E-03	2.36E-02	Wood	2.63E-05
Polynuclear Aromatic Hydrocarbons (PAH)				
Acenaphthene	2.18E-04	9.40E-04	Wood	1.06E-06
Acenaphthylene	1.18E-03	5.16E-03	Wood	5.76E-06
Acetone	4.46E-02	1.95E-01	Wood	2.18E-04
Anthracene	7.07E-04	3.10E-03	Wood	3.45E-06
Benzaldehyde	2.00E-04	8.76E-04	Wood	9.76E-07
Benzo(a)anthracene	1.53E-05	6.71E-05	Wood	7.48E-08
Benzo(a)pyrene	6.13E-04	2.68E-03	Wood	2.99E-06
Benzo(e)pyrene	6.13E-07	2.68E-06	Wood	2.99E-09
Benzo(b)fluoranthene	2.38E-05	1.04E-04	Wood	1.16E-07
Benzo(j,k)fluoranthene	3.77E-05	1.65E-04	Wood	1.84E-07
Benzo(k)fluoranthene	8.49E-06	3.72E-05	Wood	4.14E-08
Benzo(g,h,i)fluoranthene	2.36E-05	1.03E-04	Wood	1.15E-07
Benzo(g,h,i)perylene	2.19E-05	9.60E-05	Wood	1.07E-07
Biphenyl	2.13E-05	9.33E-05	PRB Coal	1.16E-07
Chrysene	8.96E-06	3.92E-05	Wood	4.37E-08
Crotonaldehyde	2.33E-03	1.02E-02	Wood	1.14E-05
Decachlorobiphenyl	6.37E-08	2.79E-07	Wood	3.11E-10
Dibenzo(a,h)anthracene	2.15E-06	9.40E-06	Wood	1.05E-08
1,2-Dibromoethene	1.30E-03	5.68E-03	Wood	6.33E-06
Dichlorobiphenyl	1.74E-07	7.64E-07	Wood	8.51E-10
1,2-Dichloroethane	6.84E-03	2.99E-02	Wood	3.34E-05
1,2-Dichloropropane	7.78E-03	3.41E-02	Wood	3.80E-05
7,12-Dimethylbenz(a)anthracene	3.34E-06	1.46E-05	Nat Gas	1.80E-08
Fluoranthene	3.77E-04	1.65E-03	Wood	1.84E-06
Fluorene	8.02E-04	3.51E-03	Wood	3.91E-06
Indeno(1,2,3,c,d)pyrene	2.05E-05	8.98E-05	Wood	1.00E-07
Naphthalene	2.29E-02	1.00E-01	Wood	1.12E-04
Phenanthrene	1.65E-03	7.23E-03	Wood	8.05E-06
Pyrene	8.72E-04	3.82E-03	Wood	4.26E-06
5-Methyl chrysene	2.75E-07	1.21E-06	PRB Coal	1.48E-09

These shaded areas are for compounds not listed in PSD/major [illegible].
These shaded areas are not expected or not available.
These shaded areas are HAPs.
Unless otherwise noted below, emission factors are from the EPA AP-42 database, and are increased by a 15% safety factor.
* Coal firing emission factors based on Wyandotte Energy stack test results. Wyandotte Energy is located in Wyandotte, Michigan.
** The tons estimated emission rates for PRB & Bituminous fuels are based on a statistical analysis of respective typical coals, with a 99% control efficiency of the baghouse collector.
*** Both HCl and HF emission factors include a 15% safety factor and 82% control using limestone in the CFB.
[1] Emissions are based on the proposed BACT.
[2] Sulfuric acid mist emission based on RBLC search, Plum Point Energy entry. This facility is located in Arkansas.
[3] Total dioxin/furan for the coal firing is from the Wyandotte Energy stack test results, and dioxin/furan for the wood combustion is from the EPA AP-42, Chapter 1.6, Table 1.6-3.
[4] Total chromium is supplied here for information purposes only. Total chromium is a sum of hexavalent and trivalent chromium.

Northern Michigan University
Marquette, MI
CFB Boiler Project

Proposed Circulating Fluidized Bed Boiler
Potential Emissions

Boiler Parameters	Specification
Boiler Type	Circulating Fluidized Bed
Maximum Rated Heat Input, (MM btu/hr)	185
Gross Output (MW/hr)	10 (Approximate; normally 7)

Material	Sulfur Content	Material Usage (%)	Heat Input (MM BTU/hr)	Heating Value (BTU/lb)	Material Throughput (lb/hr)	Material Throughput (tph)	Material Throughput (tpy)	Natural Gas Maximum Usage Rate MMscf/hr
Coal, Bituminous	1.60%	100.0%	185	12,500	14,800	7.40	64,824	0.1814
Coal, PRB	0.50%	100.0%	185	8,500	21,765	10.88	95,329	
Natural Gas	0.00%	100.0%	185	23,200	7,974	3.99	34,927	
Waste Wood	0.00%	100.0%	205	4,500	45,556	22.78	199,533	

TABLE B-1. EMISSION RATES OF CRITERIA POLLUTANTS, HAPS, AND TACS FROM THE NEW BOILER ON A PER-FUEL BASIS

Compound	CAS Reference Number	Coal, Bituminous				Coal, PRB				Natural Gas				Waste Wood			
		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates	
		Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)
PM10 (filterable and condensable)		0.03	lb/MMBtu	5.6	24.5	0.03	lb/MMBtu	5.6	24.3					0.03	lb/MMBtu	6.2	26.9
SO_2	7446095	0.20	lb/MMBtu	37.7	165.3	0.096	lb/MMBtu	17.6	77.6					0.025	lb/MMBtu	5.1	22.4
NO_x	10102440	0.10	lb/MMBtu	18.5	81.0	0.10	lb/MMBtu	18.5	81.0	0.10	lb/MMBtu	18.5	81.0	0.10	lb/MMBtu	20.5	89.8
CO	630080	0.15	lb/MMBtu	27.8	121.5	0.15	lb/MMBtu	27.8	121.5	0.15	lb/MMBtu	27.8	121.5	0.17	lb/MMBtu	34.8	152.6
Lead [1]	7439921	1.34E-05	lb/MMBtu	0.002	0.011	4.52E-06	lb/MMBtu	0.001	0.004					5.52E-07	lb/MMBtu	1.13E-04	4.96E-04
VOC		0.002	lb/MMBtu	0.43	1.89	0.003	lb/MMBtu	0.63	2.74	5.33	lb/MMscf	1.15	5.0	0.02	lb/MMBtu	4.0	17.6
Mercury	7439976	3.00E-06	lb/MMBtu	5.55E-04	2.43E-03	3.00E-06	lb/MMBtu	5.56E-04	2.43E-03	2.98E-04	lb/MMscf	5.42E-05	2.38E-04	3.00E-06	lb/MMBtu	6.15E-04	2.69E-03
HCl [2]	7647010	0.11	lb/ton	0.8	3.6	0.11	lb/ton	1.20	5.28								
HF [2]	7664393	0.01	lb/ton	0.1	0.4	0.0135	lb/ton	0.15	0.66								
H_2SO_4 (As Sulfuric Acid Mist) [3]	7664939	6.10E-03	lb/MMBtu	1.1	4.9	6.10E-03	lb/MMBtu	1.1	4.9								
Total Dioxin/Furan [1,3]	1746016	2.34E-12	lb/MMBtu	4.33E-10	1.90E-09	2.34E-12	lb/MMBtu	4.33E-10	1.90E-09								
Metals																	
Antimony [1]	7440360	9.09E-06	lb/MMBtu	1.68E-03	7.36E-03	9.09E-06	lb/MMBtu	1.68E-03	7.36E-03					9.09E-08	lb/MMBtu	1.86E-05	8.16E-05
Arsenic [1]	7440382	7.67E-07	lb/MMBtu	1.42E-04	6.22E-04	7.67E-07	lb/MMBtu	1.42E-04	6.22E-04	2.30E-04	lb/MMscf	4.17E-05	1.83E-04	2.53E-07	lb/MMBtu	5.19E-05	2.27E-04
Barium	7440393									5.05E-03	lb/MMscf	9.18E-04	4.02E-03	1.96E-06	lb/MMBtu	4.01E-04	1.76E-03
Beryllium [1]	7440417	2.00E-08	lb/MMBtu	3.70E-06	1.62E-05	2.00E-08	lb/MMBtu	3.70E-06	1.62E-05	1.38E-05	lb/MMscf	2.50E-06	1.10E-05	1.27E-08	lb/MMBtu	2.59E-06	1.14E-05
Cadmium [1]	7440439	9.59E-08	lb/MMBtu	1.77E-05	7.77E-05	9.59E-08	lb/MMBtu	1.77E-05	7.77E-05	1.27E-03	lb/MMscf	2.29E-04	1.00E-03	4.77E-08	lb/MMBtu	9.87E-06	4.23E-05
Chromium, total [1,4]	7440473	1.20E-06	lb/MMBtu	2.21E-04	9.69E-04	1.20E-06	lb/MMBtu	2.21E-04	9.69E-04	1.61E-03	lb/MMscf	2.92E-04	1.28E-03	2.42E-05	lb/MMBtu	4.85E-03	2.17E-02
Chromium, hexavalent [1]	18540299	3.59E-07	lb/MMBtu	6.64E-05	2.91E-04	3.55E-07	lb/MMBtu	6.56E-05	2.91E-04					4.03E-06	lb/MMBtu	8.25E-04	3.61E-03
Chromium, trivalent [1]	16065831	8.37E-07	lb/MMBtu	1.56E-04	6.78E-04	8.37E-07	lb/MMBtu	1.55E-04	6.78E-04								
Cobalt	7440484	1.15E-04	lb/ton	8.51E-04	3.73E-03	1.15E-04	lb/ton	1.25E-03	5.48E-03					7.48E-08	lb/MMBtu	1.53E-05	6.71E-05
Copper	7440508													5.64E-07	lb/MMBtu	1.16E-04	5.08E-04
Iron	7439896													1.14E-05	lb/MMBtu	2.33E-03	1.02E-02
Magnesium	7439954	1.27E-02	lb/ton	9.39E-02	4.10E-01	1.27E-02	lb/ton	1.38E-01	6.03E-01								
Manganese [1]	7439965	9.30E-06	lb/MMBtu	1.72E-03	7.54E-03	9.30E-06	lb/MMBtu	1.72E-03	7.54E-03	4.37E-04	lb/MMscf	7.93E-05	3.47E-04	1.84E-05	lb/MMBtu	3.77E-03	1.65E-02
Molybdenum	7439987									1.27E-03	lb/MMscf	2.29E-04	1.00E-03	2.42E-08	lb/MMBtu	4.85E-06	2.17E-05
Nickel [1]	7440020	1.67E-06	lb/MMBtu	3.09E-04	1.35E-03	1.67E-06	lb/MMBtu	3.09E-04	1.35E-03					3.80E-07	lb/MMBtu	7.78E-05	3.41E-04
Phosphorus	7723140													3.11E-07	lb/MMBtu	6.37E-05	2.79E-04
Potassium	7440097													4.49E-04	lb/MMBtu	9.19E-02	4.03E-01
Selenium	7782492	1.50E-03	lb/ton	1.11E-02	4.86E-02	1.50E-03	lb/ton	1.63E-02	7.15E-02					3.27E-08	lb/MMBtu	6.70E-06	2.88E-05
Silver	7440224													1.96E-05	lb/MMBtu	4.01E-03	1.76E-02
Sodium	7440235													4.14E-06	lb/MMBtu	8.49E-04	3.72E-03
Strontium	7440246													1.15E-07	lb/MMBtu	2.36E-05	1.03E-04
Tin	7440315													2.65E-07	lb/MMBtu	5.42E-05	2.37E-04
Titanium	7440326													2.30E-07	lb/MMBtu	4.72E-05	2.07E-04
Vanadium	7440622									2.65E-03	lb/MMscf	4.80E-04	2.10E-03	1.13E-08	lb/MMBtu	2.31E-06	1.01E-05
Yttrium	7440655													3.45E-09	lb/MMBtu	7.07E-07	3.10E-06
Zinc (as zinc oxide) [1]	1314132	2.83E-04	lb/MMBtu	5.23E-02	2.29E-01	2.83E-04	lb/MMBtu	5.23E-02	2.29E-01	3.34E-02	lb/MMscf	6.06E-03	2.66E-02	4.39E-06	lb/MMBtu	9.00E-04	4.34E-03
Organic Compounds																	
Acetaldehyde	75070	6.58E-04	lb/ton	4.95E-03	2.12E-02	5.68E-04	lb/ton	7.13E-03	3.12E-02					9.55E-04	lb/MMBtu	1.96E-01	8.57E-01
Acetophenone	98862	1.73E-05	lb/ton	1.28E-04	5.59E-04	1.73E-05	lb/ton	1.88E-04	8.22E-04					3.68E-09	lb/MMBtu	7.54E-07	3.30E-06
Acrolein	107028	3.34E-04	lb/ton	2.47E-03	1.08E-02	3.34E-04	lb/ton	3.63E-03	1.59E-02					1.16E-04	lb/MMBtu	2.38E-02	1.05E-01
Benzene	71432	1.50E-03	lb/ton	1.11E-02	4.86E-02	1.50E-03	lb/ton	1.63E-02	7.13E-02	2.42E-03	lb/MMscf	4.38E-04	1.92E-03	4.83E-03	lb/MMBtu	9.90E-01	4.34E+00
Benzyl chloride	100447	8.05E-04	lb/ton	5.96E-03	2.61E-02	8.05E-04	lb/ton	8.78E-03	3.84E-02								
Benzoic acid	65850													5.41E-09	lb/MMBtu	1.11E-06	4.85E-06
Bis(2-Ethylhexyl)phthalate	117817	8.40E-05	lb/ton	6.21E-04	2.72E-03	8.40E-05	lb/ton	9.14E-04	4.00E-03					5.41E-08	lb/MMBtu	1.11E-05	4.86E-05
Bromoform	75252	4.48E-05	lb/ton	3.32E-04	1.45E-03	4.48E-05	lb/ton	4.88E-04	2.14E-03								
Carbon disulfide	75150	1.50E-04	lb/ton	1.11E-03	4.86E-03	1.50E-04	lb/ton	1.63E-03	7.13E-03								
Carbazole	86748													2.07E-06	lb/MMBtu	4.24E-04	1.86E-03

TABLE B-2. MAXIMUM EMISSION RATES

Compound	Maximum Emission Rates (lb/hr)	Maximum Emission Rates (tpy)	Fuel	Emission Factor lb/MMBtu
PM10 (filterable and condensable)	6.15	26.9	Wood	3.00E-02
SO_2	37.74	165.3	Coal	2.04E-01
NO_x	20.50	89.8	Wood	1.00E-01
CO	34.85	152.6	Wood	1.70E-01
Lead	0.002	0.011	Coal	1.34E-05
VOC	4.01	17.6	Wood	1.96E-02
Mercury	6.15E-04	2.69E-03	Wood	3.00E-06
HCl	1.2	5.28	PRB Coal	6.48E-03
HF	0.2	0.69	PRB Coal	8.12E-04
H_2SO_4	1.1	4.94	Coal	6.10E-03
Total Dioxin/Furan	4.33E-10	1.90E-09	Coal	2.34E-12
Metals				
Antimony	1.68E-03	7.36E-03	Coal	9.09E-06
Arsenic	1.42E-04	6.22E-04	Coal	7.67E-07
Barium	9.18E-04	4.02E-03	Nat Gas	4.96E-06
Beryllium	3.70E-06	1.62E-05	Coal	2.00E-08
Cadmium	2.29E-04	1.00E-03	Nat Gas	1.24E-06
Chromium, total	4.85E-03	2.17E-02	Wood	2.42E-05
Chromium, hexavalent	8.25E-04	3.61E-03	Wood	4.03E-06
Chromium, trivalent	1.56E-04	6.78E-04	Coal	8.37E-07
Cobalt	1.25E-03	5.48E-03	PRB Coal	6.76E-06
Copper	1.18E-04	5.06E-04	Wood	5.64E-07
Iron	2.33E-03	1.02E-02	Wood	1.14E-05
Magnesium	1.38E-01	6.03E-01	PRB Coal	7.44E-04
Manganese	3.77E-03	1.65E-02	Wood	1.84E-05
Molybdenum	2.20E-04	1.00E-03	Nat Gas	1.24E-06
Nickel	3.09E-04	1.35E-03	Coal	1.67E-06
Phosphorus	6.37E-05	2.79E-04	Wood	3.11E-07
Potassium	9.19E-02	4.03E-01	Wood	4.49E-04
Selenium	1.63E-02	7.14E-02	PRB Coal	8.82E-05
Silver	4.01E-03	1.76E-02	Wood	1.96E-05
Sodium	8.49E-04	3.72E-03	Wood	4.14E-06
Strontium	2.36E-05	1.03E-04	Wood	1.15E-07
Tin	5.42E-05	2.37E-04	Wood	2.65E-07
Titanium	4.72E-05	2.07E-04	Wood	2.30E-07
Vanadium	4.80E-04	2.10E-03	Nat Gas	2.50E-06
Yttrium	7.07E-07	3.10E-06	Wood	3.45E-09
Zinc	5.23E-02	2.29E-01	Coal	2.83E-04
Organic Compounds				
Acetaldehyde	1.96E-01	8.57E-01	Wood	9.55E-04
Acetophenone	1.88E-04	8.22E-04	PRB Coal	1.01E-06
Acrolein	2.38E-02	1.05E-01	Wood	1.16E-04
Benzene	9.90E-01	4.34E+00	Wood	4.83E-03
Benzyl chloride	8.78E-03	3.84E-02	PRB Coal	4.74E-05
Benzoic acid	1.11E-06	4.85E-06	Wood	5.41E-09
Bis(2-Ethylhexyl)phthalate	9.14E-04	4.00E-03	PRB Coal	4.94E-06
Bromoform	4.88E-04	2.14E-03	PRB Coal	2.64E-06
Carbon disulfide	1.63E-03	7.13E-03	PRB Coal	8.79E-06
Carbazole	4.24E-04	1.86E-03	Wood	2.07E-06

Prepared by NTH Consultants, Ltd.

Northern Michigan University
Marquette, MI
CFB Boiler Project

Proposed Circulating Fluidized Bed Boiler
Potential Emissions

Boiler Parameters	Specification
Boiler Type	Circulating Fluidized Bed
Maximum Rated Heat Input, (MM btu/hr)	185
Gross Output (MW/hr)	10

(Approximate; normally 7)

Material	Sulfur Content	Material Usage (%)	Heat Input (MM BTU/hr)	Heating Value (BTU/lb)	Material Throughput (lb/hr)	Material Throughput (tph)	Material Throughput (tpy)	Natural Gas Maximum Usage Rate MMscf/hr
Coal, Bituminous	1.50%	100.0%	185	12,500	14,800	7.40	64,824	0.1814
Coal, PRB	0.50%	100.0%	185	8,500	21,765	10.88	95,329	
Natural Gas	0.00%	100.0%	185	23,200	7,974	3.99	34,927	
Virgin Wood	0.00%	100.0%	205	4,500	45,558	22.78	199,533	

TABLE B-1. EMISSION RATES OF CRITERIA POLLUTANTS, HAPS, AND TACS FROM THE NEW BOILER ON A PER-FUEL BASIS

Compound	CAS Reference Number	Coal, Bituminous				Coal, PRB				Natural Gas				Waste Wood			
		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates	
		Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)
Carbon tetrachloride	56235													5.18E-05	lb/MMBtu	1.06E-02	4.65E-02
Chlorine	7782505													9.09E-04	lb/MMBtu	1.86E-01	8.16E-01
2-Chloroacetophenone	532274	8.05E-06	lb/ton	5.96E-05	2.61E-04	8.05E-06	lb/ton	8.76E-05	3.84E-04					2.76E-09	lb/MMBtu	5.66E-07	2.48E-06
Chlorobenzene	108907	2.53E-05	lb/ton	1.87E-04	8.20E-04	2.53E-05	lb/ton	2.75E-04	1.21E-03					3.80E-05	lb/MMBtu	7.78E-03	3.41E-02
Chloroform	67663	6.79E-05	lb/ton	5.02E-04	2.20E-03	6.79E-05	lb/ton	7.38E-04	3.23E-03					3.22E-05	lb/MMBtu	6.60E-03	2.89E-02
2-Chloronaphthalene	91587													2.76E-09	lb/MMBtu	5.66E-07	2.48E-06
2-Chlorophenol	95578													2.76E-08	lb/MMBtu	5.66E-06	2.48E-05
Cumene	98828	6.10E-06	lb/ton	4.51E-05	1.98E-04	6.10E-06	lb/ton	6.63E-05	2.91E-04								
Cyanide	74908	2.88E-03	lb/ton	2.13E-02	9.32E-02	2.88E-03	lb/ton	3.13E-02	1.37E-01								
1,4-Dichlorobenzene	106467									1.38E-03	lb/MMscf	2.50E-04	1.10E-03				
2,4-Dinitrotoluene	121142	3.22E-07	lb/ton	2.38E-06	1.04E-05	3.22E-07	lb/ton	3.50E-06	1.53E-05								
Dimethyl sulfate	77781	5.52E-05	lb/ton	4.08E-04	1.79E-03	5.52E-05	lb/ton	6.01E-04	2.63E-03								
2,4-Dinitrophenol	51285													2.07E-07	lb/MMBtu	4.24E-05	1.86E-04
Ethylbenzene	108678	1.08E-04	lb/ton	8.00E-04	3.50E-03	1.08E-04	lb/ton	1.18E-03	5.15E-03					3.57E-05	lb/MMBtu	7.31E-03	3.20E-02
Ethylchloride	75003	4.83E-05	lb/ton	3.57E-04	1.57E-03	4.83E-05	lb/ton	5.26E-04	2.30E-03								
Ethylene dichloride	107062	4.60E-05	lb/ton	3.40E-04	1.49E-03	4.60E-05	lb/ton	5.01E-04	2.19E-03								
Ethylene dibromide	106934	1.38E-06	lb/ton	1.02E-05	4.47E-05	1.38E-06	lb/ton	1.50E-05	6.58E-05								
Formaldehyde	50000	2.76E-04	lb/ton	2.04E-03	8.95E-03	2.76E-04	lb/ton	3.00E-03	1.32E-02	8.63E-02	lb/MMscf	1.56E-02	6.85E-02	6.06E-03	lb/MMBtu	1.04E+00	4.54E+00
Heptachlorobiphenyl	28655712													7.59E-11	lb/MMBtu	1.56E-08	6.82E-08
Hexachlorobiphenyl	26601649													6.33E-10	lb/MMBtu	1.30E-07	5.68E-07
Hexanal	66251													8.05E-06	lb/MMBtu	1.65E-03	7.23E-03
Hexane	110543	7.71E-05	lb/ton	5.70E-04	2.50E-03	7.71E-05	lb/ton	8.38E-04	3.67E-03	2.07E+00	lb/MMscf	3.75E-01	1.64E+00				
Isobutyraldehyde	78842													1.38E-05	lb/MMBtu	2.83E-03	1.24E-02
Isophorone	78591	6.67E-04	lb/ton	4.94E-03	2.16E-02	6.67E-04	lb/ton	7.26E-03	3.18E-02								
2-Methylnaphthalene	91576									2.76E-05	lb/MMscf	5.01E-06	2.19E-05	1.84E-07	lb/MMBtu	3.77E-05	1.65E-04
3-Methylchloranthrene										2.07E-06	lb/MMscf	3.76E-07	1.64E-06				
Monochlorobiphenyl														2.53E-10	lb/MMBtu	5.19E-08	2.27E-07
Methyl bromide (bromomethane)	74839	1.84E-04	lb/ton	1.36E-03	5.96E-03	1.84E-04	lb/ton	2.00E-03	8.77E-03					1.73E-05	lb/MMBtu	3.54E-03	1.55E-02
Methyl chloride	74873	6.10E-04	lb/ton	4.51E-03	1.98E-02	6.10E-04	lb/ton	6.63E-03	2.91E-02					2.65E-05	lb/MMBtu	5.42E-03	2.37E-02
Methyl ethyl ketone	78933	4.49E-04	lb/ton	3.32E-03	1.46E-02	4.49E-04	lb/ton	4.88E-03	2.14E-02					6.21E-06	lb/MMBtu	1.27E-03	5.58E-03
Methyl hydrazine	60344	1.96E-04	lb/ton	1.45E-03	6.34E-03	1.96E-04	lb/ton	2.13E-03	9.32E-03								
Methyl methacrylate	80626	2.30E-05	lb/ton	1.70E-04	7.45E-04	2.30E-05	lb/ton	2.50E-04	1.10E-03								
Methyl tert butyl ether	1634044	4.03E-05	lb/ton	2.98E-04	1.30E-03	4.03E-05	lb/ton	4.38E-04	1.92E-03								
Methylene chloride (Dichloromethane)	75092	3.34E-04	lb/ton	2.47E-03	1.08E-02	3.34E-04	lb/ton	3.63E-03	1.59E-02					3.34E-04	lb/MMBtu	6.84E-02	2.99E-01
2-Nitrophenol	88755													2.76E-07	lb/MMBtu	5.66E-05	2.48E-04
4-Nitrophenol	100027													1.27E-07	lb/MMBtu	2.59E-05	1.14E-04
Pentachlorobiphenyl	25429292													1.38E-09	lb/MMBtu	2.83E-07	1.24E-06
Pentachlorophenol	87865													5.87E-08	lb/MMBtu	1.20E-05	5.27E-05
Perylene	198550													5.98E-10	lb/MMBtu	1.23E-07	5.37E-07
Phenol	108952	1.84E-05	lb/ton	1.36E-04	5.96E-04	1.84E-05	lb/ton	2.00E-04	8.77E-04					5.87E-05	lb/MMBtu	1.20E-02	5.27E-02
Propionaldehyde	123386	4.37E-04	lb/ton	3.23E-03	1.42E-02	4.37E-04	lb/ton	4.76E-03	2.08E-02					7.02E-05	lb/MMBtu	1.44E-02	6.30E-02
Propanal	123386													3.68E-06	lb/MMBtu	7.54E-04	3.30E-03
Styrene	100425	2.88E-05	lb/ton	2.13E-04	9.32E-04	2.88E-05	lb/ton	3.13E-04	1.37E-03					2.19E-03	lb/MMBtu	4.48E-01	1.96E+00
Tetrachlorobiphenyl	26914330													2.88E-09	lb/MMBtu	5.89E-07	2.58E-06
Tetrachloroethylene	127184	4.95E-05	lb/ton	3.66E-04	1.60E-03	4.96E-05	lb/ton	5.38E-04	2.36E-03					4.37E-05	lb/MMBtu	8.96E-03	3.92E-02
Toluene	108883	2.76E-04	lb/ton	2.04E-03	8.95E-03	2.76E-04	lb/ton	3.00E-03	1.32E-02	3.91E-03	lb/MMscf	7.09E-04	3.11E-03	1.06E-03	lb/MMBtu	2.17E-01	9.50E-01
o-Tolualdehyde	529204													8.28E-06	lb/MMBtu	1.70E-03	7.43E-03
p-Tolualdehyde	104870													1.27E-05	lb/MMBtu	2.59E-03	1.14E-02
Trichlorobiphenyl														2.99E-09	lb/MMBtu	6.13E-07	2.68E-06

TABLE B-2. MAXIMUM EMISSION RATES

Compound	Maximum Emission Rates (lb/hr)	Maximum Emission Rates (tpy)	Fuel	Emission Factor lb/MMBtu
Carbon tetrachloride	1.06E-02	4.65E-02	Wood	5.18E-05
Chlorine	1.86E-01	8.16E-01	Wood	9.09E-04
2-Chloroacetophenone	8.76E-05	3.84E-04	PRB Coal	4.74E-07
Chlorobenzene	7.78E-03	3.41E-02	Wood	3.80E-05
Chloroform	6.60E-03	2.89E-02	Wood	3.22E-05
2-Chloronaphthalene	5.66E-07	2.48E-06	Wood	2.76E-09
2-Chlorophenol	5.66E-06	2.48E-05	Wood	2.76E-08
Cumene	6.63E-05	2.91E-04	PRB Coal	3.59E-07
Cyanide	3.13E-02	1.37E-01	PRB Coal	1.69E-04
1,4-Dichlorobenzene	2.50E-04	1.10E-03	Nat Gas	1.35E-06
2,4-Dinitrotoluene	3.50E-06	1.53E-05	PRB Coal	1.89E-08
Dimethyl sulfate	6.01E-04	2.63E-03	PRB Coal	3.25E-06
2,4-Dinitrophenol	4.24E-05	1.86E-04	Wood	2.07E-07
Ethylbenzene	7.31E-03	3.20E-02	Wood	3.57E-05
Ethylchloride	5.26E-04	2.30E-03	PRB Coal	2.84E-06
Ethylene dichloride	5.01E-04	2.19E-03	PRB Coal	2.71E-06
Ethylene dibromide	1.50E-05	6.58E-05	PRB Coal	8.12E-08
Formaldehyde	1.04E+00	4.54E+00	Wood	5.06E-03
Heptachlorobiphenyl	1.56E-08	6.82E-08	Wood	7.59E-11
Hexachlorobiphenyl	1.30E-07	5.68E-07	Wood	6.33E-10
Hexanal	1.65E-03	7.23E-03	Wood	8.05E-06
Hexane	3.75E-01	1.64E+00	Nat Gas	2.03E-03
Isobutyraldehyde	2.83E-03	1.24E-02	Wood	1.38E-05
Isophorone	7.26E-03	3.18E-02	PRB Coal	3.92E-05
2-Methylnaphthalene	3.77E-05	1.65E-04	Wood	1.84E-07
3-Methylchloranthrene	3.75E-07	1.64E-06	Nat Gas	2.03E-09
Monochlorobiphenyl	5.19E-08	2.27E-07	Wood	2.53E-10
Methyl bromide	3.54E-03	1.55E-02	Wood	1.73E-05
Methyl chloride	6.63E-03	2.91E-02	PRB Coal	3.58E-05
Methyl ethyl ketone	4.88E-03	2.14E-02	PRB Coal	2.64E-05
Methyl hydrazine	2.13E-03	9.32E-03	PRB Coal	1.15E-05
Methyl methacrylate	2.50E-04	1.10E-03	PRB Coal	1.35E-06
Methyl tert butyl ether	4.38E-04	1.92E-03	PRB Coal	2.37E-06
Methylene chloride	6.84E-02	2.99E-01	Wood	3.34E-04
2-Nitrophenol	5.66E-05	2.48E-04	Wood	2.76E-07
4-Nitrophenol	2.59E-05	1.14E-04	Wood	1.27E-07
Pentachlorobiphenyl	2.83E-07	1.24E-06	Wood	1.38E-09
Pentachlorophenol	1.20E-05	5.27E-05	Wood	5.87E-08
Perylene	1.23E-07	5.37E-07	Wood	5.98E-10
Phenol	1.20E-02	5.27E-02	Wood	5.87E-05
Propionaldehyde	1.44E-02	6.30E-02	Wood	7.02E-05
Propanal	7.54E-04	3.30E-03	Wood	3.68E-06
Styrene	4.48E-01	1.96E+00	Wood	2.19E-03
Tetrachlorobiphenyl	5.89E-07	2.58E-06	Wood	2.88E-09
Tetrachloroethylene	8.96E-03	3.92E-02	Wood	4.37E-05
Toluene	2.17E-01	9.50E-01	Wood	1.06E-03
o-Tolualdehyde	1.70E-03	7.43E-03	Wood	8.28E-06
p-Tolualdehyde	2.59E-03	1.14E-02	Wood	1.27E-05
Trichlorobiphenyl	6.13E-07	2.68E-06	Wood	2.99E-09

Prepared by NTH Consultants, Ltd.

Proposed Circulating Fluidized Bed Boiler
Potential Emissions

Boiler Parameters	Specification
Boiler Type	Circulating Fluidized Bed
Maximum Rated Heat Input, (MM btu/hr)	185
Gross Output (MW/hr)	10

(Approximate; normally 7)

Material	Sulfur Content	Material Usage (%)	Heat Input (MM BTU/hr)	Heating Value (BTU/lb)	Material Throughput (lb/hr)	Material Throughput (tph)	Material Throughput (tpy)	Natural Gas Maximum Usage Rate MMscf/hr
Coal, Bituminous	1.50%	100.0%	185	12,500	14,800	7.40	64,824	0.1814
Coal, PRB	0.60%	100.0%	185	8,500	21,766	10.88	95,329	
Natural Gas	0.00%	100.0%	185	23,200	7,974	3.99	34,927	
Virgin Wood	0.00%	100.0%	205	4,500	45,556	22.78	199,533	

TABLE B-1. EMISSION RATES OF CRITERIA POLLUTANTS, HAPS, AND TACS FROM THE NEW BOILER ON A PER-FUEL BASIS

Compound	CAS Reference Number	Coal, Bituminous				Coal, PRB				Natural Gas				Waste Wood			
		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates	
		Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)
Trichlorofluoromethane	75694													4.72E-05	lb/MMBtu	9.67E-03	4.23E-02
Trichlorethene	79016													3.45E-05	lb/MMBtu	7.07E-03	3.10E-02
1,1,1-Trichloroethane	71556	2.30E-05	lb/ton	1.70E-04	7.45E-04	2.30E-05	lb/ton	2.50E-04	1.10E-03					3.57E-05	lb/MMBtu	7.31E-03	3.20E-02
2,4,6-Trichlorophenol	88062													2.53E-08	lb/MMBtu	5.19E-06	2.27E-05
Vinyl acetate	108054	8.74E-05	lb/ton	6.47E-04	2.83E-03	8.74E-05	lb/ton	9.51E-04	4.17E-03								
Vinyl Chloride	75014													2.07E-05	lb/MMBtu	4.24E-03	1.86E-02
Xylenes	1330207	4.26E-05	lb/ton	3.15E-04	1.38E-03	4.26E-05	lb/ton	4.63E-04	2.03E-03								
o-Xylene	95476													2.88E-05	lb/MMBtu	5.89E-03	2.58E-02
Polynuclear Aromatic Hydrocarbons (PAH)																	
Acenaphthene	83329	5.87E-07	lb/ton	4.34E-06	1.90E-05	5.87E-07	lb/ton	6.38E-06	2.80E-05	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	1.05E-06	lb/MMBtu	2.15E-04	9.40E-04
Acenaphthylene	208968	2.88E-07	lb/ton	2.13E-06	9.32E-06	2.88E-07	lb/ton	3.13E-06	1.37E-05	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	5.75E-06	lb/MMBtu	1.18E-03	5.16E-03
Acetone	67641													2.19E-04	lb/MMBtu	4.48E-02	1.96E-01
Anthracene	120127	2.42E-07	lb/ton	1.79E-06	7.83E-06	2.42E-07	lb/ton	2.63E-06	1.15E-05	2.76E-06	lb/MMscf	5.01E-07	2.19E-06	3.45E-06	lb/MMBtu	7.07E-04	3.10E-03
Benzaldehyde	100527													9.78E-07	lb/MMBtu	2.00E-04	8.78E-04
Benzo(a)anthracene	56553	9.20E-08	lb/ton	6.81E-07	2.98E-06	9.20E-08	lb/ton	1.00E-06	4.39E-06	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	7.48E-08	lb/MMBtu	1.53E-05	6.71E-05
Benzo(a)pyrene	50328	4.37E-08	lb/ton	3.23E-07	1.42E-06	4.37E-08	lb/ton	4.76E-07	2.08E-06	1.38E-06	lb/MMscf	2.50E-07	1.10E-06	2.99E-06	lb/MMBtu	6.13E-04	2.68E-03
Benzo(e)pyrene	192972									1.38E-06	lb/MMscf	2.50E-07	1.10E-06	2.99E-09	lb/MMBtu	6.13E-07	2.68E-06
Benzo(b)fluoranthene	205992									2.07E-06	lb/MMscf	3.75E-07	1.64E-06	1.15E-07	lb/MMBtu	2.36E-05	1.03E-04
Benzo(j,k)fluoranthene	206440													1.84E-07	lb/MMBtu	3.77E-05	1.65E-04
Benzo(k)fluoranthene	205823									2.07E-06	lb/MMscf	3.75E-07	1.64E-06	4.14E-08	lb/MMBtu	8.49E-06	3.72E-05
Benzo(b,j,k)fluoranthene		1.27E-07	lb/ton	9.36E-07	4.10E-06	1.27E-07	lb/ton	1.38E-06	6.03E-06					1.15E-07	lb/MMBtu	2.36E-05	1.03E-04
Benzo(g,h,i)perylene	191242	3.11E-08	lb/ton	2.30E-07	1.01E-06	3.11E-08	lb/ton	3.38E-07	1.48E-06	1.38E-06	lb/MMscf	2.50E-07	1.10E-06	1.07E-07	lb/MMBtu	2.19E-05	9.60E-05
Biphenyl	92524	1.96E-06	lb/ton	1.45E-05	6.34E-05	1.96E-06	lb/ton	2.13E-05	9.32E-05								
Chrysene	218019	1.15E-07	lb/ton	8.51E-07	3.73E-06	1.15E-07	lb/ton	1.25E-06	5.48E-06	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	4.37E-08	lb/MMBtu	8.96E-06	3.92E-05
Crotonaldehyde	4170303													1.14E-05	lb/MMBtu	2.33E-03	1.02E-02
Decachlorobiphenyl	2051243													3.11E-10	lb/MMBtu	6.37E-08	2.79E-07
Dibenzo(a,h)anthracene	53703									1.38E-06	lb/MMscf	2.50E-07	1.10E-06	1.05E-08	lb/MMBtu	2.15E-06	9.40E-06
1,2-Dibromoethene	540498													6.33E-05	lb/MMBtu	1.30E-02	5.68E-02
Dichlorobiphenyl	2050682													8.51E-10	lb/MMBtu	1.74E-07	7.64E-07
1,2-Dichloroethane	107062													3.34E-05	lb/MMBtu	6.84E-03	2.99E-02
1,2-Dichloropropane	78875													3.80E-05	lb/MMBtu	7.78E-03	3.41E-02
7,12-Dimethylbenz(a)anthracene	57976									1.84E-05	lb/MMscf	3.34E-06	1.46E-05				
Fluoranthene	206440	8.17E-07	lb/ton	6.04E-06	2.65E-05	8.17E-07	lb/ton	8.89E-06	3.89E-05	3.45E-06	lb/MMscf	6.28E-07	2.74E-06	1.84E-06	lb/MMBtu	3.77E-04	1.65E-03
Fluorene	86737	1.05E-06	lb/ton	7.74E-06	3.39E-05	1.05E-06	lb/ton	1.14E-05	4.99E-05	3.22E-06	lb/MMscf	5.84E-07	2.56E-06	3.91E-06	lb/MMBtu	8.02E-04	3.51E-03
Indeno(1,2,3,c,d)pyrene	193395	7.02E-08	lb/ton	5.19E-07	2.27E-06	7.02E-08	lb/ton	7.63E-07	3.34E-06	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	1.00E-07	lb/MMBtu	2.05E-05	8.98E-05
Naphthalene	91203	1.50E-05	lb/ton	1.11E-04	4.85E-04	1.50E-05	lb/ton	1.63E-04	7.13E-04	7.02E-04	lb/MMscf	1.27E-04	5.57E-04	1.12E-04	lb/MMBtu	2.29E-02	1.00E-01
Phenanthrene	85018	3.11E-06	lb/ton	2.30E-05	1.01E-04	3.11E-06	lb/ton	3.38E-05	1.48E-04	1.96E-05	lb/MMscf	3.55E-06	1.55E-05	8.05E-06	lb/MMBtu	1.65E-03	7.23E-03
Pyrene	129000	3.80E-07	lb/ton	2.81E-06	1.23E-05	3.80E-07	lb/ton	4.13E-06	1.81E-05	5.75E-06	lb/MMscf	1.04E-06	4.57E-06	4.26E-06	lb/MMBtu	8.72E-04	3.82E-03
5-Methyl chrysene	3697243	2.53E-08	lb/ton	1.87E-07	8.20E-07	2.53E-08	lb/ton	2.75E-07	1.21E-06					9.89E-12	lb/MMBtu	2.03E-09	8.88E-09

These shaded areas depict air contaminants subject to PSD review.
These shaded areas indicate no data available.
These shaded areas depict HAPs.
Unless otherwise noted below, emission factors are from the EPA AP-42 database, and are increased by a 15% safety factor.
* Coal firing emission factor based on Wyandotte Energy stack test results. Wyandotte Energy is located in Wyandotte, Michigan.
** The lead estimated emission rates for PRB & Bituminous fuels are based on a statistical analysis of respective typical coals, with a 99% control efficiency of the baghouse collector.
*** Both HCl and HF emission factors include a 15% safety factor and 92% control using limestone in the CFB.
[1] Emissions are based on the proposed BACT.
[2] Sulfuric acid mist emission based on RBLC search, Plum Point Energy entry. This facility is located in Arkansas.
[3] Total dioxin/furan for the coal firing is from the Wyandotte Energy stack test results, and dioxin/furan for the wood combustion is from the EPA AP-42, Chapter 1.6, Table 1.6-3.
[4] Total chromium is supplied here for information purposes only. Total chromium is a sum of hexavalent and trivalent chromium.

CFB Boiler Maximum Single HAP Emission Rate (HCl) = 6.3 tpy

CFB Boiler Maximum Combined Total HAP Emission Rate = 22.7 tpy

TABLE B-2. MAXIMUM EMISSION RATES

Compound	Maximum Emission Rates (lb/hr)	Maximum Emission Rates (tpy)	Fuel	Emission Factor lb/MMBtu
Trichlorofluoromethane	9.67E-03	4.23E-02	Wood	4.72E-05
Trichlorethene	7.07E-03	3.10E-02	Wood	3.45E-05
1,1,1-Trichloroethane	7.31E-03	3.20E-02	Wood	3.57E-05
2,4,6-Trichlorophenol	5.19E-06	2.27E-05	Wood	2.53E-08
Vinyl acetate	9.51E-04	4.17E-03	PRB Coal	5.14E-06
Vinyl Chloride	4.24E-03	1.86E-02	Wood	2.07E-05
Xylenes	4.63E-04	2.03E-03	PRB Coal	2.50E-06
o-Xylene	5.89E-03	2.58E-02	Wood	2.88E-05
Polynuclear Aromatic Hydrocarbons (PAH)				
Acenaphthene	2.15E-04	9.40E-04	Wood	1.05E-06
Acenaphthylene	1.18E-03	5.16E-03	Wood	5.75E-06
Acetone	4.48E-02	1.96E-01	Wood	2.19E-04
Anthracene	7.07E-04	3.10E-03	Wood	3.45E-06
Benzaldehyde	2.00E-04	8.78E-04	Wood	9.78E-07
Benzo(a)anthracene	1.53E-05	6.71E-05	Wood	7.48E-08
Benzo(a)pyrene	6.13E-04	2.68E-03	Wood	2.99E-06
Benzo(e)pyrene	6.13E-07	2.68E-06	Wood	2.99E-09
Benzo(b)fluoranthene	2.36E-05	1.03E-04	Wood	1.15E-07
Benzo(j,k)fluoranthene	3.77E-05	1.65E-04	Wood	1.84E-07
Benzo(k)fluoranthene	8.49E-06	3.72E-05	Wood	4.14E-08
Benzo(b,j,k)fluoranthene	2.36E-05	1.03E-04	Wood	1.15E-07
Benzo(g,h,i)perylene	2.19E-05	9.60E-05	Wood	1.07E-07
Biphenyl	2.13E-05	9.32E-05	PRB Coal	1.16E-07
Chrysene	8.96E-06	3.92E-05	Wood	4.37E-08
Crotonaldehyde	2.33E-03	1.02E-02	Wood	1.14E-05
Decachlorobiphenyl	6.37E-08	2.79E-07	Wood	3.11E-10
Dibenzo(a,h)anthracene	2.15E-06	9.40E-06	Wood	1.05E-08
1,2-Dibromoethane	1.30E-02	5.68E-02	Wood	6.33E-05
Dichlorobiphenyl	1.74E-07	7.64E-07	Wood	8.51E-10
1,2-Dichloroethane	6.84E-03	2.99E-02	Wood	3.34E-05
1,2-Dichloropropane	7.78E-03	3.41E-02	Wood	3.80E-05
7,12-Dimethylbenz(a)anthracene	3.34E-06	1.46E-05	Nat Gas	1.80E-08
Fluoranthene	3.77E-04	1.65E-03	Wood	1.84E-06
Fluorene	8.02E-04	3.51E-03	Wood	3.91E-06
Indeno(1,2,3,c,d)pyrene	2.05E-05	8.98E-05	Wood	1.00E-07
Naphthalene	2.29E-02	1.00E-01	Wood	1.12E-04
Phenanthrene	1.65E-03	7.23E-03	Wood	8.05E-06
Pyrene	8.72E-04	3.82E-03	Wood	4.26E-06
5-Methyl chrysene	2.75E-07	1.21E-06	PRB Coal	1.49E-09

Proposed Circulating Fluidized Bed Boiler
Potential Emissions

Boiler Parameters	Specification
Boiler Type	Circulating Fluidized Bed
Maximum Rated Heat Input, (MM btu/hr)	185
Gross Output (MW/hr)	10

(Approximate; normally 7)

Material	Sulfur Content	Material Usage (%)	Heat Input (MM BTU/hr)	Heating Value (BTU/lb)	Material Throughput (lb/hr)	Material Throughput (tph)	Material Throughput (tpy)	Natural Gas Maximum Usage Rate MMscf/hr
Coal, Bituminous	1.50%	100.0%	185	12,500	14,800	7.40	64,824	0.1814
Coal, PRB	0.60%	100.0%	185	8,500	21,765	10.88	95,329	
Natural Gas	0.00%	100.0%	185	23,200	7,974	3.99	34,927	
Virgin Wood	0.00%	100.0%	205	4,500	45,556	22.78	199,533	

TABLE B-1. EMISSION RATES OF CRITERIA POLLUTANTS, HAPS, AND TACS FROM THE NEW BOILER ON A PER-FUEL BASIS

Compound	CAS Reference Number	Coal, Bituminous				Coal, PRB				Natural Gas				Waste Wood			
		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates	
		Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)
PM_{10} [1] (filterable and condensable)		0.03	lb/MMBtu	5.6	24.3	0.03	lb/MMBtu	5.6	24.3					0.03	lb/MMBtu	6.2	26.9
SO_2 [1]	7446095	0.20	lb/MMBtu	37.7	165.3	0.096	lb/MMBtu	17.8	77.8					0.026	lb/MMBtu	5.1	22.4
NO_x [1]	10102440	0.10	lb/MMBtu	18.5	81.0	0.10	lb/MMBtu	18.5	81.0	0.10	lb/MMBtu	18.5	81.0	0.10	lb/MMBtu	20.5	89.8
CO [1]	630080	0.15	lb/MMBtu	27.8	121.5	0.15	lb/MMBtu	27.8	121.5	0.15	lb/MMBtu	27.8	121.5	0.17	lb/MMBtu	34.9	152.6
Lead **	7439921	1.34E-05	lb/MMBtu	0.002	0.011	4.52E-06	lb/MMBtu	0.001	0.004					5.52E-07	lb/MMBtu	1.13E-04	4.96E-04
VOC		0.002	lb/MMBtu	0.43	1.88	0.003	lb/MMBtu	0.63	2.74	6.33	lb/MMscf	1.15	5.0	0.02	lb/MMBtu	4.0	17.6
Mercury	7439976	3.00E-06	lb/MMBtu	5.55E-04	2.43E-03	3.00E-06	lb/MMBtu	5.55E-04	2.43E-03	2.98E-04	lb/MMscf	5.42E-05	2.38E-04	3.00E-06	lb/MMBtu	6.15E-04	2.69E-03
HCl ***	7647010	0.11	lb/ton	0.8	3.6	0.11	lb/ton	1.20	5.26								
HF ***	73602616	0.01	lb/ton	0.1	0.4	0.0138	lb/ton	0.15	0.66								
H_2SO_4 (As Sulfuric Acid Mist) [2]	7664939	6.10E-03	lb/MMBtu	1.1	4.9	6.10E-03	lb/MMBtu	1.1	4.9								
Total Dioxin/Furan [3]	1746016	2.34E-12	lb/MMBtu	4.33E-10	1.90E-09	2.34E-12	lb/MMBtu	4.33E-10	1.90E-09								
Metals																	
Antimony *	7440360	9.09E-06	lb/MMBtu	1.68E-03	7.36E-03	9.09E-06	lb/MMBtu	1.68E-03	7.36E-03					9.09E-08	lb/MMBtu	1.86E-05	8.16E-05
Arsenic *	7440382	7.67E-07	lb/MMBtu	1.42E-04	6.22E-04	7.67E-07	lb/MMBtu	1.42E-04	6.22E-04	2.30E-04	lb/MMscf	4.17E-05	1.83E-04	2.53E-07	lb/MMBtu	5.19E-05	2.27E-04
Barium	7440393									5.06E-03	lb/MMscf	9.18E-04	4.02E-03	1.96E-06	lb/MMBtu	4.01E-04	1.76E-03
Beryllium *	7440417	2.00E-08	lb/MMBtu	3.70E-06	1.62E-05	2.00E-08	lb/MMBtu	3.70E-06	1.62E-05	1.38E-05	lb/MMscf	2.50E-06	1.10E-05	1.27E-08	lb/MMBtu	2.59E-06	1.14E-05
Cadmium *	7440439	9.59E-08	lb/MMBtu	1.77E-05	7.77E-05	9.59E-08	lb/MMBtu	1.77E-05	7.77E-05	1.27E-03	lb/MMscf	2.29E-04	1.00E-03	4.72E-08	lb/MMBtu	9.67E-06	4.23E-05
Chromium, total *[4]	7440473	1.20E-06	lb/MMBtu	2.21E-04	9.69E-04	1.20E-06	lb/MMBtu	2.21E-04	9.69E-04	1.61E-03	lb/MMscf	2.92E-04	1.28E-03	2.42E-05	lb/MMBtu	4.95E-03	2.17E-02
Chromium, hexavalent *	18540299	3.59E-07	lb/MMBtu	6.64E-05	2.91E-04	3.59E-07	lb/MMBtu	6.64E-05	2.91E-04					4.03E-06	lb/MMBtu	8.25E-04	3.61E-03
Chromium, trivalent *	16065831	8.37E-07	lb/MMBtu	1.55E-04	6.78E-04	8.37E-07	lb/MMBtu	1.55E-04	6.78E-04								
Cobalt	7440484	1.15E-04	lb/ton	8.51E-04	3.73E-03	1.15E-04	lb/ton	1.25E-03	5.48E-03					7.48E-08	lb/MMBtu	1.53E-05	6.71E-05
Copper	7440508													5.64E-07	lb/MMBtu	1.16E-04	5.06E-04
Iron	7439896													1.14E-05	lb/MMBtu	2.33E-03	1.02E-02
Magnesium	7439954	1.27E-02	lb/ton	9.36E-02	4.10E-01	1.27E-02	lb/ton	1.38E-01	6.03E-01								
Manganese *	7439965	9.30E-06	lb/MMBtu	1.72E-03	7.54E-03	9.30E-06	lb/MMBtu	1.72E-03	7.54E-03	4.37E-04	lb/MMscf	7.93E-05	3.47E-04	1.84E-05	lb/MMBtu	3.77E-03	1.65E-02
Molybdenum	7439987									1.27E-03	lb/MMscf	2.29E-04	1.00E-03	2.42E-08	lb/MMBtu	4.95E-06	2.17E-05
Nickel *	7440020	1.67E-06	lb/MMBtu	3.09E-04	1.35E-03	1.67E-06	lb/MMBtu	3.09E-04	1.35E-03					3.80E-07	lb/MMBtu	7.78E-05	3.41E-04
Phosphorus	7723140													3.11E-07	lb/MMBtu	6.37E-05	2.79E-04
Potassium	7440097													4.49E-04	lb/MMBtu	9.19E-02	4.03E-01
Selenium	7782492	1.50E-03	lb/ton	1.11E-02	4.86E-02	1.50E-03	lb/ton	1.63E-02	7.16E-02					3.22E-08	lb/MMBtu	6.60E-06	2.89E-05
Silver	7440224													1.96E-05	lb/MMBtu	4.01E-03	1.76E-02
Sodium	7440235													4.14E-06	lb/MMBtu	8.49E-04	3.72E-03
Strontium	7440246													1.15E-07	lb/MMBtu	2.36E-05	1.03E-04
Tin	7440315													2.65E-07	lb/MMBtu	5.42E-05	2.37E-04
Titanium	7440326													2.30E-07	lb/MMBtu	4.72E-05	2.07E-04
Vanadium	7440622									2.65E-03	lb/MMscf	4.80E-04	2.10E-03	1.13E-08	lb/MMBtu	2.31E-06	1.01E-05
Yttrium	7440655													3.45E-09	lb/MMBtu	7.07E-07	3.10E-06
Zinc (as zinc oxide) *	1314132	2.83E-04	lb/MMBtu	5.23E-02	2.29E-01	2.83E-04	lb/MMBtu	5.23E-02	2.29E-01	3.34E-02	lb/MMscf	6.06E-03	2.65E-02	4.83E-06	lb/MMBtu	9.90E-04	4.34E-03
Organic Compounds																	
Acetaldehyde	75070	6.56E-04	lb/ton	4.85E-03	2.12E-02	6.56E-04	lb/ton	7.13E-03	3.12E-02					9.55E-04	lb/MMBtu	1.96E-01	8.57E-01
Acetophenone	98862	1.73E-05	lb/ton	1.28E-04	5.59E-04	1.73E-05	lb/ton	1.88E-04	8.22E-04					3.68E-09	lb/MMBtu	7.54E-07	3.30E-06
Acrolein	107028	3.34E-04	lb/ton	2.47E-03	1.08E-02	3.34E-04	lb/ton	3.63E-03	1.59E-02					1.16E-04	lb/MMBtu	2.39E-02	1.06E-01
Benzene	71432	1.50E-03	lb/ton	1.11E-02	4.85E-02	1.50E-03	lb/ton	1.63E-02	7.13E-02	2.42E-03	lb/MMscf	4.38E-04	1.92E-03	4.83E-03	lb/MMBtu	9.90E-01	4.34E+00
Benzyl chloride	100447	8.05E-04	lb/ton	5.96E-03	2.61E-02	8.05E-04	lb/ton	8.76E-03	3.84E-02								
Benzoic acid	65850													5.41E-08	lb/MMBtu	1.11E-05	4.85E-05
Bis(2-Ethylhexyl)phthalate	117817	8.40E-05	lb/ton	6.21E-04	2.72E-03	8.40E-05	lb/ton	9.14E-04	4.00E-03					5.41E-08	lb/MMBtu	1.11E-06	4.86E-06
Bromoform	75252	4.49E-05	lb/ton	3.32E-04	1.45E-03	4.49E-05	lb/ton	4.88E-04	2.14E-03								
Carbon disulfide	75150	1.50E-04	lb/ton	1.11E-03	4.86E-03	1.50E-04	lb/ton	1.63E-03	7.13E-03								
Carbazole	86748													2.07E-08	lb/MMBtu	4.24E-04	1.86E-03

TABLE B-2. MAXIMUM EMISSION RATES

Compound	Maximum Emission Rates		Fuel	Emission Factor
	(lb/hr)	(tpy)		lb/MMBtu
PM_{10} (filterable and condensable)	6.16	26.9	Wood	3.00E-02
SO_2	37.74	165.3	Coal	2.04E-01
NO_x	20.50	89.8	Wood	1.00E-01
CO	34.85	152.6	Wood	1.70E-01
Lead	0.002	0.011	Coal	1.34E-05
VOC	4.01	17.6	Wood	1.96E-02
Mercury	6.15E-04	2.69E-03	Wood	3.00E-06
HCl	1.2	5.26	PRB Coal	6.49E-03
HF	0.2	0.66	PRB Coal	8.12E-04
H_2SO_4	1.1	4.94	Coal	6.10E-03
Total Dioxin/Furan	4.33E-10	1.90E-09	Coal	2.34E-12
Metals				
Antimony	1.68E-03	7.36E-03	Coal	9.09E-06
Arsenic	1.42E-04	6.22E-04	Coal	7.67E-07
Barium	9.16E-04	4.02E-03	Nat Gas	4.96E-06
Beryllium	3.70E-06	1.62E-05	Coal	2.00E-08
Cadmium	2.29E-04	1.00E-03	Nat Gas	1.24E-06
Chromium, total	4.95E-03	2.17E-02	Wood	2.42E-05
Chromium, hexavalent	8.25E-04	3.61E-03	Wood	4.03E-06
Chromium, trivalent	1.55E-04	6.78E-04	Coal	8.37E-07
Cobalt	1.25E-03	5.48E-03	PRB Coal	6.76E-06
Copper	1.16E-04	5.06E-04	Wood	5.64E-07
Iron	2.33E-03	1.02E-02	Wood	1.14E-05
Magnesium	1.38E-01	6.03E-01	PRB Coal	7.44E-04
Manganese	3.77E-03	1.65E-02	Wood	1.84E-05
Molybdenum	2.29E-04	1.00E-03	Nat Gas	1.24E-06
Nickel	3.09E-04	1.35E-03	Coal	1.67E-06
Phosphorus	6.37E-05	2.79E-04	Wood	3.11E-07
Potassium	9.19E-02	4.03E-01	Wood	4.49E-04
Selenium	1.63E-02	7.15E-02	PRB Coal	8.82E-06
Silver	4.01E-03	1.76E-02	Wood	1.96E-05
Sodium	8.49E-04	3.72E-03	Wood	4.14E-06
Strontium	2.36E-05	1.03E-04	Wood	1.15E-07
Tin	5.42E-05	2.37E-04	Wood	2.65E-07
Titanium	4.72E-05	2.07E-04	Wood	2.30E-07
Vanadium	4.80E-04	2.10E-03	Nat Gas	2.59E-06
Yttrium	7.07E-07	3.10E-06	Wood	3.45E-09
Zinc	5.23E-02	2.29E-01	Coal	2.83E-04
Organic Compounds				
Acetaldehyde	1.96E-01	8.57E-01	Wood	9.55E-04
Acetophenone	1.88E-04	8.22E-04	PRB Coal	1.01E-06
Acrolein	2.39E-02	1.05E-01	Wood	1.16E-04
Benzene	9.90E-01	4.34E+00	Wood	4.83E-03
Benzyl chloride	8.76E-03	3.84E-02	PRB Coal	4.74E-06
Benzoic acid	1.11E-05	4.85E-05	Wood	5.41E-08
Bis(2-Ethylhexyl)phthalate	9.14E-04	4.00E-03	PRB Coal	4.94E-06
Bromoform	4.88E-04	2.14E-03	PRB Coal	2.64E-06
Carbon disulfide	1.63E-03	7.13E-03	PRB Coal	8.79E-06
Carbazole	4.24E-04	1.86E-03	Wood	2.07E-06

Prepared by NTH Consultants, Ltd.

Proposed Circulating Fluidized Bed Boiler
Potential Emissions

Boiler Parameters	Specification
Boiler Type	Circulating Fluidized Bed
Maximum Rated Heat Input, (MM btu/hr)	185
Gross Output (MW/hr)	10

(Approximate; normally 7)

Material	Sulfur Content	Material Usage (%)	Heat Input (MM BTU/hr)	Heating Value (BTU/lb)	Material Throughput (lb/hr)	Material Throughput (tph)	Material Throughput (tpy)	Natural Gas Maximum Usage Rate MMscf/hr
Coal, Bituminous	3.50%	100.0%	185	11,800	15,678	7.84	68,669	0.1814
Coal, PRB	0.60%	100.0%	185	8,500	21,765	10.88	95,329	
Natural Gas	0.00%	100.0%	185	23,200	7,974	3.99	34,927	
Virgin Wood	0.00%	100.0%	205	4,600	45,559	22.78	199,533	

TABLE B-1. EMISSION RATES OF CRITERIA POLLUTANTS, HAPS, AND TACS FROM THE NEW BOILER ON A PER-FUEL BASIS

Compound	CAS Reference Number	Coal, Bituminous				Coal, PRB				Natural Gas				Waste Wood			
		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates	
		Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)
PM_{10} [1] (filterable and condensable)		0.03	lb/MMBtu	5.6	24.3	0.03	lb/MMBtu	5.6	24.3					0.03	lb/MMBtu	6.2	26.9
SO_2 [1]	7446095	0.475	lb/MMBtu	87.8	384.5	0.200	lb/MMBtu	37.0	162.1					0.025	lb/MMBtu	5.1	22.4
NO_x [1]	10102440	0.10	lb/MMBtu	18.5	81.0	0.10	lb/MMBtu	18.5	81.0	0.10	lb/MMBtu	18.5	81.0	0.10	lb/MMBtu	20.5	89.8
CO [1]	630080	0.15	lb/MMBtu	27.8	121.5	0.15	lb/MMBtu	27.8	121.5	0.15	lb/MMBtu	27.8	121.5	0.17	lb/MMBtu	34.9	152.8
Lead **	7439921	1.34E-05	lb/MMBtu	0.002	0.011	4.52E-06	lb/MMBtu	0.001	0.004					5.52E-07	lb/MMBtu	1.13E-04	4.98E-04
VOC		0.002	lb/MMBtu	0.45	1.97	0.003	lb/MMBtu	0.63	2.74	6.33	lb/MMscf	1.15	5.0	0.02	lb/MMBtu	4.0	17.6
Mercury	7439976	3.00E-06	lb/MMBtu	5.55E-04	2.43E-03	3.00E-06	lb/MMBtu	5.55E-04	2.43E-03	2.99E-04	lb/MMscf	5.42E-05	2.38E-04	3.00E-06	lb/MMBtu	6.15E-04	2.69E-03
HCl ***	7647010	0.11	lb/ton	0.9	3.8	0.11	lb/ton	1.20	5.26								
HF ***	73602616	0.01	lb/ton	0.1	0.5	0.0138	lb/ton	0.15	0.66								
H_2SO_4 (As Sulfuric Acid Mist) [2]	7664939	6.10E-03	lb/MMBtu	1.1	4.9	6.10E-03	lb/MMBtu	1.1	4.9								
Total Dioxin/Furan *[3]	1746016	2.34E-12	lb/MMBtu	4.33E-10	1.90E-09	2.34E-12	lb/MMBtu	4.33E-10	1.90E-09								
Metals																	
Antimony *	7440360	9.09E-06	lb/MMBtu	1.68E-03	7.36E-03	9.09E-06	lb/MMBtu	1.68E-03	7.36E-03					9.09E-08	lb/MMBtu	1.86E-05	8.16E-05
Arsenic *	7440382	7.67E-07	lb/MMBtu	1.42E-04	6.22E-04	7.67E-07	lb/MMBtu	1.42E-04	6.22E-04	2.30E-04	lb/MMscf	4.17E-05	1.83E-04	2.53E-07	lb/MMBtu	5.19E-05	2.27E-04
Barium	7440393									5.06E-03	lb/MMscf	9.18E-04	4.02E-03	1.96E-06	lb/MMBtu	4.01E-04	1.76E-03
Beryllium *	7440417	2.00E-08	lb/MMBtu	3.70E-06	1.62E-05	2.00E-08	lb/MMBtu	3.70E-06	1.62E-05	1.38E-05	lb/MMscf	2.50E-06	1.10E-05	1.27E-08	lb/MMBtu	2.59E-06	1.14E-05
Cadmium *	7440439	9.59E-08	lb/MMBtu	1.77E-05	7.77E-05	9.59E-08	lb/MMBtu	1.77E-05	7.77E-05	1.27E-03	lb/MMscf	2.29E-04	1.00E-03	4.72E-08	lb/MMBtu	9.67E-06	4.23E-05
Chromium, total **[4]	7440473	1.20E-06	lb/MMBtu	2.21E-04	9.69E-04	1.20E-06	lb/MMBtu	2.21E-04	9.69E-04	1.61E-03	lb/MMscf	2.92E-04	1.28E-03	2.42E-05	lb/MMBtu	4.95E-03	2.17E-02
Chromium, hexavalent *	18540299	3.59E-07	lb/MMBtu	6.64E-05	2.91E-04	3.59E-07	lb/MMBtu	6.64E-05	2.91E-04					4.03E-06	lb/MMBtu	8.25E-04	3.61E-03
Chromium, trivalent *	16065831	8.37E-07	lb/MMBtu	1.55E-04	6.78E-04	8.37E-07	lb/MMBtu	1.55E-04	6.78E-04								
Cobalt	7440484	1.15E-04	lb/ton	9.01E-04	3.95E-03	1.15E-04	lb/ton	1.25E-03	5.48E-03					7.48E-08	lb/MMBtu	1.53E-05	6.71E-05
Copper	7440508													5.64E-07	lb/MMBtu	1.16E-04	5.06E-04
Iron	7439896													1.14E-05	lb/MMBtu	2.33E-03	1.02E-02
Magnesium	7439954	1.27E-02	lb/ton	9.92E-02	4.34E-01	1.27E-02	lb/ton	1.38E-01	6.03E-01								
Manganese *	7439965	9.30E-06	lb/MMBtu	1.72E-03	7.54E-03	9.30E-06	lb/MMBtu	1.72E-03	7.54E-03	4.37E-04	lb/MMscf	7.93E-05	3.47E-04	1.84E-05	lb/MMBtu	3.77E-03	1.65E-02
Molybdenum	7439987									1.27E-03	lb/MMscf	2.29E-04	1.00E-03	2.42E-08	lb/MMBtu	4.95E-06	2.17E-05
Nickel *	7440020	1.67E-06	lb/MMBtu	3.09E-04	1.35E-03	1.67E-06	lb/MMBtu	3.09E-04	1.35E-03					3.80E-07	lb/MMBtu	7.78E-05	3.41E-04
Phosphorus	7723140													3.11E-07	lb/MMBtu	6.37E-05	2.79E-04
Potassium	7440097													4.49E-04	lb/MMBtu	9.19E-02	4.03E-01
Selenium	7782492	1.50E-03	lb/ton	1.18E-02	5.15E-02	1.50E-03	lb/ton	1.63E-02	7.15E-02					3.22E-08	lb/MMBtu	6.60E-06	2.89E-05
Silver	7440224													1.96E-05	lb/MMBtu	4.01E-03	1.76E-02
Sodium	7440235													4.14E-06	lb/MMBtu	8.49E-04	3.72E-03
Strontium	7440246													1.15E-07	lb/MMBtu	2.36E-05	1.03E-04
Tin	7440315													2.65E-07	lb/MMBtu	5.42E-05	2.37E-04
Titanium	7440326													2.30E-07	lb/MMBtu	4.72E-05	2.07E-04
Vanadium	7440622									2.65E-03	lb/MMscf	4.80E-04	2.10E-03	1.13E-08	lb/MMBtu	2.31E-06	1.01E-05
Yttrium	7440655													3.45E-09	lb/MMBtu	7.07E-07	3.10E-06
Zinc (as zinc oxide) *	1314132	2.83E-04	lb/MMBtu	5.23E-02	2.29E-01	2.83E-04	lb/MMBtu	5.23E-02	2.29E-01	3.34E-02	lb/MMscf	6.06E-03	2.65E-02	4.83E-06	lb/MMBtu	9.90E-04	4.34E-03
Organic Compounds																	
Acetaldehyde	75070	6.56E-04	lb/ton	5.14E-03	2.25E-02	6.56E-04	lb/ton	7.13E-03	3.12E-02					9.65E-04	lb/MMBtu	1.98E-01	8.57E-01
Acetophenone	98862	1.73E-05	lb/ton	1.36E-04	5.92E-04	1.73E-05	lb/ton	1.88E-04	8.22E-04					3.66E-09	lb/MMBtu	7.54E-07	3.30E-06
Acrolein	107028	3.34E-04	lb/ton	2.61E-03	1.15E-02	3.34E-04	lb/ton	3.63E-03	1.59E-02					1.16E-04	lb/MMBtu	2.39E-02	1.05E-01
Benzene	71432	1.50E-03	lb/ton	1.17E-02	5.13E-02	1.50E-03	lb/ton	1.63E-02	7.13E-02	2.42E-03	lb/MMscf	4.38E-04	1.92E-03	4.83E-03	lb/MMBtu	9.90E-01	4.34E+00
Benzyl chloride	100447	8.05E-04	lb/ton	6.31E-03	2.76E-02	8.05E-04	lb/ton	8.76E-03	3.84E-02								
Benzoic acid	65850													5.41E-08	lb/MMBtu	1.11E-05	4.85E-05
Bis(2-Ethylhexyl)phthalate	117817	8.40E-05	lb/ton	6.58E-04	2.88E-03	8.40E-05	lb/ton	9.14E-04	4.00E-03					5.41E-08	lb/MMBtu	1.11E-05	4.85E-05
Bromoform	75252	4.49E-05	lb/ton	3.52E-04	1.54E-03	4.49E-05	lb/ton	4.88E-04	2.14E-03								
Carbon disulfide	75150	1.50E-04	lb/ton	1.17E-03	5.13E-03	1.50E-04	lb/ton	1.63E-03	7.13E-03								
Carbazole	86748													2.07E-06	lb/MMBtu	4.24E-04	1.86E-03

TABLE B-2. MAXIMUM EMISSION RATES

Compound	Maximum Emission Rates (lb/hr)	Maximum Emission Rates (tpy)	Fuel	Emission Factor lb/MMBtu
PM_{10} (filterable and condensable)	6.15	26.9	Wood	3.00E-02
SO_2	87.80	384.5	Coal	4.75E-01
NO_x	20.50	89.8	Wood	1.00E-01
CO	34.85	152.6	Wood	1.70E-01
Lead	0.002	0.011	Coal	1.34E-05
VOC	4.01	17.6	Wood	1.96E-02
Mercury	6.15E-04	2.69E-03	Wood	3.00E-06
HCl	1.2	5.26	PRB Coal	6.49E-03
HF	0.2	0.66	PRB Coal	8.12E-04
H_2SO_4	1.1	4.94	Coal	6.10E-03
Total Dioxin/Furan	4.33E-10	1.90E-09	Coal	2.34E-12
Metals				
Antimony	1.68E-03	7.36E-03	Coal	9.09E-06
Arsenic	1.42E-04	6.22E-04	Coal	7.67E-07
Barium	9.18E-04	4.02E-03	Nat Gas	4.96E-06
Beryllium	3.70E-06	1.62E-05	Coal	2.00E-08
Cadmium	2.29E-04	1.00E-03	Nat Gas	1.24E-06
Chromium, total	4.95E-03	2.17E-02	Wood	2.42E-05
Chromium, hexavalent	8.25E-04	3.61E-03	Wood	4.03E-06
Chromium, trivalent	1.55E-04	6.78E-04	Coal	8.37E-07
Cobalt	1.25E-03	5.48E-03	PRB Coal	6.76E-06
Copper	1.16E-04	5.06E-04	Wood	5.64E-07
Iron	2.33E-03	1.02E-02	Wood	1.14E-05
Magnesium	1.38E-01	6.03E-01	PRB Coal	7.44E-04
Manganese	3.77E-03	1.65E-02	Wood	1.84E-05
Molybdenum	2.29E-04	1.00E-03	Nat Gas	1.24E-06
Nickel	3.09E-04	1.35E-03	Coal	1.67E-06
Phosphorus	6.37E-05	2.79E-04	Wood	3.11E-07
Potassium	9.19E-02	4.03E-01	Wood	4.49E-04
Selenium	1.63E-02	7.15E-02	PRB Coal	8.82E-05
Silver	4.01E-03	1.76E-02	Wood	1.96E-05
Sodium	8.49E-04	3.72E-03	Wood	4.14E-06
Strontium	2.36E-05	1.03E-04	Wood	1.15E-07
Tin	5.42E-05	2.37E-04	Wood	2.65E-07
Titanium	4.72E-05	2.07E-04	Wood	2.30E-07
Vanadium	4.80E-04	2.10E-03	Nat Gas	2.59E-06
Yttrium	7.07E-07	3.10E-06	Wood	3.45E-09
Zinc	5.23E-02	2.29E-01	Coal	2.83E-04
Organic Compounds				
Acetaldehyde	1.98E-01	8.57E-01	Wood	9.65E-04
Acetophenone	1.88E-04	8.22E-04	PRB Coal	1.01E-06
Acrolein	2.39E-02	1.05E-01	Wood	1.16E-04
Benzene	9.90E-01	4.34E+00	Wood	4.83E-03
Benzyl chloride	8.76E-03	3.84E-02	PRB Coal	4.74E-05
Benzoic acid	1.11E-05	4.85E-05	Wood	5.41E-08
Bis(2-Ethylhexyl)phthalate	9.14E-04	4.00E-03	PRB Coal	4.94E-06
Bromoform	4.88E-04	2.14E-03	PRB Coal	2.64E-06
Carbon disulfide	1.63E-03	7.13E-03	PRB Coal	8.79E-06
Carbazole	4.24E-04	1.86E-03	Wood	2.07E-06

Prepared by NTH Consultants, Ltd.

Northern Michigan University
Marquette, MI
CFB Boiler Project

Proposed Circulating Fluidized Bed Boiler
Potential Emissions

Boiler Parameters	Specification	
Boiler Type	Circulating Fluidized Bed	
Maximum Rated Heat Input (MM btu/hr)	185	
Gross Output (MW/hr)	10	(Approximate; normally 7)

Material	Sulfur Content	Material Usage (%)	Heat Input (MM BTU/hr)	Heating Value (BTU/lb)	Material Throughput (lb/hr)	Material Throughput (tph)	Material Throughput (tpy)	Natural Gas Maximum Usage Rate MMscf/hr
Coal, Bituminous	3.50%	100.0%	185	11,800	15,678	7.84	68,669	0.1814
Coal, PRB	0.60%	100.0%	185	8,500	21,765	10.88	95,329	
Natural Gas	0.00%	100.0%	185	23,200	7,974	3.99	34,927	
Virgin Wood	0.00%	100.0%	205	4,500	45,556	22.78	199,533	

TABLE B-1. EMISSION RATES OF CRITERIA POLLUTANTS, HAPS, AND TACS FROM THE NEW BOILER ON A PER-FUEL BASIS

Compound	CAS Reference Number	Coal, Bituminous				Coal, PRB				Natural Gas				Waste Wood			
		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates	
		Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)
Carbon tetrachloride	56235													5.18E-05	lb/MMBtu	1.06E-02	4.65E-02
Chlorine	7782505													9.09E-04	lb/MMBtu	1.86E-01	8.16E-01
2-Chloroacetophenone	532274	8.05E-06	lb/ton	6.31E-05	2.76E-04	8.05E-06	lb/ton	8.76E-05	3.84E-04					2.76E-09	lb/MMBtu	5.66E-07	2.48E-06
Chlorobenzene	108907	2.53E-05	lb/ton	1.98E-04	8.69E-04	2.53E-05	lb/ton	2.75E-04	1.21E-03					3.80E-05	lb/MMBtu	7.78E-03	3.41E-02
Chloroform	67663	6.79E-05	lb/ton	5.32E-04	2.33E-03	6.79E-05	lb/ton	7.38E-04	3.23E-03					3.22E-05	lb/MMBtu	6.60E-03	2.89E-02
2-Chloronaphthalene	91587													2.76E-09	lb/MMBtu	5.66E-07	2.48E-06
2-Chlorophenol	95578													2.76E-08	lb/MMBtu	5.66E-06	2.48E-05
Cumene	98828	6.10E-06	lb/ton	4.78E-05	2.09E-04	6.10E-06	lb/ton	6.63E-05	2.91E-04								
Cyanide	74908	2.88E-03	lb/ton	2.25E-02	9.87E-02	2.88E-03	lb/ton	3.13E-02	1.37E-01								
1,4-Dichlorobenzene	106467									1.38E-03	lb/MMscf	2.50E-04	1.10E-03				
2,4-Dinitrotoluene	121142	3.22E-07	lb/ton	2.52E-06	1.11E-05	3.22E-07	lb/ton	3.50E-06	1.53E-05								
Dimethyl sulfate	77781	5.52E-05	lb/ton	4.33E-04	1.90E-03	5.52E-05	lb/ton	6.01E-04	2.63E-03								
2,4-Dinitrophenol	51285													2.07E-07	lb/MMBtu	4.24E-05	1.86E-04
Ethylbenzene	108678	1.08E-04	lb/ton	8.47E-04	3.71E-03	1.08E-04	lb/ton	1.18E-03	5.15E-03					3.57E-05	lb/MMBtu	7.31E-03	3.20E-02
Ethylchloride	75003	4.83E-05	lb/ton	3.79E-04	1.66E-03	4.83E-05	lb/ton	5.26E-04	2.30E-03								
Ethylene dichloride	107062	4.60E-05	lb/ton	3.61E-04	1.58E-03	4.60E-05	lb/ton	5.01E-04	2.19E-03								
Ethylene dibromide	106934	1.38E-06	lb/ton	1.08E-05	4.74E-05	1.38E-06	lb/ton	1.50E-05	6.58E-05								
Formaldehyde	50000	2.76E-04	lb/ton	2.16E-03	9.48E-03	2.76E-04	lb/ton	3.00E-03	1.32E-02	8.63E-02	lb/MMscf	1.56E-02	6.85E-02	5.06E-03	lb/MMBtu	1.04E+00	4.54E+00
Heptachlorobiphenyl	28655712													7.59E-11	lb/MMBtu	1.56E-08	6.82E-08
Hexachlorobiphenyl	26601649													6.33E-10	lb/MMBtu	1.30E-07	5.68E-07
Hexanal	66251													8.05E-06	lb/MMBtu	1.65E-03	7.23E-03
Hexane	110543	7.71E-05	lb/ton	6.04E-04	2.65E-03	7.71E-05	lb/ton	8.38E-04	3.67E-03	2.07E+00	lb/MMscf	3.75E-01	1.64E+00				
Isobutyraldehyde	78842													1.38E-05	lb/MMBtu	2.83E-03	1.24E-02
Isophorone	78591	6.67E-04	lb/ton	5.23E-03	2.29E-02	6.67E-04	lb/ton	7.26E-03	3.18E-02								
2-Methylnaphthalene	91576									2.76E-05	lb/MMscf	5.01E-06	2.19E-05	1.84E-07	lb/MMBtu	3.77E-05	1.65E-04
3-Methylchloranthrene										2.07E-06	lb/MMscf	3.75E-07	1.64E-06				
Monochlorobiphenyl														2.53E-10	lb/MMBtu	5.19E-08	2.27E-07
Methyl bromide (bromomethane)	74839	1.84E-04	lb/ton	1.44E-03	6.32E-03	1.84E-04	lb/ton	2.00E-03	8.77E-03					1.73E-05	lb/MMBtu	3.54E-03	1.55E-02
Methyl chloride	74873	6.10E-04	lb/ton	4.78E-03	2.09E-02	6.10E-04	lb/ton	6.63E-03	2.91E-02					2.65E-05	lb/MMBtu	5.42E-03	2.37E-02
Methyl ethyl ketone	78933	4.49E-04	lb/ton	3.52E-03	1.54E-02	4.49E-04	lb/ton	4.88E-03	2.14E-02					6.21E-06	lb/MMBtu	1.27E-03	5.58E-03
Methyl hydrazine	60344	1.96E-04	lb/ton	1.53E-03	6.71E-03	1.96E-04	lb/ton	2.13E-03	9.32E-03								
Methyl methacrylate	80626	2.30E-05	lb/ton	1.80E-04	7.90E-04	2.30E-05	lb/ton	2.50E-04	1.10E-03								
Methyl tert butyl ether	1634044	4.03E-05	lb/ton	3.16E-04	1.38E-03	4.03E-05	lb/ton	4.38E-04	1.92E-03								
Methylene chloride (Dichloromethane)	75092	3.34E-04	lb/ton	2.61E-03	1.16E-02	3.34E-04	lb/ton	3.63E-03	1.59E-02					3.34E-04	lb/MMBtu	6.84E-02	2.99E-01
2-Nitrophenol	88755													2.76E-07	lb/MMBtu	5.66E-05	2.48E-04
4-Nitrophenol	100027													1.27E-07	lb/MMBtu	2.59E-05	1.14E-04
Pentachlorobiphenyl	25429292													1.38E-09	lb/MMBtu	2.83E-07	1.24E-06
Pentachlorophenol	87865													5.87E-08	lb/MMBtu	1.20E-05	5.27E-05
Perylene	198550													6.98E-10	lb/MMBtu	1.28E-07	5.37E-07
Phenol	108952	1.84E-05	lb/ton	1.44E-04	6.32E-04	1.84E-05	lb/ton	2.00E-04	8.77E-04					5.87E-05	lb/MMBtu	1.20E-02	5.27E-02
Propionaldehyde	123386	4.37E-04	lb/ton	3.43E-03	1.50E-02	4.37E-04	lb/ton	4.76E-03	2.08E-02					7.02E-05	lb/MMBtu	1.44E-02	6.30E-02
Propanal	123386													3.68E-06	lb/MMBtu	7.54E-04	3.30E-03
Styrene	100425	2.88E-05	lb/ton	2.25E-04	9.87E-04	2.88E-05	lb/ton	3.13E-04	1.37E-03					2.19E-03	lb/MMBtu	4.48E-01	1.96E+00
Tetrachlorobiphenyl	26914330													2.88E-09	lb/MMBtu	5.89E-07	2.58E-06
Tetrachloroethylene	127184	4.95E-05	lb/ton	3.88E-04	1.70E-03	4.95E-05	lb/ton	5.38E-04	2.36E-03					4.37E-05	lb/MMBtu	8.96E-03	3.92E-02
Toluene	108883	2.76E-04	lb/ton	2.16E-03	9.48E-03	2.76E-04	lb/ton	3.00E-03	1.32E-02	3.91E-03	lb/MMscf	7.09E-04	3.11E-03	1.06E-03	lb/MMBtu	2.17E-01	9.50E-01
o-Tolualdehyde	529204													8.28E-06	lb/MMBtu	1.70E-03	7.43E-03
p-Tolualdehyde	104870													1.27E-05	lb/MMBtu	2.59E-03	1.14E-02
Trichlorobiphenyl														2.99E-09	lb/MMBtu	6.13E-07	2.58E-06

TABLE B-2. MAXIMUM EMISSION RATES

Compound	Maximum Emission Rates		Fuel	Emission Factor
	(lb/hr)	(tpy)		lb/MMBtu
Carbon tetrachloride	1.06E-02	4.65E-02	Wood	5.18E-05
Chlorine	1.86E-01	8.16E-01	Wood	9.09E-04
2-Chloroacetophenone	8.76E-05	3.84E-04	PRB Coal	4.74E-07
Chlorobenzene	7.78E-03	3.41E-02	Wood	3.80E-05
Chloroform	6.60E-03	2.89E-02	Wood	3.22E-05
2-Chloronaphthalene	5.66E-07	2.48E-06	Wood	2.76E-09
2-Chlorophenol	5.66E-06	2.48E-05	Wood	2.76E-08
Cumene	6.63E-05	2.91E-04	PRB Coal	3.59E-07
Cyanide	3.13E-02	1.37E-01	PRB Coal	1.69E-04
1,4-Dichlorobenzene	2.50E-04	1.10E-03	Nat Gas	1.35E-06
2,4-Dinitrotoluene	3.50E-06	1.53E-05	PRB Coal	1.89E-08
Dimethyl sulfate	6.01E-04	2.63E-03	PRB Coal	3.25E-06
2,4-Dinitrophenol	4.24E-05	1.86E-04	Wood	2.07E-07
Ethylbenzene	7.31E-03	3.20E-02	Wood	3.57E-05
Ethylchloride	5.26E-04	2.30E-03	PRB Coal	2.84E-06
Ethylene dichloride	5.01E-04	2.19E-03	PRB Coal	2.71E-06
Ethylene dibromide	1.50E-05	6.58E-05	PRB Coal	8.12E-08
Formaldehyde	1.04E+00	4.54E+00	Wood	5.06E-03
Heptachlorobiphenyl	1.56E-08	6.82E-08	Wood	7.59E-11
Hexachlorobiphenyl	1.30E-07	5.68E-07	Wood	6.33E-10
Hexanal	1.65E-03	7.23E-03	Wood	8.05E-06
Hexane	3.75E-01	1.64E+00	Nat Gas	2.03E-03
Isobutyraldehyde	2.83E-03	1.24E-02	Wood	1.38E-05
Isophorone	7.26E-03	3.18E-02	PRB Coal	3.92E-05
2-Methylnaphthalene	3.77E-05	1.65E-04	Wood	1.84E-07
3-Methylchloranthrene	3.75E-07	1.64E-06	Nat Gas	2.03E-09
Monochlorobiphenyl	5.19E-08	2.27E-07	Wood	2.53E-10
Methyl bromide	3.54E-03	1.55E-02	Wood	1.73E-05
Methyl chloride	6.63E-03	2.91E-02	PRB Coal	3.58E-05
Methyl ethyl ketone	4.88E-03	2.14E-02	PRB Coal	2.64E-05
Methyl hydrazine	2.13E-03	9.32E-03	PRB Coal	1.15E-05
Methyl methacrylate	2.50E-04	1.10E-03	PRB Coal	1.35E-06
Methyl tert butyl ether	4.38E-04	1.92E-03	PRB Coal	2.37E-06
Methylene chloride	6.84E-02	2.99E-01	Wood	3.34E-04
2-Nitrophenol	5.66E-05	2.48E-04	Wood	2.76E-07
4-Nitrophenol	2.59E-05	1.14E-04	Wood	1.27E-07
Pentachlorobiphenyl	2.83E-07	1.24E-06	Wood	1.38E-09
Pentachlorophenol	1.20E-05	5.27E-05	Wood	5.87E-08
Perylene	1.23E-07	5.37E-07	Wood	5.98E-10
Phenol	1.20E-02	5.27E-02	Wood	5.87E-05
Propionaldehyde	1.44E-02	6.30E-02	Wood	7.02E-05
Propanal	7.54E-04	3.30E-03	Wood	3.68E-06
Styrene	4.48E-01	1.96E+00	Wood	2.19E-03
Tetrachlorobiphenyl	5.89E-07	2.58E-06	Wood	2.88E-09
Tetrachloroethylene	8.96E-03	3.92E-02	Wood	4.37E-05
Toluene	2.17E-01	9.50E-01	Wood	1.06E-03
o-Tolualdehyde	1.70E-03	7.43E-03	Wood	8.28E-06
p-Tolualdehyde	2.59E-03	1.14E-02	Wood	1.27E-05
Trichlorobiphenyl	6.13E-07	2.68E-06	Wood	2.99E-09

Prepared by NTH Consultants, Ltd.

Proposed Circulating Fluidized Bed Boiler
Potential Emissions

Boiler Parameters	Specification
Boiler Type	Circulating Fluidized Bed
Maximum Rated Heat Input (MM btu/hr)	185
Gross Output (MW/hr)	10

(Approximate; normally 7)

Material	Sulfur Content	Material Usage (%)	Heat Input (MM BTU/hr)	Heating Value (BTU/lb)	Material Throughput (lb/hr)	Material Throughput (tph)	Material Throughput (tpy)	Natural Gas Maximum Usage Rate MMscf/hr
Coal, Bituminous	3.50%	100.0%	185	11,800	15,678	7.84	68,669	0.1814
Coal, PRB	0.80%	100.0%	185	8,500	21,765	10.88	95,329	
Natural Gas	0.00%	100.0%	185	23,200	7,974	3.99	34,927	
Virgin Wood	0.00%	100.0%	205	4,500	45,556	22.78	199,533	

TABLE B-1. EMISSION RATES OF CRITERIA POLLUTANTS, HAPS, AND TACS FROM THE NEW BOILER ON A PER-FUEL BASIS

Compound	CAS Reference Number	Coal, Bituminous				Coal, PRB				Natural Gas				Waste Wood			
		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates		Emission Factors		Emission Rates	
		Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)	Value	Units	(lb/hr)	(tpy)
Trichlorofluoromethane	75694													4.72E-05	lb/MMBtu	9.67E-03	4.23E-02
Trichlorethene	79016													3.45E-05	lb/MMBtu	7.07E-03	3.10E-02
1,1,1-Trichloroethane	71556	2.30E-05	lb/ton	1.80E-04	7.90E-04	2.30E-05	lb/ton	2.50E-04	1.10E-03					3.57E-05	lb/MMBtu	7.31E-03	3.20E-02
2,4,6-Trichlorophenol	88062													2.53E-08	lb/MMBtu	5.19E-06	2.27E-05
Vinyl acetate	108054	8.74E-05	lb/ton	6.85E-04	3.00E-03	8.74E-05	lb/ton	9.51E-04	4.17E-03								
Vinyl Chloride	75014													2.07E-05	lb/MMBtu	4.24E-03	1.86E-02
Xylenes	1330207	4.26E-05	lb/ton	3.34E-04	1.46E-03	4.26E-05	lb/ton	4.63E-04	2.03E-03								
o-Xylene	95476													2.88E-05	lb/MMBtu	5.89E-03	2.58E-02
Polynuclear Aromatic Hydrocarbons (PAH)																	
Acenaphthene	83329	5.87E-07	lb/ton	4.60E-06	2.01E-05	5.87E-07	lb/ton	6.38E-06	2.80E-05	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	1.05E-06	lb/MMBtu	2.15E-04	9.40E-04
Acenaphthylene	208968	2.88E-07	lb/ton	2.25E-06	9.87E-06	2.88E-07	lb/ton	3.13E-06	1.37E-05	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	5.76E-06	lb/MMBtu	1.18E-03	5.16E-03
Acetone	67641													2.19E-04	lb/MMBtu	4.48E-02	1.96E-01
Anthracene	120127	2.42E-07	lb/ton	1.89E-06	8.29E-06	2.42E-07	lb/ton	2.63E-06	1.15E-05	2.76E-06	lb/MMscf	5.01E-07	2.19E-06	3.45E-06	lb/MMBtu	7.07E-04	3.10E-03
Benzaldehyde	100527													9.78E-07	lb/MMBtu	2.00E-04	8.76E-04
Benzo(a)anthracene	56553	9.20E-08	lb/ton	7.21E-07	3.16E-06	9.20E-08	lb/ton	1.00E-06	4.39E-06	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	7.48E-08	lb/MMBtu	1.53E-05	6.71E-05
Benzo(a)pyrene	50328	4.37E-08	lb/ton	3.43E-07	1.50E-06	4.37E-08	lb/ton	4.76E-07	2.08E-06	1.38E-06	lb/MMscf	2.50E-07	1.10E-06	2.99E-06	lb/MMBtu	6.13E-04	2.68E-03
Benzo(e)pyrene	192972									1.38E-06	lb/MMscf	2.50E-07	1.10E-06	2.99E-09	lb/MMBtu	6.13E-07	2.68E-06
Benzo(b)fluoranthene	205992									2.07E-06	lb/MMscf	3.75E-07	1.64E-06	1.15E-07	lb/MMBtu	2.36E-05	1.03E-04
Benzo(j,k)fluoranthene	206440													1.84E-07	lb/MMBtu	3.77E-05	1.65E-04
Benzo(k)fluoranthene	205823									2.07E-06	lb/MMscf	3.76E-07	1.64E-06	4.14E-08	lb/MMBtu	8.49E-06	3.72E-05
Benzo(b,j,k)fluoranthene		1.27E-07	lb/ton	9.92E-07	4.34E-06	1.27E-07	lb/ton	1.38E-06	6.03E-06					1.15E-07	lb/MMBtu	2.36E-05	1.03E-04
Benzo(g,h,i)perylene	191242	3.11E-08	lb/ton	2.43E-07	1.07E-06	3.11E-08	lb/ton	3.38E-07	1.48E-06	1.38E-06	lb/MMscf	2.50E-07	1.10E-06	1.07E-07	lb/MMBtu	2.19E-05	9.60E-05
Biphenyl	92524	1.96E-06	lb/ton	1.53E-05	6.71E-05	1.96E-06	lb/ton	2.13E-05	9.32E-05								
Chrysene	218019	1.15E-07	lb/ton	9.01E-07	3.95E-06	1.15E-07	lb/ton	1.25E-06	5.48E-06	2.07E-06	lb/MMscf	3.75E-07	1.64E-06	4.37E-08	lb/MMBtu	8.96E-06	3.92E-05
Crotonaldehyde	4170303													1.14E-05	lb/MMBtu	2.33E-03	1.02E-02
Decachlorobiphenyl	2051243													3.11E-10	lb/MMBtu	6.37E-08	2.79E-07
Dibenzo(a,h)anthracene	53703									1.36E-06	lb/MMscf	2.50E-07	1.10E-06	1.05E-08	lb/MMBtu	2.15E-06	9.40E-06
1,2-Dibromoethene	540498													6.33E-05	lb/MMBtu	1.30E-02	5.68E-02
Dichlorobiphenyl	2050682													8.51E-10	lb/MMBtu	1.74E-07	7.64E-07
1,2-Dichloroethane	107062													3.34E-05	lb/MMBtu	6.84E-03	2.99E-02
1,2-Dichloropropane	78875													3.80E-05	lb/MMBtu	7.78E-03	3.41E-02
7,12-Dimethylbenz(a)anthracene	57976									1.84E-05	lb/MMscf	3.34E-06	1.46E-05				
Fluoranthene	206440	8.17E-07	lb/ton	6.40E-06	2.80E-05	8.17E-07	lb/ton	8.89E-06	3.89E-05	3.45E-06	lb/MMscf	6.26E-07	2.74E-06	1.84E-06	lb/MMBtu	3.77E-04	1.65E-03
Fluorene	86737	1.05E-06	lb/ton	8.20E-06	3.59E-05	1.05E-06	lb/ton	1.14E-05	4.99E-05	3.22E-06	lb/MMscf	5.64E-07	2.56E-06	3.91E-06	lb/MMBtu	8.02E-04	3.51E-03
Indeno(1,2,3,c,d)pyrene	193395	7.02E-08	lb/ton	5.50E-07	2.41E-06	7.02E-08	lb/ton	7.63E-07	3.34E-06	2.07E-06	lb/MMscf	3.76E-07	1.64E-06	1.00E-07	lb/MMBtu	2.05E-05	8.98E-05
Naphthalene	91203	1.50E-05	lb/ton	1.17E-04	5.13E-04	1.50E-05	lb/ton	1.63E-04	7.13E-04	7.02E-04	lb/MMscf	1.27E-04	5.57E-04	1.12E-04	lb/MMBtu	2.29E-02	1.00E-01
Phenanthrene	85018	3.11E-06	lb/ton	2.43E-05	1.07E-04	3.11E-06	lb/ton	3.38E-05	1.48E-04	1.96E-05	lb/MMscf	3.55E-06	1.55E-05	8.05E-06	lb/MMBtu	1.65E-03	7.23E-03
Pyrene	129000	3.80E-07	lb/ton	2.97E-06	1.30E-05	3.80E-07	lb/ton	4.13E-06	1.81E-05	5.75E-06	lb/MMscf	1.04E-06	4.57E-06	4.26E-06	lb/MMBtu	8.72E-04	3.82E-03
5-Methyl chrysene	3697243	2.53E-08	lb/ton	1.98E-07	8.69E-07	2.53E-08	lb/ton	2.75E-07	1.21E-06					9.69E-12	lb/MMBtu	2.03E-09	8.88E-09

TABLE B-2. MAXIMUM EMISSION RATES

Compound	Maximum Emission Rates		Fuel	Emission Factor
	(lb/hr)	(tpy)		lb/MMBtu
Trichlorofluoromethane	9.67E-03	4.23E-02	Wood	4.72E-05
Trichlorethene	7.07E-03	3.10E-02	Wood	3.45E-05
1,1,1-Trichloroethane	7.31E-03	3.20E-02	Wood	3.57E-05
2,4,6-Trichlorophenol	5.19E-06	2.27E-05	Wood	2.53E-08
Vinyl acetate	9.51E-04	4.17E-03	PRB Coal	5.14E-06
Vinyl Chloride	4.24E-03	1.86E-02	Wood	2.07E-05
Xylenes	4.63E-04	2.03E-03	PRB Coal	2.50E-06
o-Xylene	5.89E-03	2.58E-02	Wood	2.88E-05
Polynuclear Aromatic Hydrocarbons (PAH)				
Acenaphthene	2.15E-04	9.40E-04	Wood	1.05E-06
Acenaphthylene	1.18E-03	5.16E-03	Wood	5.75E-06
Acetone	4.48E-02	1.96E-01	Wood	2.19E-04
Anthracene	7.07E-04	3.10E-03	Wood	3.45E-06
Benzaldehyde	2.00E-04	8.78E-04	Wood	9.78E-07
Benzo(a)anthracene	1.53E-05	6.71E-05	Wood	7.48E-08
Benzo(a)pyrene	6.13E-04	2.68E-03	Wood	2.99E-06
Benzo(e)pyrene	6.13E-07	2.68E-06	Wood	2.99E-09
Benzo(b)fluoranthene	2.36E-05	1.03E-04	Wood	1.15E-07
Benzo(j,k)fluoranthene	3.77E-05	1.65E-04	Wood	1.84E-07
Benzo(k)fluoranthene	8.49E-06	3.72E-05	Wood	4.14E-08
Benzo(b,j,k)fluoranthene	2.36E-05	1.03E-04	Wood	1.15E-07
Benzo(g,h,i)perylene	2.19E-05	9.60E-05	Wood	1.07E-07
Biphenyl	2.13E-05	9.32E-05	PRB Coal	1.15E-07
Chrysene	8.96E-06	3.92E-05	Wood	4.37E-08
Crotonaldehyde	2.33E-03	1.02E-02	Wood	1.14E-05
Decachlorobiphenyl	6.37E-08	2.79E-07	Wood	3.11E-10
Dibenzo(a,h)anthracene	2.15E-06	9.40E-06	Wood	1.05E-08
1,2-Dibromoethane	1.30E-02	5.68E-02	Wood	6.33E-05
Dichlorobiphenyl	1.74E-07	7.64E-07	Wood	8.51E-10
1,2-Dichloroethane	6.84E-03	2.99E-02	Wood	3.34E-05
1,2-Dichloropropane	7.78E-03	3.41E-02	Wood	3.80E-05
7,12-Dimethylbenz(a)anthracene	3.34E-06	1.46E-05	Nat Gas	1.80E-08
Fluoranthene	3.77E-04	1.65E-03	Wood	1.84E-06
Fluorene	8.02E-04	3.51E-03	Wood	3.91E-06
Indeno(1,2,3,c,d)pyrene	2.05E-05	8.98E-05	Wood	1.00E-07
Naphthalene	2.29E-02	1.00E-01	Wood	1.12E-04
Phenanthrene	1.65E-03	7.23E-03	Wood	8.05E-06
Pyrene	8.72E-04	3.82E-03	Wood	4.26E-06
5-Methyl chrysene	2.75E-07	1.21E-06	PRB Coal	1.49E-09

These shaded areas depict air contaminants subject to PSD review.
These shaded areas indicate no data available.
These shaded areas depict HAPs.

CFB Boiler Maximum Single HAP Emission Rate (HCl) = 5.3 tpy

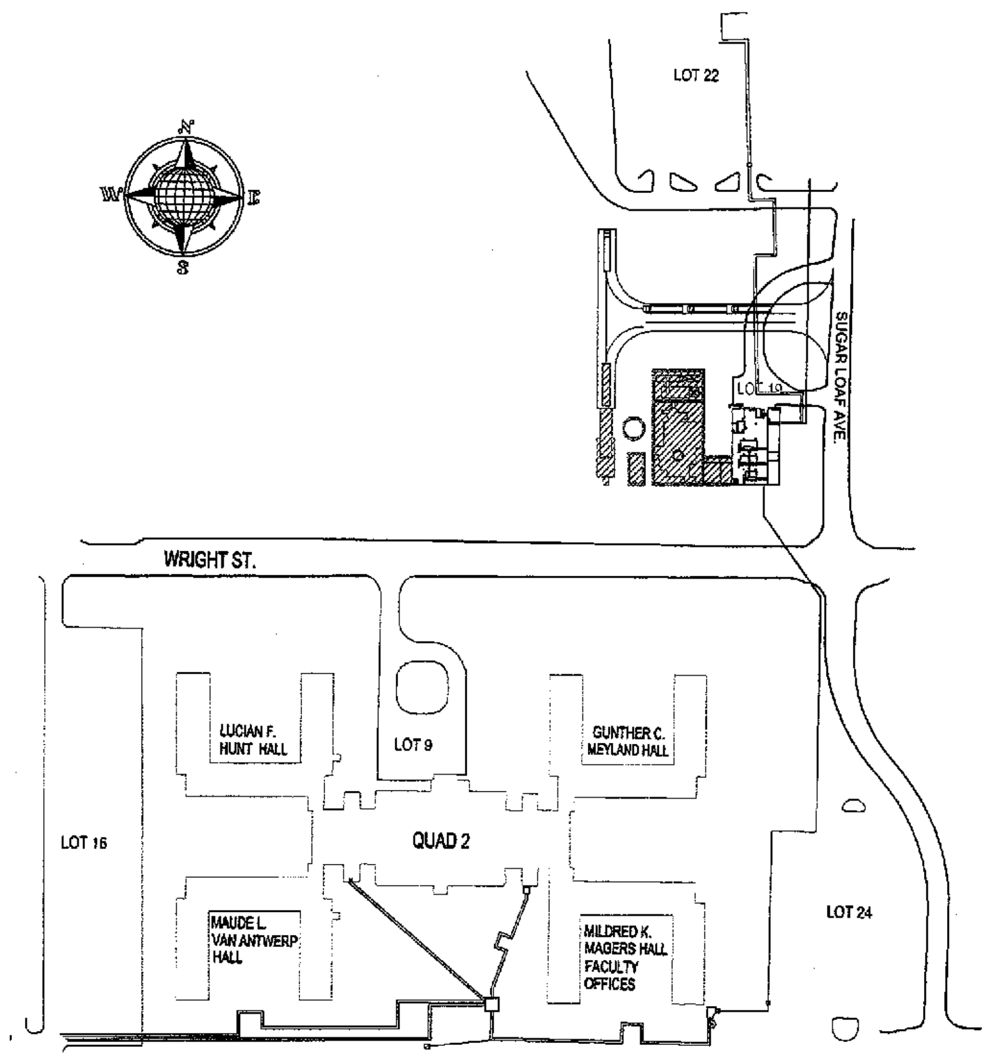
CFB Boiler Maximum Combined Total HAP Emission Rate = 22.7 tpy

Unless otherwise noted below, emission factors are from the EPA AP-42 database, and are increased by a 15% safety factor.
* Coal firing emission factor based on Wyandotte Energy stack test results. Wyandotte Energy is located in Wyandotte, Michigan.
** The lead estimated emission rates for PRB & Bituminous fuels are based on a statistical analysis of respective typical coals, with a 99% control efficiency of the baghouse collector.
*** Both HCl and HF emission factors include a 15% safety factor and 92% control using limestone in the CFB.
[1] Emissions are based on the proposed BACT.
[2] Sulfuric acid mist emission based on RBLC search, Plum Point Energy entry. This facility is located in Arkansas.
[3] Total dioxin/furan for the coal firing is from the Wyandotte Energy stack test results, and dioxin/furan for the wood combustion is from the EPA AP-42, Chapter 1.6, Table 1.6-3.
[4] Total chromium is supplied here for information purposes only. Total chromium is a sum of hexavalent and trivalent chromium.

CAMPUS MAP - NORTHERN SECTION

NORTHERN MICHIGAN UNIVERSITY

MARQUETTE, MICHIGAN
DATE: SEPTEMBER 4, 2003

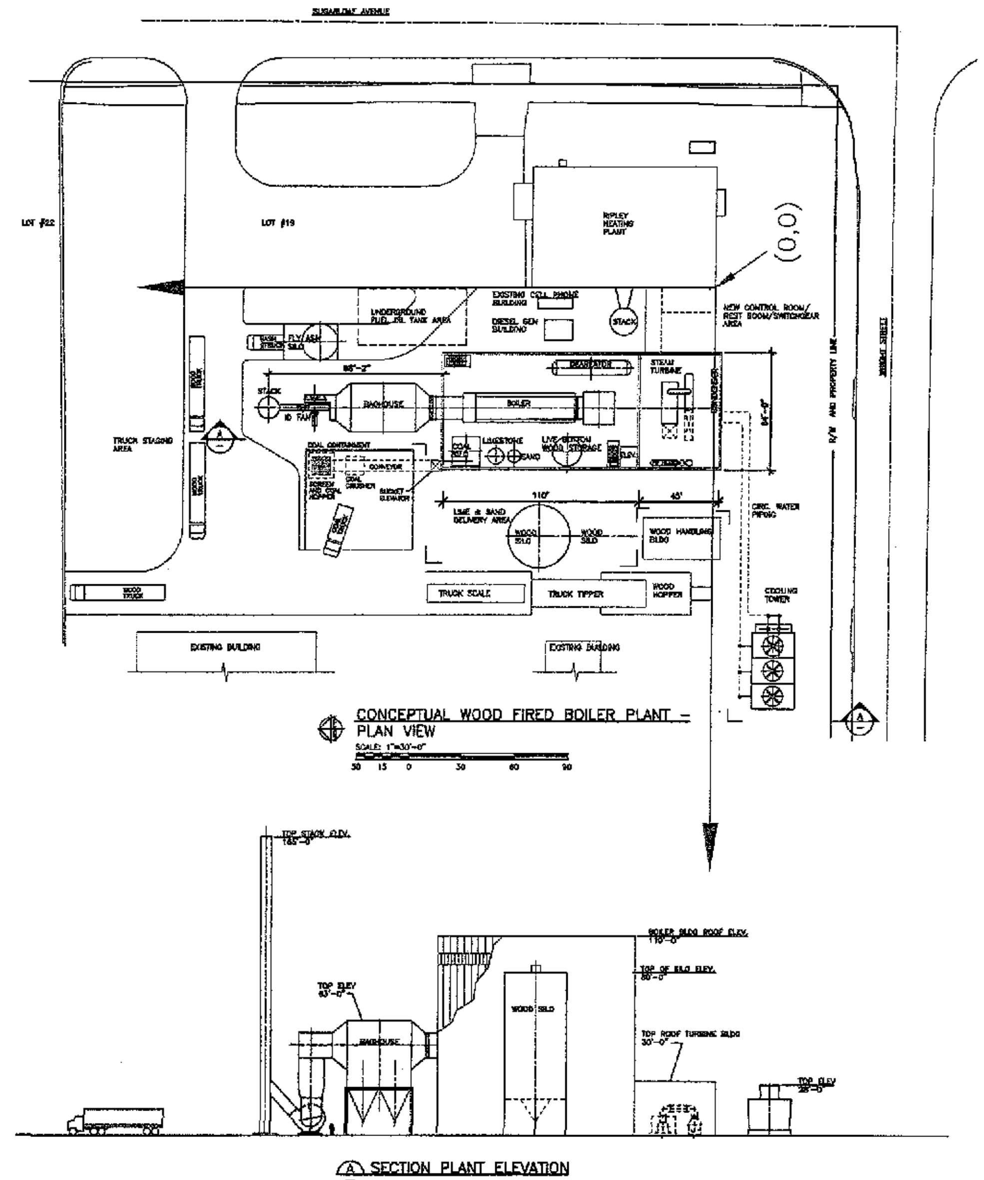


ELECTRICAL LEGEND

SYMBOL	UTILITY
—	ELECTRIC
❋	HIGH MAST LIGHTPOLE
•●	SINGLE SHOEBOX LIGHTPOLE
•●•	DOUBLE SHOEBOX LIGHTPOLE
✣	QUAD SHOEBOX LIGHTPOLE
	LIGHTPOLE
*	CODE BLUE STATION
o	MANHOLE
▬	LIGHTED BUILDING SIGNS

STEAM LEGEND

SYMBOL	UTILITY
—	STEAM
	ABANDONED STEAM
o	MANHOLE
	STEAM VAULT (SV)



NOT TO BE USED FOR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	ENGR	CHK	APPV

CUMMINS & BARNARD, INC.
CONSULTING ENGINEERS
5405 DATA COURT
ANN ARBOR, MICHIGAN 48108
(734) 761-8130 Fax (734) 761-6681
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NORTHERN MICHIGAN UNIVERSITY
WOOD/COAL FIRED BOILER

EQUIPMENT ARRANGEMENT

SCALE: 3/8"=1'-0" | PROJECT NO. 5049-01
DWG. NO. 5049-CGA-M1001A | REV. A

DWG. NO. 5049-CGA-M1001A

Northern Michigan University
New CFB Boiler
Toxic Air Contaminant Modeling Results

1.0 Gram/Sec Modeled Impacts

Averaging Period	Impact (ug/m^3 / 1 g/s)
Annual	0.211
24 Hour	1.589
8 Hour	2.712
1 Hour	15.779

Table C-1. TAC Emission Rates and Modeling Impact Results

Compound	CAS No.	Maximum Emission Rates (lb/hr)	Maximum Emission Rates (tpy)	Modeled Rate (gram/sec)	ITSL (ug/m3)	IRSL (ug/m3)	Averaging Period	Ambient Impact (ug/m3)	% of SL
Lead	7439-92-1	2.48E-03	1.09E-02	3.12E-04	1.5		24 hour	4.96E-04	0.03%
HCl	7647-01-0	1.20	5.26	1.51E-01	20		24 hour	2.41E-01	1.20%
HF	7664-39-3	0.15	0.66	1.89E-02	26		1 hour	2.99E-01	1.15%
H_2SO_4	7664-93-9	1.13	4.94	1.42E-01	10		8 hour	3.86E-01	3.86%
Total Dioxin/Furan	1746-01-6	4.33E-10	1.90E-09	5.45E-11		2.30E-07	Annual	1.15E-11	0.00%
Metals									
Antimony	7440-36-0	1.68E-03	7.36E-03	2.12E-04	0.2		24 hour	3.37E-04	0.168%
Arsenic	7440-38-2	1.42E-04	6.22E-04	1.79E-05		0.0002	Annual	3.77E-06	1.88%
Barium	7440-39-3	9.18E-04	4.02E-03	1.16E-04	5		8 hour	3.14E-04	0.006%
Beryllium	7440-41-7	3.70E-06	1.62E-05	4.66E-07	0.02		24 hour	7.41E-07	0.004%
Beryllium	7440-41-7	3.70E-06	1.62E-05	4.66E-07		0.0004	Annual	9.83E-08	0.025%
Cadmium	7440-43-9	2.29E-04	1.00E-03	2.89E-05		0.0006	Annual	6.09E-06	1.02%
Chromium, total	7440-47-3	4.95E-03	2.17E-02	6.24E-04	0.1		Annual	1.31E-04	0.131%
Chromium, hexavalent	18540-29-9	8.25E-04	3.61E-03	1.04E-04	0.1		24 hour	1.65E-04	0.17%
Chromium, hexavalent	18540-29-9	8.25E-04	3.61E-03	1.04E-04		8.30E-05	Annual	2.19E-05	26.40%
Chromium, trivalent	16065-83-1	1.55E-04	6.78E-04	1.95E-05	5		8 hour	5.29E-05	0.001%
Cobalt	7440-48-4	1.25E-03	5.48E-03	1.58E-04	0.2		8 hour	4.28E-04	0.214%
Copper	7440-50-8	1.16E-04	5.06E-04	1.46E-05	2		8 hour	3.95E-05	0.002%
Iron		2.33E-03	1.02E-02	2.94E-04	0.1		Annual	6.20E-05	0.06%
Magnesium	7439-95-4	1.38E-01	6.03E-01	1.73E-02	100		8 hour	4.70E-02	0.047%
Manganese	7439-96-5	3.77E-03	1.65E-02	4.75E-04	0.05		24 hour	7.55E-04	1.51%
Molybdenum		2.29E-04	1.00E-03	2.89E-05	0.1		Annual	6.09E-06	0.006%
Nickel	7440-02-0	3.09E-04	1.35E-03	3.89E-05		0.0042	Annual	8.21E-06	0.20%
Phosphorus	7723-14-0	6.37E-05	2.79E-04	8.02E-06	1		8 hour	2.17E-05	0.002%
Potassium		9.19E-02	4.03E-01	1.16E-02	0.1		Annual	2.44E-03	2.44%
Selenium	7782-49-2	1.63E-02	7.15E-02	2.06E-03	2		8 hour	5.58E-03	0.279%
Silver	7440-22-4	4.01E-03	1.76E-02	5.05E-04	0.1		8 hour	1.37E-03	1.37%
Sodium		8.49E-04	3.72E-03	1.07E-04	0.1		Annual	2.25E-05	0.02%
Strontium		2.36E-05	1.03E-04	2.97E-06	0.1		Annual	6.26E-07	0.001%
Tin	7440-31-5	5.42E-05	2.37E-04	6.83E-06	20		8 hour	1.85E-05	0.000%
Titanium		4.72E-05	2.07E-04	5.94E-06	0.1		Annual	1.25E-06	0.001%
Vanadium		4.80E-04	2.10E-03	6.04E-05	0.1		Annual	1.27E-05	0.013%
Yttrium		7.07E-07	3.10E-06	8.91E-08	0.1		Annual	1.88E-08	0.000%
Zinc (as ZnO)	1314-13-2	5.23E-02	2.29E-01	6.59E-03	50		8 hour	1.79E-02	0.036%
Organic Toxic Air Contaminants (TACs)									
Acetaldehyde	75-07-0	1.96E-01	8.57E-01	2.47E-02	9		24 hour	3.92E-02	0.435%
Acetaldehyde	75-07-0	1.96E-01	8.57E-01	2.47E-02		0.5	Annual	5.20E-03	1.04%
Acetophenone	98-86-2	1.88E-04	8.22E-04	2.37E-05	490		8 hour	6.41E-05	0.000%
Acrolein	107-02-8	2.39E-02	1.05E-01	3.01E-03	0.02		Annual	6.34E-04	3.17%
Acrolein	107-02-8	2.39E-02	1.05E-01	3.01E-03	0.5		1 hour	4.75E-02	9.50%
Benzene	71-43-2	9.90E-01	4.34E+00	1.25E-01	30		24 hour	1.98E-01	0.66%
Benzene	71-43-2	9.90E-01	4.34E+00	1.25E-01		0.1	Annual	2.63E-02	26.30%
Benzyl chloride	100-44-7	8.76E-03	3.84E-02	1.10E-03		0.02	Annual	2.33E-04	1.16%
Benzoic acid	65-85-0	1.11E-05	4.85E-05	1.40E-06	0.1		Annual	2.94E-07	0.000%
Biphenyl	92-52-4	2.13E-05	9.32E-05	2.68E-06	15		8 hour	7.27E-06	0.000%
Bis(2-Ethylhexyl)phthalate	117-81-7	9.14E-04	4.00E-03	1.15E-04		0.2	Annual	2.43E-05	0.012%
Bromoform	75-25-2	4.88E-04	2.14E-03	6.15E-05		0.9	Annual	1.30E-05	0.001%
Carbon disulfide	75-15-0	1.63E-03	7.13E-03	2.05E-04	700		24 hour	3.26E-04	0.000%
Carbazole	86-74-8	4.24E-04	1.86E-03	5.35E-05	0.1		Annual	1.13E-05	0.011%
Carbon tetrachloride	56-23-5	1.06E-02	4.65E-02	1.34E-03		0.07	Annual	2.82E-04	0.40%
Chlorine	7782-50-5	1.86E-01	8.16E-01	2.35E-02	15		8 hour	6.36E-02	0.42%
2-Chloroacetophenone	532-27-4	8.76E-05	3.84E-04	1.10E-05	0.03		24 hour	1.75E-05	0.058%
Chlorobenzene	108-90-7	7.78E-03	3.41E-02	9.80E-04	70		24 hour	1.56E-03	0.002%
Chloroform	67-66-3	6.60E-03	2.89E-02	8.32E-04		0.4	Annual	1.75E-04	0.044%
2-Chloronaphthalene	91-58-7	5.66E-07	2.48E-06	7.13E-08	0.1		Annual	1.50E-08	0.000%
2-Chlorophenol	95-57-8	5.66E-06	2.48E-05	7.13E-07	0.1		Annual	1.50E-07	0.000%
Cumene	98-82-8	6.63E-05	2.91E-04	8.36E-06	400		24 hour	1.33E-05	0.000%
Cyanide	57-12-5	3.13E-02	1.37E-01	3.94E-03	50		1 hour	6.22E-02	0.12%
1,4-Dichlorobenzene	106-46-7	2.50E-04	1.10E-03	3.15E-05	800		24 hour	5.01E-05	0.000%
1,4-Dichlorobenzene	106-46-7	2.50E-04	1.10E-03	3.15E-05		0.14	Annual	6.65E-06	0.005%
2,4-Dinitrophenol	51-28-5	4.24E-05	1.86E-04	5.35E-06	0.1		Annual	1.13E-06	0.001%
2,4-Dinitrotoluene	121-14-2	3.50E-06	1.53E-05	4.42E-07	2		8 hour	1.20E-06	0.000%
2,4-Dinitrotoluene	121-14-2	3.50E-06	1.53E-05	4.42E-07		0.009	Annual	9.31E-08	0.001%
Dimethyl sulfate	77-78-1	6.01E-04	2.63E-03	7.57E-05	0.5		8 hour	2.05E-04	0.041%
Ethylbenzene	100-41-4	7.31E-03	3.20E-02	9.21E-04	1000		24 hour	1.46E-03	0.000%
Ethylbenzene	100-41-4	7.31E-03	3.20E-02	9.21E-04		3	Annual	1.94E-04	0.006%
Ethylchloride	75-00-3	5.26E-04	2.30E-03	6.62E-05	10000		24 hour	1.05E-04	0.000%
Ethylene dichloride	107-06-2	5.01E-04	2.19E-03	6.31E-05		0.04	Annual	1.33E-05	0.033%
Ethylene dibromide	106-93-4	1.50E-05	6.58E-05	1.89E-06	9		24 hour	3.01E-06	0.000%
Ethylene dibromide	106-93-4	1.50E-05	6.58E-05	1.89E-06		0.002	Annual	3.99E-07	0.020%
Formaldehyde	50-00-0	1.04E+00	4.54E+00	1.31E-01		0.08	Annual	2.75E-02	34.44%

Northern Michigan University
New CFB Boiler
Toxic Air Contaminant Modeling Results

1.0 Gram/Sec Modeled Impacts

Averaging Period	Impact (ug/m³ / 1 g/s)
Annual	0.211
24 Hour	1.589
8 Hour	2.712
1 Hour	15.779

Table C-1. TAC Emission Rates and Modeling Impact Results

Compound	CAS No.	Maximum Emission Rates (lb/hr)	Maximum Emission Rates (tpy)	Modeled Rate (gram/sec)	ITSL (ug/m3)	IRSL (ug/m3)	Averaging Period	Ambient Impact (ug/m3)	% of SL
Heptachlorobiphenyl	28655-71-2	1.56E-08	6.82E-08	1.96E-09	0.1		Annual	4.13E-10	0.000%
Hexachlorobiphenyl	26601-64-9	1.30E-07	5.68E-07	1.63E-08	0.1		Annual	3.44E-09	0.000%
Hexanal	66-25-1	1.65E-03	7.23E-03	2.08E-04	2		Annual	4.38E-05	0.002%
Hexane	110-54-3	3.75E-01	1.64E+00	4.73E-02	700		24 hour	7.52E-02	0.011%
Isobutyraldehyde	78-84-2	2.83E-03	1.24E-02	3.56E-04	160		24 hour	5.66E-04	0.000%
Isophorone	78-59-1	7.26E-03	3.18E-02	9.15E-04	280		1 hour	1.44E-02	0.005%
Isophorone	78-59-1	7.26E-03	3.18E-02	9.15E-04		3.7	Annual	1.93E-04	0.005%
2-Methylnaphthalene	91-57-6	3.77E-05	1.65E-04	4.75E-06	10		Annual	1.00E-06	0.000%
3-Methylchloranthrene		3.75E-07	1.64E-06	4.73E-08	0.1		Annual	9.97E-09	0.000%
Monochlorobiphenyl		5.19E-08	2.27E-07	6.53E-09	0.1		Annual	1.38E-09	0.000%
Methyl bromide	74-83-9	3.54E-03	1.55E-02	4.46E-04	5		24 hour	7.08E-04	0.014%
Methyl chloride	74-87-3	6.63E-03	2.91E-02	8.36E-04	90		24 hour	1.33E-03	0.001%
Methyl chloride	74-87-3	6.63E-03	2.91E-02	8.36E-04		1.6	Annual	1.76E-04	0.011%
Methyl ethyl ketone	78-93-3	4.88E-03	2.14E-02	6.15E-04	5000		24 hour	9.77E-04	0.000%
Methyl hydrazine	60-34-4	2.13E-03	9.32E-03	2.68E-04	0.1		Annual	5.65E-05	0.057%
Methyl methacrylate	80-62-6	2.50E-04	1.10E-03	3.15E-05	700		24 hour	5.01E-05	0.000%
Methyl tert butyl ether	1634-04-4	4.38E-04	1.92E-03	5.52E-05	3000		24 hour	8.77E-05	0.000%
Methylene chloride	75-09-2	6.84E-02	2.99E-01	8.61E-03		2	Annual	1.82E-03	0.091%
Naphthalene	91-20-3	2.29E-02	1.00E-01	2.88E-03	3		24 hour	4.58E-03	0.15%
Naphthalene	91-20-3	2.29E-02	1.00E-01	2.88E-03		0.08	Annual	6.07E-04	0.76%
2-Nitrophenol	88-75-5	5.66E-05	2.48E-04	7.13E-06	0.1		Annual	1.50E-06	0.002%
4-Nitrophenol	100-02-7	2.59E-05	1.14E-04	3.27E-06	0.1		Annual	6.89E-07	0.001%
Pentachlorobiphenyl		2.83E-07	1.24E-06	3.56E-08	0.1		Annual	7.51E-09	0.000%
Pentachlorophenol	87-86-5	1.20E-05	5.27E-05	1.51E-06	100		24 hour	2.41E-06	0.000%
Pentachlorophenol	87-86-5	1.20E-05	5.27E-05	1.51E-06		0.03	Annual	3.19E-07	0.001%
Perylene	198-55-0	1.23E-07	5.37E-07	1.54E-08	0.1		Annual	3.26E-09	0.000%
Phenol	108-95-2	1.20E-02	5.27E-02	1.51E-03	600		1 hour	2.39E-02	0.004%
Propionaldehyde	123-38-6	1.44E-02	6.30E-02	1.81E-03	4		Annual	3.82E-04	0.010%
Propanal	123-38-6	7.54E-04	3.30E-03	9.51E-05	4		Annual	2.00E-05	0.001%
Styrene	100-42-5	4.48E-01	1.96E+00	5.64E-02	1000		24 hour	8.97E-02	0.009%
Styrene	100-42-5	4.48E-01	1.96E+00	5.64E-02		1.7	Annual	1.19E-02	0.70%
Tetrachlorobiphenyl		5.89E-07	2.58E-06	7.43E-08	0.1		Annual	1.57E-08	0.000%
Tetrachloroethylene	127-18-4	8.96E-03	3.92E-02	1.13E-03	0.1		Annual	2.38E-04	0.24%
Toluene	108-88-3	2.17E-01	9.60E-01	2.73E-02	5000		24 hour	4.34E-02	0.001%
o-Tolualdehyde	529-20-4	1.70E-03	7.43E-03	2.14E-04	440		24 hour	3.40E-04	0.000%
p-Tolualdehyde	104-87-0	2.59E-03	1.14E-02	3.27E-04	0.1		Annual	6.89E-05	0.069%
Trichlorobiphenyl		6.13E-07	2.68E-06	7.72E-08	0.1		Annual	1.63E-08	0.000%
Trichlorofluoromethane	75-69-4	9.67E-03	4.23E-02	1.22E-03	56200		1 hour	1.92E-02	0.000%
Trichlorethene	79-01-6	7.07E-03	3.10E-02	8.91E-04		0.6	Annual	1.88E-04	0.031%
1,1,1-Trichloroethane	71-55-6	7.31E-03	3.20E-02	9.21E-04	1000		24 hour	1.46E-03	0.000%
2,4,6-Trichlorophenol	88-06-2	5.19E-06	2.27E-05	6.53E-07		0.3	Annual	1.38E-07	0.000%
Vinyl acetate	108-05-4	9.51E-04	4.17E-03	1.20E-04	200		24 hour	1.90E-04	0.000%
Vinyl Chloride	75-01-4	4.24E-03	1.86E-02	5.35E-04	100		24 hour	8.50E-04	0.001%
Vinyl Chloride	*75-01-4*	*4.24E-03*	*1.86E-02*	*5.35E-04*		*0.11*	*Annual*	*1.13E-04*	*0.10%*
Xylenes	1330-20-7	4.63E-04	2.03E-03	5.83E-05	100		24 hour	9.27E-05	0.000%
o-Xylene	95-47-6	5.89E-03	2.58E-02	7.43E-04	100		24 hour	1.18E-03	0.001%
Polynuclear Aromatic Hydrocarbons (PAH)									
Acenaphthene	83-32-9	2.15E-04	9.40E-04	2.70E-05	210		24 hour	4.30E-05	0.000%
Acenaphthylene	208-96-8	1.18E-03	5.16E-03	1.49E-04	35		24 hour	2.36E-04	0.001%
Acetone	67-64-1	4.48E-02	1.96E-01	5.64E-03	5900		8 hour	1.53E-02	0.000%
Anthracene	120-12-7	7.07E-04	3.10E-03	8.91E-05	1000		24 hour	1.42E-04	0.000%
Benzaldehyde	100-52-7	2.00E-04	8.78E-04	2.52E-05		0.4	Annual	5.32E-06	0.001%
Benzo(a)anthracene	56-55-3	1.53E-05	6.71E-05	1.93E-06	0.1		Annual	4.07E-07	0.000%
Benzo(a)pyrene	50-32-8	6.13E-04	2.68E-03	7.72E-05		0.0005	Annual	1.63E-05	3.26%
Benzo(e)pyrene	192-97-2	6.13E-07	2.68E-06	7.72E-08	0.1		Annual	1.63E-08	0.000%
Benzo(b)fluoranthene	205-99-2	2.36E-05	1.03E-04	2.97E-06	0.1		Annual	6.26E-07	0.001%
Benzo(j,k)fluoranthene		3.77E-05	1.65E-04	4.75E-06	0.1		Annual	1.00E-06	0.001%
Benzo(k)fluoranthene	205-82-3	8.49E-06	3.72E-05	1.07E-06	0.1		Annual	2.25E-07	0.000%
Benzo(b,j,k)fluoranthene		2.36E-05	1.03E-04	2.97E-06	0.1		Annual	6.26E-07	0.001%
Benzo(g,h,i)perylene	191-24-2	2.19E-05	9.60E-05	2.76E-06	12		24 hour	4.39E-06	0.000%
Chrysene	218-01-9	8.96E-06	3.92E-05	1.13E-06	0.1		Annual	2.38E-07	0.000%
Crotonaldehyde	4170-30-3	2.33E-03	1.02E-02	2.94E-04	9		1 hour	4.64E-03	0.052%
Decachlorobiphenyl	2051-24-3	6.37E-08	2.79E-07	8.02E-09	0.1		Annual	1.69E-09	0.000%
Dibenzo(a,h)anthracene	53-70-3	2.15E-06	9.40E-06	2.70E-07	0.1		Annual	5.70E-08	0.000%
1,2-Dibromoethene	540-49-8	1.30E-02	5.68E-02	1.63E-03	0.1		Annual	3.44E-04	0.34%
Dichlorobiphenyl		1.74E-07	7.64E-07	2.20E-08	0.1		Annual	4.63E-09	0.000%
1,2-Dichloroethane	107-06-2	6.84E-03	2.99E-02	8.61E-04		0.04	Annual	1.82E-04	0.45%
1,2-Dichloropropane	78-87-5	7.78E-03	3.41E-02	9.80E-04	4		24 hour	1.56E-03	0.039%
7,12-Dimethylbenz(a)anthracene		3.34E-06	1.46E-05	4.20E-07	0.1		Annual	8.86E-08	0.000%
Fluoranthene	206-44-0	3.77E-04	1.65E-03	4.75E-05	140		24 hour	7.55E-05	0.000%
Fluorene	86-73-7	8.02E-04	3.51E-03	1.01E-04	140		24 hour	1.60E-04	0.000%
Indeno(1,2,3,c,d)pyrene	193-39-5	2.05E-05	8.98E-05	2.58E-06	0.1		Annual	5.45E-07	0.001%
Phenanthrene	*85-01-8*	*1.65E-03*	*7.23E-03*	*2.08E-04*	*0.1*		*Annual*	*4.38E-05*	*0.044%*
Pyrene	129-00-0	8.72E-04	3.82E-03	1.10E-04	100		24 hour	1.75E-04	0.000%
5-Methyl chrysene	3697-24-3	2.75E-07	1.21E-06	3.47E-08	0.1		Annual	7.31E-09	0.000%

Note: An ITSL of 0.1 that is red bolded is a default screening level per AQD air toxics policy