

Michigan Dept of Environmental Quality Attn: Ms. Mary Ann Dolehanty, Supervisor

AOD - Thermal Process Unit

February 5, 2007

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

# RECEIVED

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## AIR QUALITY DIV.

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

Dear Ms. Dolehanty:

P.O. Box 30260

Lansing, MI 48909

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  $21^{st}$  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 subbituminous 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

Hellman lichael 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



February 5, 2007

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

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

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Michael G. Hellmán,

Facilities Specialist/Planner

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY - AIR QUALITY DIVISION 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.

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.

1. FACILITY CODES: State Registration Number (SRN) and North Ame	rican Industry Classif	cation System (NAICS)				
SRN 14 3 7 9 2 NAICS 2 2	1 1 1	2	Sor			
2. APPLICANT NAME: (Business License Name of Corporation, Partne Northern Michigan University - Ripley	- Cox 3					
3. APPLICANT ADDRESS: (Number and Street) 1401 Presque Isle Avenue		MAIL CODE:	Gile			
CITY: (City, Village or Township) Marquette	STATE: MI	ZIP CODE: 49855				
4. EQUIPMENT OR PROCESS LOCATION: (Number and Street - If dif	-					
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 cil/natural cas						
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.)  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 OPERATIN	IG PERMIT (ROP)?					
PENDING APPLICATION OR ROP NUMBER MI-	ROP-B2357-20	06				
10. AUTHORIZED EMPLOYEE: Michael Hellman	THLE: Facilities	Planner	PHONE NUMBER: (Include Area Code) 906-227-2120			
Michael Sellman	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 DEQUISE ONLY & DO NOT WRITE BELOW.						
DATE PERMIT TO INSTALL APPROVED:	SIGNATURE	<u> </u>				
DATE APPLICATION VOIDED:	SIGNATURE	<u></u>				
DATE APPLICATION DENIED:	SIGNATURE	4 •				
A PERMIT CERTIFICATE WILL BE ISSUED UPON APPROVAL OF A PERMIT TO INSTALL						

EQP 5615E (Rev. 09/2004)

FOR DEQ USE APPLICATION NUMBER



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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<sub>10</sub>), sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), 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

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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

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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 control, not redesign, the source proposed by the applicant. Note that the statute does not require an emission limitation based upon the "Best Available Design Technology." Therefore, NMU believes that MDEO 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

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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;



- 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<sub>2</sub>), carbon dioxide (CO<sub>2</sub>) 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<sub>4</sub>) 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<sub>3</sub>) 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub>.

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, wabash River Generation 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

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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;
- 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;
- Commercial risk of IGCC technology is currently considered higher than that of CFB or PC technology;
- 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<sup>th</sup> 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:

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- 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.
- 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)
- Source information
- Air quality analysis (monitoring)
- Ambient impact analysis

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 (preconstruction 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 Provide Lorest 35 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.

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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% Reduction60.43b - Standard for Particulate Matter:0.10 lb/MMBtu60.44b - 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).

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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.

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# 3.2.2 Health Based Screening Levels for Air Toxics

Michigan Rule 225 (R 336.1225) requires that the ambient concentrations ( $\mu$ g/m<sup>3</sup>) 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<sub>2</sub>), 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<sub>10</sub>/PM<sub>2.5</sub>), lead (Pb), and non-volatile metallic HAPs; a selective non-catalytic reduction (SNCR) system will be installed to control nitrogen oxides (NO<sub>x</sub>) 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<sub>2</sub>, NO<sub>x</sub>, 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.

Pollutant	Emission Rates			Desis
	lb/MM Btu	lb/hr	tpy	Dasis
PM/PM <sub>10</sub> (filterable)	0.025	5.1	22.4	PSD-BACT
PM <sub>10</sub> (filterable & condensable	0.03	6.2	26.9	PSD-BACT
SO <sub>2</sub> <sup>(1)</sup>	0.48	88.8	388.9	PSD-BACT
NO <sub>x</sub>	0.10	20.5	89.8	PSD-BACT
СО	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 <sub>2</sub> SO <sub>4</sub> 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

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

Notes:

(1) SO<sub>2</sub> 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<sub>2</sub>. Therefore, total reduced sulfur and reduced sulfur compounds, including H<sub>2</sub>S are not likely to be formed and thus, will not be emitted.

### 4.1.1 Particulate Matter (PM/PM<sub>10</sub>/PM<sub>2.5</sub>)

MM-10 000-2.5

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 PM2.5

NAAQS, states should use PM<sub>10</sub> as the surrogate for determining whether a facility or

modification is considered major for PM2.5 under PSD. Therefore states and facilities should use

projected PM10 emissions and net emissions increases (and decreases) as a surrogate for PM2.5.

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:

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

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

Compliance with the PM/PM<sub>10</sub> 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<sub>10</sub> and opacity limits.

#### 4.1.2 Sulfur Dioxide (SO<sub>2</sub>)

Sulfur dioxide emissions are proportional to the sulfur content of the coal. In order to minimize the SO<sub>2</sub> 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<sub>2</sub>) 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<sub>2</sub> emissions from the boiler because wood contains very little sulfur. The boiler will be designed to meet the NSPS SO<sub>2</sub> emission limit of 0.20 lb/MM Btu heat input, or 8 percent (0.08)





of the potential SO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> concentrations, with either oxygen (O<sub>2</sub>) or carbon dioxide (CO<sub>2</sub>) concentrations, and will record the output of the system as required in 60.47b(a). Initial and continuous compliance with the SO<sub>2</sub> 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<sub>2</sub> emission limit and percent reduction requirements will be aperated, but not later than 180 days after initial startup of the boiler.

#### 4.1.3 Nitrogen Oxides (NO<sub>x</sub>)

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<sub>x</sub> 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.

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

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

The facility will install, calibrate, maintain, and operate continuous emission monitoring systems (CEMS) for measuring NO<sub>2</sub> concentrations, with either O<sub>2</sub> or carbon dioxide CO<sub>2</sub> concentrations, and will record the output of the systems. Initial and continuous compliance with the NO<sub>x</sub> 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

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will be 34.85 pph for all fuels firing represents BACT. The limit is based on a 30-day rolling average.

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

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

# 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.

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

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

# 4.1.7 Mercury Emissions T. River

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).

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

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

# 4.1.8 Sulfuric Acid Mist (H<sub>2</sub>SO<sub>4</sub>) 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<sub>2</sub>SO<sub>4</sub> 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 sulfurbearing 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<sub>2</sub>, NO<sub>x</sub>, 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<sub>2</sub>, NO<sub>x</sub>, 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

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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.

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### 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.

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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<sub>2</sub>, and NO<sub>x</sub>, 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<sub>10</sub>/PM<sub>2.5</sub>)

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).

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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 10microns 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<sub>2</sub>)

 $SO_2$  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<sub>2</sub> 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<sub>2</sub>. 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<sub>2</sub> 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<sub>2</sub> control devices typically result in 80 to 99% control of the potential SO<sub>2</sub> emissions, depending on the concentration of SO<sub>2</sub> in the exhaust gas, and ratio of slurry to SO<sub>2</sub>.

## 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 calcium and converted to calcium oxide because the carbon dioxide that is driven off of the calcium carbonate. The SO<sub>2</sub> then reacts with the calcium oxide. Using this type of control removes the SO<sub>2</sub> 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<sub>2</sub> 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  $SO_2 \approx 0.09 - 1.6$  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.

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NMU is proposing a maximum SO<sub>2</sub> emission limit of  $\emptyset$ .475 pound per million Btu heat input, and this is within the nation-wide range of accepted SO<sub>2</sub> 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<sub>2</sub> BACT is necessary.

## 5.4 NITROGEN OXIDES (NO<sub>x</sub>)

 $NO_x$  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  $NO_x$ .

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## 5.4.1 Proposed BACT Emission Limit

From the RBLC, the nation-wide BACT range of emission limits for NO<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> emission limit of 0.10 lb/MMBtu heat input. This is more stringent than the nation-wide range of NO<sub>x</sub> 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<sub>2</sub> 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<sub>3</sub>, 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.

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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.



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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<sub>2</sub>, and NO<sub>x</sub> 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

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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<sup>o</sup>) is oxidized to form Hg<sup>2+</sup> 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, coincidently, 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.

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## 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<sub>2</sub>, PM<sub>10</sub>, and NO<sub>x</sub> 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<sub>2</sub>, PM<sub>10</sub>, and NO<sub>x</sub> 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

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emissions greater than the PSD significant emission rates (i.e., SO<sub>2</sub>, PM<sub>10</sub>, CO and NO<sub>x</sub>), 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 <u>will not</u> result in maximum ambient impacts greater than the appropriate SILs, while the SO<sub>2</sub> 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<sub>2</sub> 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-bycompound 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.

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Section 6.1 describes the modeling methodology utilized in the criteria pollutant (i.e. CO, SO<sub>2</sub>,  $PM_{10}$  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<sub>2</sub>,  $PM_{10}$ ,  $NO_x$ , 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<sub>2</sub>,  $PM_{10}$ , 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.

Pollutant	Averaging Period	Concentration (µg/m <sup>3</sup> )	
со	8-Hour	500	
	1-Hour	2,000	
SO2	Annual	1 .	
	24-Hour	5	
	3-Hour	25	
PM <sub>10</sub>	Annual	1	
	24-Hour	5	
NO <sub>x</sub>	Annual	1	

Table 6-1. Significant Impact Levels for Criteria Pollutants

Table 6-2. PSD Allowable Increments (µg/m<sup>3</sup>)

Pollutant	Averaging Period	PSD Increment Standards (µg/m <sup>3</sup> )		
		Class I	Class II	
SO <sub>2</sub>	Annual <sup>2</sup>	2	20	
	24-Hour <sup>1</sup>	5	91	
	3-Hour <sup>1</sup>	25	512	
PM <sub>10</sub>	Annual <sup>2</sup>	4	17	
	24-Hour <sup>1</sup>	8	30	
NOx	Annual	2.5	25	

<sup>1</sup> High 2<sup>nd</sup> High over a five-year period.

<sup>2</sup> Annual arithmetic mean.

Pollutant	Averaging Period	National Ambient Standards (µg/m³)		
		Primary	Secondary	
CO	8-Hour <sup>1</sup>	10,000	n/a	
	1-Hour <sup>1</sup>	40,000	n/a	
SO <sub>2</sub>	Annual <sup>2</sup>	80	n/a	
	24-Hour <sup>1</sup>	365	n/a	
	3-Hour <sup>1</sup>	n/a	1,300	
PM <sub>10</sub>	Annual <sup>2</sup>	50	50	
	24-Hour <sup>3</sup>	150	150	
NOx	Annual <sup>2</sup>	100	100	

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

<sup>1</sup> High 2<sup>nd</sup> High.

<sup>2</sup> Annual arithmetic mean.

<sup>3</sup> High 6<sup>th</sup> 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 <u>AMS/EPA Regulatory Model Improvement Committee (AERMIC) Model (AERMOD)</u> 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.







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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.

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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<sub>2</sub>,  $PM_{10}$  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 preprocessor 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 preprocessed "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.

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#### **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.

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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 preprocessing 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).

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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<sub>2</sub> 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<sub>2</sub>,  $PM_{10}$ ,  $NO_x$ , and TAC emission rates from the proposed new powerhouse emission sources. CO, SO<sub>2</sub>,  $NO_x$  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 SCPR0J200716060504-NMUXINU TSD\_Final.doc

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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.

Pollutant	Maximum Hourly Emission Rate (lb/hour)	Modeled Emission Rate (gram/sec)	
СО	34.85	4.39	
$SO_2$	87.80	11.06	
PM <sub>10</sub>	6.15	7.75E-01	
NO <sub>x</sub>	20.50	2.58	

### Table 6-4. New CFB Boiler Criteria Pollutant Emission Rates

Based on worst-case emissions per fuel type.

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### **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<sub>10</sub> 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.

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Pollutant	Maximum Hourly Emission Rate (lb/hour)	Modeled Emission Rate (gram/sec)	
CO	24.90	3.14	
SO <sub>2</sub>	86.18	10.86	
PM <sub>10</sub> – PSD Increment Rate	4.44	0.56	
PM <sub>10</sub> – NAAQS Rate	4.79	0.60	
NO <sub>x</sub> <sup>2</sup>	10.24	1.29	

### Table 6-5. Existing Ripley Heating Plant Criteria Pollutant Emission Rates<sup>1</sup>

<sup>1</sup> 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.

<sup>2</sup> 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<sub>2</sub>. 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.

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Baghouse Exhaust Stack	UTM Easting <sup>1</sup> (meters)	UTM Northing <sup>1</sup> (meters)	Stack Height (feet)	Exhaust Temp (°F)	Flow Rate <sup>2</sup> (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 <sup>2</sup>	468,868.2	5,156,623.6	160	300	47,234	12.22	60

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

<sup>1</sup> 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<sub>2</sub>, PM<sub>10</sub>, and NO<sub>x</sub> 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<sub>2</sub> 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<sub>2</sub> 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 emailed 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<sub>2</sub> 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.

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Table 6-7. List of Off-Site Sources for the NMU SO2 NAAQS Modeling Analysis

ow Velocity FM) (m/s)	ow Velocity FM) (m/s)	FM) Velocity FM) (m/s) 171 24.96	ow FM)         Velocity (m/s)           171         24.96           172         19.16	ow FM)         Velocity (m/s)           171         24.96           172         19.16           115         22.84
(deg F)   (ACFM	(deg F) (ACFM)	(deg F) (ACFM) 289.23 401,171	(deg F) (ACFM) 289.23 401,171 252.54 185,172	(deg F) (ACFM) 289.23 401,171 252.54 185,172 339.19 338,115
	_	122.2	95.4	95.4
		133.80	133.80	133.80 280.27 402.70
		19.9	19.9	19.9 4.0 1.7
		152.64	152.64 39.74	152.64 39.74 1,272.85
	neters	neters 1,211.4	neters 1,211.4 315.4	aeters 1,211.4 315.4 10,102.0
	urces/Paran	urces/Param 5,143,680	urces/Paran 5,143,680 5,153,000	urces/Paran 5,143,680 5,153,000 5,158,290
	Modeling So	Modeling So 453,954	<b>Modeling So</b> 453,954 469,900	<b>Modeling So</b> 453,954 469,900 469,745
	SO <sub>2</sub> NAAQS Increment	<b>SO<sub>2</sub> NAAQS Increment</b> ] Empire Iron Mining Partner	SO <sub>2</sub> NAAQS Increment ] Empire Iron Mining Partner Marquette Board of Light & Power	SO <sub>2</sub> NAAQS Increment ] Empire Iron Mining Partner Marquette Board of Light & Power Wisconsin Electric Power Co
		B1827	B1827 B1833	B1827 B1833 B1833 B4261

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### **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<sub>2</sub>,  $PM_{10}$ , and NO<sub>x</sub> were obtained from the MDEQ-AQD via email on August 21, 2006. However, as will be discussed in the results section, only SO<sub>2</sub> requires a full dispersion modeling analysis to demonstrate compliance with the applicable NAAQS. Therefore, only the background concentration of SO<sub>2</sub> is needed for the NMU modeling analysis. Table 6-8 summarizes the background concentrations that have been used in the NAAQS analysis for SO<sub>2</sub>. Monitor selection and background concentrations are presented in Appendix C, along with the background concentrations of the other pollutants.

Pollutant	Averaging Period	Concentration (µg/m <sup>3</sup> )
	Annual	2.7
SO2	24-Hour	13.3
	3-Hour	45.2

Table 6-8. Background Concentrations for NAAQS Modeling

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<sub>2</sub>, PM<sub>10</sub>, and NO<sub>x</sub> 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<sup>3</sup> on a 1-hour basis and 500  $\mu$ g/m<sup>3</sup> 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<sup>3</sup> on a 1-hour basis and 27.2  $\mu$ g/m<sup>3</sup> 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.

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Averaging Period	NMU Maximum Impact <sup>1</sup> (μg/m <sup>3</sup> )	Year of Maximum Impact	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Significant Impact Level (µg/m <sup>3</sup> )	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%

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

### 6.5.2 SO<sub>2</sub> PSD Increment Modeling Results

The SO<sub>2</sub> 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<sub>2</sub> impacts from the CFB boiler alone would be greater than the applicable SILs for SO2. As the existing boilers were installed and/or modified after the SO2 PSD baseline date of February 8, 1980 (AQCR 126), it has been assumed that all existing boilers are sources of SO2 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<sub>2</sub> - 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<sub>2</sub> PSD Increments (as NMU is the only source included in the 100% analysis). The NMU SO<sub>2</sub> emission sources modeled for the PSD Increment analysis include all sources of SO<sub>2</sub> emissions - both existing boilers and the new CFB boiler. The NMU SO<sub>2</sub>



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

Averaging Period	NMU & PSD Maximum Impact <sup>1</sup> (µg/m <sup>3</sup> )	Impact UTM Easting (meters)	Impact UTM Northing (meters)	100% of PSD Class II Increment (µg/m <sup>3</sup> )	80% of PSD Class II Increment (µg/m <sup>3</sup> )	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%

### Table 6-10. Results of NMU SO<sub>2</sub> 80% and 100% Increment Modeling (01-05 SAW MET)

<sup>1</sup> Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1<sup>st</sup> 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 2<sup>nd</sup> 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub>, 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<sub>2</sub> NAAQS are applicable over the annual, 24-hour, and 3hour averaging periods. The NAAQS modeling analysis includes all SO<sub>2</sub> emission sources – all NMU SO<sub>2</sub> emission sources and all off-site SO<sub>2</sub> emission sources (sources listed for SO<sub>2</sub> 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<sub>2</sub> NAAQS modeling analysis are presented in Table 6-11.

Averaging Period	Maximum Impact <sup>1</sup> (μg/m <sup>3</sup> )	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Primary NAAQS (µg/m³)	Background Concen- tration (µg/m <sup>3</sup> )	Total NAAQS Impact (μg/m <sup>3</sup> )	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%

Table 6-11. Results of the NMU SO<sub>2</sub> NAAQS Modeling Analysis (01-05 SAW MET)

Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1<sup>st</sup> 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 2<sup>nd</sup> high impacts from the same five year set of meteorological data.



As shown in Table 6-11, the SO<sub>2</sub> NAAQS modeling analysis shows that the proposed project will not cause a violation of the SO<sub>2</sub> 3-hour, 24-hour, or annual NAAQS when the model predicted maximum impacts are added to the background concentrations.

### 6.5.4 PM<sub>10</sub> 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 µg/m<sup>3</sup> on a 24-hour basis and 1 µg/m<sup>3</sup> 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 µg/m<sup>3</sup> on a 24hour basis and 0.35 µg/m<sup>3</sup> 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.

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Averaging Period	NMU Maximum Impact <sup>1</sup> (µg/m <sup>3</sup> )	Year of Maximum Impact	ImpactImpactUTMUTMEastingNorthing(meters)(meters)		Significant Impact Level (µg/m <sup>3</sup> )	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%

### Table 6-12. Results of the NMU PM<sub>10</sub> SIL Modeling Analysis (01-05 SAW MET)

Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1<sup>st</sup> 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 2<sup>nd</sup> high impacts from the same five year set of meteorological data.

### 6.5.5 NO<sub>x</sub> Significant Impact Level (SIL) Modeling Results

The NO<sub>x</sub> significant impact level modeling analysis considered all NMU boilers, both existing and the newly proposed boiler. Similar to CO and  $PM_{10}$ , the NO<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub>). However, the results predicted that the NO<sub>x</sub> impacts would be below the applicable SIL.

Per the preceding discussion, the NO<sub>x</sub> combined impacts from the two stacks have been determined for comparison with the applicable SIL of 1  $\mu$ g/m<sup>3</sup> 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<sub>x</sub> 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<sup>3</sup> 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<sub>x</sub> PSD Increment standard and NAAQS.



Averaging Period	NMU Maximum Impact <sup>1</sup> (µg/m <sup>3</sup> )	Year of Maximum Impact	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Significant Impact Level (µg/m <sup>3</sup> )	NMU Impact As % Of SIL
Annual	0.974	2005	468,960.8	5,157,154.0	1	97.40%

Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1<sup>st</sup> 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-

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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 =  $1.589 (\mu g/m^3)/(g/sec)$ 

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

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<sup>3</sup>, which is approximately 0.44% of the acetaldehyde screening level of 9  $\mu$ g/m<sup>3</sup> 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.

Averaging Period	Modeled Impact (µg/m <sup>3</sup> )/(g/sec)	X (East) Impact Location <sup>1</sup> (meters)	Y (North) Impact Location <sup>1</sup> (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
l-Hour	15.779	466,860.8	5,151,904.0	283.74

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

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

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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  $1.5 \,\mu\text{g/m}^3$  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.

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ISC AERMOD View Files	File Description	Meteorological Data
NMU01_CO through NMU05_CO	CO SIL Models	2001-2005
NMUPM_P1 through NMUPM_P5	PM <sub>10</sub> SIL Models	2001-2005
NMU01SO2 through NMU05SO2	SO <sub>2</sub> PSD and NAAQS Models	2001-2005
NMU_NOx1 through NMU_NOx5	NO <sub>x</sub> SIL Models	2001-2005
NMU_GPS2	TAC modeling Gram/Second Model	2005

### Table 6-18. Summary of the NMU Modeling Files



### 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

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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 COhave 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  $\frac{\mu g}{m}$  (primary NAAQS is 100  $\frac{\mu g}{m}$ )

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The highest predicted SO<sub>2</sub> 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.

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### 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.



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### APPENDIX C

Dispersion Modeling Support Information



NMU Campus Modeling Building Layouts

(with Building Heights)



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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 Cauth

The Southwest Corn	er of the EXI	sting Riple	y Heating I	Plant Bldg	Equals Site	e Coordina	te (0,0)	
Building	Corner	Coordin	ates (feet)	Height	Coordina	tes (meters)	Height	1
Rinley Heating Plant	A1			(reet)		<u>Y (N)</u>	(meters)	4
Ropley Heating Flant	<u>λ</u> 2	0.00	102.02	79.00	0.00	21 27	24.08	-1
	A3	66.92	102.32	79.00	20.00	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 Boller 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	-
·· _· ·· ··	84	-36.53	42.82	110.00	-11.14	13.05	33.53	-
	85	-101.53	42.82	110.00	-30.95	13.05	33.53	-
New Steam Turbine Bldg	<u> </u>	101.53	_4 19	30.00	-30.95	-1.28	9 1/1	-
	<u> </u>	101.53	42.92	30.00	-30.05	13.05	0.14	-
	<u>C3</u>	-36.53	42.82	30.00	-1114	13.05	9.14	4
		-36.53	-4 10	30.00	-11.14	-1.28	9,14	-1
·····	C5	-101.53		30.00	-30.05	-1.20	9.14	-
New Control Room	D1	1 28 52	0.00	20.00	-30.85	-1.20	3.14	-
New Cond of Room		20.00	0.00	30.00	-11,14	0.00	9.14	-
		-30.03	39.13	30.00	-11.19	11.93	9.14	-
		0.00	39.13	30.00	0.00	11.93	9,14	-
		0.00	0.00	30.00	0.00	0.00	9.14	-
Ocol Ocole	D	-30.53	0.00	30.00	-11.14	0.00	9.14	-
Coal Contaiment Structure	<u>E1</u>	-145,96	167.00	8.00	-44.49	50.90	2.44	4
	<u>E2</u>	-145.96	169.00	8,00	-44.49	51.51	2.44	4
	E3	90.29	169.00	8.00	-27.52	51.51	2,44	4
	E4	-90.29	229.00	8.00	-27.52	69.80	2.44	-
	<u> ±5</u>	-145.96	229.00	8.00	-44.49	69.80	2.44	4
	Eb	-140.96	231.00	8.00	-44.49	/0.41	2,44	-
	<u> </u>	-88.29	231.00	8.00	-26.91	(0.41	2,44	4
	<u>E8</u>	-88.29	167.00	8.00	-26.91	50.90	2.44	-
	E9	145.96	167.00	8.00		50.90	2.44	4
Wood Handling Building	F1	-151.12		22.00	-46.06	-1.35	6.71	1
	F2	151.12	39.14	22.00	-46.06	11.93	8,71	4
·	<u>F3</u>	-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	4
	<u> </u>	-151.12	-4.43	22.00	-46.06	-1.35	6.71	1
New Baghouse Structure	<u>G1</u>	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	-63.75	168.12	63.00	-16.38	51.24	19.20	]
	G5	-80.76	168.12	63.00	-24.62	51.24	19.20	1
Cooling Towar Structure	Ht	-233.86	-46.48	28.00	-71.28	-14.17	8.53	1
	H2	-233.86	-22.48	28.00	-71.28	-6.85	8.53	
	НЗ	-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	11	-237.56	222.84	40.00	-72.41	67.92	12,19	1
	12	-237.56	323.23	40.00	-72.41	98.52	12.19	1
	13	-191.52	323.23	40.00	-58.37	98.52	12.19	İ
	4	-191.52	222.84	40.00	-58.37	67.92	12.19	1
	15	-237.56	222.84	40.00	-72.41	67.92	12.19	1
Existing Nearby Bidd #2	,11	-230.95	62.16	40.00	-70.39	18.95	12.19	1
	J2	-230.95	93.06	40.00	-70.39	28.37	12.19	1
	13	-195.64	93.06	40.00	-59.94	28.37	12 19	1
	.]4	196.64	62 16	40.00	-59.94	18.95	12 19	1
	.15	-230.95	62 16	40.00	-70.39	18.95	12 19	1
Gunther C. Meyland Hall	K1	242.84	-412 65	120.00	-74.02	-125 78	36.52	1
(NE Section of Ound 2)	1/2	-242.84	-712-00	120.00	-74.02	-78 10	36.50	1
and bounder of Gudu 21	K3	-198.80	-250.20	120.00	-14.02	-70.20	26 59	1
	KA	-198 AD	-368 41	120.00	-60.58	-112.20	38.59	1
	*5	- 75 19	-368.44	120.00	-00.08	-112.23	30.00	
· · ·	KR	_75.19	-250.96	120.00	-22.00	-76.20	00.00	
	K7	-30.78	-250.20	120.00	-22.00	-76.20	36.50	
	83	20.70	_412 65	120.00	-5.50	-10.20	00.00	
	Va Va	.00.70	412.00	120.00	-0.30	-12J.10	30.00	
		-4-14.04	-412.00		-74.0Z	20.70	30.00	
Circular Strutures	Genter	Coordina	tes (teet)	Height	Coordinate	es (meters)	Diameter	Hei
	1.9.	X (E)	Y (N)	(feet)	X (E)	Y (N)	(meters)	(រាវាទ
New Ash Silo	01		221.91	81.00	-9.31	67.64	6.10	24
Wood Silo	P1	-138.44	97.43	80.00	-42.19	29.70	10.65	24
	1							
Cinet-	1	Coordina	tes (feet)	Height	Coordinate	es (meters)	Diameter	He
JIACKS	L LD.	X (E)	Y (N)	(feet)	X (E)	Y (N)	(mèters)	íme
New Baghouse Stack	NewBHStk	-67.25	250.08	165.00	-20.50	76.22	1.83	50
Existing Boiler Stack	ExistStk	-19.02	51.28	150.00	-5,80	15.63	1.52	45
			· · · · · · · · · · · · · · · · · · ·		~~~~		1.	

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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	Coordina	(es (meters)	Height	UTM Coord	inates (meters)	Elevation
	I.D.	X (E)	Y (N)	(feet)	Easting	Northing	(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
	84	-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
	<u>C3</u>	-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
	<u>C5</u>	-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
	<u>D2</u>	-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		468874.00	5156608.00	195.38
	D5	-11.14	0.00	30.00	468862.86	5156608.00	195.38
Coal Contaiment Structure	<u>E1</u>	-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
	<u> </u>	-27.52	69.80	8.00	468846.48	5156677.80	195.38
	<u>E5</u>	-44.49	69.80	8.00	468829.51	5156677.80	195.38
	<u>E0</u>	-44.49	70.41	8.00	468829.51	51566/8.41	195.38
· · · · · · · · · · · · · · · · · · ·		-20.91	70.41	8.00	468847.09	5156678.41	195.38
	50	-20.91	50.90	8.00	468847.09	5150658.90	195.38
Wood Handling Ruilding		49.08	00.90	0.00	400029.01	5156608.80	195.30
wood nanoing Building	F1 F2	-40.00	-1.00	22.00	408827.94	5156610.00	195.38
	F2	-38.08	11.93	22.00	400021.94	5156610.02	105 20
	 F4	-38 98	-1 35	22.00	468835.02	5156606.65	105 39
······································		-46.06	-1.35	22.00	468827.94	5156608.65	195.38
New Baghouse Structure	G1	-24.62	51.24	63.00	468849 38	5156659.24	105.38
	62	-24 62	62.41	63.00	468849 38	5156670.41	105.38
	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
	НЗ	-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	1	-72.41	67.92	40.00	468801.59	5156675.92	196.90
· · · · · · · · · · · · · · · · · · ·	12	-72.41	98.52	40.00	468801.59	5156706.52	196.90
	13	-58.37	98.52	40.00	468815.63	5156706.52	196.90
	4	-58.37	67.92	40.00	468815.63	5156675.92	196.90
	15	-72.41	67.92	40.00	468801.59	5156675.92	196.90
Existing Nearby Bidg #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)	К2	-74.02	-76.28	120.00	468799.98	5156531.72	195.38
	<u>K3</u>	-60.69	-76.28	120.00	468813.41	5156531.72	195.38
	<u>K4</u>	-60.59	-112.29	120.00	468813.41	5156495.71	195.38
	<u>K5</u>	-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
· · · · · · · · · · · · · · · · · · ·	<u>K7</u>	-9.38	-76.28	120.00	468864.62	5156531.72	195.38
	<u>K8</u>	-9.38	-125.78	120.00	468864.62	5156482.22	195.38
	r.9	-74.02	-125.78	120.00	468/99.98	I 5156482.22	195.38

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### 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	Coordinate	es (meters)	Height	UTM Coordi	nates (meters)	Elevation	
	I.D.	X (E)	Y (N)	(feet)	Easting	Northing	(meters)	
Circular Strutures	Center	Coordina	ates (feet)	Height	UTM Coordi	nates (meters)	Diameter	Height
	I.D.	X (E)	Y (N)	(fe <b>et</b> )	UTM Easting	UTM Northing	(meters)	(meters)
New Ash Silo	01	-9.31	67.64	81.00	468864.69	5156675.64	6.10	24.69
Wood Silo	<u>P1</u>	-42.19	29.70	80.00	468831.81	5156637.70	10.65	24.38
Stacks		Coordina	ites (feet)	Height	UTM Coordin	nates (meters)	Diameter	Height
	I.D.	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

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vised in inputs modeling inputs



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### **Receptor Grid Layout Diagrams**





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### **Existing Source Emission Rates**

# NMU Boiler Project - Existand Source Emission Rates

Pre Permit 126-05 Emission Estimates

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

Basis:

Potential Fuel OII Capacity

(MM gal/year) 10,356,267

Total (MM Btu) 109,368 388,409 385,365 (MM Btu) Fuel Oil 49.0 Heat input (MM Btu) Nat Gas Fuel Oil 1313 363 (gal) 22471 25896 Nat Gas (MM scf) 358.057 363.933 363.933 401.341 377.819 384.185 Year 2001 2001 2003 2003

Max Actual Capacity Factor Equiv Hrs using Fuel Oil/year

0.0026 21.90

Past Actual - Estimated Annual Emissions

	g	ç	Tons/Year		-
2	×	2	ЫЧ	202	202
17.9	2	15.04	1.36	0.16	0.98
18.2	0	15.29	1.38	0.12	1.00
20.0	2	16.85	1.53	0.12	1.10
19.12		15.92	1.48	0.93	1.04
19.47		16.20	1.51	1.06	1.06
20.02		16.86	1 52	1 06	4 T
11111	I	20101	2011	001	2
4.582		3.848	0.348	0.242	0.252

annual average lb/hour 0.252 0.242 0.348 3,848 4.582

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

	2 Bollers				
	Capacity	Nat	Gas	en 4	101
	(MM Btu/hr)	(MM scf/hr)	(MM scf/yr)	(gal/hr)	(gal/year)
Nat Gas	167.2	0.1639	1,057.14		
Fuel Oil	159.6			1,182.22	2,732,040
		Potential	Emissions (T	ns/Year)	
Pollutant	NOX	8	PN	\$02	VOC
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	nla	n/a
Totele	74 07	22 C	ט בר	00.00	
10101	10.14	11.02	20.2	76.66	3.20
		Ċ	ş		

Note: red bold = maximum emission rate used for future potential modeling purposes VOC 0.902 0.319 0.748 502 0.098 86.184 22.808 **1.246 4.788** 2.180 13.769 24.898 16.705 8.196 15.960 **10.244** Oil Oaly (max hourly) Ib/hour Limited Oil Use (annual ave hourly) Ib/hr (annual) lb/hour Nat Gas only

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

	NUX	3	μM	202
PSD Increment	0.714		0.559	10.829
NAQS	1.291	3.137	0.603	10.859
	Emission rates a	bove given in ur	its of gram/sec	ond

File: NMU Modeled Rates (Exist & New) Tab: Existing Equip Summary

XON	Nat Gas (Ibímmscf) 100	Fuel Oil (tb/mmBtu) 0.148
3	84	0.037
Md	7.6	0.03
\$02	0.6	0.54
202	5.5	0.002

AP42 Factors

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tion With Fuel Type		Nat Gas	Fuel Oil
Annual Operat	(hourlyear)	6449.1	2310.9

NOx/AP42 Factors	Nat Gas	(ib/mmsci	NOX 50	CO 84	PM 7.6	SO2 0.6	VOC 5.5
	Fuel OII	(lb/mmBtu)	0.100	0.156	0.03	0.54	0.002

0.5 Wt-% Sulfur in Fuel Oil

2/1/2007 4:14 PM



### Summary of TAC Analysis Results



### **Background Concentrations**

### BACKGRND (Aug 21 06)

## BACKGROUND CONCENTRATIONS

1 ] ]	CITY	ADDRESS	TYPE	YEAR	Distance	3-HR	24-班氏	ANNUAL	
502 502 502	Escanaba Escanaba	County Road 414 County Road 414 Seney Nat'L Wildlife Refuge, Hcr2,	Rural Rural Rural	2003 2004 2005	65.3 km 65.3 km 158.5 km	45.2 34.6 29.3	13.3 10.6 13.3	20.0	
	CITY	ADDRESS		YEAR	Distance	45.2 45.2	13.3	2.7	
NO2 NO2 NO2	TWO RİVƏIS TWO RİVƏIS	Harrington Beach State Park, 531 Hw Manitowoc/Woodlnd Dunes, 2315 Goodw Manitowoc/Woodlnd Dunes, 2315 Goodw	<pre>   Rural   Rural   Rural   Rural </pre>	2003 2004 2005	225.4 km 176.5 km 176.5 km	11.5 5.7 5.7			
	CITY	ADDRESS	н 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	YEAR	Distance	11.5 24-HR	TRUNAL		
o ima o ima	Green Bay Green Bay Green Bay	Prangeway, 1300 N Quincy Street Prangeway, 1300 N Quincy Street Prangeway, 1300 N Quincy Street	Urban Urban Urban	2004 2004 2005	160.8 htm 160.8 htm 160.8 htm 160.8 htm	, , , , , , , , , , , , , , , , , , ,	19.0 15.0 22.0		
					- - - - - - - - - - - - - - - - - - -	48.0 4th High	22.0		
	CITY	ADDRESS	TYPE	YEAR	Distance	1-HR	8-HR		
888	Milwaukee Milwaukee	Dnr Ser Hågrus, 2300 N M. L. King J Dnr Ser Hågrus, 2300 N M. L. King J Seney Nat'L Wildlife Refuge, Hdr2,	( Urban Rural	2003 2004 2005	258.5 km 258.5 km 158.5 km	4408 4524 812	3016 3480 464		
				- 		4524	3480		
	CITY	ADDRESS	ЗЛУТ	YEAR	Distance (	) UARTER			
		· · · · · · · · · · · · · · · · · · ·							

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0.03 0.01 0.01

262.1 km 256.2 km 316.5 km 

2003 2004 2005

Urban Rural Rural

Health Center, 1337 So 16th St Mayville, Near N6705 Madison Rd 1769 S Jeffs Rd

Milwaukee

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### **APPENDIX D**

### **RACT/BACT/LAER Clearinghouse Results**

Michigan University	RBLC
Northern	

and The state of the

		-	-				_	_	_		_	_	_	_			-	
BASIS	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-P50	BACT+PSD	BACT-PSO	BACT-PSD	BACT-PSO	BAGT-PSO	BACT-PSD	BACT-PSO	BACT-PSD	BACT-PSD	BACT-PSD
AVG TIME	3-HR TEST	3-HR TEST	4-HOUR BLOCK AVERAGE	30 DAY AVERAGE	3-HR TEST	3-H TEST	4-HOUR BLOCK AVERAGE	30-DAY ROLING AVERAGE	3-HOUR AVERAGE	30 DAY ROLLING AVG	30 DAY ROLLING AVERAGE	3 HOUR ROLLING AVERAGE	3 HOUR AVERAGE	3 HOUR AVERAGE	3 HOUR AVERAGE	3 HOUR AVERAGE	3 HOUR AVERAGE	3 HOUR AVERAGE
UNIT	LBMMBTU	LBMMBTU	LEMMBTU	LBAMABTU	LB/MMBTU	LEAMMETU	LB/MMBTU	LB/MMBTU	LEVMMBTU	) LAMMBTU	LB/MMBTU	LB/MMETU	свимато	GRUDSCF	GRUDSCF	GRUDSCF	GROSCF	GRUSCF
EMIS LIMIT	0.025	0.025	6.0	0.15	0.025	0.025	E.0	0.15	0.02	60	0.1	0.11	0.048	0.004	0.004	0.004	0.004	0.004
POLLUTANT	Perticulate Matter (PMI)	Particulate Matter < 10 µ (PM10)	Carbon Monoxide	Nitrogen Öxides (NÖx)	Particulate Matter < 10 µ (PM10)	Particulate Matter (PM)	Carbon Monoxide	Nitrogen Oxides (NOx)	Particulate Matter < 10 µ (PM10)	Sulfur Oxides (80x)	Nitrogen Oxídes (NOx)	Carbon Monoxide	Particulate Matter (PM)	Particulate Mauter < 10 µ (PM10)	Particulate Matter < 10 µ (PM10)	Particulate Matter < 10 µ (PM10)	Perticulate Matter < 10 µ (PM 10)	Particulate Matter < 10 μ (PM10)
PROCESS NOTES						·	1	<b></b>			- - - - - - - - - - - - - - - - - - -	CONTROL DEVICE FOR THE DISTILLER'S GRAIN	COLUMNS AND COLUMNS AND BIOMETHANATOR (I.E. CASES FROM THESE PROCESSES ARE	FOR COMBUSTION).		<b>.</b>	·	. <u></u>
UNIT	menbtu/h	ambtu/h	unbtu/h	numbturh	ambtulh	mbtuth	որենսի	ditation	ммвти/н	MMBTUNH	MMBTU/H	MMBTU/H	H/UT8MM	ЧI	4	분	HH.	H
THRUPUT	230	230	230	530	230	230	230	230	260	) 250	250	250	250	2	420	92	420	27
FUEL	DODW	DOOM	MOOD	0004	ψοορ	MOOD	MOOD	MOOD	LIGNITE		LIGNITE	LIGNITE	LIGNITE					
PROCESS NAME	SOILER, WOOD FIRED	BOILER, WOOD FIRED	BOILER, WOOD FIRED	BOILER, WOOD FIRED	BOLER, WOOD FIRED	BOILER, WOOD FIRED	BOILER, WOOD FIRED	BOILER, WOOD FIRED	BOILER, COAL- FIRED	BOILER, COAL-	BOILER, COAL- FIRED	BOILER, COAL- FIRED	BOILER, COAL- FIRED	DDGS COOLING	GRAIN RECEIVING	HAMMERWILLING	DDGS LOADOUT	COAL HANDLING
DESCRIPTION				IWOOD FIRED BOILER. 230 MMBTU/H HEAT MPUT, SPREADER STOKER								FIMANO DOGU DAMA	PLANT RATED AT 65 MILLION GALLONS PER YEAR.					
PERMIT	6/30/2005	6/30/2005	6/30/2005	6/30/2005	6/30/2005	6/30/2005	6/30/2005	6/30/2005	8/4/2004	8/4/2004	8/4/2004	8/4/2004	8/4/2004	8/4/2004	B/4/2004	8/4/2004	8/4/2004	8/4/2004
PERMIT No.	13700028-005	13700028-005	13700028-005	13700028-005	13700027-003	13700027-003	13700027-003	13700027-003	4004	4004	4004	4004	4004	4004	4004	4004	4004	4004
STATE	NW	NW	NW	NM	MN	NW	NM	NW	â	£	ĝ	ĝ	â	ĝ	Ð	Q	Q	g
FACILITY NAME	VIRGINIA DEPARTMENT OF PUBLIC UTLITIES	VIRGINIA DEPARTMENT OF PUBLIC UTILITIES	VIRGINIA DEPARTMENT OF PUBLIC UTILITIES	VIRGINIA DEPARTMENT OF PUBLIC UTTLITIES	HIBBING PUBLIC UTILITIES	HIBBING PUBLIC UTILITIES	HIBBING PUBLIC	HIBBING PUBLIC	RICHARDTON PLANT	RICHARDTON	RICHARDTON	RICHARDTON	RICHARDTON PLANT	RICHARDTON	RICHARDTON PLANT	RICHARDTON	RICHARDTON	RICHARDTON
RBLCID	8500-NW	MN-0058	MN-0058	MN-0058	000-NW	MN-6059	MN-0059	MN-0059	ND-0020	ND-0020	ND-0020	ND-0020	ND-0020	ND-0020	ND-0020	ND-020	ND-C020	ND-0020

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Northern Michigan University RBLC

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	EASIS	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-P50	BACT-PSD
	AVG TIME		EACH BOILER					EACH BOILER				EACH BOILER	EACH BOILER		-		EACH BOILER	
		LB/MMBTU	LBH	LB/MMBTU	GRACF	GRIACE	LEAMMBTU	LB/H	LEVMMBTU	GR/ACF	LBMMBTU	LB/H	LB/H	LB/MMGTU	GRACF	LEVANGTU	LBA	LB/MMBTU
		0.7	5.2	1.0 1.0	0.01	0.01	0.7	B.15	1.6	10.0	0.7	0.38	с, S	1.8	0.01	0.7	88	1.6
	POLLUIANE	Nitrogen Oxídes (NOx)	Carbon Monoxide	Suffur Dioxide (SO2)	Particulste Matter < 10 µ (PM10)	Particulate Matter < 10 µ (PM 10)	Nitrogen Oxides (NOx)	Carbon Monovide	Sutfur Dioxide (SO2)	Particulate Matter < 10 µ (PM10)	Mitragen Oxides (NOX)	Volatile Organic Compounds (VOC)	Carbon Monoxide	Sulfur Dioxide (SO2)	Perticultate Matter < 10 µ (PM10)	Nitrogen Oxides (NOx)	Carbon Monoxide	Sulfur Dioxide (SO2)
	PROCESS NULES		t	L	+			TWO BOILERS, CAPABLE OF BURNING AND WITH	NUMBERS 2 AND 6 FUEL NUMBERS 2 AND 6 FUEL OILS. POUND PER HOUR LIMITS ARE FOR EACH	BOILEN; AND EXCEPT	UMBINELL CUAL USAGE FOR BOTH BOILERS TOGETHER NOT TO EXCEED 125,682 TONS/ROLLING 12	MUNINS - THESE LIMITS - FOR THE COAL.	I	I	<u> </u>	L		
	in n	MMBTU/H	MMBTU/H	MABTU/H	MMBTU/H	HUTBMM	нулдим	MMBTU/H	MMETU/H	MMBTU/H	MMBTUNH	нуламм	MMBTUH	MMBTU/H	MMBTUNH	MMBTUH	HUTBINH	ницин
	INKUPU	538	238	<b>73</b> 8	538	538	538	538	538	538	586	238	238	238	538	238	238	238
1910	LOEL	COAL	COAL	COML	CCAL	NO. 6 FUEL	NO. 6 FUEL OIL	NO. 6 FUEL OIL	NO. 6 FUEL OIL	NO. 2 FUEL. OIL	NO. 2 FUEL OIL	NO. 2 FUEL OIL	NO. 2 FUEL OIL	NO. 2 FUEL OIL	NATURAL GAS	NATURAL GAS	NATURAL GAS	NATURAL GAŠ
201010 00 000		BOILER (2), COAL FIRED	BOILER (2). COAL FIRED	BOILER (2), COAL FIRED	BOILER (2). COAL FIRED	BOILER (2), NO. 6 FUEL OIL	BOILER (2), NO. 6 FUEL OIL	BOILER (2), NO. 6 FUEL OIL	BOILER (2), NO. 6 FUEL OIL	BOILER (2), NO. 2 FUEL OIL	BOILER (2), NO. 2 FUEL OIL	BOILER (2), NO. 2 FUEL OIL	BOILER (2), NO. 2 FUEL OIL	BOILER (2), NO. 2 FUEL OIL	BOILER (2), NATURAL GAS	BOILER (2), NATURAL GAS	BOILER (2). NATURAL GAS	BOILER (2), NATURAL GAS
DESCENTAN				$\bigcirc$		THIS FACULTY BREWS	AND PACKAGES BEER. EACH BOILER NOT TO EXCEED 180,000 LB STEAMH OR 238 MMBTUH. 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 TURBING GENERATOR TO AN EXISTING COAL FIRED BOILER (THERE WERE	NO EMISSIONS FROM THE STEAM TURBINE (TSELF), THIS MODIFICATION WAS TO INCREASE THE HCL	HOURLY AND TYR LIMITS AND SOZIMMBTU LIMIT. THE TYR FACLLITYWIDE LIMITS	HAVE NOT CHANGED. EXCEPT FOR HCL WHICH HAS INCREASE BY 46.1 T/YR IN THIS NEW	PERMIT.				
PERMIT	DATE	5/27/2004	5/27/2004	5/27/2004	6/27/2004	5/27/2004	5/27/2004	5/27/2004	5/27/2004	5/27/2004	6/27/2004	5/27/2004	5/27/2004	5/27/2004	5/27/2004	5/27/2004	5/27/2004	5/27/2004
DECONST NO		14-05515	14-05515	14-05515	14-05515	14-05515	14-05515	14-05515	14-05515	14-05515	14-05515	14-05515	14-05515	14-05515	14-05515	14-06515	14-05515	14-06515
CTATC		£	¥	Ą	Ю	ß	¥	¥	Ŗ	Ю	ъ	A	¥	A	М	ы	A	R
EACH ITV NAME		MILLER BREWING COMPANY	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY - TRENTON	MILLER BREWING COMPANY -
		OH-0241	0:+-0241	OH-0241	QH-0241	OH-0241	OH-0241	OH-0241	ОН-0241	OH-0241	OH-0241	OH-0241	0H-0241	OH-0241	OH-0241	CH-0241	CH-0241	CH-0241

RBLC NMU2

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thern Michigan University	RBLC

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BASIS	BACT-PSD	A/A	BACT-PSD	MA	BACT-PSD	N.N	BACT-PSD	BACT-PSD	NA.	AIA	BACT-PSD	BACT-PSD
AVG TIME						ON FUEL OIL	WITH FUE- OIL	with fuel oil.	FOR FUEL OIL	WITH NATURAL GAS	WITH NATURAL GAS	WITH NATURAL GAS
UNIT	LB/H	LB/H	LB/H	FB/H	LBH	Hai	LB/H	LG/H	HIBM	HBH	Han	FBH
EMIS (JMIT	3.97	27.98	8, E	22.13	6.71	43.13	57.24	80°6 .	58	14.82	27.17	£
POLLUTANT	Particulate Matter < 10 µ (PM10)	Nitrogen Oxides (NOx)	Carbon Monoxide	Ŝultur Dłoxide (SQ2)	Particulate Matter < 10 µ (PM10)	Nitragen Öxides (NOx)	Carbon Monoxide	Particulete Metter < 10 µ (PM10)	Sultur Dioxide (SC2)	Nitrogen Oxides (NOX)	Carbon Monoxide	Particulate Matter < 10 µ (PM10)
PROCESS NOTES								Uxotation cataryst, selective catalytic reduction, sodum bicarbonate injedion, reverse air baghouse w/98% control.				
UNIT	MMBTUAH	Мивтилн	MMBTU/H	MMBTU/H	ACFM	ММВТШН	Н/П	MMBTU/H	MIBTU/H	ММВТ///Н	MMBYLVH	MMBTUH
THRUPUT	175	175	175	175	130495	227	521	227	227	247	247	247
FUEL	000M	acow	doaw	DOCW		FUEL OIL #2	FUEL OIL #2	FUEL OIL#2	FUELOIL#2	NATUR <b>A</b> L GAS	NATURAL GAS	NATURAL GAS
PROCESS NAME	WOOD FIRED BOILERS (7)	WOOD FIRED BOILERS (7)	WOOD FIRED BOILERS (7)	WOOD FIRED BOILERS (7)	W000 HANDLING SYSTEM	AUXIJARY BOILER	AUXILIARY BOILER	AUXILIARY BOILER	AUXILIARY BOILER	AUXIJARY BOILER	AUXLIARY BOILER	ALXLIARY BOILER
DESCRIPTION							SEVEN BOILERS	PURCHASED FROM AN ETHANOL PLANT, REBUILDING TO BURN OROD AND TO GENERATE POWER, USING WOOD WASTE				
PERMIT	1/5/2004	1/5/2004	1/5/2004	1/5/2004	1/5/2004	1/5/2004	1/5/2004	1/5/2004	1/5/2004	1/5/2004	1/5/2004	1/5/2004
PERMIT No.	07-00534	07-00534	07-00534	07-00634	07-00534	07-00534	07-00534	07-00534	07-00534	07-00634	07-00534	07-00534
STATE	ъ	6	A	P	B	5	ē	£	ð	Ð	Ð	£
FACILITY NAME	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER	BIOMASS ENERGY, LLC- SOUTH POINT POWER
RBLCID	ОН-0269	6920-HO.	0H0269	0ң-0269	OH-0269	OH-0269	OH-0269	OH-0269	ОН-0269	OH-0269	OH-0269	0H-0269

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BAGIS	N	Other Case-by-Case	Other Case-by-Case	Other Case-by-Case	Other Case-by-Case	Other Case-by-Case	Other Case-by-Case	Other Case-by-Casa	Other Case by-Case
AVG TIME	WITH NATURAL GAS	EACH							
UNIT	LB/H	H/81	HABL	LE/MMBTU	LEVMMETU	LB/MMBTU	LEVAMBTU	LB/MMBTU	LE/MM8TU
EMIS LIMIT	0.15	105.5	279,1	0.15	0.14	0.47	0.4	0.44	0.15
POLLUTANT	Sultur Dioxide (SO2)	Carbon Monoulde	Carban Monoxido	Particulate Matter (PM)	Particulate Matter < 10 µ (PM10)	Suifur Dioxide (SQ2)	Nitrogen Diaxide (NO2)	Carbon Monoxide	Particulate Matter (PM)
PROCESS NOTES		EMISSION POMTS 74A (NO.1) AND 74B (NO.2)	EMISSION POINT 76A		Wood limit 70% Mixture.	Wood/Bark excluding any wood which contains thereat treatments or has affixed thareto paint and/or finibing meterials or page finibing meterials or page Average annual heat	content: 5,000 Btu/fb HHV		In order to meat the enrural emission limitation initiation included in this permit, the wood/coal mixture shall not exceed 30% coal by BTU content on an annual least.
UNIT	MMBTUH	MMBTUH EACH	HIUTBMM	HUTBMM	MMBTUM	MMBTUH	MMBTU/H	MMBTUH	MMBTUH
THRUPUT	247	e S	154.2	120	120	120	120	120	5 <u>7</u>
FUEL	NATURAL GAS	WOOD	WOOD WASTE	wood	wood	MOOM	wood	abow	COAL
PROCESS NAME	AUXIJARY BOILER	KIPPER BOILERS NO.1 AND NO.2 (EACH)	MCBURNEY BOILER NO.4	BOILER, STEAM	BOLER, STEAM	BOILER, STEAM	BOILER, STEAM	BOILER, STEAM	BOILER. STEAM
DESCRIPTION		JOVCE 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.				STEAM FRODUCTION FACILITY		
PERMIT	1/5/2004	4/24/2002	4/24/2002	2/15/2002	2/15/2002	2/15/2002	2/15/2002	2/15/2002	2/15/2002
PERMIT NO.	07-00534	PSD-LA-679	PSD-LA-678	30529	30529	30529	30529	30629	67506
STATE	A	5	5	\$	¢,	\$	\$	\$	\$
FACILITY NAME	BIÓMASS ENERGY, LLC- SOUTH POINT POWER	JOYCE MILL	JOYCE MILL	THERMAL VENTURES	THERMAL	THERMAL	THERMAL	T'HERMAL VENTURES	THERWAL
RBLCID	*OH-0269	LA-0128	LA-0126	VA-0268	VA-0268	VA-0268	VA-0268	VA-0268	VA-0268

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BASIS	Other Case+by-Case	Cutrer Case-by-Case	Other Case-by-Case	Other Case-by/Case	Other Cese by Cese	Other Case-by-Case	8ACT-FSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD
AVG TIME												
UNIT	LEMMMBTU	с симмети	LBANMETU	LB/MMBTU	LB/H	H/81	LB/H	LB/H	H/87	LB/H	H/91	HIBH
EMIS LINIT	0.14	0.47	0.4	0.44	47.91	191,58	0.37	0.09	0.88	0.22	10.27	9.31
POLLUTANT	Particuliste Marter < 10 µ (PM10)	Sulfur Dioxida (502)	Nitrogen Cwides (NOx)	Carbon Moroxide	Nitrogen Oxides (NOX)	Carbon Monoxide	Nitrogen Oxides (NOx)	Carbon Monoxide	Nitragan Dxkdas (NOX)	Carbon Monoxide	Nitrogen Oxides (NOx)	Carbon Monoxide
PROCESS NOTES	Average annual heat context 13:00 Bauki HHV. Average sulfur context per shipment 0.9% and average ach context per altipment 7%.	In order to meet the annual	erasson intructions included in this parinit, the woodcreal mixture shall not acceed 30% coal by BTU Average annual heat Average annual heat average suffix contexh per shipment 0.5% and	average san control per shipment 7%.	EIQ NO. 017. NO PAYSICA. MODIFICATION TO THE MOLLERS WILL DE NEEDD (FRWIG RATES WILL BE NOT REGUIRED) SACTI IS NOT REQUIRED) FOR EMISSIONS FROM BOLLERS.		EIO NO. 028. SOC FOR GAS VENEER DYER,	PINES. NO THROUGHPUT GIVEN,	EIQ NO. 029. SCC FOR GAS VENEER DYER,	PINES. NO THROUGHPUT GIVEN.	INFORMATION IN THE PERMIT IS ORGANIZED	UNDER THE REGENERATIVE THERMAL OXIDIZER OR
UNIT	ммвт∪/н	MMBTUH	MNBTUH	мматцин	HAUTBAAAA	MMBTUNH						
тнкирит	120	120	120	120	ŝ	233						
FUEL	COAL	COAL	COAL	COAL	AD DO M	docw	NATURAL GAS	NATURAL GAS	NATURAL GAS	NATURAL GAS	NATURAL GAS	NATURAL GAS
PROCESS NAME	BOILER. STEAM	BOILER, STEAM	BOILER, STEAM	BOILER, STEAM	WOOD FIRED BOILER	WOOD FIRED BOILER	VENNER DRYER NO.1 COOLING ZONE	VENNER DRYER NO.1 COOLING ZONE	VENNER DRYER ND.2 COOLING ZONE	VENNÉR DRYER ND.2 COOLING ZONE	VENEER DRYERS, HOT ZONES	VENEER DRYERS, HOT ZONES
DESCRIPTION			STEAM PRODUCTION		WILLAMETTE WILLAMETTE INDUSTRIES REQUESTED A PSD MODHICATION TD INSTAL A REGENERATIVE THERMAL OXDIZER OR	RTO/RCO), REMOVE (RTO/RCO), REMOVE THE PRODUCTION LIMIT	OPERATING PERMIT NO. 3240-00010-V2, AND MODERNITE THE	PLYWOOD PLYWOOD MANUFACTURING				
PERMIT	2/15/2002	2115/2002	2/15/2002	2/15/2002	1/7/2002	1/7/2002	1772002	17/2002	1/7/2002	1/7/2002	17/2002	17/2002
PERMIT No.	30528	30529	57 <u>5</u> 05	30523	PSD-LA-627 (M-1)	PSD-LA-627 (M-1)	PSD-LA-627 (M-1)	PSD-LA-627 (M-1)	PSD-LA-527 (M-1)	PSD-LA-627 (M-1)	PSD-LA-627 (M-1)	PSD-LA-627 (M-1)
STATE	\$	\$	₹,	\$	5	۲,	5	٢	5	٤	5	5
FACILITY NAME	THERMAL	THERMAL	THERMAL. VENTURES	Saynlwan Tembaht	WILLAMETTE INDUSTRIES, INC.	WILLAMETTE INDUSTRIES, INC.	WILLAMETTE INDUSTRIES, INC.	WILLAMETTE INDUSTRIES, INC.	WILLAMETTE INDUSTRIES, INC.	WILLAMETTE INDUSTRIES, INC.	WILLAMETTE INDUSTRIES, INC.	WILLAMETTE INDUSTRIES, INC.
RBLCID	VA-0268	VA-0268	VA-0268	VA-0268		LA-0125	LA-0125	LA-0125	LA-0125	LA-0125	LA-0125	LA-0125

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BASIS	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	- Other Case-by-Case	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD
AVG THRE						24 M. average			comblined	combined				
LIND	LB/H	E83	нивл	H/81	HIGH	Ad A	HIGH	Hall	H H	HIBIH	LB/MMBTU	LB/MMBTU	LEMMBTU	LEMMBTU
EMIS LIMIT	2.9	یا ا۔ م 3.62	36.1	33.2	2.9	6	62	1.1	2530	246	0.16	(0.8)	0.4	0.208
POLLUTANT	Particulate Matter < 10 µ (PM10)	Sufur Dioxde (SO2)	Nitrogen Dioxide (NOZ)	Carbon Monoxide	Particulate Matter (PM)	Carbon Monoxide	Sultur Dioxide (SO2)	Nitragen Oddes (NOX)	Sultur Dodde (SO2)	Nitrogen Oxides (NOX)	Particulate Matter (PM)	Suifur Dioxide (502)	Nitrogen Oxides (NOX)	Carbon Monoxide
PROCESS NOTES			No. 11 boller. Boller produces steam for generation of electricity.	1	1	Co catalysi technology used with a coal fried sucre was feering the coal fried sucre was feering bo position in ductwerk. The catalyst is exposed to a substatification of fly ash in the flue gas stream. No physical amount of fly ash in the flue gas stream. No physical modification was made for this process under this determination.		Throughput is confidential. This carbon black mig	process is heirg added. Vew stacks: SN-31, SN-48, SN-49, BACT determination for SO2 and MOx only.	Ĩ		POWER BOILER CAN FIRE COAL, NO. 6 FUEL OIL, OR BARKWOOD FIBER SLADGE		<b>_</b>
TINU	MMBTURH	HIUTAWM	MBTUHH	MMBTU/H	MMBTU/H	MM81 U/H FOR EACH					MMBTU/H	ММВТU/Н	MMBTU/H	MMBTUM
THRUPUT	146.7	146.7	146.7	146.7	146.7	0026					249	249	249	249
FUEL	COAL	COAL	COAL	COAL	COAL	SUB- BIT UNINOUS	NATURAL GAS	NATURAL GAS	FEEDSTOCK OIL	FEEDS TOCK OIL	COAL	COAL	COAL	COAL
PROCESS NAME	BOILER, Overfeed Stoker	BOILER, OVERFRED STOKER	BOILER, OVÉRFEED STOKER	BOILER. OVERFEED STOKER	BOILER. OVERFEED STOKER	COAL FIRED BOILERS (2)	CARBON BLACK MFG, UNIT D STACK & VENT	CARBON BLACK MFG, UNIT D STACK & VENT	CARBON BLACK MFG., UNITS A, B, & C	CARBON BLACK MFG., UNITS A, B, & C	BOILER, POWER, COAL-FIRED	BOILER, POWER, COAL-FIRED	BOILER, POWER, COAL-FIRED	BOILER, POWER. COAL-FIRED
DESCRIPTION			Steam generation for electricity.			This plant makes taabon blaak taing the of furnance process. This determination process of SO2 and Nox increases of SO2 and Nox will exceed the PSD visiterance lovels. increases of PM10. FSD Virremod. Other	pollutants' proposed emissions are lower than the past actual emissions	because of the addition of new control equipment. Pollutent Emissions (T/yr)	Carbon Disufide 87.75 Carbony sulfide 13.46 Hydrogen 117.76 TRS 219.04			WODIFICATION FOR INSTALLATION OF NEW EQUIPMENT TO INCREASE PRODUCTION		
PERMIT	8/30/2001	<u>il'sol2001</u>	8/30/20D1	8/30/2001	8/30/2001	6/9/2001	8/9/2001	8/9/2001	8/9/2001	8/8/2001	5/10/2001	1002/01/5	5/10/2001	1002/01/5
PERMIT No.	20124	20124	20124	20124	20124	906-AOP-R1 (70- 0014)	906-AOP-R1 (70- 0014)	906-AOP-R1 (70- 0014)	996-ADP-R1 (70- 0014)	906-AOP-R1 (70- 0014)	03138R16	03138R16	03138R16	03138R16
STATE	×۸	\$	\$	¥	×	Å	AR	AR	AR	¥	NC NC	о <mark>у</mark>	¥	RC
FACILITY NAME	VPI POWER STATION	VP! POWER STATION	VPI POWER STATION	VPI POWER STATION	VPI POWER STATION	COLUMBIAN COLUMBIAN	COLUMBIAN CHEMICALS - EL DORADO	COLUMBIAN CHEMICALS - EL DORADO	COLUMBIAN CHEMICALS - EL DORADO	COLUMBIAN CHEMICALS - EL DORADO	RIEGELW000	RIEGELWOOD	RIEGELWOOD	RIEGELWOOD
RBLCID	VA-0267	VA-0267	VA-0267	VA-0267	VA-0267	AR-0045	AR-0045	AR-0045	AR-0045	AR-0045	NC-0092	NC-0092	NC-0092	NC-0082

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BASIS	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	BACT-PSD	N/A	BACT-PSD	NIA	N/A
AVG TIME															
UNIT	LEAMMBRU	LB/MMBTU	LEMAMBTU	LEMMETU	LBMMBTU	LEVAMETU	LE/MMBTU	LB/MMB/LU	H/81	LB/H	Нал	GR/DSCF @	20 % 02 LBH	GRDSCF @ 10% 02	PPM @ 10%
EMIS LIMIT	0.0562	, . B.O	0.367	0.033	0.25	0.024	0.35	0.5	979,2	586.5	357.1	0.044	6.2	0.13	ŵ
POLLUTANT	Particulare Matter (PM)	Sulfur Dioxide (SO2)	Nitrogen Oxides (NOx)	Carbon Manaxide	Particulate Matter (PM)	Sulfur Dioxide (SO2)	Nitrogen Oxides (NOx)	Carbon Monoxide	Sulfur Diaxide (SO2)	Nitrogen Dioxide (NO2)	Carbon Monoxide	Particulate Matter (PM)	Sulfur Dioxide (SQ2)	Particulate Malter (PM)	Todal Reduced Sulfur
PROCESS NOTES		<u> </u>		POWER BOILER CAN	FIRE COAL, NO. & FUEL OIL, DR BARKWOOD FIBER SLUDGE.	1	1	<u>+</u> .		J		BOILER FIRES AN	AVERAGE OF 5.59 MILLION POUNDS OF BLACK LIQUOR SOLIDS PER DAY		
UNIT	H/DIBMM	MMBTU/H	H/N18MW	MMBTUM	MMBTU/H	MMBTU/H	MMBTU/H	MMBTUM	MMBTU/H	MMBTU/H	MMBTU/H	MMBTU/H		LB/MMBTU	LEMMABTU
THRUPUT	249	249	249	249	600	BDO	600	600	557	557	557	257		212	212
FUEL	NO. 6 FUEL OIL	NO. 6 FUEL OIL	NO. 6 FUEL OIL	NO. 6 PUEL OIL	WCODWAST E	WQOOWAST	WOCDWAST	WOODWAST E	NO. 6 FUEL Ol	NO. 6 FUEL OIL	NO. 6 FUEL OIL	NO. 6 FUEL OIL		NO.6 FUEL	NO.6 FUEL
PROCESS NAME	BOILER, POWER, OIL-FIRED	BOILER, POWER, OIL-FIRED	BOILER, POWER, OIL-FIRED	BOILER, POWER, OIL-FIRED	BOILER, POWER, WOODWASYE- FIRED	BOILER, POWER, WOODWASTE- FIRED	BOILER, POWER, WOODWASTE- FIRED	BOILER, POWER, WOODWASTE- FIRED	RECOVERY BOILER	RECOVERY BOILER	RECOVERY BOILER	RECOVERY BOILER	SMELT TANKS	LIME KILN	LIME KILN
DESCRIPTION							MODIFICATION FOR INSTALLATION OF NEW EQUIPMENT TO	NGREASE PRODUCTION CAPACITY.							
PERMIT DATE	6/10/2001	5/10/2001	5/10/2001	5/10/2001	5/10/2001	6/10/2001	\$/10/2001	5/10/2001	5/10/2001	5/10/2001	5/10/2001	5/10/2001	5/10/2001	5/10/2001	6/10/2001
PERMIT NO.	03138R16	03138R16	03138R16	03138R16	03138R16	03138R16	03136R16	03138R16	03138R16	03138R16	03138R16	03138R16	03138R16	<b>G3138R16</b>	03138R16
STATE	Ŋ	Ŋ	NC NC	UN N	2	NC	Ŋ	у 2	у Z	у ¥	Ŷ	NC	NC	DN N	о <mark>х</mark>
FACELITY NAME	RIEGELWOOD	MILL	REGELWOOD	RIEGELWOOD MILL	RIEGELWOOD	RIEGELWOOD	RIEGELWOOD MILL	RIEGELWOOD	RIEGELWOOD	WILL REGELWOOD	RIEGELWOOD	RIEGELWOOD	RIEGELW000 MILL	RIEGELWOOD	RIEGELWOOD
RELCID	7500-CN	NC-0092	NC-0092	NC-0092	NC-0092	NC-0092	NC-0092	NC-0092	NC-0092	NC-0092	NC-0092	NC-0092	NC-0092	NC-0092	NC-0092

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### **APPENDIX E**

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## **ESA** Documentation

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JENNIFER M. GRANHOLM GOVERNOR STATE OF MICHIGAN 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 <u>SargenL2@michigan.gov</u>.

Sincerely. vi A Sargens

Lori G. Sargent Endangered Species Specialist Wildlife Division

NATURAL RESOURCES COMMISSION Keith J. Charters, Chair • Mary Brown • Darneil Earley • Bob Garner • Gerald Hall • John Madigan • Frank Wheatlake STEVENS T. MASON BUILDING • P.O. BOX 30028 • LANSING, MICHIGAN 48909-7528

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



IN REPLY REFER TO:

### 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

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. Czamecki Field Supervisor

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

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



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## **APPENDIX** F

**Cooling Tower Modeling Output** 

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******	*******			******		*****	******	******	*****	*****	******	*****	******	*****	***
******	*******	*****	******	*											
EPRI 3	PLUME AN	ID DRI	LFT AN	ALYSIS	SYSTE	M PREE	ROCESS	OR CODE	, PRE	-RELE	ASE VER	SION 0.	9-01-90	}	
CASE S	STUDY: N	orthe	ərn Mi	chigan	Univer	rsity	- MARQ	UETTE -	- COOL	ING TO	WER AN	ALYSIS	(NTH)		
															e de alta da
*******	*******	******	******	******	******	*****	*****	******	******	****	******	*****	*****		***
*******	*******	*****		*											
TNPIT	TNFORM	TON													
SURFAC	CE TAPE	TYPE :	:		CD144										
TOWER	TYPE:			LINEA	R MECHI	ANICAI	DRAFT								
TOWER	HEIGHT	(M):			12.50										
TOWER	HEAT (1	SR (141) CW()+		71	47.00										
TOWER	AIR FLO	W (KG	3/5):		579.50										
SITE 1	LATITUDE	3 :			46.60										
SITE 1	LONGITUI	DE 1			87.40										
SITE !	CIME ZON	₹E:÷		<u>E</u> 2	Astern										
ROUGH	vess hei	GHT (	(CM) :		0.07										
REFERI	ENCE HEI	(GHT (	(M) :		10.00										
פרטפו	רמיסטיים	INC SH	արաներ։		8750										
RECORI	D SKIPPI	ING FA	ACTOR :		1										
HOURL	recori	) PRIN	T LOG		NOT SI	ELECTR	D								
BI-DA	ILY MIXI	ING HE	EIGHT	TAPE :	SELEC.	FED									
MIXING	G HEIGHT	r typi	3 x		RURAL										
FOGGII	G/ICING	G OPTI	ION:		SELEC:	red									
DRIFT	OPTIONS				SELEC.	red									
MONTH	LY CLEAD	ness	INDEX	1											
.TAN	FTE	RAM	APR	MAV	אדד	. 1111.	AUG	SEP	oct	NOV	DEC				
	2 1115	1.11.11.1			0.011	004		<b>W</b> -10.1							
.460						~									
	.490	.520	.490	.530	.550	.560	.550	.530	.500	.420	.420				
	.490	.520	.490	.530	.550	.560	.550	.530	.500	.420	. 420				
	.490	.520	.490	.530	.550	.560	.550	.530	.500	.420	 . 420				
TOTAL	.490 .	520 SOLAR	.490 ENERG	.530 Y DEPO:	.550 BITION	.560	.550	.530	.500	.420	.420				
TOTAL (Le	.490 DAILY S	520 SOLAR	.490 ENERG	.530 Y DEPOS	.550 BITION (H)	.560	.550	.530	.500	.420	.420	-			
TOTAL (Le	.490 . DAILY S	520 SOLAR A AVE	.490 ENERG RAGE F	.530 Y DEPOS	.550 SITION (H)	.560	.550	.530	.500	.420	.420				
TOTAL Ld JAN	.490 . DAILY S ONG-TERN FEB	 520 SOLAR 4 AVEI	.490 ENERG RAGE F	.530 Y DEPOS OR MON APR	.550 3ITION (H) MA:	.560 ¥	.550 JUN	.530 JUL	.500	.420	.420 SEP	OCT	NOV	,	DEC
TOTAL (L( JAN	.490 . DAILY S DNG-TERN FEB	520 SOLAR 4 AVE	.490 ENERG RAGE F	.530 EY DEPOS OR MON APR	.550 SITION (H) MA:	.560 Y	.550 JUN	.530 JUL	. 500 AU	.420	.420 SEP	OCT	NOV	<b>,</b>	DEC
TOTAL (L( JAN  5.74	.490 . DAILY S DNG-TERN FEB	.520 SOLAR 4 AVEH 	.490 ENERG RAGE F  IAR 	.530 EY DEPOS OR MON APR 15.08	.550 SITION (H) MA: 20.4	.560 Y 47 2	.550 JUN 22.69	.530 JUL  22.52	.500 AU(	.420 .34	.420 SEP 	OCT  10.05	NOV  5.8	2	DEC
TOTAL (L( JAN  5.74 4.60	.490 DAILY S DNG-TERN FEB	.520 SOLAR 4 AVE 	.490 ENERG RAGE F MAR	.530 EY DEPOS OR MON APR 15.08	.550 SITION (TH) MA: 20.4	.560 Y 47 2	.550 JUN 2.69	.530 JUL 22.52	.500 AU(	.420 3 34 1	.420 SEP	OCT  10.05	NOV  5.8	22	DEC
TOTAL (LC JAN  5.74 4.60	.490 DAILY S DNG-TERN FEB  8.75	.520 SOLAR 4 AVE 	.490 ENERG RAGE F  4AR 	.530 EY DEPOS OR MON APR 16.08	.550 SITION (H) MAX 	.560 Y 47 2	JUN 22.69	JUL 22.52	.500 AU( 19.	.420 3 34 1 FREQU	.420 SEP  L4.78 JENCY	OCT  10.05	NOV  5.8	22	DEC
TOTAL (L( JAN  5.74 4.60 1 TABLE**	.490 DAILY S DNG-TERN FEB  8.79	.520 SOLAR 4 AVER 	.490 ENERG RAGE F  4AR  3.10	.530 EY DEPOS OR MON APR 15.08	.550 SITION (H) 	.560 Y 47 2	JUN 22.69	JUL  22.52 **WIND	.500 AU( 19. SPEED	.420 3 34 1 FREQU	.420 SEP  L4.78 JENCY	OCT  10.05	NOV  5.8 (NTH)	22	DEC
TOTAL (L( JAN  5.74 4.60 1 TABLE***	.490 DAILY S DNG-TERN FEB  8.79	.520 SOLAR 4 AVER 	.490 ENERG RAGE F  AR  3.10	.530 EY DEPOS FOR MON APR 16.08	.550 SITION (H)  20.4 Unive	.560 Y - 47 2 ******	JUN 22.69	JUL  22.52 **WIND UETTE -	.500 AU( 19. SPEED - COOL	 .420 3	.420 SEP  L4.78 JENCY DWER AN	OCT 10.05	NOV  5.8 (NTH)	22	DEC
TOTAL (L0  JAN  5.74 4.60 1 TABLE*** WIND FROM***	.490 DAILY S DNG-TERN FEB  8.79		.490 ENERG RAGE F  4AR  3.10 ****** ******	.530 EY DEPOS FOR MON APR 16.08	.550 SITION (H)  20.4	.560 Y - 47 2 ******	JUN 22.69	JUL 22.52 **WIND UETTE - ******	.500 AU4 19. SPBED - COOL	 .420 3	.420 SEP  L4.78 JENCY OWER AN	OCT  10.05 ALYSIS	NOV  5.8 (NTH)	2	DEC
TOTAL (L0 JAN 5.74 4.60 1 TABLE*** WIND FROM*** SPEEL	.490 DAILY S DNG-TERN FEB  8.79	.520 SOLAR 4 AVER 	.490 ENERG RAGE F 	.530 EY DEPOS OR MON APR 16.08 	.550 BITION (H)  20.4 Unive:	.560 Y - 47 2 ****** rsity ******	JUN 22.69 	JUL 22.52 **WIND UETTE - *******	.500 AU 19. SPBED - COOL	 .420 34 1 FREQU ING TO IND S	.420 SEP  L4.78 JENCY OWER AN	OCT 10.05 ALYSIS	NOV  5.8 (NTH) WSW	2 2 W	DEC
TOTAL (LC JAN  5.74 4.60 1 TABLE** WIND FROM*** SPEEN WNW NT	.490 DAILY S DNG-TERN FEB  8.79 ********	 .520 SOLAR 4 AVER 	.490 ENERG RAGE F 	.530 SY DEPO: OR MON APR 16.08 	.550 3ITION (H) 	.560 Y - 47 2 ****** rsity *****	JUN 22.69 ****** - MARQ ******	JUL 22.52 **WIND UETTE SE	.500 AUG 19. SPEED - COOL SSE	.420 34 3 FREQU ING TO IND	.420 SEP  L4.78 JENCY DWER AN SSW	OCT 10.05 ALYSIS SW	NOV  5.8 (NTH) WSW	52 W	DEC
TOTAL (LC JAN  5.74 4.60 1 TABLE*** WIND FROM*** SPEEN WNW NT RANGE	.490 DAILY S DNG-TERN FEB  8.79 ********* N N N N N N N N N N N N N N	 .520 SOLAR 4 AVE  9 13  9 13 	.490 ENERG AGE F 	.530 SY DEPO: OR MON APR 16.08 	.550 3ITION (H) 	.560 Y - 47 2 ****** csity ***** E	JUN 22.69 	JUL 22.52 **WIND UETTE - ********	.500 AU 19. SPEED - COOL *****WI	.420 .420	.420 SEP  L4.78 JENCY DWER AN SSW	OCT 10.05 ALYSIS SW	NOV  5.8 (NTH) WSW	х 22 W	DEC
TOTAL (L( JAN  5.74 4.60 1 TABLE*** WIND FROM*** SPEEI WNW M RANGI HEADED*	.490 DAILY S DNG-TERN FEB  8.79 ************************************	 .520 SOLAR 4 AVE  9 13 	.490 ENERG RAGE F 	.530 SY DEPO: OR MON APR 15.08 	.550 SITION TH) 	.560 Y - 47 2 ****** ****** E ******	JUN 22.69 	JUL 22.52 **WIND UETTE - ******** SE *******	.500 AU 19. SPEED - COOL SSE	.420 .420	.420 SEP  L4.78 JENCY DWER AN SSW	OCT 10.05 ALYSIS SW	NOV  5.8 (NTH) WSW	w	DEC
TOTAL (L( JAN  5.74 4.60 1 TABLE*** WIND FROM*** SPEEI WNW M RANGI HEADED** (M/S)	.490 DAILY S DNG-TERN FEB 8.79 8.79 	.520 SOLAR 4 AVE 	.490 ENERG RAGE F 	.530 SY DEPO: OR MON APR 15.08 	.550 3ITION (H) 	.560 Y - 47 2 ****** ***** E ****** E ****** W	.550 JUN 2.69 - MARQ ***** ESE ******	JUL 22.52 **WIND UETTE - ******** SE ********	.500 AUG 19. SPEED - COOL SSE SSE *****WII NNW	.420 .420	.420 SEP  L4.78 JENCY DWER AN SSW NNE	OCT 10.05 ALYSIS SW NE	NOV 5.8 (NTH) WSW ENE	32 ₩ E	DEC
TOTAL (L( JAN  5.74 4.60 1 TABLE*** WIND FROM*** SPEEI WNW M RANGI HEADED* (M/S) ESE SI	.490 DAILY S DNG-TERN FEB 8.79 8.79 8.79 8.79 8 8.79 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	SOLAR 4 AVE 4 AVE 13 13 13 14 14 14 14 14 14 14 14 14 14 14 14 14	.490 ENERG RAGE F 	.530 SY DEPO: OR MON APR 15.08 	.550 3ITION (H) 	.560 Y -7 2 ****** ***** ***** E ****** E ****** W	.550 JUN 2.69 	JUL 22.52 **WIND UETTE - ******* SE ********	.500 AU 19. SPEED - COOL SSE *****WI NNW	.420 .420	.420 SEP L4.78 JENCY OWER AN SSW NNE	OCT 10.05 ALYSIS SW NE	NOV 5.8 (NTH) WSW ENE	у 32 W Е	DEC
TOTAL (L( JAN  5.74 4.60 1 TABLE*** WIND FROM*** SPEEI WNW NG RANGI HEADED* (M/S) ESE SI	.490 DAILY S DNG-TERN FEB 8.75 8.75 8.75 8.75 9 ***********************************		.490 ENERG RAGE F  3.10 ****** ****** NNE ****** SSW M 0.000	.530 Y DEPO: OR MON APR 15.08 	.550 SITION (H) 	.560 Y 47 2 ****** ****** E ****** E ****** W 0.000	JUN 22.69 - MARQ ****** ESE ****** WNW	JUL 22.52 **WIND UETTE - ******* SE ******** NW 0.000	.500 AU 19. SPEED - COOL SSE ****WI NNW 0.000	.420 .420 	.420 SEP L4.78 JENCY DWER AN SSW NME	OCT 10.05 ALYSIS SW NE 0.000	NOV 5.8 (NTH) WSW ENE 0.000	v 22 W E 0.000	DEC

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> 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

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2	TO 3	0.0	17 0.009	0.011	0.007	0.009	0.004	0.007	0.010	0.022	0.017	0.012	0.015	0.022
3	0.009 TO 4	0.010	16 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	0.0	14 0.019	0.015	0.005	0.002	0.002	0.007	0.010	0.031	0.016	0.013	0.008	0.011
5	то 6	0.0	12 0.012	0.010	0.002	0.001	0.001	0.006	0.008	0.030	0.016	0.007	0.007	0.006
0.005	0.007	0.008	0.139						a=		0 007		0 000	
0.004	0.006	0.005	0.083	0.004	0.001	0.000	0.001	0.002	0.005	0.017	0.007	0.004	0.003	0.004
7	то 8	0.0	08 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 TO 9	0.002	0.056	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	*****		01000	0.000							
9 0 000	TO 10	0.0	06 0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.003	0.001	0.001	0.001
10	TO 11	0.0	05 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	0 000	0.000							0 000	0 001	0.000
0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
12	TO 13	0.0	01 0.001	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	0.0	00 0.000	0.000	0.000	0.000	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		~ ~~~				a		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	0.000	0.000	0.000	0.000
15	то 20	0.0	00 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	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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 D.000	0.000	0.000	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 OVE	R 0.0	00 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 ******* ******* AGE	0.000 ***** ***** 4.476	0.000 ******** ******** 99 V	****** ****** Arianci	******* ***** 5 4.5	****** 52228	***** STI	******* D DEV	2.12	******	*****	*****	*****	******
0.000 ****** ***** AVERA STD 1	0.000 ******* ******* AGE SRR	0.000 ***** ***** 4.476 0.024	0.000 ********* 99 V 59 S	****** ****** ARIANCI KEWNES:	****** ***** 5 1.3	52228 31718	sti Kui	******* D DEV RTOSIS	2.12	******* 2657 1213	****	*****	****	*****
0.000 ****** ***** AVERA STD 1	0.000 ******* ******* AGE SRR *******	0.000 ***** 4.476 0.024 *****	0.000 ********* ******** 99 V 59 S ********	****** ****** ARIANCE KEWNESS	***** ***** 3 1.3	****** 52228 31718	STI KUI	******* D DEV RTOSIS	2.12 2.01	****** 2657 1213 ******	*****	******	*****	******
0.000 ****** AVERA STD 1 *****	0.000 ******* AGE SRR *******	0.000 ***** 4.476 0.024 *****	0.000 ********* 99 V 59 S ********	****** ARIANCI KEWNES: ******	***** E 4.5 3 1.3 *****	52228 31718	STI KU	******* D DEV RTOSIS	2.12 2.01	******	****	******	*****	*****
0.000 ****** AVER/ STD I ****** 1 TABLE	0.000 ******* AGE SRR *******	0.000 ***** 4.476 0.024 ***** *****	0.000 ********* 99 V. 59 S. ********* ********	****** ARIANCI KEWNES ****** ******	• • • • • • • • • • • • • • • • • • •	52228 31718 *******	STI KUI *****	***** D DEV RTOSIS ****** BLATIVE	2.12 2.01	****** 2657 1213 ****** DITY FF	********* ****************************	****** *******	*****	****
0.000	0.000	0.000 ***** 4.476 0.024 ***** ***** **** ****	0.000 ********* 99 V 59 S ********* ******** ********* thern Mi	******* ARIANCI KEWNESS ******* ******* chigan	2 4.5 3 1.3	52228 31718	STI KUI ******RI	******** D DEV RTOSIS ******* LATIVE JETTE -	2.12 2.01	2657 1213 ******* DITY FF	******* ******* REQUENC	******* ******* 2¥ MYSIS		****
0.000 ****** AVERI STD I ****** 1 TABLE FROM**	0.000	0.000 ***** 4.476 0.024 ***** **** Nor ****	0.000 ********* 99 V. 59 S. ********* **************************	******* ARIANCI KEWNESS ******* ******* chigan ******	2 4.5 3 1.3	52228 31718	STI KUI *****RI - MARQI	******* D DEV RTOSIS ******* LATIVE JETTE -	2.12 2.03 - HUMII - COOL3	******** 2657 1213 ******* DITY FI ING TOP	····· Requenc		(NTH)	*****
0.000 ****** AVERI STD 1 ****** 1 TABLB* REI FROM** HUR	0.000 *********************************	0.000 ***** 4.476 0.024 ***** ***** Nor ***** ****	0.000 ********* 99 V. 59 S: ********* **************************	******* ARIANCI KEWNESS ******* ******* chigan ******* ****** NE	E 4.5 3 1.3 	52228 31718 ******* csity - E	STI KUI *****RI - MARQI *****	**************************************	2.12 2.01 ******* E HOMII - COOL3 *****W] SSE	******* 2657 1213 ******** DITY FF ING TOP IND S		******* :Y LYSIS SW	 	********
0.000 ****** AVERJ STD I ****** 1 TABLE FROM** HUN WNW	0.000 *********************************	0.000 ***** 4.476 0.024 ***** *** Nor *** *** Nor *** *** Nor *** *** Nor ***** ****	0.000 *********************************	******* ARIANCI KEWNESS ***********************************	E 4.5 3 1.3 ***** Univer ENE	52228 31718 	STI KUI - MARQI ESE	D DEV RTOSIS ******* SLATIVE JETTE - *******	2.12 2.03 - HUMII - COOL3 - SSE	******* 1213 ******** DITY FI ING TOP IND S	REQUENC		(NTH) WSW	******** *********
0.000 ****** AVERJ STD I ****** 1 TABLE TABLE FROM** HUN WNW RAN HEADEI	0.000 ******* AGE SRR ******* ******* ******* LATIVE ******* UDITY NW VGE (%) 0*****	0.000 ***** 4.476 0.024 ***** ***** Nor *** **** Nor *** **** NNW ***	0.000 *********************************	**************************************	2 4.5 3 1.3 4.4.4.4 4.4.4 4.4.4 4.4.4 4.4.4 4.4.4 4.4.4 4.4.4 4.4.4 4.4.4 4.5 4.5	52228 31718	STI KUI - MARQI ESE	**************************************	2.12 2.01 ******* * HUMII - COOLJ *****W] SSE	2657 1213 ******* DITY FF ING TOP IND S D	SSW		(NTH) WSW	********
0.000 ****** AVERJ STD I ****** 1 TABLE FROM** HUT WIW RAN HEADEI ESE	0.000	0.000 ****** 4.476 0.024 ****** Nor **** Nor *** NN NN *** SSE	0.000 *********************************	**************************************	E 4.5 3 1.3 	52228 31718 	STI KUI - MARQI ESE	**************************************	2.12 2.03 ****** * HOMII - COOL3 *****WIN SSE	******** 1213 ******** DITY FI ING TOP IND S ID N	SSW	******* SY ALYSIS SW NE	.****** (NTH) WSW ENE	********* ********* W E
0.000 ****** AVERJ STD 1 ****** 1 TABLE TABLE FROM** HUN WINW RAN HEADEI ESE	0.000 *********************************	0.000 ***** 4.476 0.024 ***** ***** Nor **** **** NNW *** **** SSE	0.000 *********************************	**************************************	E 4.5 3 1.3 5 1.3 Univer ENE WSW	52228 31718 ******** csity - E *******	STI KUI - MARQI ESE - WAW	**************************************	2.12 2.01 4.4.4.4.4 5.4.0011 4.4.4.4.4 5.5.5.5 5.5.5.5 5.5.5	2657 1213 ******** DITY FF ING TOP IND S D N	SSW	SW NE	(NTH) WSW ENE	********* ********* W E
0.000 ****** AVER/ STD I ****** 1 TABLE FROM** HUT WIW RAN HEADEI ESE 0 0.000	0.000 *********************************	0.000 ***** 4.476 0.024 ***** ***** NOT ***** NNW **** SSE 0.0 0.000	0.000 *********************************	**************************************	E 4.5 3 1.3 Univen ENE WSW 0.000	52228 31718 	STI KUI - MARQI - MARQI ESE - WNW 0.000	**************************************	2.12 2.03 ****** *****************************	2657 1213 ******** DITY FI ING TOP IND S D N 0.000	A CONTRACTOR OF CONTRACTOR AND CONTRACTOR AND CONTRACTOR AND CONTRACTOR AND CONTRACTOR C			********* ********* W E C.000
0.000 ****** AVERJ STD I ****** 1 TABLE FROM** HUT WIW RAI HEADEI ESE 0 0.000 10	0.000 *********************************	0.000 ***** 4.476 0.024 ***** ***** Nor ***** NOT ***** NOT ***** SSE 0.00 0.000 0.000	0.000 *********************************	**************************************	E 4.5 3 1.3 Univer ENE WSW 0.000 0.000	52228 31718 ******** E ******* W 0.000 0.000	STT KUI - MARQI - MARQI - SE - MARQI -	D DEV RTOSIS ******** SE ******** * SE ******* NW 0.000 0.001	2.12 2.01 ****** E HUMII - COOL3 *****WI SSE ****WIN NNW 0.000 0.000	2657 1213 ******** DITY FI ING TOP ING TOP ING S S ID N 0.000 0.000			(NTH) WSW ENE 0.000 0.000	********** ********** W E C.000 0.000
0.000 ****** AVERJ STD 1 ****** 1 TABLE TABLE FROM*' HUN WNW RAN HEADEI ESE 0.000 10 0.000 20	0.000 *********************************	0.000 ***** ***** 4.476 0.024 ***** ***** Nor **** Nor **** NNW *** SSE 0.00 0.00 0.000 0.000 0.000 0.000	0.000 *********************************	**************************************	E 4.5 3 1.3 5 1.5 5 1.5	52228 31718 ****** csity - E ****** W 0.000 0.000 0.000	STI KUI - MARQI ESE - WAW 0.000 0.000	**************************************	2.12 2.01 ******* ****************************	2657 1213 ******* DITY FI ING TOP ING TOP IND S D N 0.000 0.001 0.003			(NTH) WSW ENE 0.000 0.000	W E 0.000 0.000 0.001
0.000 ****** AVERI STD I ****** 1 TABLE FROM** FROM** HEADEI ESE 0.000 10 0.000 20 0.000	0.000 *********************************	0.000 ***** 4.476 0.024 ***** ***** NOT ***** NOT **** NOT **** NOT **** ****	0.000 ******** 99 V. 59 S. ************************************	**************************************	E 4.5 3 1.3 Univer ENE WSW 0.000 0.000 0.000	52228 31718 ***********************************	STI KUI - MARQI - MARQ	**************************************	2.12 2.03 ******* 5 HUMII - COOLJ *****WI SSE ****WIN NNW 0.000 0.000 0.000	2657 1213 ******** DITY FI ING TOP IND S ID N 0.000 0.000 0.001 0.003			(NTH) WSW ENE 0.000 0.001	********** W E 0.000 0.000 0.001
0.000 ****** AVERJ STD 1 ****** 1 TABLE TABLE FROM*' HUN WNW RAN HEADEI ESE 0 0.000 10 0.000 20 0.000 30 0.003	0.000 *********************************	0.000 ***** ***** 4.476 0.024 ***** ***** Nor ***** Nor **** NN NNW *** SSE 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	0.000 ******** 99 V. 59 S. ******** ******** thern Mi. ******** NINE ******** SSW SUM 00 0.000	**************************************	E 4.5 3 1.3 4.4.4.4 5.4.4.4 Univer ENTE WSW 0.000 0.000 0.000 0.000 0.000	52228 31718 	STI KUI - MARQI - MARQ	**************************************	2.12 2.01 4.4.4.4.4 5.4.4.4.4 5.55 5.55 5.55 5.5	2657 1213 ******* DITY FR ING TOP IND S ID N 0.000 0.001 0.003 0.007			(NTH) WSW ENE 0.000 0.000 0.001 0.004	W E C.000 O.000 O.001 O.004
0.000 *********************************	0.000 *********************************	0.000 ***** ***** 4.476 0.024 ***** ***** NOT ***** NNT ***** NNT ***** SSE 0.0 0.000 0.000 0.000 0.000 0.001 0.001	0.000 *********************************	**************************************	E 4.5 3 1.3 Univer ENE WSW 0.000 0.000 0.000 0.000 0.002 0.002	52228 51718	STI KUI - MARQI - MARQI - SE - MARQI -	D DEV RTOSIS ******** SE ******** NW 0.000 0.001 0.002 0.004 0.002	2.12 2.01 ****** E HOMII - COOL3 *****WIN SSE ****WIN NNW 0.000 0.000 0.000 0.003 0.005 0.005	2657 1213 ******* DITY FF ENG TOP ENG TOP END S 10 N 0.000 0.001 0.003 0.007 0.013	NNE 0.000 0.001 0.004 0.007		(NTH) WSW ENE 0.000 0.001 0.001 0.004 0.004	********** ********** W E 0.000 0.000 0.001 0.001 0.004 0.005
0.000 ****** AVERJ STD I ****** 1 TABLE FROM** HUN WIN WIN RAN HEADEI ESE 0 0.000 10 0.000 20 0.000 30 0.003 40 0.003 50	0.000 *********************************	0.000 ***** ***** 4.476 0.024 ***** ***** NOT ***** NOT ***** NNNW ***** SSE 0.0 0.000 0.0 0.000 0.000 0.000 0.001 0.00 0.001 0.00 0.001 0.00 0.001 0.00 0.001 0.00 0.001 0.00 0.001 0.00 0.001 0.00 0.001 0.00 0.000 0.00 0.000 0.00 0.000 0.00	0.000 ******** 99 V. 59 S. ************************************	**************************************	E 4.5 3 1.3 Univer EME WSW 0.000 0.000 0.000 0.000 0.000 0.000 0.000	52228 51718 52228 51718 55119 55119 5 55119 5 55119 5 5 5 5 5 5 5 5 5 5 5 5 5	STT KUI - MARQI - MARQ	D DEV RTOSIS ***********************************	2.12 2.01 4.4.4.4.4 5 HUMII - COOLJ 5.55 5.55 5.55 5.55 5.55 5.55 5.000 0.000 0.000 0.005 0.005 0.005	2657 1213 ******* DITY FI ING TOP ING TOP ING TOP ING 0.000 0.000 0.001 0.003 0.007 0.013 0.020	NNE 0.000 0.001 0.004 0.011		(NTH) WSW ENE 0.000 0.000 0.001 0.004 0.004 0.005	W E 0.000 0.000 0.001 0.004 0.005 0.008

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prep 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 TO 90 0.029 0.014 0.009 0.005 0.006 0.003 0.005 0.009 0.026 0.020 0.016 0.010 0.022 80 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 Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH) TEMP N NNE NE ENE Е ESE SE SSE S SSW SW WSW W WNW NW NINW SSW NNE NE ENE Е S SM WSW WNW NW NNW W N 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 -20 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 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 -5 TO 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 0.005 0.005 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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1		*****	*****	*****	*****	*****	*****	STABIL	ITY CL	ASS FR	EQUENC	Y		
TABLE	*****	******	*****	*****	*****	***								
		North	ern Mi	chigan	Unive	rsity	- MARQ	UETTE	- COOL	ING TO	wer an	ALYSIS	(NTH)	
ST FROM*	******	¥ *******	******	******	******	******	*****	******	******	IND				
CL	ASS	N	NNE	NE	ENE		RSE	SE	বর্তন্থ	q	ଟ୍ଟା	SU	wew	W
WNW	NW	NNW				-		55	992		0011	51	100	
		*****	*****	*****	*****	*****	*****	*****	****WI	ND				
HEADE	D****	****	*****	*****	*****	*****	*****	**						
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ESE	SE	sse st	DΜ											
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	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
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0 005	5	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
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01,000	5	0.015	a.ao7	0.007	0.005	0.006	0 004	0.006	0.011	0.035	0.019	0.012	0.009	0.014
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	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
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AVER	AGE	4.25201	V.	ARIANCI	G 0.:	99227	S41	n nrv	0.9	0617				
Series 1		A 644 - A								3023				
310	ERR	0.01152	S	KEWNESS	5 1.	07871	KU	RTOSIS	1.2	1936				
*****	ERR ******	0.01152	S	KEWNES:	5 1.	07871	KU	RTOSIS	1.2	1936	******	*****	******	******
*****	ERR ******	0.01152	S *****	KEWNES: ******	5 1. *****	07871 ******	KU	RTOSIS *****	1.2	1936 *****	* * * * * *	****	*****	****
*****	ERR ******: ******	0.01152 ********** ************************	S ****** ******	KEWNES: ****** *****	5 1. ***** *****	07871 ******	KU:	TOSIS	1.2 ******	1936 ******	* * * * * *	*****	****	****
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***** ***** 1 TABLE FROM*	ERR ****** ******* ******* K ******	0.01152	S ****** ****** ****** ern Mi ******	KEWNES: ****** ****** ****** chigan *****	5 1. ***** ***** Unive: *****	07871 ***********************************	KU ****** **** - MARQ *****	D DAV RTOSIS ******* ******* UETTE ******	1.2 ****** *K FRE - COOL:	1936 ****** QUENCY ING TO IND	****** Ver Ani	****** \\YSIS	***** (NTH)	****
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***** ***** 1 TABLE FROM* {UA WNW	ERR ******* ******* K ****** /VE} NW	0.01152	S ****** ****** ****** ****** NNE	KEWNES: ****** ****** chigan ****** NE	5 1. ***** ***** Unive: ***** ENE	07871 ***********************************	KU ****** **** - MARQ ***** ESE	D DAV RTOSIS ******* UETTE ******* SE	1.2 ****** *K FRE - COOL: *****W: SSE	1936 ****** QUENCY ING TO IND S	ver ani SSW	****** Alysis SW	(NTH) WSW	****
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***** ***** 1 TABLE FROM* {UA WNW RA HEADE	ERR ******* ******* K ******* /VE} NW NGE D*****	0.01152 ***********************************	S ****** ****** ****** ****** NNE	KEWNES: ****** chigan ****** NE ******	5 1.	07871 ***********************************	KU ****** - MARQ ***** ESE	D DIV RTOSIS ****** UETTE ****** SE ******	1.2. ******* *K FRE - COOL: *****W: SSE	1936 ****** QUENCY ING TO IND S	ver and SSW	******* Alysis SW	(NTH) WSW	**** W
***** ***** 1 TABLE FROM* (UA WNW RA HEADE	ERR ******* ******* K ******* /VE } NW NGE D*****	0.01152 ***********************************	SSW	KEWNES: ****** chigan ****** NE ****** NE ****** SW	5 1.	07871 ***********************************	KU ****** - MARQ ***** ESE ***** WINW	D DIV RTOSIS ****** UETTE ****** SE ****** ** NW	1.2. ******** *K FRE - COOL: *****W: SSE ****WIJ NNW	1936 ****** QUENCY ING TO IND S ND N	VER ANI SSW NNE	******* Alysis SW NE	(NTH) WSW ENE	**** W E
***** ***** 1 TABLE FROM* {UA WNW RA: HEADE ESE	ERR ******* ******* K ******* /VE) NW NGE D***** SE	0.01152 ***********************************	SW NNE SSW	KEWNES: ****** chigan ****** NE ****** NE ****** SW	5 1.	07871 ***********************************	KU ***** - MARQ ***** ESE ***** WNW	D DIV RTOSIS ****** UETTE ****** SE ******* ** NW	1.2. ******* *K FRE - COOL: *****W: SSE *****WII NNW	1936 ****** QUENCY ING TO IND S ND N	ver and SSW NNE	Alysis SW NE	(NTH) WSW ENE	**** W E
***** ***** 1 TABLE FROM* (UA WNW RA HEADE ESE 0.0	ERR ******** ******** K ******* VE) NW NGE D****** SE	0.01152	S ****** ****** ****** ****** NNE ****** SSW M	KEWNES: ****** chigan ****** NE ****** SW	5 1.	07871 ***********************************	KU ****** - MARQ ***** ESE ****** WIW	P DEV RTOSIS ******* UETTE ******* * SE ******* ** NW	1.2. ******** *K FRE - COOL: *****W: SSE ****WIJ NNW	1936 ****** QUENCY ING TO IND S ND N	VER ANI SSW NNE	ALYSIS SW NE	(NTH) WSW ENE	**** W E
***** ***** 1 TABLE FROM* (UA WNW RA: HEADE ESE 0.0 0.000	ERR ***********************************	0.01152	S ****** ****************************	KEWNES: ****** chigan ****** NE ****** SW 0.000	5 1.	07871 ***********************************	KU ****** - MARQ ***** ESE ****** WNW 0.000	D.000	1.2. ******** *K FRE - COOL: *****W: SSE *****WII NNW 0.000	1936 ******* QUENCY ING TO IND S ND N 0.000	******* VER ANJ SSW NNE 0.000	******* ALYSIS SW NE 0.000	(NTH) WSW ENE 0.000	********* W E 0.000
***** ***** 1 TABLE FROM* (UA WNW RA: HEADE ESE 0.0 0.000 0.1	ERR ***********************************	0.01152 ***********************************	SW 0.000 0.000	KEWNES:	5 1.	07871 ***********************************	KU ****** - MARQ ***** ESE ****** WNW 0.000	D.000	1.2. ******* *K FRE - COOL: *****W: SSE *****WIJ NNW 0.000	1936 ******* QUENCY ING TO IND S ND N 0.000	WER ANJ SSW NNE 0.000	******* ALYSIS SW NE 0.000	(NTH) WSW ENE 0.000	********* W E 0.000
***** TABLE FROM* (UA WNW RA: HEADE ESE 0.0 0.000 0.1 0.000	ERR ***********************************	0.01152 ***********************************	S ****** ****** ****** ****** NNE ****** SSW 0.000 0.000 0.000	KEWNES: ************************************	5 1.	07871 ***********************************	KU ****** - MARQ ***** ESE ****** WNW 0.000 0.000	D.000	1.2 ******* *K FRE - COOL: *****W SSE *****WIJ NNW 0.000 0.000	1936 ****** QUENCY ING TO IND S ND N 0.000 0.000	******* VER ANJ SSW NNE 0.000 0.000	******* ALYSIS SW NE 0.000 0.000	(NTH) WSW ENE 0.000 0.000	******** W E 0.000 0.000
***** TABLE FROM* (UA WNW RA: HEADE ESE 0.0 0.000 0.1 0.000 0.2	ERR ***********************************	0.01152 ***********************************	S ****** ****** ****** ****** NNE ****** SSW 0.000 000 0.000 000 0.000	KEWNES: ************************************	5 1.	07871 ***********************************	KU ****** - MARQ ***** ESE ****** WNW 0.000 0.000 0.000	D.000 0.000	1.2 ******** *K FRE - COOL: *****W: SSE *****WIJ NNW 0.000 0.000 0.000	1936 ****** QUENCY ING TO IND S ND N 0.000 0.000	******* VER ANJ SSW NNE 0.000 0.000	******* ALYSIS SW NE 0.000 0.000	(NTH) WSW ENE 0.000 0.000	********* W E 0.000 0.000
***** TABLE FROM* {UA WNW RA: HEADE ESE 0.0 0.000 0.1 0.000 0.2 0.000	ERR ***********************************	0.01152 ***********************************	SSW 0.000 0.000 0.000 0.000 0.000 0.000	<pre>kewnes: ************************************</pre>	5 1. Unive: ENE WSW 0.000 0.000 0.000	07871 ***********************************	KU ****** - MARQ ***** ESE ****** WIW 0.000 0.000 0.000	D DEV RTOSIS ******* UETTE ******* * SE ******* NW D.000 0.000 0.000	1.2 ******** *K FRE - COOL: *****WI SSE *****WI NAW 0.000 0.000 0.000	1936 ****** QUENCY ING TO IND S ND N 0.000 0.000 0.000	VER ANJ SSW NNE 0.000 0.000 0.000	ALYSIS SW NE 0.000 0.000 0.000	(NTH) WSW ENE 0.000 0.000 0.000	********* W E 0.000 0.000 0.000
***** TABLE FROM* {UA WNW RA: HEADE ESE 0.0 0.000 0.1 0.000 0.2 0.000 0.3	ERR ***********************************	0.01152 ************************************	S S S S S S S S S S S S S S	<pre>kewnes: ************************************</pre>	5 1.	07871 ***********************************	KU ****** - MARQ ***** ESE ****** WIW 0.000 0.000 0.000 0.000	D DDV RTOSIS ******* UETTE ******* * SE ******* NW D.000 0.000 0.000 0.000	1.2 ******** *K FRE - COOL: *****WI SSE *****WI NAW 0.000 0.000 0.000 0.000	1936 ****** QUENCY ING TO IND S ND N 0.000 0.000 0.000	VER ANJ SSW NNE 0.000 0.000 0.000 0.000	ALYSIS SW NE 0.000 0.000 0.000 0.000	(NTH) WSW ENE 0.000 0.000 0.000 0.000	W E 0.000 0.000 0.000 0.000
***** TABLE FROM* {UA WNW RA: HEADE ESE 0.0 0.000 0.1 0.000 0.2 0.000 0.3 0.000	ERR ***********************************	0.01152 ************************************	SSW 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	<pre>kewnes: ************************************</pre>	5 1. Unive: ENE WSW 0.000 0.000 0.000 0.000	07871 ***********************************	KU ****** - MARQ ***** ESE ****** WIW 0.000 0.000 0.000 0.000 0.000	D DDV RTOSIS ******* UETTE ******* * SE ******* NW D.000 0.000 0.000 0.000	1.2 ******** *K FRE - COOL: *****WII SSE *****WII NANW 0.000 0.000 0.000 0.000	1936 ****** QUENCY ING TO IND S ND 0.000 0.000 0.000 0.000	NER ANJ SSW NNE 0.000 0.000 0.000 0.000	ALYSIS SW NE 0.000 0.000 0.000 0.000	(NTH) WSW ENE 0.000 0.000 0.000 0.000	W E 0.000 0.000 0.000 0.000
***** TABLE FROM* {UA WNW RA: HEADE ESE 0.0 0.000 0.1 0.000 0.2 0.000 0.3 0.000 0.4	ERR ***********************************	0.01152 ************************************	SSW 0.000	<pre>kewnes: ************************************</pre>	5 1. Unive: ENE 0.000 0.000 0.000 0.000 0.000 0.000	07871 ***********************************	KU ****** - MARQ ***** ESE ****** WIW 0.000 0.000 0.000 0.000 0.000	D DDV RTOSIS ******* UETTE ******* * SE ******* NW D.000 0.000 0.000 0.000 0.000 0.000 0.000	1.2 ******** *K FRE - COOL: *****WI SSE *****WI NNW 0.000 0.000 0.000 0.000 0.000	1936 ****** QUENCY ING TO IND S ND 0.000 0.000 0.000 0.000 0.000	VER ANJ SSW NNE 0.000 0.000 0.000 0.000 0.000	ALYSIS SW NE 0.000 0.000 0.000 0.000 0.000	(NTH) WSW ENE 0.000 0.000 0.000 0.000 0.000	W E 0.000 0.000 0.000 0.000 0.000
***** TABLE FROM* {UA WNW RA: HEADE ESE 0.0 0.000 0.1 0.000 0.2 0.000 0.2 0.000 0.3 0.000 0.4 0.000	ERR ***********************************	0.01152 ************************************	S 	<pre>kewnes: ************************************</pre>	5 1. Unive: ENE WSW 0.000 0.000 0.000 0.000 0.000	07871 ***********************************	KU ****** - MARQ ***** ESE ****** WIW 0.000 0.000 0.000 0.000 0.000 0.000	D DDV RTOSIS ******* UETTE ******* * SE ******* NW D.000 0.000 0.000 0.000 0.000 0.000	1.2 ******** *K FRE - COOL: *****WI SSE *****WI NNW 0.000 0.000 0.000 0.000 0.000	1936 ****** QUENCY ING TO IND S ND 0.000 0.000 0.000 0.000 0.000	VER ANJ SSW NNE 0.000 0.000 0.000 0.000 0.000 0.000	ALYSIS SW NE 0.000 0.000 0.000 0.000 0.000	(NTH) WSW ENE 0.000 0.000 0.000 0.000 0.000	W E 0.000 0.000 0.000 0.000 0.000
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prep 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 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 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 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 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 \* \*\*\*\*\*\*\*\*\*\*\* AVERAGE 3.50000 VARIANCE 0.00000 STD DEV 0.00000 STD ERR 0.00000 SKEWNESS 1.00000 KURTOSIS 1.00000 \*\*\*\*\* \* 1 Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH) VSTAR N NNE NE ENE E ESE SE SSE s 9 9 W CM. WSW W WNW NW NNN RANGE HEADED\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*\*\*\* S SSN SW NSW W WIND NW NME NNW N ME. 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 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 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 3 TO 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 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 5 **TO** 0.000 0.000 0.000 0.001 5 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 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 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 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 10 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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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
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5.4	TO 5.5 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
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
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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
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 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
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7.0	D.000 0.000 0.000	0.000	0.000	0.000	9.000	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
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
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8.0 0.000	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	<b></b>
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
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 8.6	0.000 0.000 0.000 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
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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
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
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0.000	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	- 0.000 0.000 0.000 - 0.000 0.000	0.000	0.000	0.000	0.000	0.000						0 000
9.8 0.000	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
1	*********	*****	******	*****	**PLUM	e leng	TH PAF	AMETER	FREQU	ENCY		
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Page 8

prep Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH) \*\*\*\*\* PLUME FROM\*\*\*\*\* \*\*\*\*\* WSW W SSE 8 SSW SW ESE SE LENGTH N NNE NE ENE E WINW NN NNW RANGE (M) \*\*\*\*\* HEADED\*\*\* \*\*\*\* ENE Е NNW N NNE NE S SSW SW WSW w WINW NW ESE SE 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 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 0.001 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 0.001 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 0.001 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 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 0.001 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 0.001 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 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 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 0.001 15.6 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 0.001 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 D.000 0.000 0.000 0.000 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 0.001 17.2 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 17.6 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 0.001 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 0.001 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 0.001 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 0.001 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 0.003 21.0 TO 22.0 0.000 0.001 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

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25.0 TO 2	26.0 0.0	01 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 0.00	0.000	0.005							0 001	0 000	a aaa	0 000	0.000
26.0 TO 2	27.0 U.U 11 0.000	00 0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	01000
27.0 TO 2	28.0 0.0	00 0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000
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28.0 TO 2	29.0 0.0 nn 0 000	00 0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000
29.0 TO 3	30.0 0.0	01 0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000
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30.0 TO 3	31.0 0.0 00 0 000	00 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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32.0 TO 3	33.0 0.0	00 0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33.0 TO 3	34.00.000	00 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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34.0 TO 3	35.0 0.0 00 0 000	00 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 3	36.0 0.0	00 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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37.0 TO 3	38.0 0.0	00 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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40.0 TO 0	OVER 0.0	00 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 0.00	00 0.000 ******** ******** 1.558	0.000 *********************************	****** ****** ARIANCI	***** ***** E 31.	*****	***** ST	****** D DEV	****** 5.6	*****	*****	*****	*****	******
0.000 0.04	00 0.000 ******** ******** 1,558 0.065	0.000 *********************************	****** ARIANCI KEWNES	***** ***** 5 4.	****** 63983 17934	****** ST: KU	***** D DEV RTOSIS	****** 5.6 18.0	****** 2493 8287	****	*****	* * * * * * *	******
0.000 0.04	00 0.000 ******** 1.558 0.065	0 0.000 ********************************	****** ****** ARIANCI KEWNES	***** ***** E 31. S 4. *****	****** 63983 17934 ******	***** ST: KU	***** D DEV RTOSIS ******	****** 5.6 18.0	****** 2493 8287 *****	; * * * * * * * * * * * * * * * * * * *	*****	* * * * * * * *	*******
0.000 0.00 ********* AVERAGE STD ERR	00 0.000 ********* 1.558 0.065 *******	0.008	****** VARIANCI SKEWNES:	***** ***** E 31. S 4. ******	****** 63983 17934 *****	* * * * * * * * * * * * * * * * * * *	****** D DEV RTOSIS *****	****** 5.6 18.0 *****	****** 2493 8287 ******	*****	*****	* * * * * * *	*******
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0.000 0.04 ********* AVERAGE STD ERR ***********************************	00 0.000 ********* 1.558 0.065 ************************************	C.000	****** ARIANCI KEWNES ******* Chigan ****** NE ******* NE *******	***** E 31. S 4. ***** ***** Unive ***** ENE ****** WSW	****** 63983 17934 ****** ****** E ****** E ****** W	ST: KU: ***PLUM - MARQ ***** ESE ***** WNW	****** D DEV RTOSIS ****** E HEIG UETTE ******* SE ****** * NW	******* 5.6: 18.0: ****** HT PAR - COOL: *****WI SSE ****WI NNW	******* 2493 8287 ******* AMETER ING TO IND S ND N	FREQUI VER ANI SSW NNE	ency Alysis SW	* * * * * * * * * * * * * * * ( NTH) WSW ENE	********* ********** W E
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0.000 0.04 ********* AVERAGE STD ERR ***********************************	00 0.000 ********* 1.558 0.065 ************************************	0.000	ARIANCI SKEWNES: ****** chigan ****** NE ****** SW 0.055 0.000	****** 5 31. 5 4. ****** ******* Unive. ****** ENE ****** WSW 0.023 0.000	63983 17934 ****** rsity ****** E ****** W 0.02D 0.001	ST: KU: ***PLUM - MARQ ***** ESE ****** WNW 0.012 0.000	****** D DEV RTOSIS ****** E HEIG UETTE ****** SE ****** NW 0.027 0.000	5.6: 18.0: ****** HT PAR - COOL: *****WI SSE *****WI NNW 0.049 0.001	**************************************	******* FREQUI WER AM/ SSW NNE 0.091 0.000	******* ENCY ALYSIS SW NE 0.061 0.000	****** (NTH) WSW ENE 0.048 0.000	********** ********** W E 0.072 0.001
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0.000 0.04 ********* AVERAGE STD ERR ***********************************	00 0.000 ******** 1.558 0.065 ******** ***************************	0.000 	ACL 0.000	****** 5 31. 5 4. ****** ****** Unive. ****** ENE ****** WSW 0.023 0.000 0.000 0.000 0.000	63983 17934 ****** rsity ****** E ****** W 0.020 0.001 0.001 0.000 0.000	ST: KU: ST: KU: ST: KU: ST: ST: ST: ST: ST: ST: ST: ST: ST: ST	****** D DEV RTOSIS ****** E HEIG ******* SE ******* NW 0.027 0.000 0.001 0.001	5.6: 18.0: ****** HT PAR - COOL: *****WI SSE ****WI NNW 0.049 0.001 0.001 0.001	******* 2493 8287 ******* AMETER ING TOI IND S ND N 0.147 0.001 0.001 0.002	FREQUI WER AM/ SSW NINE 0.091 0.000 0.001	ENCY ALYSIS SW NE 0.061 0.000 0.000	******* (NTH) WSW ENE 0.048 0.000 0.000 0.000	W E 0.072 0.001 0.001 0.000
0.000 0.04 ********* AVERAGE STD ERR ***********************************	00 0.000 ********* 1.558 0.065 ********* **************************	0.000 0.000 1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.	ACLASSING	****** S 31. S 4. ****** ****** Unive ****** ENE ****** WSW 0.023 0.000 0.000 0.000 0.000 0.001	****** 63983 17934 ****** rsity ****** E ****** W 0.02D 0.001 0.000 0.000 0.000	ST: KU: ***PLUM - MARQ ****** ESE ****** WNW 0.012 0.000 0.000 0.000 0.000 0.000	****** D DEV RTOSIS ****** E HEIG UETTE ******* SE ******* NW 0.027 0.000 0.001 0.000 0.001	5.6: 18.0 ****** HT PAR - COOL *****WI SSE ****WI NNW 0.049 0.001 0.001 0.000 0.001	******* 2493 8287 ******* AMETER ING TOU IND S ND N 0.147 0.001 0.001 0.002 0.002	FREQUI VER AM SSW NNE 0.091 0.000 0.001 0.001 0.001	ENCY ENCY ALYSIS SW NE 0.061 0.000 0.000 0.000 0.000	****** (NTH) WSW ENE 0.048 0.000 0.000 0.000 0.000	********** ********** W E 0.072 0.001 0.001 0.001 0.000 0.000
0.000 0.04 ********* AVERAGE STD ERR ***********************************	00 0.000 ******** 1.558 0.065 ******** ******** ********* ******** ****	COOD COULT COOD COULT COOD COULT	ARIANCI KEWNES: ************************************	****** s 31. s 4. ****** Unive. ****** ENE ****** WSW 0.023 0.000 0.000 0.000 0.000 0.001 0.000	<pre>63983 17934 ****** *****************************</pre>	ST: KU: ***PLUM - MARQ ***** ESE ****** WNW 0.012 0.000 0.000 0.000 0.000 0.000	****** D DEV RTOSIS ****** E HEIG UETTE ****** SE ****** NW 0.027 0.000 0.001 0.001 0.001 0.001	******* 5.6 18.0 ****** HT PAR - COOL *****WI SSE ****WI NNW 0.049 0.001 0.001 0.000 0.001 0.000	******* 2493 8287 ****** AMETER ING TOU IND S ND N 0.147 0.001 0.001 0.002 0.002 0.002	FREQUI VER ANY SSW NNE 0.091 0.000 0.001 0.001 0.001 0.001 0.001	ENCY ALYSIS SW NE 0.061 0.000 0.000 0.000 0.000 0.000 0.001	**************************************	W E 0.072 0.001 0.001 0.000 0.000 0.000 0.000

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0.000	0.000 0.000 0.007			-				0 001		0 000		0 000
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	4.000
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											
0.0	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					~ ~~~		0 001		0 000	0 000	0 000
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
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			0 001		a	0 000	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	0.000	0.000	0.000	0.000	0.000
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	0 000	0 000	0.000	0 000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000 0.000 0.000	0.000	91000		0.000	01000	01000		•••••	•••••		
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 D.000 0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000		0 000	0.000	0.000	0 000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000 0.000 0.000	01000							••••			
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
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		0 000		0 000	A AAA	0 000	0 000	0 000	0 000	0 000	0 000
0.000	10 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
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	0 000	0 000	0 000	0 000	0 000	0.000	0.000	0.000
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
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											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
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	то 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						A 444	0 000		0.000	0 000	0 000
3.4	TO 3.5 0.000 0.000	U.U00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	9,000
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	0 000	0 000	0 000	A 000	0 000	0 000	0.000	0 000	0.000	0.000	0.000
0.000	0.000 0.000 0.000	0.000	0.000	0.000	0.000	0.000	5.000	5.000	5.000	3.000	5.005	
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
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prep 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 4.5 TO 4.7 0.000 D.000 0.000 0.000 0.000 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 Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH) PLUME NNE HEIGHT N NE ENK E. ESE SE SSE S SSW SW WSW w WNW NW NNW RANGE (M) \*\*\*\*\*\*\*\*\* HEADED\*\*\*\*\* \*\*\*\*\*\* s SSW N NNE NE ENE Е SW WSW W WNW NW NNW SSE ESE SE 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 D.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 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 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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Northern Michigan University - MARQUETTE - COOLING TOWER ANALYSIS (NTH)

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	STABILI	ITY CATE	SORY 1	STABILI	TY CATE	GORY 2	STABILITY
CATEGORY 3 PLUME					·		
LENGTH							
RANGE (M)	ĸi	K2	КĴ	ĸi	K2	ĸз	Kl
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
0.5 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
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
1.4 TO 1.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000
				c	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
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
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
2.8 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	D.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			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
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
4.4 TO 4.6	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000 0.000			~ ~~~	<u> </u>			0 000
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5.8 TO 6.0 0.000 0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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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
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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
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9.4 TO 9.6 0.000 0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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RANGE (M) K2 K3	K1	к2	к3	<b>K1</b>	K2	к3	K1
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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
13.2 TO 13.6	0.000	0.000	0.000	0.000	0.000	0.001	0.000
13.6 TO 14.0	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
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17.2 TO 17.6	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
18.0 TO 18.4	0.000	0.000	0.000	0.000	0.000	0.001	0.000
18.4 TO 18.8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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21.0 TO 22.0 0.000 0.003	0.000	0.000	0.000	0.000	0.000	0.002	0.000
22.0 TO 23.0 0.000 0.001	0.000	0.000	0.000	0.000	0.000	0.003	0.000
23.0 TO 24.0 0.000 0.002	0.000	0.000	0.000	0.000	0.000	0.002	0.000
24.0 TO 25.0	0.000	0.000	0.000	0.000	0.000	0.005	0.000
25.0 TO 26.0	0.000	0.000	0.000	0.000	0.000	0.004	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
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35.0 0.000	TO 36.0 0.000		0.000	0.00	0.0	000	0.000	0.000	0.000		0.000
36.0	TO 37.0		0.000	0.00	0 0.0	000	0.000	0.000	0.000		0.000
37.0	TO 38.0		0.000	0.00	0 0.0	000	0.000	0.000	0.000		0.000
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0 0012	1	FOG	10.0	0.25	263.1	-0.010	262.6	0.3	270.1	500.	6.24
0.0004	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	5	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	259.4	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	q	FOG	16.5	A 25	293 1	-0.010		0.3	795 E	500	0.00
0.0001	10	200	15 5	0.25	203.1	-0.010	273.9	0.5	203.0	500.	0.00
0.0001		FUG	13.5	0.45	293.I	-0.010	491.1	0.3	294.9	500.	0.00
0.1517	11	PLUME	3.9	0.15	289.6	-0.018	279.4	0.3	288.1	868.	0.00
0.6676	12	PLUME	4.9	0.25	278.5	-0.010	273.9	0.3	281.5	850.	9.48
0.1118	13	PLUME	2.2	0.30	277.0	0.030	273.7	0.3	280.8	950.	18.88
0.0001	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 0007	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

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0 0004						prep					
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	275.0	-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	PLIME	5 7	0.25	201.2	-0.010	201.1	0.3	202.3	/20. ED1	10 22
0.0007	37	DT.IIMP	4.2	0.25	200.0	-0.010	207 5	0.3	203.2	031.	11 12
0.0005	20		ч. <u>с</u>	0.25	200.0	-0.010	287.5	0.3	291.1	830.	11.12
0.0003	20		3.0	0.25	209.0	-0.010	289.5	0.3	292.8	902.	12.95
0.0004		PLUME	4.0	0.45	284.3	-0.010	284.2	0.3	288.2	767.	12.85
0.0005	40	PLOME	5.1	0.25	282.1	-0.010	282.0	0.3	286.3	675.	12.29
0.0005	4T	PLOME:	5.9	0.25	278.1	-0.010	278.0	0.3	282.9	510.	12.64
0.0003	42	PLUME	3.1	0.25	292.1	-0.010	292.0	0.3	295.1	603.	13.13
0.0127	43	PLUME	3.6	0.25	283.9	-0.010	283.8	0.3	287.9	701.	18.87
0.0298	44	Plume	2.9	0.25	277.5	-0.010	277.4	0.3	282,4	604.	24.83
0.0174	45	PLUME	3.3	0.25	271.6	-0.010	271.6	0.3	277.4	605.	29.10

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

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### APPENDIX G

# Visibility Modeling Support Information

Northern Michigan University Marquate, Mi CFB Boller Project

Citrulating Platester Holine Parameters 605 m Type Reprisen Atased (1981 1992) MAR Dodry Brose (2004 (2004 1974)

Proposed Circulating Fluidized Bed Boller Potential Emissions

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Malaster Tirreughoud (tpr)	04 824	15.356	34.927	
Manadah Thraughaut (IGN)	740	10.01	369	
Harariel Thraughpul (bulk)	14,800	21,765	11.6%	
Hoaring Value (BTUAD)	25.50	3,000	23,200	1.50
Steel Japur Jage BTUihr]	53	7	6	
Marchise Lippe	100.0%	10.00	100.0-1	7.001
Suifur Cardent	150%	C 80%	0.00%	0.05%

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Cost Basemond	43	100.5%	3	2,500	14.800	140	04 824	ŀ.
Cont PHB	0.801	TO DE	ž	9 50.5	17.00		100	
Wohnryd Grug	1,000	1000	MI.	24.5%	101	204	200.0	
Vennin Woud	0.052	1000	. <u>1</u>	F		12.74		
TABLE B-1. EMISSION RATES OF CRIT	<b>JERIA POLLUTANTS</b>	3, HAPS, AND TA	CS FROM T	HE NEW BC	NER ON	A PER FUEL	BASIS	
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Company		Emission Flu	51013	Enderlan	Rahas	Easter 70-	Cataline -	

Fundant Fundant Fundant Fundant B. (188-05)B. TABLE B-2. MAXIMUM EMISSICH RATES

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Comparison 2 ADDOLUZION OF

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	BSDIE		a a	2.365.05 1 1.01E-L	Pr 3.116-01	Lange L	3,165,05	1.466-04	1.966-45 1.15	484ec 266	C6. 1540-05	B.056.06	INUSARIA	NAE.02	and and		N-177			10.31
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(1) Statistical Statistics and set of set Offender (1) (2).
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DFB Builde Russimum Single MAP Endeelon Rete (HCG) = 6.3 kpy CFB Bolter Meelingen Combined Youri HAP Endeelon Rete x 5.4 (2046)(\* 46)

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Pg 1 of 3

Рюраный Бү №1 И Сотяниалы, Цей. Mattilf 10,000 Name

ABLE B-3. MAXMUM EMISSION RATE! An Operation and Summary and Compound Mallican Mallican Materia Bandan Bandan Bandan Gronistan Islai Gronistan Islai Gronistan Islai 
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2.246-12 5.06-10 7.576-07 1.566-06 1.566-06 1.346-06

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Proposed Circulating Pluidzed Red Boller Potential Emissions

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Northern Michigan University Marquette, Mi CFB Boller Project

Proposed Circulating Fluidized Bed Boller Potential Emissions

brockmate; normally 7) Specification routeting Fluidtzed B Boile Parameters Boker Type Maximum Rated Mest in(p.a. (MM blacht) Gross Outpot (MM/hr)

	Sulfur Contant	Material Usoge (%)	Hear Input (UNK BTUAN)	Heating Value (BTURb)	Material Throughpun (lb/hr)	Material Throughput (tph)	Material Throughput (10y)	Natural Gas Maximum Usaga Rata Milacifin
-	1.50%	100,0%	185	12,500	14,800	7,40	64,824	
	0.60%	100.001	185	8.500	21,766	10.88	95,329	1 1 1 1 1
	0:00%	¥0:004	185	23,200	7,974	80	34,927	5
	%000	¥0'001	505	4,500	45.566	BL 77	199,533	

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A PER-FUEL BASIS	2
APS, AND TACS FROM THE NEW BOILER DN	Coal, Bhuminous
SION RATES OF CRITERIA POLLUTANTS, N	
3LE 8-1. EMIS	

TABLE B-1. EMISSION RATES OF CRITERIA	A POLLUTANTS	S, HAPS, AND TA	CS FROM	THE NEW	BOILER	IN A PER-FUE	L BASIS	000								[	TABLE B-2. MAXIMUM EMISS	ION RATES	5		
CA CA	AS Reference	Farino Far	ckan	Emisei	nn Rates	Falselo	a Famora	Emiselo	A Parac	Entrelat En		Inter Detre	Lonization	T UNDERT	1000		ļ			Ĩ	Emission
	Number	Vahio	Units	(Ib/br)	(tov)	Value	linite	(ib/hr)	(tev)	Value	- No	1100	Value	Inter		franch 1				Ž	Flactor
Certion letractionide	56235	「「「「「「「「」」」」」」」」」」」」」」」」」」」」」」」」」」」」」	ALC: NO.	Contraction of the	のないないない	たいないのとうと	STATES STATES	A DESCRIPTION OF THE PARTY OF	Constant of the	State of the second second		「注意を見たい」の	5 19E.OF	Manut.	A DEE AD	1 665 04	Automotion for the second second second second second second second second second second second second second s	1 0.00	Adda -		
Deficie	7782505					<u> </u>							O DE DE		1.005-04	41.00E-UC		1.065.02	4.655-412	DOOM	6.16E-05
2-Chomseatonherme	632234	A DEF-DR	Britch	S ORF-DS	2615-24	P. DEF CE	Deter State States	R TREAS	A SAF DA				0 785 PG		E GOT OT	2. TUE -01		1.005-01		1000	8.095.04
Chlorobenzene	108507	2.536-05	hinn	1.87E-04	8.20E-04	2.535-05	plice	2.76E-04	1,216-03				3.806-06	IS/MIRHu	7 786-03	3 415-02	Checklergere	8.70E-00	2.245-UR		*/#F-0/
Chloroform	67663	6.70E-05	lb/ton	5.02E-04	2.206-03	5.79E-05	Ibiton	7.38E-04	3.236-03				3.22E-05	MMM	6.60F-03	2 AGE. 1/2	Chloenton	A SOF 12	2 EGE-07		0.10C 00
2-Chloronachthalwne	B1587			State State		1.	22.00		10 A.				2.766-00	to MARKIN	5.66E-07	2.48E-06	2-Chiomachthaine	5.66E-07	2.435-06	Noother Party	2 76F_06
2-Chlorophanol	85678		Constant of the					13. A. 192	がたい	100 A			2.76E-DB	INMERS .	5.66E-06	2.48E-05	2-Chitrophenol	5.666-06	2.48E-06	Wedd	2.76E-08
Cunerre	98628	6.105-06	Diton	4.51E-O5	1.965-04	6.10E-06	nohdi	6.63E-05	2.918-04								Cuntine	6.03E-05	2.91E-04	PRB Coal	3.596-07
Cyanide	74908	2.88E-03	noha	2.136-02	9.325-02	2.88E-03	lation	3,136-02	10-37E.1		ALC: NOT THE REAL OF		0.632.64		The second second		Oyanide	3.13E-02	\$.37E-01	PRB Coal	1.896-04
1,4-Elchloroberzene	106467						* 4 - 1			1.36E-03 By	MMsdf 2.60E	04 1.10E-CB	で、新した				5,4-Dichlorobenosme	2.50E-04	1.10E-00	Nar Gas	1.356-08
2.4-Dinkrotokuene	121142	3.22E-07	hafa	2.38E-06	1.046-05	3.22E-07	lbfton	3.505-06	1.53E-05								2,4-Cintratotuene	3.506-06	1.535-06	PRB Coal	1,805-08
Dimethy suffere	18222	5.52E-05	nahai	4.08E-04	1.79E-03	6.62E-05	RV100	8.01E-04	2.63E-03						Constant in the second second		Dimethyl surliate	6.D1E-04	2.63E-03	PRB Coal	3.256-06
2.4-Dinitrophenol	61285				日本		語の日本	C.Wite-					2.07E-07	Ib/MMBfur	4.24E-05	1.86E-04	2.4-Dintrophanol	4.248-05	1.86E-04	Mood	2.07E-07
Ethybercare	106676	1.DBE-04	nohå.	8.006-04	3.50E-03	1.08E.04	fbflon	1.1BE-03	5.15E-03			1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	3.57E-05	b/MMBlu	7.31E-03	3.20E-02	Ethylbenzene	7.316-03	3.20E-02	Wood	3.57E-05
E try Achloride	6009/	4.836-05	Lioluti	3.576-04	1.57E-03	4.836-06	15/Ion	5.25E-04	2.306-03								epinoNokota	5.20E-04	2.30E-03	PRB Coal	2.84E-06
Elliyiene dicritoride	10/082	4.60E-05	Solo I	3.405-04	1496-03	4,60E-05	Long	5.01E-04	2.196-03								Ethylene dichloride	5.01E-04	2.10E-03	PRB Coll	2.71E-06
Elliy/terre ditromate	106934	1.385-06		1.025-05	1476-05	1.365-06	5	1.505-05	6.58E-05								Ettrylene dibromide	1.505-05	0.56E-05	PR5 Coal	8.12E-08
Formationhyde	80005	2.76E-04	Drin	2.04E-03	BL-355-6	2.78E-04	la/lon	3.DOE-03	1.32E-02	8.63E-02 PM	MAIscf ( 1.566	-02 6,80E-02	6.06E-03	ID/AMBRU	1.04E+00	4.546+00	Formaldehyde	1.04E+00	4.64E+00	Nood	5.06E-03
Heptackhorotophenyk	28655712				and the second				時にたって				7.59E-11	DAMER	1.56E-08	8.82C-OB	Heptechtorotzishenyi	1.566-08	0.82E-08	Wood	7.596-11
Hex ac Norobachenyi	26601643				True and		A STOCK	行いたがい					6.33E-10	IDMMBIU	1.306-07	5.68E-07	Hexachlorobiphenyl	1.30E-02	6.68E-07	Wood	6.33E-10
Crex and	10293								の方法にあり				B.05E-06	IDMMBh1	1.65E-03	7.23E.03	Hereich	1.65E-03	7.235-03	Wadd	8.05E-06
everally and a second s	042011	7.71E-06	D/ten	5.70E-04	2.50E-03	7.71E-05	biton	6.36E-Q4	3.876-03	2.07E+D0 EM	MMscf 3.756	-01 1.64E+00					Hexane	3.76E-01	1.84E+00	Nal Gas	2.036-03
is obutyral dehyde	79642		Coxes and	Statistics of the second second second second second second second second second second second second second s			CONSTRUCTION OF						1.36E-05	ID/MMBhu	2.83E-03	1.24E-02	kututyraidahyde	2.835-03	124E-02	Wood	1.38E-06
Sophorane	1809/	E.E.PUK	(DIGN	4.94E-US	2.16E-02	E.67E-04	DADA DECEMBER OF	/ 205-413	3.13E-02		語いたななの						teophorane	7,26E-03	3.18E-02	PRB Coai	3.92E-06
2 · Methytrachthatene	91576							「「「「「」」		2.76E-05 Ib/8	VIMSel 5,01E	-06 2.19E-05	1.B4E-07	iaMMBm	3.77E-05	1.65E-04	2-Methylinaphthalene	3.775-05	1.65E-04	Wood	1.846-07
3-Mathytchioranthrena									STATES OF	2.07E-06 Ib/	Wideol 3.76E	-07 1.64E-US					3- Webrytchiorenfreene	3.75E-07	1.B4E-08	Net Gas	2.006-09
Monocrecebipmenty			「「「「「」」		「「「「「「」」」			1000 2 1000	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1				2.53E-10	15MMBtu	5.196-08	2.27E-07	Monochlorobiphenyl	5.19E-08	2.27E-07	Wood	2.53E-10
Metry storade (promonenalis)	2000 C			1.205-00		1.945-104		2.005-113	Bran B				1.73£-05	DANKBRU	3.54E-00	1.566-02	Mathyl bromide	3.546-03	1.55E-02	Wood	1.77E-06
Manual and the second	1000	0.100 to		1 375 01	1,205-02	0.10E-04		2000 00 V	7716-07				2,806-10	DEMMO	5.42E-03	2.376-02	Methyl chloride	6.63E-03	2.01E-02	3	3.566-05
Nito that have a served	AMAR A	1.061.04		A ACT AN	0.340.00			1 1 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	0.795.00				0.215-00	INVINING	12/15-03	5.50E-03	Methy athy kelone	197E-03	2.14E-02	PRB Coal	2.6HE-05
Makind matteriate	20636	7 1015-04	in in in	1 705 04	7 465-04	1 205		2 KPEAN	8.32E-00					to the second		N. Salar	Methy hydrazine	2.136-03	9.32E-08	PRB Cont	t.15E-05
Methyd tert butyl ether	1634044	4.03E-05	to/q	2.B6E-04	1.30E-03	4.03E-06	Line of the second second second second second second second second second second second second second second s	4.38E-04	1 92E-03								Methyl text buthd ether	4 3AF-04	1 425-04		1-10E-U0
Methylene chloride (Dichloromethane)	15092	3.34E-04	(prior	2.47E-03	1.086-02	3.34E-04	natital	3.63E-03	1.59E-02			THE REPORT OF	3.346-04	MMMMM	6.84E-02	2.995-01	Mathylene chickbe	6.84E-02	2.99E-01	Noad	3.34E-04
& Nitrophenol	88755		がある										2.76E-07	ID/MM6tu	5.BBE-06	2.48E-04	2-Nitrophenol	5.68E-05	2,48E-04	Nood	2.76E-07
4-Nitrophenol	100027										ALC: AND ALC: A		1.276-07	1bMMMBuu	2.395-05	1.14E-04	4-Nilrophenol	2.59E-05	1.14E-04	Nood	127E-07
Pentachorotophermy	25429282						19.94						1.38E-09	<b>IDMIMBOU</b>	2.83E-07	1.24E-06	Pertachlorobiphenyl	2.83E-07	1.24E-08	Need	1.38E-09
Perfectionsprend	87800	A State State State	大学の						ALC: NO				5.676-08	RyMMBtur	1.20E-05	5.27E-05	Participhenol	1.205-05	5.276-05	Naco	5.87E-09
Phenot	10,835,7	1 MEAN	then	1 RF-M	Prop. 10	1 ALE-ON	INTERNATION OF THE OWNER OF THE OWNER OF THE OWNER OF THE OWNER OF THE OWNER OF THE OWNER OF THE OWNER OF THE O	OMEAN	A TTE-AM				A DTE OF	E-Miller P-Autor	1.23E-07	5.375-07	Perylene	1.236-07	5.37E-07	Nace	5.98E-10
Prozionuskiehunde	123388	1375-04	Ibran	3.236-03	1.426-02	4.375-04	the first	4 76E-00	2.006-00				7 105-05	P/LAUPH	146-02	6 THE TO	Provinski kale	1446.00	0.2/ E-U2		0.012-020
Propertel	123396	A PARTY AND	State of the			Sector Sector		A REAL PROPERTY.					3.685-06	D/MBh	1545-04	3.206-03	Protected	7 FAE-DA	1305.00	2000	
Styrene	100425	2.836-05	Refer	2.13E-04	B.32E-04	2.88E-05	lb/on	3.135-04	1.376-00				2,196-03	EVAMBLAL	4.48E-01	1.96E+00	Shrene	4 40F.01	1065-00	-	
Tetrechicrobiphenyl	26914330		ALC: NO					1 State Law	The second				2.886-09	DMMBA	5.00E-07	2.666-06	Tetrachkurobiptenvi	5.69E-07	2.560.08	N	2 RE-CO
Tetrachtoroethykene	127184	4.96E-05	nahđi	3.66E-OH	1.60E-03	4.66E-06	(b/ton	6.385-04	2.365-03				4.37E-05	IMMMBIN	8.86E-03	3.82E-02	Tetrachiomethylene	8.98E-03	3.82E-02	NDOOL	137E-05
Toluene	106663	2.765-04	lt/ten	2.04E-03	8.96E-03	2 76E-04	Brhtt	3.00E-03	1.12E-02	3.0HE-03 Ib/h	AMsof 7.096	C4 3.11E-03	1.06E-03	Ib/MeBlu	2.17E-01	8.60E-01	folveno	2,176-01	9.50E-01	Poo V	1.06E-03
o-Toluakienyde	529204							Sec. Sec.					8.285-06	INMMBIN	1.70E-05	7.436-03	o-Toketsehyde	1.70E-03	7,436-03	Nood	1265-06
p-Tobuldehyde	104870	A DOWNER WAS			and a second	Test to a series							12TE-05	IN/MB/U	2.69E-08	1.146-02	p-Tolusidehyde	2.69E-03	1.14E-02	Vood	1.27E-05
Thoracobipheny Making	「「「「「」」」という									のないの			2.996-06	DMM/Bhu	6.13E-07	2.655-06	Trichiorobiptwery	B.13E-07	2.68E-06	Nood	0-36E-09
																		Prepa	ned by NTH	Consultants,	Ę,

NRM\_Updated Emission Spreadsheet for %S on Bit Coal Future 100%

Pg 2 of 3

Northern Michigan University Marquette, MI CFB Boller Project

Proposed Circulating Fluidized Bed Boiler Potential Emissions

Fixidized Sed	185	10 KAntrovimele: normally 7.
Circulating		
Boller Type	Maximum Reled Heat brud, (MM bruffs)	Gross Output (MWhy)

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<b>अं वा हर्ग</b> ले।	Sulfur Contant	Katerial Usage (%)	Heat Input (Mile BTUIns)	Heating Velue (BTUNb)	Material Throughput (Buhr)	Malevizi Throughput (tph)	Material Throughpul (tpy)	Natural Gas Maximum Usage Rate Milactifir
mimous	1.50%	100.0%	385	12,500	14,800	7.40	BA, 824	
	0.60%	100.0%	185	9,500	21,796	10.85	98,329	A 1814
	0.00%	100.0%	185	23,200	1 974 1	3,09	34,927	2
8	500.0	100.0%	205	4,500	45,556	22.78	199,533	

TABLE B-1. EMISSION RATES OF CRITE	ERIA POLLUTANT	S, HAPS, AND T	ACS FROM	1 THE NEW	BOILER ON	A PER-FUE	BASIS	960			Manual Care						TABLE B-2. MAXIMUM EMISS	YON RATE			- 1
Contractioned	CAS Reference	Pritabo #	lardone	Emleale	An Dates	Berline	Z Incente	Embada	- Halas	Particular Part			;   - 		50 MOOR				mmi		ē
	Number	Value	Units	1 Linda	hav	Value	thills		(Junit	Value 1	Links - file	Instantin Kare		rsion rectars		Ion Rates	Computered	Emilia	on Rates		
Tricriorolluoromethane	76894	Construction of the second	Participation of	のなけのないのない	A STATE OF A	A STREET ST	CARACTER ST	Contraction of the local division of the loc	A CONTRACTOR OF A CONTRACTOR	State State State	STATE OF STATE	Contraction of the local division of the loc	Visiti -			And and			1 Adu		-
Tricklorettene	91062							11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A CONTRACTOR				24 C		N ADE-U	4.23E-02	1 NONRO RUCOMBINATE	9.67E-03	4.236.02	Wood	<u> </u>
1,1,1-Triahloroethare	71556	2.305-05		1,705-04	7.45E-04	230E-05	lotton -	2.50E-04	1,10E-03				ANN 3.hrev	DE PAMAR	7.315.03	3.305.00	1 1 1. Trichterweiterse	m-1/0-7	1100-02	Macod	-
2,4,6-Trichlorophenol	88062		No. of the local sector			E. Marsha	The Real Property in	Constant of	A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR OF			Section 2	25.5E	PANANE PANANE	195.0	2 27E-06	2 A. D. Tricklessenson	00100	0.00EV4	0004	910
Viny/ acetale	108054	8.74E-05	lan	6.47E-04	2.83E-03	8.74E-05	Mon	9.51E-04	4.17E-0G								Vint anatata	0.195-00	4 12E AB	2004	<b>۱</b>
Vinyl Chloride	75014	a state of the second	のがある	Sector Sector	語ったない		N. STATU	1	Sarra Sarra				100 COTE	DE I NUMBER	u 4 24F-03	1.000	View Cracelle	1 245 10			1
Xydertes	1330207	4.26E-05	biton	3.15E-04	1.36E-03	4.26E-05	Ibilon	4.83E-C4	2.03E-03	100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100		C. C. C. C. C. C. C. C. C. C. C. C. C. C			ALC: NO.		Vilener.	00-247 F	1000-00		Ň
o-Xytene	95476	State State			The second second	Contraction of	Los Santa		TAXA TAX				2.83E4		040700004607000	2.56F-02	Altera	4 002 V	1000.00		1
Polynuolear Aromatic Hydrocarbons (PAH) 📢	ALL THE SECTION		のないないの	領人語を見る		「「「「「「「「「「」」」」」	「「「「「「「「「「」」」	A STREET	C. Contraction	語のである。	がい、語いたので		時間の温泉の	Contraction of the local distribution of the	「「「「「「「」」」」	の記念が必要にな	PD0/rectoar Aromatic Rustry and	200 CO. 000	Contraction of the local sectors of the local secto	Procession of the second second second second second second second second second second second second second s	1
Acenaphthene	83028	5.87E-07	natid	4.34E-06	1.90E-05	5.87E-07	hiton	6.36E-08	2.80E-05	2.07E-06 Ib	WMsol 3.76	E-07 1.64E-	06 1.05E-	ISMINGI BO	1 2.15E-04	9.406-04	Ademochthome	2 15F.04	0 ADE-DA	VANA CONTRACTOR	
Acenaphilitylene	206968	2.88E-07	lbfton	2,136-06	9.32E-06	2.88F-07	Prion	3.136-06	1.376-05	2.07E-06 by	WHECT 3.754	E-07 1.84E	36 5.75E4	19MNgi B	1.18E-03	5.186-03	Acerahibidean	146		Mond	-14
Acetone	67641	State States			1. 1. A.			CANAL CONTRACTOR	The second second		A SHORE		2.19E4	H PMWB	4.486-02	1.96E-01	Acelone	4.405.00	0.95-00	Mond	<b>•</b>  •
Anthractine	120127	2.42E-07	(anan	1,79E-08	7.83E-08	2.42E-07	Inton	2.635-08	1.15E-05	2.76E-06   lb/	MMscf 5.016	E-07 2.19E-	38 3.45E4	X INMMB	1.076-04	3.10E-03	Anthracene	7.076-04	3 10F.08	Minut	4
Benzardehyde	100627				No. of the							が大学	HERT D.78EH	17 IbAMBh	2.00E-04	8.78E-04	Benzaldehvda	2 00E-04	8.78E-04	Wind	8 0
Benzo(a lantivacane	56553	9.20E-08	lbiton	8.61E-07	2.986-06	9.20E-08	laton	1.00E-08	1.39E-06	2.07E-06 Ib/	MMscf 3.75E	5-07 1.64E-	36 T.ABE4	BAAABa	1.536-05	6.71E-06	Benzo(a)antinacene	1625-06	A TIFAIN	Proved in	1
Benzo(a)pyrana	50328	4.37E-08	uqq	3.23E-07	1.426-06	4.37E-08	B/tan	4.76E-07	2.08E-06	1.38E-06 Ib/	MMsof 2.50t	1-07 1.10E4	76 2.596-1	ASLANDA	6.13E-04	2.68E-03	Berzo(a)ovene	0.13E-04	2.686-03	Mond	
Eenza(e)pyrenH	218264	ALC: NO POINT OF			The second	Part and the	ない、世界に	The second		1.38E-06 Ibi	MMscf 2.50t	5-07 1.10E4	76 Z.99E-C	BINAMBR	6.13E-07	2.68E-06	Benzo(e)pyrene	6.13E-07	2.68E-06	Wood	1
Benzo(b)Auoranthera	205302				以上の学	100 Mar 100		「ないないない」		2.07E-08 ht	WMsci 3.75L	5-07 1.B4E4	36 1.15E-4	7 i Iommen	2.36E-06	1.035-04	Benzo(b)fluoranthene	2.36E-05	1.03E-04	Wood	÷
Benco(), k)/tuoranthems	206440	Contraction of the second second second second second second second second second second second second second s		State of the second	12000		Support States	The second second					1.BME-L	7 Iblandeu	3.77E-05	1.656-04	Henco(Jk) (tuoranthene	8.77E-06	1.85E-OH	Wood	-
Benzo(k)fluoranBrene	205623	and the second for		明治にない		日にある		31 (SE) 164 (SE)	18. A. A. A. A. A. A. A. A. A. A. A. A. A.	2.07E-06 (b4	Whited 3.75E	5-07 1.84E4	76 4.14E-C	B NUMBER	1 8.49E-06	3.72E-06	Berro(k)fluoranthene	8.496-06	3.72E-06	Wand	
Perso(b), k) Automatiene		1.27E-07	Lines n	9.36E-07	4-105-06	1.276-07	hond	1.38E-06	6.036-06				1.15E4	7 IbAAABa	2.36E-05	1.03E-04	Benzo(b.j.k)fluorenthene	2.36E-06	1.03E-04	Wood	÷
Benzo(g,h,i)penylene	191242	3.11E-08	thin .	2.30E-07	1.01E-06	3.11E-08	Rhan	3.38E-07	1,48E-06	1.38E-06 Ib/	Wiker 2.50k	5-07 1.10E-	1.07E-L	7 IOMMBA	2.196-05	9.605-05	Berzo(g,h,)perylens	2,19E-06	0.60E-05	Wood	≃
Biphonyd	82524	1.865-06	Dfton	1.455-05	8.34E-05	1.96E-C6	Pon D	2.13E-05	8.32E-05 🐺								Bistrond	2.136-05	9.12E-IN5	PR6 Coal	1-
Chrysene	218019	1,156-07	liption.	8.51E-07	3.735-06	1.15E-07	Dibn	1.2ªE-06	5.485.06	2.07E-06 Ib/	Midset 3.756	-07 1.64E-	16 4.37E-C	a hAMAG	6.98E-08	3.92E-05	Chrystene	8,996-06	3.92E-05	Wood	Ĩ
Crotorialdetryde	4170303	Contraction of the second	A STATE		14-20-20	「「「「				小田小の人			11NF4	6 IDAMABI	2.33E-03	1.02E-02	Crotonaldehyde	2.336-03	1.02E-02	Wood	1-
Decachlorobipheny	2051243				Service R	The state of the	1		A STATE				311E-1	D INMMPIA	8.37E-08	2.796-07	Decechiorobiphenyl	8.37E-08	2.706-07	Wood	6
Urbertzo(a, h)anthracente	EO7E2	The second second	Constants.	St. 12			1.12.20		1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	1.38E-06 ID/	VIMsof 2:50E	1.10E4	16 1.06E-L	B DAMABRI	2.16E-06	8.40E-06	Diberza(a,h)en/hracane	2.156-08	9.40E-06	Wood	ļΞ
ensite and the second of the s	Repr							1000 C	No. of Street, or Stre		Sec. of a	S. C. S. S. S.	YEE 0 33E-4	5 IDAMIBE	1.30E-02	5.68E-02	1,2-Dizromoethene	1.30E-02	5.68E-02	Wood	φ
Dicritoriolophierry/	2050682	「「なる」ない	No.				Asses at				State State		8.51E-1	0 Ibrinen	1.748-07	2.84E-07	Dichlombiphenyt	1746-07	7.64E-07	Nood	8
1.2-Dictriorgethere	107052					Party and			H MAR			Cherry Car	334E4	5   IDAMARIA	8.84E-03	2,996-02	1,2-Dichlonoethane	6.84E-CD	2.996-02	Weod	6
3.2-Dichlorapropane	76875					1.1.1.1.1.1.1	A DECEMBER OF	CLANSING ST				の大きまた	3.80E-0	5 IDAMAG	7.7BE-03	3.41E-02	1,2-Dichlaropmparae	7.786-03	3.41E-02	Wood	8
7,12-Dimethylberz(a)anthacana	57976									1845-05 184	uluser 3.34E	F-06 1.46E4	6 202 B				7,12-Dimothylbenz(a)entimecone	3.34E-06	1.46E-05	Nal Ces	12
Auoranthans	206440	8.17E-07	10/00	6.04E-08	2.65E-05	8.17E-07	(b/ton	8.69E-06	3.895.05	345E-06 Ib/	Musci 6.266	-07 2.74E-4	16 1.BAE-0	6 IbMMBN	3.77E-04	1.856-03	Fluoranthene	3.77E-04	1.655-00	Nood	<b> </b> ~
lucreane	86737	1.066-06	L L L	7.74E-06	3.39E-05	1.05E-06	hand	1.14E-05	4.99E-05	3.22E-06 Ibn	MMsc1 5.84E	-07 2.66E4	16 3.BHE-0	B DAMMBIU	8.02E-04	3.51E-03	Fkuorene	B.OZE-DK	3.51E-03	Wood	18
ndeno(1.2.3.r.d)pyrene	193365	7.026-09	hond	5.196-07	2.27E-06	7.02E-08	Brion	7.63E-07	3.346-06	107E-06 IBM	AMset 3.75E	-D7 1.84E-(	B 1.00E-0	7 ID/MMB/m	2.056-05	8.965-05	Inderect 5, 2, 3, c, d)pyrene	2.05E-D5	B.90€-05	Nood	15
Vaphuhalene	BH203	1.606-05	U010	1.11E-04	4.855-04	1.50E-05	- Solution	1.63E-04	7,136-04	7.025-04 (bA	dMscf 1.27E	-04 5.57E-L	4 1.12E-0	4 (bridden	229E-02	10-3001	Nephiltsferve	2.296-02	1.005-01	Wood	12
Phenandhene	85016	3.11E-09	Logo	2.305-05	1.01E-04	3.11E-DB	han	3.386-05	1.486-04	1.98E-05 IbA	MMscf 3.55E	-06 1.55E-U	5 8.05E-0	BruinBiu	1.65E-03	7.23E-03	Phenonthrene	1.665-03	7,236-03	Weod	15
yrana	129000	3.80E-07	uayaj	2.815-06	1.235-05	3.8dE-07	Plan	4.135-08	1.81E-05 6	1.75E-05 GA	AMscf 1,04E	-08 4.576-0	6 4.26E-0	BAMMBu	B.72E-D4	3.02E-D3	Pynene	B.72E-04	3.826-03	Nood	12
S-Mathyl chrysere	3697243	2.53E-08	Б.	1.87E-07	8.20E-07	2.63E-08	Letter The	2.75E-07	1.216-06	Contraction of the second			GE-1	TO/WRAIBIL	2.03E-09	8.40E-09	5-Methyr chrysene	2.75E-07	1.21E-06	PRB Coal	12

1.165-07 1.065-07 1.065-08 1.165-08 1.146-08 3.115-10 0.8516-10 0.8516-10 0.8516-10 0.8516-10 0.8516-10 0.8516-10 0.8516-10 1.866-08 1.866-08 1.866-08 1.866-08

3.976-06 1.00E-07 8.05E-06 1.496-09

1.84E-07 4.14E-08

1.16E-07

9.786-07 7.40E-08 2.006-08 2.86E-09

3.45E-

4.726-05 3.456-05 31576-05

Emissio

5.91E-06

2.07E-05

2.60E-06

Pyrene S-Methyl chrysene

CFB Bolter Maximum Single HAP Emission Rate (HCf)=

22.7 CFB Boffer Maximum Combined Total HAP Emission Rate =

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6.3

There are an experience and experience and other properties of the second se

NMU\_Updated Emission Spreadsheet for %S on Bit Cost Future 100%

Pg 3 of 3

Prepared by NTH Consultants, Ltd.

9/18/2007 11:18 AM

Northern Michigan University Marquette, Mi CFB Boller Project

Proposed Circulating Fluidized Bed Boller Potential Emissions

azimide; normally 7) pocification ing Fluidized Bed (MM bture) Bolley Parameters Bolley Type Muxtmom Rated Med (MW/M)

Matural Gas Maxbnum Usage Rate Mikaci/hr				
Material Throughput (ipy)	64,824	95.329	34,927	00 6.12
Material Throughput (tph)	1.40	10.68	3.99	7576
Material Throughput (Ib/hr)	14,800	21.765	7,974	14.6.6
Hewing Value (BTU/Ib)	12.600	000 P	23,200	4 500
Heat Input (NM BTUIN)	185	185	88	33%
Material Usuge (%)	100.0%	%0'D01	100.0%	100 012
Sulfur Content	%051	0.60%	0.60%	0.07%
Materia	oal. Bitumimous	cal, PRB	stural Gae	roin Wood

m         m	a, AND I.A.
Im         Um         Um <thum< th="">         Um         Um         Um<!--</th--><th>tors Emission Rates</th></thum<>	tors Emission Rates
D         Description         Distribution         Distribution <thdistribution< th="">         Distribution</thdistribution<>	Unita (Ibihe) (toy) Va
0         0.000         371 <td>IbAAMBtu 5.6 24.3 0.03</td>	IbAAMBtu 5.6 24.3 0.03
0         0.0000         0.01	EXMINEL 37.7 165.3 0.09
0         0.0000         0.001         0.	UMMMBN 27.8 (21.5 0.16
Image: 100 million         2.71         2.84         2.84         1.95         2.74         1.95         2.74         1.95         2.74         1.95         2.74         1.95         2.74         1.95 <td>12/MM/Bhbu 0.002 0.011 4.52E-1</td>	12/MM/Bhbu 0.002 0.011 4.52E-1
n         n	INTRABLE 0.43 1.86 0.00
0         man         0.0         man         0.0         man	Man 0.8 3.6 0.1
0.0         base         1.1         0.0 <td>ByRon 0.1 0.4 0.01</td>	ByRon 0.1 0.4 0.01
1         0	IMMR84 1.1 4.9 6.10
0         0.0000         1.84:61         2.75:61         0.66:50         0.66:50         0.66:50         0.66:50         0.66:50         0.66:50         0.66:50         0.66:50         0.66:50         0.66:50         0.66:50         0.75:50         0.66:50         0.75:50         0.66:50         0.75:50         0.66:50         0.75:50         0.76:	EMMBru 4.33E-10 1.90E-08 2.34E
0         0.00050         1.015-0         2.015-0         1.015-0         2.115-0         1.015-0         2.115-0         1.01	b/MMBtu 1.68E-03 7.38E-03 8.08E-
(1)         (1) <td>MMMBau 1.12E-04 6.22E-04 7.87E-</td>	MMMBau 1.12E-04 6.22E-04 7.87E-
0         0	
e         monten         121-50         111-50	MMBtu 3.70E-06 1.62E-05 2.00E-0
0         0	2008-00-00-00-00-00-00-00-00-00-00-00-00-
0         Immini         156.01         0         176.01	www.Bru 6.64E-05 2.91E-04 3.59E
00         10600         136501         346503         64670         bunuali         13750         0000         13750         13670         13770         13670         13770         13670         13770         13670         13770         13670         13770         13670         13770         13770         13770         13770         13770         13770         13770         13770         13770         13770         13770         13770         137700         13770         13770 <t< td=""><td>MANJaw 1.55E-04 8.78E-04 8.07E</td></t<>	MANJaw 1.55E-04 8.78E-04 8.07E
Number         Number<	Ibron B.616-04 3.736-03 1.16E-
monun         1.78-61         0.0000         1.78-61         0.0000         0.2345         0.0000	100 100 100 100 100 100 100 100 100 100
United         1.7.8.41         VARUAD         1.7.8.41	
Trinking         Trinking	MMM840 1.72E-03 7.54E-03 9.30E-0
abuilling         JAFC 401         JAFC 401         JAFC 401         JAFC 402	
1         0	MMMBh 3.006-04 1.35E-03 1.67E-08
I         Mater         1/4/4/0         N/1/4/0         M/1/4/0         M/1/4/0 <thm 0<="" 1="" 4="" th=""> <thm 0<="" 1="" 4="" th=""> <thm 0<="" 1="" 4="" <="" td=""><td></td></thm></thm></thm>	
1         1         1         2         0	toton 1.11E-02 4.86E-02 1.50E-0
1         1	
1         1	
1         1	
Mark         Anticle         A	
Number         Answer         Answer<	
04         behulle         535-01         3345-01         3345-02         545-02         4365-02         4365-02         4365-02         535-0	
1         0         1         0         1         0	MMBbu 6.23E-02 2.29E-01 2.83E
M         Diversion         7.16-Col         3.16-Col         3	
In the         1382-04         3.382-04         3.382-04         3.382-07 <t< td=""><td>Exhon 4.85E-03 2.12E-02 6.56E-04</td></t<>	Exhon 4.85E-03 2.12E-02 6.56E-04
Device         2.386.43         1.186.04         Lowalin         2.386.43         Life of the control         Lowalin         2.386.43         Life of the control         Life of the contro <thlife of<br="">the control         &lt;</thlife>	Thittom 1.286-04 5.596-04 1.736-05
Dbn         1/86-20         7.186-20         2.426-00         PAMALIC         4.386-50         4.386-30         2.426-10         4.386-30         2.426-10         2.446-10         2.	byton 2,47E-03 1,06E-02 3,34E-04
M         bbm         1.06:40         3.46:43         0.014         0.116:00         0.106:00         0.106:00 <td>Editon 1.11E-02 4.85E-02 1.50E-0</td>	Editon 1.11E-02 4.85E-02 1.50E-0
All         All <td>DNon 5.96E-03 2.61E-02 8.05E</td>	DNon 5.96E-03 2.61E-02 8.05E
ds         bern         314E-04         4.00E-03         5.41E-03         5.41E-05         5.41E-05         6.45E-05         8.4E-04         8	
Ob         JMm         4.88-04         2.148-02         2.148-03         1.028-03         1.028-0	lb/kon 8,21E-04 2,72E-03 3.
04 INVIA 113E-03 713E-03 713E-03 1 153E-03 1 153E-03	Ibron 3.32E-04 1.45E-03 4.4
	0/001   1,11E-03   4,85E-03   1,5

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NMU\_Updated Emission Spreadsheet for %S on Bit Coal Future 100%

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Northern Michigan University Marquette, MI CFB Boller Project

Proposed Circulating Fluidized Bed Boller Potential Emissions

			(Approximate; nomelly 7)	
Specification	Circulating Fluidized Beb	195	10	
Boltor Paramotors	Boiler Type	Maximum Rated Heat Input, (MM brufer)	Gross Output (MW/Y)	

Natural Gas Maximum Usage Rate Mikacifin		7 4844	ţ	
Material Throughput (107)	699'99	95,329	34,927	199,533
Meterial Throughput (tph)	184	10.86	3.69	BY.22
Macortai Throughpus (Ibihr)	15,078	21.765	7.974	45.559
Healing Value (BTU/b)	11,800	8,600	23,200	4.600
Heat Input {Mbi BTU/hr)	135	186	185	205
Material Usage (%)	100.0%	100.0%	100.0%	100.0%
Sulfur Content	3.50%	0.60%	0.00%	0.00%
Malarici	cel, Bitumimous	Coal, PKB	latural Gas	Poor W need

A PER-FUEL BASIS	Coal, PRB
HAPS, AND TACS FROM THE NEW BOILER ON I	Coal, Bituminous
I. EMISSION RATES OF CRITERIA POLLUTANTS,	
TABLE 8-1	

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 Store rearized

 Emission Ratio
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 Emission Ratio<

TABLE 8-1. EMISSION RATES OF CRI	TERIA POLLUTANT	S, HAPS, AND T	ACS FROM	THE NEW P	IOILER ON	A PER-FUEL	BASIS											TABLE B-2. MAXIMIBM EMISS	NON RATES
	CAS Reference		COP, BIN	SUONE		1	Coal	PRB			Netural	Gas			Wate Wo	500			Max
	Number			Emissio	Stopy 1				n Hates	Emission	Factors	Emission	Cathe	Emission F.	actors	Emission (	Rates	Cempound	Enlasi
		Value	Unita	(IPUr)	[lpy	Value	Units.	(IbAhr)	(tpy)	Value	Units	(ip/pr)	(tey)	Value	Units	(h/h)	(fay)		(IDANC)
P.M. s <sup>2</sup> (filterable and condensable)	日本にたいたいで	0.08	<b>IDMMBIL</b>	5.6	24.3	0.03	its/MMBtu	5.6	24.3	のなどのない	「日本語の語言」	AS MARKED		0.03	<b>B</b> MMBh	69	96.9	PMm ((therable and condensable)	8.1E
so,	7446096	0.475	UDBMMMar .	87.8	384.5	0.200	D/MMBh	0.76	162.1		大学の	「市中市市の	なる語言の	D.025	DAMABLU	5.1	22.4	so.	87.80
NO, 1	101(2440	0.10	12MMBb	18.5	61.0	0.10	MMMBL	(8.5	0,18	0.10	<b>IDAMABI</b> U	18.5	61.0	0.1D	E/MMB/U	20.5	69.8	NO	20.50
co	630060	0.15	<b>INMMBtu</b>	27.B	121.5	0.15	RVMMBIU	27.8	121.5	0.75	IMMARIU	27.8	121.5	0.17	EMUBau	34.8	152.8	co	34.85
Lead **	7439921	1.346-05	Ch/MM Bhu	0.002	a.pH	4 52E-06	ID/MMBIN	0.001	0.004	Constants.	学校の語を	認いの言語に		5.52E-07	In Margan	1.136-04	4.98E-04	Lead	0.00
NOC.	南京の時代にある	0.002	<b>MMMBtu</b>	0.45	78.1	0.003	DAMBtu	D.63	274	6.33	<b>b/MMscf</b>	1,16	5.0	0.02	\$2/MM/BOJ	40	17.6	VOC	101
Mercury	7430976	3.00E-D6	<b>MMMBhu</b>	5.55E-04	2.436-03	3.00E-06	PMMB40	5.356-04	2.43E-03	299E-04	Dimmaci 5	42E-05 2	385.4	0.00E-06	P.MARIN	8 15F-04	2,605-03	Marchine	A TEF-DA
HCI I	7647010	0.11	Ibîtan	0.9	3.8	0.11	lbren	120	5.26	N. N. S. L. S.	1. Same -	23 NO44-14-1	CONCERCIÓN DE	100 A.	市での茶をかって	A CARLES	語の語言で	HCI IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	1
H +-	73602616	10.0	inton	0.1	<u>6.0</u>	0.0138	hand	0.15	80	NUCLARY.	100 100 100 100 100 100 100 100 100 100		100 Sec. 10.00		Concession of the second	and the second second		L L	1 2
H <sub>2</sub> SQ <sub>4</sub> (As Suiturle Acid Mist) <sup>2</sup>	7664939	8.10E-03	<b>BANNER</b>	- 	67	8.10E-03	TAMM BRU	÷	6								13	H.SO.	1 2
Total Dioxin/Furan	1746016	2.34E-12	IbMMBtu	4 335-10	1.906-09	2.34E-12	IbMMGRu	4.33E-10	1.905-09	A NAME OF A DESCRIPTION	10 10 10 10 10 10 10 10 10 10 10 10 10 1							Total Post Sector	
Metals															2004 - AUG - AUG			I ULAR COUNTRY GEORGE	4 335-10
Antimony *	7440360	8.08E-08	INMANBOU	1.66E-03	7,365-03	90-360.8	<b>Ibritikeru</b>	1.68E-03	7.366-03	のなどのない	101075838	合語の意思なな	国家会会	0.095-08	DAMMERL	365-05	8.18F-05	Antimotes	4 GREAN
Arsenie *	7440382	7.87E-07	<b>CMMBU</b>	1.42E-04	6.22E-04	7.676-07	<b>MANABILI</b>	1,425-04	6.22E-04	2 30F-04	b Mart 4	175.05 1	AREINE	53E.07		A LOE M	0 37C-04	Amonto a	10101
Barium	7440393	「日本のなどれていい」	「「「「「「「「」」」」	ないのないです。	Shew Sheeting	VICTOR AND	1×1000000	CONTROL OF	1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.	5.065-03	himbled a	10E-04	075.02	and and		A NE M	265-03	Badan	1446
Bendium *	7440417	2.00E-08	<b>IDMMB</b>	3.705-06	1.62E-05	2 COF-OB	Ib MARkin	3 705-06	1.826-05	1.315-01	hitter 3	EVE AS	UE VE					Designer.	3' 10E-04
Cadmium *	7440439	9,505,08	DAMPh	1.776-05	7.776-05	9.585-08	INGA MIRAN	1 776-06	7 775-05	1 275-00	Attend of	000000							57-00-00
Chroniters, tetal **	2440473	1.205-08	LAN Pho	2.21E-D4	9.69E-04	1.20E-06	DAMPIN	2 21F.04	9 AGE OF	1615.00	P.M.Hecl		200.00				5 1 2 C 1 5		2.286-04
Chmmkum, hexavalent *	18640290	3.505.07	IN/MMER-	R.AFLINS	2 81E-04	3.595-07	MURIN	E RAE AC	0 20 0	Constant and a second	100 M 10 M 10 10 10 10		1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.			1. 20E VU			4,201-005
Chromium trivalera	16066631	8.375-07	DAMBA	1.565-04	6.7RE-04	8.37F-07	IMMMRIN .	1 565 .04	R 78E-M				1944 APRIL 1954	CALCONNELLING	Contraction of the second second second second second second second second second second second second second s	10.007			8 70F 04
Contat	7407434	1 145-04	1	DOLEDI	1 OKE IN	1 150.04	-	1 365 M				A STATE OF	P. E.G. AND P. C.	Contraction of the second second second second second second second second second second second second second s	South States and States	Contractor Service			1.00E-04
Province in the second s	24.406.00	10000000000000000000000000000000000000	1 100 K K K K	10000000	COMPANY ST	A REAL OF LAND	No. of Street of Street	100.08 You	2.405-03		8-20-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0		100 A	ABE-DB	Dimmeter .	123E 05		Cotati	12 12 12 12 12 12 12 12 12 12 12 12 12 1
	anontal	A LON AND CONTRACTOR							- 第二日の一日の		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			04E-07	NEWMO	186-04	5.08E Q4	Capper	1.166-04
	140001		Contraction of the local division of the loc	a to the subscription	No by State		1		100 N 100 N	10 10 10 10 10 10 10 10 10 10 10 10 10 1		11 YO & 40		14E-03	D/MMBlu 2	0.335-03	1.02E-U2	Iron	2.33E-00
	40804	70-317-0		20-978.8	4.466-01	17/1-02	MON	1.388-01	6.03E-01			がなない	1.00 Sec. 2.00	の一部に、「			でならの家	Magnashim	1.38E-01
eserection and the second second second second second second second second second second second second second s	1438963	9.30E-06	DAMAShu Analogia	1.725-03	2.54E-63	B.30E-08	ID/MMB4u	1.72E-03	7.54E-03	4.37E-04	balliser 7.	н 19 19 19 19	47E-04	.04E-05	DAMABLU 3	0.76-03	1.66E-02	Manganese	3.77E-03
Movpderulin	199961	District Structures in		and the second	1 A. M. M. M. M. M. M. M. M. M. M. M. M. M.	10 10 4 20 10 E	Station Street St	A. S. Sales ( Sales ) A.	内公式が安まり	1.27E-08	MMacf 2	206-04 1	8-92	42E-08	b/M/Btu 4	1,96E.06 2	2176-05	Mahbdenum	2.296-04
Nockel -	7440020	1.6/E-06	DOMMBIL	3.096-04	1.365-03	1.876-06	DalMBbu	3.096-04	1356-03	10 10 10 10 10 10 10 10 10 10 10 10 10 1	States and the second		いたの	BOE-07	bMMBtu 7	7.78E-05 3	8.416-04	Nickel	3.095-04
Phosphorus	7723140						な時に現ると思想	100 C 10	n and a state of the state of t		A STREET STREET	なすない		11E-07	bAINBu B	337E-05 2	L79E-04	Phosphorus	6.375-05
Potasata	7440087		の教室の実行の	の時代のです。		「大人」の言語に言い								48E-04	b/MMBbu B	9.19E-02 4	036-01	Potassium	9.186-02
Salanum	1782492	1505-03	te lon	1.18E-02	6.15E-02	1.50E-03	noñal	1.63E-02	7.15E-02			ないので	1000	22E-06	entimetra 6	5.80E-08 2	30-368.05	Salanium	1.63E-02
Silver	7440224	A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR A		CHART CO	100 million (100 million)	Service of the	100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100	19 N. W. W. S.			1.00 A. 1.00 A. 1.00 A.	「「「「「「「」」」	1 1 1	B6E-05	MMMBhu +	1.01E-03 1	.76E-02	Sther	4.01E-03
Sedhm	7440235			12.2.2.2.2.2		10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1							1000	14E-06	b/MMBtu 8	496-04 3	(72E-03	Sodium	8.49E-04
Sirentium	7440246			-8. 15 - 23	100 Control of the local division of the loc		1000 C				State State		「動物の	.156-07	b/MMBhu 2	.36E-05 1	.03E-04	Stionlisen	2.365-05
5	7440315			の第二部連合は	Constant of the	1000000000			「「「「「「」」」	10 10 10 10 10 10 10 10 10 10 10 10 10 1	「「「ないない」の	100 AN AN	2002	65E-07	D/MMBtu 5	42E-75 2	JTE-ON	Tim	5.42E-05
Ttarium	7440326									語の行いたい		1.1.5	「個に記	306-07	b/MMBtu 4	.72E-05 2	DTE-04	Tatemátura	4.72E-05
Variadium	3440622		1927 N	10000						2.656-03	bAMASCI 4	-80E-64 2.	10E-03	136-68	DIMMBlu 2	31E-06	.D1E-05	Venedium	4.80E-04
Mathan Market	7440655		が設定した		いたいないです。		Same and the second sec	「「ないのない」	State State	The set of the	のないのである	1.08 200 E.S	東京学	465-09	2 RAMABAU	:07E-07 3	L10F-06	Ythium	7.07E-07
Zino (as zanc oxade)	1314132	2.83E-04	DWNBIN	5.236-02	2.236-01	2.836-04	(PAN)Bhu	6.23E-02	2.296-01	3.346-02	b/MMect 6.	05E-03 2	66E-02	63E-06	b/MMBbu   9	1.90E-04 4	.34E-03	200	5.23E-02
Lagance Compounds															sta Section . T			Organic Compounds. The State	
Accelerate hyde	15070	6.56E-04	ID(GL)	5.146-03	2,286-02	6.56E-04	Voya	7.13E-03	3.12E-02		<u> </u>		9 9 9 9 9	666-04	DMMBtu 1	98E-01 8	.57E-01	Acteletehyde	1.985-01
Acetophenone	58862	1.73E-06	lbton	1.366-04	5.92E-04	1.73E-05	hton	1.68E-04	8.22E-OA 🏷		CHANGE V.			.08E-09	WMMBtu 7	.54E-07 3	1305-06	Acetophenane	1.88E-04
Aorolein	107028	3.34E-04	Eta I	2.616-03	1. ISE-02	3.345-04	Ibrian	3 63E-03	1.596-02	ので、		記録のない	- <u>優</u> 落	.16E-04 I	MMMBhu 2		.05E-01	Acrolein	2.38E-02
Renzene	71432	1.50E-03	K2)4	1.17E-02	5.13E-02	1.50E-03	Ibhan	1.63C-02	7.13E-02	2426-00	MMMsof 4.	38E-04 1.	92E-03 4	82E-03 4	MMBhu 9	30E-01 4	34E+00	Benzene	9,90E-01
Benzyl chloride	100447	8.05E-04	blon	6.31E-03	2.76E-02	8.05E-04	than	8.76E-03	3.84E-02		C. C. C. L. L. L. L. L. L. L. L. L. L. L. L. L.							Benzyl chloride	8.76E.00
Benzoic acte	e6850	L'ALLE MAN	の変換の	「「「「「	ゆう 通道の言	「日本の	のないので			Sector Sec			<ul> <li>一座次線</li> </ul>	A15-08 8	MMBhu 1	.11E-05 4	.86E-06	Bonzolo acid	1.11E-05
Bisi 2-Ethythexylichtheliale	112817	8,40E-05	npla	6.55E-04	2.88E-03	3.40E-06	io/oi	9.14E-04	4.00E-03	語の正式	100 miles	South States	9 19 19	415-08	MMBhu 1	.11E-05 4	87E-05	Bis(2-Ethy@reccyd)phthral.ete	9.14E-04
Eromotorm	75252	4.49E-05	କ୍ଷୟ	3.52E-04	1.54E-03	4.495-05	ib/ton	4.88E-04	2.14E-03 🔅						の一般ない			Branoform	4.88E-04
Carbon disufficte	76150	1.508-04	10 July	1.17E-03	5.136-03	1.60E-04	avton	1.636-03	7.13E-03			100 CO	Ser Carlo	N. S. S. S. S. S. S. S. S. S. S. S. S. S.			の見いた。	Carbon disulfade	1.63E-03
Carbazole	86748		「「「「「「「「」」」	A CONTRACT	のないののである		「日本の家のない」	19月1日の1月1日	Same and the second second	W REAR		「「「「「「「「」」」」	<b>2</b> (法)(法)	07E-06	AMMBbu 4.	24E-04 1	.BGE-03	Carbazole.	4.24E-04
													and the second second						

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Future 100% NMU Emission Est & TAC Analysis (Final 01 25 07)

Pg 1 of 3

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Prepared by NTH Consultants, Ltd. 1/25/2007 4:59 PM
Northern Michigan University Marquette, Mi CFB Bolter Project

Proposed Circulating Fluidized Bed Boller Potential Emissions

(7 yiermale; normally 7) Specification Circulating Fluidized Bed 185 10 Boilar Perametars Boler Type Maximum Rayed Heat Inour, (NM Sydm) Gress Cutput (NWM)

Natural Gas Vaximum Usage Rate Müsstfihr		0.484.4	2	
Material Throughput (tpy)	68.869	66,329	34,927	199,533
Metarial Throughput {tpn}	7.84	10,89	3.99	22.78
Maturial 7 Moughput (ไปที่เก)	15,678	21,785	7,974	45,558
Hesting Yatue (BTUAb)	008 11	8,500	23,200	4,500
Hoat Input (854 BTUAN)	1 981	185	<b>9</b> 81	EDZ
Material Uaage (%)	700.0%	100.0%	100.0%	100.0%
Suther Content	3,50%	%0970	%0070	000%
Motoria)	Coal, Bitumimous	Coal, PRB	Vatural Ges	Virgin Wood

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I ABLE B-1. EMISSION RAIES OF CRI	I ERIA POLLUINN	0, TIAPO, MNU 1,	Coal Ritter	I'THE WEY'R		AFERSTOC	- DAGIO	800			Marking Control			10		ſ	TABLE B-2. MAXIMUM #MISS	HON RATES	Ī	ł	
Compaund	CAS Reference	Emission Fa	actors	Emissio	n Ratos	Emission	Factors	Emiaston	Rates	Emission Fac	tors	lission Rates	Emlasio	n Factors	Emission	o Rates	Canteound	Emitraio	n Rates	1	nission Inchar
-	12011047	Value	Units	(Ib/hr)	(ipy)	Value	Units	(b(hr)	(tpy)	Value	Julia (Ib)	r) (toy)	Vatue	Unite	(phin)	((0))		(14)(Q)	(tay)		94 M Bbu
Carbon ustrachlorids	CE236	「「「「「「「「」」」」	1.000 (S. 10)	1000 AND 1000	の時間に	No. of the second						の学校の変換を	5.18E-05	D/MM/Bhu	1.06E-02	4.66E-02	Carbon tetracidorida	1 065-00	4 ASE-00 14	inort A	APL OF
Chorino	7782505			Same and the	な読みの	States and a second sec	Contraction of the						B.09E-04	ID/MALERU:	1.86E-01	8.16E-01	Chartne	1.86E-01	8.16E-01 M	100	065-04
2-Chbroacetophenone	532374	8.05E-06	Ibton	6.31E-05	2.76E-04	8.055-09	Ibiton	8.76E-05	3.84E-04			同時の	2.76€-09	IDMMBhu	5.60E-07	2.48E-06	2-Chloroaceliqnienone	8.765-05	3.84E-04 P	HB Coal	746-07
Chlorobenzene	108907	2.53E-05	Ibton	1.98E-04	8.69E-04	2.53E-05	Ibitor	2.75E-04	1.21E-03	のないでは			3.806-05	INMERI	7.786-03	3.416-02	Chiprobenzene	785.03	3.41E-02 V	8	806-05
Chioroform	67663	6.79E-05	ibiton	5.32E-04	2.33E-03	6.79E-05	thran	7.38E-04	3.23E-03	CONTRACTOR INCOME	SUN 2000		3.22E-05	INTIME	6.60E-03	2.89E-02	Chiomlann	6 80E-03	2.89E-02 M	100	22E-05
2-Chloronaphthalene	54687								100000 N			NG REPARTO	2.76E-09	IDMM6RU	5.86E-07	2.48E-0B	2-Chlorenaphthalana	5.86E-07	2.48E-06 M	P00	706-09
2-Chlorophanol	65578	高いなどの	「二十二の一方の					and the second second					2.76E-00	IDMMBh	5.68E-DB	2.48E-05	2-Cistorophenol	5.86E-06	2.48E-05 M	Poo	76E-08
Currens	<b>55926</b>	0.10E-06	Ploy	4.70E-05	2.08E-04	6.10E-08	fa/ton	8.635-05	2.91E-04		の空空人に発展し		このでは実法		「京美に満	のため	Cumene	8.635-05	2.01E-04 P	R Coul 3	598-07
Cyanide	74908	2.88E-03	to/di	2.25E-02	9.87E-02	2.886-03	- Phot	8.13E-02	1.37E-01	전 물수 집 전	Barris and a second	1. S. M. S.	語言を	「「「「ない」」という		な感に内に	Cyanide	3.135-02	1.37E-01 P	Coal 1	90E-04
1.4-Dichkrobenzene	106467	方がある								1.36E-03 Ib/	Midsof 2.50E	04 1.106-03					1,4-Dichlorabenzene	2,606-04	1.10E-03	at Gass	35E-06
2.4-Divitrotoluene	121142	3.22E-07	three .	2.62E-06	1,112-05	3.22E-07	Dillon	3.505-06	1.532-05				100 A	A CONTRACTOR	102 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 -		2,4-Dinibotokuene	3.60E.06	1.535-06 19	E Coal	SE-08
Dimethyl sulfate	18775	8.52E-05	lb/ton	4.336-04	1.90E-03	5.626-05	Dren	6.01E-D4	2.63E-03		語のないないの	の日本の日本のの	のないの			いないため	iOimethyl suitate	6.016.04	2.63E-03	28 Coul	256-06
2.4-Dinitrophenol	61285			ALC: NOT STATE	1997 - 1997 -	South States and States		14.4.5.1.5.1.5.1.5.	1. 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		「「「「「「「」」」	A Sector Sector	2.07E-07	ID-MMBbu	4.24E-05	1.86E-04	2,4-Diritrophenol	4.24E-06	1.86E-04 W	2	DTE-07
Ethytomzene	105678	1.086-04	ibiten -	8.47E-04	3.71E-03	1.08E-04	tbfton	1.18E-03	5.15E-03				3.57E-05	<b>XMMBb</b>	7.316-03	3.205-02	Ethybenzene	7.31E-00	3.20E-02 W	3	215-06
EInyichionide	75003	4.83E-05	C/OD	3.79E-04	1.66E-03	4.83E-05	tallan	5.26E-04	2.30E-03				100 N 100 N				Ethytothoride	6.26E-04	2.30E-03	2B Coal	20
Ethylene dichloride	107062	4.60E-05	tron	3.81E-D4	1.56E-03	4.BDE-US	te/lan	PD-F1075	2.19E-03	語言は語言に言語		「影売時間になる	語言の漫		See Section	創業産業	Ethytene dictrionide	5.01E-04	2.196-03 19	Cond 2	16-06
Elhylane dibromide	106504	1.36E-06	tota	1.08E-06	4.74E-05	1.36E-06	talan	1.50E-05	8.58E-05 🖔						20. A. O. C.	「「「「「「「「「」」」」	Ethylene dibromide	1.60E-05	6.58E-05 PF	808	26-08
Formaldehyde	00009	2.76E-04	blon	2.166-03	9.48E-03	2.76E-04	han	3.DDE-03	1.32E-02	8.63E-02   Ib/	Ahsof 1.56E	02 8.85E-02	5.066-03	EMMBtu	1.04E+00	4.54E+00	Formaldehyde	1.04E+00	4.54E+00 W	3 9 100	60-19 10
Hepta chiorchiphanyi	28855712	「東京の学校の学校		語のないないない		Services.			3 그럼 걸려 2		5000 100 R		7.596-11	NEWEN	1.565-08	6.82E-08	Haptachlorobiphenyl	1.566-08	6.82E-08 W	28	10E-11
Hexachicrobiphenyi	26601649	State State State	A. S. S. S. S.	5.420.425.24	S. 40 . 30 .	「「「「「「」」」	States and the	2012-2013년 1월	細たななの理想に	Section Section 32	A LE LE LE LE LE LE LE LE LE LE LE LE LE	いたたべ、 東西の日本	01-305.0	Ib/MMBbu	1.30E-07	5,68E-07	Hexachiorobiphenyi	1.30E-07	6.68E-07 W	9	3E-10
Hezense	15230		の記念が	12.20 C						1. S. C. C. S. S. S. S. S. S. S. S. S. S. S. S. S.			3055-06	INVINEN	1.66E-03	7.226-03	Hexansi	1.65E-03	7.23E-03 W	20	56-06
Hexane	110543	7.71E-05	Ibîan	B.04E-04	2.65E-03	7.71E-05	thin	8.365-04	3.67E-03	2.07E+00 Ibil	Mscf 3.75E-	01 1.64E+00	の語言が	State State	The second second	記録の	Hexans	3.75E-D1	1.64E+00 Ns	t Gas 2	36-03
lsobury-raidattycke	78842	使用の決定を		語言が語る	たいのない	Salar Salar	100 Contraction 100		10.00 L 10.00		的现在分词		1.386-05	<b>Bythemettu</b>	2.83E-03	1.246-02	isobutyraide hyde	2.BJE-03	1.24E-02 W	100	SE-05
sophorone	78691	6.87E-04	ê/tan	5236-00	2.296-02	6.675-02	Pto	7.26E-03	3,18E-02			atala se a con	State of the state	Sector Sector	The second	の語言な	is optionane	7.265-03	3.18E-02 PF	(B Cost 3.	2E-05
2-Methylnaghthalene	91576							のないの	Mar North	2.76E-05 Ib/R	Mscf 5.01E-	06 2.19E-06	1.84E-07	ID/MMB/tu	3.77E-05	1.66E-04	2-Methylnaphiralene	J.77E-05	1.65E-04 W	1	45-07
3-Methytchlorarthrena		いていたの					のないので、		10000	2.07E-06 Ib/0	thisci 3.75E-	07 1.64E-05	50 35 MG	Safe and the set of th		PLACE AND	3-Methylori oranthreno	10-354 E	1.64E-06 Na	4 Gas 2.1	GE-09-
Monochiorabipheny	「「「「「「「」」」」	のないの言葉を言語	100 M	のであるの	のない		14.4 B 2 2 2 2			ananya arang			2.538-10	IPMW807	5.16E-08	2.27E-07	Morachiorobiphenyl	5.19E-08	2.27E-07 W	2	0E-10
Nethyl thromkie (bromomethene)	748.78	1.846-04	19Vql	1.44E-03	6.32E-03	1.84E-04	biton	2.00E-03	8.77E-03		Contraction of the second	100 N. C. MARINE	1.736-05	ID/MMBtu	3.64E-03	1.566-02	Methyl bromide	3.54E-03	1.55E-02 W	8	3E-05
Methyl chordde	74873	6.10E-04	년 년	4.785-00	2.096-02	6.10E-04	lten	6.63E-03	2.915-02				2.06E-05	IbAMBlu	5425-03	2.37E-02	Methyl chloride	6.63E-03	2.01E-02 PF	B Coal 3.	BE-05
Mathyl ethyl ketone	78833	4.49E-04	holdi	3.52E-01	1.54E-02	4.49E-04	Dton	4.88E-03	2,14E-02				8.21E-08	NEVENUE	1.27E-03	5.58E-03	Methyl ethyl katons	4.86E-03	2.14E-02 PF	B Cost 2.1	46-05
Methyl hydrazine	60341	1.96E-04	te Mon	1.53E-03	6.71E-03	1.066-04	Ibiton	2.136-03	9.32E-03						ALC: N		Methyl hydrazina	2.13E-03	0.32E-03 PF	B Coal 1	26-05
Methyl methacrytate	80828	2.30E-05	nofal	1.600-04	7.90E-04	2.30E-05	Ibtion	2.60E-04	1.106.03							24-24 C	Methyl methocylolic	2.50E-04	1.10E-03 PA	B Coal 1.	20-30
Methyl tert butyl ether	1634044	4.03E-05	th/on	3.16E-04	1,38E-03	4.03E-05	1bftcn	4.38E-04	1.92E-03		語の必要に語るの		派にある政治		3263/00		Methyl lert buryl ether	4.38E-04	1.82E-03 #PF	B Coel 2:	26-32
Methylene chloride (Dichloromethane)	75092	3.34E-04	thon	2.61E-03	1.468-02	3.34E-04	Iblion	3.63E-03	1.50E-02		朝気を見ためない		3.34E-04	(b/MABtu	6.84E-02	2.98E-01	Methykene zbbride	6.84E-02	2.99E-01 W	к ро	AC-D4
2-Milliogrenoi	86755				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1						100 No.	の言語のです。	2.78E-07	(b/MkiBru	6.68E-05	2,48E-04	2-Mibrophenol	6.666-06	2.48E-04 W	2; 2	8E-07
4-hBrophanol	100027				Market State			ST CALL ST CALL	10 10 10 10 10 10 10 10 10 10 10 10 10 1				1.27E-07	(b/MABRU	2.596-05	1.14E-04	4-Nitrophanol	2.596-05	1.14E-04 Wi	21	TE-DT
Perilachiorobipmenyi	28/A7607	Constant and the second second second second second second second second second second second second second se		No. of the second		1000 Call 1000		ALL COMPANY OF BUD		地市は、おいろうと行き		No. No. No.	1,285-09	(D/MMBtu	2.83E-07	1.246-08	Pertacticrobiphunyt	2.83E-07	1.24E-09 W	xod 1.3	8C-C9
Persection option of	8/900		Contraction of the local distribution of the			10.000 March 200						がわけ	5.875-08	Ib/MMBbs	1.205-05	5.27E-05	Pentachterophenol	1.205-06	527E-05 W	20	32
	100000		la base		0.000 M	100 M				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		ALC: NO.	0,885-10	NUMPL	173571	5.3/E-01	Perjóstra	1.236-07	5.37E-07 W	2	8E-10
	202001	1.915.01		1.44E-04	10,552.04	1.010		2.005-04		N SALAT			0.875-05	EMM/Bhu	1.20E-02	5.27E-02	Prenci	1 206-02	5.27E-02 W	25	8
Froportiesonyde	123480	A JIE - OF	IONON	5.43E-U3	1.005-02	4.3/644	UDIVO	4.705-03			1000 N 1000		7.02E-06	IDM94184	1.44E-02	6.30E-02	Freptaneldehyde	1,44E-02	8.30E-02 W	2.C	8.9
Propanal	120300	State State	1.72 Sec. 18		1. Star	A ABS ALL AND A	C-4250 (0010)						3.686-06	DAMMER	7.545-04	3.306-03	Propanai	7.548-04	3.30E-03 We	33	85-06
Stylene -	4047 1000	LOOD ADD TO ADD TO ADD TO ADD	THE REPORT OF THE REPORT OF THE REPORT OF THE REPORT OF THE REPORT OF THE REPORT OF THE REPORT OF THE REPORT OF	2,205-10 (New Work	COLUMN THE	2.00F40	AUROS (*****) 17	0.10E44	50-9/C1				2.185-03	DANABEU	4.48E-01 :	1.366+00	Styrene	4 485 01	1.96E+00 Wo	2	87 W
	POPEID02	NUMBER OF A CONTRACT OF A CONTRACT OF A CONTRACT OF A CONTRACT OF A CONTRACT OF A CONTRACT OF A CONTRACT OF A C	Contraction of the second second second second second second second second second second second second second s	PLAN NACEDAR	· YOC VO	a new accesso	NACES STREET	e voe de	States of States				2.886-09	ID/WHENU	0.65E-07	2.565-08	T abscribrationabiphany	5.69€-07	2.58E-08 Wo	2	80-08
1 AUROLANDAU SERVE	H01.751	4-306-00		2.000 L	1./UC/US	9,905-00		1.005-04		5.44-2000 Belle		A LOK LOS	4.3re-05	DMMBlu	8.98E-03	1.BZE-02	Tatrachicocethylane	3.965-03	3.92E-02 Wr	Ŧ	16.05
Toluene	108853	2.785-04	Non Union	Z 16E-03	9.48E-03	2.76E-04	Post Concernance	3.005-03	1.32E-02	591E-03 15/0	March 7.0664	04 3.115-03	1.066-03	<b>DAIMBI</b>	2.17E-01	9.50E-01	Toluene	2.17E-01	9.50E-01 Mr	8	8
0-1 cluaidehyrde	029204			100 00 00 000	Constant of the							240 Mar 199	8.266-08	HEMMA	1.705-63	2 (K B	o-Toluskjehtyde	1.706-03	7.43E-03 MG	8	90-ij
p-Toluationhyde	040401	STATES STATES	Constant of the	の「「「「「「「」」」	1 304 304 10	COLUMN DE REGISTRE		STATE AND A	511251 26 3			スないの記念して	1.27E-06	DMMBIU	2.596-03	3.14E-02	p-Trahaldehyde	2.596-03	1.14E-02 Mg	5 2	7E-05
T ACTION OD OTHER Y	の後になるのである。	などのであるという	通行 計画 開合と	ないとないないないが	No. of Society, a	A STATES AND AND AND AND AND AND AND AND AND AND	Sec. 250 - 251 - 25	いたないないという				などのであるという	2,996-09	PMMBin 1	6.13E-07	2.54E-06	Trichicrobipheny	6.13E-07	2.68E-06 W	5 5 8	1E-09
																		Prepar	ed by ATH CD	nsuitants, Lid	

NIAU Emission Est & TAC Analysis (Final 01 25 07) Future 100%

Toluene o-Toluaidshyda p-Toluaidshyda Thdhlorobiphany

Pg 2 d 3

Proposed Circulating Fluidized Bed Batler Potential Emissions

Specification Orculating Fludszed Bed 185 (MM DRUTH) Boller Paramotore Boler Type Meximum Reled Hebi Inp.0. (M) Gross Output (MM/hr) 

Northern Michigan University Marquette, Mi CFB Boiler Project

Approximate; normetly 7)

Natural Gos Naximum Uasge Rate MMacfihr					
Meterial Throughpul (tpy)	66,689	66,329	34,927	198,533	
Materiol Throughput (iph)	7.84	10.39	3.99	22,78	
Material Throughput (bihr)	15,678	21,765	7,974	45,558	
Heating Value (BTU/Ib)	11,800	005'9	23,200	4,500	
Heat Input (HIN BTUAr)	185	185	185	205	
Material Usege (%)	100.0%	100.0%	100.0%	100.0%	
Suitur Content	3.50%	0.80%	0.00%	0.00%	
H Diarial	nal, Bitumbous	oal, PRB	elurel Gas	rgio Waad	

Campound	CAS Defenses		Coal, Bilumi	Enou	•		Coal	'RB	_		Naturel Ga	1		Wash	1 Wood				Maximum	-	
	Number	EmissionFa	actors	Emission	Lates	Emission	Factors	Emission	Rates	Emission	actors	Emission Recos	100 A	tion Factors	Emis	aion Rates	Compound		Haston Rate	in Fuel	Factor
		Vatue	Units	(shirt)	(tay)	Value	Units	(Julie)	(tpy)	Value	Units (1	(hpy) (hpy)	Value	Critica	(Julya)	(Ada)		(mud)	) (te	\$	BAMAG
chlorofluoromethane	75694	100 No. 11	1988 S	1913 Sec. 191	単語にある	のないない			100 CA 100				3 4.72E-0	5 (ILMNBhu	- 9.67E-Q1	1 4,235-02	Trictiscreftuoromethane	9.875-0	00 4 23	PLOS WORLD	4776-1
chlorethene	79016				いいの言語	10 10 10 10 10 10 10 10 10 10 10 10 10 1	日本のない		のための		100 Contrato		3.45E-Q	5 Ib/WNEtb	7.07E-05	1 3.10E-02	Trichterschere	7.075-0	8	00	1464
1-Trickloroethane	71556	2.306-05	hdhan Nar	1.80E-04	7.80E-04	2.30E-05	hol/di	2.506-04	1.106-03	「「ないない」である。			3.57E-0	5 DAMARU	7.31E-05	1 3.206-02	1.1.1.Trictforcetrane	7.316-0	320	Mand	1876
.6-Triotelorophenol	89062						全な構築を	は家族の	の時間の	38.55			2.53E-D	3 BMMBIU	5.196-06	1 2.27E-06	2.4.6-Trichtorotenol	5.950	36 9.7	MINO	3 1.00
yl acetate	108054	B.74E-05	la/tan	6.85E-04	3.00E-03	8.74E-05	Iblian	9.516-04	1175-00	States and	and the states		100 200 000 00A	March 1	States and		Virvé accelate	P StE-0	10	CO DOB Co.	
yl Chloride	75014	「市場をないた」	のないない		石を読みるが		であるので			Constant of the second	るのでの変更	「日本になる」ので、「あい	2 O7E-D	h hAMBlu	4 24F-00	1 965-10	Mind Chiedra	4 9/6 /	190		
seres	1330207	4.26E-05	Ibren	3.34E-04	1.46E-03	4.26E-05	naha	4.83E-04	2.03E-00			ALC: NOT ALC		Sector Sector	N N N N	10 10 10 10 10 10 10 10 10 10 10 10 10 1	Kylanee	V 200 F	3		
Mane	35476			などのあるが		「「ないないない」	1212	「「「「「「「「「「」」」」					2,605-01	DMMBRU	6.89E-23	2.58E-02	o-Xviena	7.00E.0	3 5		
ymuclear Aromatic Hydrocarbons (PAH)																	Polynoslaar Arematic Hydr	Scarbona (PAH)			
enaphihene	83329	5.876-07	lbton	4.60E-06	2.01E-05	5.87E-07	loftan	6.38E-06	2.80E-06	2.07E-C6 1	VAMASCI 3.7	3E-07 1.64E-0	6 1.05E-04	<b>b/MMBI</b>	2.156-04	9.40E-04	Acenaphthene	2.15F.0	14 0.40	A WINN	1 nee v
enaphthylena	208668	2.885-07	biton	2.256-06	9.87E-C6	2.886-07	hon	3.136-06	1.37E-06	2.07E-C6 1	WAMSET 3.73	3E-07 1.64E-4	6.766-00	DIMMER	1.18E-03	5.186-03	Acenseletivelene	1		Paratition in the	A YEE A
store	67641				1 2000 Mar	12.00		1. 1. 2. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.		Section 2 and the			2.195-00	DAMBRU	4.48E-02	1.966-01	Acelone	4.486-00			
hracene	120127	2.42E-07	IMon	1.696-06	3.29E-06	2.42E-07	hohdi	2 83E-06	1.15E-05	2.766-06 2	Withhert 5.0	1E-07 2.18E-0	6 3.456-06	NMMBh	7.07E-04	3.10P-03	Anthracente	TAYEN			
12ald e hyde	100627	1000 No. 600				での語言に		Contraction of the		10 1. 10 10 10 10 10 10 10 10 10 10 10 10 10	の行うないない	「大学家の主要のため」	9.785-03	DOMMERA	2.COE-04	8.76E-04	Percelvatura	2 MEA		1	
vzo(a)antimecene	66563	9.205-06	uang	7.21E-07	3.16E-06	9.206-08	ta/tan	1.006-06	1 39E-06	2.076-08	MMRcf 3.75	15-07 1 1 KdE-0	G 7.4AE.AF	Mahlah	1 STEAK	6 71E-06	Bonney (A) we have			3	7.00%
energe (signere)	50328	4.37E-06	han	3.436-07	1.50E-06	4.376-08	(htten	4 765-07	2 DRF-DR	1 46.06	NULLET 25	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	2 2 0 0 C		1 1 L 1		Degrock(s) drive degra	1.0.16 -0.	8	200M 07	7.486-0
uzo(e)ovterne	192902	の語を授うが明知ったが	10250346-000 000	States of the	1. 192 - 192	いたのであるのな	10 2 1 2 2 2 2 2 2 1 2 1 2 1 2 1 2 1 2 1	10.100 EVA 10.10	Constantine C	av ant y	AAted 25					1007	BURYDRING	7-37L G		DOOM ED	2,881.0
and by the second second second second second second second second second second second second second second s	205002	A CONTRACTOR OF A CONTRACTOR O					100 100 100 100 100 100 100 100 100 100		01.0000000		VINNECT C.D.		2.33E-U		6,135-07	2.685-06	Beno(e)pyrene	8.13E-0.	97 2.661	100 M 80	2.996-0
	2000110			10000000000000000000000000000000000000	1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.	and of the design of the	101 2003 100 100			2,0/E-06 II	weeksci 3.7	0E-07 1.64E-U	1.15E-0	EVMMB4u	2.366-05	1.03E-04	Benzo(b)Iluoranthene	2.365-0	36 1.001	04 Wood	1.158-0
120().Kimovantrene	205440						ないがある						1.84E-01	DAMABitu	3.776-05	1.65E-04	Beruco((,k)fluoranthene	3.776-0:	1691 - 1661	-04 Wood	1.84E-0
200(k)thurdenergenergenergenergenergenergenergene	209623	「「「「ない」などの語いので、	る人のたちなからう	にないないないない	18.19.20 St.	NAME AND ADDREED	上野シンを訪	(三年)総会生		2.07E-06   K	WMMsof 3.76	SE-07 1.84E-0	10-311 - 14E-01	h IbMMBbu	B.49E-06	3.72E-05	Benzo(k)fluonanthene	8.45E-04	10 3.72E	-06 Wood	4.14E-0
120(b/,k)/horanthene	「「ないの時代のない」	1.27E-07	nohdi	9.92E-07	4.34E-06	1.27E-07	(puter)	1.385-06	6.03E-06				1115E-01	INMMBh.	2,30E-05	1.03E-04	Benzo(b.j.k)fluoranthene	2.36E-06	1.035	-Do Wood	1.15E-0
vzo(g.n.,l)perytene	191242	3.116-08	thon	2.43E-07	1.07E-06	3.11E-08	lbiton	3.386-47	1.48E-06	1.38E-06 E	VMMscf 2.50	XE-07 1.10E-0	6 1.07E-07	E-MM8thu	2.19E-06	9:00E-05	Benzo(0,h.)bendene	2.166-06	16 9,606	-05 Wood	1075.0
henyl	32524	1.96E-05	thron	1.53E-05	8.71E-05	1.86E-06	then.	2.13E-05	9.326-05								Bitherné	2.13F-0F	400	05 PER Cos	
rysecte	218019	1,15E-07	lbrton	0.01E-07	3.955-06	1.15E-07	Ibfen	1.256-06	5.48E-06	2.07E-06	(Mikeci 3.75	1.54E-0	6 4.37E-06	ID/MMBru	8.96E-06	3.925-05	Christine	R REF.OR	305	Nevel 2	12.1
otoraidet tyde	4170303			感が悪なの	New York	The Alberta with	の変換の影響	194 20 A 194	「「ないない」	No. A Carlo	内部国際になる政治	「日本のない」	S 1.14E-05	(b/MABtu	2.33E-03	1.02E-02	Crotoria Idenvide	2 CREAK	100	Month	
cachtorobiphenyl	2051243	のないの											🥂 3.11E-10	In Thirtheau	6.87E-06	2.79E-07	Decacitarobiohenvi	6.37E-08	8 2.79E	-07 Mode	3.116-31
enzo(a,h)anthracene	53703		No. of Control of Cont	R. S. S. S. S. S. S. S. S. S. S. S. S. S.	語の語言が	N. N. S. S. S. S. S. S. S. S. S. S. S. S. S.		STATES AND IN THE REAL PROPERTY OF A DECEMBER OF A DECEMBE	調整の	1.36E-06 IL	WMART 2.50	110E-07 1110E-0	6 1.05E-06	INMMBO	2.15E-09	9.40E-08	Dibenzo(a,h)pnbracene	2.156-06	16 9.40E	O6 Wood	1055-01
-Dibromoethere	540438				立場の影響	国家の意思を	は国家教教		のないのである	18 88 8 S	和正式 医生物	Second Second	S 6.33E-05	ISMM BU	1.30E-02	5.6BE-02	1,2-Ditromoethene	1.30E-02	12 5.66E	-02 Wood	6.33E-00
histoblatenyi	2060682	1	19 8 8 1 A	(のないのの)のの	A CONTRACT	「「「「「「「「「「「」」」」」	国際語の	語をなる	国際の語名の	高齢があ		100 Carl 100 Carl	2 8.51E-10	DUMMENU	1.74E-07	7.646-07	Dishterohyteryf	1.745-03	V 7.BAE	-07 Wood	6.51E-10
-Dichloroethane	107082			1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.			<u> </u>	経験記述	の時間の		1400		्रें 3.346-06	<b>Itelevilletu</b>	0.84E-00	2.99E-02	1,2-Dichlomechane	6.845-03	1 2.99E	-02 Wood	3.34E-04
-Distributionane	78875	またい いたいないかいい	ST AN AND A	STRAIN AND STRAINS	A SUBSET IN		5.88.100 N.C.		いのないの	総合には			🎋 3.80E-06	D/MMBhu	r.78E-03	3.415-02	1,2-0khloropropane	7,786-03	346	02 Wood	3.806-00
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NMU Emission Est & TAC Analysis (Final 01 25 07) Future 100%

Pg 3 of 3

Prepared by NTH Consultants, Ltd.

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CAMPUS MAP - NORTHERN SECTION NORTHERN MICHIGAN UNIVERSITY

MARQUETTE, MICHIGAN DATE: SEPTEMBER 4, 2003









ELECTRICAL LEGEND



2



## Northern Michigan University New CFB Boiler Toxic Air Contaminant Modeling Results

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

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## Toxic Air Contaminant Modeling Results Northern Michigan University New CFB Boiller

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860000	1 0212-02	NIDUL		26200	1.22E-03	4.23E-02	EO-378.6	<b>₽-69-9</b> 2	ອນຂະບອກແດນການດາດການ
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26090 0	50-368 9	IsunnA		1.0	3.27E-04	1.14E-02	2,696-03	0-28-901	6-1 OULSION
% 0000	70-3076	1001 2		011	3.1¢E-0¢	7.43E-03	1.70E-03	258-50-4	ebyfebleuloT-o
M#Z0	1 200 3V2 V	100 02		0005	2.73E-02	10-309.8	2112E-01	5-88-801	Toluene
%000°0	00-71011	lengra	· · · _ · _ · _ · _ · _ · _ · _ · _ · _	1.0	1.13E-03	3'65E-05	£0-396.8	127-18-4	Tetrachioroethylene
%0000	70-7211	Isoura -		1 1.0	7.43E-08	2.68E-06	70-398.2		Levachlorobiphenyl
%600.0	70-3/4-0				2'64E-05	1.96E+00	¢.48E-01	100-42-5	Styrene
%100.0	60-100'7			0001	2°94E-05	1 39E+00	4°48E-04	100-45-6	Styrene
%0100	50-370°C	ISD(I)OV		¥	9.51E-05	3.30E-03	7.546-04	153-38-6	Proparal
% 50000	70-366'7			*	1.81E-03	C-30E-02	1'44E-05_	153-38-6	Propionaldehyde
%00000	60-3025			009	1.51E-03	5.27E-02	1"50E-05	108-96-5	Phenol
9(100:0	10-396 5	lenduð		1.0	1.54E-08	70-376.8	1.23E-07	0-99-861	Perytene
%0000	10 3010		60.0		1.51E-06	50-372.8	1'50E-02	99-28	Pentachtorophenal
%0000'0	2446.06	shou ye		100	1.51E-06	50-372.8	1.20E-06	S-99-78	Pentachlorophenol
9610010	10-360.0	PROVEN		1.9	3.56E-08	1.24E-06	70-358.5		Pentachlorobiphenyl
9670010	20 306 5	ISUNDA		1.0	3.27E-06	1146-04	2'28E-02	1-20-001	tonartganiN-4
%97.0	50 305 F	BUILE		1.0	90-361.7	2.48E-04	50-399'S	9-92-88	konartqovi/V+S
%01.0	E0-300.4	1000 67	800	h	2.88E-03	10-300.1	2.29E-02	81-50-3	anaisrindeN
%180'0	F0-370'1	11201 11.00	L		2.66E-03	10-300.1	2.29E-02	81-20-3	analadian
%00010	60-371.0	1000 67	C	0000	50-319.8	2.99E-01	8.84E-05	2-60-57	Metriviene chloride
%00000	C0-310.6	(00) +7		3000	50-325-05	1.92E-03	4.38E.04	1834-04-4	Wethyl leit bulyl ether
%/00/0	20-300.0		⊢	002	30-391.6	1.10E-03	2.50E-04	9-29-08	Methy methacrylale
%00000	10-3/JA	1001-57		1.0	2.68E-04	9.32E-03	2.13E-03	P-96-34-4	Methyl hydrazine
9611000	FO-2011	IPDUUS	-	0009	\$0-351-9	5.14E-02	4.88E-03	£-£6-87	Methy ethy ketone
%LOD'O	\$0-30CT		91		9.36E-04	2.91E-02	6.63E-03	2-78-47	abinatry kithew
%*100	#0-300 F	1000 57		06	8'39E-U4	20-316-02	6.63E-03	8-78-45	Methyl chloride
%0000	10 200 1	1801162		9	4.46E-04	1'22E-05	80 ∃F2 8	6-68-47	Methy bromide
%0000	1 385 10	ISDURY I		F.0	60-363.8	20-372-27	80-361/9		Monochiorobiphenyl
\$0000	00 340 0	leuro A		10	4'.13E-08	1.64E-06	20-392°S		3-Wethylchioranihrene
%G0000	50 300 V			UL	90°392't	1'99E-04	30-377E-05	9-29-16	enelsrihrigeniyriteM-S
%G0000	70-360 0		28	007	9.15E-04	3.16E-02	7.26E-03	1-69-82	euououdosi
9400010	THE BOOK	10011-13		580	0 12E 04	3.185-02	7.266-03	1-69-82	leophorone
%1100	70-3701	24 001		091	9.56E-04	1.24E-02	2.63E-03	2- <del>1</del> -8-87	ebytaldehytede
947000	60-3652	100 76		002	4'13E-05	1.64E+00	10-392°E	110-24-3	Hexane
76CUUU	90-3667	leurinA		5	2.08E-04	7.23E-03	1.65E-03	I-92-99	Hexanal
10000	5446-00	IsunaA		L'0	1.63E-08	70-389.8	1.30E-07	56601-64-9	Hexachlorobiphenyl
9(008.0	ALA ALA TZ	ICHONA		£.0	60-396't	6.82E-08	1.56E-08	7-12-99982	Muandidonoinasigari
%000°0	(cul/Ba)	DOULD	(and the second	1					
%000°0 ``\\$ Iº %	(cu/6n)	poliod	(£ɯ/Đn)	(ɛɯ/bn)	(districted)	((d))	(Ju/qj)	CAS No.	
%000°0 "1\$10%	(n0,u3) (n0,u3) (ubact	Averaging Poriod	(£ɯ/ɓṅ) ୮୫୪୮	(gw/Bn) TS1I	Rate (gram/sec)	(cbA) Du Kates	yissim3 (14/dl)	CAS No.	Compound