EMEW ELECTROWINNING PROCESS

PREVENTATIVE MAINTENANCE AND MALFUNCTION ABATEMENT PLAN

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August 2018

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SECTION 1

INTRODUCTION

1.1 BACKGROUND

The White Pine Copper Refinery, Inc. (WPCR or "the Facility") is located in White Pine, Michigan. The Facility comprises an electrolytic copper refinery. In summary, copper bearing materials are supplied and refined to produce copper cathode sheets.

Electrowinning is an important control step for the copper refining process at the Facility. This process involves the electrolytic recovery of copper from an aqueous solution of sulfuric acid. The electrowinning process, referred to as the Electrometals Electrowinning System (EMEW), is fitted with an exhaust ventilation system, scrubber, and demister to capture and control sulfuric acid emissions from the process. Emissions from the EMEW system are permitted by Michigan Department of Environmental Quality – Air Quality Division (MDEQ-AQD).

1.2 REGULATORY REQUIREMENTS

MDEQ-AQD issued Renewable Operating Permit (ROP) No. MI-ROP-N7396-2017 on June 22, 2017. Permit To Install number 321-07 for the EMEW system, designated as emission unit EURF02R1, was approved on November 27, 2007 and was incorporated into previous ROP MI-ROP-N7396-2012. WPCR's Air Permit Special Conditions III.1 and IX.1 establish requirements for a Preventative Maintenance and Malfunction Abatement Plan (PM/MAP) for the EMEW that conforms to the requirements of Air Pollution Control Rule 911 (2). In accordance with Rule 911 (2) the PM/MAP (or "the Plan") will specify the following:

- A complete preventative maintenance program, including:

- Identification of the supervisory personnel responsible for overseeing the inspection, maintenance, and repair of air-cleaning devices
- A description of the items or conditions that shall be inspected
- The frequency of inspections or repairs
- Identification of major replacement parts that shall be maintained in inventory for quick replacement

- Identification of the source and air-cleaning devices operating variables that shall be monitored to detect a malfunction or failure, the normal operating range of these variables, and a description of the method of monitoring or surveillance procedures.
- A description of the corrective procedures or operational changes that shall be taken in the event of a malfunction or failure to achieve compliance with the applicable emission limits.

Permit To Install condition III.1 requires that the scrubber and demister serving the process be operating satisfactorily whenever the process is operated. In accordance with EMEW System Special Condition III.2, the electrowinning process shall cease immediately, consistent with safe operating procedures, upon:

a. A dissolved copper concentration of less than 1.0 grams per liter; or
b. Exceedance of 90 minutes between dissolved copper titration testings.

The electrowinning process shall not restart until:

a. The copper concentration has been adjusted: and
b. The concentration confirmed by titration or an acceptable dissolved copper titration test result is obtained following a 90 minute testing exceedance.

These limitations were based on the potential for arsine gas generation if the electrolyte solution contained arsenic, which is feedstock dependent. If the feedstock does not contain arsenic these limitations should not apply, but they are permit requirements.

1.3 DEFINITION OF MALFUNCTION EVENTS

For the purposes of this Plan a "malfunction" is defined by Air Pollution Control Rule 336.1113 and means any sudden, infrequent and not reasonably preventable failure of a source, process, process equipment, or air pollution control equipment to operate in a normal or usual manner. Failures that are caused in part by poor maintenance or careless operation are not malfunctions.

A true malfunction must have a reasonable potential to cause an exceedance in emissions. Following are example malfunction events covered by this Plan that could cause an emissions exceedance.

- Failure of the scrubber fluid supply system – Refers to the complete loss, interruption or unplanned variation in the fluid serving the scrubber.
- Structural malfunction or failure – Refers to failures of any physical equipment, vessels, and ductwork associated with the air pollution control system.

It should be noted that, under Rule 912, a malfunction causing excess emissions lasting more than two hours must be reported to the MDEQ. **Appendix B** includes an example notification and information on reporting the malfunction.

1.4 RESPONSIBLE PARTIES

Overall responsibility for the Plan lies with the WPCR Manager. The underlying responsibilities for implementing the Plan, however, lie with the area operations, maintenance, and environmental personnel. Identified personnel are charged with implementing the plan, documenting malfunction events and corrective actions taken to mitigate the events, updating the plan as required, and

developing the appropriate reports. Plant Operations/Maintenance Supervisor(s) will be responsible for directing of maintenance activities, proper documentation of maintenance activities, and will report to the Plant Manager; The Maintenance Staff will be performing and identifying maintenance activities, and will report to the Plant Operations/Maintenance Supervisor(s) and/or Plant Manager; The Operations Staff will be charged with the proper operation of the Facility, along with identifying problems through direct observation of equipment and/or plant operational indicators, they will report to the Plant Operations/Maintenance Supervisor(s) and/or Plant Manager; **Figure 1** provides an organization chart that outlines the roles and responsibilities of various parties at the WRCR Facility who are charged with the designated activities relative to this Plan.

1.5 PLAN MAINTENANCE AND UPDATES

The PM/MAP will be adhered to by Facility personnel, and the Plan will be updated consistent with any changes in Facility equipment and practices. Any actions taken by Facility personnel that are not consistent with this Plan will require that the Plan be modified. The Plan will also be updated if process or system modifications occur that affect the details of the Plan.

The Facility maintains a complete copy of the PM/MAP in accordance with the Facility's Document Control policy. Copies of the Plan are maintained electronically and at the Plant Manager's office.

1.6 REFERENCE TO STANDARD PROCEDURES AND EQUIPMENT MALFUNCTION CLASSIFICATIONS

Certain sections of this Plan may reference other WRCR Facility documents, including preventative maintenance procedures, standard operating procedures for equipment and systems, and other similar Facility documents. When referring to other documents, this Plan is referring to the most recent version of any such applicable document and is only referring to the portions of

the referenced document that are specifically applicable to the equipment or system to which the relevant portion of this Plan is directed.

In addition, certain types of equipment and system malfunctions that may result in emissions exceeding permit limits have been grouped and classified for reference under this Plan. These equipment malfunction classifications are identified as follows:

- Power failure – Refers to the complete loss, interruption, or unplanned variation in electric supply serving a portion of the equipment or all of the equipment associated with a particular process.

- Loss of feedstocks – Refers to the complete loss, interruption, or unplanned variation in feedstocks serving a unit.

- Loss of scrubber fluid – Refers to the complete loss, interruption or unplanned variation in the fluid serving the scrubber.

- Loss of instrument air – Refers to the complete loss, interruption, or unplanned variation in instrument air serving a portion of or all of the air-actuated equipment associated with a particular process.

- Structural malfunction/failure – Refers to failures of any physical equipment, vessels, and ductwork associated with the air pollution control systems.

- Loss of motor(s) – Refers to a reduction or termination of process liquid flow or hydraulic fluid flow provided by mechanical pump(s) outside of nominal operating limits.

- Loss of fan(s) – Loss of fan(s) can include a reduction or termination of gaseous flow caused by, but not limited to, a physical failure of the fan, housing, or damper system, buildup of material on fan blades, imbalance, loss of motor, failure of starters, failure of drive systems, failure of actuators/cylinders, failure of coolant or lubricant systems, or modulator, etc.

- Loss of valve(s) – Loss of valve(s) can include a reduction or termination of gaseous or liquid flow caused by, but not limited to, a physical obstruction, loss of actuator control, rupture or leakage of weld or flange gasket, or a valve stuck in the closed position. Loss of valve(s) can also include a failure to seat properly in the closed position (i.e., inability to adequately restrict or terminate flow).

- Loss of piping – Refers to a reduction or termination of process liquid, hydraulic fluid flow, or gas flow caused by, but not limited to, such things as a physical obstruction, rupture or leakage of connecting weld or flange, and material failure. Also refers to the dampers and valves within the piping that impact the ability of the operator to control the flow of process liquid, hydraulic fluid, or gas to a system.

- Loss of instrumentation– Refers to the inability of the process logic controller (digital or analog), process monitoring equipment, distributive control system (DCS), sensors, controllers, actuators, cylinders, modulators, solenoids, thermocouples, flame detectors, monitors and monitoring systems (including continuous monitoring systems required to satisfy permit requirements), safety interlocks, etc., to function properly or perform a required task.

- Loss of data handling systems – Loss of data handling systems means the inability to monitor and/or record the appropriate data to ensure the proper operation and control of a permit regulated system. Example equipment includes a process logic controller (PLC), PI Data, other data acquisition system, computer, cabling, etc.

1.7 PLAN ORGANIZATION AND CONTENT

The following information is summarized within the Plan:

- Process Descriptions and Preventative Maintenance – These subsections include an overview of the regulated system and details for the process equipment and air pollution

control and monitoring systems including simple process flow diagrams showing pertinent details and routine maintenance required to ensure normal operation.

- Malfunction Events – Where applicable, subsections are included for regulated systems that include important definitions, provide details for process-specific malfunction events and corrective actions.

- Recordkeeping Checklists – Contains checklists for consistency and for minimizing recordkeeping efforts.

SECTION 2

AFFECTED UNITS

As designated in the Permit To Install, the following Processes and Emission Units are included in the Plan:

- EMEW System
- Scrubber and Demister serving the sulfuric acid solution storage tanks associated with the EMEW System

These process and air pollution control equipment are collectively identified as Emission Unit EURF02R1 in the permit.

Figure 2 schematically depicts the processes and illustrates the relationship between the electrowinning process and the scrubber and demister system.

2.1 EMEW SYSTEM

2.1.1 Electrowinning Process Description

The Facility operates two separate but related Electrometals Technologies Limited Electrowinning (EMEW) plating plants designated as EMEW#1 and EMEW#2. The primary EMEW plant, EMEW#1, was designed to maintain a constant copper concentration within the refinery, within the limits of the production capacity for the Facility. EMEW#2 was designed to deplete copper in the Facility's bleed stream. The complete EMEW operation is controlled by a PLC that is interfaced to the Facility's DCS, which can be queried to produce an operating log. The system can operate 24 hours per day, 7 days per week with EMEW #1 in a mode of continuous feed stock

supply and removal and EMEW #2 in a batch sequencing or continuous feed stock supply and removal mode.

In summary, an electrolytic solution containing copper is circulated rapidly through a bank of plating cells. Direct current power is applied across each cell and copper plates as a solid sheet on a permanent stainless steel cathode and is harvested by removing the cathodes and mechanically separating the pure copper cathode. Plating cells are of a closed top design with no direct emissions. Electrolyte solution vapors are collected from the solution tank vents and directed to a scrubber.

Pilot studies using the EMEW System may occur, up to certain limits, without the need to operate the air pollution control equipment as long as the emissions are in compliance with the limitations established in Rule 291 of the Michigan Air Pollution Control Rules, being R 336.1291 Permit to Install Exemptions; Emission Units with “de minimis” Emissions. Acid mist is generated in the sulfuric acid solution tank(s) when bubbles of oxygen or hydrogen burst on the surface. During historic operations of the EMEW using electrolyte from the refinery, gas generation occurred and sulfuric acid mist generation was possible. During the dissolution of copper oxide as a feedstock, gas generation does not occur based on communication from emewCorporation, therefore sulfuric acid mist is not generated. In addition, EPA guidance indicates that in aqueous solutions of sulfuric acid, “at concentrations below approximately 75% [sulfuric acid], the vapor that evaporates from the solution is essentially water” (EPA-745-R-97-007). Therefore, appreciable sulfuric acid vapor generation is not expected at the low acid concentrations (typically less than 20%) used for pilot studies. To conservatively comply with Rule 291, WPCR has determined that if 100 or less cells of the EMEW system are in operation using copper oxide as the copper source that the potential emissions are “de minimis” in accordance with Rule 291 and therefore operation of the air pollution control equipment is not necessary. If alternate copper sources are used, documentation will be developed and maintained demonstrating compliance with Rule 291 or other permit exemptions, or the air pollution control equipment will be operated.

2.1.2 Air Pollution Control Equipment

The EMEW System includes a ventilation system that serves the sulfuric acid solution storage tank(s). Acid vapors or mists are collected and conveyed to a COLAG Mist Vapor and Fume Collector, referred to in the Permit To Install as a Scrubber Demister. Air enters the unit at high velocity and is evenly distributed by a perforated plate. Water, the scrubbing fluid, is supplied to the perforated plate and entrained upward to the reaction pad. The reaction pad is constantly flooded with water, creating turbulent bubbling which scrubs sulfuric acid mists from the air stream. Liquid droplets which pass from the reaction pad are trapped by the sloped eliminator pads and drain along with other waste to the scrubber drain.

As indicated in Section 1.2, Permit To Install condition III.1 requires that the scrubber and demister system be operating properly whenever the EMEW is operating. Proper operation is defined as the pressure drop and liquid flow rate being within an appropriate range established by the manufacturer. The water flow range is based on the operating manual which specifies 0.88 to 3.15 gallons per minute (GPM). To provide a reasonable tolerance around this figure, a water flow range of about 0.5 to 4.0 GPM should be considered normal. Above or below that range, water flows should be adjusted.

The manual predicts an operating differential pressure (dP) of about 3.1 to 5.4 inches. Plant experience is that brand new filters yield a dP of about 5.5 inches, while filters in service for reasonable periods of time yield 7 inches of dP or more. To allow for air-flow variations and filter loading variation, it would be reasonable to have an operating range of 2 to 8 inches of filter dP. Below that range would indicate low air flow or a filter bypass, while above that would indicate excessive air flow or high filter loading. Corrective actions would be to verify fan flow, look for leak/bypass (low dP), or change the filters (high dP).

Upon startup, these values will be manually recorded at six-hour intervals, twice per 12-hr shift. If exceedances of operating parameters are noted, operations personnel will make adjustments as necessary. If the exceedance is not corrected by adjustments, supervision will be notified to initiate

further corrective actions. In the future, these parameters may be monitored on a continual basis by the Facility's DCS. Compliance with the specified ranges will be based on six-hour block averages. When values fall outside of the designated limits, operators will be notified by alarms. The DCS can be queried to produce an operating log.

2.1.3 Preventative Maintenance

The Facility employs maintenance staff to service all aspects of plant operations. Preventative maintenance (PM) activities for each operation and piece of equipment are based on manufacturer guidelines and operating experience. Once preventative maintenance activities are identified, they are manually tracked or entered into a maintenance management database which generates a preventative maintenance calendar and work orders for required preventative maintenance tasks. Additionally, the system accommodates the generation of work orders for non-scheduled maintenance tasks.

The Facility may use Microwest Software Systems, Inc. Advanced Maintenance Management System (AMMS) application to manage and track maintenance activities. Work orders generated manually or by AMMS are provided to appropriate maintenance staff for action. When the work order is completed, hours are entered into the Facility's maintenance management system, spare parts are ordered to maintain the spare parts inventory (**Appendix A**) at adequate levels, and the hard copy work order is filed. Maintenance will be performed and scheduled as required or as needed. Refer to **Table 2-1**.

TABLE 2-1 EURF02R1 Preventative Maintenance Program		
Air Pollution Control Equipment		
Item/Condition to be Inspected	**Frequency of Inspection or Repair**	**Recordkeeping Method**
Scrubber	Routine per AMMS or manual log, periodic visual, repaired as necessary	AMMS/Daily Operating Log, Work List or Report
Demister	Routine per AMMS or manual log, periodic visual, repaired as necessary	AMMS/Daily Operating Log, Work List or Report
Process Equipment and Structural Components (Ductwork, Piping, Tank(s), etc.)	Periodic visual, repaired as necessary	AMMS/Daily Operating Log, Work List or Report

2.1.4 Malfunction Events

For the purposes of this PM MAP, malfunctions that can result in excess emissions have been grouped into three distinct categories: Process Support/Feed Stream Malfunctions, Process Equipment Malfunctions, and Air Pollution Control/Monitoring Equipment Malfunctions. The three types are summarized in **Table 2-2**. A description of each type of malfunction follows:

- Process Support/Feed Stream Malfunctions are malfunctions that result in the partial or full loss of feedstocks (e.g., electrolyte, sulfuric acid, or power).
- Equipment Malfunctions are malfunctions that result in partial or full loss of the EMEW Process.
- Air Pollution and Monitoring Equipment Malfunctions are malfunctions that result in partial or full loss of the air pollution control equipment or the sensors (including data acquisition systems) that monitor air pollution control equipment performance.

Table 2-2
List of Malfunction Events and Abatement Actions for the EMEW System

Malfunction Event	Potential Release Point	Abatement Action
Process Support/Feed Stream Malfunctions		▪ Notify Maintenance ▪ Notify Operations Supervisor ▪ Notify Environmental ▪ Discontinue process operations ▪ Identify and correct problem ▪ Reset PLC ▪ Verify that problem has been corrected ▪ Resume process operations
Power Failure Loss of feedstock flow	Building Scrubber Stack	
Process Equipment Malfunctions		
Power failure Loss of pumps Loss of valves Loss of PLC or DCS	Building Scrubber Stack	
Air Pollution Control/Monitoring Equipment Malfunctions		
Loss of power Loss of pumps Loss of fans Loss of scrubber fluid flow Loss of DCS Pressure drop outside of range Flow outside of range	Scrubber Stack	

2.1.5 Record Keeping

Records are developed and maintained in accordance with the Facility's document control procedures. Records associated with the Facility's PM/MAP include:

- DCS generated operating logs for the EMEW,
- DCS generated operating logs for the scrubber and demister system,
- Manual logs of scrubber/demister parameters and other operating parameters,
- Titration records,
- Completed work orders,
- Correspondence with MDEQ regarding any malfunction events or plan revisions.

If at any time the PM/MAP fails to address or inadequately addresses an event that meets the characteristics of a malfunction, the WPCR will amend the PM/MAP within 45 days after such an event occurs and notify MDEQ.

SECTION 3

RECORD RETENTION AND REPORTING REQUIREMENTS

WPCR will keep, in a satisfactory manner, PM/MAP records at the Facility for a period of at least five years and make them available to the Department upon request.

WPCR will notify MDEQ of an abnormal condition, start-up, shut down, or malfunction that results in emissions of a hazardous or toxic air pollutant which continue for more than one hour in excess of any applicable standard or limitation, or emissions of any air contaminant continuing for more than two hours in excess of an applicable standard or limitation.

WPCR will provide notice to theMDEQ-AQD, Upper Peninsula District Supervisor, (1504 West Washington Street, Marquette, Michigan 49855, telephone 906.228.4853) not later than 2 business days after discovery of the abnormal condition or malfunction.

Written reports, if required, will be filed with the Department within 10 days after the abnormal condition or malfunction is corrected, or within 30 days of discovery of the abnormal condition or malfunction, whichever is first.

The written reports will include:

- The time and date, the probable causes or reasons for, and the duration of the abnormal conditions, start-up, shutdown, or malfunction.
- An identification of the source, process or process equipment which experienced abnormal conditions, or which malfunctioned and all other affected process or process equipment that have emissions in excess of an applicable requirement, including a description of the type and, where known or where it is reasonably possible to estimate, the quantity or magnitude of emissions in excess of applicable requirements.

- Information describing the measures taken and air pollution control practices followed to minimize emissions.

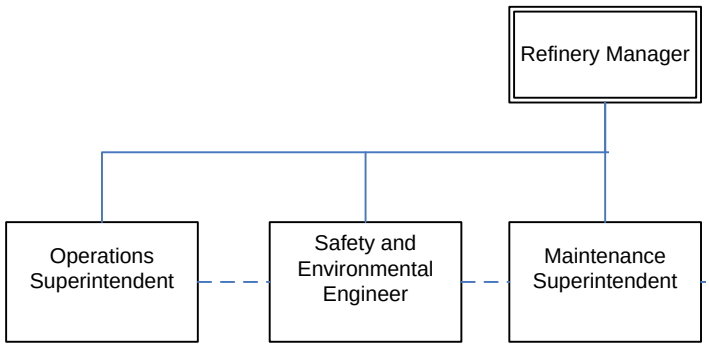
- For abnormal conditions and malfunctions, the report shall also include a summary of the actions taken to correct and to prevent a reoccurrence of an abnormal condition or a malfunction and the time taken to correct the malfunction.

- Certification by a responsible official of the truth, accuracy and completeness of the written report.

A template for a notification letter is provided in **Appendix B**.

FIGURES

Figure 1. White Pine Copper Refinery, Inc. Functional Organization for PM/MA Plan Implementation



Responsibilities

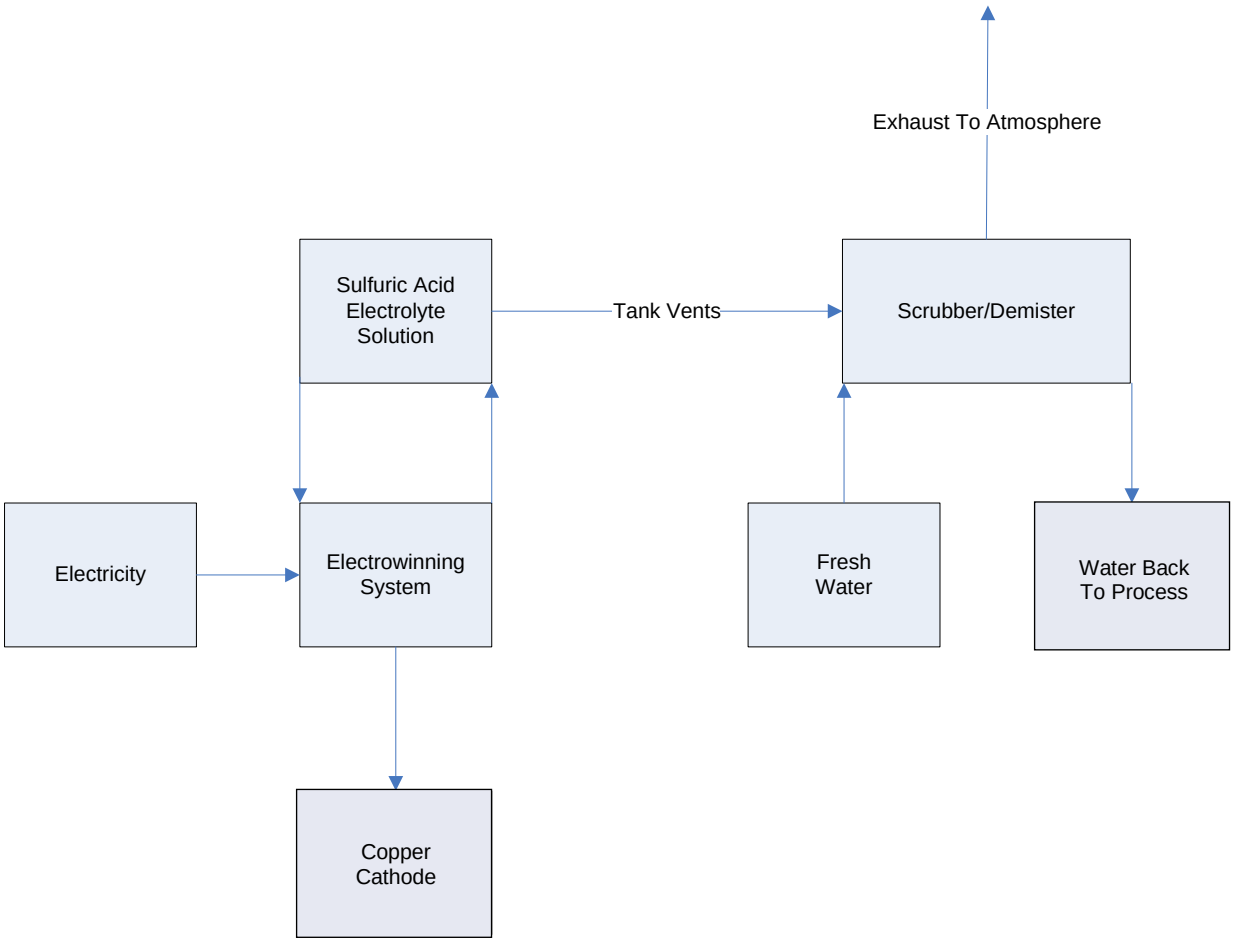
Refinery Manager – Overall Responsible for PM/MAP Implementation

Operations Superintendent – Operating Systems in accordance with PM/MAP

Safety and Environmental Engineer – PM MAP Maintenance

Maintenance Superintendent – PM/MAP Implementation, Work Order Response

Figure 2. White Pine Copper Refinery, Inc. Electrometals Electrowinning Process Flow Diagram



APPENDIX A
TYPICAL SPARE PARTS INVENTORY

Typical Spare Parts for the Scrubber and Demister

Drive belts
Scrubber pads
Scrubber racks
Motor
Spare fan
Flowmeter
Differential pressure meter

APPENDIX B
MALFUNCTION NOTIFICATION REPORT TEMPLATE

Date

Michigan Department of Environmental Quality
Air Quality Division
Attn: Upper Peninsula District Supervisor
1504 West Washington Street
Marquette, Michigan 49855

Subject: White Pine Copper Refinery, Inc.
Malfunction Notification Report

To Whom it May Concern:

The White Pine Copper Refinery is submitting this Malfunction Notification Report pursuant to MDEQ Rule 336.1912. This report provides a summary of actions taken during a malfunction event. The fax copy of this report satisfies the requirement to notify MDEQ within two (2) business days of the event. The original copy of the report will be submitted to the Agency within ten business (10) working days of the event. A full description of the event is provided below.

Regulated System:
Date:
Time:
Duration:
Event Type:
Probable Cause:
Estimated Emissions:
Corrective Actions:
Plans to prevent reoccurrence:
Malfunction Abatement Plan Followed: Yes/No

The Preventative Maintenance and Malfunction Abatement Plan have been updated to include preventative maintenance and malfunction abatement actions applicable to this event.

If you have any questions, or require additional information, please contact me at 906-885-7100.

Sincerely,
White Pine Copper Refinery, Inc.

Dick Barlock
Refinery Manager