NorthMet Mine and Ore Processing Facilities Project

Mineral Fibers Data Related to the Processing of NorthMet Deposit Ore

Addendum 02

Fine Particle Air Emission Control Technology Update

Prepared for
PolyMet Mining Inc.

December 2011
Version 2

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1.0 Introduction

The October 2005 Scoping Decision Document for the NorthMet project Environmental Impact Statement (EIS) identified that the "… EIS will provide information about the presence of fibers in the NorthMet deposit . …". Since February 2006 fibers-related information has been submitted to the Minnesota State Agencies (Department of Natural Resources, MDNR; Pollution Control Agency, MPCA; Department of Health, MDH) for their review and consideration. The report entitled *NorthMet Mine and Ore Processing Facilities Project, Fibers Data Related to the Processing of NorthMet Deposit Ore* (June 2007), hereafter referred to as the "2007 Mineral Fibers Report", provided the bulk of the fibers-related data and information.

Amphibole and serpentine mineral fibers are of primary interest for this project. Overall, amphibole mineral fibers were found to represent a relatively small percent of the mineral fibers associated with the processing of NorthMet ore (Flotation Pilot Testing in July and August 2005); amphibole mineral fibers were approximately 9 percent of the fibers identified from all collected samples of ore, tailings and flotation process water. Serpentine mineral fibers were not identified in samples of ore, tailings or process water collected from the Flotation Pilot Testing. However, PolyMet's petrographic observations indicate that serpentine minerals are about two percent of the minerals associated with the waste rock from the NorthMet Project.

Data provided in the 2007 Mineral Fibers Report indicates that more about 95 percent of the mineral fibers identified in samples collected from the Flotation Pilot Testing were 3 microns or smaller in size, with most being less than 2 microns in size. Therefore, $PM_{2.5}$ (fine particulate) is being used as a surrogate for all mineral fibers, including amphibole and serpentine mineral fibers.

Ongoing discussions between PolyMet and the state agencies resulted in proposed project changes, including an agreement by PolyMet to further reduce potential emissions of fine particles. Addendum 01 to the 2007 Mineral Fibers Report was provided to the Minnesota State Agencies in September of 2007. That addendum reflected the proposed project changes at that time and provided summary information on fine particle emission control technology. The summary information on fine particle emission control technology was obtained from the original review of fine particulate controls that was detailed in a separate report entitled *Emission Control Technology Review for NorthMet Project Processing Plant* (October 2007 submittal to the MPCA). The available information at that time identified that baghouses provided the best control for fine particulates.

PolyMet agreed to install emission controls in the Crushing Plant that are consistent with the best available control technology (BACT) used in the metallic ore processing industries for fine particulates (Addendum 01 to the 2007 Mineral Fibers Report).

In February 2009 Addendum 01 to the *Emission Control Technology Review for NorthMet Project Processing Plant* (October 2007) was prepared and provided an updated emission control technology review. Since the February 2009 addendum, PolyMet has proposed several refinements for controlling fine particle emissions associated with the proposed project. These changes include the use of cartridge filters for some emission units and the recycling of building air to reduce energy consumption and to reduce NO_x emissions from the space heaters to be used for building heating. Other changes to the Project have also been proposed by PolyMet. The project as currently proposed is described in NorthMet EIS Draft Alternative Summary Revised March 4, 2011 and NorthMet Project Description Version 3 submitted September 13, 2011.

Because of the proposed changes to the Project, the MPCA requested an update to the emission control technology review to provide information for the Supplemental Draft Environmental Impact Statement (SDEIS) to account for any advances in $PM_{2.5}$ control technology since February 2009 and to ensure that the particulate emission control equipment selection for the Project is consistent with other projects currently going through Prevention of Significant Deterioration (PSD) review in Minnesota. This updated review of fine particle emission control technologies is provided in a revised addendum to the *Emission Control Technology Review for NorthMet Project Processing Plant* report (November 2011). With the proposed control technologies, potential $PM_{2.5}$ emissions from the Crushing Plant are estimated to be about 134 tons/year (potential emissions based on equipment with a design processing rate of 100,000 tons/day). Actual emissions associated with a processing rate of 32,000 tons/day are expected to be lower.

Information from the November 2011 emission control technology review update for fine particles is summarized in this second addendum to the June 2007 Mineral Fibers Report.

This document is being provided as a stand-alone document for review and it will be integrated into the NorthMet Project Air Data Package after acceptance by the Lead Agencies. Any discrepancy between this document and the NorthMet Project Air Data Package will be resolved in favor of this document.

2.0 Update to Emission Control Technologies for Ore Crushing

Ore crushing and handling sources at the Plant Site have the potential to release mineral fibers to air. A brief overview of potential emission sources is provided below. The updated technology selection for sources of fine particulate air emissions is also summarized below. Additional details on the control technology evaluation are provided in the November 2011 Revised Addendum 01 to the *Emission Control Technology Review for NorthMet Project Processing Plant.*

2.1 Overview of Plant Site Operations and Sources of Particulate Air Emissions

Crude ore is delivered to the plant by rail car. Rail cars are tipped to unload the ore into the coarse ore crusher. Coarse ore crushing consists of two stages of gyratory crushing (primary and secondary crushing). After coarse ore crushing, the ore is transported into the coarse ore storage bins via pan feeders and conveyors. The two stages of fine ore crushing (tertiary and quaternary) are fed by vibratory feeders from the crude ore bins. Ore is screened after the first fine crushing stage allowing ore that is small enough to bypass the second stage. Ore from the fine ore crushers is fed to the fine ore storage bins via conveyors. Fine ore is transported from the fine ore bins to milling via vibratory feeders and conveyors. The final ore size reduction step is accomplished by wet milling. Wet milling occurs in rod mills followed by ball mills. The milled ore is conveyed to ore concentration in an ore/water slurry.

Sources of particulate matter, PM_{10} and $PM_{2.5}$, in the crushing section of the plant include crushers, screens, vibratory and pan feeders, and material drops. All crushing and screening equipment and conveyor transfer points will be enclosed and ventilated to dust control equipment. Fine particulates collected by dust control equipment will be recovered to the process by adding to the ball mills, with the exception of the Tripper Cars Dust Collectors. Dust collected by the Tripper Car Dust Collectors will drop into the ore storage bin associated with the Tripper Car. No solid waste stream is generated. No particulates are emitted from wet milling as the addition of water to the ore prevents dust formation.

With regard to mineral fibers, the emissions of potential concern from the crushing operations are in the fine particulate, $PM_{2.5}$, fraction. Particulate emissions that are expected to be associated with the Plant Site ore crushing sources are expected to be essentially 100% filterable (i.e. no condensable particulate emissions).

2.2 Control Technology Review and Selection

A recent search (June 10, 2011) of the U.S. EPA's RACT/BACT/LAER Clearinghouse (RBLC) database was conducted. That search included all $PM_{2.5}$ determinations since January 1, 2000, and the RBLC search output included PM_{10}, PM and TSP limits as well as $PM_{2.5}$ limits. The information provided from the RBLC database identified that for solids material handling and processing types of sources similar to those proposed for the Plant Site, baghouses (i.e., fabric filters) were typically identified as BACT because they are the most effective for both coarse particulate matter (PM_{10}) and for fine particulates ($PM_{2.5}$). In fact the performance differential between fabric filters and other emission control technologies is more pronounced for finer filterable particulate sizes (i.e., fabric filters capture more of the fine particles than do other control technologies). The results from the RBLC database search are provided in the November 2011 revised addendum to the *Emission Control Technology Review for NorthMet Project Processing Plant* report.

In summary, the RBLC database identifies that fabric filters are considered to be the best controls currently used in the metallic ore processing industries for fine particles.

2.3 Considerations for Control of Fine Particle Emissions

The November 2011 revised addendum to the *Emission Control Technology Review for NorthMet Project Processing Plant* report includes an updated and more detailed discussion on fabric filters, including additional types of filter media for filter bags and cartridges that are now available. The information presented here is a brief summary of items considered pertinent to the control of fine particles from air emission sources associated with ore crushing.

In this addendum, the term "fabric filter" is used as a generic term to indicate filter bags or cartridge filters. A fabric filter (baghouse or cartridge filter) consists of a number of individual filters (filter bags or cartridges) placed in parallel inside of an enclosure. Particulate matter is collected on the surface of the bags or cartridges as the gas stream passes through them. The dust cake which forms on the filter media from the collected particulate can contribute significantly to increasing the collection efficiency.

Overall, when considering emission rate, cartridge filter systems can be considered to perform in a manner consistent with conventional filter bags. However, the size of cartridges is limited, which means that a cartridge filter cannot be used in applications where large volumes of air must be treated.

The main operating limitation of a fabric filter is that its operating temperature is limited by the bag material. Most commonly used filter bag materials are limited to 250ºF – 300º F. Lower temperatures can be accommodated at ambient moisture levels (i.e. processes where appreciable quantities of water are not added to the exhaust gas). Fabric filters do not operate well when there is a significant amount of liquid phase water in the stream being treated. The moisture causes the particulates to form a very thick, wet and heavy cake that plugs the bags and cannot be removed. The plugging significantly reduces or blocks the airflow increasing the pressure drop across the bags or completing making the unit inoperable. High moisture levels can also weaken some bag materials (e.g. polyester) due to hydrolysis, resulting in reduced bag life.

In summary, fabric filters are most effective controlling sources with filterable particulates and are less effective controlling moist hot exhaust streams with condensable particulates. In addition, fabric filter media is more effective at removing submicron particles than electrostatic precipitators (ESPs) or wet scrubbers.

3.0 Proposed Control for Fine Particle Emissions Associated with Ore Crushing

PolyMet has agreed to install emission controls on ore crushing operations which are consistent with the best controls currently used in the metallic ore processing industries. This will ensure that emissions of fine particulate matter from ore crushing sources are controlled by state of the art emission controls consistent with recent BACT determinations in similar industries.

For the ore crushers and associated material handling sources, PolyMet proposes fabric filter (baghouse or cartridge filter) controls with a design specification of 0.0025 grains per dry standard cubic foot of air (gr/dscf) as measured by U.S. EPA Method 5. Fabric filters are the best choice for this application because the exhaust from the crushing operations will be at essentially ambient temperature and moisture, so there is no need to cool the gas stream to remove condensable particulate matter and problems due to the formation of a wet particulate cake are not expected to occur. Large Table 1 provides a listing of the Crushing Plant emission sources and the proposed control equipment.

PolyMet has also agreed to use cartridge filters followed by High Efficiency Particulate Air (HEPA) filters for controlling fine particulate matter for selected sources when recycling controlled emissions exhaust streams back into buildings (Large Table 1). HEPA filters are used when exhaust air from the fabric filter is routed back into the building to provide an added level of assurance that worker exposure to inhalable dust is minimized. In this case the venting of exhaust air back into a building provides a benefit of reduced heating fuel demand that offsets the additional cost and energy usage associated with rerouting of air back into a building. According to manufacturer's data, estimated efficiency of a combination of cartridge and HEPA filters for fine particulate matter is 99.97%[1]. For those emission units that will be vented indoors, audible alarms will be installed on the pressure drop meters. As described in the MPCA's August 16, 2010 memorandum, if an alarm is triggered, the emissions unit will either be shut down or the emissions will be vented outdoors and not indoors. It

[1] The 99.97% control efficiency the manufacturer lists for its HEPA filter is based on a specific test* procedure for measuring HEPA filter performance. The HEPA filter is tested using a thermally generated oil based aerosol with a particle size of 0.3 microns. Inlet aerosol concentration for the test must be 0.15 to 0.18 gr/dscf (80 to 100 mg/l). In comparison, ore crushing dust in the cartridge filter exhaust will be vs. 0.0025 gr/dscf or less.

*Institute of Environmental Science and Technology (IEST) Recommended Practice IEST-RP-CC01 (Type A, C or D) should be understood that the triggering of an alarm does not mean that particulate emissions would have zero control. Rather, the triggering of an alarm means that the pressure drop has gone outside of the specified range but the control equipment (i.e., the cartridge filter + HEPA filter) is still operating and capturing fine particles. However, some adjustment is needed to the equipment to bring it back into the specified range for the pressure drop. The November 2011 Revised Addendum to the *Emission Control Technology Review for NorthMet Project Processing Plant* provides additional details on the agreement with MPCA regarding recycling controlled emissions exhaust back into buildings.

When baghouse/cartridge filter exhaust is vented to the atmosphere, residual dust in the filter exhaust mixes with the ambient air and disperses. Therefore, inhalable dust concentrations at the facility boundary are significantly reduced. Air quality modeling studies previously completed and soon to be updated for the SDEIS have shown that $PM_{2.5}$ emissions from the facility will meet ambient air quality standards. Therefore, the use of HEPA filters would provide little if any benefits for reducing exposure to fine particulates outside the facility boundary, while increasing cost and energy usage.

Equipment performance is expected to be verified through air emissions testing. Performance testing is expected to be conducted at periodic intervals during plant operations. Overall, the use of fabric filters to control potential fine particle emissions from sources associated with ore crushing at the Plant Site are expected to further reduce the potential for mineral fibers to be released to ambient air.

Ambient air concentrations of mineral fibers are currently being monitored in Hoyt Lakes. Baseline ambient air monitoring for mineral fibers was initiated voluntarily by PolyMet in May 2008 at a site located near the wastewater treatment plant in Hoyt Lakes. The monitoring location was approved by the MPCA and the monitoring is being conducted according to MPCA methodology. A 96-hour sample is collected every twelfth (12^{th}) day and is analyzed according to MDH specifications by a MDH-certified laboratory. Ambient air monitoring for mineral fibers will also be conducted for one year after facility start up. The mineral fibers data collected after the facility start up will provide comparison data to the baseline conditions.

4.0 Previously Submitted Reports on Fibers and Fine Particle Emissions

PolyMet Mining, 2007. NorthMet Mine and Ore Processing Facilities Project; Fibers data related to the processing of NorthMet deposit ore. Prepared by Barr Engineering Company. June 2007.

PolyMet Mining, 2007. Addendum 01, Supplemental Information to the Draft Report on Fibers Data Related to the Processing of NorthMet Deposit Ore. Prepared by Barr Engineering Company. September 2007.

PolyMet Mining 2007. Emission Control Technology Review for NorthMet Project Processing Plant. Prepared by Barr Engineering Company. October 2007.

PolyMet Mining 2009. Emission Control Technology Review for NorthMet Project Processing Plant. Addendum 01. Prepared by Barr Engineering Company. February 2009.

PolyMet Mining, 2011. Emission Control Technology Review for NorthMet Project Processing Plant. Revised Addendum 01. Version 2. Prepared by Barr Engineering Company. November 2011.

Large Tables

Large Table 1 Listing of Emission Units Associated with Crushing and Concentrating and Proposed Equipment to Control Fine Particle Emissions

System	Equipment Served	Existing Control Equipment	Proposed Control Equipment (primary control / secondary control)	Performance Specification for Primary Control Device (grains per dry standard cubic foot)	Must Vent Inside?	Could Vent Inside?
Coarse Crushers						
North rail dump	North 60" crusher	Baghouse for 60" crusher	Upgraded baghouse	0.0025 gr/dscf	No	No
North crushing	North distribution box and 36" crushers	Baghouse for 60" crusher	Cartridge	0.0025 gr/dscf	No	No
South rail dump	South 60" crusher	Baghouse for 60" crusher	Upgraded baghouse	0.0025 gr/dscf	No	No
South crushing	South distribution box and 36" crushers	Baghouse for 60" crusher	Cartridge	0.0025 gr/dscf	No	No
North pan feeders	North pan feeder aspiration	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
South pan feeders	South pan feeder aspiration	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
North pan feeder discharge	North transfer to conv. 1A	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
North pan feeder discharge	North transfer to conv. 1B	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
South pan feeder discharge	South transfer to conv. 1A	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
South pan feeder discharge	South transfer to conv. 1B	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
Drive House						
Conveyor transfer point	Conveyor 1A&2A	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Heating season only
Conveyor transfer point	Conveyor 1B&2B	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Heating season only
Fine Crushers						
2A tripper car dust collection	2A tripper car	none	Cartridge w/ HEPA	0.0025 gr/dscf	Yes	Year-round
2B tripper car dust collection	2B tripper car	none	Cartridge w/ HEPA	0.0025 gr/dscf	Yes	Year-round
West tripper car discharge bins	West coarse ore bins	Baghouse + wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Heating season only
East tripper car discharge bins	East coarse ore bins	Baghouse + wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Heating season only
West fine crushers 1 and conveyance	W1 crushing line	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Heating season only
West fine crushers 2 and conveyance	W2 crushing line	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Heating season only
East fine crushers 1 and conveyance	E1 crushing line	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Heating season only
Conveyor 3A, 3B, & 4B transfer point	Conveyor 3A, 3B, to 4B	Wet scrubber	Cartridge w/ HEPA	0.0025 gr/dscf	No	Heating season only

System	Equipment Served	Existing Control Equipment	Proposed Control Equipment (primary control / secondary control)	Performance Specification for Primary Control Device (grains per dry standard cubic foot)	Must Vent Inside?	Could Vent Inside?
Concentrator						
Conveyor transfer point	Conveyor 4B and 5N (North Transfer Point)	Wet scrubber	Cartridge	0.0025 gr/dscf	No	No
5N tripper car dust collection	5N tripper car	none	Cartridge w/ HEPA	0.0025 gr/dscf	Yes	Year-round
Analytical lab	Analytical lab dust collection	Wet scrubber	Cartridge	0.0025 gr/dscf	No	No
North bin ventilation #1	North fine ore bins	1 of 3 wet scrubbers	1 of 8 Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
North bin ventilation #2	North fine ore bins	1 of 3 wet scrubbers	1 of 8 Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
North bin ventilation #3	North fine ore bins	1 of 3 wet scrubbers	1 of 8 Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
North bin ventilation #4	North fine ore bins	1 of 3 wet scrubbers	1 of 8 Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
North bin ventilation #5	North fine ore bins	1 of 3 wet scrubbers	1 of 8 Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
North bin ventilation #6	North fine ore bins	1 of 3 wet scrubbers	1 of 8 Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
North bin ventilation #7	North fine ore bins	1 of 3 wet scrubbers	1 of 8 Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
North bin ventilation #8	North fine ore bins	1 of 3 wet scrubbers	1 of 8 Cartridge w/ HEPA	0.0025 gr/dscf	No	Year-round
Bin discharge conveyance section 1	North concentrator lines 1-3	1 of 3 wet scrubbers	1 of 4 Cartridge	0.0025 gr/dscf	No	No
Bin discharge conveyance section 2	North concentrator lines 4-6	1 of 3 wet scrubbers	1 of 4 Cartridge	0.0025 gr/dscf	No	No
Bin discharge conveyances section 3	North concentrator lines 7-9	1 of 3 wet scrubbers	1 of 4 Cartridge	0.0025 gr/dscf	No	No
Bin discharge conveyances section 4	North concentrator lines 10-12	1 of 3 wet scrubbers	1 of 4 Cartridge	0.0025 gr/dscf	No	No

Notes

Cartridge filter as stated in vendor information is 99.99% efficient on particles sized 0.5 micron and larger.

HEPA filter as stated in vendor information is 99.97% efficient for particles sized 0.3 micron and larger.

Recommended HEPA filter failure detection is to monitor pressure drop across the HEPA filter.

HEPA filters will only be installed and used where venting will occur inside of buildings.

Performance specification of 0.0025 gr/dscf does not include additional potential removal of particulate from the use of HEPA filters (i.e., HEPA filters as a secondary control).

This table only lists dust collectors that will operate at the commencement of operations. Additional, redundant, equipment is included in the emission inventory and impact analyses completed to date and is planned to be included in the air emission permit for the facility.