Design Basis for Incinerator

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1. Introduction

Mary River Project (the Project) is located at Mary River, north Baffin Island, in the Qikiqtani Region of Nunavut.

The Project consists of the construction, operation, closure and reclamation of an open mine pit and associate infrastructure for mining, ore crushing, screening, transportation and shipment of 18 [Mt/a] of high grade iron ore (average of 64.66%) to international markets.

The construction of the Project is assumed to start in 2013 and continue for four years, until 2016. The operating lifespan of the Project is estimated as 21 years, until the year 2035. The closure phase is expected to be three to five years, followed by a minimum of five years of post-closure safety and environmental monitoring and treatment.

Throughout the Project lifecycle, solid and liquid waste will be generated from the Mine Site, port facilities, railway, wastewater treatment plant, accommodation camps, infrastructure, laboratory and medical facilities.

In order to divert putrescible wastes from the landfill and thus prevent problems associated with odors, animals potentially milling at the landfill or the creation of poisonous or flammable gases through decomposition of putrescible materials, incinerators will be installed at each main camp location (i.e., Mine Site, Steensby Port, Milne Port and the Construction Camps).

The incinerator will be used for combustible, non-hazardous wastes including, but not limited to:

- Putrescible wastes from construction and accommodation camps;
- Organics from construction camps;
- Maintenance/workshop waste (such as hydrocarbons and solvents contaminated rags, oil filters, etc.; and
- Sludge from the sewage treatment plant.

Biomedical waste, hazardous waste, non-combustible materials, or treated wood products must not be incinerated. Incineration of plastics will be minimized to reduce the volume of potentially dioxin/furan-related plastics during the procurement process.

The capacity of the incinerator should suit the needs during the construction, operation and closure phase of the Project. However, during operation, the number of people in the camps will be reduced, in comparison with the number of people during the construction phase. For this reason, incinerators will be designed to suit the needs during the operational phase, and therefore more than one incinerator will be located during construction phase, giving the flexibility to remove incinerators or to keep them as a standby facility.

The incinerators used during the lifespan of the Project will meet the requirements of the Canada-wide Standards for Dioxins and Furans and the Canada-wide Standards for Mercury Emissions.

2. Law and Regulations

2.1 Emission Regulations

The Nunavut government has several air quality guidelines. However, there are several other guidelines and objectives that can be applied to the Project. For this reason, Table 2-1 presents a comparative chart with the Federal objectives, the Northwest Territories (NWT) criteria, the Nunavut guidelines, the Canada Wide Standards (CWS), and the World Health Organization (WHO) guidelines, in order to establish a threshold for different contaminants. The value of the threshold is going to be selected base on the most stringent criteria.

Table 2-1: Ambient Air Quality Criteria, Standards and Objectives

Criteria	Averaging Time	Federal Objectives			CWS	Nunavut	NWT	WHO	Threshold
		Desirable	Acceptable	Tolerable					
TSP [$\mu g/m^3$]	24 hr		120	400		120	120		120
	Annual	60	70			60	60		60
PM_{10} [$\mu g/m^3$]	24 hr						50*	50	50
$PM_{2.5}$ [$\mu g/m^3$]	24 hr				30**		30	25	30
SO_2 [$\mu g/m^3$]	1 hr	450	900			450	450		450
	24 hr	150	300	800		150	150	20	150
	Annual	30	60			30	30		30
NO_2 [$\mu g/m^3$]	1 hr		400	1,000				200	400
	24 hr		200	300					200
	Annual	60	100					40	60
CO [$\mu g/m^3$]	1 hr	15,000	35,000						15,000
	8 hr	6,000	15,000	20,000					6,000
O_3 [$\mu g/m^3$]	1 hr	100	160	300					
	8 hr				127***		127	100	
	24 hr	30	50						
	Annual		30						
* Ontario Interim Ambient Quality Criterion (AAQC). Ontario Ministry of the Environment, September 2001.									
** Annual 98th percentile 24-hour concentration, averaged over 3 years.									
*** Annual 4th highest 8-hour concentration, averaged over 3 years.									

There are currently no provincial or territorial regulations regarding the emissions from incinerators for the Nunavut or the Northwest Territories. However, the design of the incinerators used during the Project will meet the requirements of the Canadian Council of Ministers of the Environment (CCME) Canada-wide Standards for Dioxin and Furans (CCME, 2000a) and the CCME Canada-wide Standards for Mercury Emissions (CCME, 2000b). The Table 2-2 shows the performance limits for the incinerators according the CCME CWS for Dioxins and Furans and CCME CWS for Mercury.

Table 2-2: Performance Limits for the Incinerators

Type of Waste	Canada-wide Standards	
	Dioxins/Furans [pg I-TEQ/m^3)]	Mercury [µg/Rm^3]
Municipal waste	80	20
Medical waste	80	20
Hazardous waste	80	50
Sewage sludge	80	70

The Nunavut government does not currently have guidance/regulations related to used oil. As a result, the management of used oil will be regulated by the Used Oil and Waste Fuel Management Regulations, N.W.T. Reg. 064-2003 (NWT, 2003). The NWT Used Oil and Waste Fuel Management Regulations (NWT, 2003) stipulates the maximum level of contaminants in used oil that can be incinerated. The Table 2-3 presents the used oil impurity limit for use in incineration. If the used oil exceeds one or more parameter of the criteria presented in Table 2-3, it is not allowed to blend, collect, incinerate, offer for sale, sell or transfer possession of that oil.

Table 2-3: Used Oil Impurity Limit

Impurity	Maximum Level [ppm]
Cadmium	2
Chromium	10
Lead	100
Total Organic Halogens (as Chlorine)	1000
Polychlorinated biphenyls	2

Ash produced from the incineration process will be disposed of according to the Nunavut Environmental Guideline for Industrial Waste Discharges (D of SD, 2002). The ashes from the incineration process will be placed in closed drums and buried within a designated area of the landfill, only after receipt of Toxicity characteristic leaching procedure (TCLP) analysis that meets the standards stipulates in the Environmental Guideline for Industrial Waste Discharges. Table 2-4 presents the standards for Solid Waste/Process Residuals Suitable for Landfill.

Table 2-4: Standards for Solid Waste/Process Residuals Suitable for Landfill

Parameter	Concentration [mg/L]
Arsenic	2.5
Barium	100
Cadmium	0.5
Carbon Tetrachloride	0.5
Chromium	0.5
Cyanide (free)	20
DDT	3
Endrin	0.02
Heptachlor + Heptachlor epoxide	0.3
Lead	5
Lindane	0.4
Mercury	0.1
Methooxychlor	10
Methyl ethyl ketone	200
Metolachlor	5
PCBs	50*
Selenium	1
Silver	5
Tetrachloroethylene	3
Toxaphene	0.5
Trihalomethanes	10
2, 4, 5-TP (Silvex)	1
Zinc	500
* Based on Concentration by Mass	

3. Design Requirements

3.1 Operational Requirements

Permanent camp incinerators are to be installed at each of the camps associated with the Mary River Project, i.e., Milne Port, Mine Site and Steensby Port.

Each of these incinerators uses dual-chamber; variable airflow design technology specifically designed for remote camp operations, and is to be diesel operated with the option of recycled oil being added into the fuel stream. All incinerators will have the option of using a liquid waste

system to burn waste petroleum products such as used oil or off-spec fuels, which would decrease diesel requirements but would increase power consumption.

Each of these incinerators shall be designed to suit the necessities of the operational phase. For this reason, incinerators will be designed to suit the needs during the operational phase, and therefore more than one incinerator will be located during construction phase, giving the flexibility to remove incinerators or to keep them as a standby facility.

Waste destined for the incinerator will be segregated as part of operating procedures to ensure that only appropriate materials will be incinerated. Loading chamber must have an opening large enough to accommodate loading via a standard sized front end loader. As part of operating procedures, all wastes will be sorted prior to loading of the units, to ensure that only appropriate materials will be incinerated. The incinerator will be used for combustible, non-hazardous wastes including, but not limited to:

- Putrescible waste from construction and accommodation camps;
- Organics from construction camps;
- Maintenance/workshop wastes (such as hydrocarbon and solvents contaminated rags, oil filters, etc.; and
- Sludge from the sewage treatment plant.

Biomedical waste, hazardous waste, non-combustible materials, or treated wood products must not be incinerated. Incineration of plastics will be minimized to the maximum extent practicable in order to reduce the volume dioxin/furan generated during the incineration process.

The incineration process occurs in two different stages. In the first one, the wastes are converted into burnable gases in the primary chamber at approximately 650-850 ºC. At this temperature, any potential infectious material is destroyed. This process is self fuelling until the mass is reduced by 99%.

During the second stage of the incineration process, the gases generated in the primary chamber enter the secondary chamber. The secondary chamber is oxygen rich with turbulent conditions. The temperature in the second chamber is higher than in the primary chamber, generally around 1000 ºC. Combustion is complete after a minimum retention time.

If the temperature inside the burn chamber is high enough and maintained for a long enough period of time, the hot gases are completely converted into water vapour and carbon dioxide, which is then released into the air. If the temperature inside the burn chamber is not high enough and the burn time is too short, complete conversion of the burnable gases does not occur and visible smoke is released into the air. Another problem of the incineration at low temperatures is the formation of contaminants that were not originally present, such as dioxins, furans and others complex chemicals.

The ashes from the incineration process will be collected and placed in closed drums and buried within a designated area of the landfill, only after receipt of TCLP analysis that meets acceptable standards. If the ashes do not meet the standards, they will be treated onsite (if possible) or they will be transported for offsite disposal at a licensed facility.

3.2 Mechanical requirements

The design and construction of the incinerator and all associated components must ensure that, during operation, they will not crack, warp, or otherwise fail structurally so as to permit flame passage or emission of combustion gases or sparks into the building.

The incinerator assembly shall be made of carbon steel plate and adequately reinforced with structural steel members. If different materials are used, a certificate of material compliance is required. For sheet steel hot dip galvanised coating to ASTM B852-94 and for irregular shaped articles 380 g/m2 zinc coating to CSA G164 standard shall be applied.

In order to prevent any accidents associated with explosions, explosion relief shall be provided as per National Fire Protection Association NFPA 82.

The primary and secondary chambers shall be seal welded completely to prevent the inclusion of incoming air, and shall be provided with adequate access doors for waste loading, inspection, maintenance and ash discharge.

Door assembly shall include a sealing device adequate to stand the internal temperature of the chambers and to prevent air leakage from outside.

The incinerators must have adequate ladder and platform for easy access and personal safety guards to perform regular operations, inspection and maintenance of incinerator and ancillary equipment. Also, the incinerator stack shall incorporate appropriate sampling ports to allow for stack testing during incinerator operation.

Insulation must be included in order to isolate personnel from the heat generated during the incineration process. Where insulation is not practical, guards, barriers or partitions must be provided.

3.3 Electrical Requirements

All the incinerators on site shall be equipped with monitor pilots, main burners, fans, fuel supplies, combustion chambers, stack and all other required parameters.

Other control parameters to be considered in the design include:

- Temperature: temperature control shall be segmented per burned gallery; and
- Residence time: both in primary and secondary chamber.

In order to prevent dangerous conditions or procedures, all incinerators shall be equipped with system failure that shut down the equipment in case of detection of any hazardous condition.

4. References

- Canadian Council of Ministers of the Environment (CCME), 2000a. Canada-Wide Standards for Dioxins and Furans, May, 2000;
- Canadian Council of Ministers of the Environment (CCME), 2000b. Canada-Wide Standards for Mercury Emissions, June 2000;

- NWT, 2003. Used Oil and waste fuel management regulations, 2004, NWT Reg 064-2003. January 1, 2003;
- Department of Sustainable Development (D of SD), 2002. Environmental Guideline for Industrial Waste Discharges. January 2002;
- Department of Environment, Environmental Guideline for the Burning and Incineration of Solid Waste. October 2011**;**
- Meadowbank Mining Corporation (MMC), 2007b. Meadowbank Gold Project Incinerator Waste Management Plan, Version 2, dated May 2009; and
- Baffinland Iron Mine Corporation. Mary River Project (2011). Environmental design bases.