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Memo

To:	Mark Palmer, INAC	**Date:**	December 13, 2010
cc:		**From:**	Daryl Hockley
Subject:	Response #3 to MVEIRB Deficiency Statement – Hazard Duration vs. Lifespan of Containment System	**Project #:**	1CS019.010.0060

The third comment of the MVEIRB Deficiency Statement poses the following two questions related to the comparison of the expected duration of a hazard against the expected lifespan of its containment system:

A. What is the longevity of each component of the containment system compared to the duration of the hazard?

B. What is the level of effort required to maintain the system?

Response Summary

We interpret the term “hazard” as referring to an underlying state or condition that has the potential to cause harm. The “hazard” of the arsenic trioxide dust will exist in perpetuity, but it will only become a significant “risk” if there is a failure of the containment system. The overall system can be grouped into the following components: active (or hybrid) freezing system, passive treatment system, temperature monitoring devices, and water collection and treatment system. Replacement of ageing or defective components will be completed as part of routine maintenance. The project cost estimates include allowances for the costs of these replacements as needed over their required operating lifespan.

Detailed Response

Risk assessment professionals use various definitions of the term “hazard”. The broadest definition is the one given by ISO Guide 073, which defines hazard as a “source of potential harm”. The term “risk” on the other hand, normally incorporates a consideration of probability. ISO Guide 073, for example, defines risk as the “effect of uncertainty on objectives”.

Other references, such as those used in health and safety management, similarly define hazard as “any source of potential damage, harm or adverse health effects ...” , and risk as “the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard" (Canada Center for Occupational Health and Safety, <http://www.ccohs.ca/oshanswers/hsprograms/hazard_risk.html>).

Using these definitions, the underlying hazard referred to in the Board's questions is the arsenic trioxide dust. Under the proposed management plan, the dust will continue to exist in perpetuity. But it will only become a significant risk to humans or the environment if there is a failure of the containment system.

The DAR describes several components of the arsenic containment system. The overall system includes redundancies and backups that can best be appreciated by analyzing the chain of events that would need to occur before arsenic would be released to the environment. These events are described in DAR Section 6.2.8.2 and again in the response to the Review Board's Question #1 of the Deficiency Statement.

To more directly address the questions of longevity and maintenance requirements, the remainder of this response will look at the individual components of the containment system. These can be grouped as follows:

- Active (or hybrid) freezing system (used for the initial freezing of the frozen blocks);
- Passive freezing system (i.e. thermosyphons installed following the initial freezing);
- Temperature monitoring devices; and,
- Water collection and treatment system (including the underground pumping and piping, treatment plant, overland pipelines, and outfall diffuser)

i) Active (or Hybrid) Freezing System

DAR Section 6.2.6 describes the initial freeze using an active freezing method. Table 6.2.6 lists an example sequence for the active freeze initiation. This indicates that during Year 9 all chamber areas will be converted from active to passive freezing. Using a hybrid system could either accelerate or slow down this initial freezing period. Details of the active freezing schedule and the implications of applying a hybrid system are both being examined as part of the Freeze Optimization Study (FOS). The minimum required longevity of the active or hybrid freezing system will be determined by the results of that work, but will be in the order of ten years.

It is further expected that the active or hybrid system would be maintained for several years after initiation of the passive freezing system, until monitoring demonstrates that there is no need for additional energy input. During those years, components of the active or hybrid system would be "moth-balled" in a way that would allow the system to be reactivated as needed. The choice of which components will be decommissioned and which will be moth-balled will be possible only in later stages of design.

The example of active freezing used at the McArthur River Mine (in operation for over 10 years) and as described in DAR Section 6.2.8.3, demonstrates the longevity of active systems. In addition, the hybrid freezing systems used as examples in the DAR have been in operation since 2002 for Diavik and from September 1997 to April 2004 for the Oak Ridge National Laboratory. Experience to date demonstrates that with proper care and maintenance, an active (or hybrid) freeze system can operate well beyond the period required for the initial freeze at Giant Mine.

ii) Passive Freezing System

The Review Board notes in the DAR Deficiency Statement that the longevity of thermosyphons is adequately described in DAR Section 6.2.8.3.

As stated in Sections 7.7 and 7.8 of the Remediation Plan, permanent site staff will also carry out daily or weekly monitoring of the freeze system and the performance of each thermosyphon will be monitored by annual checks of gas pressure and monitoring of heat transfer from the radiators. Ground temperatures will continue to be monitored using the thermistors mounted on freeze pipes and in independent drillholes.

The estimate of maintenance costs for the passive freezing system includes an annual amount equal to 1% of the construction costs for thermosyphon maintenance and replacement.

iii) Temperature Monitoring Devices

Temperature monitoring devices installed in drillholes around the frozen blocks are likely to consist of thermistors (thermocouples and resistance temperature devices may also be used and are currently being tested in the FOS). These devices are required in perpetuity to monitor the status of the thermosyphons.

SRK has been involved in the installation of thermistors in the north extensively in the past 20 years. We have found that the greatest risk of damage to thermistors is during installation. Once properly installed, the thermistor sensors are well protected, but they can exhibit “drift” over time. In other words, a thermistor in rock that remains at -10.0 ºC might, over a period of many years, may begin to register temperatures of -10.1 ºC, then -10.2 ºC, then -10.3 ºC, etc. The calibration drift would be noticeable by comparison to other thermistors.

Thermistor costs are small compared to other components of the containment system, and malfunctioning strings would be replaced as part of the maintenance of the passive freezing system.

iv) Water Collection and Treatment Systems

The minewater collection and treatment system will continue to operate during the establishment of the frozen blocks, and for at least another 20 years thereafter. Even after the residual arsenic trioxide outside the frozen blocks is collected and treated, water from the remainder of the mine is expected to need collection and treatment, as there is a large inventory of less soluble arsenic in tailings and mine waste distributed throughout the mine workings.

Water treatment plants have been in operation in North America for upwards of 100 years. Minewater treatment plants have been in continuous operation for more than 40 years in Canada and likely much longer in other jurisdictions. In all cases, proper maintenance and replacement of plant components is required to sustain effective treatment over long periods. All plants operating for extended periods require a capital replacement allowance to assure adequate funding is available to maintain the facilities over the long term. The life of the components of the treatment plant vary greatly with civil structures and works, some lasting 50 years or more, while electrical components and mechanical process equipment can last for 10 to 25 years before major repair or replacement is required. With regard to the diffuser in Back Bay, its lifespan is anticipated to be similar to that of other civil works and structures (i.e., 50 years or more).

For the Giant Mine, the water treatment plant as designed can perform essentially in perpetuity given proper care and maintenance. To account for these care and maintenance requirements, the project cost estimate includes an annual "capital replacement allowance" of 4% of the total cost of the system. The capital cost allowance means that an amount equal to 4% of the initial construction cost will be available every year for maintenance and/or replacement of any aging or defective components. In simple terms, the capital cost allowance provides for a complete re-build of the water treatment system every 25 years.