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Mr Emery Paquin  
Director  
Environmental Protection Division  
GNWT  
600, 5102 - 50th Ave  
Yellowknife, NWT  
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October 17, 1995

Dear Mr Paquin

**Re: Roaster Stack Air Dispersion Mechanical Feasibility Assessment**

Royal Oak Mines commissioned Dillon Consulting Engineers to complete a feasibility assessment of modifications to the existing roaster exhaust system discharge parameters. This included changes to stack height, exit gas temperature and exit gas velocity. Order of magnitude cost estimates were developed for modification to each of the parameters listed above. Discussion of project alternatives and costs are listed as follows:

**Increased Stack Height**

A sensitivity analysis completed by Dillon during the Air Dispersion Modelling Study (May 1995), indicated that increased stack height would have a very positive effect on dispersion of SO<sub>2</sub> from the roaster. Custodis-Cottrell, a well known chimney fabrication company, was contacted and options were discussed for increasing the height of the existing stack, which is a 150 foot high, 9 foot diameter brick structure constructed in 1955 by the Traylor Engineering Construction Company of Toronto. The two options that exist are to extend the existing stack or to construct a brand new stack.

The amount of extension that can be installed on the existing stack is dictated by the ability of the foundation to withstand increased deadload and overturning moments from the extension. Based on their experience, Custodis-Cottrell recommends a maximum extension of 30 to 35 feet to the existing stack, bringing the overall stack to approximately 180 feet. Steel construction is recommended for this extension as it is easier to construct and will add less weight to the overall foundation load than if brick construction were utilized. Cost for this alternative would be on the order of \$125 000.

If greater overall stack heights are required, a new stack would have to be installed. A new 200 foot



stack and foundation will cost approximately \$875 000. A new 300 foot stack and foundation will cost approximately \$1 900 000. A new stack would be constructed of steel and lined to resist corrosion. It would consist of a number of straight sections joined by cones which reduce the diameter as the stack height increases.

The cost for stacks greater than 300 feet in height escalate rapidly due to the requirement for different types of materials, complex foundations and construction methods. Installation of a 400 foot stack will cost approximately \$3.25 million.

Operating and maintenance costs associated with either an extension to the existing stack or installation of a new stack would change very little. There would be a nominal increase in fan motor horsepower to overcome increased friction loss with stack height, however this could be accommodated within the range of operation for the existing stack discharge fan motor.

#### Increased Exit Gas Temperature

The exhaust gas temperature at the stack discharge fan is currently maintained at 230 °F. This is the maximum temperature which can be maintained in the baghouse to allow precipitation of arsenic and not result in damage to the bags themselves, which have a maximum temperature rating of 260 °F.

Sensitivity analysis completed during the air dispersion modelling assignment showed that increased exit gas temperature would have a very positive effect on dispersion of SO<sub>2</sub> from the stack. The sensitivity analysis showed that the greater the temperature increase of the exhaust gases, the greater the reduction in ground level SO<sub>2</sub> concentration which could be achieved during the summer months. Incremental temperature increases of 50 °F, 100 °F, 150 °F and 200 °F were reviewed and it was found that a 50 to 60 percent reduction in ground level concentration could be achieved during the summer months, for a 200 °F temperature increase. Temperature increases of 150 °F, 100 °F and 50 °F, had correspondingly less impact on reducing ground level concentrations.

For the purpose of this study, the maximum temperature increase of 200 °F was used for equipment requirements and sizing. The basic approach for increasing the exit gas temperature is to install a propane fired heater in the ductwork downstream of the existing stack discharge fan. The duct heater would be sized to provide a temperature increase of 200 °F, raising the exhaust gas exit temperature to approximately 430 °F.

In addition to the propane fired heater, a new stack discharge fan would also be required, to operate reliably at the higher operating temperature. The fan and propane fired heater would be located in a new pre-engineered, insulated metal building. Installation of a fuel supply facility would also be required.



The capital cost to install this system would be on the order of \$700 000. Operating costs for fuel and maintenance, would be on the order of \$650 000 / year.

#### Increased Exit Gas Velocity

The exit gas velocity from the existing 9 foot diameter stack is approximately 9 feet per second (fps), based on 35 000 cfm exhaust gas volume. This exit velocity is considerably less than the guideline recommended values of 50 to 60 fps, which are typically required to ensure the exit gas stream has sufficient momentum to carry it into the atmosphere and achieve optimum dispersion.

The sensitivity analysis showed that increased exit gas velocity from the current stack height would result in no reduction in ground level SO<sub>2</sub> concentrations. The Air Dispersion Modelling Report concluded that "the plume rise is buoyancy flux dominated". Mr Ron Hilburn, who performed the air dispersion modelling, indicated that momentum (ie; velocity) changes are not effective in achieving greater dispersion in this case because the plume is constrained by the upper layer of free-flowing atmosphere, which is a meteorological condition of the Yellowknife area. Based on his knowledge of dispersion and modelling, he stated that pursuing options for increasing the exit gas velocity would not be beneficial in this case. He recommended that increased stack height and exit gas temperature be focused upon to achieve greater dispersion of the exhaust gases. Based on this recommendation, no options were investigated for increasing the exit gas velocity.

It should be noted however, that if the stack height were to be increased, the diameter could be reduced at relatively little cost. In this manner, exit gas velocity could also be increased. At increased stack heights, there may be an opportunity to further reduce ground level SO<sub>2</sub> concentrations, by adjusting exit gas velocity.

#### Conclusion

This report reviews options and order of magnitude cost estimates for changes in the stack discharge parameters of stack height and exit gas temperature of the roaster exhaust ventilation system at Royal Oak Giant Mine. Options for increasing exit gas velocity were not investigated based on recommendations of the Air Dispersion Modelling Report (May 1995). We did note however, that with increased stack heights, there may be an opportunity to further reduce ground level SO<sub>2</sub> concentrations, by adjusting exit gas velocity.



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We trust this assessment addresses the questions raised during the course of several meetings and discussions held, pertaining to improvements in Yellowknife air quality. If you have any further questions, please address them to Mr Erik Madsen, who will be replacing me as Superintendent - Environmental Services, NWT Division.

Yours sincerely,

Royal Oak Mines Inc

David Anthony P Eng  
Manager - Environmental Services  
NWT Division

cc Ms Laura Johnston - Environment Canada, Yellowknife