Q. Please explain what further environmental benefits and improved emissions would arise by use of a .5% as opposed to a 1% sulphur fuel oil. Would the use of .5% sulphur fuel oil be a lesser cost alternative to retrofitting the Holyrood facility?

A. The formula specified by the Department of Environment and Conservation for calculation of annual emissions of sulphur dioxide at the Holyrood facility is:

SO_2 (kg) = (19.579 * S * barrels of fuel consumed * 158.9873 * specific gravity) / 1000

Where

19.579 = emission factor, kg/1000 litres
158.9873 = conversion factor, litres/barrel
Specific Gravity = 141.5/(131.5 + API)
S = percent sulphur content as a whole number

As S is one of the three variables in this formula, the others being the barrels of fuel consumed and the specific gravity, use of a .5% as opposed to a 1% sulphur fuel oil will have a direct effect on the volume of SO_2 emissions resulting.

US Environmental Protection Agency document AP 42, Fifth Edition, *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources* states:

"Sulphur oxides (SO_X) emissions are generated during oil combustion from the oxidation of sulphur contained in the fuel. The emissions of SO_X from conventional combustion systems are predominantly in the form of SO_2. Uncontrolled SO_X emissions are almost entirely dependent on the sulphur content of the fuel and are not affected by boiler size, burner design, or grade of fuel being fired. On average, more than 95 percent of the fuel sulphur is converted to SO_2, about 1 to 5 percent if further oxidized to sulphur trioxode(SO_3), and 1 to 3 percent is emitted as sulphate particulate."

Therefore, the emission rate for SO_2 from the Holyrood facility can be expected to be directly proportional to the sulphur content of the fuel. In this case, there would be a 50% reduction.

US EPA AP 42 also identifies a link between the sulphur content of No. 6 oil and particulate matter emissions. AP 42 states:

"Filterable particulate matter emissions depend predominantly on the grade of fuel fired. Combustion of lighter distillate oils results in significantly lower PM formation than does combustion of heavier residual oils. Among residual oils, firing of No. 4 or No. 5 oil produces less PM than does the firing of heavier No. 6 oil.

In general, filterable PM emissions depend on the completeness of combustion as well as on the oil ash content. The PM emitted by distillate oil-fired boilers primarily comprises carbonaceous particles resulting from incomplete combustion of oil and is not correlated to the ash or sulphur content of the oil. However, PM emissions from residual oil burning are related to the oil sulphur content. This is because low-sulphur No. 6 oil,

either from naturally low-sulphur crude or desulphurized by one of several processes, exhibits substantially lower viscosity and reduced asphaltene, ash and sulphur content, which results in better atomization and more complete combustion."

Therefore, use of a .5% as opposed to a 1% sulphur fuel oil would result in reduced particulate matter emissions. The formula recommended in US EPA AP 42 for calculating particulate emissions rates from uncontrolled industrial boilers firing No. 6 oil based on sulphur content of the fuel is:

$8.34(1.12(S) + 0.37)$ (in $lb/10^3$ gal) where S is the weight percent sulphur content of the fuel.

Using this formula, the projected particulate emission rate using 1% sulphur fuel would be 12.43 $lb/10^3$ gallons, and that using 0.5% sulphur fuel would be 7.76 $lb/10^3$ gallons, or a 38% reduction.

The use of 0.5% sulphur fuel oil would be a lesser cost alternative to retrofitting the Holyrood facility with a flue gas desulphurization / electrostatic precipitator (FGD/ESP) to achieve the same reduction in emissions.

As noted in CA 14 NLH(c), the price premium for low sulphur fuel oil such that the economic/financial advantage of using 1% S fuel oil option over FGD/ESP would be eliminated would be $9.90 per barrel. In CA 1, the forecast price premium for 0.5% S fuel oil over 2.0% fuel oil is below $9.90 except for the last three years of the period in question. As well, as indicated on pages 4-5 and 4-6 of the *Cost Analysis of FGD vs Low Sulphur Fuel Oil – Air Emissions Controls Assessment – Holyrood Thermal Generating Station Final Report*, SGE Acres, February 2004, in order to achieve a reduction in SO_2 emissions

equivalent to using 0.5% S fuel oil, the capital cost of the FGD would also increase significantly, compared to the capital cost of the FGD in order to achieve a reduction in SO_2 emissions equivalent to using 1.0% S fuel oil.