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REF: Dispersion Sensitivity Analysis

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MESSAGE:

Recognizing that the controll of ground level concentrations of SO_2 can be approached from two directions, reducing mass emission rates of SO_2 and/or enhancing the dispersion of emitted SO_2, this effort evaluates the ability to meet provincial air emissions requirements by enhancing atmospheric dispersion. Recognizing further that the extent to which stack emissions are mixed and diluted by atmospheric dispersion is influenced by both meteorological factors and stack discharge parameters. this effort is aimed at characterizing the influence of stack discharge parameters (stack height, exit gas velocity, and exit gas temperature) on controlling ground level concentrations of SO_2.

Model runs were made over a wide range of values of stack height (150 ft - 400 ft), exit gas temperature (112 C - 200 C), and exit gas velocity (2.7 m/s - 24.2 m/s) to determine the effect these parameters have on maximum ground level SO_2 concentrations. ISCST2 model runs were configured so that the 49 largest 1hr avg SO_2 concentrations computed anywhere on the model grid were tabulated for each monthly meteorological data set. ISCST2 model runs were also configured so that the 24 largest 24hr avg SO_2 concentrations computed anywhere on the model grid were tabulated for each monthly meteorological data set.The model grid is a square area (12 km x 12 km) that extends 6 km to the north, south, east, and west of the stack. Ground level concentrations are computed at 300m intervals across the entire grid.

Stack discharge parameters (stack height, exit gas velocity, and exit gas temperature) were varied individually and jointly for ten monthly meteorological data sets. The objective was to identify a range of parameter values which would yield ambient SO_2 concentrations that did not exceed the 1 hr. and 24 hr. average provincial SO_2 guidelines (450 ug/m3 and 150 ug/m3 respectively). All model runs were made at a mass emission rate of 65 x 10^3 kg/day for SO_2.

Model results, shown here in Table 1, were made with all three discharge parameters set jointly to significantly increased values (stack ht. = 400 ft., EGT = 200 C., and EGVel. = 24.2 m/s). Even at these significantly increased discharge parameter values, exceedences of the 1 hr and 24 hr SO_2 guideline values were not eliminated for almost all of the ten months considered. While maximum ground level SO_2 were reduced by increasing these parameter values, the effect was not enough to eliminate exceedences. The 1 hr. guidline concentration was exceeded by all 49 high values for each of the ten months. Likewise, the 24 hr. guidline concentration was exceeded by all 24 high values for eight of the ten months. The base case model run shows that a 14 fold reduction in maximum grid 1 hr average concentration was required to avoid exceedences, while the largest reduction afforded by increasing stack height, exit gas velocity, and exit gas temperature for any one month ranged from 5 to 10 fold.

The meteorological conditions that produce maximum ground level concentrations tend to have mixing heights ranging from 300m to 800m. Stack emissions are contained in a depth of atmosphere between ground level and the mixing height. Dispersion and mixing within this layer is not enhanced very much by increases in stack height, temperature and velocity.

Table 1 - Predicted SO_2 Concentrations

Meteorological Data Set	Max 1 Hr. Avg. Conc. (ug/m3)	Max 24 hr. Avg. Conc. (ug/m3)
March 1993	1597	287
April 1993	1775	299
May 1993	1811	524
June 1993	2014	272
July 1993	2116	491
August 1993	1910	334
September 1993	1644	276
October 1993	1320	241
November 1993	883	147
December 1993	853	127

Based on these results, the prospect of eliminating 1 hr and 24 hr SO_2 exceedences by adjusting stack discharge parameters does not appear to be very promising. I look forward to your comments.