

SKOOKUMCHUCK PULP MILL UPGRADE ENVIRONMENTAL IMPACT ASSESSMENT

Terms of Reference: Air Quality Impact Assessment

1. INTRODUCTION:

The upgrade of the CFI Skookumchuck pulp mill will result in a change of emissions and a corresponding change in regional air quality. For some pollutants there will be an anticipated reduction in emissions, however there is still a need to assess the resulting air quality after the mill upgrade and to determine just how much of change in air quality will potentially occur. The eventual goal of the air quality assessment is to determine what the effects of the emissions will have on the surrounding environment by comparing predicted air quality to air quality objectives. In some situations there may be no established objectives, however it is still valuable to predict air quality changes as the information can be used to effect facility design changes and reveal further permit conditions.

To quantify the resulting change in air quality, an assessment of the impact before and after the upgrade must be done. This will entail the calculation of pollutant concentrations in the Kootenay River valley corridor. More specifically, the assessment should answer the following questions:

- (a) What are the predicted geographic distributions of exceedences and the associated occurrence frequencies of the most stringent and least stringent ambient air quality criteria levels? These criteria are listed in Table 1.
- (b) For each pollutant, what is the maximum expected ambient concentration, and where and under what conditions is it occurring?

Detailed modelling of sulphur dioxide, total suspended particulate (TSP), total reduced sulphur (TRS), chlorinated organic emissions, nitrogen oxides (NOx), PM10, chlorine and chlorine dioxide (as Cl2), carbon monoxide (CO) and any other pollutant identified by the Regional Waste Manager, is required before the potential impact on air quality due to the proposed upgrade can be assessed. The evaluation must be repeated for each pollutant.

For the assessment of each species, two dispersion models must be used: one to estimate ambient ground level concentrations at elevations below the lowest stack-top and the other for sites at higher elevations.

It must be emphasized that a complete assessment of the air quality impacts cannot be done unless the terms of reference are followed by the proponent.

2. AIR QUALITY EVALUATION

2.1 Emissions:

A detailed characterization of all emissions from the present and upgraded pulp mill must be provided. This should include all point and area sources.

Each emission source must be characterized by the following:

- temperature at exit
- exit speed
- exit diameter
- exit height above ground
- chemical composition and emission rates
- particle sizes and amounts
- water content
- time variations (short and long term) under routine operating conditions
- any fugitive emission sources difficult to characterize

For the model simulations of the 1 hr, 24 hr and annual average concentrations, the corresponding **maximum** possible hourly, 24 hour and annual emission rates under **normal** (routine) operating conditions should be used. If sufficient information to allow individual treatment is unavailable, then the collective emissions from these sources should be modelled as fugitive emissions from an area source.

It is recognized that **abnormal** or non routine situations (as defined in the following list) will also occur, thus it is important to characterize the emissions and define their frequency of occurrence under the following scenarios:

- start-up or shut-down
- pollution control equipment failure
- process equipment malfunction
- other accidental/unplanned emissions

Under these scenarios, modelling should be done to define ground level concentration isopleths under meteorological conditions which result in the worst-case, short term (one hour average) concentrations.

It is appreciated that the emission characteristics may not be completely known for all present discharge points. In the case where this information is lacking, emission information from other sources may be used, providing similar operating characteristics are assured. In the cases where outside sources are used for this information, these sources shall be

identified and a table comparing operating parameters of present emission sources and those used for emission information shall be provided.

2.2 Terrain Considerations and the Modelling Domain

The Skookumchuck mill is located in the bottom of the North South oriented Kootenay River valley bounded by the Purcell Mountains on the west and the Kootenay Ranges on the east. Within the valley there are populated areas at the north end of Premier Lake, at Wasa Lake, Canal Flats, Ta Ta Creek, Fort Steele and the towns of Cranbrook and Kimberley. The domain covered by an air quality assessment should include a corridor bounded by the mountain ridge lines to the east and west of the Kootenay River (roughly 15 km wide on either side of the mill) with the northern border 27 km north and the southern border at Cranbrook (roughly 45 km south).

2.3 General Modelling Requirements:

- a) For each pollutant, ambient pollutant concentrations at elevations less than the stack-top elevation of the lowest stack are to be simulated using the ISCST dispersion model.
- b) For each pollutant, ambient pollutant concentrations at all other elevations are to be simulated using the RTDM dispersion model.
- c) One hour, 24 hour and annual average concentrations are to be simulated.
- d) LOW ELEVATION MODEL

The low elevation model is to be run in rural mode with the following regulatory default options selected:

- stack downwash
- final plume rise used at all downwind receptor locations
- bouyancy induced dispersion effects are parameterized
- default vertical potential temperature gradients are assigned (A - D: 0.0, E:0.02, F:0.35 K/m)
- no calm processing: see Section 2.4b for dealing with light wind (<1 m/s) situations
- no decay assigned
- revised building wake effects procedure is selected, which uses either the method of Huber and Snyder, or that of Schulman and Scire, depending the stack height and building dimensions.
- default wind profile exponents (.07, .07, .10, .15, .35, .55 for stabilities A through F respectively)
- terrain elevations are input (terrain elevation option selected = 1).

Receptor points should be modelled on a grid with sufficient resolution so that areas of high concentrations and gradient are captured and the uncertainty in establishing the location of isolines can be minimized. Given the large modelling domain required for this assessment, a number of runs may have to be done with different grid sizes applying to different sources to insure adequate coverage. For regions beyond 10 km, a coarser grid could be used since the concentration gradients are expected to be small. The Ministry will check to insure that the maximum concentrations are captured by the selected grid. Specific receptors are to be established at the north end of Premier Lake, the top of Premier Ridge (just east of the mill), Wasa Lake, Skookumchuck, Canal Flats, Ta Ta Creek, Fort Steele, and the towns of Kimberly and Cranbrook if their respective elevations require that they be included in the ISC modelling assessment.

e) RAISED TERRAIN MODEL

The raised terrain model, RTDM, is to be run in the rural mode with following default options:

- PR004 = 1 for dilution wind speed extrapolated to plume height
- PR006 = 3 for ASME stability-dependent dispersion parameters
- PR009 = 0 for no partial plume penetration
- PR010 = 1 for use in buoyancy induced dispersion (3.162 is set as the buoyancy-enhanced dispersion coefficient)
- PR011 = 1 for unlimited mixing height during stable conditions
- PR012 = 1 for transitional plume rise
- PR013 = 6×0.5 stability dependent plume path correction
- PR014 = 0.02; 0.035 vertical potential temperature gradient for E and F stability
- PR015 = 1 for stack tip downwash
- PR020 = 0 for wind shear not used
- PR022 = 1 for use of partial surface reflection
- PR023 = 2; 6×22.5 for use of 22.5 deg. sector averaging for all stabilities.

The default wind profile exponents are 0.09, 0.11, 0.12, 0.14, 0.20, and 0.30 for stabilities A to F respectively.

Insure that RTDM accounts for calm conditions by setting the windspeed equal to 1 m/s if the windspeed is less than 1 m/s.

Options which consider hourly vertical potential temperature gradient and hourly horizontal wind shear cannot be used because of data deficiencies.

Special care must be exercised in selecting receptor locations in order to identify sites that will experience the maximum concentrations for various stabilities and the adequately characterize zones of sharp concentration gradients. Receptor spacing should be densest along the slopes nearest the source. Receptor elevation increments should not exceed 30 meters. The receptors should extend to provide adequate coverage of the domain and it may be required to superimpose the results from a number of model runs. The Ministry will check to insure that the receptor resolution is such that the maximum concentrations are captured. It is possible that some or all of the specific receptors listed in Section 2.3 d) may fall under the modelling exercise with RTDM. If so, they should be included as specific receptors.

f) Estimates of NO₂ concentrations should be based on the assumption that 100% of the NO_x is emitted as NO₂. The Ministry recognizes that the 100 % conversion rate assumption yields conservative estimates of NO₂.

2.4 Meteorological Considerations:

a) General Comment

The models require a meteorological data set that combines parameters derived from both surface and upper air monitoring programs. The general lack of representative meteorological data will introduce a greater degree of uncertainty in the model predictions and thus the Ministry will exert a greater degree of conservatism to insure the regional airshed is protected. The nearest continuous meteorological monitoring program is operated by the Ministry and is located approximately 11 km south of the mill just west of the Kootenay River. Hourly observations are also available from both the Cranbrook and Kimberley airports.

b) Atmospheric Parameters Required as Model Inputs.

One year of meteorological data will be required so that the models can simulate one year. The simulation period should be based on data from the period of June 1, 1989 through to May 31, 1990. This period experienced the greatest data capture at the Ministry meteorological station. Any missing data should be replaced by data collected at Cranbrook airport for the corresponding hour. The parameters available from this station on an hourly basis are the following:

- mean temperature
- mean wind speed
- wind vector magnitude
- wind vector direction
- standard deviation of vector wind direction

For the ISC and RTDM modelling exercise, use the mean wind speed, wind vector direction as measured at the Ministry meteorological site and the P-G stability class for the corresponding hour as determined at the Cranbrook airport. There will be occurrences of windspeeds < 1 m/s. For these situations, set the windspeed to 1 m/s and include them in the modelling assessment.

Both models require upper air data so that hourly mixing heights can be calculated and some idea of plume level winds can be established. In the Cranbrook area, neither direct measurements of mixed layer depth or upper data are available. Thus assume that the surface winds will represent what is experienced at plume level. For the hourly mixing layer assignment use the plume rise of the highest plume for that hour plus 100 m.

The data collected at the Ministry site needs to be evaluated for temporal representativeness. This can be done by comparing the one year wind direction rose at the Cranbrook airport to the long term wind rose. The direction frequencies can be compared using the Chi-squared distribution and tested for the null hypothesis at a given significance level (i.e. that there is no significant difference between the distributions being compared). If there is a significant difference, an adjustment of the wind direction statistics to represent the long term average for the modelling assessment may be in order. If required, this option will have to be discussed with the Ministry.

The data must be used to provide some idea of persistence of low wind speed periods (where mean wind speed is less than 1.0 m/s). Specify the probability that any hour will experience low wind speed periods of x consecutive hours for different seasons. This is accomplished by determining the number of x consecutive low wind speed periods and dividing by the total number of hours in a year.

2.5 Required Analyses:

To estimate the degree to which ambient air quality will be altered by the proposed upgrade it is necessary to determine both the existing and potential distribution of atmospheric pollutants from this source.

a) Existing Air Quality

The air quality associated with the current emissions (the maximum emission rates as discussed in item 2.1 above) should be simulated. Map the distribution of exceedance of the least

stringent and most stringent air quality criteria for 1 and 24 hour averaging times; provide isolines of number of exceedances of the thresholds. In addition, the proponent should map the area covered by greater than or equal to 5 hourly exceedances for the regions which have elevations lower than the lowest stack height and for the areas which experience greater than or equal to 9 hours for areas which have elevations higher than the lowest stack height. In addition, the areal distribution of the frequency of simultaneous occurrences of hourly SO₂ and NO₂ concentrations greater than 140 ug/m³ and 100 ug/m³ respectively at the same receptor must be plotted. Isolines of annual average concentrations (where there are annual average ambient criteria as listed in Table 1) within the modelling corridor should be plotted. Mappings should be done on a topographic base with a scale of 1:50,000 or for areas of large concentration gradients near the mill, on a higher resolution map. Identify the magnitude, location and associated meteorological conditions of the maximum ground level concentrations for each species.

For the specific receptor locations mentioned in Section 2.3 d), frequency distributions in the form of histograms of pollutant concentrations, must be developed so that the number of occurrences of hourly average concentrations above and below the air quality criteria can be determined. The conditions (stability, windspeed, mixing height) under which exceedances occur must be identified and tabulated.

For situations where the short term concentrations are determined under the abnormal or non-routine emission conditions as described in Section 2.1, plot the resulting one hour average isopleths under the worst case meteorological conditions. Identify the maximum concentration (magnitude and location) and the atmospheric conditions under which it occurs. Also identify the expected frequency of these meteorological conditions.

b) Future Air Quality

The air quality associated with the upgraded pulp mill (using maximum anticipated emission rates as discussed in item 2.1 above) should be simulated. Emission rates to be used for the modelling of the future air quality from a new recovery boiler and smelt dissolving tank should agree with the criteria given in Table 2. Discuss the differences between the predicted air quality for the existing facility and the upgraded mill.

c) Fog Assessment

The visibility impairment and icing potential on nearby roads

and bridges due to fog formation from water vapour sources needs to be assessed. The greatest potential for fog formation is during the winter when the atmosphere has a reduced capacity to retain water vapour. A discussion on the potential of ice fog formation and the extent of visibility impairment needs to be included.

d) Depositions of Acid Forming Compounds

Deposition of SO₂ and NO_x are relevant to issues related to acid deposition effects. A discussion of the degree of deposition which would be expected and a synopsis of soil and vegetation sensitivity needs to be included.

e) Further Analysis

Any further analysis necessary to clearly elucidate the air quality before and after the proposed expansion should be provided. In addition, it is possible that the results from this modelling exercise may indicate that further modelling investigations to be done. If the proponent has suggestions which will serve to enhance this assessment, these can be discussed with the Ministry. Any changes to these terms of reference must be agreed to in writing.

3. DOCUMENTATION

In addition to documenting the emission inventory, meteorological assessment, modelling undertaken and air quality evaluations, the various input data sets and model outputs should be made available to the Ministry of IBM AT compatible diskettes.

Table 1.

Ambient Air Quality Criteria

Contaminant	Averaging Time	Most Stringent ug/m3	Least Stringent ug/m3
SO ₂	1 hr.	450 ¹	900 ²
	24 hr.	160 ¹	260 ²
	annual	25 ¹	50 ²
TRS as H ₂ S	1 hr.	7 ¹	28 ²
	24 hr.	3 ¹	6 ²
Chlorine	24 hr.	150 ¹	300 ²
ClO ₂ (as Cl ₂)	24 hr.	150 ¹	300 ²
TSP	24 hr.	150 ¹	200 ²
	annual (geometric)	60 ¹	70 ²
NO ₂	1 hr.	400 ⁴	
	24 hr.	200 ⁴	
	annual	60 ³	
PM ₁₀	24 hr.	100 ²	
	annual	30 ⁵	
CO	1 hr.	15000 ³	
	8 hr.	6000 ³	

Key:

- ¹ Level A
- ² Level B
- ³ Federal National Ambient Air Quality Objective - Max. Desirable
- ⁴ Federal National Ambient Air Quality Objectives - Max. Acceptable
- ⁵ EPA

Table 2
Emission Criteria

1. Recovery Boiler

SO ₂	-150 ppm, max. 1 hr. ave.
	-30 ppm, max. 24 hr. ave.
NO _x	-150 ppm, max. 1 hr. ave.
(as NO ₂)	-125 ppm, max. 24 hr. ave.
TRS	-5 ppm, max. 1 hr. ave.
	-3 ppm, max. 24 hr. ave.

Total Part. -60 mg/m³; max. 1 hr. ave.

2. Smelt Dissoving Tank

SO ₂	-40 ppm, max. 1 hr. ave.
TRS	-20 ppm, max. 1 hr. ave.

Total Part. -180 mg/m³ max. 1 hr ave.

Note: The time averages for these emission criteria are associated with the modelling study only.