



Northwest
Territories Renewable Resources

5 January 1994

J. L. Tennell
K. Kum
P. O'Hara

Dear Stakeholder;

The Department of Renewable Resources proposes to establish a guideline respecting ambient air quality that would be applied in all of the Northwest Territories for the air pollutants sulphur dioxide and total suspended particulate matter. A copy of the draft guideline prepared by the Department is attached with this letter along with background information explaining the degree of environmental protection that the proposed criteria levels are intended to provide. You are invited to review this guideline and send us your comments. All comments that we receive will be considered before the guideline is finalized and adopted under the *Environmental Protection Act*.

The guideline would establish a long-term goal for air quality in the whole of the Northwest Territories for the two air pollutants. A guideline, while not enforceable like a regulation, provides direction, information and clarification towards achieving the Department's mandate. In unpolluted areas of the Northwest Territories, the criteria set under the guideline will be considered when assessing proposed developments and determining what control options may be needed to prevent pollution. In areas where pollution levels are in excess of the criteria, they would be applied as long term goals for the voluntary adoption of control options to reduce emissions or, if necessary, form the basis for regulations to ensure these goals are achieved.

In order to ensure that we have time to fully consider all comments on the enclosed draft of the guideline, please send your comments before 18 February 1994 by mail to:

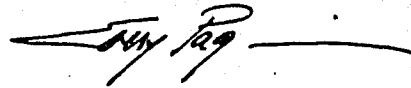
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Or send your comments by fax to (403) 873-0221. If you have any questions about this information please call Jim Sparling at 873-7654.

Yours sincerely,

A handwritten signature in dark ink, appearing to read "Emery Paquin", followed by a horizontal line.

Emery Paquin
Director
Environmental Protection Division

**GUIDELINE RESPECTING AMBIENT AIR QUALITY CRITERIA FOR
SULPHUR DIOXIDE AND TOTAL SUSPENDED PARTICULATE IN THE
NORTHWEST TERRITORIES**

This Guideline is established under the *Environmental Protection Act* and sets criteria respecting the maximum desirable levels of the contaminants sulphur dioxide and total suspended particulates in ambient air in the Northwest Territories. These criteria apply to the whole of the Northwest Territories. They define the long term goal for air quality to protect unpolluted parts of the Territory and for the continuing development of control options in polluted areas.

Definitions:

"Ambient Air" means the air surrounding the earth, but does not include the air within a structure or within any underground space.

"Chief Environmental Protection Officer" means the Chief Environmental Protection Officer appointed under subsection 3(1) of the Environmental Protection Act.

"Standard Conditions" means a temperature of 25 degrees Celsius and a pressure of 101.3 kilopascals absolute.

"Total Suspended Particulate" (TSP) is a general term which applies to a wide variety of solid or liquid particles of a size and configuration such that they tend to remain suspended in the air and can thus be drawn into the respiratory passages.

Criteria:

Sulphur dioxide micrograms per cubic metre ($\mu\text{g}/\text{m}^3$)			TSP micrograms per cubic metre ($\mu\text{g}/\text{m}^3$)	
annual	24 hour	1 hour	annual	24 hour
30	150	450	60	120

All measurements will be referenced to standard conditions.

Measurements for all reporting periods for sulphur dioxide and 24 hour TSP will be reported as arithmetic means. Annual TSP measurements will be reported as geometric means.

The Chief Environmental Protection Officer may request from time to time that ambient air measurements will be made in a specified manner.

BACKGROUND INFORMATION

ESTABLISHING AMBIENT AIR QUALITY CRITERIA FOR SULPHUR DIOXIDE (SO₂) AND TOTAL SUSPENDED PARTICULATES (TSP) IN THE NORTHWEST TERRITORIES

There are no territorial guidelines, standards or criteria respecting ambient air quality in the Northwest Territories. Criteria for maximum desirable levels of sulphur dioxide (SO₂) and Total Suspended Particulate (TSP) are now being considered for establishment as a guideline under the Northwest Territories *Environmental Protection Act*. Ambient air quality criteria would not be enforceable but would be used to define the goal for air quality and provide a basis for determining the significance of air pollution from existing or proposed sources. If necessary, regulations could be proposed to establish emission limits on activities that contribute to pollution levels above the ambient air quality criteria. This document presents a rationale for the proposed criteria levels. Ambient air quality criteria for other contaminants are not being proposed at this time.

Summary of Ambient Air Quality Criteria in Other Jurisdictions

A summary of ambient air legislation was prepared for Renewable Resources by M.M. Dillon Ltd. (1993). Table 1 contains a summary of ambient SO₂ and TSP levels established in the jurisdictions reviewed.

Most criteria that have been established by various Canadian jurisdictions to define acceptable contaminant levels in ambient air have been based on a review conducted in the early 1970's by the Federal/Provincial Committee on Air Pollution (FPCAP). The results of that review were published in 1976 by the Subcommittee on Air Quality Objectives in a report entitled "Criteria for National Air Quality Objectives". The report contains a review of numerous scientific studies carried out in the preceding two decades, information regarding environmental and human health effects of carbon monoxide, suspended particulate matter, sulphur dioxide and ozone and it also contains recommended ranges for air pollutants. In 1987, a review of the scientific literature on the effects of SO₂ was conducted by the Federal/Provincial Advisory Committee on Air Quality (FPACAQ) who concluded that the SO₂ objectives developed in 1976 should be retained.

Table 1 Federal and Provincial "Acceptable" Sulphur Dioxide and Total Suspended Particulate Objectives, Standards or Criteria.

	Sulphur dioxide ($\mu\text{g}/\text{m}^3$)			TSP ($\mu\text{g}/\text{m}^3$)	
	annual	24 hr	1 hr	annual *	24 hr
Canada - desirable	30	150	450	60	-
- acceptable	60	300	900	70	120
- tolerable	-	800	-	-	400
British Columbia	49.2	255.6	884.9	68.8	196.6
Alberta	30	150	450	60	100
Saskatchewan	30	150	450	70	120
Manitoba	60	300	900	70	120
Ontario	55	275	690	60	120
Quebec	52.2	289.1	1315.2	70.3	150.6
New Brunswick	59.1	295.6	886.9	69	118.3
P.E.I.	60	300	900	70	120
Newfoundland	55	274.8	824.5	64.1	109.9
Nova Scotia	-	-	-	-	-
Yukon	-	-	-	-	-
Alaska	79	360.2	1283 (3 hr)	49.3	148
U.S.A.	80	365	1300 (3 hr)	50	150

NOTE: Concentrations reported at 25° C, 101.3 kpa.
Annual TSP level is expressed as geometric mean.

The Canadian Ambient Air Quality Objectives listed in Table 1 are found within the *Canadian Environmental Protection Act*. Federal objectives are stated in terms of desirable, acceptable and tolerable levels.

The **Maximum Desirable Level** defines the long-term goal for air quality and provides a basis for an antidegradation policy for the unpolluted parts of the country and for the continuing development of control options.

The **Maximum Acceptable Level** is intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well being. It represents the realistic objective today for all parts of Canada. When this level is exceeded, control action by a regulatory agency is indicated.

The **Maximum Tolerable Level** denotes time-based concentrations of air contaminants beyond which, due to a diminishing margin of safety, appropriate action is required without delay to protect the health of the general population.

Provincially, few regulators have developed air quality criteria further than what is found in the Canadian Ambient Air Quality Objectives. Most jurisdictions have adopted either the maximum acceptable or the maximum desirable concentrations into their own legislation. These levels are variously listed as criteria, guidelines, objectives or regulations.

Some jurisdictions (such as B.C.) have also established industry specific emission levels. In most jurisdictions, point source emission rates from existing and proposed facilities are reviewed in terms of their impact on achieving the ambient objectives. Emission rates are regulated through licensing or permitting processes or through a regulation specific for that source. Thus, the ambient air objective is applied as a target and is not in itself applied as an enforceable standard because, in many situations, pollution levels in the air are the result of a number of point and non-point source activities.

Effects of Sulphur Dioxide

Sulphur is an essential element for plants and animals. Normally, sulphur is taken up by plant roots as a nutrient in the sulphate form. Background levels of SO_2 in the atmosphere are $4 \mu\text{g}/\text{m}^3$ or less and there is no evidence that these levels can cause harm. Current information demonstrates that vegetation is generally more sensitive to SO_2 than human health but a clear threshold level, below which there are no effects, has not been identified.

Severe effects are caused by higher levels, or by long periods of exposure to SO_2 . Information from scientific and technical reports regarding the effects of SO_2 on vegetation and humans was reviewed by FPACAO in 1987. This section provides a summary of the findings from that review.

The earliest sign of injury to vegetation is damage to the leaves (including needles). SO_2 and its oxidation products are toxic to cells found within leaves and, when levels are high enough, dead or necrotic areas begin to appear within hours of exposure. Data from a number of studies indicate that this type of acute injury to plants results from exposure to SO_2 doses ranging from $2500 \mu\text{g}/\text{m}^3$ for one hour to $650 \mu\text{g}/\text{m}^3$ for eight hours (FPACAO

1987). For acute injury to occur, environmental and plant factors such as sunlight, temperature, humidity, soil moisture and plant type and stage of growth are important. If these factors are not conducive to injury, the plants may escape injury even if the doses are two to three times higher than mentioned. Conversely, if the factors are conducive, acute injury could result from lower doses. Doses as low as $78 \mu\text{g}/\text{m}^3$ for one hour have been reported to injure extremely sensitive strains of eastern white pine.

Long term chronic effects on tree leaves first appear as a yellowing or chlorosis of leaves. Further effects include premature leaf loss, reduced growth and early death of individual plants. Over a number of years there can be alterations in plant community structure as the more sensitive species die out. These effects can appear either from short-term episodes of high levels followed by SO_2 free periods or from long term sub-lethal levels. For example, studies on forests around a smelter in the Sudbury area found that where annual SO_2 levels averaged $44 \mu\text{g}/\text{m}^3$ chronic effects on forest growth were prominent. Slight chronic effects were found where annual SO_2 levels averaged $21 \mu\text{g}/\text{m}^3$. Other studies have shown that epiphytic lichens, which grow on trees, are particularly sensitive to SO_2 and start showing reduced abundance and species diversity when annual SO_2 levels are between 40 to $50 \mu\text{g}/\text{m}^3$.

The effects of SO_2 on human health include irritation of the respiratory tract and aggravation of existing lung diseases. Exercising individuals and asthmatics are more sensitive to SO_2 than individuals at rest. FPACAQ (1987) reported that the SO_2 levels at which effects from short term exposure (i.e. one hour) first become apparent are not clear. Healthy, exercising individuals showed minor and transient effects in a few studies when exposed to levels below $2600 \mu\text{g}/\text{m}^3$. Asthmatics have shown some effects at levels as low as $1000 \mu\text{g}/\text{m}^3$. The taste and odour threshold for SO_2 ranges between 780 to $2600 \mu\text{g}/\text{m}^3$.

Adverse effects from longer term exposure to SO_2 have been observed in studies of people living in polluted areas. Other pollutants were often also present in many of these studies so it can be difficult to isolate the effect of SO_2 alone. Exposure to 24 hour SO_2 levels of 400 to $500 \mu\text{g}/\text{m}^3$ have been associated with increases in hospital admissions for cardiac or respiratory illnesses and with worsening of health status in bronchitics. In studies of annual exposures it is even more difficult to attribute observed effects to SO_2 alone since, in all cases, levels of particulate matter and other pollutants were elevated. FPACAQ (1987) concluded that effects on pulmonary function and increases in respiratory disease have been observed in populations exposed to mixtures of pollutants where the annual level of SO_2 exceeded approximately $100 \mu\text{g}/\text{m}^3$.

Effects of Total Suspended Particulate

Suspended particulates is a general term applied to a wide variety of solid or liquid particles which remain suspended in the atmosphere. Characteristics of particulate matter are determined by the source which can include road dust, wood smoke and other fires, a variety of industrial sources, automobile exhaust or many other sources. The chemical composition of particulate material, its physical state and the size of the particle may profoundly affect its action. Particulates in the air interfere with visibility and cause soiling of materials. The Sub-committee on Air Quality Objectives (1976) noted that visibility and nuisance effects could occur when 24 hour TSP levels were as low as 50 to 60 $\mu\text{g}/\text{m}^3$.

As a respiratory irritant, particulate also affects human health. In a review of studies that have been conducted on human exposure to particulates, Withey (1989) found that health effects are limited to the lung. Humans most at risk include individuals with lung disease, asthmatics, the elderly, children, individuals with influenza, smokers and those who are oronasal or mouth breathers. A recent study on the health effects of wood smoke by Vedal (1993) found that "exposure to wood smoke results in at least a transient decrease in level of lung function in children and appears to increase the risk of acute respiratory illness in very young children." The health effects of wood smoke were largely attributed to the inhalable particulate.

Studies have not shown any evidence of distinct thresholds but, Withey (1989) concluded that in the absence of other pollutants, health effects from TSP are generally minor below 24 hour levels of about 300 $\mu\text{g}/\text{m}^3$. When other pollutants such as SO_2 are present, effects have been observed to start at 24 hour levels of about 100 $\mu\text{g}/\text{m}^3$.

Combined Effects of SO_2 and TSP

In an urban environment, exposure to a pollutant is almost always simultaneous with exposure to other pollutants and this can markedly increase the likelihood of adverse effects. The association between SO_2 , sulphuric acids and sulphates with particulates has been the subject of numerous epidemiological studies, starting with fog pollution episodes of the 1950's caused by coal burning in the United Kingdom. Particulates can carry sulphur oxides and other absorbed materials to the extremities of the lung where their toxic action may be greater than additive. Withey (1989) notes that although a synergistic interaction between particulates and SO_2 has been demonstrated, it is not yet possible to clearly define the relationship for the response to simultaneous exposure to both of these pollutants. FPACAQ (1978) recommended that further caution is indicated when simultaneous high TSP and SO_2 levels occur.

NWT Ambient Air Quality Criteria for SO₂ and TSP

Criteria respecting maximum levels of the contaminants sulphur dioxide and total suspended particulates in ambient air in the Northwest Territories are proposed to be established as a guideline under the *Environmental Protection Act*. The proposed criteria in Table 2 are set at levels which follow the desirable levels in the Canadian Ambient Air Quality Objectives found within the *Canadian Environmental Protection Act*. The desirable level defines the long-term goal for air quality and provides a basis for an antidegradation policy for unpolluted areas. This level of protection is most relevant in the Northwest Territories because most areas are presently unpolluted. In those parts of the Northwest Territories where pollution levels already exceed the proposed criteria, the long-term goal would be applied towards the continuing development of control options.

Sulphur dioxide ($\mu\text{g}/\text{m}^3$)			TSP ($\mu\text{g}/\text{m}^3$)	
annual	24 hour	1 hour	annual	24 hour
30	150	450	60	120

SO₂ criteria are set below levels at which human health effects have been demonstrated.

TSP criteria are set close to levels considered to be natural background levels. The source of the particulate matter, and the presence of other pollutants should be considered in interpreting the significance of levels exceeding these criteria. These limits do not apply to chemically active particulates. At these levels visibility and nuisance effects will be minimal and are below levels at which human health effects have been observed.

When adopted, the criteria will be applied to the whole of the Northwest Territories. They define the long term goal for air quality to protect unpolluted parts of the Territory and for the continuing development of control options in polluted areas.

Literature Cited

- Federal Provincial Advisory Committee on Air Quality. 1987. (unpublished) *Review of National Ambient Air Quality Objectives for Sulphur Dioxide (Desirable and Acceptable Levels)*. Environment Canada, Ottawa. 31 pages.
- Subcommittee on Air Quality Objectives. 1976. *Criteria for National Air Quality Objectives*. Reports to the Federal/Provincial Committee on Air Pollution. 27 pages + appendix.
- M.M. Dillon Ltd. 1993. *Review of Ambient Air Quality Standards and Used Oil Regulations*. Contract report to GNWT Renewable Resources. 21 pages + appendices.
- Vedal, S. 1993. (unpublished) *Health Effects of Wood Smoke: A Report to the Provincial Health Officer of British Columbia*. University of British Columbia. 34 pages.
- Withey, J.R. 1989. *A Critical Review of the Health Effects of Atmospheric Particulates*. Toxicology and Industrial Health. Vol. 5, No. 3. pp 519-553.