Australian and New Zealand
Environment Council

NATIONAL GOALS FOR FLUORIDE IN AMBIENT AIR AND FORAGE

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PREFACE

The Australian and New Zealand Environment Council (ANZEC) comprises Commonwealth, State, Territory and New Zealand Ministers responsible for environmental matters.

This document was prepared by the Advisory Committee on Air Quality and has been endorsed by ANZEC.

The document establishes criteria for the protection of areas of the natural environment which are sensitive to airborne fluoride. Goals have been set which will offer protection levels linked to a variety of land uses.

NATIONAL GOALS FOR FLUORIDE IN AMBIENT AIR AND FORAGE

1. INTRODUCTION

Unlike most ambient objectives, guidelines or standards for common air pollutants, goals for ambient air fluoride are designed to protect against injury to plants and grazing animals rather than to protect human health. This is because fluoride can injure vegetation at one thousandth the level of concern to human health. These effects occur at very low concentrations (sometimes near the limit of detection) and are largely determined by the local ecological regime, land use, climate, emission source characteristics and presence of other air pollutants.

The relationship between fluoride in air and the response of the receptor organism or plant is often complex. Further indirect effects of fluoride on ecosystems may be as important, if not more important, than the direct effects on individual species. The significance of these effects can only begin to be established when there is a proper understanding of the structure and function of the relevant local ecosystem.

Implicit in establishing national goals are value judgements as to what constitutes an acceptable level of effects or impact on the environment. In terms of determining an ambient air goal for fluoride the question arises as to whether this goal should protect against inhibition of photosynthesis or chlorosis or necrosis, or growth retardation effects in individual species and whether such protection ensures against any adverse effects on the local ecosystem.

2. RATIONALE FOR PROPOSED GOALS

The well established standards applying in the United States are based on averaging times usually less than three months and accommodate local climatic conditions. To date, most of the information on the effects of fluoride on vegetation determined in Australia is for averaging times of three months or more.

It is believed that in the short term, variations in climatic conditions have little influence on changes to fluoride up-take by plants. However, it is recognised that added stress, for example due to adverse meteorological conditions, may compound the effects of fluoride exposure.

It is necessary to differentiate between indigenous plant populations and cultivated crops. Some species are extremely sensitive to fluoride. Grape vines, for example, suffer visible injury to their leaves at very low concentrations. Experimental studies of the effects of fluoride on fruit yield have shown that there is no detectable influence at a concentration of 0.28 ug HF m^{-3} (1,2). This would suggest that, for the grape varieties examined, the threshold for economic damage to grapes is in excess of 0.28 ug HF m^{-3} for the duration of the growing season.

Some quantitative information has been available on the effects of fluoride on stone fruits, but a recent study (3) found that exposure of 0.26 ug F m^{-3} for 70 days resulted in 95% of the fruit being diseased, with 68.6% severely affected by suture red spot.

Investigations on native species under experimental conditions, and observation in the field on a total of 250 species indicated that a three month average exposure of 0.5 ug HF m^{-3} would result in little significant visible injury to the majority of the plant

species studied (4,5). This is in close agreement with the objectives set down by Washington State of the USA (6).

One very sensitive Australian native plant species, *Eucalyptus citriodora*, shows visible injury symptoms and loss of growth under an ambient fluoride concentration of 0.6 ug HF m^{-3} applied for seven days. *Eucalyptus tessellaris* and *Xanthorrhoea preissii* show visible injury at ambient fluoride concentrations consistent with the Victorian objectives (7). *Acacia saligna* is visibly injured at low ambient fluoride concentrations (1.0 ug HF m^{-3}) but growth appears to be unimpeded, and mature foliage carries little evidence of the effects of fluoride that occurred in young expanding foliage (8).

Protection of all these very sensitive species would require application of the Canadian "acceptable" objective (9). The provision of such protection in every location where the species occur would be a social rather than a technical decision, as none of the species so far identified as very sensitive are rare or endangered.

The effects on natural fauna of ambient fluoride concentrations that conform with established air quality objectives have not been clearly defined but on the basis of published work (6) it is likely that the effects will be small. For domestic grazing animals, appropriate animal husbandry techniques will ensure that economic loss does not occur.

3. PURPOSE OF A GOAL FOR AIRBORNE FLUORIDE

In view of the large variation in the effects produced in different receptor species, a national goal will need to be structured to take into account the risks associated with plant populations surrounding individual sources.

For example, a highly degraded ecosystem, near a proposed fluoride source, would not be expected to be afforded the same level of protection as an ecosystem of commercial or conservation value, but further degradation would need to be prevented.

Therefore, it is appropriate that the national goals should:

(1) generally protect established or preferred forms of land use, recognising that land use patterns may be changed deliberately for some purpose;

(2) for crop species, prevent significant economic loss, as assessed by the yield and/or quality (including visual appeal) of a product;

(3) for pastures, prevent the development of pollutant-induced disease in grazing animals; and

(4) for natural ecosystems, prevent significant structural and/or functional changes as reflected in either plant or animal components, prevent the loss of rare and endangered species, and in areas of high aesthetic value, also prevent unacceptable visual effects such as marginal necrosis in an otherwise pristine environment.

Air quality objectives will generally be applied at the outer limits of an industrial buffer zone, but different objectives may also be applied to different forms of land use or ecosystems beyond the buffer zone.

4. AMBIENT FLUORIDE GOALS

4.1 Ambient Air Goals

The ambient air goals for fluoride are intended for areas of commercial or conservation value and not intended for comparison with airborne or foliar fluoride levels within industrial areas or buffer zones associated with fluoride emitting industries.

Averaging Time	Maximum acceptable average ambient fluoride concentrations (ug HF m^{-3})*	
	General Land Use	Specialised Land Use
12 Hours	3.7	1.8
1 day	2.9	1.5
7 days	1.7	0.8
30 days	0.84	0.4
90 days	0.5	0.25

*Concentrations are expressed @ 0°C and 101.3 kPa.

The goals set for General Land Use (including residential) are designed to protect most of the sensitive species in the natural environment.

The goals set for Specialised Land Use apply when commercially valuable plants, which are demonstrated to be very sensitive to fluoride, are being considered.

It is acknowledged that the observation of the effects of fluoride on Australian native plant species is not definitive. The above goals should protect the majority of species under most conditions.

It is recommended that for the natural ecosystems of important conservation value such as national parks, wilderness or other significant areas, where the sensitivity to fluoride of a number of plant species is not known, a conservative goal of 0.1 ug HF m^{-3} be adopted for a 90 day average as an interim protective measure.

It should also be recommended that where this situation arises, a proponent should undertake studies of such plant species to determine their sensitivities. The ambient goal for the area may be relaxed in the light of such research only when there is adequate evidence to show that the natural system will not be injured.

4.2 Forage Limits

Ambient air levels shall be controlled so that

(i) Running averages of 12 monthly samples of forage or hay or silage grown in the area as feed may not exceed 40 micrograms F per gram dry tissue in unwashed samples.

(ii) The average of any two consecutive months' samples of forage or hay or silage grown in the area as feed may not exceed 60 micrograms F per gram dry tissue in unwashed samples.

(iii) A monthly sample of forage or hay or silage grown in the area as feed may not exceed 80 micrograms F per gram dry tissue in unwashed samples more than once in any 12 consecutive months.

5. RECOMMENDED METHODS FOR THE MEASUREMENT OF FLUORIDE IN AMBIENT AIR AND VEGETATION

5.1 Ambient Air

AS2618-1 (1983) Ambient air - determination of gaseous and particulate fluorides (1 ug/m3 or greater) - automated double paper tape sampling.

AS2618-2 (1984) Ambient air - determination of gaseous and particulate fluorides (0.1 ug/m3 or greater) - manual, double filter paper sampling*.

5.2 Vegetation

Appropriate monitoring methods specified by State or Territory authorities should be used. Otherwise the following standard Analytical Procedures developed by the Environment Protection Authority of Victoria are recommended.

C1 (1982) Sampling requirements - fluoride in forage**.

CS (1982) Analysis - fluoride in vegetation.

* It is recognised that in practice, some authorities and industries use either a PVC filter holder, or in some cases a Millipore filter holder and maintain the same sample flow rate.

** In general practice it is not recommended that foliar fluoride be sampled as a measure of ambient air fluoride concentrations. Similarly the diet of cattle changes throughout the year, and it is almost impossible to 'copy' the diet taken in by the animal. Statistical sampling will not accurately reflect the forage consumed by an animal but will give a reasonable estimate.

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