NRC Canada 1977 Environmental Fluorides: Quotes

“Many systems utilized for airborne emission-control contribute extensively to the amount of fluoride discharged in wastewaters.”

“Long-term ingestion, with accumulation of fluoride in animals and man, induces metabolic and biochemical changes, the significance of which has not yet been fully assessed.”

“Fluoride is a persistent bioaccumulator, and is entering into human food-and-beverage chains in increasing amounts.”

“Until further data become available we recommend that statements relating to fluoride intakes by adults in North America should assume a "from foods" fluoride intake of 1.5 to 2.75 mg/day, and an intake from "foods and beverages" (in areas with water fluoridated at 1 ppm) of 3.5 to 5.5 mg/day.”

“These data clearly indicate that under some circumstances, humans can receive a considerable amount of fluoride from airborne sources.”

“...the early stages of chronic fluoride intoxication are associated with changes in blood and urine components, and that these precede radiologically-detectable bone abnormalities. In the early phase, there was an increase in blood urea and acid phosphatase, with a concomitant increase in urinary output of phosphorus and urea. As the fluoride intoxication progressed, there was a gradual impairment of urinary creatinine clearance, leading to renal insufficiency.”

6.0 OVERVIEW AND RECOMMENDED RESEARCH

1. Despite improvements in, and more extensive use of, emission control equipment, large quantities of fluoride continue to be discharged into the atmosphere from industrial sources. In 1972, at least 14,236 metric tons of fluoride (calculated as fluorine) were discharged into the air in Canada, and some 150,000 metric tons were discharged in all of North America.

2. Large quantities of fluoride are also discharged into streams, rivers, lakes and oceans, as a component of industrial waste-waters. It appears probable that the amounts thus discharged are several-fold larger than the amounts discharged into the atmosphere. Many systems utilized for airborne emission-control contribute extensively to the amount of fluoride discharged in wastewaters.

3. Much of the fluoride discharged into the atmosphere arises from "point sources" such as smelters. Dispersion of the pollutant in the surrounding area is not uniform; therefore, the siting of monitoring devices, and the selection of sites for sampling of vegetation, must consider:

a) Stratification of the pollutant, with the higher levels of atmospheric fluoride found at the greater heights. This has significance to ecological damage to vegetation on exposed hilltops or mountainsides, even at considerable distances from the emitting source;

b) The "shielding" effects of vegetation and other obstacles, which results in lower fluoride exposure (and uptake by) vegetation growing on the downwind side of such obstacles.

4. The ecological impact of airborne fluoride emissions is known to be serious with regard to coniferous forests and to epiphytes and bryophytes. However, lichens and mosses are less susceptible to fluoride injury than coniferous trees. Relatively little is known about the effects of fluoride on aquatic life, even though large amounts of fluoride are known to be released into some waterways. More attention should be paid to fluoride effects on pollinating insects and on plankton.

5. Airborne fluoride has had a serious impact on agricultural and silvicultural species. With airborne gaseous fluoride there is no evidence for a no-effect threshold level below which no reduction in crop yield occurs, especially over the long term. For exposure of Canadian forest species, the average (30-day) airborne gaseous fluoride concentration should not exceed 0.2 ug/M3. There is an urgent need for long-term Cause/Effect studies of species known to be sensitive to fluoride injury.

6. There have been episodes where the impact of fluoride pollution on livestock and on wild ungulates has been severe. To date, regulations limiting the fluoride content of fodders have provided neither adequate protection against economic loss to the farmer nor adequate control of airborne fluoride. For young growing swine, an 18-week exposure to dietary fluoride (whether in forages, feeds, or mineral supplements) can be expected to decrease daily weight-gain by about 4% for each 100 ppm increment of dietary fluoride. The need for further data on which Cause/Effect equations can be based is apparent. Loss of weight-gain may be a suitable measure of sub-clinical (pre-skeletal) intoxication.

7. There is clear evidence that wildlife species are more vulnerable to fluoride toxicosis than are livestock species. The impact seems to be most severe on predator species, because they must capture their prey and because they are more susceptible to the bioaccumulation of fluoride through their food chain. Cause/Effect studies of these species should include consideration of the multiple stresses imposed by the ecosystem (e.g. malnutrition).

8. Researchers in various regions of the world have reported that human hydrofluorosis is less severe when the waterborne fluoride is ingested from hard waters, than from soft waters. There is evidence that chronic intake of fluoride increases the long-term metabolic requirement for both calcium and magnesium. Other studies have indicated that fluoride may increase the metabolic requirement for vitamin C and manganese. The Cause/Effect aspects of these dietary/nutritional factors require urgent attention, with regard to chronic intake of fluoride. There is no doubt that inadequate nutrition increases the severity of fluoride toxicosis.

9. Fluoride has displayed mutagenic activity in studies of vegetation, insects, and mammalian oocytes. There is a high correlation between carcinogenicity and mutagenicity of pollutants, and fluoride has been one of the major pollutants in several situations where a high incidence of respiratory cancer has been observed. For these reasons, the relation between airborne fluoride and incidence of lung cancer needs to be investigated.

10. Long-term ingestion, with accumulation of fluoride in animals and man, induces metabolic

and biochemical changes, the significance of which has not yet been fully assessed. It cannot be assumed that such changes are of no significance to human health. There is evidence that neurological complaints are related to the early histological changes that precede overt skeletal fluorosis. There is also evidence that the early bone changes can reflect an entire gamut of abnormalities, depending on factors such as nutritional and metabolic status. Further studies on the early subtle changes of fluoride toxicosis in humans, in terms of both diagnostic aids and Cause/Effect interrelations, should have a high priority.

11. Fluoride is a persistent bioaccumulator, and is entering into human food-and-beverage chains in increasing amounts. Careful consideration of all available data indicates that the amount of fluoride ingested daily in foods and beverages by adult humans living in fluoridated communities currently ranges between 3.5 and 5.5 mg. For a 70 kg human adult, this range is close to the 0.03 to 0.07 mg/kg/day estimated for "an acceptable daily intake". In addition to the food-chain, dentifrices and pharmaceuticals can contribute significantly to the fluoride intake of some individuals.

12. Inhalation of airborne fluoride may contribute several milligrams to the total daily intake of industrial workers, and may be significant for persons residing near sources of fluoride emissions. However, the effect of airborne fluoride on human respiratory tissue is not necessarily related to total body burden, but may relate to the direct impact of fluoride on respiratory tissues. The contribution of cigarette-smoking to fluoride intake also requires study.

13. In the assessment of the impact of fluoride on animals and man, more attention should be focused on the concentration of inorganic fluoride in blood plasma. Available evidence indicates that accurate assessment of the plasma F concentration can provide valuable information about the body-burden during chronic fluoride intake.

14. In addition to industrial workers, there are several sub-groups of the population who may be more affected by environmental fluoride than the population at large. These are persons who:

a) Have a sub-optimal nutritional status, especially with regard to calcium, magnesium, vitamin C, manganese, or a low dietary Ca/P ratio (Note: This also applies to animals);
b) Live in the proximity of fluoride-emitting industries;
c) Live in regions where goitre is endemic, because there is suggestive evidence that fluoride may increase the incidence of goitre in such regions;
d) Have kidney impairments, particularly those with bilateral pyelonephritis or nephropathic Diabetes Insipidus;
e) Have the excessive-thirst polydipsia associated with diabetes, because they consume large quantities of fluids.

These may be called "critical groups" (ICRP 1977) either because they accumulate more fluoride or suffer toxic effects more readily.

15. Standards limiting emissions or environmental concentrations of fluoride should be based on criteria which include those derived from studies of these "critical groups".

16. In addition to the research recommendations we have made, we would like to acknowledge those presented in a recent U.S. National Academy of Sciences report (see Fleischer et al. 1974):

a) Additional detailed studies are needed of the health of human and animal populations exposed to high concentrations of airborne fluorides;

b) The gross effects of fluoride on plants and animals have been studied, but much needs to be done on the basic biochemical lesions induced by fluoride, and on dietary factors affecting fluoride uptake by man;

c) The very large emission of fluorocarbons (freons), and their rapidly increasing use, require study of their distribution, rate of degradation, and possible effects on plants, animals and humans;

d) Waste waters of high fluoride content have been released from phosphate processing and from the aluminum industry, with detrimental effects to such marine organisms as oysters and crabs. Possible chronic effects from exposure of such organisms to lower levels of fluoride need study;

e) In view of the high fluoride content reported to exist in some fish-protein concentrates used as food supplements, the possible impact of this added source of fluoride in the diet should be further investigated;

f) Methods of sampling and separating gaseous and particulate forms of airborne fluoride need study and standardization;

g) Further work is needed on the relation of the uptake of fluorine by plants to its concentration in the air;

h) Study of the form of fluorine in plants is highly desirable, especially the nature of fluorine bonding in plant tissue and its solubility in aqueous solutions;

i) More data are needed on the relation of the fluoride content of groundwaters to the mineralogical and chemical composition of the source rocks.

These NAS recommendations are fully compatible with the information that we have presented in this report or in our previous review (Marier and Rose 1971).