

# Investigation of the Environmental Fate of Tritium in the Atmosphere

## Overview

This report is primarily a literature review. It looks at natural and man-made sources of tritium, examines how tritium gas transforms into tritiated water and describes the behaviour of tritium in the natural cycle of water in the environment. The study also compares predictions from a standard model of tritium environmental behaviour to observed concentrations in air and water for representative nuclear facilities that release tritium.

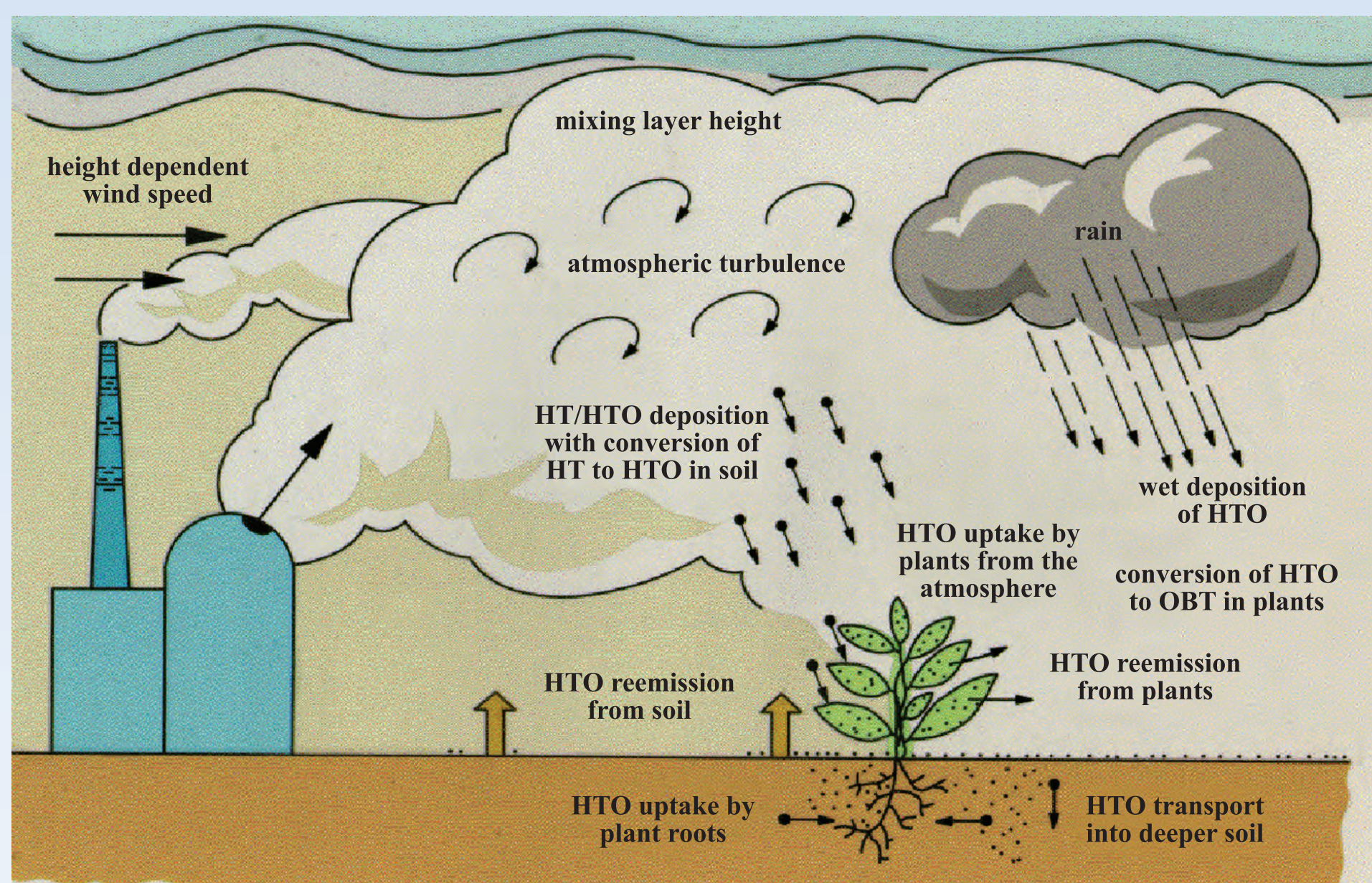
## Objective

This report aims to provide practical and scientific knowledge of the environmental behaviour of tritium released to the atmosphere to support regulatory approaches at nuclear facilities releasing tritium.

## Main Findings

### 1. Tritium behaviour in the atmosphere is reasonably well understood.

- Sources (natural and man-made) and chemical forms (gas and water vapor) are identified and characterized.
- Physical and chemical behaviour (diffusion, dispersion and deposition), chemical transformations (tritiated gas [HT] to tritiated water [HTO]), and hydrological cycle (partitioning from air to soil water and surface water, from soil water to groundwater, as well as in lakes and rivers) are explained (see Figure 1).



**Figure 1. Environmental tritium processes**

This diagram depicts the tritium cycle in the atmosphere. Tritium is released from the stack and disperses in the air. It is then deposited on vegetation and soil by rainfall (washout) or through vapour exchange. The tritium may then be re-emitted from the plants and soil to the atmosphere.

### 2. There are discrepancies in tritium measurements.

- There are discrepancies between active and passive air sampler results.
- There are also uncertainties in passive samplers at some facilities (for example, approximately twice as high).
- These discrepancies and uncertainties could influence dose estimates and safety assessments. However, licensees use the higher values to conservatively estimate doses to members of the public.
- The CANDU Owners Group (COG) has completed research on this issue and shared this information with the CNSC. The CNSC is considering the implications of COG's findings for improving the accuracy of routine environmental compliance air monitoring. Table 1 summarizes results of both samplers at some nuclear facilities.

**Table 1. Discrepancies between passive and active samplers**

Darlington			Pickering			Bruce Power		
Site	Active Sampler Bq/m <sup>3</sup>	Passive Sampler Bq/m <sup>3</sup>	Site	Active Sampler Bq/m <sup>3</sup>	Passive Sampler Bq/m <sup>3</sup>	Site	Active Sampler Bq/m <sup>3</sup>	Passive Sampler Bq/m <sup>3</sup>
D1	0.8	1.8	P2	17.3	31.3	B3	3.51	1.84
D2	0.9	1.8	P6	6.8	14	B4	2.72	3.31
D6	0.3	0.5	P10	19.7	48	B5-1	2.39	1.91

### 3. Modelling is suitable and conservative.

- The Gaussian dispersion model as described in the Canadian Standards Association (CSA N288.1-08) standard was applied.
- Tritium predictions in air were modelled using the IMPACT code, and results obtained of tritium in air and water agree with those measured.
- The standard air models used for verifying releases are somewhat conservative and therefore suitable to estimate annual public dose.
- The Gaussian air model is more suitable for long-term release than for short releases or releases in complex terrain.

## Conclusions

- The information and practices compiled in this report are useful tools for better understanding the environmental fate of tritium in the atmosphere.
- The modelling approach used by the CNSC and licensees is conservative, and therefore suitable for regulatory use and to estimate public dose.
- Annual public doses are overestimated and environmental risk exposures to tritium are not underestimated.