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Tritium Calculations with IMBA	Page 1 of 4
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RECORD OF ISSUE/REVISIONS			
ISSUE AUTHORIZATION DATE	**EFFECTIVE DATE**	**REV. NO.**	**DESCRIPTION**
4/22/2003	4/22/2003	0	New document to provide guidance on the use of IMBA to calculate tritium doses.

1.0 PURPOSE

This Technical Information Bulletin provides guidance on the use of IMBA to calculate tritium doses. This guidance is applicable to IMBA Expert OCAS-Edition (Task 1) and IMBA Expert USDOE-Edition Phase I.

Background

At Department of Energy and Atomic Weapons Employer facilities, tritium can be found in various chemical compounds. The ICRP has specified five different categories of tritium compounds. Many of these compounds are categorized as gases or vapors. While the IMBA program currently includes tritium, it does not yet handle gases and vapors. It is, however, possible to utilize IMBA to calculate doses for these compounds. This Technical Bulletin provides instructions for performing these calculations. The specific instructions are presented as bullets at the beginning of section.

Urine Measurements

For most elements the ICRP (ICRP 78) lists predicted urinalysis on a per day basis, such as Bq/day. However, for tritiated water (HTO) the ICRP calculated values as a concentration, such as Bq/L. The "Bioassay Calculations" window in IMBA indicates activity per day, however, the values are actually in units of activity per liter. IMBA correctly performs any calculations provided the operator realizes that the column header is incorrect and the units are actually on a per liter basis.

This affects any calculation performed when "Hydrogen-3 (inorganic)" is selected. When "Hydrogen-3 (organic)" is selected, the column is correctly labeled as activity per day.

4.0 Elemental Tritium (HT) and Tritiated Methane

- Specify the radionuclide as "inorganic" tritium.
- Specify "injection" as the route of entry for inhalation exposures (ingestion is not applicable for gaseous compounds).
- If using IMBA to calculate intake from bioassay
  - Doses calculated from the IMBA-generated intake will be correct;
  - Actual inhalation intake of HT is 10,000 time higher than IMBA calculated;
  - Actual inhalation intake of tritiated methane is 100 times higher than IMBA calculated.
- If calculating dose from airborne concentrations
  - Adjust the actual intake of HT by dividing it by 10,000 for input into IMBA or by 100 for tritiated methane.
  - Dose and bioassay calculated from adjusted intake will be correct

Discussion

Elemental tritium is chemically hydrogen gas. The ICRP model for elemental tritium assumes the gas is inhaled and readily exhaled. The dose delivered to the lungs while the gas is in the lungs is considered trivial. However, 0.01% of the gas is assumed to convert into tritiated water vapor and be instantaneously absorbed into the blood. At that point, it is assumed to behave the same as tritiated water in the body. Therefore, the dose from elemental tritium is one ten thousandth that of tritiated water (i.e. 0.01% converted to HTO).

Chemically, tritiated methane is simply methane gas with one or more hydrogen atoms replaced by tritium. The ICRP model for tritiated methane assumes the gas is inhaled and readily exhaled. The dose delivered to the lungs while the gas is in the lungs is considered trivial. However, 1% of the gas is assumed to be metabolized and is then instantaneously absorbed into the blood. At that point, it is assumed to behave the same as tritiated water in the body. Therefore, the dose from tritiated methane is 1% that of tritiated water.

5.0 Tritiated Water (HTO)

Specify the radionuclide as "inorganic" tritium.

- Specify "injection" as the route of entry for both inhalation and ingestion
- If calculating intake from bioassay
  - Dose calculated from the IMBA-generated intake will be correct;

  - Intake calculated by IMBA is correct for ingestions
  - Intake calculated by IMBA for inhalations is the correct TOTAL intake. 1/3 of the total intake is from skin absorption.
- If calculating dose from airborne concentrations
  - Not applicable for ingestions;
  - Adjust the intake obtained from airborne concentrations and volume of air breathed by multiplying it by 1.5 for input into IMBA (to account for skin absorption);
  - Dose and bioassay calculated from adjusted intake will be correct.

Discussion

Tritiated water is chemically equivalent to water. The ICRP model for HTO assumes that all the vapor inhaled is instantaneously absorbed into the blood. From there, it is evenly distributed throughout all the body's water. This has the affect of producing the same dose to all tissues of the body. ICRP also assumes an individual exposed to HTO vapor will absorb some HTO through the intact skin. This amount is assumed to be 50% of the amount inhaled. Therefore, an individual inhaling 1 Bq of HTO is assumed to have a total intake of 1.5 Bq of HTO (1 Bq through inhalation plus 0.5 Bq through skin absorption). Ingestion of HTO is treated the same as inhalation excluding the skin absorption. Therefore, the dose coefficients for inhalation and ingestion are identical.

Organically Bound Tritium (OBT)

- Specify the radionuclide as "organic" tritium.
- IMBA works correctly for ingestions
  Specify "injection" as the route of entry for inhalations

Discussion

Organically bound tritium is tritium bound to an organic molecule other than methane. The ICRP model treats ingestion of OBT differently than inhalation. Ingestion is treated as any other radionuclide using the ICRP 30 GI tract model, with an assumed f1 of 1. Inhalation, however, is treated as a vapor. All the inhaled OBT activity is assumed to be instantaneously absorbed into the blood then uniformly distributed throughout the body.

Tritium Particulates

- Specify the radionuclide as "inorganic" tritium.
  IMBA works correctly for both inhalations and ingestions

Discussion

This category encompasses any particulate compound of tritium. The ICRP treats this category as any other particulate. That is to say, the biokinetic model is connected to the ICRP 30 GI tract model and the ICRP 66 lung model (if inhalation is the route of entry). The HTO biokinetic model is used as the biokinetic model for particulate tritium.

8.0 References

1. ICRP (2001) *Doses to the Embryo and Fetus from Intakes of Radionuclides by the Mother.* Clarification page 517-518. ICRP Publication 88. Annals of the ICRP 31 (1/3). Pergamon Press, Oxford, UK.
2. ICRP (1997) *Individual Monitoring for Internal Exposure of Workers.* ICRP Publication 78. Annals of the ICRP 27 (3/4). Pergamon Press, Oxford, UK.
3. ICRP (1995) *Age-dependent doses to members of the public from intake of Radionuclides: Part 4 Inhalation Dose Coefficients.* ICRP Publication 71. Annals of the ICRP 25 (3/4). Pergamon Press, Oxford, UK.