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Atomic Energy Control Board

Commission de contrôle de l'énergie atomique

REGULATORY DOCUMENT R-105

Regulatory Policy Statement

THE DETERMINATION OF RADIATION DOSES FROM THE INTAKE OF TRITIUM GAS

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Canada

R-105, THE DETERMINATION OF RADIATION DOSES FROM THE INTAKE OF TRITIUM GAS

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THE DETERMINATION OF RADIATION DOSES FROM THE INTAKE OF TRITIUM GAS

1. BACKGROUND

Occupational exposures to tritium in the nuclear industry usually involve tritiated water (HTO), but on occasion tritium gas (HT) is encountered either alone or in combination with tritiated water.

Tritium gas is only slightly soluble in body fluids and tissues and hence it is only the tritium gas contained in air within the lung which contributes significantly to doses of ionizing radiation received from inhaled tritium gas. On this basis, the derived air concentration (DAC) for tritium gas has been determined to be about 10^4 times that for tritiated water [Ref. 1]. Although tritium gas is only slightly soluble in the body, it has been shown that, within the body, a certain amount may be converted to tritiated water which is much more soluble in tissue. This situation has been discussed in Bioassay Guideline 2: Guidelines for Tritium Bioassay [Ref. 2] as follows:

> "When tritium is observed in the urine of individuals working with HT, and if the HT/HTO ratio in air is unknown, an immediate investigation shall be initiated. The concentration of tritium in urine shall be used to calculate the dose to tissues and organs other than the lung by assuming the exposure was to HTO. Dose to the lung must be estimated from air monitoring results (6) [Ref. 1 in this document]. However, an estimate of the maximum possible lung dose can be obtained from the concentration of tritium in urine (see Appendix B)."

Since the publication of these guidelines, further experimental work has been done at Chalk River Nuclear Laboratories [Ref. 3] which has resulted in an improved numerical estimate of the upper limit on lung dose. The method described in Appendix B of the guidelines is still appropriate, but equation B-6 should be replaced by $H_L = 0.8 \times 10^{-8} \times C_u$, where H_L = upper limit to lung dose in sieverts (Sv), and C_u = tritium concentration in urine in becquerels per litre (Bq L^{-1}). For further details, the references should be consulted. For the calculation of effective dose from tritiated water, which is equivalent to the soft tissue dose, the method given in Document R-100 [Ref. 4] shall be used.

Licensees are cautioned, however, that the Bioassay Guideline is based on the International Commission on Radiological Protection system of dose limitation and does not contain quarterly limits, as required by the Atomic Energy Control Regulations. The derived action level in the Bioassay Guideline, by means of which decisions are to be made on the significance of urinalysis results, is based on an implied annual lung dose limit of 420 mSv; therefore, it must be modified if compliance with the present annual lung dose limit of 150 mSv and quarterly limit of 80 mSv is to be demonstrated.

The AECB position is presented in the following policy statement.

2. POLICY STATEMENT

2.1 Preamble

Intakes of tritium gas give rise to dose to the lung and may give rise to soft tissue doses from HTO, due to the conversion to HTO within the body. In the interpretation of urinalysis data, soft tissue doses shall be calculated according to the method given in R-100. This procedure will give the correct HTO dose even if HTO detected in urine was taken in as HTO rather than HT. However, if some tritium was taken in as HTO then the calculated lung dose from urinalysis attributable to HT inhalation will be overestimated, which is why it is better to calculate the lung dose from air monitoring data, but it should be noted that the R-100 procedure will give the upper limit on lung dose. This question has been reviewed by the Federal-Provincial Working Group on Bioassay and In Vivo Monitoring Criteria, in the course of the preparation of their document Bioassay Guideline 2: Guidelines for Tritium Bioassay [Ref. 2] published by the authority of the Minister of National Health & Welfare (83-EHD-87). That document includes, in Appendix B, a procedure for the calculation of an upper limit on lung dose from the intake of tritium gas, by means of urinalysis measurements.

Licensees are cautioned that this policy statement refers only to that part of the Bioassay Guideline concerned with the dose calculation. If licensees wish to use the derived limits in the guidelines, those limits must be modified to conform to the quarterly limits in the Atomic Energy Control Regulations.

2.2 Policy

In the determination of radiation doses from the intake of tritium gas, the Atomic Energy Control Board requires that the calculation of the effective dose equivalent include both the contribution of the soft tissue dose resulting from tritiated water circulating in the body, either as a result of conversion within the body of tritium gas or of inhalation of HTO, and the contribution of the lung dose from the contained tritium gas, multiplied by the lung weighting factor of 0.12. The soft tissue dose shall be calculated from urinalysis results using the methods prescribed in R-100. The lung dose should be estimated from air monitoring data, but an upper limit on lung dose can be calculated using the method given in Appendix B of Bioassay Guideline 2: Guidelines for Tritium Bioassay (83-EHD-87) but using a dose conversion factor of 0.8×10^{-8} Sv/(Bq.L^{-1}).

Sources:

1. International Commission on Radiological Protection, 1979, "Limits for Intakes of Radionuclides by Workers", ICRP Publication 30, Part 1, Annals of the ICRP, Vol. 2, No. 3/4.

2. Federal-Provincial Working Group on Bioassay and In Vivo Monitoring Criteria, 1982, Bioassay Guideline 2: Guidelines for Tritium Bioassay, National Health and Welfare Publication 83-EHD-87.

3. Peterman, B.F., Johnson, J.R., and McElroy, R.G.C., 1985, "HT/HTO Conversion in Mammals", Fusion Technology 8, 2557.

4. Atomic Energy Control Board, Regulatory Document R-100, The Determination of Effective Doses from the Intake of Tritiated Water, August 27, 1987.