Draft STD-1027 Supplemental Directive (Alternate Hazard Categorization) Methodology

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Revised Hazard Category 2 value for tritium (water)

Revised value based on the use of:

- ICRP 72 (public) dose coefficient
- Breathing rate of 3.33 E-4 m^3/sec (per ICRP 68 "light work")

Ref. ICRP 72, Table A.3 (Inhalation dose coefficients)

Tritiated water e(T) adult = 1.8 E-11 Sv/Bq

$$= 1.8\text{ E-11 Sv/Bq}\left(\frac{100\,rem}{1Sv}\right)\left(\frac{3.7\,E10\,Bq}{1Ci}\right)$$

= 66.6 rem/Ci

Note: Per discussion on 10/22/10 with Keith Eckerman (ICRP Chairman for the Task Group on Dose Calculations), the ICRP 72 value for tritiated water does <u>not</u> include skin absorption. Therefore, tritiated water e(T) adult = 66.6 rem/Ci × 1.5 = 9.99 E1 rem/Ci

The HC2 threshold equation from p. A-6 of DOE-STD-1027 is as follows:

$$Q(g) = (1\ \text{rem})/(RF \times SA \times \chi/Q \times (CEDE \times RR + CSDE))$$

RF = Airborne Release Fraction (note: As with the HC3 calculation for tritium (water), an RF of **0.5** is used here.)

SA = Specific Activity = 9.63 E3 Ci/g

χ/Q = 1 E-4 sec/m^3 (per 1027)

CEDE = 9.99 E1 rem/Ci (per ICRP 72 and as noted above)

RR = respiration rate (note: revised value of 3.33 E-4 m^3/sec is used here vs 3.5 E-4 m^3/sec

CSDE = Ø

$Q(g) = (1\ rem)/(0.5) \times (9.63\ E3\ Ci/g) \times (1\ E\text{-}4\ sec/m^3) \times (99.9\ rem/Ci \times 3.33\ E\text{-}4\ m^3/sec)$

$Q(g) = 1\ rem/0.0160\ rem/g$

$Q(g) = 62.4\ g$

Revised HC2 threshold value for tritium (water) = 62.4 g

Note: This exactly matches the value calculated in the Excel spreadsheet.

Revised HC3 value for tritium (water)

Revised value based on the use of:

- ICRP 68 (worker) dose coefficient
- Breathing rate of 3.33 E-9 m^3/sec (per ICRP 68, “light work”)

Consistent with the EPA Technical Background Document (Feb. 1989), Appendix E, the lowest release value for tritium was for the inhalation pathway, and the corresponding inhalation dose coefficient from ICRP 68 was selected.

Reference ICRP 68, p. 75, Annexe C (effective dose coefficients), which provides inhalation doses for tritium.

Tritiated water $e_{inh}(50)$ = 1.8 E-11 Sv/Bq

- Per Footnote (b) in Annexe C, the dose from skin absorption is not included in the above value.
- Per Bill Weaver, TFG, and consistent with DOE-HDBK-1129 (Tritium Handbook), need to add a 50% allowance for skin absorption to the above value for $e_{inh}(50)$

Therefore, $e_{inh}(50)$ for tritiated water

= 1.8 E-11 Sv/Bq × 1.5

= 2.7 E-11 Sv/Bq

Per ICRP 68, p. 17, ALI (Bq) = $\frac{0.02\,Sv}{e(50)}$

ALI (Bq) = $\frac{0.02\,Sv}{2.7\,E-11\,Sv/Bq}$

= 7.40 E8 Bq

Since this ALI determination is based on an annual average effective dose limit of 0.02 Sv (or 2 rem), the above ALI needs to be multiplied by 2.5 to get an dose limit of 5 rem (see additional discussion on next slide)

Therefore, ALI = 7.40 E8 Bq × 2.5

= 1.85 E9 Bq (5 rem)

= $1.85\ E9\ Bq \left(\frac{1 Ci}{3.7\ E10\ Bq}\right)\left(\frac{1\ \mu Ci}{1E-6\ Ci}\right)$

ICRP 68-based ALI = 5 E3 µCi

Per the EPA Technical Background Document (Feb. 1989), the inhalation pathway release value (Ci) is calculated as follows:

Note: This EPA document used ICRP 30 ALIs, based on 5 rem CEDE. That is why the ICRP 68 ALI was multiplied by 2.5.

Inhalation release value (Ci) = ALI/(10) × (R) × χ/Q × (BR) × (1 E6)

where

ALI = ALI for inhalation (µCi) = 5 E4 µCi
(note: the ICRP 68-based ALI was used)

10 = Factor to adjust dose equivalent on which ALI is based (note: This arrives at an effective dose equivalent of 500 mrem per the EPA methodology. This factor will be adjusted (see next slide) to determine the HC3 threshold value (10 rem doses at 30 meters).

R = Airborne Release Fraction (dimensionless)
(note: Consistent with Appendix A (Airborne Release/Inhalation) of the EPA Technical Document, a value of 0.5 was chosen for tritium.

χ/Q = 8.4 E-13 day/cm^3

BR = 2.87 E7 cm^3/day (vs 2.3 E7 cm^3/day in the EPA document) (note: This revised value is equivalent to 3.33 E-4 m^3/sec, per ICRP 68 ("light work")

1 E6 = Conversion factor (µCi ↔Ci)

Inhalation Release Value (Ci)

= 5 E4 µCi/(10) × (0.5) × (8.4 E-13 $\frac{day}{cm^3}$) × (2.87 E7 $\frac{cm^3}{day}$) × (1 E6)

= 414.80 Ci

As noted on the previous page, the EPA methodology used a factor of 10 to arrive at an effective dose equivalent of 500 mrem. In order to determine the HC3 threshold value (10 rem doses at 30 meters), the calculated inhalation release value needs to be multiplied by 20. This gives:

Inhalation Release Value = 414.80 Ci × 20

= 8.29 E3 Ci (10 rem @ 30 m)

Or, using a specific activity of 9.63 E3 Ci/g, the revised HC3 threshold value for tritium (water) = 8.29 E3 Ci $\left(\frac{1g}{9.63\,E3\,Ci}\right)$ = 0.86 g

Note: The actual value calculated in the Excel spreadsheet is 0.866 g.