OAK RIDGE National Laboratory

Overview of DOE-STD-1027-2018 Issues: ALI Values for Cat 3 TQs and Changes in Cat 2 TQs

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Brief Explanation of Cat 3 TQ Issue: *Whole Body ALI or Tissue/Organ Dose Annual Limit for Intake (ALI)*

Per DOE-STD-1029-92-CN1

DOE has chosen to use an EPA model* to calculate the threshold quantities for Category 3. The model assumes that: the distance from the point of release to the point of exposure is 30 meters; the dose-equivalent limit is 10 rem effective whole body dose; and there is no radioactive decay (for the sake of conservatism and simplicity). For the period of exposure, the models used assume that persons are exposed for one day for inhalation and direct exposure, but that persons are exposed for longer periods through the ingestion pathway.

Per EPA Technical Background Doc…[pg.4-2]

EPA used the ALIs from ICRP 30 to determine RQs by estimating the quantity of radionuclides that, if released, could result in the intake of one-tenth of an ALI. The ALIs were divided by 10 to adjust the dose that they are based on (an effective dose-equivalent of 5 rem for most radionuclides and, for a minority of radionuclides, a dose-equivalent of 50 rem to the critical organ) to an effective dose-equivalent of 0.5 rem (500 millirem). A

ICRP-68: *Where are the ALI's?*

- ICRP-30 used a 0.05-Sv basis for calculating WB and Tissue /Organ ALIs.
- ICRP later changed the dose threshold to 0.02-Sv basis.
  - Tissue / Organ ALI rarely limiting for lower dose threshold (see below).
- As such, Pub-68 only published effective (Whole Body) Dose Coefficients (DCs). *(No tissue/organ DCs in Pub-68!)*

ICRP Pub. 68…[pg.17]

(42) Although ALIs based on the 1990 recommendations will be, for the most part, more restrictive than those based on the 1977 recommendations, an annual limitation on effective dose of 20 mSv permits intakes which can result in a committed equivalent dose of the order of 1 Sv to individual organs, in particular to bone surfaces, the kidneys and the extrathoracic tissues. Due to the protracted nature of the exposure from many internally deposited radionuclides, it is unlikely that the lifetime equivalent dose would be sufficient to result in deterministic effects. In addition, for the alpha-emitting radionuclides the committed effective dose (or the equivalent dose) as calculated here incorporates a radiation weighting factor, w_R, of 20 based on stochastic effects. As discussed in *ICRP Publication 58* (ICRP, 1989b), this probably overestimates the possibility of deterministic effects.

Example Case: *Pu-239*

Table 3-1. Pu-239 ALI Calculations for 1μm AMAD – Adsorption Type M (Inhalation)

Organ/Tissue	DC [Sv/Bq]	DL [Sv]	Pub 68 ALI [Bq]
Adrenals	2.5E-06	0.5	2.00E+05
Bladder Wall	2.5E-06	0.5	2.00E+05
Bone Surface	1.5E-03	0.5	**3.33E+02**
Brain	2.5E-06	0.5	2.00E+05
Breast	2.5E-06	0.5	2.00E+05
GI-Tract			
Oesophagus	2.5E-06	0.5	2.00E+05
Thymus	2.5E-06	0.5	2.00E+05
Thyroid	2.5E-06	0.5	2.00E+05
Uterus	2.5E-06	0.5	2.00E+05
Remainder	2.6E-05	0.5	1.92E+04
Effective dose	**4.7E-05**	**0.02**	**4.26E+02**

Organ/Tissue DCs provided by Dr. Keith Eckerman

Table 3-8. Summary of ICRP Pub 68 Limiting Pu-239 Inhalation and Ingestion ALIs [Bq]

		Inhalation					
				ALI_{inh}		ALI_{inh}	
Nuclide	$t_{1/2}$	Type	f_1	1 μm AMAD		5 μm AMAD	
Pu-239	2.41E+04y	M	5E-04	**3.3E+02**	**Bone Surface**	5.0E+02	Bone Surface
				4.3E+02	*Effective Dose*	*6.3E+02*	*Effective Dose*
		S	1E-05	1.3E+03	Effective dose	2.4E+03	Effective dose

Net Result: *An Instance Where Tissue/ Organ Exposure is Limiting for HC-3 TQ Analysis*

- Inhalation:
  - Only 80 nuclides identified where limiting ALI was not whole body *(out of +1,200 total nuclides!)*
    - 6 had same ALI as Whole Body
  - 31 of 74 remaining nuclides are bounded by other pathways

- Ingestion:
  - Only 46 nuclides identified where limiting ALI was not whole body.
    - 1 had same ALI as Whole Body
  - 40 of 45 remaining nuclides are bounded by other pathways
  - Of the remaining 5:
    - 4 bounded by existing food pathway ALI
    - 1 Limited by inhalation ALI

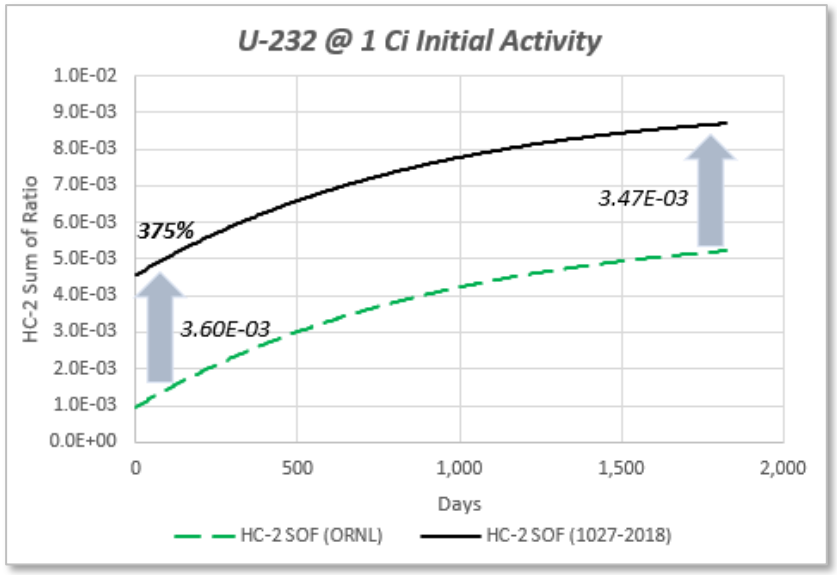
Cat 2 TQs: *NNSA vs 1027-2018*

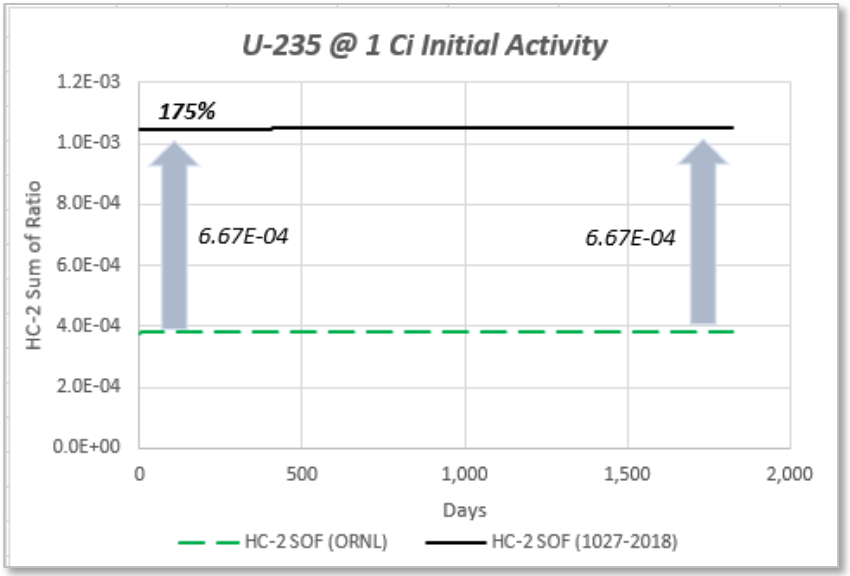
- ICRP Pub-72 Table 2
  - Recommended (NNSA Suppl. Guidance) vs. Bounding (2017-2018) selection of DCs

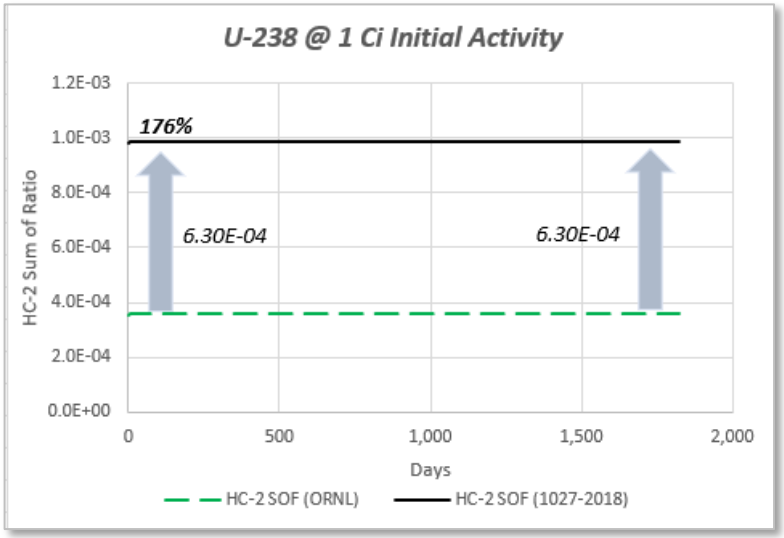
Mercury	F, M	SR-1	*30, Part 2*
Thallium	F		*30, Part 3*
Lead	F, M[b], S		*67* and *71*
Bismuth	F, M		*30, Part 2*
Polonium	F, M[b], S		*67* and *71*
Astatine	F, M		*30, Part 3*
Francium	F		*30, Part 3*
Radium	F, M[b], S		*67* and *71*
Actinium	F, M, S		*30, Part 3*
Thorium	F, M, S[b]		*69* and *71*
Protactinium	M, S		*30, Part 3*
Uranium	F, M[b], S		*69* and *71*
Neptunium	F, M[b], S		*69* and *71*
Plutonium	F, M[b], S		*67* and *71*
Americium	F, M[b], S		*67* and *71*
Curium	F, M[b], S		*71*
Berkelium	M		*30, Part 4*
Californium	M		*30, Part 4*
Einsteinium	M		*30, Part 4*
Fermium	M		*30, Part 4*
Mendelevium	M		30, Part 4

[a]For particulates: F, fast; M, moderate; S, slow. [b]Recommended default absorption Type for particulate aerosol when no specific information is available (see *ICRP Publication 71*, 1996). [c]Also for ingestion dose coefficients.

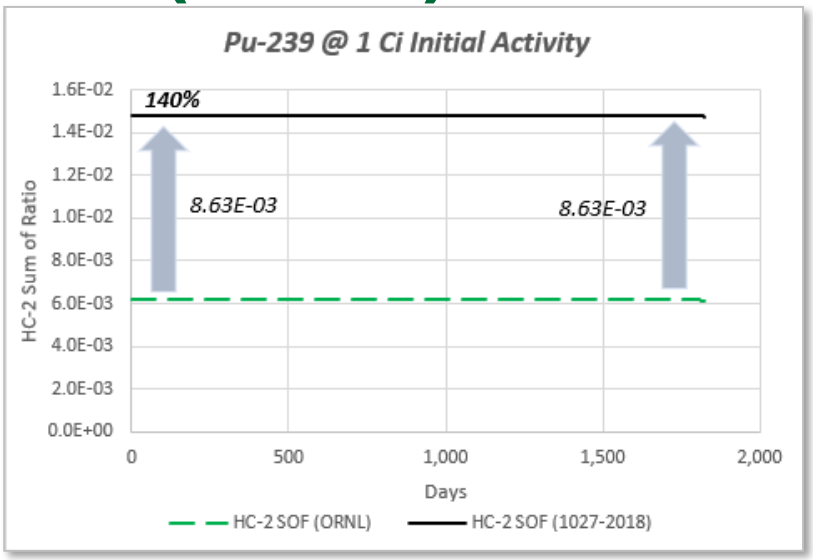
Dynamic Analysis of Selected Cat 2 SOR TQs (1 of 3)

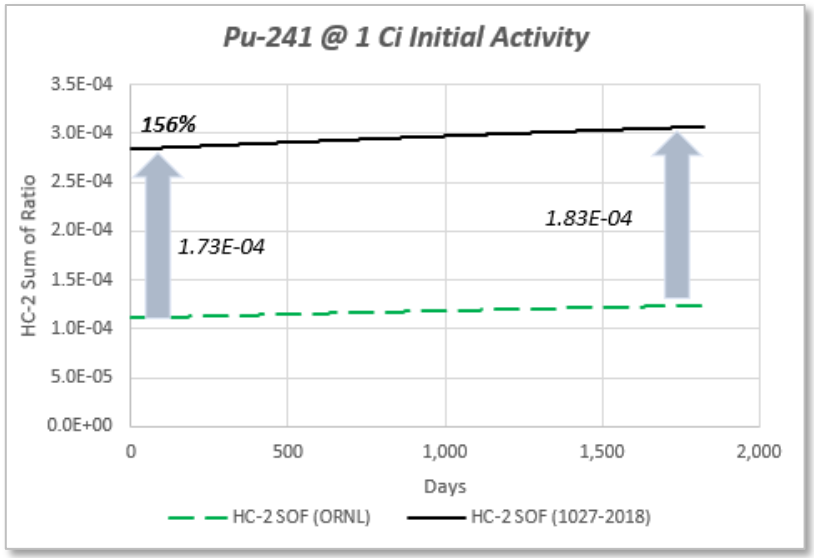


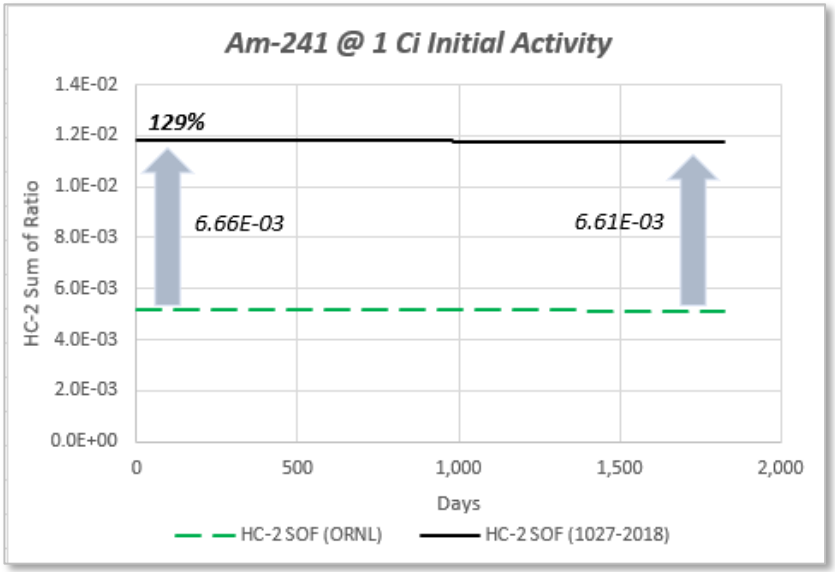




Dynamic Analysis of Selected Cat 2 SOR TQs (2 of 3)







Dynamic Analysis of Selected Cat 2 SOR TQs (3 of 3)