EXTERNAL EVENTS

The WILDCARD of EMERGENCY MANAGEMENT

Transition to ICRP 68/72 DCFs

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DOE Order / Guide

- DOE O 151.1C
  - 4.a.(14)(d): Protective action criteria for releases of hazardous materials are listed below.
    - For radioactive material - Protective Action Guides (PAGs) promulgated by the Environmental Protection Agency (EPA) must be used.
- DOE G 151.1-1, Volume II, Appendix B *Consequence Thresholds* …
  - Radiological Protective Action Criteria
    - the Order specifies that PAGs published in *Manual of Protective Action Guides and Protective Actions For Nuclear Incidents* (EPA-400) are to be used for comparison with exposures resulting from radiological releases to determine the appropriate emergency class.

Dose Definitions (10CFR835)

- Committed effective dose equivalent (CEDE) - sum of committed dose equivalents to various tissues in the body, each multiplied by appropriate *weighting factor*.
- Effective dose equivalent (EDE) - summation of products of the dose equivalent received by specified tissues of the body and appropriate *weighting factor*
- Total effective dose equivalent (TEDE) - sum of EDE (external exposure) and CEDE (internal exposure).

10 CFR 835 Weighting Factors

Weighting Factors For Various Organs and Tissues

Organs or tissues, T	Weighting factor, w_T
Gonads	0.25
Breasts	0.15
Red bone marrow	0.12
Lungs	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder [1]	0.30
Whole body [2]	1.00

[1] "Remainder" means the five other organs or tissues, excluding the skin and lens of the eye, with the highest dose (e.g., liver, kidney, spleen, thymus, adrenal, pancreas, stomach, small intestine, and upper large intestine). The weighting factor for each remaining organ or tissue is 0.06.

[2] For the case of uniform external irradiation of the whole body, a weighting factor (w_T) equal to 1 may be used in determination of the effective dose equivalent.

FGR 11 DCFs & ICRP Revs

- FGR 11 DCFs based on two superseded ICRP reports:
  - ICRP 26 provided guidance for assessing dose to workers
  - ICRP 30 recommended biokinetic and dosimetric models.
  - Guidance and models underlying FGR 11 were designed for application to occupational exposure.
- ICRP 26 superseded by ICRP 60 which revised & extended the list of tissue weighting factors.
- ICRP 30 superseded by ICRP 68 which substantially changed biokinetic models (especially respiratory model) and gastrointestinal absorption fractions.

Weighting Factors Compared

Organ or tissue	ICRP Pub. 26	ICRP Pub. 60
Gonads	0.25	0.20
Bone marrow (red)	0.12	0.12
Colon	--	0.12
Lung	0.12	0.12
Stomach	--	0.12
Bladder	--	0.05
Breast	0.15	0.05
Liver	--	0.05
Esophagus	--	0.05
Thyroid	0.03	0.05
Skin	--	0.01
Bone surface	0.03	0.01
Remainder	0.30[a]	0.05[b,c]

New Respiratory Model

- The ICRP's updated respiratory tract model differs considerably from the ICRP 30 model:
  - For an adult male, the updated model predicts *lower total deposition* in the respiratory tract and lower deposition in the lower lungs than does the ICRP 30 model for most particle sizes.
  - Compared with the ICRP 30 model, the updated model predicts much *different rates of absorption* from the respirator tract to blood.
  - Differences in the biokinetic & dosimetric properties of the two respiratory models often lead to substantially different estimates of lung dose.

Net Affect for Selected Isotopes

	FGR 11	FGR 11	ICRP 68	ICRP 68 (Worker)		ICRP 72 (Public)		Hotspot 2.06	New/Old
	Class	DCF (Sv/Bq)	Class	DCF (Sv/Bq)		DCF (Sv/Bq)		DCF (Sv/Bq)	(Hotspot)
		1 µm		1 µm	**5 µm**	**1 µm**	5 µm	**1 µm**	
Pu-238	W	1.06E-4	M	4.3E-5	3.0E-5	4.6E-5	3.4E-5	4.62E-5	**0.44**
(oxides)	Y	7.79E-5	S	1.5E-5	1.1E-5	1.6E-5	1.0E-5	1.61E-5	**0.21**
Pu-239	W	1.16E-4	M	4.7E-5	3.2E-5	5.0E-5	3.7E-5	5.01E-5	**0.43**
(oxides)	Y	8.33E-5	S	1.5E-5	8.3E-6	1.6E-5	1.0E-5	1.60E-5	**0.19**
Cs-137	D	8.63E-9	F	4.8E-9	6.7E-9	4.6E-9	6.7E-9	4.67E-9	**0.54**
I-131	D	8.89E-9	F	7.6E-9	1.1E-8	7.4E-9	1.1E-8	7.39E-9	**0.83**
HTO	V	1.73E-11	V	1.8E-11		1.8E-11		2.75E-11	**1.04**

De Facto Federal Adoption

- Although Federal agencies have not formally adopted the new ICRP recommendations, many (e.g., NRC, EPA, and DOE) are using them.
- NRC: commission approved use of ICRP 68 and authorized staff to grant subsequent exemptions
- EPA: risk coefficients from FGR 13, derived from ICRP 60, in CERCLA risk assessments.
- DOE: has approved use of new DCFs for Safety Analysis and ICRP 60 tissue weighting factors for worker dose calcs under 10 CFR 835.

NA-41 & EM-52 on New DCFs

- I sent an inquiry to NA-41 requesting their position on use of new DCFs.
- NA-41 (Dr. Powers) responded that the point of contact at DOE-HQ for DCF concerns was Dr. Rabovsky (EH-52)
- Joel L. Rabovsky, PhD, CHP
  DOE Office of Worker Protection
  Policy and Programs (EH-52)
  301-903-2135
- I spoke to Dr. Rabovsky; he suggested that I send him a statement of my position to which he could respond - specifically, regarding the impact of 10 CFR 835 *Occupational Radiation Protection*

RCTP 2004-01

- Radiological Control Technical Position (RCTP) 2004-01 *Guidance on the Revision of Internal Radiation Dose Estimates in Response to Updated Internal Dosimetry Methodologies*
  - ***With the exception of specifying tissue weighting factors to be used, 10CFR835 does not limit methodologies used in assessment of internal dose****. Accordingly, DOE sites may update their methodologies for internal dose assessment in accordance with the latest accepted scientific knowledge. In addition, because tissue weighting factors currently recommended by ICRP differ from those currently used by Federal agencies, it is possible Federal agencies may consider adopting updated tissue weighting factors. Thus, in the future it would be reasonable to expect DOE requirements for occupational radiation protection to change in response to advances in the understanding of radiation induced health effects …*

SRS Requests Exemption to 10CFR835 Weighting Factors

- In their exemption request, SRS noted *a primary benefit of this exemption would be the improved accuracy of dose assessments* and that *the exemption would result in benefit to human health and safety*.
- SRS determined that this exemption:
  - would be authorized by law;
  - would not present an undue risk to public health and safety, the environment, or facility workers; and
  - would be consistent with the safe operation of a DOE nuclear facility.

ESH & NNSA Accept Use of ICRP 60

- ESH & NNSA granted SRS an exemption from weighting factors in 10CFR835, specifically allowing use of ICRP 60 weighting factors. DOE, in their response, stated:
  - *While DOE permits use of the most current models to describe the intake, uptake, and metabolism of radioactive material by the human body, tissue & organ weighting factors needed to calculate CEDE are specified by regulation in 10CFR835.*
- DOE then noted that:
  - *the ICRP 60 set of tissue and organ weighting factors is considered to be more accurate than the set of tissue and organ weighting factors currently in 10 CFR 835*; and that
  - *... because of the benefit realized by using ICRP 60 tissue & organ weighting factors, EH-52 agrees that this change is warranted.*

DOE Grants 10CFR835 Exemption

- EH-52 concluded: *the effectiveness of 10CFR835 is not diminished by instituting this exemption request and therefore accepts the WSRC exemption request, with conditions specified*
- The *condition* that DOE had for implementation of ICRP 60 weighting factors was that secondary radiation protection quantities [e.g., Derived Air Concentration (DAC)] be updated to be consistent with ICRP 60 as well.

My Position: EH-52 Response

- My position (27 April memo):
  - It is permissible to use current (e.g., ICRP 60) weighting factors when calculating dose resulting from postulated releases for emergency planning. This allows use of ICRP 68 DCFs for computing dose to workers and ICRP 72 DCFs for computing dose to the public.
- Dr. Rabovsky Response (27 April Telecon):
  - “Yes”.

Feedback from State Regulator

- I forwarded my position statement to one of our more knowledgeable state regulators and got the following response:
  - *Looks good to me. You know that I am all for using the latest and greatest, peer reviewed, methodologies in the calculation of consequences of the release of radioactive materials. I won't take a position re: the use of ICRP 68 DCFs for workers, except to note that their use is consistent with the use of ICRP 72 DCFs for the general public ... which I strongly support.*
  - Jim Hardeman, Manager
    Environmental Radiation Program
    Environmental Protection Division
    Georgia Department of Natural Resources

DOE O 151.1 Exemption Process – Applicable?

- DOE O 151.1C
  - 3.c. (1) Exclusions: Generally accepted standards may be substituted for this Directive in accordance with the modified directives process…
- DOE G 151.1-1, Volume II, Appendix B *Consequence Thresholds for use in EPHA*
  - Radiological Protective Action Criteria
    - Facilities having substantive and persuasive arguments for use of other protective action threshold values may propose values that are specific to their radioactive material holdings and operations. Requests for exemption from the Order requirement should be submitted in accordance with Paragraph 3c of the Order.

References

- Legett & Eckerman: *Dosimetric Significance of the ICRPs Updated Guidance and Models, 1989-2003 and Implications for U.S. Federal Guidance* , ORNL/TM-2003/207
- ICRP 26 (1977) : *International Commission on Radiological Protection, Annals of the ICRP*, Pergamon Press, Oxford
- ICRP 30 (1979-88): *Limits for Intakes by Workers*
- ICRP 60 (1991): *1990 Recommendations of the ICRP*
- ICRP 68 (1994): *Dose Coefficients for Intakes of Radionuclides by Workers*
- ICRP 72: *Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 5. Compilation of Ingestion & Inhalation Dose Coefficients*
- 10 CFR 835: *Occupational Radiation Protection*
- EPA 400-R-92-001: *Manual of Protective Action Guides and Protective Actions For Nuclear Incidents* (October 1991)