EMERGENCY MANAGEMENT ROUNDUP

EXPECT THE UNEXPECTED

Dose Conversion Factors at DOE / NNSA Sites

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WSMS

SCAPA 2007 Annual Meeting

EMERGENCY MANAGEMENT ISSUES

DOE Order / Guide

- DOE O 151.1C
  - Protective action criteria for releases of hazardous materials …
    - For radioactive material - Protective Action Guides (PAGs) promulgated by the Environmental Protection Agency (EPA) must be used.
- DOE G 151.1-1, Volume II, App 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) be used for comparison with exposures resulting from radiological releases to determine the appropriate emergency class.

Dose Definitions (10 CFR 835)

- Committed effective dose equivalent (CEDE) -
  sum of committed dose equivalents to specified tissues, each multiplied by appropriate ***weighting factor***
- Effective dose equivalent (EDE) -
  sum of dose equivalents to specified tissues, each multiplied by appropriate ***weighting factor***
- Total effective dose equivalent (TEDE) -
  EDE (external exposure) + 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

- Current DCFs (FGR 11) based on 2 superseded ICRP reports:
  - ICRP 26 provided guidance for assessing dose to workers
  - ICRP 30 recommended biokinetic & dosimetric models
  - Models underlying FGR 11 designed for occupational exposure
- ICRP 26 superseded by ICRP 60 -
  - Revised & extended list of tissue weighting factors
- ICRP 30 superseded by ICRP 68 -
  - Substantially changed biokinetic models (especially respiratory model) and gastrointestinal absorption fractions

Weighting Factors Compared

Tissue	ICRP 26	ICRP 60
Gonads	.25	.20
Bone marrow	.12	.12
Colon	-	.12
Lung	.12	.12
Stomach	-	.12
Bladder	-	.05
Breast	.15	.05
Liver	-	.05
Esophagus	-	.05
Thyroid	.03	.05
Skin	-	.01
Bone surface	.03	.01
Remainder	.30	.05
Sum	1.00	1.00

Impact of New Weighting Factors

- In most cases, DCFs are insensitive to change in weighting factors; however, some are noticeably affected by some combination of the following:
  - Introduction of explicit factors for *Colon* & *Stomach*;
  - 67% increase in weighting factor for *Thyroid*;
  - 3X decrease in weighting factor for *Bone surface*;
  - 6X decrease in weighting factor for *Remainder*
    - affects contribution of tissues not explicitly named in either set of weighting factors (e.g., kidneys)

New Respiratory Tract Model

- Model in ICRP 68 differs greatly from ICRP 30:
  - ICRP 68 predicts *lower total deposition* in respiratory tract for most particle sizes
  - ICRP 68 predicts much *different rates of absorption* from the respiratory 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 Class	FGR 11 DCF (Sv/Bq) **1 µm**	FGR 13 DCF (Sv/Bq) **1 µm**	New/Old (Hotspot)
Pu-238	W	1.06E-4	4.6E-5	**0.44**
(oxides)	Y	7.79E-5	1.6E-5	**0.21**
Pu-239	W	1.16E-4	5.0E-5	**0.43**
(oxides)	Y	8.33E-5	1.6E-5	**0.19**
Cs-137	D	8.63E-9	4.6E-9	**0.54**
I-131	D	8.89E-9	7.4E-9	**0.83**
HTO	V	1.73E-11	1.8E-11	**1.04**

Federal Adoption

- NRC: approved use of ICRP 68 and authorized staff to grant subsequent exemptions
- EPA: uses FGR 13 in CERCLA risk assessments.
- DOE: approved use of new DCFs for Safety Analysis and ICRP 60 tissue weighting factors for worker dose calcs under 10 CFR 835.

NA-41 on ICRP 72 DCFs

- I emailed NA-41 asking their position on use of ICRP 72 DCFs
- 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
- Dr. Rabovsky suggested I send him a statement of my position to which he could respond - specifically, regarding the impact of 10 CFR 835 *Occupational Radiation Protection*

My Position: EH-52 Response

- My position:
  - It is permissible to use current (i.e., 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's response:
  - "Yes"

Subsequent NA-41 Suggestion

- Jim Fairobent suggested I contact FRMAC to determine any potential conflict with our use of ICRP 72 DCFs
- I spoke with several FRMAC reps and found that they were updating the PAG Manual for EPA to move to ICRP 72 DCFs
- *Turbo FRMAC* 2.0 allows the user to select either ICRP 30 or 72 DCFs

Status of New PAG Manual

- New PAG Manual will use ICRP 72 DCFs
- Draft went out for review late last year
- Latest draft should route to DOE sites in June, then go out for public comment in the Federal Register around September

Caveat for Use of ICRP 72 DCFs

- There are more than one set of values
  - FGR 13 database differs from ICRP disc
- Contacted Dr. Keith Eckerman (ORNL)
  - Dr. Eckerman was involved in both products (see following slides)
  - He says FGR 13 is the better choice
- Hotspot uses FGR 13 values

ICRP Database (V 2.0.1, 2001)

About this database

ICRP Database of Dose Coefficients: Workers and Members of the Public

Version 2.0.1

The membership of the Task Group on Dose Calculations at the time of preparation of this CD-ROM was:

Members: K F Eckerman (Chairman), R W Leggett, V Berkovski, I A Likhtarev, L Bertelli, D Nosske, A W Phipps and G M Kendall

Acknowledgements: The work of the Task Group was aided by significant technical contributions from T J Smith,T P Fell, K Karcher, D Bertelli and A L Sjoreen

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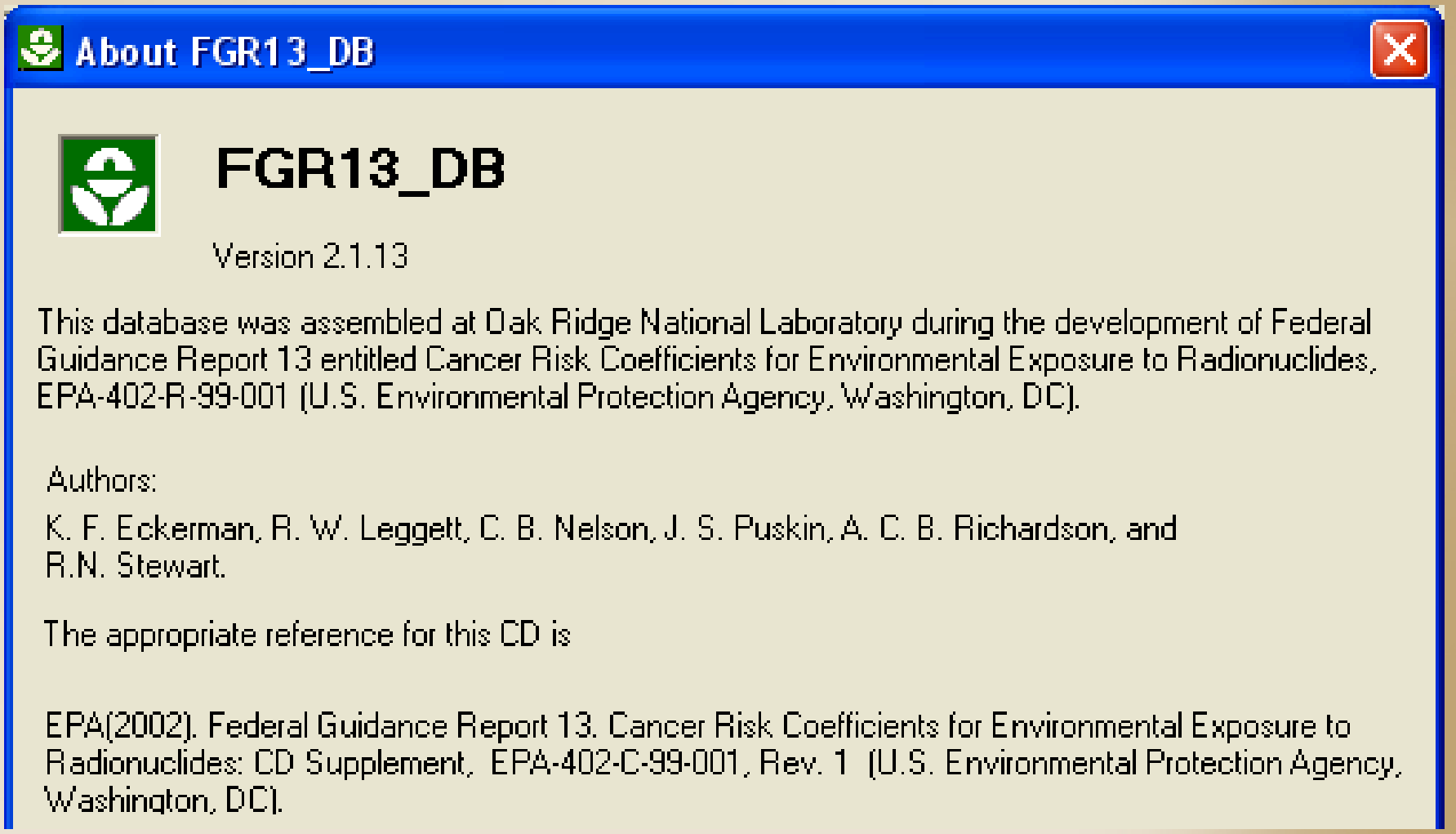
FGR 13 Database (V 2.1.13, 2002)



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)