Implementation of 2017 PAGs

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Topics for Today

- Concerns with 2017 PAGs implementation
- Visualization of 1992 vs 2017 PAGs
- EPA concurrence with FRMAC Method 3.8 for calculating water DRLs – Draft spreadsheet of DCFs available
- PAGs at 2020 NREP

Implementation Concerns

Some concerns we are hearing:

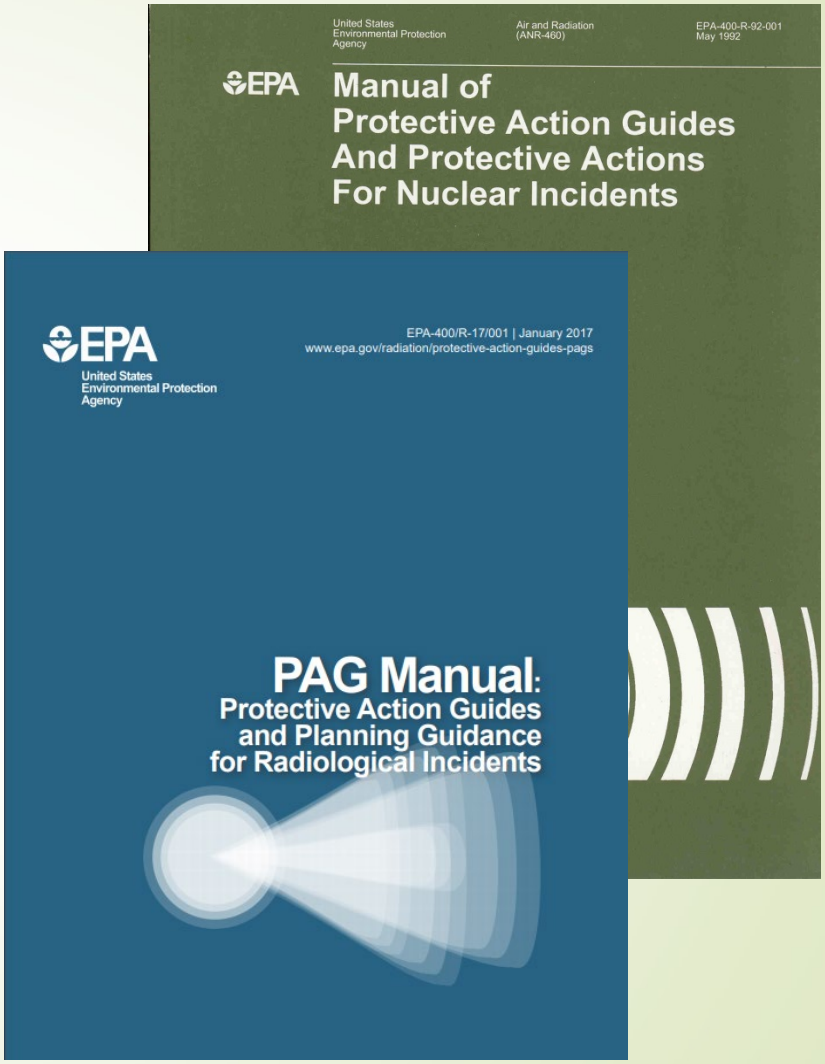
- NPPs unwilling to convert to new dosimetry/state wants to be consistent
- Insufficient resources
- Lack of access to DCFs for all age groups for water PAGs
- Not required by EPA/FEMA/NRC

ICRP 60 Ingestion Dose Coefficients by Age Group in Sv/Bq									
	Fetus Dose from Ingestion (Sv/Bq) ICRP 88	Infant Dose from Breast Milk (Sv/Bq) ICRP 95	Effective Dose Coeficient "Ingestion" (Sv/Bq) - From FGR-13						Comments from SNL
Radionuclide	Fetus	Breastfed Infant	Infant (3-month old)	1 y old	5 y old	10 y old	15 y old	Adult	
Ag-108m	1.50E-09	2.20E-10	2.07E-08	1.12E-08	6.56E-09	4.32E-09	2.87E-09	2.37E-09	
Ag-110m	2.10E-09	2.30E-10	2.41E-08	1.37E-08	7.90E-09	5.22E-09	3.44E-09	2.79E-09	
Am-241	2.70E-09	8.50E-11	3.73E-06	3.75E-07	2.74E-07	2.22E-07	2.04E-07	2.04E-07	
Am-243	2.70E-09	8.30E-11	3.66E-06	3.70E-07	2.72E-07	2.21E-07	2.03E-07	2.03E-07	
Ba-133	6.50E-09	6.40E-11	2.13E-08	6.23E-09	3.88E-09	4.68E-09	7.24E-09	1.53E-09	
Ba-139			1.41E-09	8.47E-10	4.14E-10	2.36E-10	1.50E-10	1.21E-10	

ICRP 60 Ingestion Dose Coefficients by Age Group converted to mrem/pCi								
1 Sv/Bq = 3700 mrem/pCi								
	Fetus Dose from Ingestion (mrem/pCi) ICRP 88	Infant Dose from Breast Milk (mrem/pCi) ICRP 95	Effective Dose Coeficient "Ingestion" (mrem/pCi) - From FGR-13					
Radionuclide	Fetus	Breastfed Infant	Infant (3-month old)	1 y old	5 y old	10 y old	15 y old	Adult
Ag-108m	5.55E-06	8.14E-07	7.66E-05	4.14E-05	2.43E-05	1.60E-05	1.06E-05	8.77E-06
Ag-110m	7.77E-06	8.51E-07	8.92E-05	5.07E-05	2.92E-05	1.93E-05	1.27E-05	1.03E-05
Am-241	9.99E-06	3.15E-07	1.38E-02	1.39E-03	1.01E-03	8.21E-04	7.55E-04	7.55E-04
Am-243	9.99E-06	3.07E-07	1.35E-02	1.37E-03	1.01E-03	8.18E-04	7.51E-04	7.51E-04
Ba-133	2.41E-05	2.37E-07	7.88E-05	2.31E-05	1.44E-05	1.73E-05	2.68E-05	5.66E-06
Ba-139			5.22E-06	3.13E-06	1.53E-06	8.73E-07	5.55E-07	4.48E-07

PAG Manual

- 1992 PAG Manual is still good, still in use; focuses on NPPs
- 2017 includes new Water and Late Phase (Recovery) PAGs; **Focuses on planning for ALL forms of radiological/nuclear incidents, not just NPPs**



1992 vs 2017 Assumptions

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DRAFT Default Input Settings 1992 PAG Manual vs. 2017 PAG Manual **DRAFT**			
Input		1992 Manual	2017 Manual
Dose Pathways	Early (Total Dose)	Plume and Groundshine (No Resuspension)	Plume and Ground
	Early (Avoidable Dose)	NA	Ground
	Intermediate [a]	Ground	
Dosimetry Model	Adult/Effective Dose	ICRP 30 (1983)	ICRP 60 (2015)
Breathing Rate	Plume	1.2 m^3/h	1.5 m^3/h
	Resuspension		0.92 m^3/h
Deposition Velocity	Iodine	1.0E-02 m/s	6.5E-03 m/s
	Particulate	1.0E-03 m/s	3.0E-03 m/s
	Noble Gases	NA	0.0 m/s
Exposure-to-Dose Conversion Factor	Early	1.0 mrem/mR	1.0 mrem/mR
	Intermediate [a]	0.7 mrem/mR	
Ground Roughness Factor		1.0	0.82
Lung Clearance Type		Maximum	ICRP Recommended
Particle Size Distribution (PSD)	Nuclear Power Plant	1 µm AMAD	1 µm AMAD
	Radiological Dispersal Device (RDD)	1 µm AMAD	FRMAC Default [b]
Resuspension Factor	Early	0	Maxwell-Anspaugh 2011 [d]
	Intermediate [a]	WASH1400 [c]	
Weathering Factor		WASH1400 [e]	Anspaugh 2002 [f]

[a] Includes 1st Year, 2nd Year, and 50 Year Time Phases as applicable.

[b] Radionuclide dependent

[c] Resuspension Factor for the Intermediate Phase is calculated by multiplying the Weathering Factor from WASH1400 by 1.0E-06. Turbo FRMAC emulates this using the WASH1400 calculation method in the Resuspension panel.

[d] Resuspension Factor Equation (t in seconds): $K_t = \left(1.0\text{E-}05 * e^{-8.1\text{E-}07 * t}\right) + \left(7.0\text{E-}09 * e^{-2.31\text{E-}08 * t}\right) + 1.0\text{E-}09$

[e] Weathering Factor Equation (t in seconds): $WF_t = 0.63 * e^{-3.58\text{E-}08 t} + 0.37 * e^{-2.37\text{E-}10 t}$

[f] Weathering Factor Equation (t in seconds): $WF_t = 0.4 * e^{-1.46\text{E-}08 t} + 0.6 * e^{-4.44\text{E-}10 t}$

1992 vs 2017 Relative Differences

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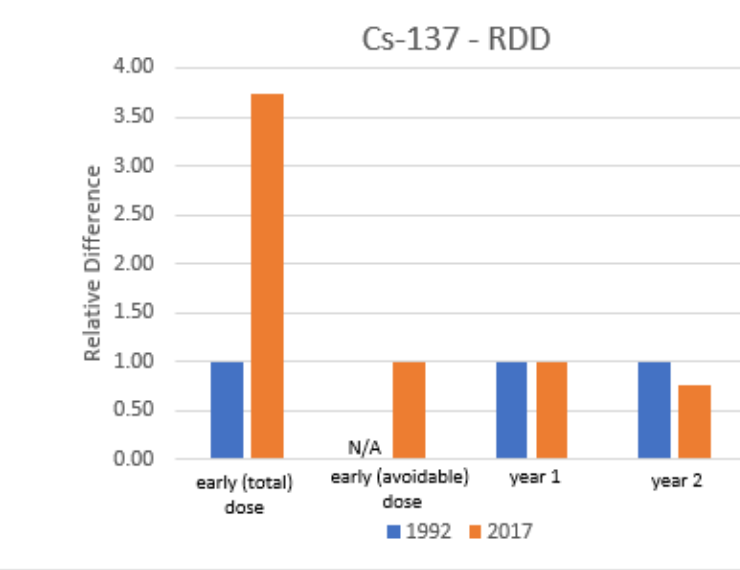
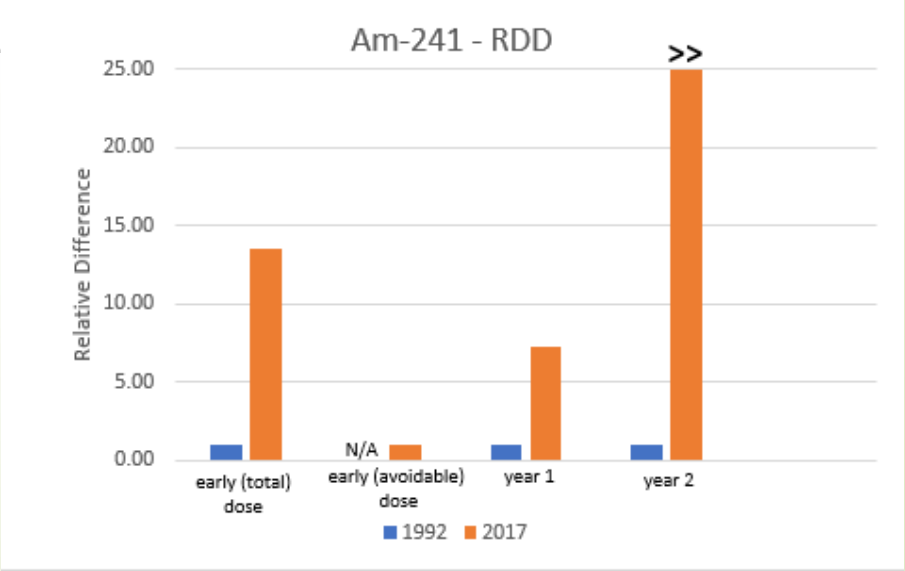


NOTES:

Larger relative DRL equals less conservative assumptions

One = baseline/1992 DRL

Zero = DRL does not exist for that PAG manual



FRMAC Methods

- PAG Manual users are referred to FRMAC Assessment Manuals for calculations using up-to-date dosimetry.
  - Lookup tables of DCFs and DRLs not in PAG Manual, they are in Appendix C of Assessment Vol. 1
  - Updated more frequently
- Training on FRMAC methods ongoing & using various methods, platforms
- EPA concurred with Method 3.8 Water Derived Response Level; Revised Assessment Manual anticipated in early 2020
- Draft spreadsheet with DCFs for all 8 age groups available*

*DCFs for breast-fed infant and fetus do not exist for all nuclides

PAGs at 2020 NREP

- 1 ½ hour workshop Wednesday April 1st
- Small group, interactive exercises
- Opportunity to ask pointed questions and engage with states who have successfully implemented 2017 PAGs

Useful Web Links

ICRP manuals – now free to download!

http://www.icrp.org/page.asp?id=5

FGR13 Website (to request a CD copy)

https://www.epa.gov/radiation/federal-guidance-report-no-13-cd-supplement

FGR13 CD Supplement (free download)

https://www.ornl.gov/crpk/software

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Eager for more PAGs? Call Us!

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