



# **Dose Assessment**

## **Update of Regulatory Guide 1.109**

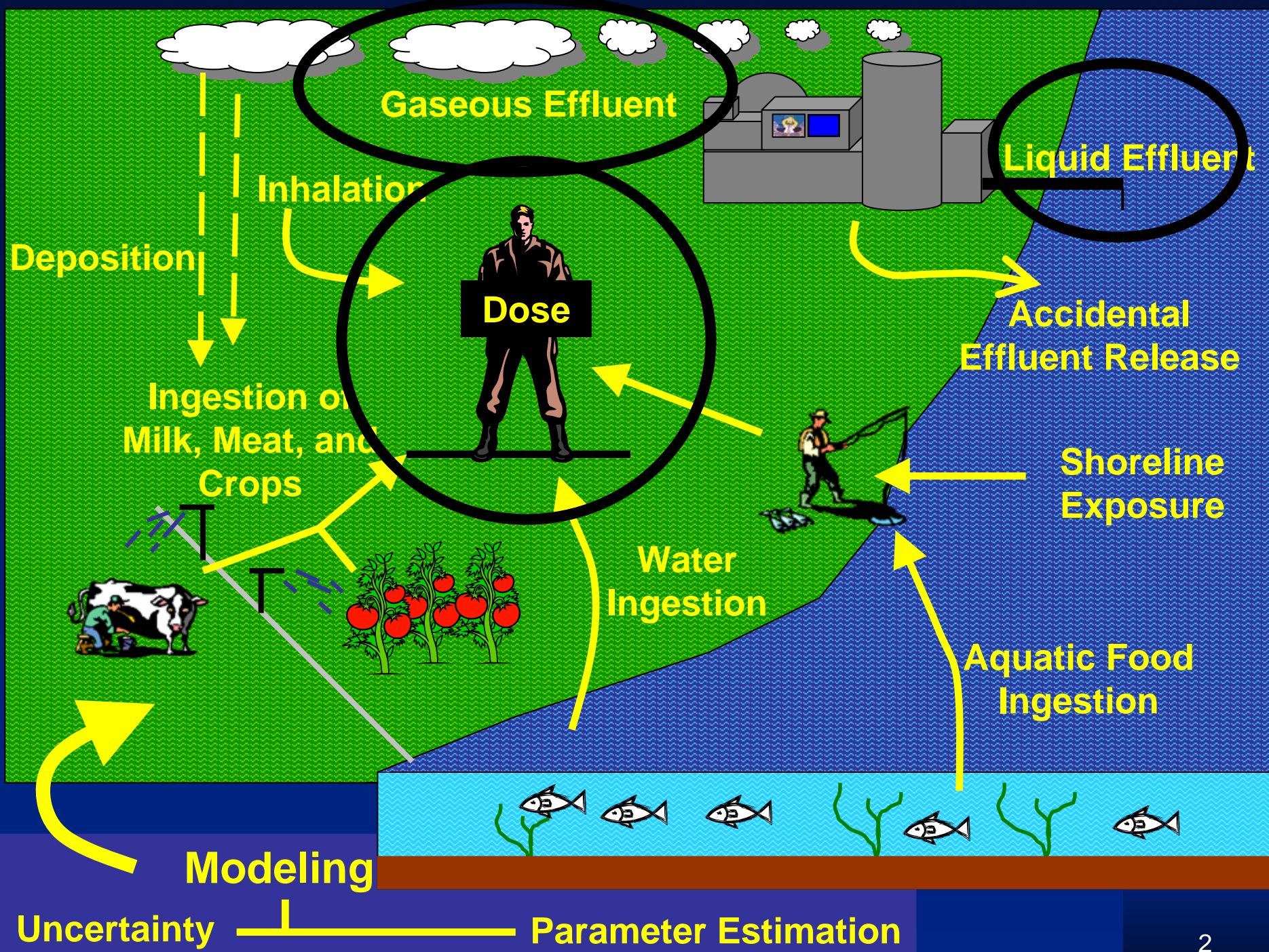
**“Calculation of Annual Doses to Man from Routine  
Releases of Reactor Effluents  
For the Purpose of Evaluating Compliance with  
10 CFR Part 50, Appendix I”**

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# Power Reactor Effluent ALARA

## Dose Objectives

10 CFR 50, Appendix I

- For routine release
  - Liquid effluents (per unit)
    - 3 mrem/yr, total body
    - 10 mrem/yr, any organ
  - Gaseous effluents (per unit)
    - 10 mrad/yr, gamma air
    - 20 mrad/yr, beta air
    - 5 mrem/yr, total body (any real person)
    - 15 mrem/yr, skin (any real person)
  - Airborne iodines and particulates ( $> 8$  day  $T_{1/2}$  , per unit)
    - 15 mrem/yr, critical organ (real pathway)
  - Power Reactor licensees use RG 1.109, in part, to demonstrate that effluents meet the ALARA objectives.

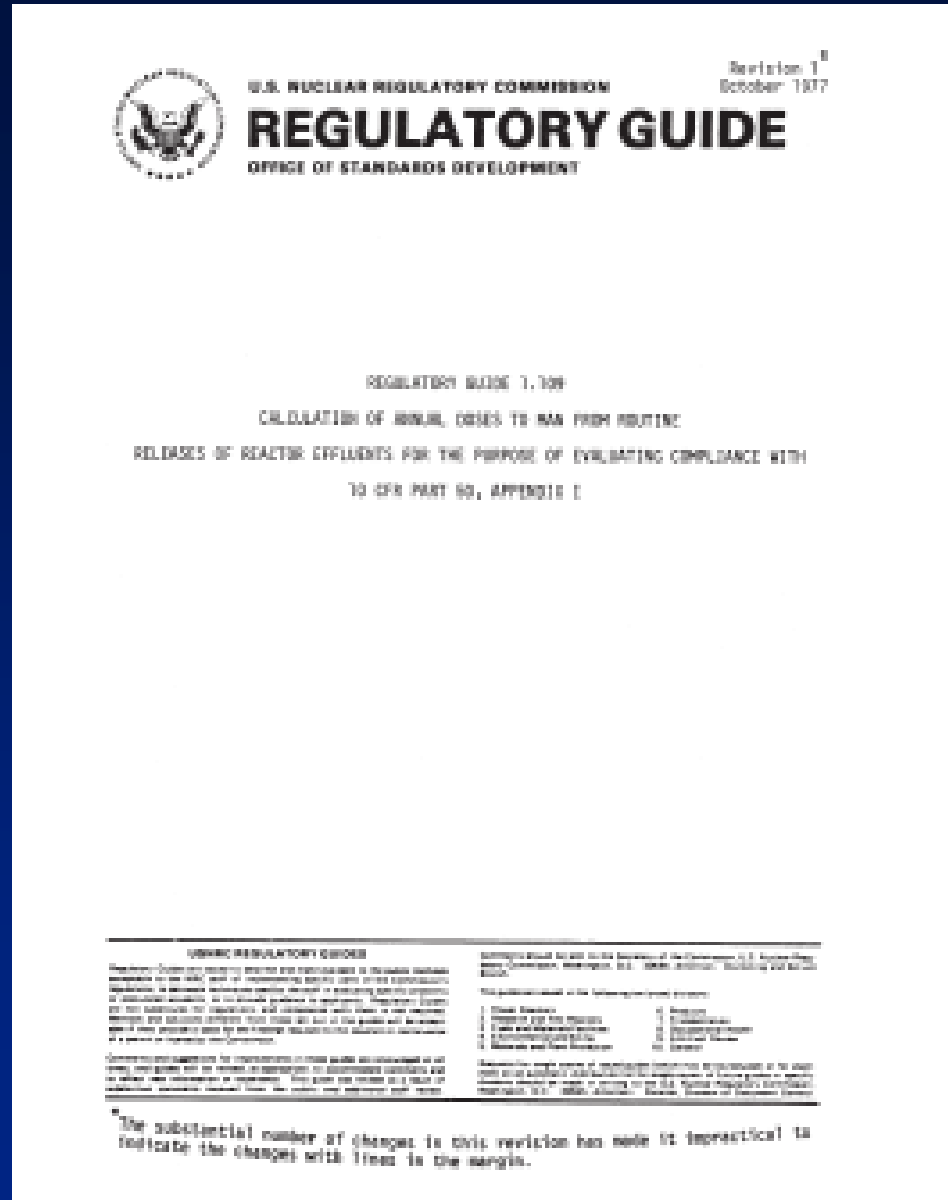


# Demonstrating Compliance with Part 50, Appendix I

- Main document is Reg. Guide 1.109 - Doses from radioactive effluents during routine operations
  - 1.111 – atmospheric transport of airborne effluents
  - 1.112 – calculating radioactive source terms for waste treatment systems
  - 1.113 – estimating aquatic dispersion of both routine and accidental releases
  - 1.110 – cost-benefit analyses for radwaste systems
  - 4.15 – maintaining radiological effluent monitoring programs
  - 1.21 – guidance on submission of reports

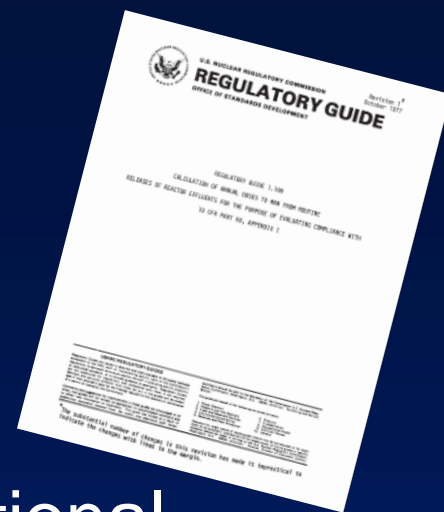
# Regulatory Guide 1.109

- Describes basic features of the computational methods and models for compliance with 10 CFR50, Appendix I
- Last updated in 1977 to include age-specific dosimetry (NUREG-0172)
  - Infant, child, teenager, and adult



## RG 1.109 cont.

- Dosimetry Concepts from the International Commission on Radiological Protection Publication 2 (ICRP 2), circa 1959
- Uses the critical organ concept and the maximally exposed individual approach
  - Bone, liver, kidneys, thyroid, lung, and lower large intestine
- Time for an update?



# Evolution of Dosimetry Systems

- **1959** – ICRP 2 critical organ concept
- **1977** through 1988 - ICRP 26/30: The effective dose equivalent,  $H_E$  concept: a weighted sum of tissue doses intended to represent the same cancer risk from a non-uniform irradiation of the body as that produced when the whole body is uniformly irradiated.

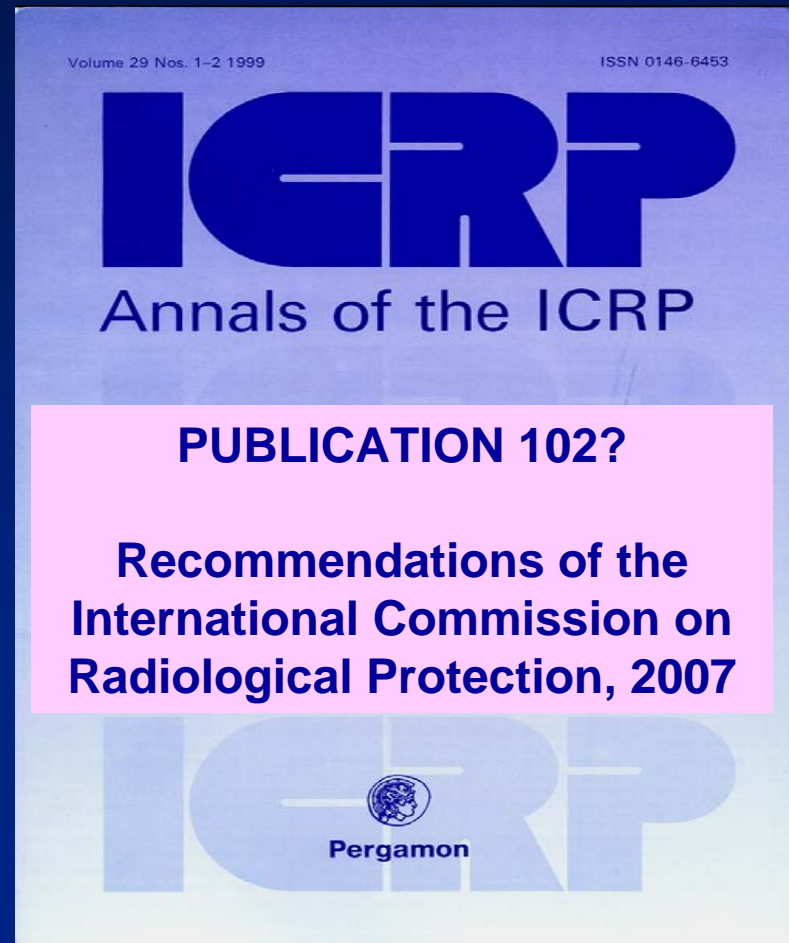
$$H_E = \sum w_T H_T$$

- where  $w_T$  is a weighting factor for tissue T and  $H_T$  is the mean dose equivalent to that tissue. Because the weighting factors are normalized to sum to 1.0, a weighting factor for tissue T corresponds to the fractional contribution of that tissue to the total risk of stochastic health effects when the body is uniformly irradiated.

# Evolution of Dosimetry Systems

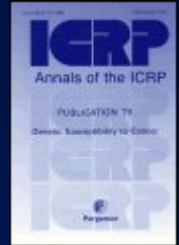
## cont.

- **1991** – ICRP 60: effective dose equivalent concept modified with updated tissue weighting factors. Introduction of the total detriment concept to include cancer morbidity, mortality, and severe genetic effects in risk estimates.
- **2007** – Draft Recommendations (ICRP 102+) – updated tissue weighting factors, same individual dose limits from ICRP 60



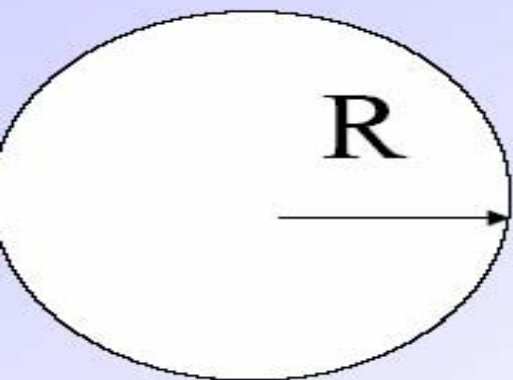
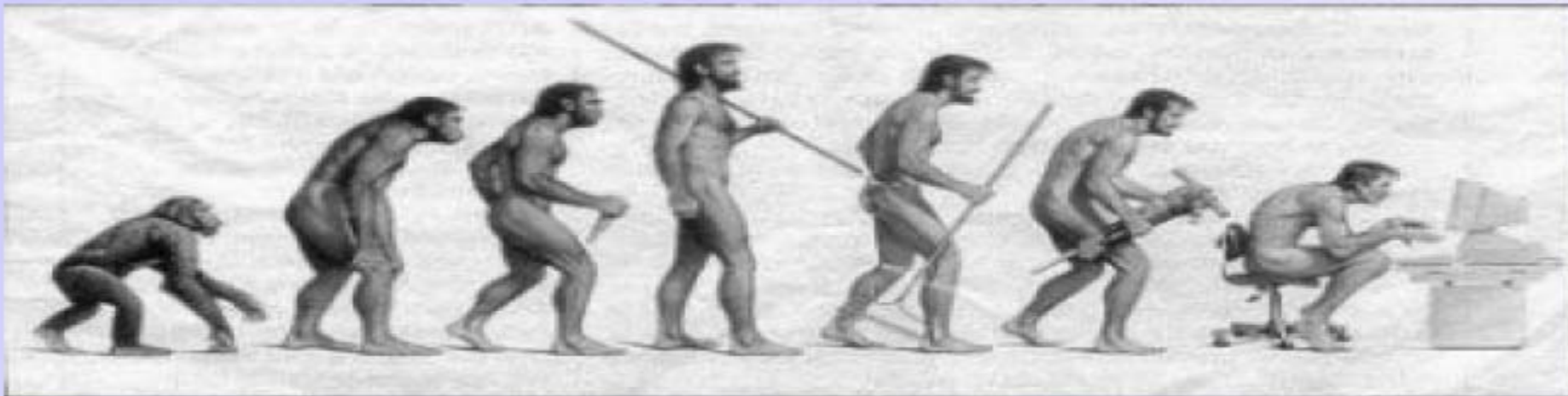


# Evolution of Tissue Weighting Factors

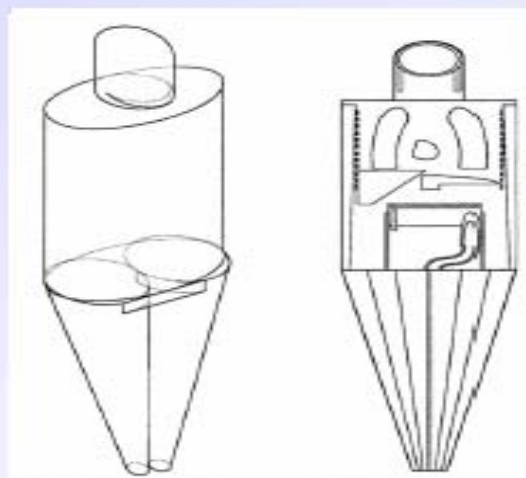


Organ	ICRP 26 (10 CFR 20)	ICRP 60	Draft ICRP 2007
Gonads	0.25	0.2	0.08
Breast	0.15	0.05	0.12
Red Bone Marrow	0.12	0.12	0.12
Lung	0.12	0.12	0.12
Thyroid	0.03	0.05	0.04
Bone Surface	0.03	0.01	0.01
Colon		0.12	0.12
Stomach		0.12	0.12
Bladder		0.05	0.04
Liver		0.05	0.04
Esophagus		0.05	0.04
Skin		0.01	0.01
Brain			0.01
Salivary glands			0.01
Remainder	0.3	0.05	0.12

# Evolution of Phantoms



**1959**



**1975**



**1999**

## Reason to change?

- Part 50, Appendix I ALARA dose objectives are more restrictive than Part 20 limits, However:
  - Use of a dual system could be confusing
  - Outdated compared to current international standards
  - Should be updated to reflect current knowledge
  - principles based on ICRP-2 are no longer taught in current health physics university curriculum

# Considerations to updating RG 1.109 – “Out-loud thinking”

- Should revision be considered without first updating Part 20 to current or upcoming ICRP recommendations?
- What about the next generation of reactors?
- Should there be one set of guides?
- Two sets of Regulatory Guides?
  - Revised guidance would address new reactors
  - Current guidance would address existing fleet
  - Would licensees have the options



# Status/Next Steps

- Assessing the Impact
  - On NRC Regulations and the Reactor Oversight Program
  - On Licensees
  - ALARA Considerations
  - Backfit Considerations (revisions to Technical Specification documents and Off-site Dose Calculation Manuals)
  - Cost-Benefit Considerations
  - Public Confidence
  - SECY Paper to Commission

# Potential Options

- Maintain Status Quo
  - Pro – more restrictive
  - Con – Outdated, Dual System at NRC
- Update to Current Part 20
  - Pro – consistent across most licensees
  - Con – not the most current recommendations
- Update to ICRP 60 issued in 1991, or 2007 ICRP Recommendations

- END