

## Purpose of Meeting

- To discuss the issues and questions identified in the ANPR and to receive information to support development of a regulatory basis for a potential revision to 10 CFR 50, Appendix I.
- This meeting is not intended to be a formal solicitation of comments, but to encourage stakeholders to provide feedback in written form during the ANPR comment period.
- This meeting is being transcribed and a transcript of the discussions will be made publicly available.



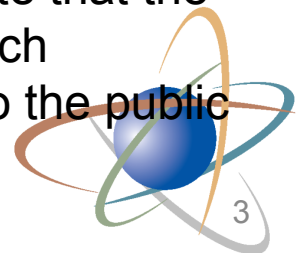
## You may submit comments by any of the following methods:

- **Federal Rulemaking Web site:** Go to <http://www.regulations.gov> and search for Docket ID NRC-2014-0044. Address questions about NRC dockets to Carol Gallagher; telephone: 301-415-3463; e-mail: [Carol.Gallagher@nrc.gov](mailto:Carol.Gallagher@nrc.gov)
- **E-mail comments to:** [Rulemaking.Comments@nrc.gov](mailto:Rulemaking.Comments@nrc.gov). If you do not receive an automatic e-mail reply confirming receipt, then contact us at 301-415-1677.
- **Fax comments to:** Secretary, U.S. Nuclear Regulatory Commission at 301-415-1101.
- **Mail comments to:** Secretary, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, ATTN: Rulemakings and Adjudications Staff.
- **Hand deliver comments to:** 11555 Rockville Pike, Rockville, Maryland 20852, between 7:30 a.m. and 4:15 p.m. (Eastern Time) Federal workdays; telephone: 301-415-1677.



## Submitting comments

- Please include **Docket ID NRC-2014-0044** in the subject line of your comment submission.
- The NRC cautions you not to include identifying or contact information in comment submissions that you do not want to be publicly disclosed in your comment submission.
- The NRC will post all comment submissions at <http://www.regulations.gov> as well as enter the comment submissions into ADAMS. The NRC does not routinely edit comment submissions to remove identifying or contact information.
- If you are requesting or aggregating comments from other persons for submission to the NRC, then you should inform those persons not to include identifying or contact information that they do not want to be publicly disclosed in their comment submission. Your request should state that the NRC does not routinely edit comment submissions to remove such information before making the comment submissions available to the public or entering the comment submissions into ADAMS.





**10 CFR 50, Appendix I –  
Advanced Notice of Proposed Rulemaking (ANPR)  
“Reactor Effluents”**

NRC Public Meeting  
August 24, 2015  
Rockville, MD

Dr. Richard Clement  
Office of New Reactors  
Division of Site Safety and Environmental Analysis  
Radiation Protection and Accident Consequence Branch

## Presentation Outline

- Background
- ANPR issues, options and questions
- Other considerations
- Possible changes to RG 1.109
- Works in progress



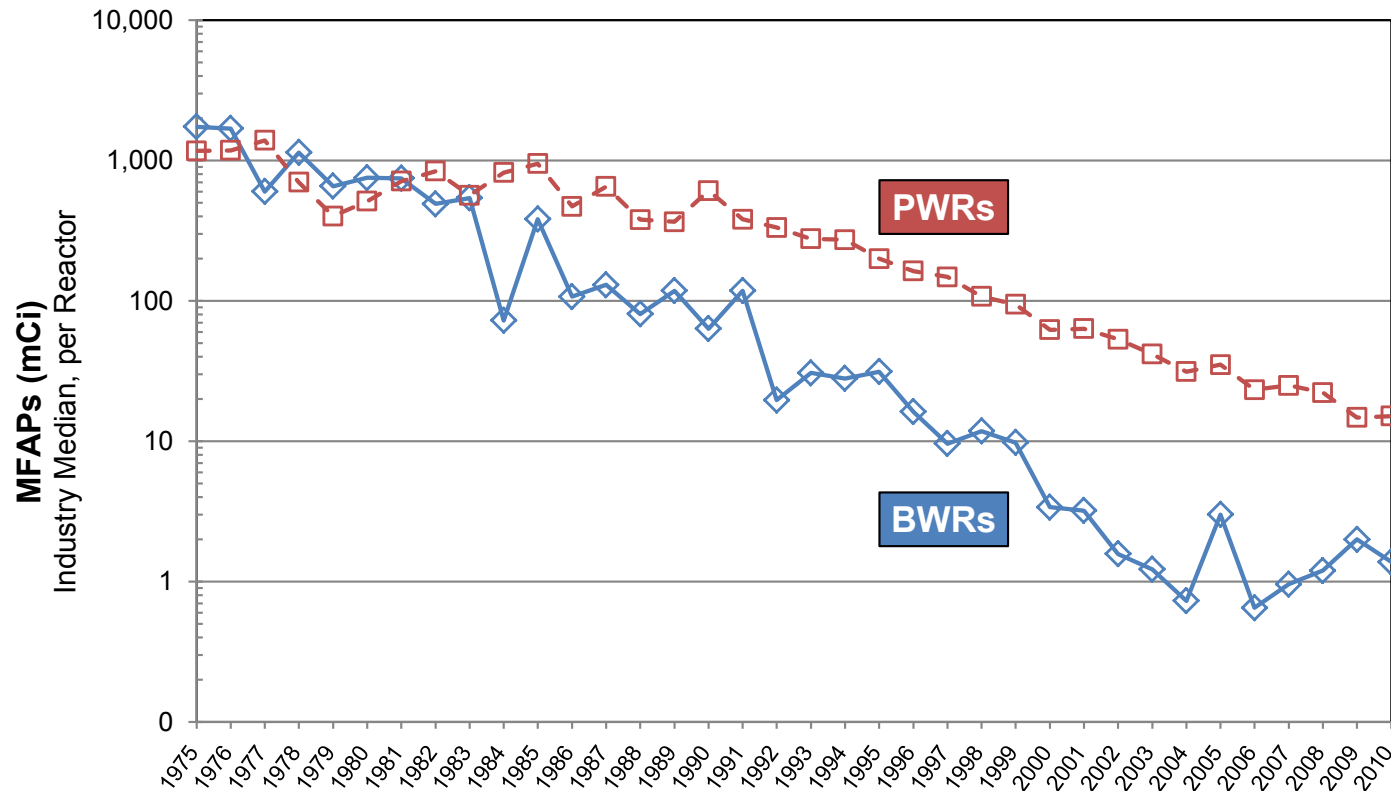
## **Background** *Reactor Effluents*

- Liquid (water) and gases as atmospheric releases (particulates, aerosols)
- Effluents must be monitored
  - Instrumentation, sampling, measurement, calculational methods
- Effluents must be as low as is reasonable achievable (ALARA)
  - RG 1.109 provides guidance to demonstrate compliance with 10 CFR 50, Appendix I
- Effluents must be reported
  - RG 1.21 provides guidance on measuring, evaluating and reporting
  - Annual Radioactive Effluent Release Reports (ARERRs) in ADAMS and at <http://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-info.html>
  - Effluent database available at <http://www.reirs.com/effluent/>
  - Annual summaries of ARERRs published as NUREG/CR-2907 volumes
- NRC routinely inspects licensee's compliance

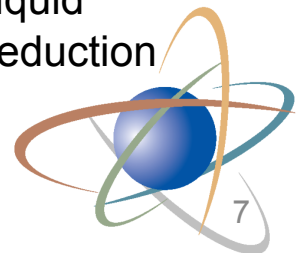


## Background

### *Long-Term Trend of MFAPs in Liquid Effluents*

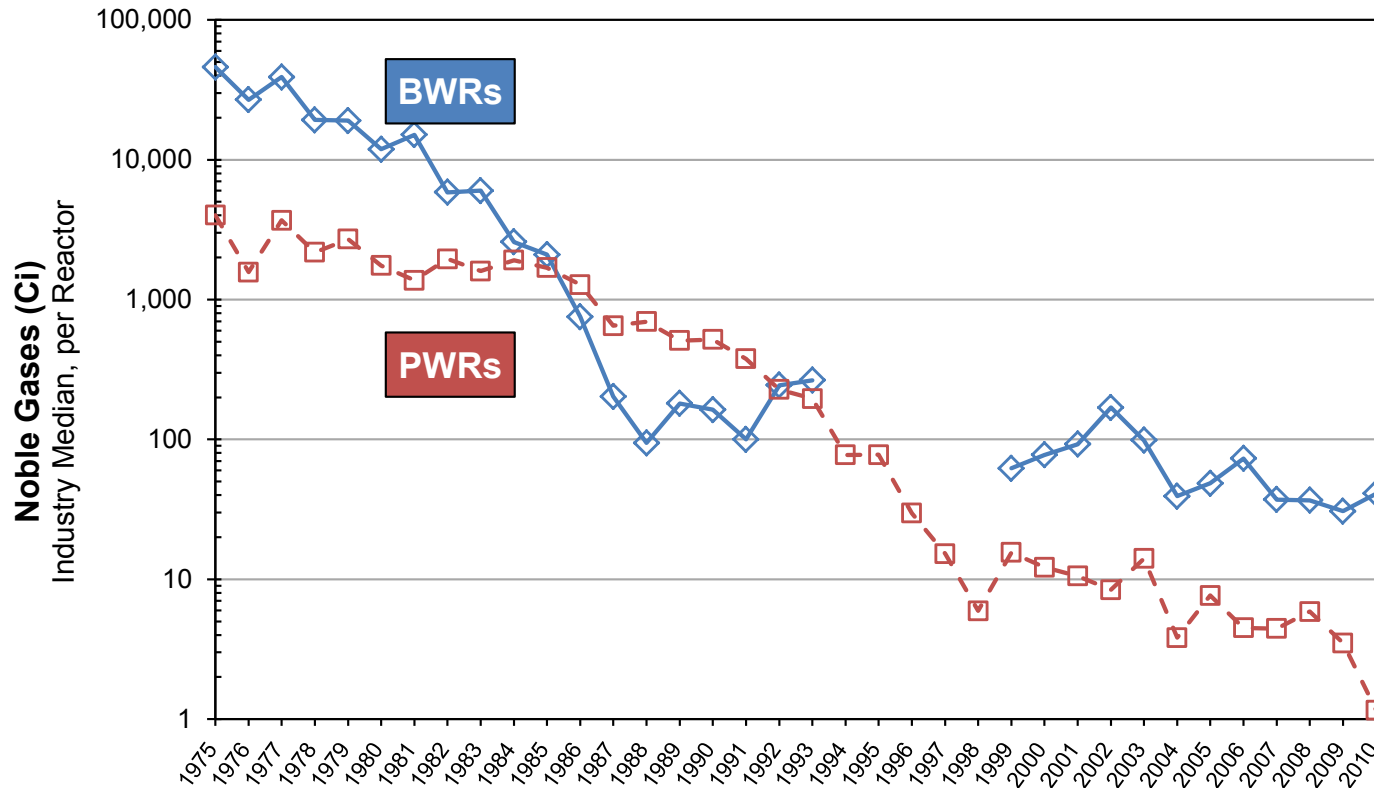


Long-term trend of mixed fission and activation products (MFAPs) in liquid effluents from BWRs and PWRs in the U.S. corresponds to a 99.9% reduction over 35 years (1975-2010).

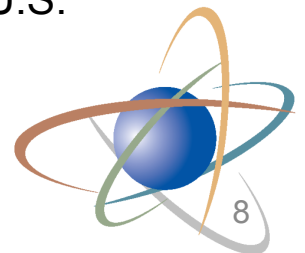


## Background

### *Long-Term Trend of Noble Gas Effluents*

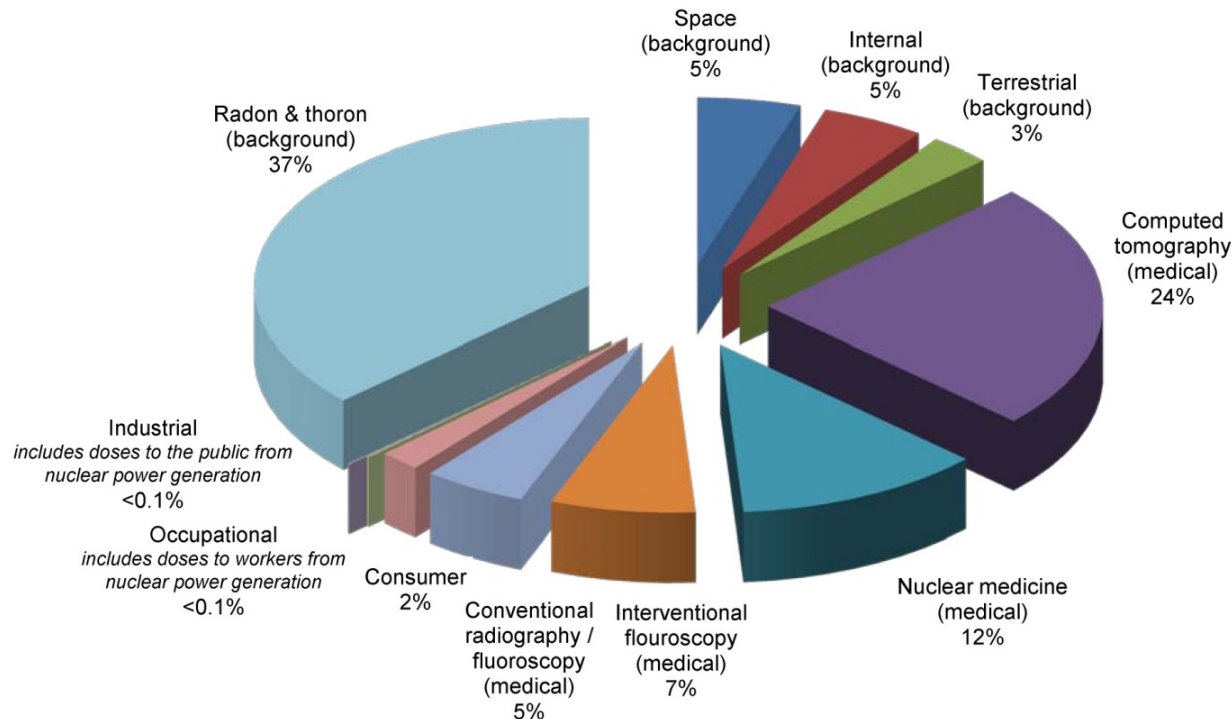


Long-term trend of noble gas effluents from BWRs and PWRs in the U.S. corresponds to a 99.9% reduction over 35 years (1975-2010).



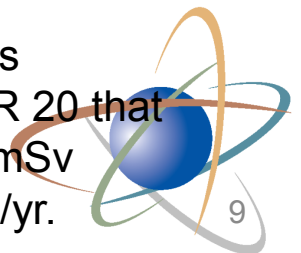


## Background *Sources of Radiation Exposure to U.S. Population*



Credit: Modification to image courtesy of NCRP Report No. 160 (2009)

About half of the total annual average U.S. individual's radiation dose of 6.2 mSv (620 mrem) comes from natural sources (radon and thoron gases, cosmic, terrestrial, and internal radiation). The other half is from man-made sources (medical, commercial, and industry activities). The NRC requires in 10 CFR 20 that licensees limit maximum radiation exposure to members of the public to 1 mSv (100 mrem)/yr and occupational radiation workers to 50 mSv (5,000 mrem)/yr.



## **Background**

### *10 CFR 50, Appendix I*

- Applies to licenses under 10 CFR 50 and combined license holders (COL) and applicants under 10 CFR 52
- Prescribes the design and performance of equipment used to control radioactive liquid and gaseous effluents to environment and doses to members of the public
- Contains design objectives (DOs) for equipment to control releases of radioactive material in reactor effluents (10 CFR 50.34a)
- Numerical guides for DOs and limiting conditions of operation (LCO), not a radiation protection standard (10 CFR 50.34a(a))
- Provides guidance for developing technical specifications (TS) to keep levels of radioactive materials in reactor effluents released in unrestricted areas ALARA (10 CFR 50.36a(a), 10 CFR 20.1003)
- Operational flexibility, but must meet public dose limits (10 CFR 20.1301, 10 CFR 50.36a(b))



## **Background**

### *10 CFR 50, Appendix I*

- Four page regulation
- Section I – Introduction (10 CFR 50.34a, 10 CFR 50.36a)
- Section II – Guides on DOs for liquid and gaseous effluents
  - II.A for liquid effluents
    - 0.03 mSv (3 mrem)/yr total body (TB)
    - 0.1 mSv (10 mrem)/yr any organ
  - II.B for noble gases in gaseous effluents
    - 0.1 mGy (10 mrad)/yr gamma-air
    - 0.2 mGy (20 mrad)/yr beta-air
    - additional provision based on TB and skin dose
  - II.C for radioactive iodines and particulates in gaseous effluents
    - 0.15 mSv (15 mrem) any organ
  - II.D for cost benefit ratios
    - \$1,000/TB man-rem and \$1,000/man-thyroid-rem



## **Background**

### *10 CFR 50, Appendix I*

- Section III – Implementation (calculational procedures, exposure pathway analysis, radioactive iodine)
- Section IV – Guides on TS for LCO (10 CFR 50.36a(a), 10 CFR 50.36a(b), 10 CFR 50.4)
- Section V – Effective dates
- Concluding statement on Docket-RM-50-2



## **Background**

### *10 CFR 50, Appendix I*

- Effluent releases are monitored and reported
  - ALARA using DOs and requirements
  - Small fraction of public dose limits
  - Compliance with EPA 40 CFR 190
- Relationship to EPA 40 CFR 190
  - Based on ICRP-2
  - EPA requirement in 10 CFR 20.1301(e)
  - Methods for demonstrating compliance in NUREG-0543
  - ANPR published February 2014, closed for public comment August 2014
- 10 CFR 20 ANPR “Radiation Protection”
  - Published July 2014, closed for public comment June 2015
  - Comments available at <http://www.regulations.gov> under Docket ID NRC-2009-0279



## **Background**

### *10 CFR 50, Appendix I*

- 10 CFR 50, Appendix I (1975) is based on ICRP-2 (1959), while 10 CFR 20 (1991) is based on ICRP-26 (1977)
  - Issue with different terminology (how dose is defined) and methodology (how dose is calculated)
  - ICRP-103 (2007) provides most recent dose terminology and methodology



## **Background**

### *10 CFR 50, Appendix I*

- Earlier effort in mid-1990s to amend 10 CFR 50, Appendix I
- Current effort resulted in SECY papers, Staff Requirements Memoranda (SRMs), and ANPRs for 10 CFR 20 and 10 CFR 50, Appendix I
  - SRM-SECY-12-0064
    - Commission approved NRC staff's development of regulatory basis for a revision to 10 CFR 20 and 10 CFR 50, Appendix I to align with most recent methodology and terminology for dose assessment including consideration of any conforming changes to all NRC regulations.
    - specific instructions for 10 CFR 20
    - no explicit instructions for 10 CFR 50, Appendix I
    - central theme is alignment



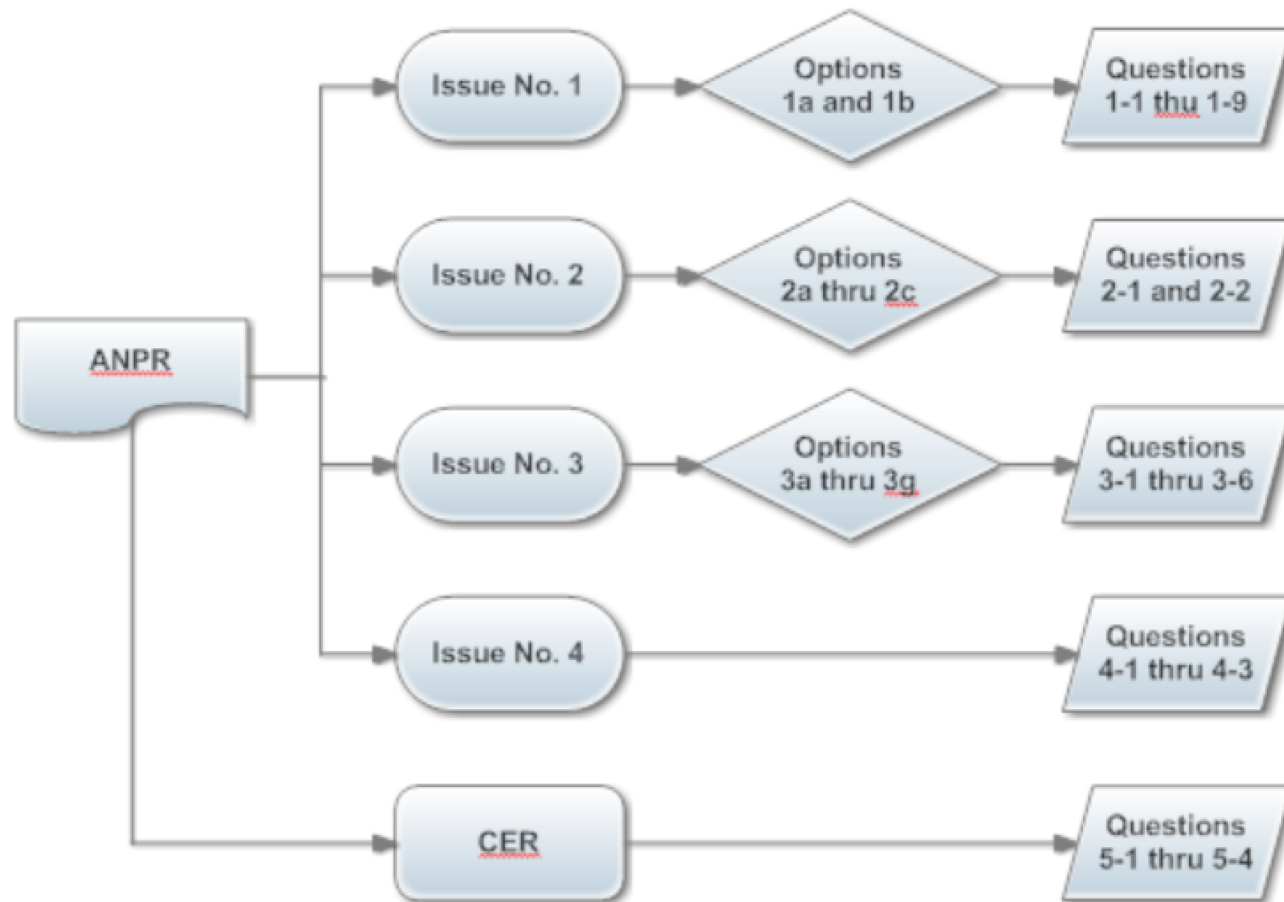
## **10 CFR 50, Appendix I ANPR** *Overview*

- Published May 4, 2015 (**80 FR 25237 - Reactor Effluents**)
- Public comment period ends **September 1, 2015**
- Summary – How to comment on **Docket ID NRC-2014-0044**
- Section I – Obtaining information and submitting comments
- Section II – Background
- Section III – Regulatory objectives
- **Section IV – Policy and technical issues**
- Section V – Public meetings
- **Section VI – Cumulative effects of regulation**
- Section VIII – Cited documents
- Section IX – Rulemaking process



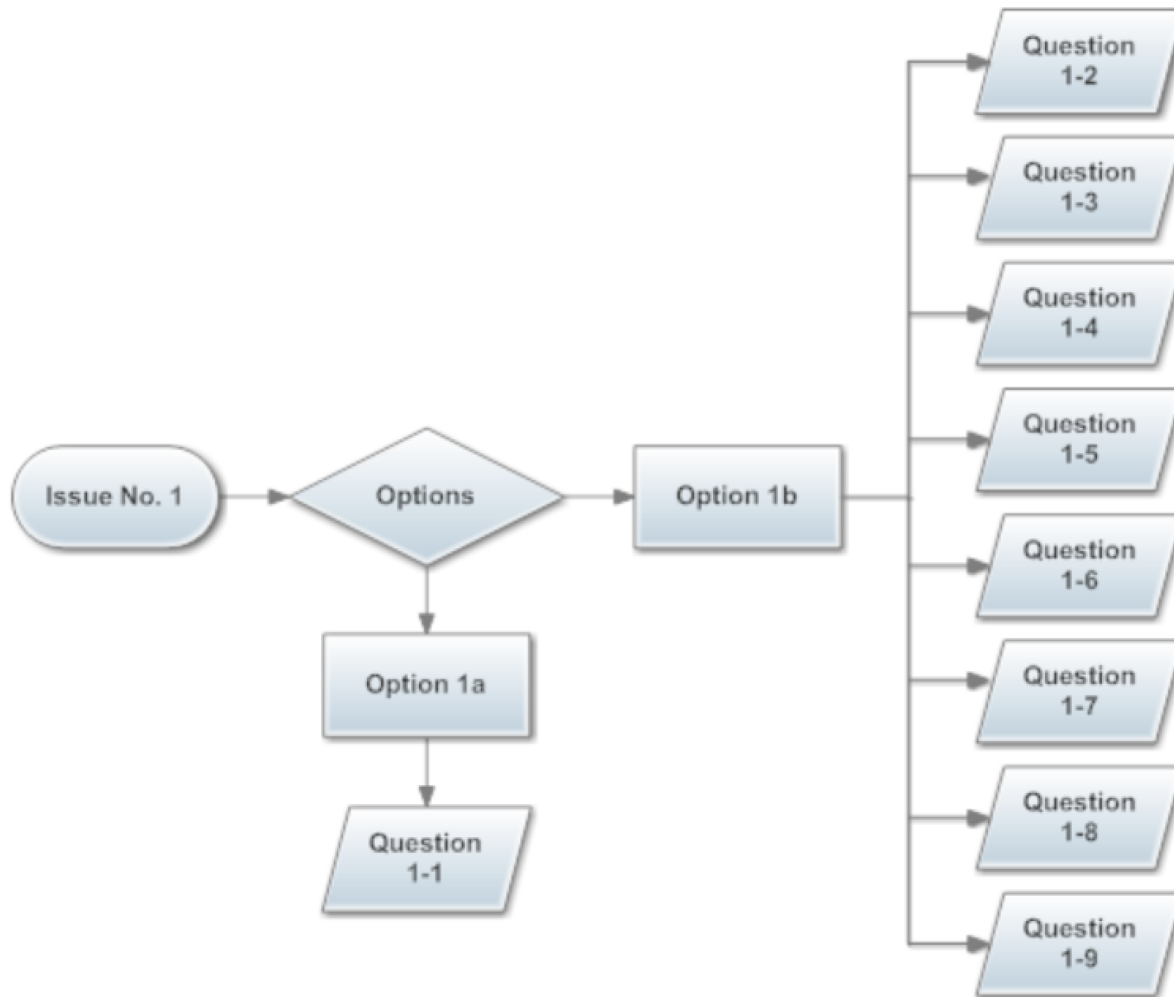


## 10 CFR 50, Appendix I ANPR *Issues, Options, and Questions*



# Policy and Technical Issue No. 1

*Closer alignment of 10 CFR 20 and  
10 CFR 50, Appendix I with ICRP-103*



# **Policy and Technical Issue No. 1**

## *Closer alignment of 10 CFR 20 and 10 CFR 50, Appendix I with ICRP-103*

- **Option 1a**
  - Do not change dosimetry basis of 10 CFR 50, Appendix I
    - current NRC regulations adequately protect the public
    - compliance demonstrates reactor effluents are ALARA
    - minor revisions to update guidance (late 1970s)
- **Option 1b**
  - Revise dose terminology and methodology in parallel with 10 CFR 20
    - consistent application of regulatory criteria
    - common regulatory basis for calculating and reporting doses



# **Policy and Technical Issue No. 1**

## *Closer alignment of 10 CFR 20 and 10 CFR 50, Appendix I with ICRP-103*

- **Option 1a – Question**

- Question 1-1: What are advantages and disadvantages of not changing the basis and revising guidance (late 1970s)?



# **Policy and Technical Issue No. 1**

## *Closer alignment of 10 CFR 20 and 10 CFR 50, Appendix I with ICRP-103*

- **Option 1b – Questions**

- Question 1-2: What are advantages and disadvantages of aligning 10 CFR 50, Appendix I with ICRP-103 terminology and methodology?
- Question 1-3: What are advantages or disadvantages of conducting parallel rulemaking (10 CFR 20 and 10 CFR 50, Appendix I) with a common effective or compliance date for both rules?
- Question 1-4: What are backfitting implications to 10 CFR 50 licensees? What are issue finality implications to 10 CFR 52 COL holders and applicants?
- Question 1-5: What cost savings would be realized over life of operational programs if dose calculation methods are standardized?



# **Policy and Technical Issue No. 1**

## *Closer alignment of 10 CFR 20 and 10 CFR 50, Appendix I with ICRP-103*

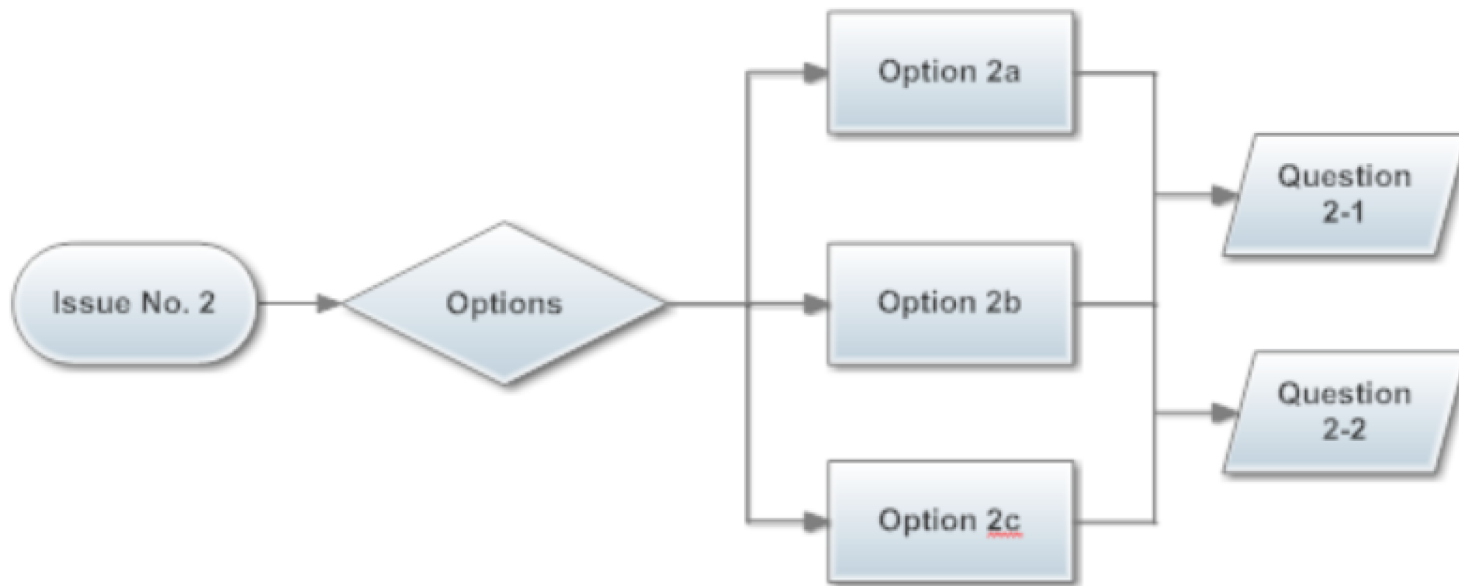
- **Option 1b – Questions (cont'd)**

- Question 1-6: What operational impacts and costs (per reactor unit) would be incurred (e.g., updating programs, procedures, computer codes, training)?
- Question 1-7: Would licensee costs and operational impacts be similar for both BWRs and PWRs?
- Question 1-8: Should all conforming changes to dose based criteria in 10 CFR 50 be changed coincidently or in separate, later rulemaking?
- Question 1-9: Should number of age groups be expanded from 4 to 6 as recommended in ICRP-103?



## **Policy and Technical Issue No. 2**

*Scope of changes to NRC guidance with  
10 CFR 50, Appendix I and RG 1.109*



## **Policy and Technical Issue No. 2**

### *Scope of changes to NRC guidance with 10 CFR 50, Appendix I and RG 1.109*

- **Option 2a\***
  - Limited scope revision (no changes to numerical values)
    - change DO for TB dose
    - RG 1.109 dose factors in
      - Table B-1 (semi-infinite noble gas cloud)
      - Table E-6 (contaminated ground)
      - Table E-7 thru E-10 (inhalation)
      - Table E-11 thru E-14 (ingestion)

\*Option does not update exposure pathway models and assumptions.





## **Policy and Technical Issue No. 2**

### *Scope of changes to NRC guidance with 10 CFR 50, Appendix I and RG 1.109*

- **Option 2b**

- Full scope revision

- retire, revise, consolidate all (30+) NRC guidance documents, generic communication
    - evaluate radwaste systems
    - update atmospheric dispersion models
    - new source terms
    - update computer codes
    - rewrite RGs 1.109, 1.110, 1.111, and 1.112

- **Option 2c**

- Expanded scope revision

- more than Option 2a, but less than Option 2b



## **Policy and Technical Issue No. 2**

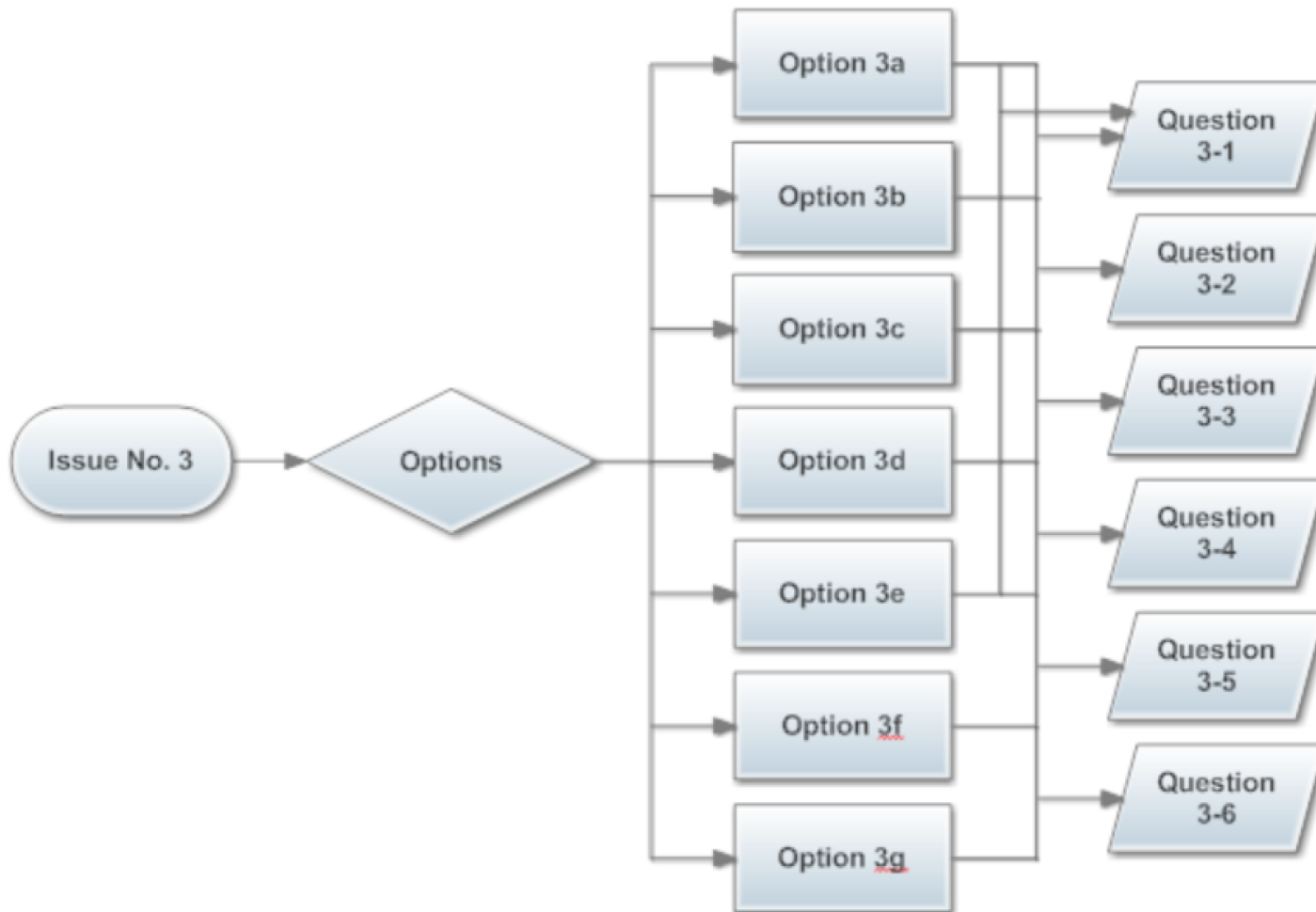
### *Scope of changes to NRC guidance with 10 CFR 50, Appendix I and RG 1.109*

- **Options 2a thru 2c – Questions**
  - Question 2-1: Which option seems most appropriate, are other options available?
  - Question 2-2: What are advantages and disadvantages of each option?



## Policy and Technical Issue No. 3

*Detailed considerations for revising  
10 CFR 50, Appendix I*



## **Policy and Technical Issue No. 3**

### *Detailed considerations for revising 10 CFR 50, Appendix I*

- **Option 3a**
  - Numerical values for DOs  
(e.g., 30  $\mu\text{Sv}$  (3 mrem)/yr TB dose  $\rightarrow$  30  $\mu\text{Sv}$  (3 mrem)/yr effective dose (ED))
    - keep numerical values, but change units
- **Option 3b**
  - Organ dose (e.g., thyroid)  
(e.g., 100  $\mu\text{Sv}$  (10 mrem)/yr any organ as DOs)
    - eliminate or provide single ED based criterion
- **Option 3c**
  - Gamma- and beta-air doses  
(e.g., 100  $\mu\text{Gy}$  (10 mrad)/yr gamma-air dose and 200  $\mu\text{Gy}$  (20 mrad)/yr beta-air dose)
    - eliminate or convert to ED



## **Policy and Technical Issue No. 3**

### *Detailed considerations for revising 10 CFR 50, Appendix I*

- **Option 3d**
  - Update constant dollar basis (1975 dollars) in cost-benefit criteria for \$1,000/TB man-rem and \$1,000/man-thyroid-rem in Section II.D
    - consider updated guidance in NUREG-1530
- **Option 3e**
  - Disposition of Docket RM-50-2 (1974) in Section V
    - remove if no longer applicable to any pending applications

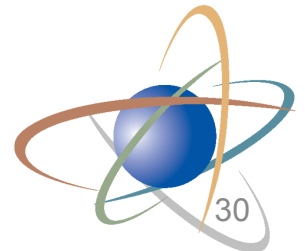


## **Policy and Technical Issue No. 3**

### *Detailed considerations for revising 10 CFR 50, Appendix I*

- **Option 3f\*\***
  - Light-water-cooled reactor provisions
    - expand scope to include designs other than light-water reactors (LWRs)
- **Option 3g\*\***
  - NRC licensing implementing guidance
    - consolidate and update RGs 1.21, 1.109, 1.206, and 4.15; NUREGs-1301, -1302, -0133, -0543, and -0800; and NUREG/CRs-4013 and -4653.

\*\*Options are unrelated to alignment with ICRP-103, but have some implications for associated NRC guidance.



## **Policy and Technical Issue No. 3**

### *Detailed considerations for revising 10 CFR 50, Appendix I*

- **Options 3a thru 3g – Questions**

- Question 3-1: Should focus be only on those changes to align with ICRP-103 (Options 3a thru 3e) or should all changes (Options 3a thru 3g) be evaluated?
- Question 3-2: What significant impacts would be expected if 10 CFR 50, Appendix I were revised to include all options (Options 3a thru 3g)?
- Question 3-3: If all changes are made (Options 3a thru 3g), should selected options be addressed in future implementation phases or in separate rulemaking efforts? If so, which options should be delayed?



## **Policy and Technical Issue No. 3**

### *Detailed considerations for revising 10 CFR 50, Appendix I*

- **Options 3a thru 3g – Questions (cont'd)**
  - Question 3-4: Should licensees still report doses separately for organs (e.g., skin, thyroid), whenever airborne effluent releases are dominated by radioactive iodines and noble gases?
  - Question 3-5: Should licensees continue to report skin, TB, and organ doses (including thyroid doses) if organ doses are eliminated? Why or why not?
  - Question 3-6: Should categories of releases (i.e., liquid activity, noble gases, iodines, tritium, other) be expanded or revised?





## **Policy and Technical Issue No. 4**

### *Metrification—units of radioactivity, radiation exposure, and dose*

- NRC 1992 metrification policy (61 FR 31169)
- Commission direction (SRM-SECY-12-0064)
  - Disapproved eliminating traditional (English) units from NRC regulations
- Issue with conversion of radioactivity unit from traditional unit (e.g., microcurie ( $\mu\text{Ci}$ ) to Systeme Internationale (SI) unit of Becquerel (Bq) is not a whole number or integer value
- Applicability to 10 CFR 50, Appendix I
  - RG 1.109 dose factors
    - Table A-1 (bioaccumulation factors)
    - Table B-1 (semi-infinite noble gas cloud)
    - Table E-6 (contaminated ground)
    - Tables E-7 thru E-10 (inhalation)
    - Tables E-11 thru E-14 (ingestion)



## **Policy and Technical Issue No. 4**

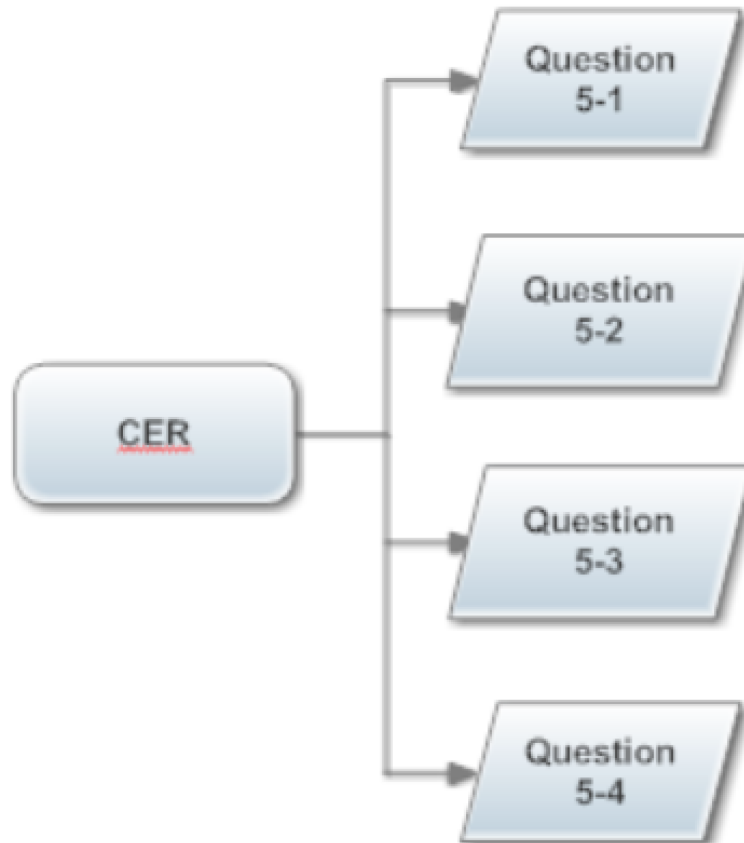
### *Metrification—units of radioactivity, radiation exposure, and dose*

- **Metrification – Questions**

- Question 4-1: Should ARERRs contain both metric and English units with metric units first, followed by English units in parentheses? Would this be an undue burden or hardship? Explain and provide examples.
- Question 4-2: What costs or other impacts to operational programs would be incurred if metrication was changed?
- Question 4-3: Should 10 CFR 20.2101(a) and RGs 1.21 and 4.15 be revised and integrated with 10 CFR 50, Appendix I allowing licensees to provide records and reports in SI units only?



## Cumulative Effects of Regulation



## Cumulative Effects of Regulation

- NRC implemented program to address the possible cumulative effects of regulations (CER) in developing regulatory bases for rulemakings
- Recognizes challenges licensees or other impacted entities (e.g., Agreement States) may face while implementing new NRC or other agency regulatory requirements
- Organizational effectiveness challenge from implementing number of complex positions, programs or requirements within a prescribed implementation period and with limited available resources and access to technical expertise



# Cumulative Effects of Regulation

- **CER – Questions**

- Question 5-1: If NRC conducts parallel rulemaking (10 CFR 20 and 10 CFR 50, Appendix I) should there be a separate, later compliance date? If so, when should this compliance date be set (time after effective date)? Explain rationale or justification for any such compliance date.
- Question 5-2: What actions could be taken to reduce or minimize implementation time?
- Question 5-3: What other requirements, regulations, or orders issued by NRC or another Federal agency may compete with or take priority over implementing any potential changes? What are consequences including associated costs and how should they be addressed?
- Question 5-4: What unintended consequences including associated costs that would negate any benefits? What could be done to minimize unintended consequences?

Please also provide information on costs and benefits of any potential revisions and associated NRC guidance documents.



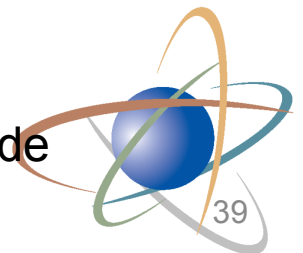
## Other Considerations

- Policy, regulatory, and technical issues
  - NRC staff identified
  - Backfit (Part 50) and finality (Part 52)
  - Qualitative considerations (SRM-SECY-14-0087)
    - scientific accuracy
    - public trust and confidence
    - clarity, transparency, and consistency of regulations
    - alignment within Federal family and international community
- Shrinking technical expertise and knowledge of applying existing guidance and computer codes (late 1970s)
- Project AIM 2020 report and recommendations (SRM-SECY-15-0015)



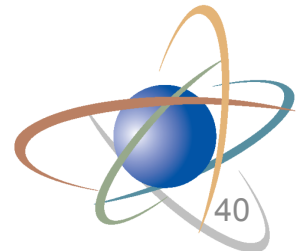
## Possible Changes to RG 1.109

- Carbon-14 dose calculations
  - EPRI Technical Report (2013) recommendations
- Exposure pathway models and assumptions
  - “Non-dose factor” parameters
    - Table A-1 (bioaccumulation factors)
    - Table D-1 (food distribution transport times)
    - Tables E-1 and E-2 (transfer data and parameters)
    - Table E-3 (animal consumption rates)
    - Table E-4 (average individual)
    - Table E-5 (maximum exposed individual)
    - Table E-15 (other values)
  - Recreational boating and swimming
    - not described in RG 1.109, but provision exists in LADTAP code



## Possible Changes to RG 1.109

- Surface contaminated grounds
  - Table E-6 (contaminated ground) – undefined age group
  - residential structural shielding
- Contaminated shoreline sediments
  - Table E-6 (contaminated ground) – dual purpose table
  - shoreline width correction factors
- Semi-infinite noble gas clouds
  - evaluate radioactive iodine and particulate releases
  - gamma- and beta-air doses to skin and TB
- Elevated plume releases
  - evaluate atmospheric dispersion model
  - update 1970s nuclear decay schemes to ICRP-107 (2008)





## Works in Progress

- Occupational data (CY2015/2016)
  - 10 CFR 20, Appendix B, Table 1 annual limits on intakes (ALIs) and derived air concentrations (DACs)
  - Bioassay data and methods (update to NUREG/CR-4884)
  - Inhalation dose coefficients
  - Ingestion dose coefficients
- Public data (CY2015/2016)
  - 10 CFR 20, Appendix B, Table 2 effluent concentration limits (ECLs)
  - 10 CFR 50, Appendix B, Table 3 releases to sewers
  - 10 CFR 50, Appendix I age and organ-specific dose coefficients
  - 10 CFR 20, DOE per-capita dose coefficients



# Questions?



# Abbreviations

ADAMS	Agencywide Documents Access and Management System
ALARA	as low as is reasonably achievable
ALI	annual limit on intake
ANPR	advanced notice of proposed rulemaking
ARERR	Annual Radioactive Effluent Release Report
Bq	Becquerel (Bq = 1 disintegration per second)
BWR	boiling water reactor
CER	cumulative effects of regulation
Ci	Curie (1 Ci = 1E+03 milliCurie (mCi) = 3.7E+10 disintegrations per second)
COL	combined license application
CFR	Code of Federal Regulations
CR	contract report
CY	calendar year
DAC	derived concentration limit
DC	design certification
DO	design objective
DOE	Department of Energy
ECL	effluent concentration limit
ED	effective dose
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute



# Abbreviations

FGR	Federal Guidance Report
FR	Federal Register
GASPAR	NRC computer code used to calculate public doses from gaseous radioactive effluents
GDC	General Design Criteria
Gy	Gray (1 microGray ( $\mu$ Gy) = 0.1 millirad (mrad))
HPS	Health Physics Society
ICRP	International Commission on Radiological Protection
LADTAP	NRC computer code used to calculate public doses from liquid radioactive effluents
LCO	limiting conditions for operations
LWR	light water reactor
MFAP	mixed fission and activation products
NCRP	National Council on Radiation Protection and Measurements
NEI	Nuclear Energy Institute
NMSS	NRC Office of Nuclear Material Safety and Safeguards
NRC	Nuclear Regulatory Commission
NRO	NRC Office of New Reactors
NUREG	NRC reports or brochures
OL	operating license
ORNL	Oak Ridge National Laboratory
PWR	pressurized water reactor
RM	rulemaking



# Abbreviations

RG	NRC regulatory guide
RP	radiation protection
SECY	Staff paper submitted to the Commission
SI	International System of Units (Système Internationale)
SRM	Staff Requirements Memorandum
Sv	Sievert (1 microSievert ( $\mu$ Sv) = 0.1 millirems (mrem))
TB	total body
TS	technical specifications
US	United States

