PRA and RIDM Infrastructure

Lecture 8-2

Key Topics

- Policy statements
- PRA standards and guidance
- Other infrastructure elements

Resources

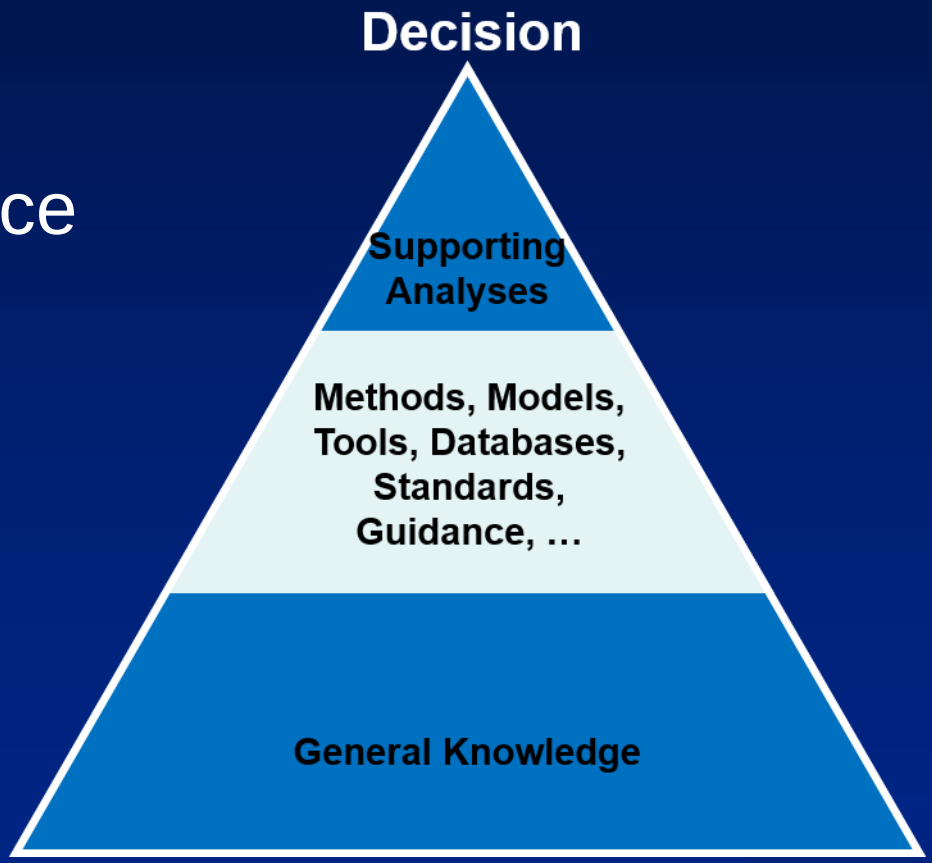
- U.S. Nuclear Regulatory Commission, "Safety Goals for the Operation of Nuclear Power Plants; Policy Statement; Correction and Republication," *Federal Register*, **51**, p. 30028 (51 FR 30028), August 21, 1986.
- U.S. Nuclear Regulatory Commission, "Use of Probabilistic Risk Assessment Methods in Nuclear Activities; Final Policy Statement," *Federal Register*, **60**, p. 42622 (60 FR 42622), August 16, 1995.
- American Society for Mechanical Engineers and American Nuclear Society, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," *ASME/ANS RA-Sa-2009, Addendum A to RA-S-2008*, ASME, New York, NY, American Nuclear Society, La Grange Park, Illinois, 2009.
- U.S. Nuclear Regulatory Commission, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," *Regulatory Guide 1.200, Revision 2*, March 2009. (ADAMS ML090410014)

Other References

- ASME Joint Committee on Nuclear Risk Management (JCNRM), "Codes & Standards" https://cstools.asme.org/csconnect/CommitteePages.cfm?Committee=100186782
- International Atomic Energy Agency, "Safety Standards" https://www.iaea.org/resources/safety-standards
- M. Tobin, K. Coyne, and N. Siu, "Current PRA knowledge management activities at the NRC," *Proceedings PSA 2011 International Topical Meeting on Probabilistic Safety Assessment and Analysis (PSA 2011)*, Wilmington, NC, March 13-17, 2011.
- M.H. Salley and A. Lindeman, "Methods for Applying Risk Analysis to Fire Scenarios (MARIAFIRES) – 2012," *NUREG/CP-0303, EPRI 3002005205*, April 2016.

RIDM Infrastructure elements

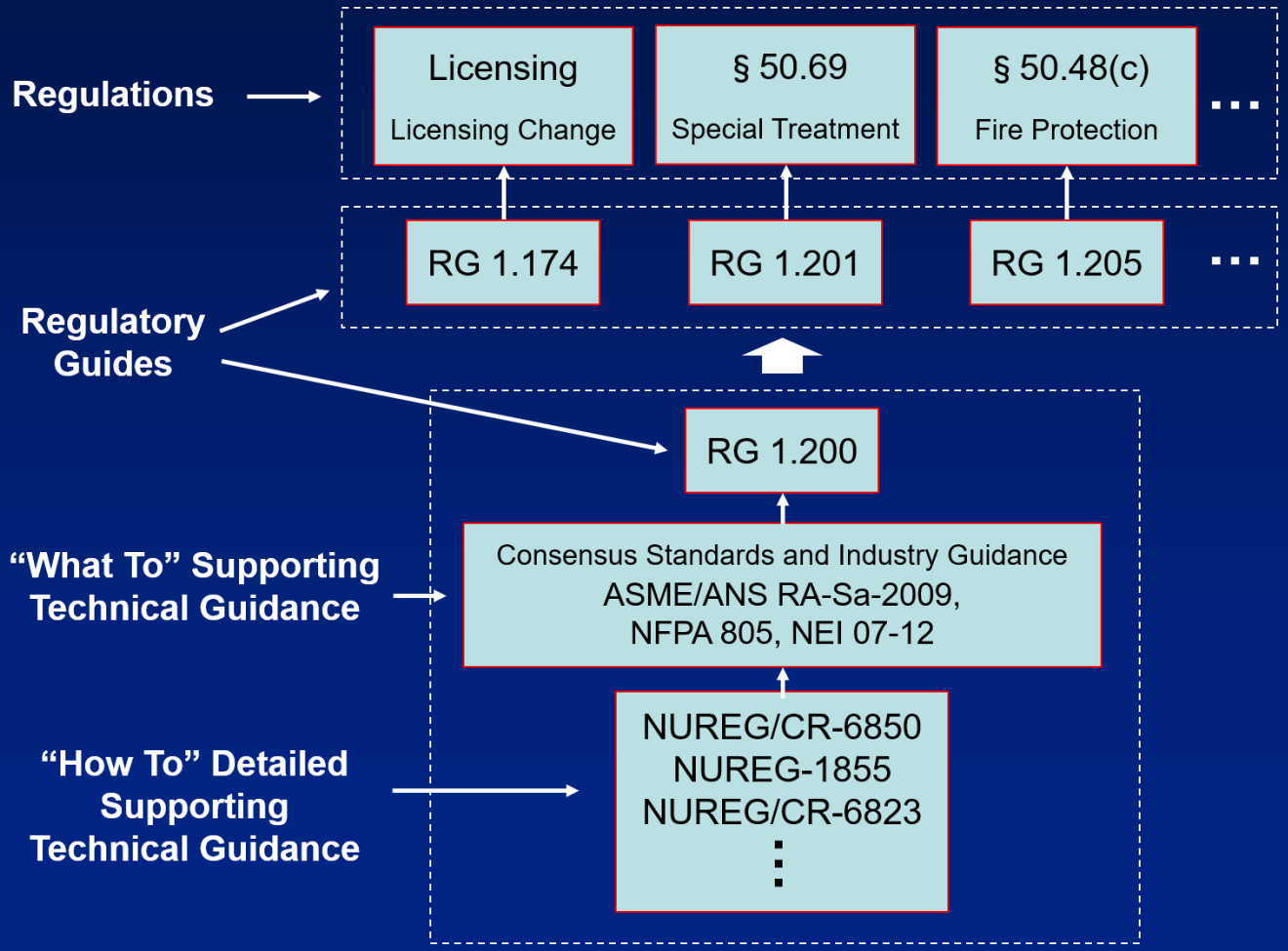
- Policy statements
- Standards and guidance
- Tools
- Staff
- Training
- R&D



Policy Statements

- Announce intention, provide direction to staff
- Safety Goals (1986)
  - Qualitative: nuclear is not a significant source of risk
  - Quantitative: significant ~ 0.1% or greater
  - Surrogate: CDF (1E-4/ry), LERF (1E-5/ry)
- PRA (1995)
  - Increase use (subject to state-of-the-art)
  - Complement deterministic, support defense-in-depth
  - Realistic as practicable; reduce unnecessary conservatism
  - Consider uncertainties when using Safety Goals

PRA Standards and Guidance



PRA Standards

- Consensus documents based on practice
- Establish “ground rules” for acceptable analyses – regulatory review can focus on peer review facts and observations (F&Os)
- Need to be careful that desire for standardization/consistency doesn’t stifle
  - use of imagination in searching for potentially important contributors
  - use of innovative problem-solving approaches (e.g., reviewer questions of “why” rather than “why not”)

PRA Reviews

- Peer review and regulatory review
  - Important before PRA standard development – provided some confidence in analysis results
  - Now an integral and formalized part of process
- Documentation is critical
- Review is in the context of an application
  - Adequate for the intended purpose
  - Other countries require “state-of-the-art” => different review standard, but also more careful definition of “state-of-the-art”

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ASME/ANS Standard Status*

- Level 1/LERF at-power published, new edition in process
- Level 2 – available for trial use
- Level 3 – in process to be published for trial use
- Low Power and Shutdown – available for trial use
- Advanced Light Water Reactors (including SMRs) – in process to be published as an appendix to new edition
- Non-Light Water Reactors – available for trial use

*As of 1-11-2017: See https://cstools.asme.org/csconnect/CommitteePages.cfm?Committee=10018678 2&Action=50220

IAEA Safety Documents Hierarchy

- Fundamentals
  - Fundamental Safety Principles SF-1
- General Requirements
  - Safety Assessment for Facilities and Activities (GSR Part 4)
- Specific Requirements
  - Safety of Nuclear Power Plants: Design (SSR-2/1)
  - Safety of Nuclear Power Plants: Commissioning and Operation (SSR-2/2)
- Safety Guides
  - Level 1 PSA (SSG-3)
  - Level 2 PSA (SSG-4)

Fundamental Safety Objective, Principles of Protection

Requirements That Must Be Met

Guidance and Recommendations for Meeting Requirements

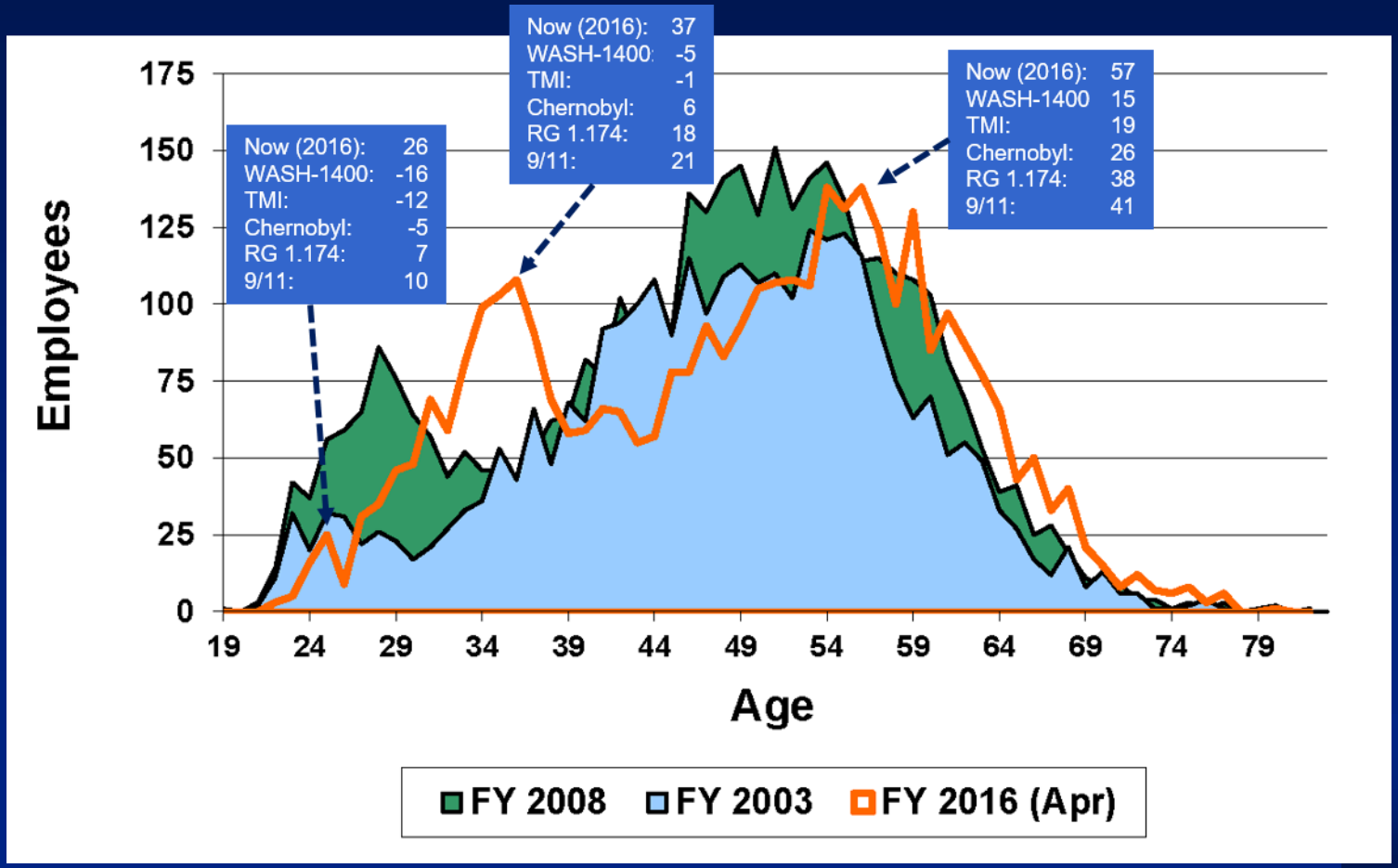
Some Other Standards and Regulatory Guides

- IEEE-1082-2017 – IEEE Guide for Incorporating Human Reliability Analysis into Probabilistic Risk Assessments for Nuclear Power Generating Stations and Other Nuclear Facilities, 2017.
- United Kingdom Health and Safety Executive, "Technical Assessment Guide: Probabilistic Safety Analysis," *T/AST/030* – Issue 03, 2013.
- Swiss Federal Nuclear Safety Inspectorate (ENSI), "Probabilistic Safety Analysis (PSA): Quality and Scope: Guideline for Swiss Nuclear Installations," *ENSI-A05/e*, 2009.
- Finland Radiation and Nuclear Safety Authority (STUK), "Probabilistic Safety Analysis in Safety Management Of Nuclear Power Plants," *Guide YVL 2.8*, 2003.

NPP PRA Tools

- Analysis Software
  - General PRA codes (e.g., SAPHIRE, CAFTA, RISKMAN, Risk Spectrum)
  - Plant-specific models (e.g., SPAR)
  - Support codes (e.g., MELCOR, MAAP, MACCS)
  - Specialized models and toolboxes (e.g., CFAST, FDS, EPRI HRA Calculator)
  - General purpose statistical analysis tools
- Databases and search tools
  - “Raw” event data (e.g., LERs)
  - Specialized databases (e.g., FIRE, ICDE, OPDE, SACADA)
  - Generic estimates
- Hardware

NRC Staff and Major Events



See also Fire PRA NUREG/CP-0303, EPRI 3002005205

NRC Staff Training

- Multiple offerings available to staff
- "Learning by doing" (OJT) is critical

No.	TItle
P-101	Risk-Informed Regulation for Technical Staff
P-102	Bayesian Inference in Risk
P-105	PRA Basics for Regulatory Applications
P-107	PRA for Technical Managers
P-108	Fire Protection SDP
P-109	Assessing Adequacy of Models for Risk-Informed Decisions
P-111	PRA Technology and Regulatory Perspectives
P-200	System Modeling Techniques
P-201	SAPHIRE Basics
P-202	Advanced SAPHIRE
P-203	Human Reliability Assessment
P-204	External Events

No.	Title
P-300	Accident Progression Analysis
P-301	Accident Consequences Analysis
P-302	Risk Assessment in Event Evaluation
P-400	Introduction to Risk Assessment in NMSS
P-401	Introduction to Risk Assessment in NMSS Overview
P-403	Quantitative Risk Assessment
P-404	Hazards Analysis for DOE SARs and QRAs Including ISA
P-406	Human Reliability Assessment for NMSS
P-501	Advanced Risk Assessment Topics
P-502	Bayesian Inference in Risk Assessment
	Fire PRA (NUREG/CP-0303, EPRI 3002005205)

NRC PRA R&D/Technical Support

- Majority focused on short-term programmatic needs, e.g.,
  - ROP support (SPAR models, data)
  - Operational experience (ASP)
  - Fire PRA realism
  - PRA standards and guidance
- Longer-term activities include
  - Level 3 PRA study
  - HRA technology development
- Includes cooperative activities with EPRI, international organizations