Update to ANS/ANSI 2.29 Probabilistic Seismic Hazard Analysis

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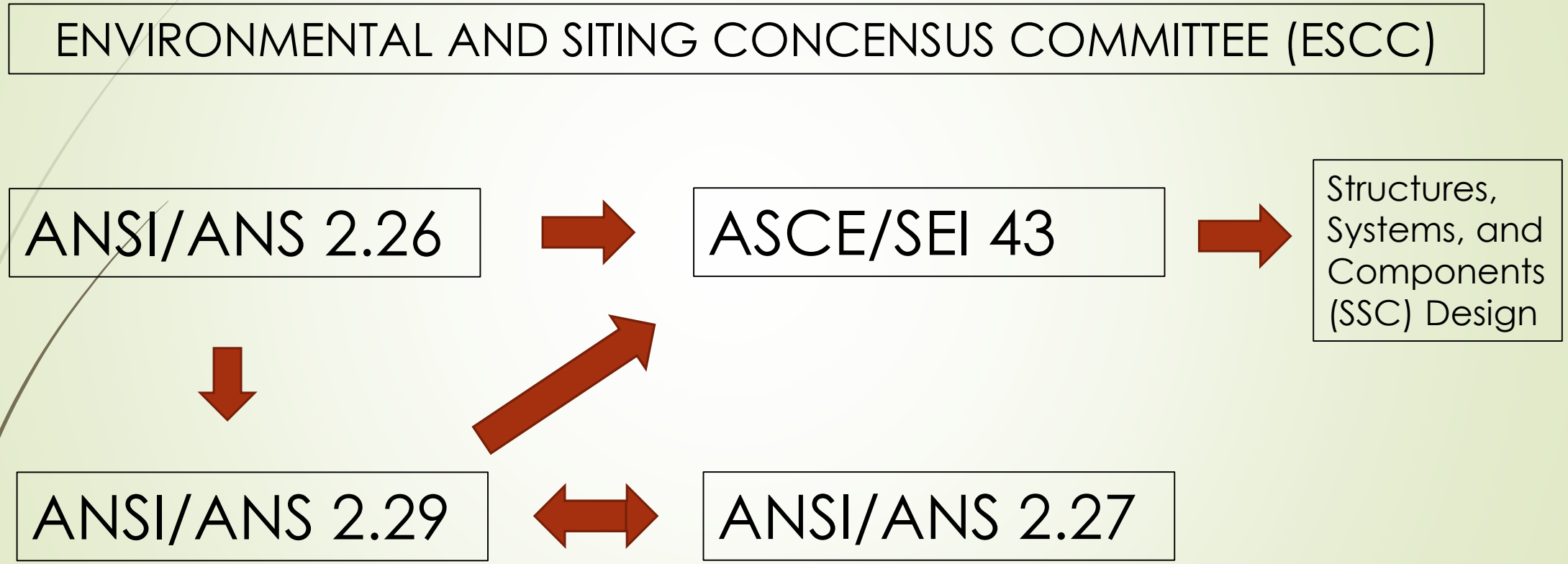
*The opinions, findings, conclusions expressed herein are those of the authors and do not necessarily represent the views of the Defense Nuclear Facilities Safety Board.

ANS Seismic Standards



ANS 2.29 Applications

- DOE STD 1020-2016, *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities*
- Source of guidance for nuclear national and international seismic hazard analysis
- Learning tool

ANS 2.29 Working Group

- Emily Gibson (Schnabel Engineering LLC) – Chair
- Lisa Schleicher (Defense Nuclear Facilities Safety Board) – Vice Chair
- Jon Ake (Nuclear Regulatory Commission)
- Nilesh Chokshi (Individual)
- Kevin Coppersmith (Coppersmith Consulting, Inc.)
- Carl Costantino (Individual)
- C.B. Crouse (AECOM Technical Services, Inc.)
- Russell Green (Virginia Polytechnic Institute and State University)
- Nick Gregor (Bechtel Corporation)
- Tom Houston (Individual)
- Yong Li (Defense Nuclear Facilities Safety Board)
- Annie Kammerer (Individual)
- Jeff Kimball (Rizzo Consultants)
- Jim Marrone (Bechtel Corporation)
- Marty McCann (Jack R. Benjamin and Associates)
- Steve McDuffie (U.S. Department of Energy)
- Cliff Munson (U.S. Nuclear Regulatory Commission)
- Suzette Payne (Idaho National Laboratory)
- Maury Power (AMEC Consultants)
- Jean Savy (Individual)
- Gabe Toro (Lettis Consultants International)
- Ivan Wong (Lettis Consultants International)
- Bob Youngs (Wood Environmental and Infrastructure Solutions)

ANS 2.29 Proposed Updates

- Consistency with other recently updated standards
  - ANS 2.27, *Criteria for Investigations of Nuclear Facility Sites for Seismic Hazard Assessments*
  - ASCE/SEI 43-18, *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities*
  - NUREG 2213, *Updated Implementation Guidelines for SSHAC Hazard Studies*
  - ASME/ANS RA-Sb-2013, *Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications*
- Less DOE-centric
- Guidance for evaluating the need to perform PSHA updates from NUREG 2213
- Focus on Interfaces between Models

PSHA Purpose, Objectives and Process

- Clearer definition of Senior Seismic Hazard Analysis Committee (SSHAC) process
- Require SSHAC process or its equivalent with the following five attributes:
  1) Role of participants clearly defined
  2) Objective evaluation of all relevant data, models, and methods.
  3) Integration of the outcome of the evaluation process
  4) Documentation
  5) Independent participatory peer review

High Level Requirements

- Removal of Chapter 4
  - High level requirements are redundant
  - Removal of table for specifying PSHA Level

SDC	Nominal Ground Motion Hazard Level	Level of uncertainty and controversy	PSHA Recommended Level
3	Low	Low	1
		High	1
	Moderate	Low	1
		High	2
	High	Low	2
		High	2
4	Low	Low	1
		High	2
	Moderate	Low	2
		High	2
	High	Low	2
		High	3
5	Low	Low	2
		High	3
	Moderate	Low	3
		High	4
	High	Low	3
		High	4

PSHA Model Components

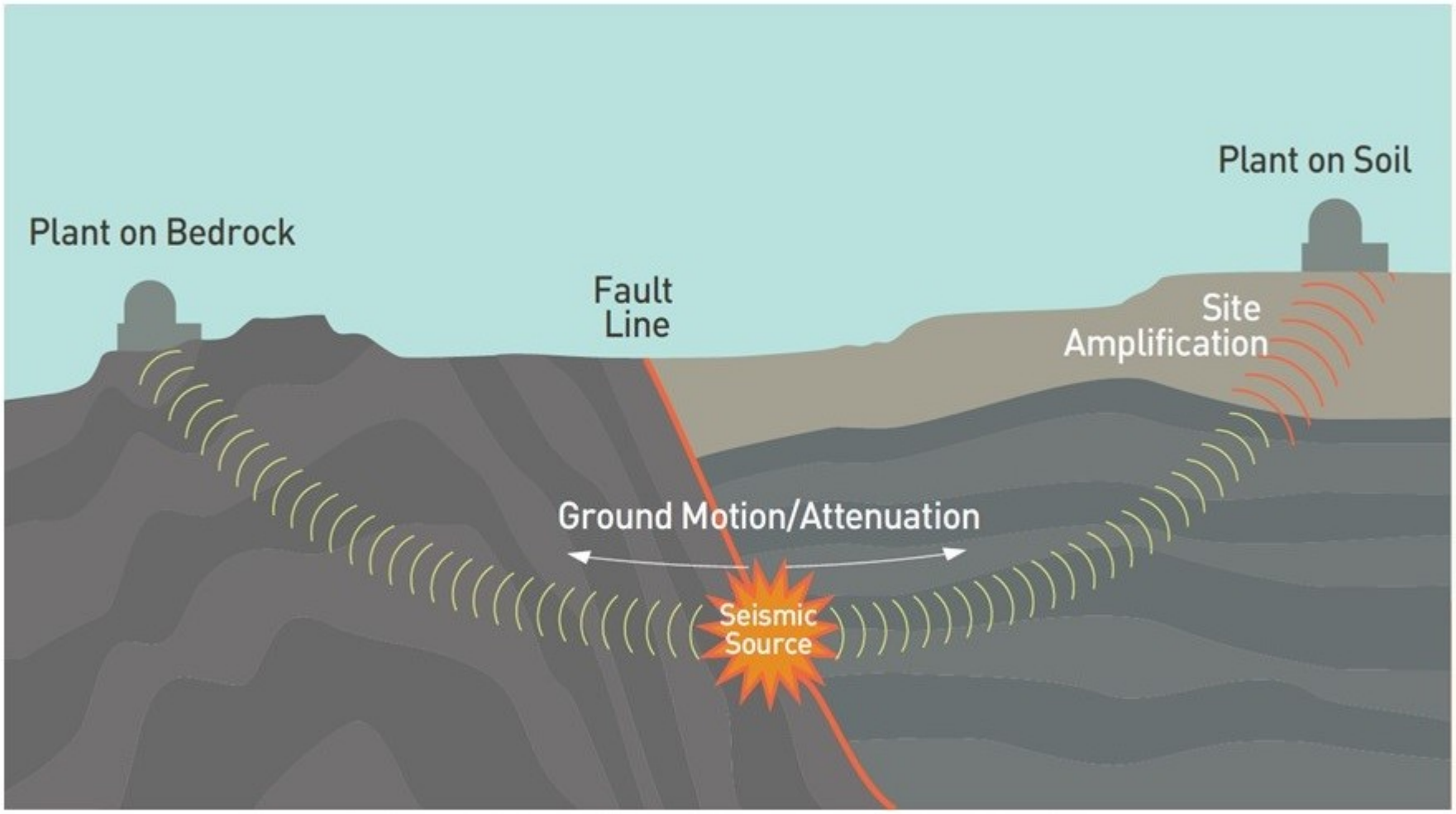


Figure from NRC Information Digest, 2014–2015 (NUREG-1350, Volume 27)

Seismic Source Characterization

- Include seismic sources significantly contributing to the hazard vs. specifying specific distances
- Additional information on areal source zones and earthquake recurrence
- Special consideration section
  - induced earthquake sources
  - volcanic earthquake sources
  - subduction zone sources
  - Discussion on additional sources

Ground Motion Characterization

- Clear delineation between the development of the median ground motion, the distribution of the aleatory variability, and assessment of epistemic uncertainty
- Discussion of different intensity measure (geomean accelerations, vertical ground motions)
- Methods for development of median models
- Definition of single station sigma
- Backbone model and Sammon's Maps to capture epistemic uncertainty
- Vs-kappa corrections
- Discussion of interfaces with seismic source characterization and site response

Site Response

- Discussion of nonlinear numerical site response
- More details on bounds of parameters
- Warning on validity of results
- Use of kappa
- Adoption of some of the guidance from the SPID

New Section: Implementation of PSHA for Seismic Design and Seismic PRA

- Derivation of site-specific hazard curves
  - Approaches for applying amplification factors discussed in NUREG/CR-6728
- Basic requirements for SPRA
- Derivation of vertical motions
- Final quantification of uncertainties
- Input to Secondary Hazards for SPRA
  - Non-vibratory hazards

Documentation and Quality Assurance

- Removed redundancies between PSHA process section and documentation section
- Adding examples of PSHA documentation and results conceptualization
- Software Quality Assurance section added referencing QA literature specifically to PSHAs

Schedule

- Expect to provide a draft approved by the ANS 2.29 Working Group in early 2019
- Will need to be approved by ESCC
- If you'd like to review the current draft please email me

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