# HIGH TEMPERATURE TWG BREAKOUT

Advanced Reactor Standards Workshop

02 May 2018

## IDENTIFIED AT MEETING INTRO

- ASME/ANS RA-S-1.4-2013 PRA for Non-LWRs (trial use)
- ANS-30.1-201x RIPB Principles and Methods (new)
- ANS-302.-201x Categorization and Classification of SSCs (new)
- ANSI/ANS-53.1-2011 MHTGR Nuclear Safety Design R2016
- ANSI/ANS-67.02.1-2014 Safety Related Instrument-Sensing Line Pipng and Tubing
- ASME Sec II Div 5 and related codes for welds, piping, etc.
- Potential revisions to ASTM stds consistent with code requirements

# ADDITIONAL BRAINSTORMING

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# NQA-1 (CROSS-CUTTING)

- Treatment of legacy data
  - Materials
  - Fuel qualification
- Stability of NQA-1
  - Periodic incremental changes
  - RG-1.28 (Rev 5) vs NEI template (NEI 11-04A)
- Need for code modifications?
  - For different license types (besides COL, DC)
  - For different materials

- Related: what data are needed for material qualification – ASME Sec II

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## RISK-INFORMED, PERFORMANCE-BASED (CROSS-CUTTING)

- Overall approach
  - Licensing Modernization Project (LMP) product
    - NRC endorsement may moot/obviate need for certain code changes in near term
      - Is ANS 53.1 still needed given LMP?
      - Alignment needed with LMP; make broader?
      - 30.1 supposed to be tech-inclusive but 30.1 and 53.1 not closely aligned
  - Limit inspections based on risk significance
    - Existing code at component level – may not be readily apparent how system-level risk analysis translates
    - Ensure SSC classification is translated to component level
    - Non-safety-related but safety significant – can be gray area (special treatment)
  - RIPB for other areas, e.g., security
- Defense in depth quantification/specification



## RISK-INFORMED, PERFORMANCE-BASED (continued)

- Overall conclusion
  - More coordination/strategizing needed to clarify where standards treatment/update needed (cf. LMP status)
    - Top-tier process for safety system infrastructure, system classification, etc.
    - Communication to design community
  - Special treatment varies
    - Programmatic controls
    - Additional monitoring surveillance
    - Selected design codes
  - Process layers within LMP
    - SSC classification
    - Defense in depth
- Other design classifications (e.g., IEEE categories, joint IEEE/IEC definitions)
- Safety basis and design basis not the same thing

# OTHER

- Cross-SDO – related to but different from cross-cutting
- Salt chemistry
  - Radioisotope retention
  - Corrosion
  - Address in MSR TWG
- Human factors for passive plants
  - Simplification to reflect limited reliance on operator action
  - Remote/autonomous operation
  - Fuel handling, robotic operations
  - Load following, demand-based power level
- Environmental review
  - Comparison with other agencies' NEPA implementation
  - Not good candidate for standards treatment

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# PRIORITIZATION/ WORKSHOP QUESTIONS

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# 1. CURRENT STATUS

- Generally speaking, sufficient for both licensing and design
- NQA-1 stability sought (later)
- Evaluation (e.g., 53.1, 30.1, 30.2) parallel with and informed by LMP worthwhile and timely
  - LMP resolution
  - Consistency between 53.1 and others



# 2. TOP FIVE MOST IMPORTANT STANDARDS

- ASME/ANS RA-S-1.4-2013 PRA for Non-LWRs (trial use)*
- ANS-30.1-201x RIPB Principles and Methods (new)*
- ANS-302.-201x Categorization and Classification of SSCs (new)*
- ANSI/ANS-53.1-2011 MHTGR Nuclear Safety Design R2016
- ANSI/ANS-67.02.1-2014 Safety Related Instrument-Sensing Line Piping and Tubing*
- ASME Sec III Div 5 and related codes for welds, piping, etc.*
- Potential revisions to ASTM stds consistent with code requirements*



* cross-cutting

# 3. TOP FIVE TECHNICAL AREAS

- Risk-informed, performance-based “suite”*
- Sec VIII cyclic loads for high temp*
- Design life for Sec VIII and Sec III Div 5*
- Fiber optic (specifically) and qualification of I&C for high temp*
- Sec XI “fitness for service” high-temp failures ISI – team formed to evaluate*

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* cross-cutting

# 4. PRIORITIZATION OF LISTS

1. RIPB-related standards
2. Everything else

*Sub-prioritize by what needs development, what needs revision, and/or what needs endorsement*

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* cross-cutting

# 4. PRIORITIZATION OF LISTS

- From question 2:
  1. Any changes needed for RIPB licensing
     a) ASME/ANS RA-S-1.4-2013 PRA for Non-LWRs (complete and endorse – currently trial use)*
     b) ANS-30.1-201x RIPB Principles and Methods (in development)*
     c) ANS-302.-201x Categorization and Classification of SSCs (in development – related to LMP)*
     d) ANSI/ANS-53.1-2011 MHTGR Nuclear Safety Design R2016
  2. ANSI/ANS-67.02.1-2014 Safety Related Instrument-Sensing Line Pipng and Tubing*
  3. ASME Sec III Div 5 and related codes for welds, piping, etc.*
  4. Potential revisions to ASTM stds consistent with code requirements*
- From question 3:
  1. Risk-informed, performance-based "suite"*
  2. Sec VIII cyclic loads for high temp*
  3. Design life for Sec VIII and Sec III Div 5*
  4. Fiber optic (specifically) and qualification of I&C for high temp*
  5. Sec XI "fitness for service" high-temp failures ISI – team formed to evaluate*

* cross-cutting – didn't spend much time ranking

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# 5A. CROSS-CUTTING ISSUES

- All of the above (except for 53.1)
- Process/understanding of how to raise code issues and get them resolved quickly
  - Accelerating research and standards development
  - Application of demonstration/prototype approach
- Recognition of/ideas for taking optimum credit for mod/sim vs testing

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## 5B. PREFERENCE FOR RIPB

- Performance based?
  - Maintain existing top level regulatory criteria
  - Performance based criteria as a more easily demonstrated metric to show we meet TLRC is a good thing
  - LMP-type approach identifies what is important in terms of functional outcomes, other prescriptive "requirements" should not apply
  - Additional discussion needed to translate this concept (currently being applied at regulatory framework level) to standards level
- Risk informed?
  - Yes, within reason
  - Defense in depth is important, but so is knowing when "enough is enough"
- What is driver?
  - Ensuring effective/efficient licensing process through safety-focused review
  - Reducing cost of plant
  - Lack of meaningful deterministic safety framework for non-LWRs

# Fast Reactor Working Group

Summary of break-out session

ANS/NRC Advanced Reactor Standards Workshop

May 2, 2018

## Key points

- Availability of standards is not a requirement for developing advanced reactors. It is an aid
- Very few people have comprehensive knowledge of status of standards (past and present standards).
  - It would be helpful to include, in the highlights of this workshop, info on where a summary table of existing and past Standards can be found
- Developers of standards cannot work in a vacuum: the effectiveness/pace of their work depends on stakeholder input

Q1: For your technology, what would you say is the current status of standards to support the development, design, and licensing of advanced reactors? Are most of the needed standards available up to date? Do they cover the issues that have the most significant impact on the design? On the schedule?

- Existing standards represent a good starting point
- However, they are not always up-to-date and/or best-suited for non-LWR technologies / fast reactors. Some high-priority standards (schedule-wise) would benefit from modifications, e.g. NQA-1
- Overall suggestion is to have existing standards (~860) grouped in high-level categories, to facilitate their identification and priority-based use. Work done at ORNL for SFR Standards can be leveraged

Q2, 4: List the five most current important standards (from any standards development organization) to your area that are in need of updating to support development, design, and licensing. Why are they your top five?

1) NQA-1 (ANS 3.2, 2012; 2015 version of NQA-1 which was approved in 2017 NRC guidance on QA). See footnote*
2) Fuel transportation/handling/dry-storage (ANS 57.1), to capture general features of fast reactor fuel. (Note: ANS 54.2 exists, but it refers to wet storage of LMR fuel)
3) Supplementing ASME Div.5:
   - Implementation of environmental effects, mainly related to corrosion
   - Implementation of cladded structural materials
   - **However: efforts are needed to find a way to accelerate the pace with which changes are made and finalized in Div.5**
4) Component inspection (ASME Pressure Vessel Section in Section XI of 2001 edition) to capture features specific to several fast reactor technologies (high-temperature, opaque coolant)

* Examples of issues in applying NQA-1 to non-LWRs:

**Subpart 2.2** (QA Requirements for Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Facilities). Concerns with classification levels (a, b, c, d) "based on important physical characteristics and not upon the important functional characteristics of the item with respect to safety, reliability, and operation."

**Subpart 2.5** (QA Requirements for Installation, Inspection, and Testing of Structural Concrete, Structural Steel, Soils, and Foundations for Nuclear Power Plants). Implicit assumptions on installation, inspection and testing of different concrete, steel, foundation, soil, earthwork, equipment and other items and their quality requirements regardless of importance to safety and based on LWR experience.

**Subpart 2.15** (QA Requirements for Hoisting, Rigging, and Transporting of Items for Nuclear Power Plants). Similar concerns on classifications based off of LWR experience for categories A-C

**Subpart 2.20** (QA Requirements for Subsurface Investigations for Nuclear Power Plants). Possibly less critical, but subsurface QA requirements based on LWR experience and LWR importance to safety of the soil and seismic effects.

Q3, 4: List the five most important technical areas that need standards development (where they currently don't have standards). Why are they your top five

**The areas that need standards development are (decreasing order of importance):**

1) Source term assessment for non-LWRs (would support EPZ size reduction)
2) Casks for shipping and dry-storage of High Assay LEU
3) Startup testing and reliability measurement of passive safety systems. Note: highest priority is for RVACS (suggested to reach an industry-agreed method to assess RVACS and address it in licensing phase)
4) Materials joining. Examples are Printed Circuit Heat Exchangers (and diffusion bonding in general), and Silicon Carbide
5) Multi-use, inter-operability components. Standardization of component interfaces to ease and increase level of modularity in construction
6) Additive manufacturing
7) Standards applicable to some specific features of micro-reactors for "niche" applications, e.g. remote locations (e.g. remote control and security aspects)
8) Digital technology (e.g. use of off-the-shelf computer applications to standardize digital technology implementation)

Q4: Provide some prioritization of the two lists, both in overall need (must have to move forward) and in timing (need by a certain date). If possible, provide insights as to why the standard has priority and what aspect of the issues are driving the priority

- Prioritization already shown on previous slides

Q5a: What cross-cutting issues do you believe need to be included in the development of new standards for advanced reactors or the updating of current standards? These could include analysis methods (like probabilistic risk assessment, thermal hydraulics, human factors, etc.) or other cross-cutting issues like staffing, emergency management, advanced instrumentation and control, security, etc

- High Assay LEU fuel transportation/ storage
- Safety-significance-based classification of SSC within NQA-1
- Source term assessment (accounting for coolant-specific radionuclide retention capability; confinement vs containment)
- Passive systems analysis/qualification

Q5b: Is there a preference across the advanced reactor industry that future advanced reactor standards be more performance based and use high-level, risk-informed principles compared to current standards? What should drive this decision?

- Yes, there is such a preference!
- Key driver for risk-informing is COST
- Caveat in risk-informing: it will likely result in more onerous efforts by the regulator
- Recommendation for risk-informing: don't be too prescriptive. Standards should be outcome-focused. Need to avoid that developers are forced to modify their designs resulting in sub-optimal performance (especially economics) "just" because they need to comply with criteria that are not outcome-based