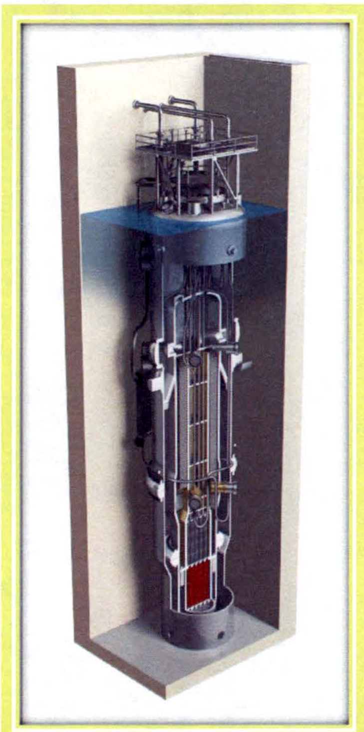
NuScale Source Term Revision



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Outline

- Purpose
- Current DCA Source Terms
- Current AST LTR Approach
- DCA Source Term Changes
  - Source Term Changes Rationale
- AST LTR Changes
  - AST LTR Iodine Spike MHA
  - AST LTR Core Damage MHA
- Regulatory Considerations
- DCA Impacts
- Schedule
- Summary

Purpose

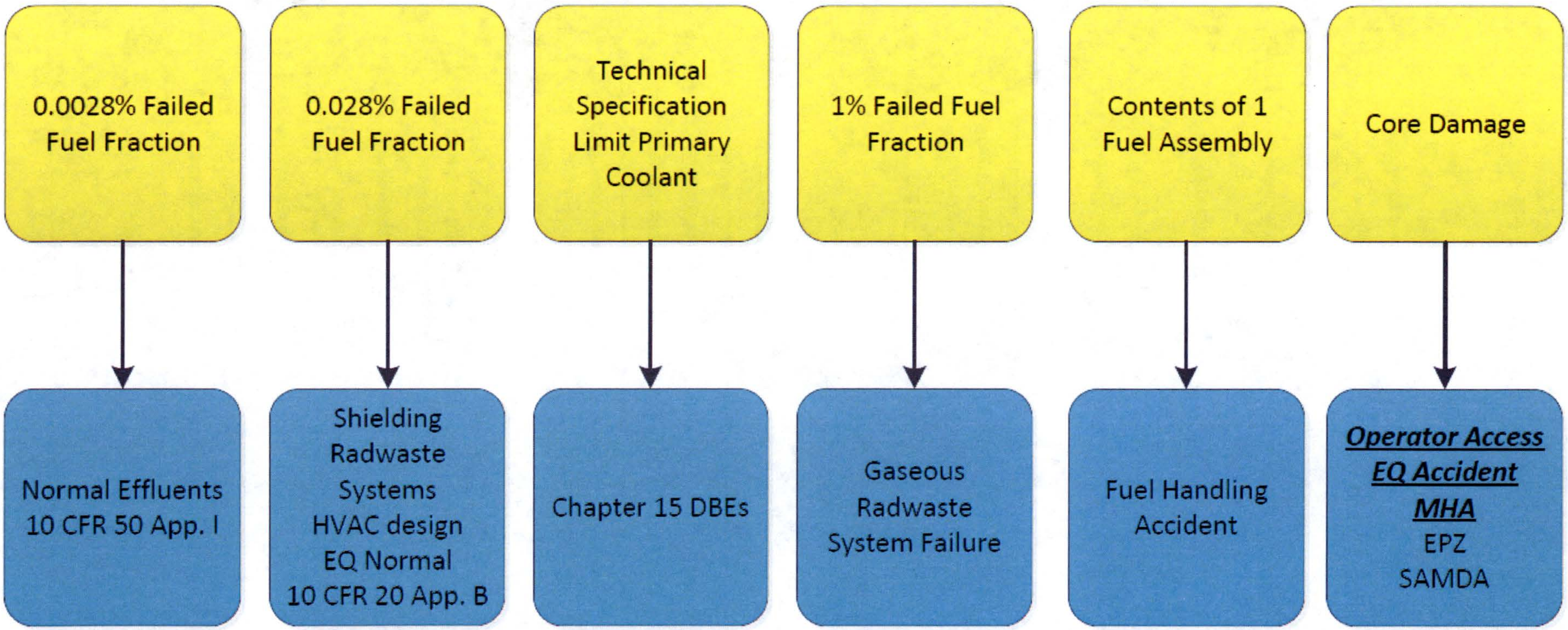
- Inform NRC of forthcoming changes to NuScale Accident Source Term Methodology Topical Report (AST LTR) and the DCA source term associated with the maximum hypothetical accident (MHA)

  Note: "MHA" is shorthand for the scenario described in 10 CFR 52.47(a)(2)(iv)

- Elicit NRC feedback on
  - technical approach
  - regulatory interpretations
  - schedules

Current DCA Source Terms

Various source terms are used in various design-basis analyses. Only the ***underlined*** text below will change.

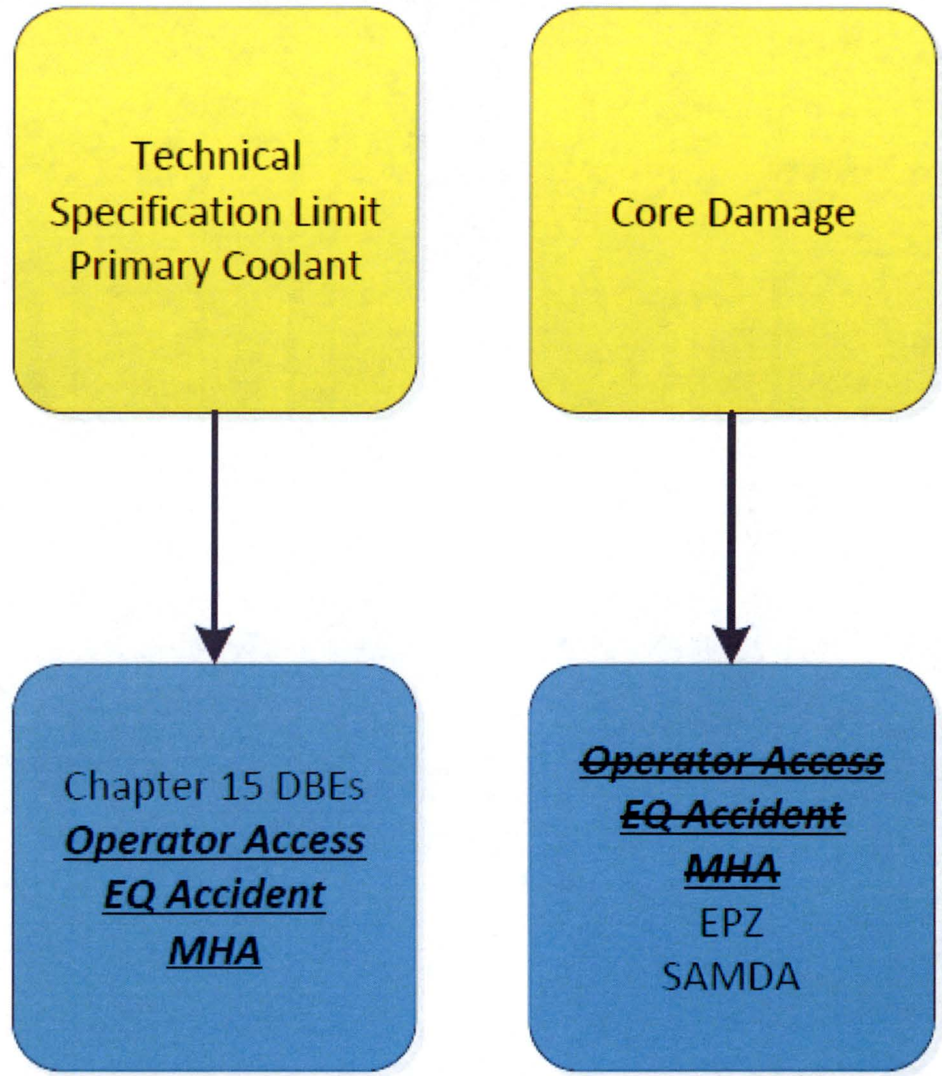


Current AST LTR Approach

- MHA source term is derived from <1E-10/year PRA core damage sequences
  - core damage leads to fission product release into containment

DCA Source Term Changes

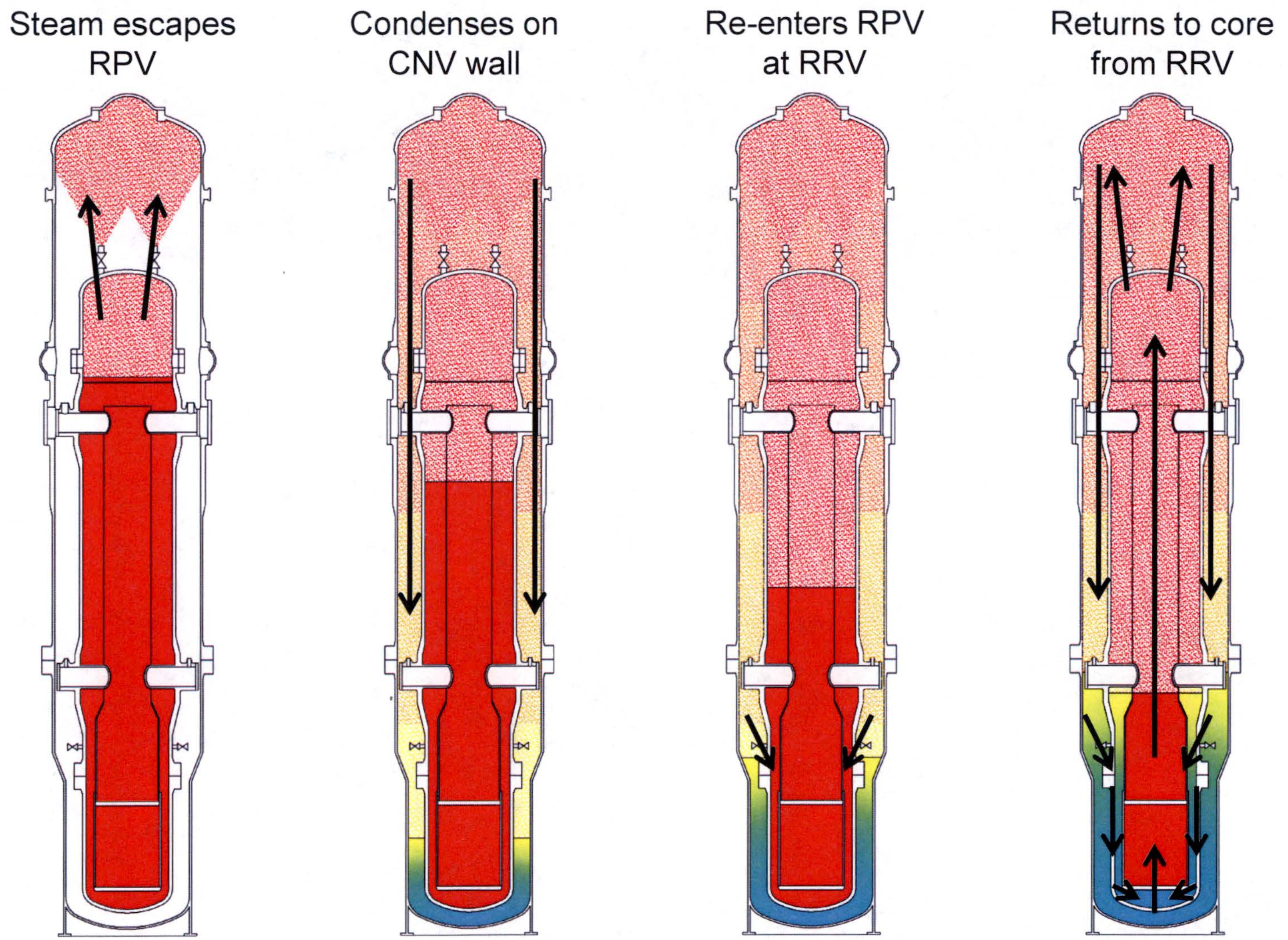
- Incredible source terms (CDF<1E-6/year) involving core damage will only be used for EPZ and SAMDA



Source Term Changes Rationale

- NuScale has elected to make these changes because the current MHA approach is overly conservative given the low probability of internal events core damage (<1E-9/year)
  - existing analyses using the current methodology result in overly conservative design requirements for
    - equipment qualification
    - control room habitability design
- Additionally, for defense-in-depth, the NuScale containment's primary purpose is to facilitate emergency core cooling, with a secondary function of retaining fission products
  - both prevention and mitigation functions

Source Term Changes Rationale



Source Term Changes Rationale

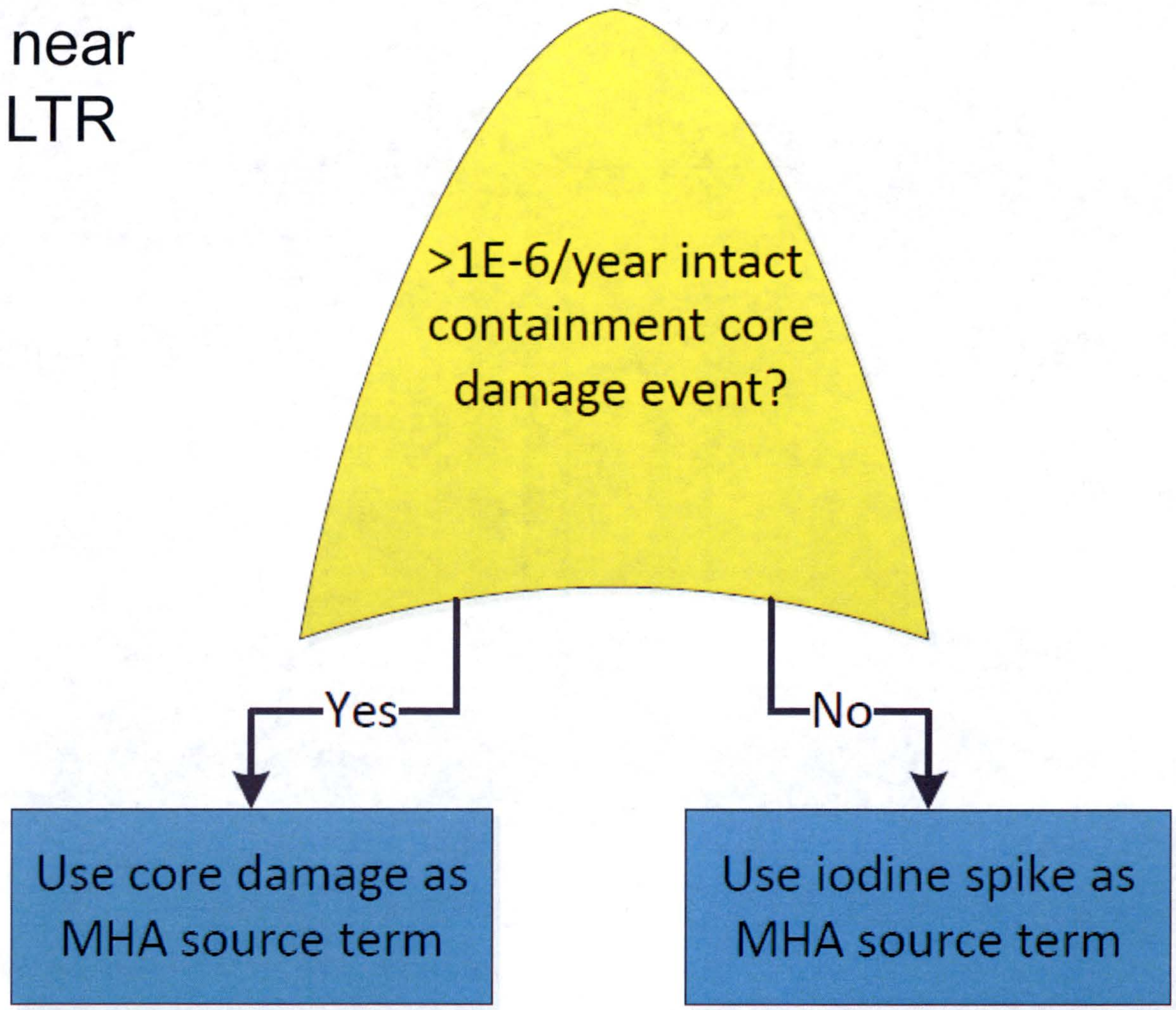
- IAEA defense-in-depth report (INSAG-10)
  - NuScale's containment provides both Level 4 and Level 3

TABLE I. LEVELS OF DEFENCE IN DEPTH

Levels of defence in depth	Objective	Essential means
Level 1	Prevention of abnormal operation and failures	Conservative design and high quality in construction and operation
Level 2	Control of abnormal operation and detection of failures	Control, limiting and protection systems and other surveillance features
Level 3	Control of accidents within the design basis	Engineered safety features and accident procedures
Level 4	Control of severe plant conditions, including prevention of accident progression and mitigation of the consequences of severe accidents	Complementary measures and accident management
Level 5	Mitigation of radiological consequences of significant releases of radioactive materials	Off-site emergency response

AST LTR Changes

- Logic gate added near beginning of AST LTR



AST LTR Iodine Spike MHA

- Surrogate MHA event derived from sequences >1E-6/year not resulting in core damage
  - LOCA in containment initiating event (e.g., CVCS break in containment) is used, as it is representative of a spectrum of events that result in primary coolant in the containment
- Radionuclides in primary coolant at technical specification limits released from core into containment
  - assume Iodine spiking
- Significantly less technically complex to analyze than the core damage MHA and significantly smaller source term

AST LTR Core Damage MHA

- Alternative path of logic gate is essentially the current MHA approach shown in AST LTR Rev. 2 that NRC already reviewed
  - two changes to how dose is calculated from the MHA source term in AST LTR Rev. 3
    - aerosol modeling
    - leak rate assumptions

Regulatory Considerations

- 10 CFR 52.47(a)(2):

  "…The following power reactor design characteristics will be taken into consideration by the Commission:…

  (iii) The extent to which the reactor incorporates unique, unusual or enhanced safety features having a significant bearing on the probability or consequences of accidental release of radioactive materials; and

  (iv) …design features intended to mitigate the radiological consequences of accidents. In performing this assessment, an applicant shall assume a fission product release[3] from the core into the containment… The applicant shall perform an evaluation and analysis of the postulated fission product release…to evaluate the offsite radiological consequences."

Regulatory Considerations

- 10 CFR 52.47, Footnote 3

“The fission product release assumed for this evaluation should be based upon a major accident, hypothesized for purposes of site analysis or postulated from considerations of possible accidental events. These accidents have generally been assumed to result in substantial meltdown of the core with subsequent release into the containment of appreciable quantities of fission products.”

Regulatory Considerations

- Footnote 3 derives from 10 CFR Part 100 siting evaluation
  - included phrase: "that would result in potential hazards not exceeded by those from any accident considered credible" and explicit reference to TID-14844 (see current 10 CFR 100.11)
  - Part 100 rulemaking to "decouple siting from accident source term and dose calculations" modified to be compatible with "revised accident source terms" (63 FR 65159)
  - 10 CFR 50.67 AST rulemaking, "There is no regulatory requirement for a specific source term for reactors to be licensed in the future" (64 FR 71995)
- Therefore, iodine spike MHA should not require an exemption from 10 CFR 52.47(a)(2)(iv)

Regulatory Considerations

- Containment leakage integrity remains applicable
  - GDC 16, Containment design: "…an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment…"
- Containment's function in accident prevention and mitigation is addressed by other requirements
  - 10 CFR 52.47(a)(4): assess "adequacy of structures, systems, and components provided for the prevention of accidents and the mitigation of the consequences of accidents."
  - 10 CFR 50.46 ECCS acceptance criteria, GDC 34 residual heat removal, GDC 35 emergency core cooling

Regulatory Considerations

- Consistent with other source term requirements
  - GDC 19, Control room: "A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident."
  - 10 CFR 52.79(a)(1)(vi): Comparable requirement for COL applications, using actual site characteristics. COL would be expected to use same approach

DCA Impacts

- Referenced AST LTR Rev. 3 methodology change
  - option of core damage or iodine spike MHA source term based on whether >1E-6/year core damage event exists
  - change to aerosol modeling
  - change to leak rate assumptions
- FSAR sections will use iodine spike MHA source term
  - 3.11 and 3.C Environmental Qualification Methodology
  - 12.2 Radiation Sources
  - 15.0.3 Radiological Consequence Analyses

Schedule

- RAI 9224 response
  - July 2018
- AST LTR Rev. 3 submittal
  - July 2018
- DCA update unilateral letter
  - July 2018

Summary

- Core damage MHA source term is overly conservative as a design basis for the NuScale Power Module
- Iodine spike MHA source term consistent with 10 CFR 52.47(a)(2)(iv) and related requirements
- RAI 9224 response, AST LTR Rev. 3, and associated DCA markups to be submitted July 2018

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