Enclosure 1:

"NuScale Effluent Release (GALE Replacement) Methodology", PM-0715-16229-NP, Revision 0, nonproprietary version

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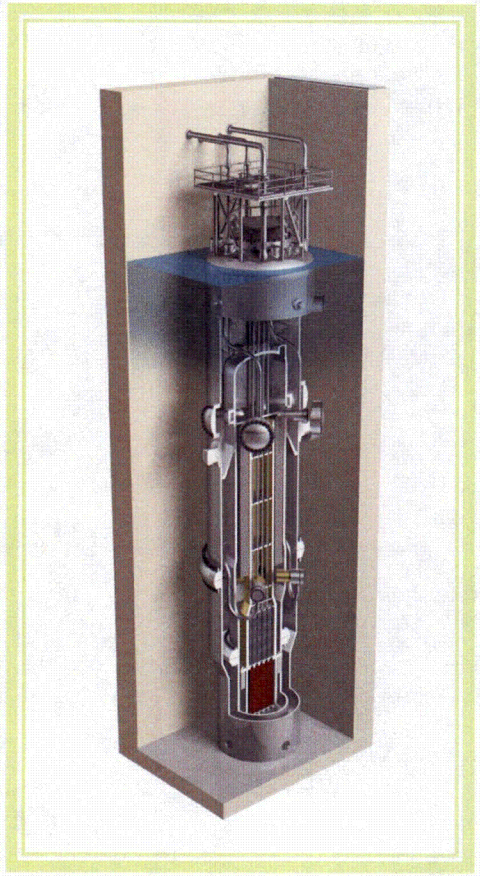
NuScale Effluent Release (GALE Replacement) Methodology



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August 20, 2015

PM-0715-16229-NP
Revision: 0

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Acknowledgement and Disclaimer

This material is based upon work supported by the Department of Energy under Award Number DE-NE0000633.

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Agenda

- Purpose
- Background
  - design features
  - effluent release points
  - regulatory requirements
  - NUREG-0017 and GALE
  - GALE applicability
  - theory
- Break
- Methodology
  - source terms
  - software
  - radionuclide transport
  - effluent release pathways
- Fuel failures
  - failure mechanisms
  - industry trend
  - mitigating features
- Summary
- Path forward

Purpose

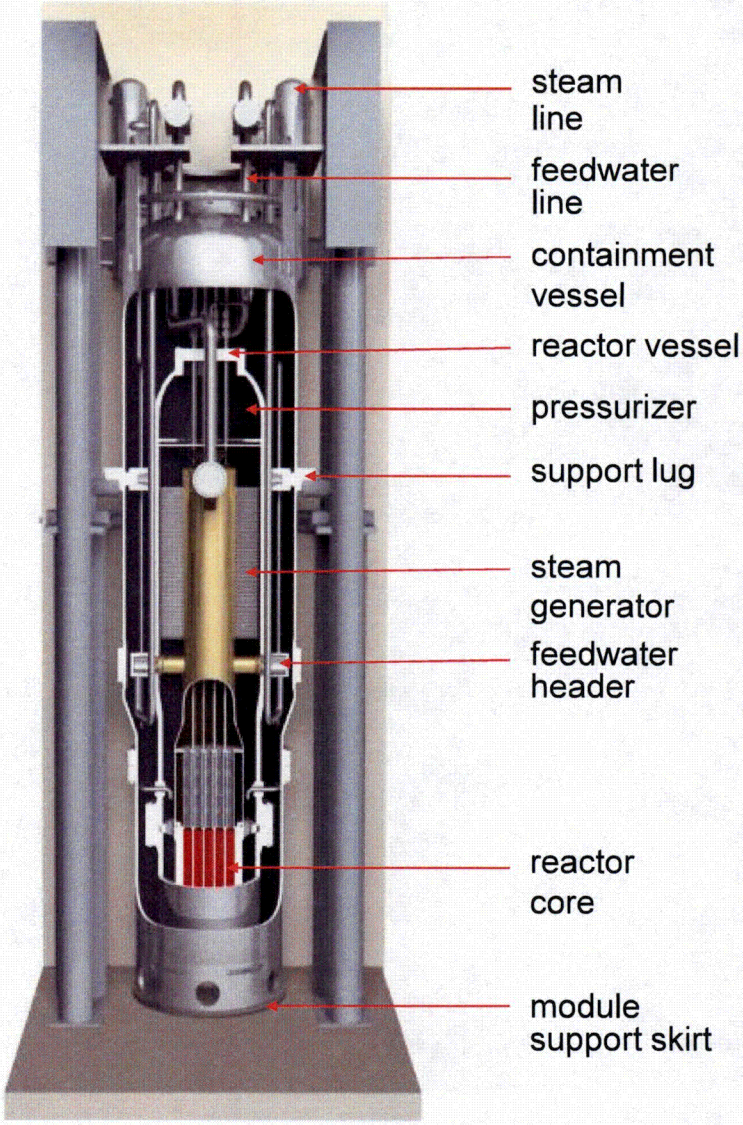
NuScale will submit a *topical report*, by the end of October 2015, on the methodology and assumptions used to conservatively estimate gaseous and liquid effluents to the environment.

The purpose of this preapplication engagement is to:

- Discuss the content and purpose of the topical report
- Discuss the similarity of the NuScale design to facilities that the NRC has reviewed and approved
- Highlight the differences in methodology between the GALE code (used by existing U.S. commercial PWRs) and NuScale
- Discuss NuScale's path forward

NuScale Design Features

- Similarities
  - reactors in a reactor building with HVAC
    - HEPA filters in HVAC for particulates
    - charcoal filters in HVAC for iodine
  - dedicated CVCS system for each module
  - secondary/turbines in a turbine building
  - common, but separate radwaste building
  - effluent release pathways
- Differences
  - large common reactor pool
  - refueling underwater directly to SFP
  - integral primary (iPWR)
  - multi-module (12 reactor modules per plant)



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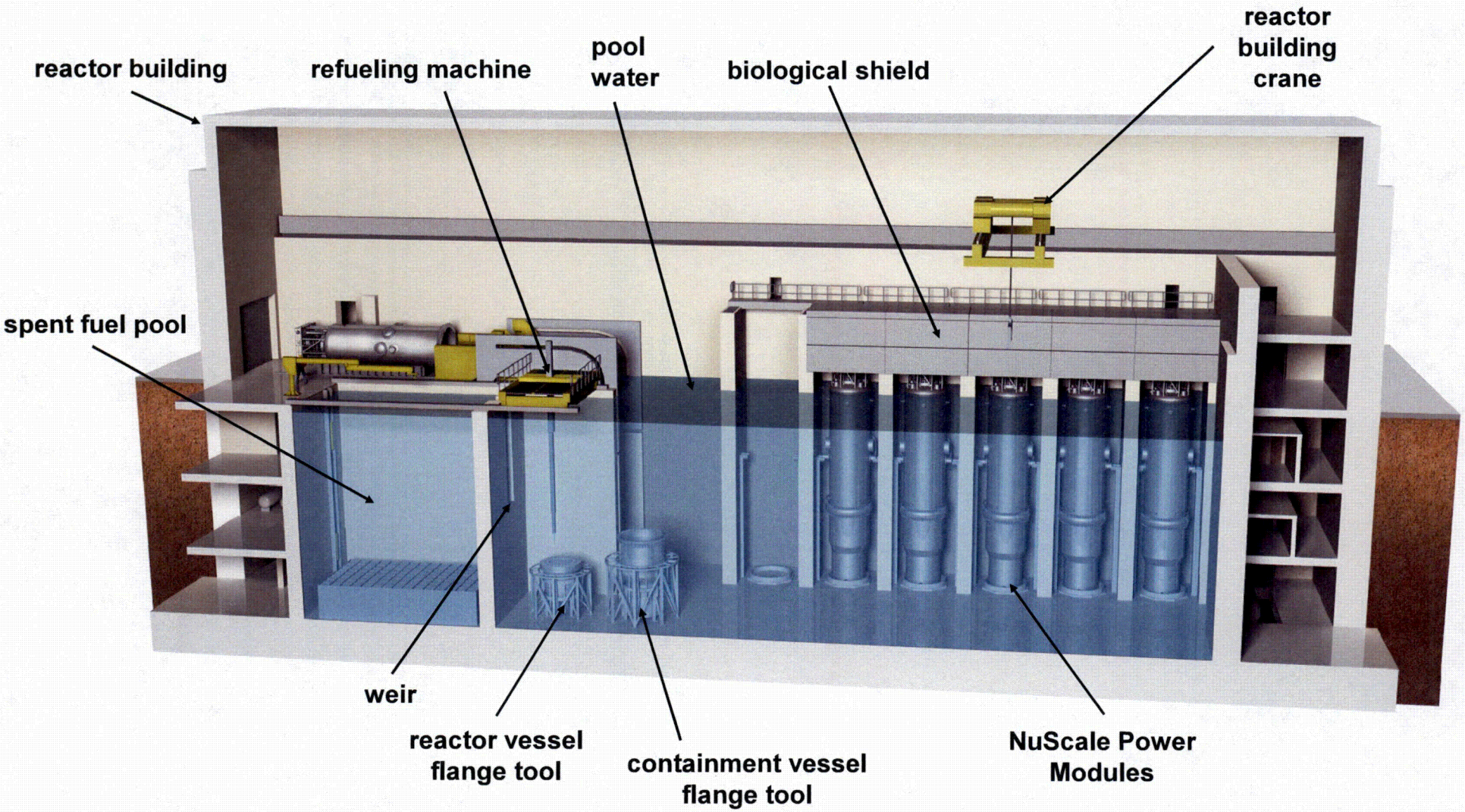
Reactor Building Elevation View



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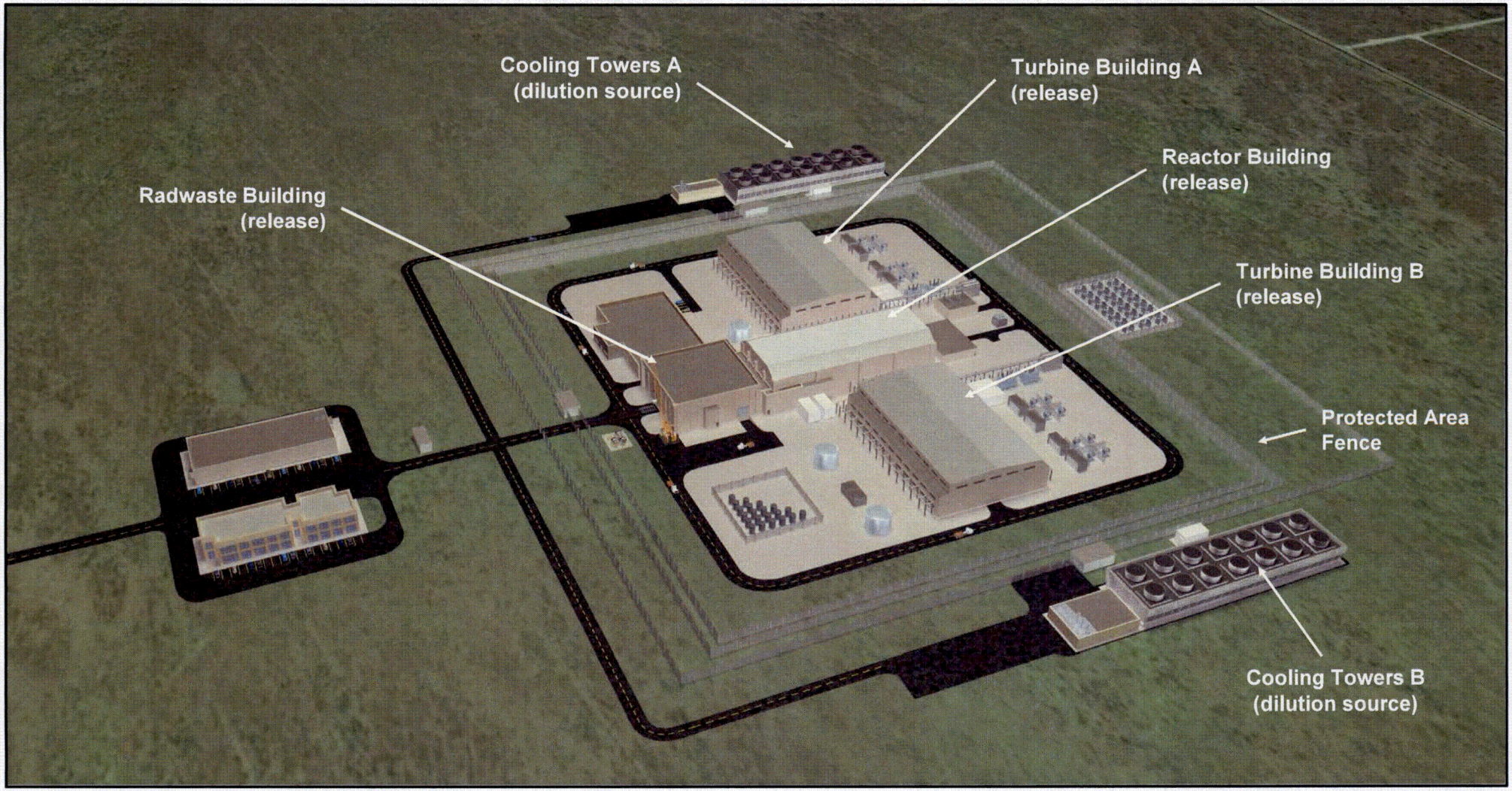
Effluent Release Points



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Regulatory Requirements

- 10 CFR 20 (radiation protection)
  - 10 CFR 20, Subpart D (public dose limits)
  - 10 CFR 20, Appendix B (effluent concentration limits)
- 10 CFR 50 (domestic licensing)
  - Appendix A (general design criteria)
  - Appendix I (public dose limits)
- 10 CFR 51 (environmental protection)
- 10 CFR 52 (design certifications)
- 40 CFR 190 (environmental protection)

Additional Guidance

- NuScale Draft DSRS (issued June 30, 2015)
  - 11.2/11.3/11.4
- Interim staff guidance
  - DC/COL-ISG-5 (calculation of routine releases)
- NUREGs
  - NUREG-0017 (calculation of releases PWR-GALE)
- Regulatory guides
  - RG 1.109 (compliance with Appendix I)
  - RG 1.112 (calculation of gaseous and liquid effluents)
  - RG 1.206 (combined license applications)
- Industry standards
  - ANSI/ANS 18.1 (normal operation source terms)

NUREG-0017 and GALE

- The PWR-GALE86 code was developed with empirical data in the 1980s for evaluation of the pressurized water reactors (PWRs) operating at that time based on NUREG-0017 methodology
- PWR-GALE08 (updated in 2008), incorporated primary and secondary coolant concentrations from ANSI/ANS 18.1-1999, but had water activation product errors
- PWR-GALE09 (updated in 2009), incorporated more recent data on capacity factors and corrected water activation product data
- Currently, NRC Office of Nuclear Regulatory Research evaluating potential iPWR-GALE code

GALE Applicability Issues

- Differences between NuScale design and traditional PWR
  - integral, helical steam generators
  - activation and evaporation from large reactor pool
- Hard-coded parameters in GALE cannot be changed to reflect NuScale
  - capacity factor and radionuclides list
- Scaling of industry data in GALE unsuitable for NuScale
  - power levels and radionuclide concentration levels
- Environmental release pathways are nearly identical

GALE Hard-Coded Parameters

- GALE incorporates
  - nuclides hard-coded, omitting environmentally mobile nuclides such as I-129 and Tc-99
  - capacity factor hard-coded

- NuScale evaluation will
  - expand nuclide list to incorporate additional nuclides
  - utilize a higher, and more appropriate, capacity factor (a higher capacity factor is more conservative also)

Scaling of Parameters

- PNNL-21386 (May 2012), Applicability of GALE86 Codes to Integral Pressurized Water Reactor Designs, states:

  "NRC staff expressed concern that there were certain limits of applicability on the parameters built into the code."

- Parameters GALE is unable to accurately scale for the NuScale design
  - thermal power
  - mass of primary coolant
  - primary system letdown rate
  - shim bleed rate

Theory

- Being unique, and first-of-a-kind, the NuScale design cannot rely on empirical effluent release data
- The NuScale methodology will use
  - first principle physics-based calculations, where appropriate
  - operational experience from recent industry, where applicable
  - lessons learned, where available
- As an example, water activation products will be estimated using:

$$RR_x = \sum_{g=1}^{G} \Phi_g \sigma_{x,g} N = \sum_{g=1}^{G} \Phi_g \Sigma_{x,g}$$

  - RR_x: number of reactions of type "x"
  - Φ_g: neutron flux in energy group "g"
  - $\sigma_{x,g}$: microscopic cross section for reaction "x" in energy group "g"
  - N: number density of target atoms
  - $\Sigma_{x,g} \equiv \sigma_{x,g}$ N: macroscopic cross section for reaction "x" in energy group "g"

Source Term Production

Contributor	Methodology
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CRUD	• Large PWR operating data • Lessons learned
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Water Activation

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Isotope	Example Production Reaction
^{3}H	$^{10}B + n \rightarrow 2\alpha + {}^{3}H$
^{14}C	$^{14}N + n \rightarrow p + {}^{14}C$
^{16}N	$^{16}O + n \rightarrow \beta^{-} + {}^{16}N$
^{41}Ar	$^{40}Ar + n \rightarrow \gamma + {}^{41}Ar$

CRUD

- NuScale evaluation of corrosion and wear activation products (CRUD) will use current large PWR operating data as a starting point and apply industry lessons learned
- ANSI/ANS 18.1-1999
  - there are no first principle physics models for CRUD generation, buildup, transport, plate-out, or solubility

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Fission Products

- Production of fission products conservatively calculated using first principle physics in SCALE 6.1 code

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- Release of fission products from fuel to primary coolant based on industry operational experience through:

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Software

- Industry standard, commercial off-the-shelf, software unmodified for NuScale use
- SCALE 6.1 (Standardized Computer Analysis for Licensing Evaluation) modular code package, will be used for analysis of source term generation
  - sequences in the TRITON and ORIGEN modules
- SCALE 6.1 will be in compliance with NQA-1 2008/2009a via commercial grade dedication under NuScale's QA program

Radionuclide Transport

- Primary
- Secondary
- Radwaste
- Reactor pool
- Airborne

Following the licensed practice of operating LWRs, NuScale liquid and airborne effluents will be diluted to ensure compliance with regulatory requirements

Primary Coolant

- Inputs
  - water activation
  - corrosion and wear product activation
  - fission products (leakage and diffusion from fuel)
- NuScale removal mechanisms

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Secondary Coolant

- Inputs
  - primary leakage from steam generators
  - water activation

- NuScale removal mechanisms

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Radwaste System

- Inputs
  - CVCS letdown
  - floor drains
  - reactor coolant drain tank
  - other contaminated waste from plant operations
  - degasifiers

- NuScale removal mechanisms

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Reactor Pool

- Inputs
  - primary coolant (post shutdown and refueling)
  - water activation

- NuScale removal mechanisms

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Airborne

- Input includes
  - reactor building pool evaporation
  - primary leakage to reactor and radwaste buildings
  - secondary releases to turbine building

- NuScale removal mechanisms

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Effluent Release Pathways

- Gaseous
  - gaseous radwaste system (decay beds)
  - reactor and radwaste buildings through HVAC
  - turbine building direct releases

- Liquid
  - controlled discharge from liquid radwaste system diluted by cooling tower blowdown

Fuel Failure Issues

- No first principle physics models (operating experience)
- Failure mechanisms
  - grid-to-rod fretting
  - debris
  - fabrication
  - pellet-cladding-interface (PCI)
  - stress corrosion cracking (SCC)
  - CRUD/corrosion

Fuel Failure Mechanisms

- PWR fuel failure mechanisms have been extensively studied over several decades with analytical and experimental data to understand the underlying causes

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References (FF Mechanisms)

- Crawford, D., LWR Fuel Performance (with Emphasis on BWR Fuel); Global Nuclear Fuel (GNF), June 3, 2009.
- IAEA, "Review of Fuel Failures in Water Cooled Reactors," IAEA, Series No. NF-T-2.1, June 2010.
- Bragg-Sitton, S., "Light Water Reactor Sustainability Program; Advanced LWR Nuclear Fuel Cladding System Development Technical Program Plan," Idaho National Library, INL/MIS-12-25696, Rev. 1, December 2012.
- American Nuclear Society, "Kurt Edsinger: EPRI and the zero fuel failures program." *Nuclear News, no. 13, Volume 53 (2010):* 40-43.

Grid-to-Rod Fretting and Debris

- Causes
  - fuel contact with (and fretting on) grid springs, dimples, flow mixing vanes, etc.
  - debris in coolant fretting on rods

- NuScale design mitigation

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Fabrication

- Causes
  - manufacturing defects

- NuScale design mitigation

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PCI and SCC

- Causes
  - pellet-cladding-interface (PCI) mechanical contact stresses
  - stress corrosion cracking (SCC) from fission product interaction with inner fuel rod walls

- NuScale design mitigation

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Corrosion

- Causes
  - hydrogen absorption embrittlement
  - oxide formation associated with coolant chemistry and impurities

- NuScale design mitigation

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U.S. PWR Fuel Failure Trend

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+ AER ⁎ GNF ■ EPRI ◎ DOE △ IAEA —Average Fuel Failure Fit ◆ NRC

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References (Fuel Failure Trend)

- Garzarolli, F., R. von Jan, and H. Stehle, "The Main Causes of Fuel Element Failure in Water-Cooled Reactors," Atomic Energy Review (AER), 1979.
- Crawford, D., LWR Fuel Performance (with Emphasis on BWR Fuel); Global Nuclear Fuel (GNF), June 3, 2009.
- Electric Power Research Institute, "The Path to Zero Defects: EPRI Fuel Reliability Guidelines," (EPRI), 2008.
- International Atomic Energy Agency, "Fuel Failure in Normal Operation of Water Reactors: Experience, Mechanisms and Management," (IAEA), June 1993.
- International Atomic Energy Agency, "Review of Fuel Failures in Water Cooled Reactors," (IAEA), Series No. NF-T-2.1, June 2010.
- Bragg-Sitton, S., "Light Water Reactor Sustainability Program; Advanced LWR Nuclear Fuel Cladding System Development Technical Program Plan," Idaho National Library, (DOE) INL/MIS-12-25696, Rev. 1, December 2012.
- U.S. Nuclear Regulatory Commission (NRC), "Nuclear Fuel Performance," Office of Nuclear Regulatory Research and Office of Nuclear Reactor Regulation Presentation, February 24, 2005, Agencywide Document Access and Management System (ADAMS) Accession No. ML050560020.

U.S. PWR Fuel Failure Trend*

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U.S. Reactors with Zero Fuel Failures

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NuScale Fuel Failure Assumption

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Summary

- NuScale design similar to large PWRs
- GALE cannot accurately estimate NuScale releases, making an alternate methodology necessary
- NuScale will use a methodology that is realistic, yet conservative, using *first principle physics*, *recent nuclear operational experience*, and *lessons learned*
- Industry trend shows long-term (continuing) improvement in fuel failure fraction
- NuScale design mitigates fuel failure mechanisms, which should improve fuel performance

Path Forward

- NuScale will submit a topical report (October 30, 2015) describing this methodology
- NuScale requests NRC feedback regarding this methodology
- Meeting with NuScale and AREVA (September 9, 2015) will provide further details on fuel design

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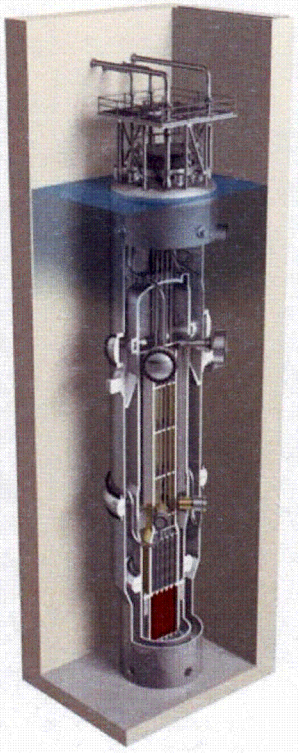

Enclosure 3:

Affidavit, AF-0715-16230

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AFFIDAVIT of Thomas A. Bergman

STATE OF OREGON

CITY OF CORVALLIS

I, Thomas A. Bergman, state as follows:

(1) I am the Vice President of Regulatory Affairs of NuScale Power, LLC (NuScale), and as such I am authorized to apply for withholding of information transmitted with this letter from public disclosure and to execute this affidavit on behalf of NuScale.

(2) I am knowledgeable of the criteria and procedures used by NuScale in designating confidential commercial information as proprietary and have been specifically delegated the function of reviewing the information described in this affidavit that NuScale seeks to have withheld from public inspection.

(3) The harm that would result if the information sought to be withheld is disclosed to the public is as follows:

(a) The presentation discloses information about the processes, methods, or other trade secrets by which NuScale develops normal operation radiological releases (effluents) in order to demonstrate compliance with appropriate regulations. NuScale has performed significant research and evaluation to develop a basis for these processes, components, structures, tools, methods, or other trade secrets and has invested significant human and financial resources in such development.

(b) NuScale's unique process, method, or other trade secrets provide NuScale with a competitive economic advantage over other companies. Public disclosure of the information would cause substantial harm to NuScale's competitive position and reduce or foreclose opportunities for NuScale to generate a return on its investment in research and development. Although the exact financial value of the information is difficult to quantify, it is a key element of the design basis for a NuScale plant and, therefore, has substantial value to NuScale.

(c) If the information were disclosed to the public, NuScale's competitors would have access to the information without having been required to undertake a similar expenditure of resources. Such disclosure would constitute a misappropriation of NuScale's intellectual property, would unfairly provide NuScale's competitors with a windfall, and would deprive NuScale of the opportunity to seek an adequate return on its investment.

(4) The information sought to be withheld is contained in the enclosed presentation scheduled for August 20, 2015 entitled "NuScale Effluent Release (GALE Replacement) Methodology". The enclosure contains the designation "NuScale Confidential - Proprietary Class 2" at the top of each page containing proprietary information. The information considered by NuScale to be proprietary is identified within double braces, "{{ }}" in the document.

(5) The basis for proposing that the information be withheld is that NuScale treats the information as trade secrets and commercial or financial information that are privileged and confidential. NuScale relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC § 552(b)(4), as well as exemptions applicable to the NRC under 10 CFR §§ 2.390(a)(4) and 9.17(a)(4).

(6) With respect to the considerations set forth in 10 CFR § 2.390(b)(4):

(a) The information sought to be withheld has been held in confidence by NuScale.

(b) The information is of a sort customarily held in confidence by NuScale and, to the best of my knowledge and belief, consistently has been held in confidence by NuScale. The procedure for approval of external release of such information typically requires review by the staff manager, project manager, chief technology officer or other equivalent authority, or the manager of the cognizant marketing function (or his delegate), for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside NuScale are limited to regulatory bodies, customers and potential customers and their agents, suppliers, licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or contractual agreements to maintain confidentiality.

(c) The information is being transmitted to and received by the NRC in confidence.

(d) No public disclosure of the information has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or contractual agreements that provide for maintenance of the information in confidence.

(e) Public disclosure of the information is likely to cause substantial harm to the competitive position of NuScale, taking into account the value of the information to NuScale, the amount of effort and money expended by NuScale in developing the information, and the difficulty others would have in acquiring or duplicating the information. The information sought to be withheld is part of NuScale's technology that provides NuScale with a competitive advantage over other firms in the industry. NuScale has invested significant human and financial capital in developing this technology and NuScale believes it would difficult for others to duplicate the technology without access to the information sought to be withheld.

I declare under penalty of perjury that the foregoing is true and correct. Executed on 8/4/2015.

Thomas A. Bergman