Update to NuScale's SSC Classification Process

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Acknowledgement and Disclaimer

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Outline

- NuScale Overview (from master marketing slide deck)
- Background / Business Need
- Regulatory Guidance and Standards
- Key Terms and Definitions
- SSC Classification and D-RAP Process Overview
- RIPB Element: Defense-in-Depth
- RIPB Element: Performance-Based Decision Making
- Augment Requirements / Special Treatment
- Summary and Conclusions

Artistic concept of the NuScale Power Plant

NuScale's Mission

NuScale Power provides scalable advanced nuclear technology for the production of electricity, heat, and clean water to **improve the quality of life for people around the world.**

We will achieve this mission by providing technology that is:

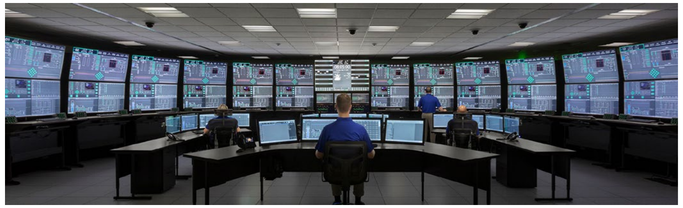
- SMARTER
- CLEANER
- SAFER
- COST COMPETITIVE

Who is NuScale Power?

- NuScale Power was formed in 2007 for the sole purpose of completing the design and commercializing a small modular reactor (SMR) – the NuScale Power Module™
- Initial concept was in development and testing since the 2000 U.S. Department of Energy (DOE) MASLWR program
- Fluor, global engineering and construction company, became lead investor in 2011
    - In 2013, NuScale won a competitive U.S. DOE Funding Opportunity for matching funds, and has been awarded over $400M in DOE funding since then
- >560 patents granted or pending in nearly 20 countries
- >400 employees in 5 offices in the U.S. and 1 office in the U.K.
- Rigorous design review by the U.S. Nuclear Regulatory Commission (NRC)—NuScale received Design Approval in August 2020
- Total investment in NuScale to date is greater than US$1B

NuScale Engineering Offices Corvallis

One-third Scale NIST-2 Test Facility



NuScale Control Room Simulator

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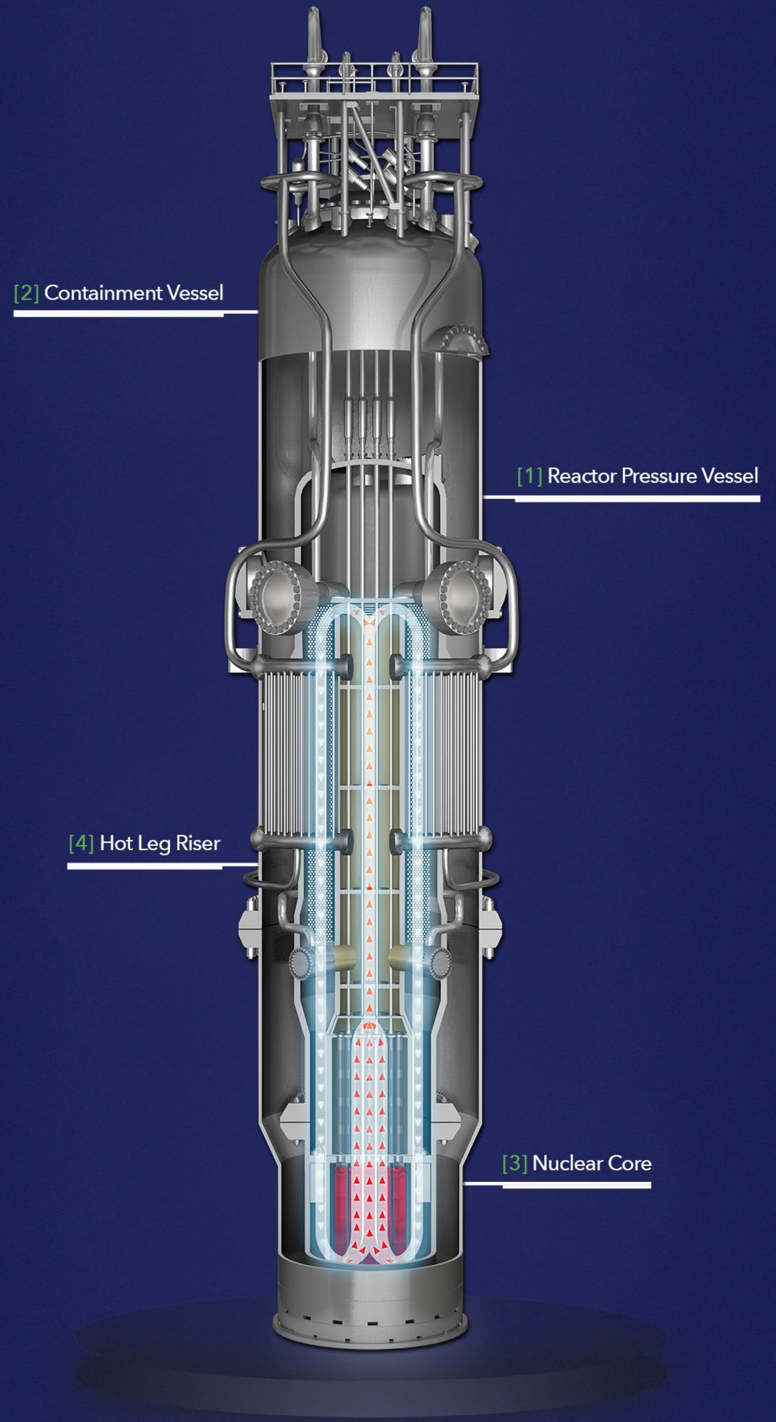
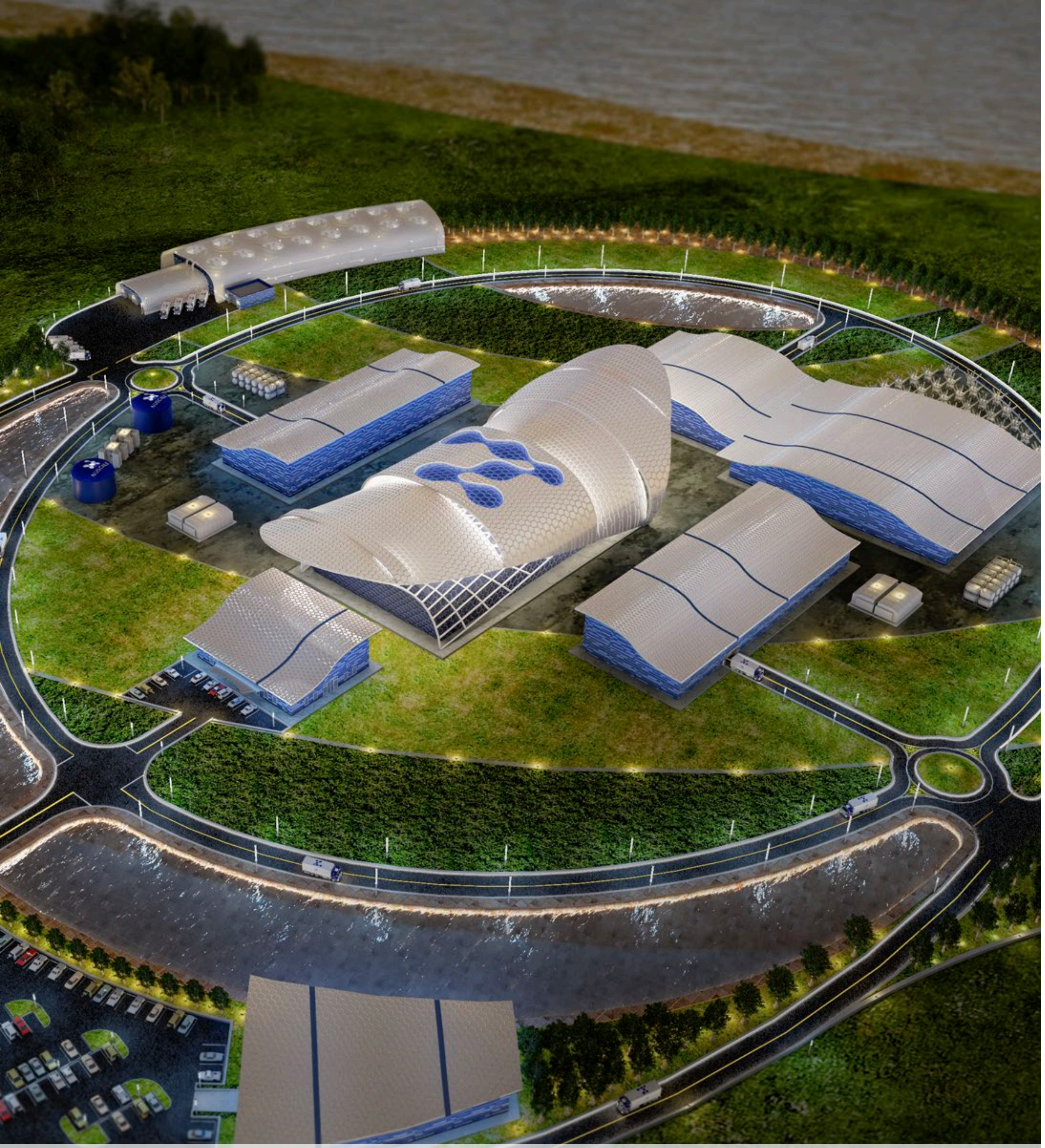


Core Technology: NuScale Power Module™

- A NuScale Power Module™ (NPM) includes the reactor vessel, steam generators, pressurizer, and containment in an integral package – simple design that eliminates reactor coolant pumps, large bore piping and other systems and components found in conventional reactors
- Each module produces up to 77 MWe
  - Small enough to be factory built for easy transport and installation
  - Dedicated power conversion system for flexible, independent operation
- Modules are incrementally added to match load growth
  - Up to 12 modules for 924 MWe gross output
  - Smaller power plant solutions available for 4-module (308 MWe) and 6-module (462 MWe) plants

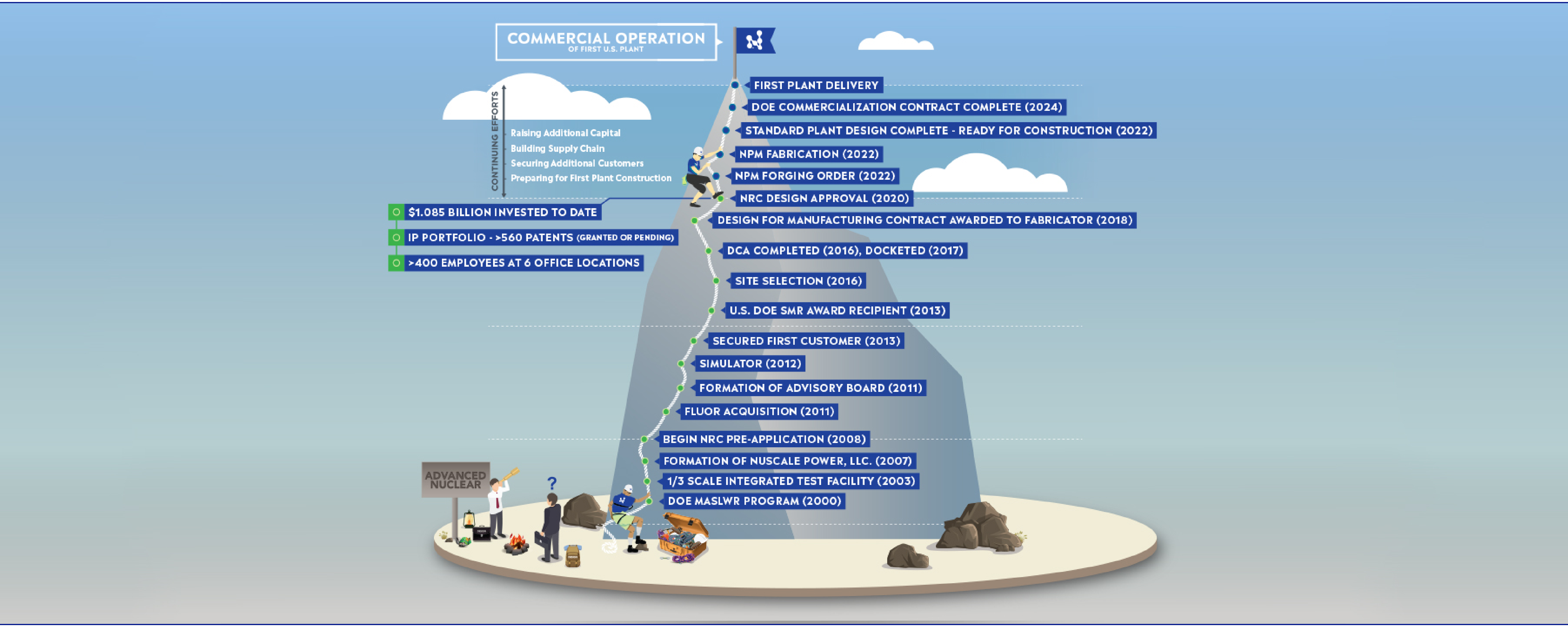


Artistic concept of the NuScale Power Plant

NuScale Product Offerings

- Reference plant design
  - Scalable 12-NPM, 924 MWe power plant
  - Design approved by US NRC in August 2020
- Smaller power plant solutions
  - Scalable 4-NPM, 308 MWe power plant
  - Scalable 6-NPM, 462 MWe power plant
  - All features and capabilities of reference plant
- Micro-reactor concepts
  - 10-50 MWe Micro-NPM
  - 1-10 MWe Heat Pipe Reactor
- Research & Development
  - Numerous design improvements identified and in development

Blazing the Trail to Commercialization



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Background and Business Need for SSC Classification Update

- Initial SSC Classification performed in 2015 and 2016 in support of the design certification application (DCA)
  - Provided information for the SSC Classification, Reliability Assurance Program, and Regulatory Treatment of Non-Safety Systems sections of the DCA
  - NuScale was responsible for all design detail regarding SSCs
  - System function categorization, SSC Classification, and D-RAP expert panel review were highly integrated
- Introduction of strategic partners to perform detailed design introduced communication and division of responsibility challenges
  - Who determines the design solution for components, based on the system requirements?
- Pursued solution includes:
  - Separating system function categorization and component classification
  - D-RAP expert panel reviews system functions, then component classification is done through procedural requirements and guidance
  - Then the D-RAP expert panel reviews the compiled list of component classifications to ensure system function categorizations were decomposed properly

Regulatory Guidance and Standards

- U.S. Nuclear Regulatory Commission, “Reliability Assurance Program,” NUREG-0800, Chapter 17.4, Rev. 1.
- U.S. Nuclear Regulatory Commission, “Regulatory Treatment of Non-Safety Systems for Passive Advanced Light Water Reactors,” NUREG-0800, Chapter 19.3, Rev. 0, June 2014.
- American Society of Mechanical Engineers/American Nuclear Society, “Safety and Pressure Integrity Classification Criteria for Light Water Reactors,” ANSI/ANS-58.14-2011, New York, NY.
- U.S. Nuclear Regulatory Commission, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” Regulatory Guide 1.26, Rev. 5, February 2017 . Current revision is 5, Feb 2017. Rev 6 pending.
- U.S. Nuclear Regulatory Commission, “Seismic Design Classification” Regulatory Guide 1.29, Rev. 5, July 2016.

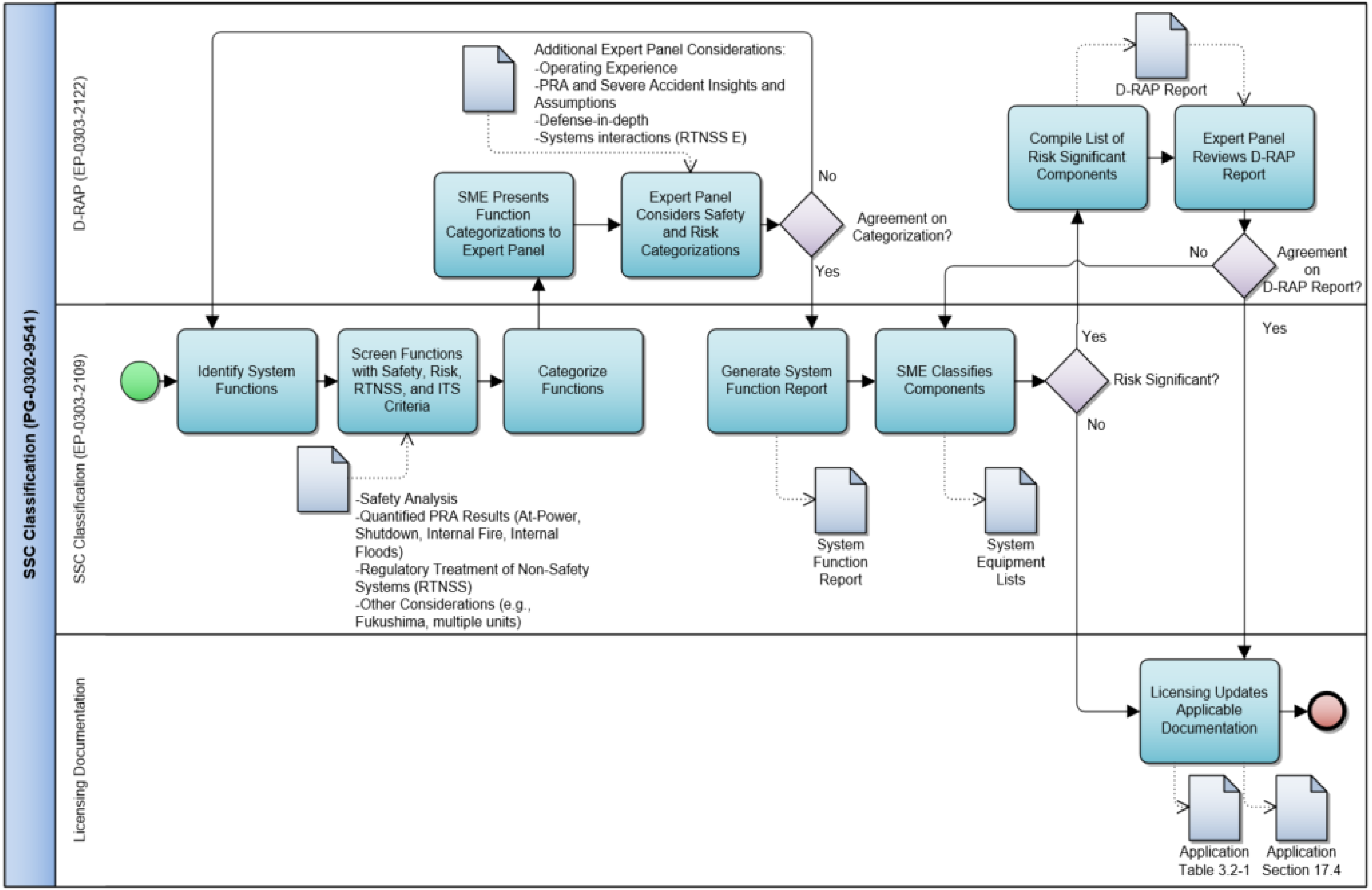
Key Terms and Definitions

- Categorization – Grouping of system functions into categories to differentiate the functional role in supporting the safety analysis (safety-related), or the probabilistic risk assessment (risk-significant) for the NuScale design.
- Classification – Grouping of SSCs into categories based predominantly on the categories of the system functions that the SSC supports. Component-level PRA may deter a component classification from following the categorization of the system function it supports.
- Defense-in-depth – A hierarchical deployment of different levels of diverse equipment and procedures to prevent the escalation of anticipated operational occurrences and to maintain the effectiveness of physical barriers placed between a radiation source or radioactive material and workers, members of the public or the environment, in operational states and, for some barriers, in accident conditions.
- Nonsafety-related with augmented requirements – Classification applied to an item that is not safety-related but that is relied upon during a special event or to which a licensing requirement or commitment applies.
- Plant capability defense-in-depth – Defense-in-depth measures incorporated into the physical plant such as multiple fission product barriers, diverse and redundant SSCs to protect fission product barriers, conservative design principles, industry codes and standards, and other physical, tangible design elements to protect public health and safety.

Key Terms and Definitions (cont.)

- Performance based – An approach to design or regulation that relies upon the desired, measurable results or performance outcomes based on objective criteria rather than a prescriptive process, technique, or procedure.
- Reliability assurance program (RAP) – The RAP applies to those SSCs that are identified as being significant contributors to plant safety as determined by using probabilistic/PRA, deterministic, or other methods of analysis, including information obtained from sources such as the plant- and site-specific PRA, industry operating experience, regulatory treatment of nonsafety-systems (RTNSS) considerations, and expert panels.
- Risk-informed performance-based (RIPB) – Process in which risk insights, engineering analysis and judgment including the principle of defense-in-depth (DID) and the incorporation of safety margins, and performance history are used, to: (1) focus attention on the most important activities, (2) establish objective criteria for evaluating performance, (3) develop measurable or calculable parameters for monitoring system and licensee performance, (4) provide flexibility to determine how to meet the established performance criteria in a way that will encourage and reward improved outcomes, and (5) focus on the results as the primary basis for decision-making.
- Risk-significant equipment – An SSC that contributes significantly to risk or could contribute significantly if it were to degrade in reliability.
- Regulatory treatment of nonsafety-systems (RTNSS) – Guidance provided as to the treatment of system functions and SSCs that meet the criteria established in Section 19.3 of NUREG-0800

SSC Classification and D-RAP Process Overview



Categorization of system functions:

A1 = safety-related, risk-significant.

A2 = safety-related, not risk-significant.

B1 = nonsafety-related, risk-significant.

B2 = nonsafety-related, not risk-significant.

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RIPB Element: Defense-in-Depth (DID)

- **DID adequacy evaluations**
  - The DID approach shall contribute specific requirements to reactor design and operations, as determined by the SME and reviewed by the D-RAP Expert Panel.
  - For each SSC presented to the Expert Panel in the D-RAP list, the functional and performance criteria shall be clearly identified.
  - The Expert Panel shall perform a DID adequacy evaluation to ensure the collection of SSCs in the D-RAP summary report and D-RAP list provides multiple layers of defense in response to internal and external initiating events.
- **Consideration of SSC Classification**
  - In the formulation of SSC performance requirements, it's important to understand the role of SSCs modeled in the PRA in the prevention and mitigation of initiating events and event sequences.
- **Programmatic Actions for Reasonable Assurance of DID**
  - Programmatic controls that ensure the risk insights and key assumptions are consistent with the plant design and construction shall be implemented.
  - These programmatic controls address organization responsibilities, design control activities, procedures and instructions, records, corrective action and assessment plans.
  - These controls provide adequate assurance that the risk, reliability, and performance targets will be met and maintained throughout the life of the plant with adequate consideration of sources of uncertainties.

RIPB Element: Performance-Based Decision Making

- Decision making during Expert Panel deliberations should be based on criteria specified at the highest level that is feasible to meet functional objectives.
- This enables maximum flexibility for realizing successful system performance.
- The performance-based decision process should have the following characteristics:
  - objective criteria to assess performance based on risk insights, deterministic analyses, and/or performance history
  - quantitative and qualitative RIPB decision criteria to support transparent and repeatable decisions
  - recognition of different levels and types of DID when considering alternatives, including evaluation of safety margins
  - evaluation of tradeoffs on plant capital and operation cost versus risk reduction
  - adequate treatment of uncertainties in the PRA results and the impact of these uncertainties on the decision-making process

Nonsafety Related Augmented Requirements (NSRAR)

NSRAR Basis

Background

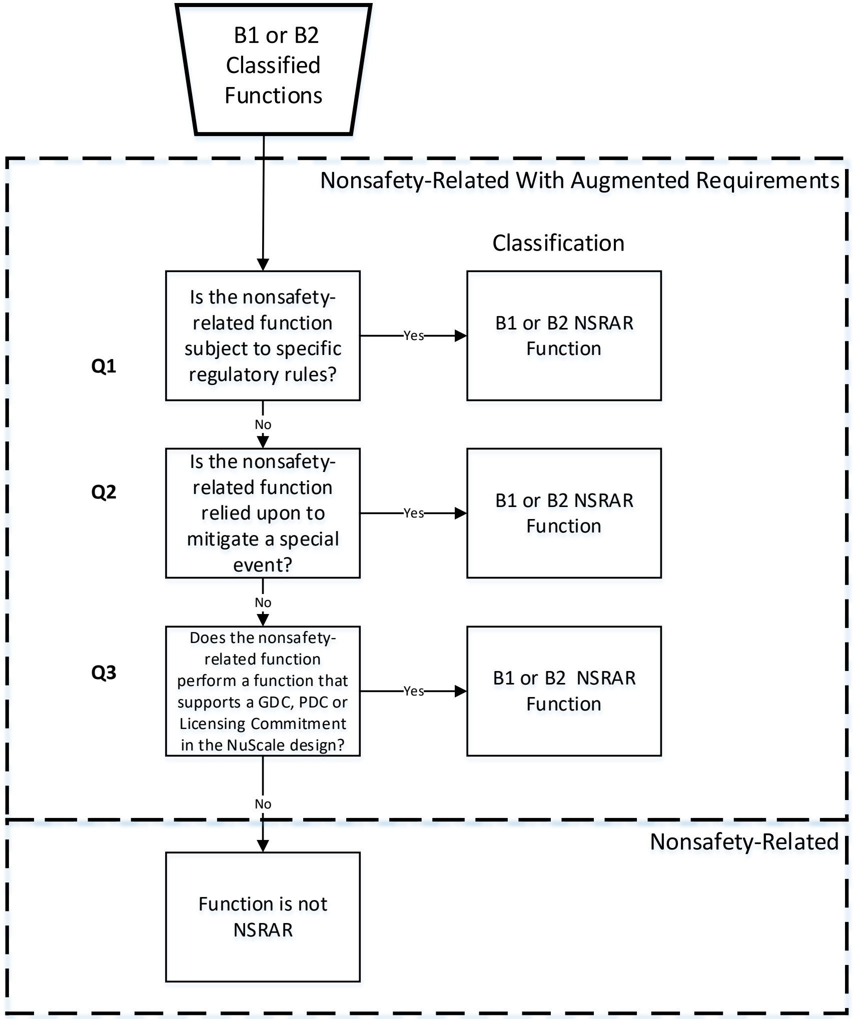
- GL 84-01
- SECY-85-119
- SECY-85-119 SRM
- SECY-86-164
- SECY-86-164 SRM

References

- ANSI/ANS 58.14 2011 (R2017)
- ANS 30.3
- EPRI NP-6895

Benchmarking

NSRAR Criteria



NSRAR List Creation

- Screen the previous list against formalized criteria.
- Capture a basis for each function categorized as NSRAR.
- Multi-disciplinary iterative approach was conducted with SME, stakeholders and management.

End Result

- NSRAR list represents a rigorously created list of functions develop with a formalized criteria.
- Represents the approved list of NSRAR functions with basis and approved design augmentations.
- Deviations not allowed without a procedure change. The NSRAR screening process is describe in detail allowing for a strong questioning attitude and basis for NSRAR function addition.
- Enhances accessibility of NuScale Design and Licensing basis to outside stakeholders.

Summary and Conclusions

- Commercialization
  - NuScale continues to blaze a trail of bringing our innovative SMR to market by the late 2020s.
  - Cutting edge R&D and work with micro-reactors parallels the core business model.
- Classification Process
  - While the SSC/D-RAP Classification was robust and acceptable for the NRC DCA submittal it created challenges towards commercialization as it lacked practical application as divisions of responsibilities were not clearly defined across the participating members of design and construction.
  - The challenges were addressed by identifying process boundaries that aligned with the division of responsibilities across the participating members. This split the D-RAP expert panel review into two parts: initial system function categorization review, and component classification verification.
- DID
  - Guidance is consistent with pending ANS 30.3 methodology
  - Includes both qualitative and quantitative RIPB criteria which enables maximum flexibility for realizing successful system performance
- Special Treatment
  - Augmented requirements are now streamlined and defendable as they provide a clear basis along with programmatic guidelines for implementation that drives consistency of application.

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