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Enclosure:

"ACRS NuScale Subcommittee Presentation: NuScale Topical Report, NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces," PM-0819-66620, Revision 0

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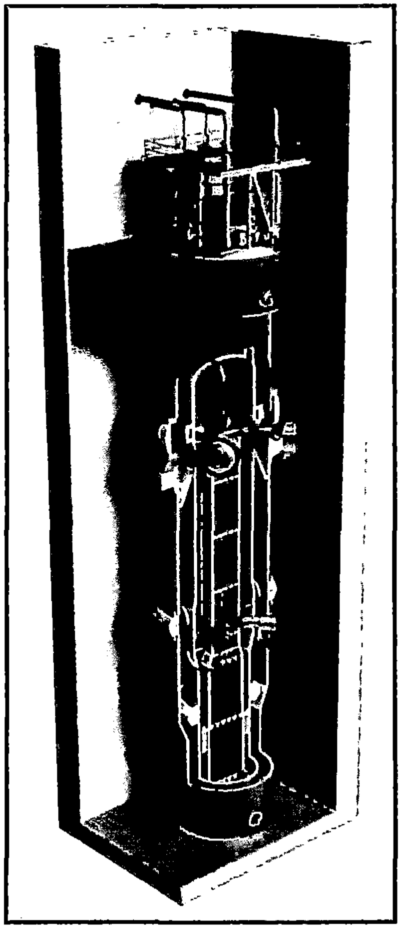
ACRS Subcommittee Presentation



NuScale Topical Report

NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces

OPEN SESSION

August 20, 2019

PM-0819-66620
Revision: 0

Template #: 0000-21727-F01 R5

Presenters

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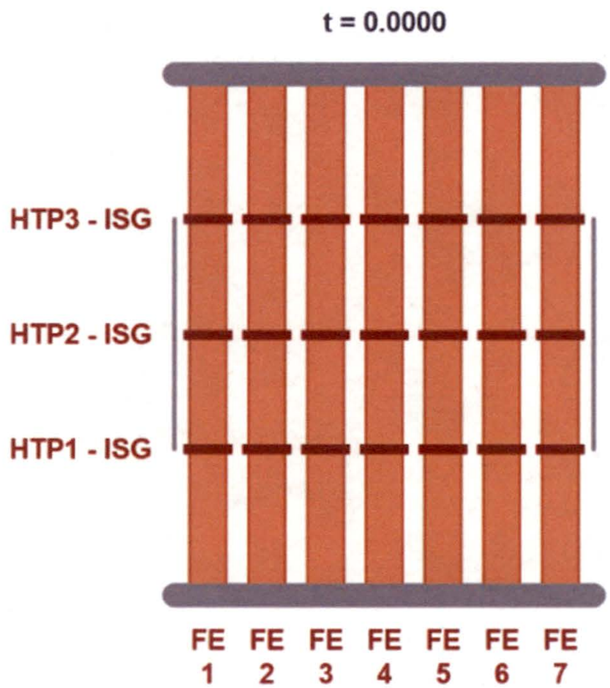
Agenda

- Overview of ANP-10337PA
- Scope of Generic Applicability of ANP-10337PA
- NuFuel-HTP2^{TM} Design Overview
- Process to Assess Applicability to NuScale
- Relevant Points from NuScale Applicability Review
- Conclusions

Overview of ANP-10337PA

- Fundamental Focus: Evaluation of fuel safety functions during earthquakes and pipe breaks.



Note: Deflections from this simulation were amplified for this animation.

- Simulations evaluate impact loads at grid locations and stresses in fuel assembly components.

Overview of ANP-10337PA

Regulatory Criteria and Guidance

Regulatory Criteria (10 CFR)

- 10 CFR Part 50, Appendix A
- 10 CFR Part 50, Appendix S
- 10 CFR Part 50.46

Regulatory Guidance

- SRP 4.2, Appendix A

1) Coolable Geometry

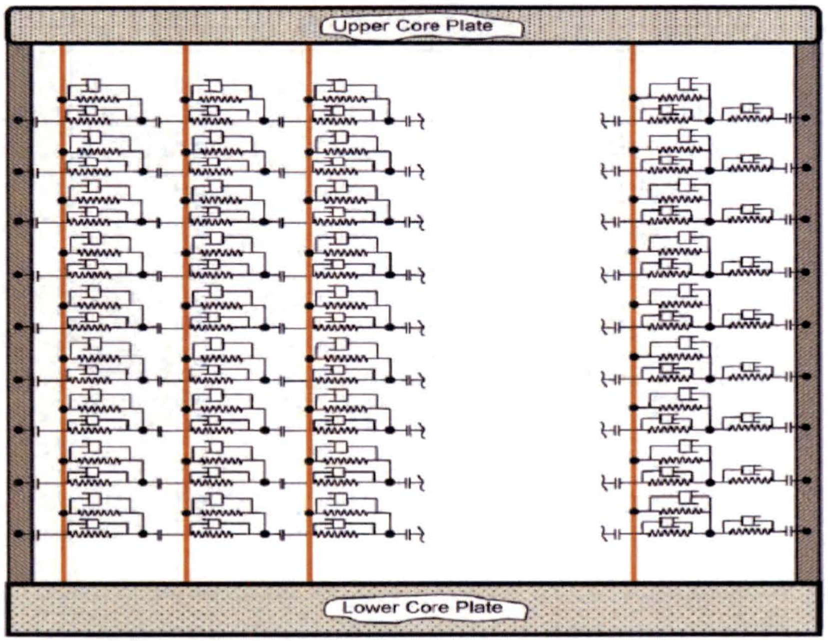
2) Control Rod Insertability

3) Fuel Rod Integrity

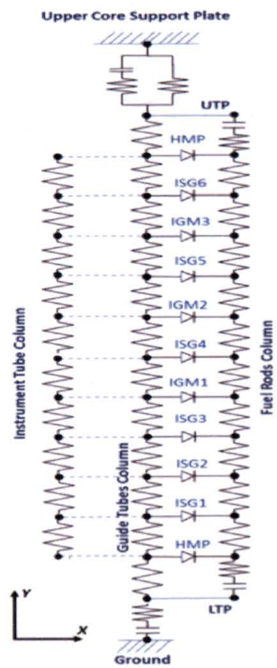
Overview of ANP-10337PA

- "Time History" inputs at the core boundaries are applied as sources of excitation
  - Derived from upstream models of reactor vessel internals

Lateral Schematic



Vertical Schematic



Overview of ANP-10337PA

- Fuel is represented using simple and generic structural models.
- Model parameters definition:
  - Most parameters are based directly on information from design documents (geometry, material properties, etc.)
  - Some model parameters are based on design-specific characterization testing
    - The full ANP-10337PA characterization protocol has been applied to NuScale
    - An NRC audit was performed during part of the NuScale testing
  - Parameters accounting for fluid effects (added mass, coupling mass, and fluid damping) are defined independent of design

Modeling is Largely Transparent to Fuel Designs

Overview of ANP-10337PA

Original Applicability

- Intended to be generically applicable to PWR designs
  - PWR fuel designs share the same basic construction, thus allowing a simple, generic, structural representation
  - PWR operating environments are all very similar
- One criteria is noted for applicability
  - Verification of modeling assumption to represent the impact behavior of spacer grids
    - NuScale uses the exact same spacer grid demonstrated in the ANP-10337PA sample problem
- Limitations & Conditions were imposed through the SER and these will be reviewed later

Requests for Additional Information

- RAI 9555 requests that L&Cs from ANP-10337PA be addressed
- The SER for ANP-10337PA imposes nine L&Cs:

#1: Demonstration of critical grid behavior from dynamic impact testing.

#2: Limits on maximum allowable spacer grid deformation.

#3: Defines controls and quality requirements on engineering software used to implement ANP-10337PA.

#4: Limits use to applications consistent with operating fleet.

#5: Limits applicability of lateral damping values to existing fuel designs.

#6: Requires a fuel rod stress assessment under faulted conditions.

#7: Requires the use of most limiting stress criteria when bounding analyses are performed for rodded and non-rodded core locations.

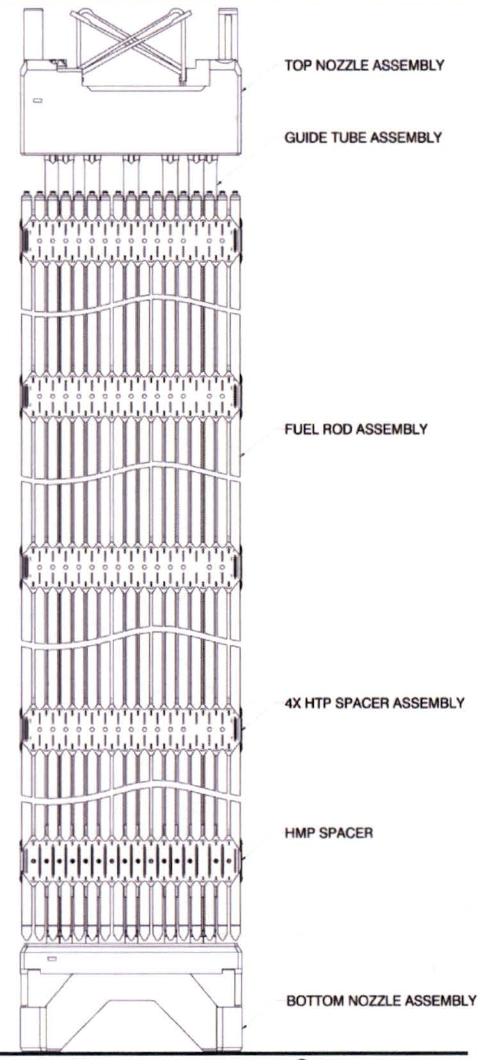
#8: Specifies that a 3-D combination of loads should be considered for non-grid components.

#9: Limitation in applicability of spacer grid impact modeling.

NuFuel-HTP2™ Design Overview

- NuFuel-HTP2™ based on Framatome's proven US 17x17 PWR technology
- NuFuel-HTP2™ design features
  - Four Zircaloy-4 HTP™ upper and intermediate spacer grids
  - Inconel 718 HMP™ lower spacer grid
  - Mesh filter plate on bottom nozzle
  - Zircaloy-4 MONOBLOC™ guide tubes
  - Quick-disconnect top nozzle
  - Alloy M5® fuel rod cladding

>>Proven features with US Operating Experience



Design Comparison
NuFuel-HTP2™ vs Framatome 17x17

Parameter	NuFuel-HTP2™ Fuel Design	Framatome 17x17 PWR
Fuel rod array	17 x 17	17 x 17
Fuel rod pitch (inch)	0.496	0.496
Fuel assembly pitch (inch)	8.466	8.466
Fuel assembly height (inch)	**94**	**160**
Spacer grid span length (inch)	20.1	20.6
Number of guide tubes per bundle	24	24
Dashpot region ID (inch)	0.397	0.397
Dashpot region OD (inch)	0.482	0.482
ID above transition (inch)	0.450	0.450
OD above transition (inch)	0.482	0.482
Number of fuel rods per bundle	264	264
Cladding OD (inch)	0.374	0.374
Cladding ID (inch)	0.326	0.326
Length of total active fuel stack (inch)	78.74	144
Fuel pellet OD (inch)	0.3195	0.3195
Fuel pellet theoretical density (%)	96	96

Operating Parameter Comparison
NuScale vs Framatome 17x17

Parameter	NuScale Design Value	Framatome 17x17 PWR Value
Rated Thermal Power (MWt)	160	3455
System Pressure (psia)	1850	2280
Core Inlet Temperature (F)	503	547
Core Tave (F)	547	584
Average Coolant Velocity (ft/s)	**3.1**	**16**
Core Average Re Number	**76,000**	**468,000**
Linear Heat Rate (kW/ft)	2.5	5.5
Fuel Assemblies in Core	37	193
Fuel Assembly Loading (KgU)	249	455
Core Loading (KgU)	9,213	87,815
Nominal Cycle Length (EFPD)	694	520
Maximum Fuel Assembly Discharge Burnup (GWd/mtU)	<50	>50

Process to Assess Applicability

1) Review regulatory criteria for NuScale fuel design
   - Same framework as ANP-10337PA
2) Comparison of parameters that are important to seismic/LOCA response (NuScale vs. Existing PWRs)
   - Fuel Assembly Length
   - Number of spacer grids
   - Coolant flow
3) Detailed review of ANP-10337PA content, including SER L&Cs, with consideration to differences

*The applicability topical is structured around a chapter-by-chapter review of ANP-10337PA

Relevant Points from the Review

Issue #1: Does the model architecture and characterization testing protocol from ANP-10337PA adequately represent the NuScale fuel design with shorter length and fewer spacer grids?

"Yes. No modifications are needed."

Issue #2: ANP-10337PA establishes lateral fuel assembly damping parameters that credit flow rates typical for existing PWRs. Are these values valid in the NuScale design?

"No. NuScale-specific damping values are derived."

Issue #3: RAI 9225 questions the need for evaluation of the fuel during refueling, specifically, while it is stored in the Reactor Flange Tool (RFT).

"An analysis is performed for the RFT using ANP-10337PA."

Conclusions

ANP-10337PA defines a methodology that is applicable to NuScale with the following modifications:

- Fuel assembly damping values specific to the NuScale design
- An additional seismic evaluation in which the core is residing in the Reactor Flange Tool (RFT)

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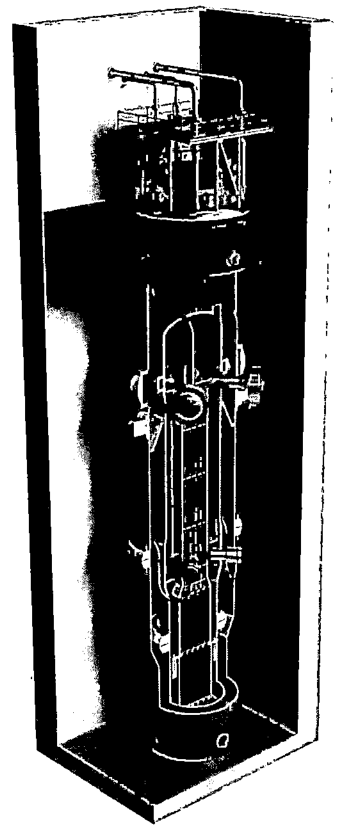

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