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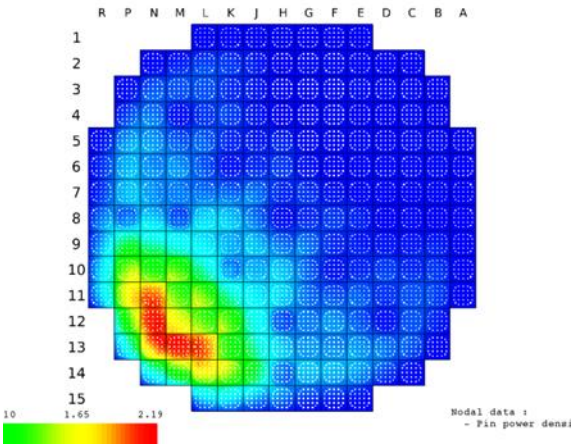
AREA

A 3D Transient Coupled Control Rod Ejection Analysis Methodology

Addresses regulatory criteria while improving margin

Challenge

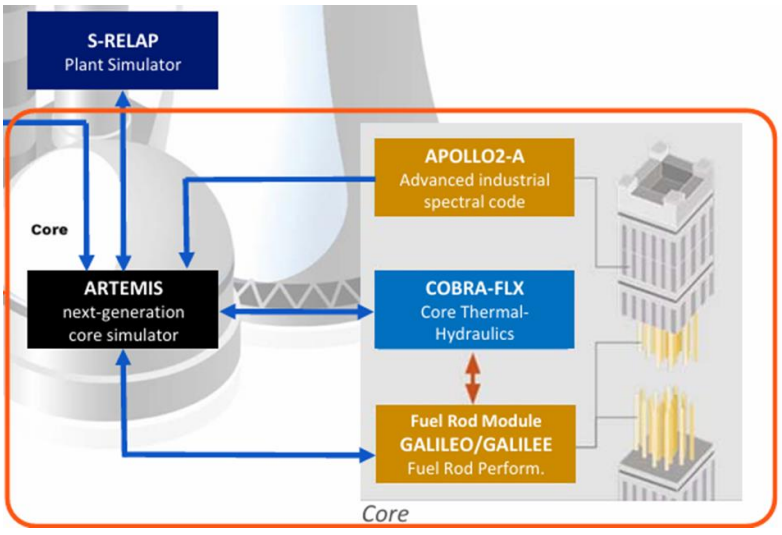
The AREA methodology was developed in response to evolving regulatory criteria, currently contained in Regulatory Guide 1.236. Legacy processes struggled to adequately capture key phenomena for this event and produce a thorough evaluation to evaluate the new criteria. Implementation of new criteria without significant changes to codes and methods would result in a severe penalty to safety analysis margins and plant operational limits.



Solution

Framatome's US NRC-approved AREA methodology introduces an evaluation model, coupling the core simulator with thermal-hydraulic and fuel rod models. The AREA methodology also contains a core and system evaluation model for the overpressure event.

This coupled modeling brings substantial margin through accurate modeling and simulation of the overall transient progression while addressing the regulatory criteria.



Customer benefits

- Addresses Emergent Regulatory Criteria
- Provides industry leading safety analysis margins to benefit:
  - Operational Margins
  - Operating Flexibility
  - Cycle Economics
- Improves understanding of plant behavior
- Removes obstacles to significant economic performance improvement initiatives
- Includes cutting-edge ARCADIA code package

Key figures

50% typical reduction in energy deposition from transition to AREA methodology from legacy methods

>1 million fuel rod axial segments analyzed with AREA rod ejection transient model

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Your performance
is **our** everyday **commitment**

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Technical Information

In the guidance for PWR Rod Ejection Accidents the NRC has laid out several new areas for analyses to address. Framatome's AREA method addresses all areas of concern.

Methods and Models

- NRC approved evaluation model
- Coupled analysis model
- Accounts for design specific information
- Accounts for burnup effects

Initial Conditions

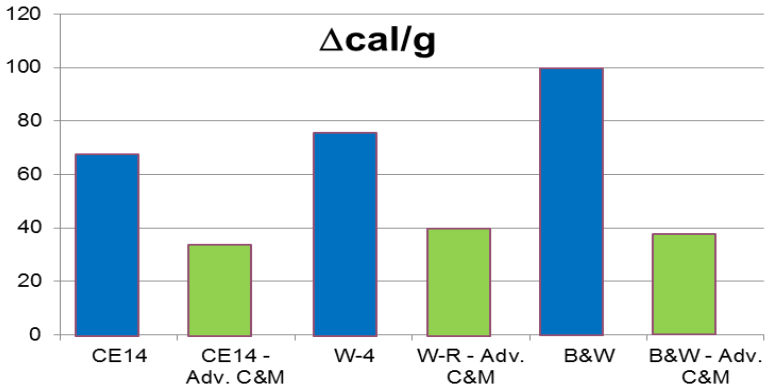
- Multiple times in life
- Multiple power levels
- Evaluation of important parameters
- Conservative biasing of significant parameters

Fuel Rod Failure Assessments

- Considers rod failure from various mechanisms
- Conservative biasing of system pressure
- Assesses event to meet regulatory criteria

Fuel Rod Failure Thresholds

- DNB margin assessed for all cases
- Fuel centerline melt margin evaluated for all cases
- Enthalpy deposition evaluated for all cases
- Thresholds consider burnup effects



The impact of the control rod ejection event is greatly reduced with the AREA methodology. Enthalpy deposition rates are effectively half of those assessed by legacy analysis.

The combination of the AREA method with Framatome's industry leading $M5_{Framatome}$ alloy is a particularly valuable combination. The AREA methodology greatly reduces the impact of the event while the $M5_{Framatome}$ material type increases failure thresholds through low corrosion and extremely low hydrogen pickup.

References

- AREA methodology applied in the US region
- Utilizes the state-of-the-art ARCADIA code system

Capabilities

- Advanced multi-physics coupling for detailed analysis of core (ARCADIA) and plant (S-RELAP5) behaviour
- Energy deposition, fuel rim melt and centerline melt evaluated for all fuel rods in core
- Minimum departure from nucleate boiling ratio (DNBR) evaluated for all sub-channels in core
- Reactor coolant system pressure evaluated by coupled plant model
- Well suited to accommodate revised NRC rod ejection analysis guidelines.

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