framatome

AREA

A coupled reactivity insertion accident methodology

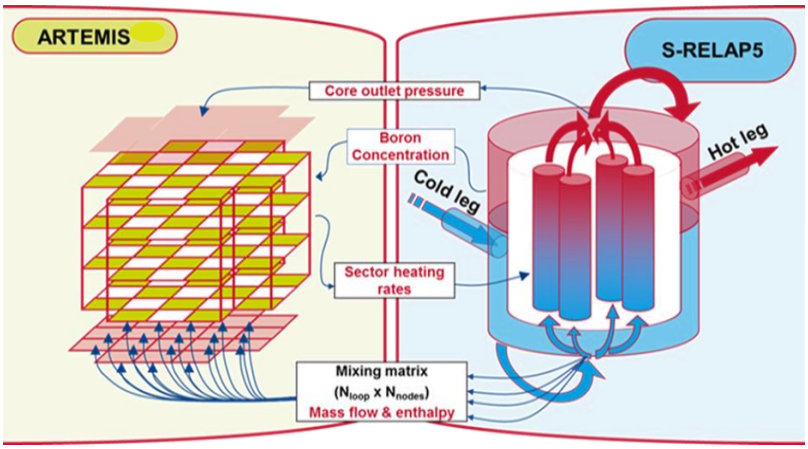
Addresses regulatory criteria while improving margin

Challenge

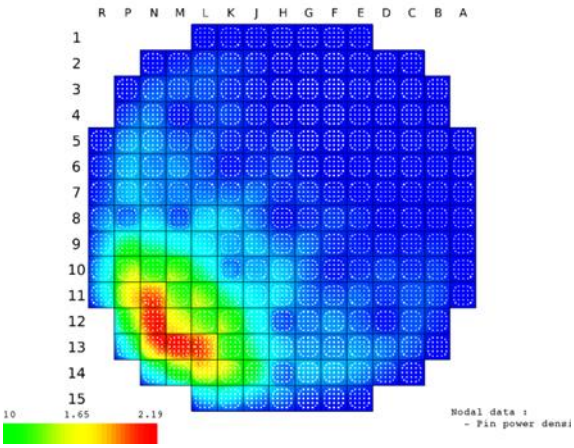
In recent years the legacy processes for analyzing reactivity insertion transients have been questioned. Past models struggle to adequately capture key phenomena in this event and produce a thorough evaluation. This has led to rod ejection analysis criteria evolving to those contained in the recently issued Regulatory Guide 1.236. 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 a coupled core and system evaluation model that brings substantial margin through accurate modeling and simulation of the overall transient progression. This method addresses the regulatory changes while using advanced modeling techniques to greatly improve analysis margins.



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



Customer benefits

- Addresses Emergent Regulatory Criteria
- Provides industry leading safety analysis margins which can be used in many areas:

Operational Margins
Operating Flexibility
Enhance Cycle Economics
Bound cyclic variation

- 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

100% of evaluated plant types are no longer limited by control rod ejection accidents

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

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

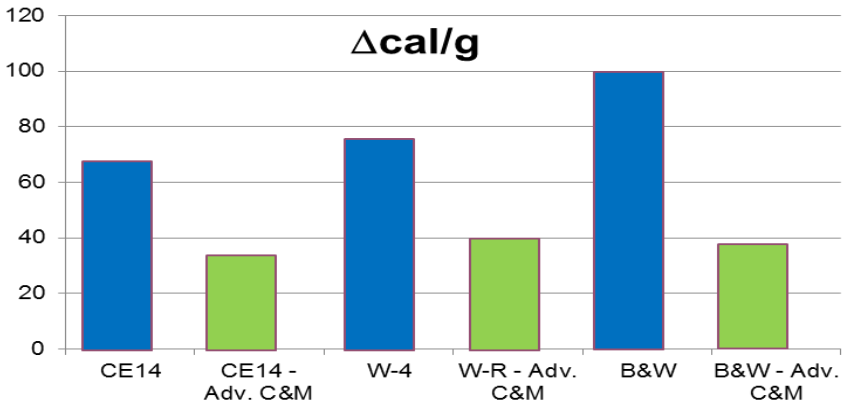
- Full range of time in life
- Full range of power levels
- Evaluation of important parameters
- Conservative biasing of significant parameters

Fuel Rod Failure Assessments

- Considers rod failure from various mechanisms
- Conservative assessment of activity release
- Conservative biasing of system pressure
- Rendered someone less important due to large analysis margins

Fuel Rod Failure Thresholds

- DNB margin assessed for cases that would challenge this limit
- Fuel centerline Melt margin evaluated for all cases
- Enthalpy deposition evaluated for all cases
- Thresholds consider burnup effects



With the AREA methodology the impact of the control rod ejection event is greatly reduced. Enthalpy deposition rates are effectively half of those assessed by legacy analysis. The margin created by this advanced analysis process removes Control Rod Ejection from the list of limiting events for all plant types evaluated to date.

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
- ARCADIA code system has been in use in AREA since 2015 and 2016 in Europe and the US respectively

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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