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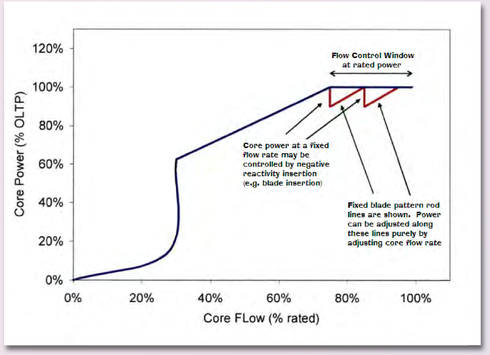
OFFICE OF NUCLEAR REGULATORY RESEARCH

Demonstration of Effectiveness of Operator Actions During Postulated ATWS-I Events for a BWR at MELLLA+ Conditions

Purpose

- To provide confirmatory analysis on Anticipated Transient Without Scram with instability (ATWS-I) events for boiling-water reactors (BWRs) operating with a maximum extended load line limit analysis plus (MELLLA+) expanded operating domain.
- It is the intent to use TRAC/RELAP Advanced Computational Engine (TRACE) to simulate postulated MELLLA+ ATWS-I events to study plant transient response and consequences and the effectiveness of mitigating actions.

MELLLA Domain



MELLLA+ Operation

Proposed for BWRs with extended power uprates (EPUs)

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Analyzes operation at high reactor thermal power (up to 120 percent of originally licensed thermal power (%OLTP)) at reduced reactor core flow (as low as 80 percent of rated core flow (%RCF)).

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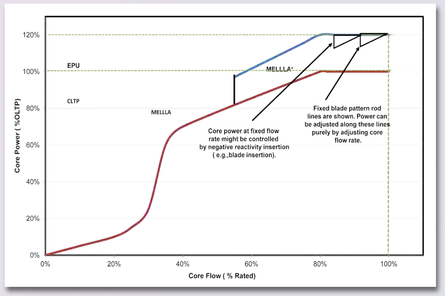
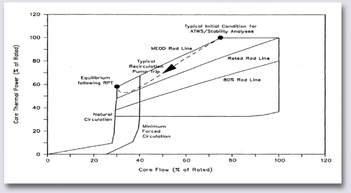
Using a flow control window (FCW) at high reactor power, used in EPU power levels.

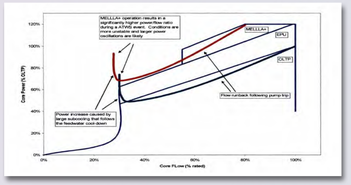
MELLLA+ Domain



Plant Response to Dual Recirculation Pump Trip from MELLLA Operating Domain



Reactor Power Following a Dual Recirculation Pump Trip



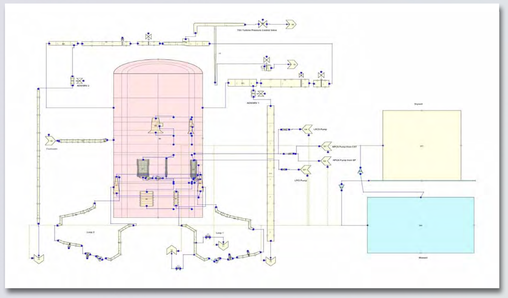
Operator Actions

Reduction of Reactor Water Level → Allows feedwater mix with steam and heat up before entering the core inlet

and

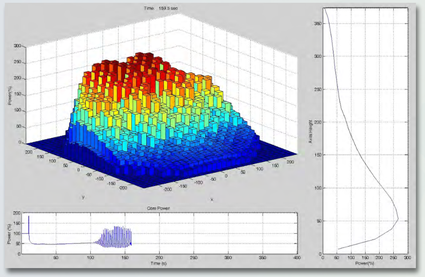
Injection of Soluble Boron (SLCS) → Acts as neutron absorber

A Typical TRACE/SNAP BWR Plant Model



MELLLA+ operating conditions may exacerbate the consequences of unstable power oscillations observed following a two-pump reactor trip.

AWTS-I Core Power Distribution

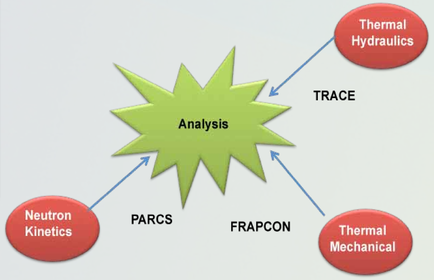


Characterization of ATWS-I Phase and Figures of Merit

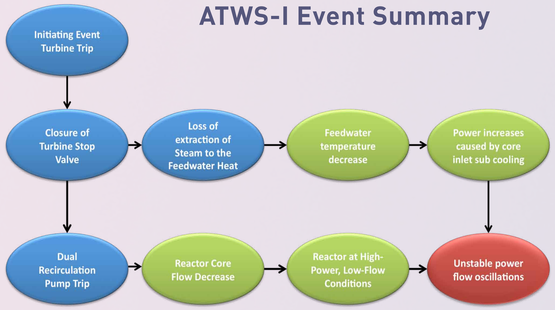
Initial Phase	Dome Pressure
Natural Circulation (approach to onset)	$P_{xyz} \cdot \frac{Q}{F\,h_{inlet}}$
Onset through normal growth	Growth Ratio
Onset through normal growth	Downcomer Level
Bimodal power oscillations	Instantaneous modal reactivity less modal eigenvalue difference
Nonlinear bimodal power oscillations	Frequency
Decay	Decay Ratio
Long-term (approach to cold shutdown)	Ratio of two-phase to single phase average channel pressure drop

Analysis Capability Review

The capability matrix review process associates the highly ranked phenomena with specific code capabilities.



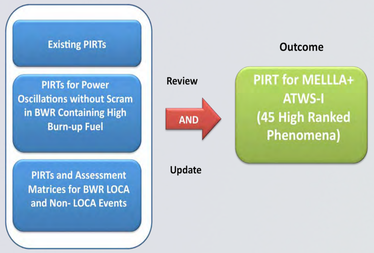
ATWS-I Event Summary

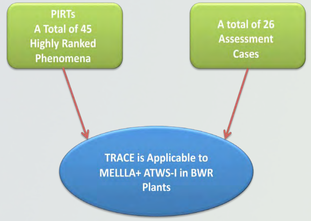


Phenomena Identification and Table Ranking and Code Applicability Determination

The PIRT process is used for code applicability determination by selecting phenomena of highest importance.

The collection of highly important phenomena is used to establish an appropriate assessment matrix.





Conclusions

- TRACE results indicate reasonable agreement with assessment cases.
- All highly ranked phenomena modeled with TRACE show reasonable or excellent agreement with experimental data over the range of conditions of interest for ATWS-I.
- Based on these findings, TRACE is deemed adequate for ATWS-I analyses of MELLLA+ BWR plants.

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