NuScale LOCA PIRT

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U.S. Nuclear Regulatory Commission
Pre-Application Meeting
Rockville, MD

NuScale Power™

Outline

- Introduction
- Evaluation Model Development and Assessment Process (EMDAP)
- Phenomena Identification and Ranking Table (PIRT) Process
- NuScale Loss-of-Coolant Accident (LOCA) PIRT
- Summary
- Conclusions

Introduction

- Objectives
  - Describe revised PIRT and summarize the differences from the original PIRT
  - Obtain direct feedback from the U.S. Nuclear Regulatory Commission (NRC) on phenomena identification and ranking as applied to adequacy of NuScale test programs for LOCA methods development

Introduction

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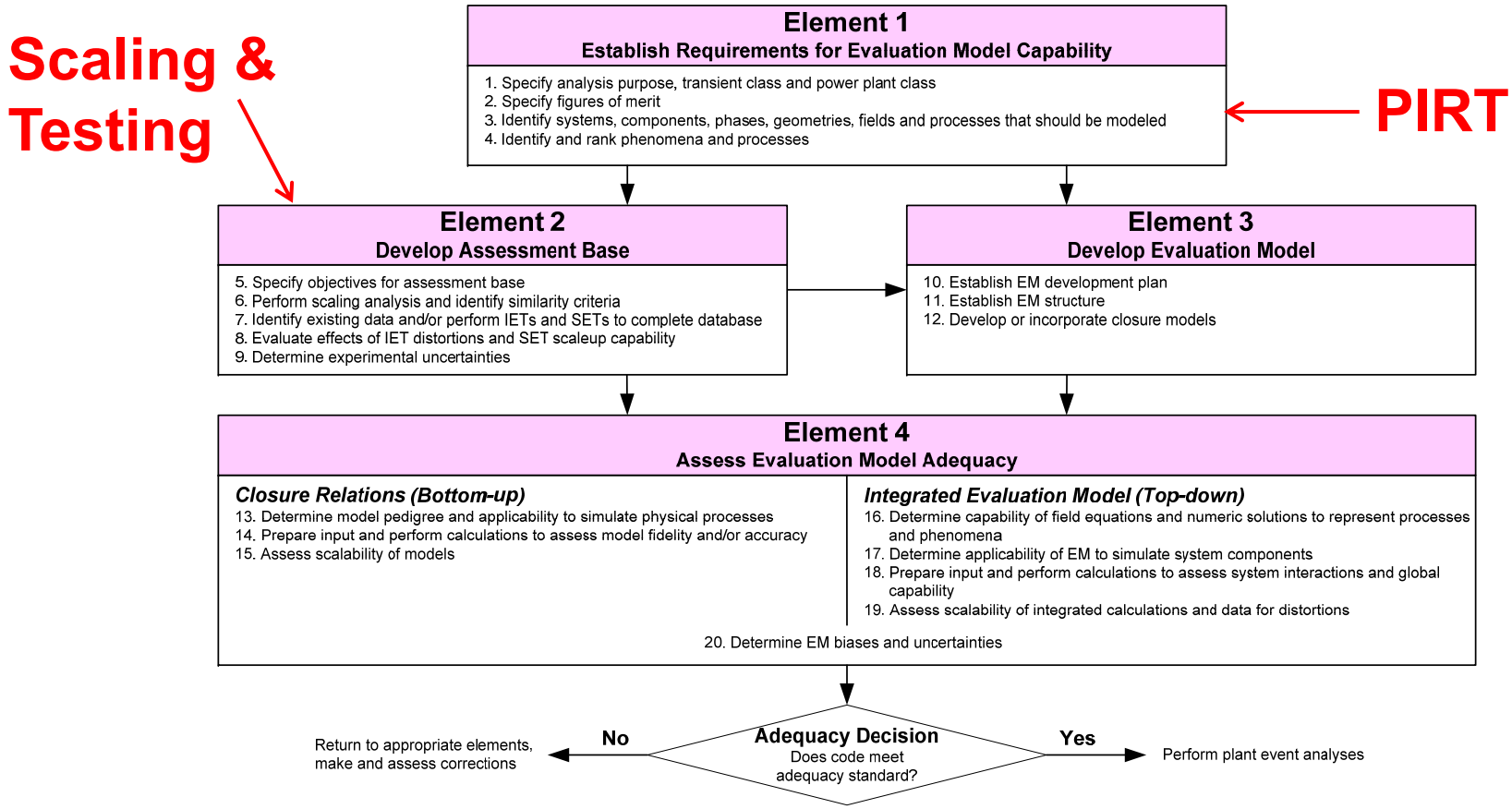
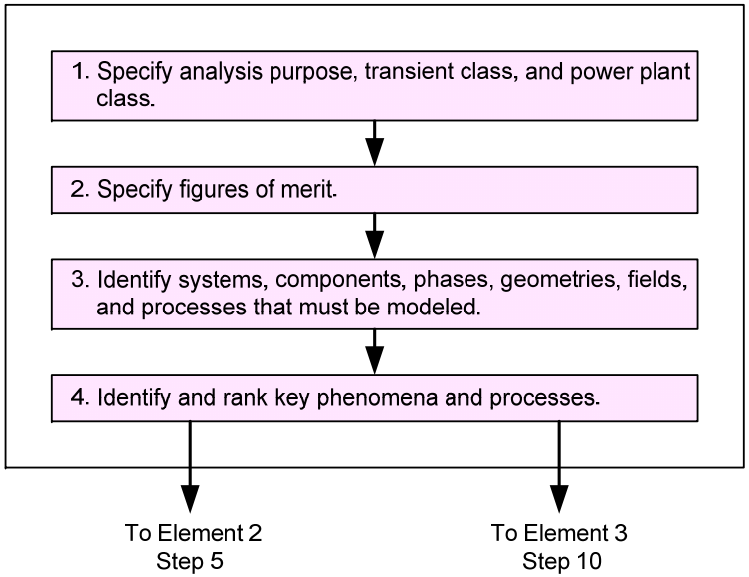
EMDAP for NuScale LOCA Analysis



Evaluation Model Development and Assessment Process (EMDAP)[1]

[1] Regulatory Guide 1.203, "Transient and Accident Analysis Methods," U.S. Nuclear Regulatory Commission, December 2005.

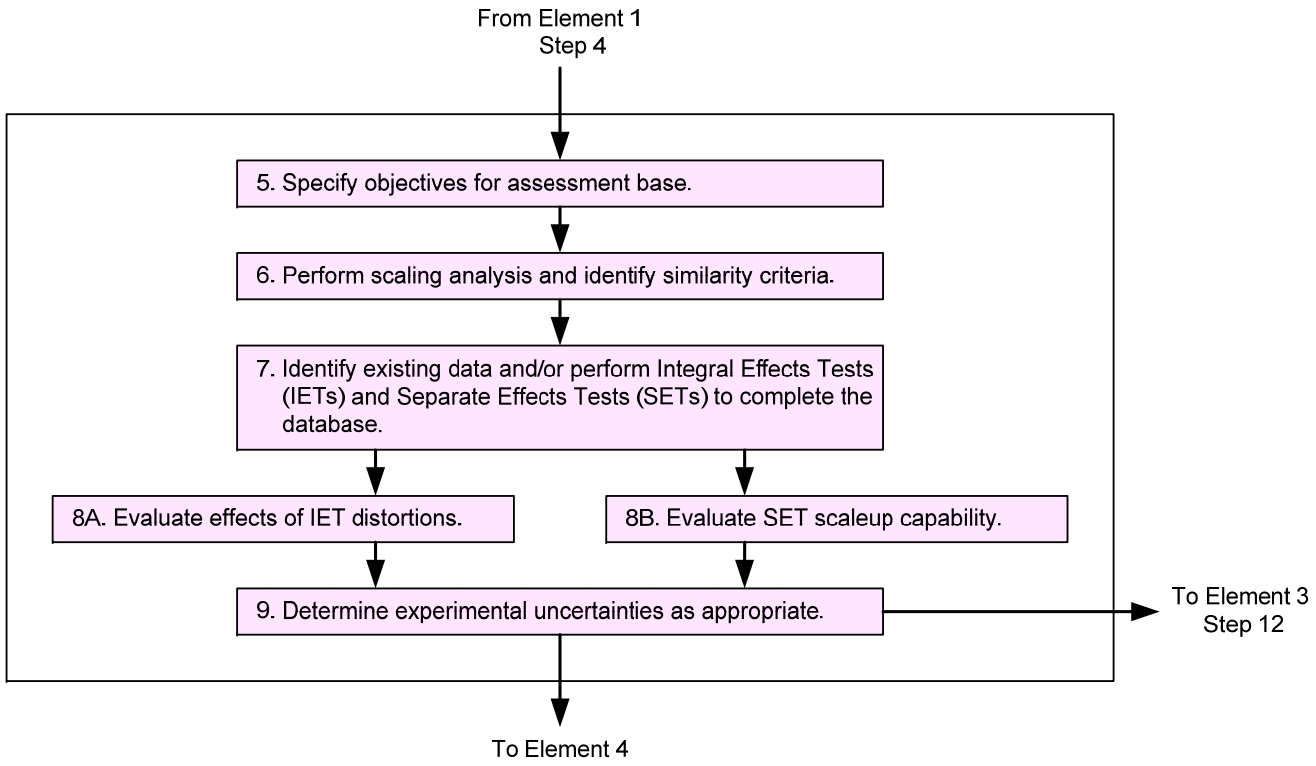
EMDAP – Element 1



EMDAP - Element 1: Establish Requirements for Evaluation Model Capability[1]

[1] Regulatory Guide 1.203, "Transient and Accident Analysis Methods," U.S. Nuclear Regulatory Commission, December 2005.

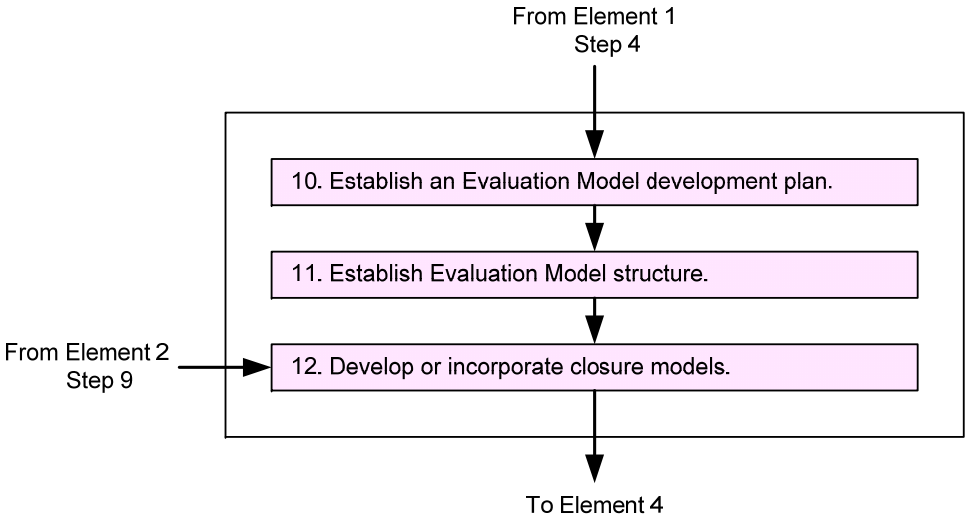
EMDAP – Element 2



EMDAP - Element 2: Develop Assessment Base[1]

[1] Regulatory Guide 1.203, "Transient and Accident Analysis Methods," U.S. Nuclear Regulatory Commission, December 2005.

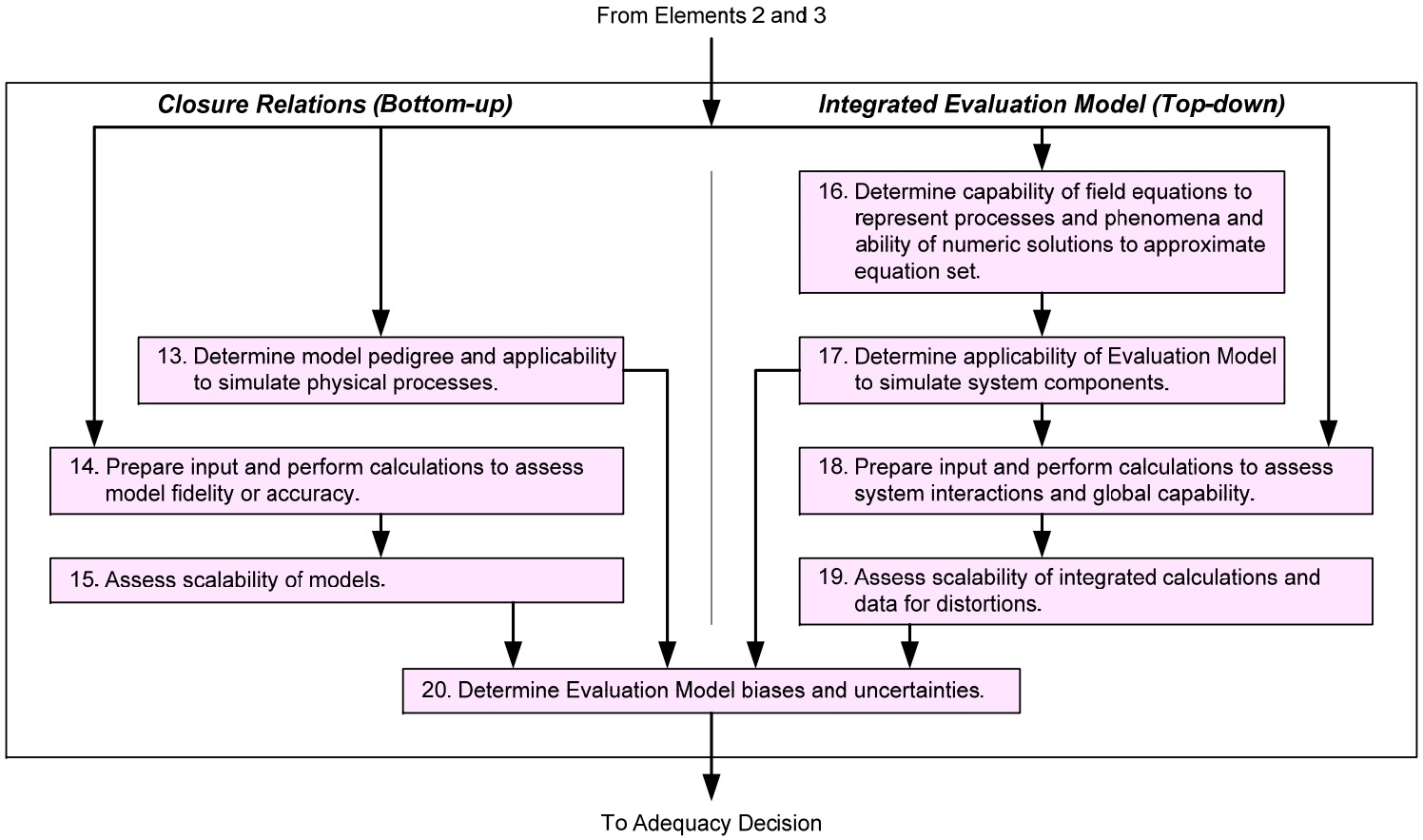
EMDAP – Element 3



EMDAP - Element 3: Develop Evaluation Model[1]

[1] Regulatory Guide 1.203, "Transient and Accident Analysis Methods," U.S. Nuclear Regulatory Commission, December 2005.

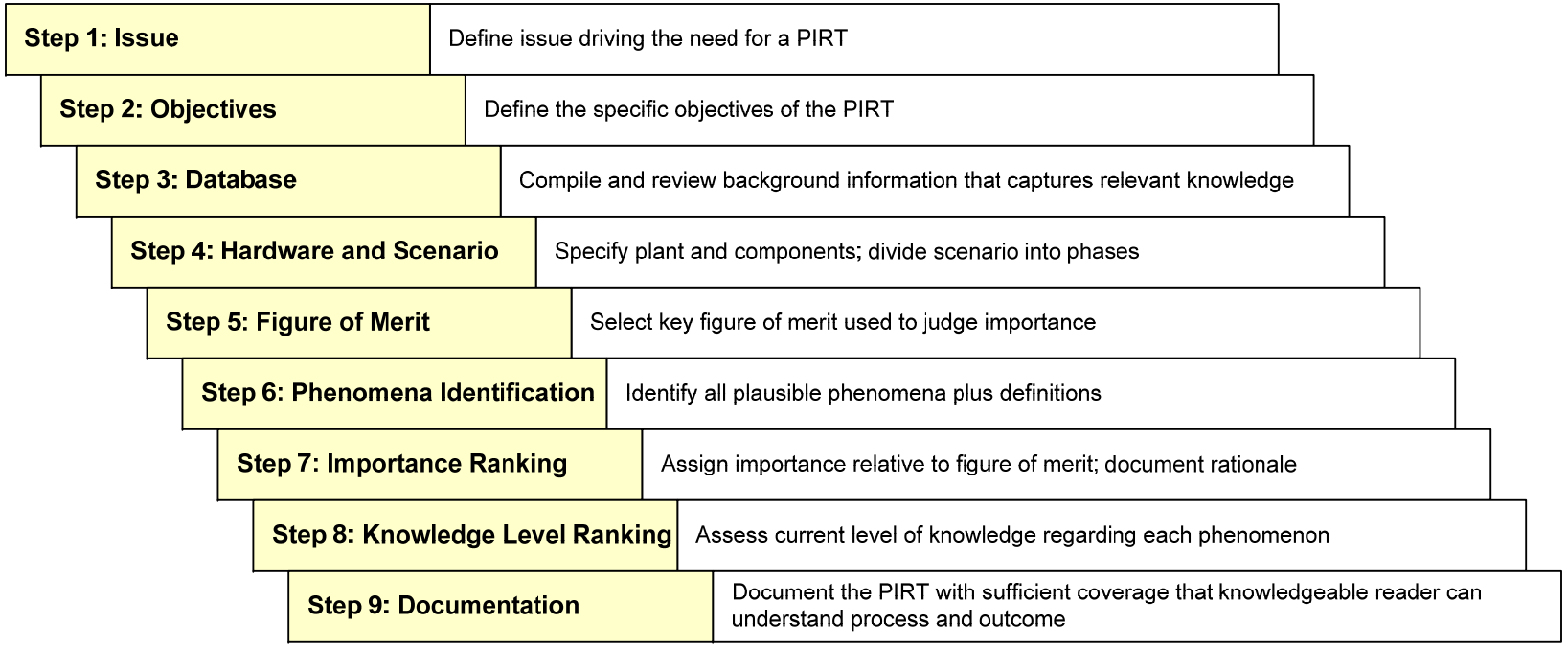
EMDAP – Element 4



EMDAP - Element 4: Assess Evaluation Model Adequacy[1]

[1] Regulatory Guide 1.203, "Transient and Accident Analysis Methods," U.S. Nuclear Regulatory Commission, December 2005.

PIRT Process



PIRT Process[2]

[2] Brent E. Boyack and Gary E. Wilson, "Lessons Learned in Obtaining Efficient and Sufficient Applications of the PIRT Process," Best Estimates 2004, Washington, D.C., November 14-18, 2004.

Revised LOCA PIRT (January 2012)

Step 1: Issue

NuScale PIRT effort is required to

- support EMDAP Element 1 – Requirements Definition.
- focus resources by identifying important phenomena to evaluate, test, and model.

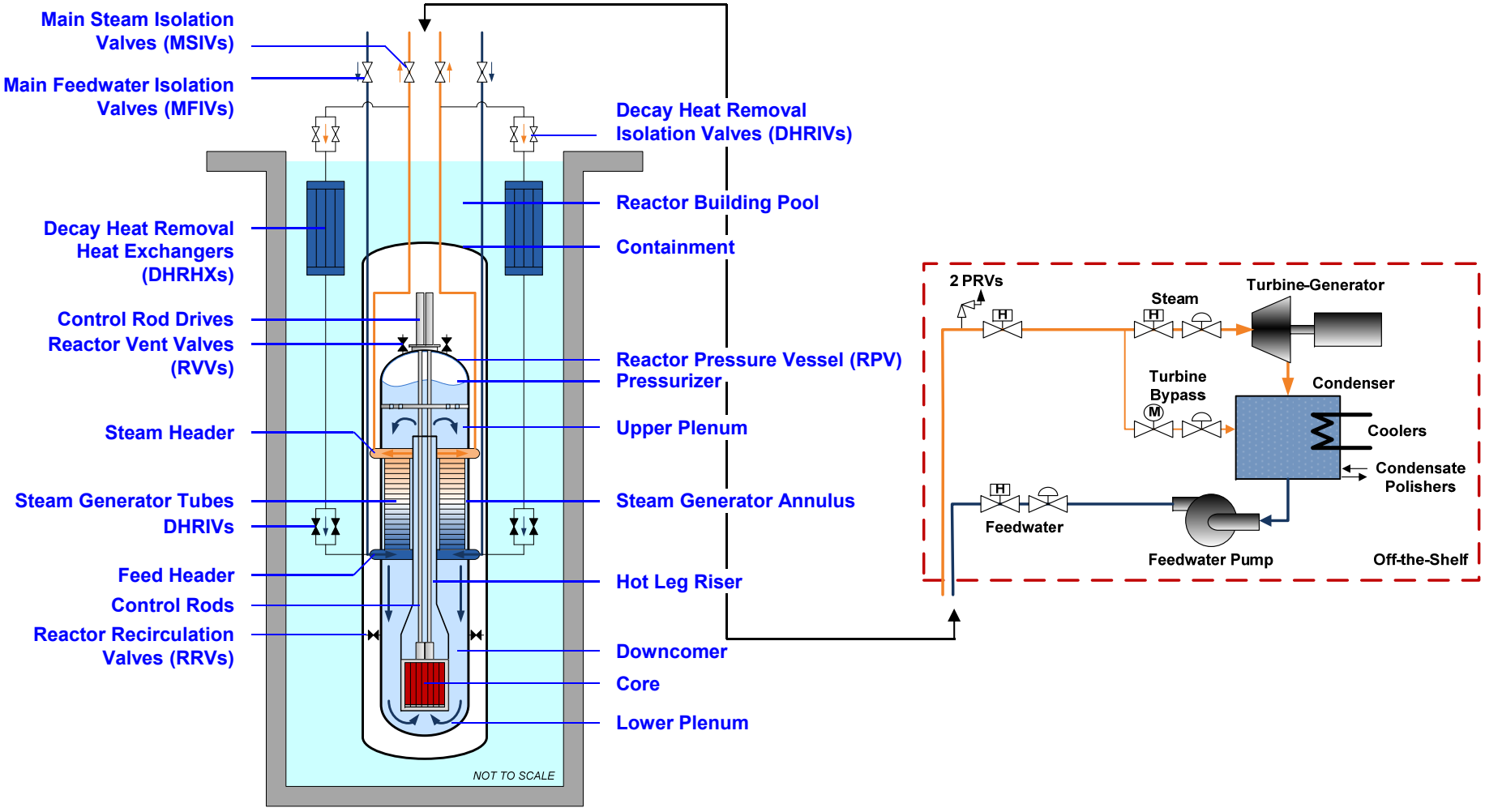
Step 2: Objectives

- Compile and review background information that captures relevant knowledge.
- Specify plant (NuScale) and components; divide scenario — small break loss-of-coolant accident (SBLOCA) — into phases.
- Select key figure of merit used to judge importance.
- Identify all plausible phenomena plus definitions.
- Assign importance relative to figure of merit: document rationale.
- Assess current level of knowledge regarding each phenomenon.
- Document the PIRT with sufficient coverage that a knowledgeable reader can understand the process and outcome.

Step 3: Database

- A system design description (detailed)
- An accident sequence description, including an event table
- Plant calculations that included:
  - Baseline scenario (best-estimate)
  - Sensitivity studies
  - Graphics of components, systems, and calculated quantities
- Experimental data
- Experimental facility scaling studies

Step 4: Hardware (1/2)



NuScale Power Module

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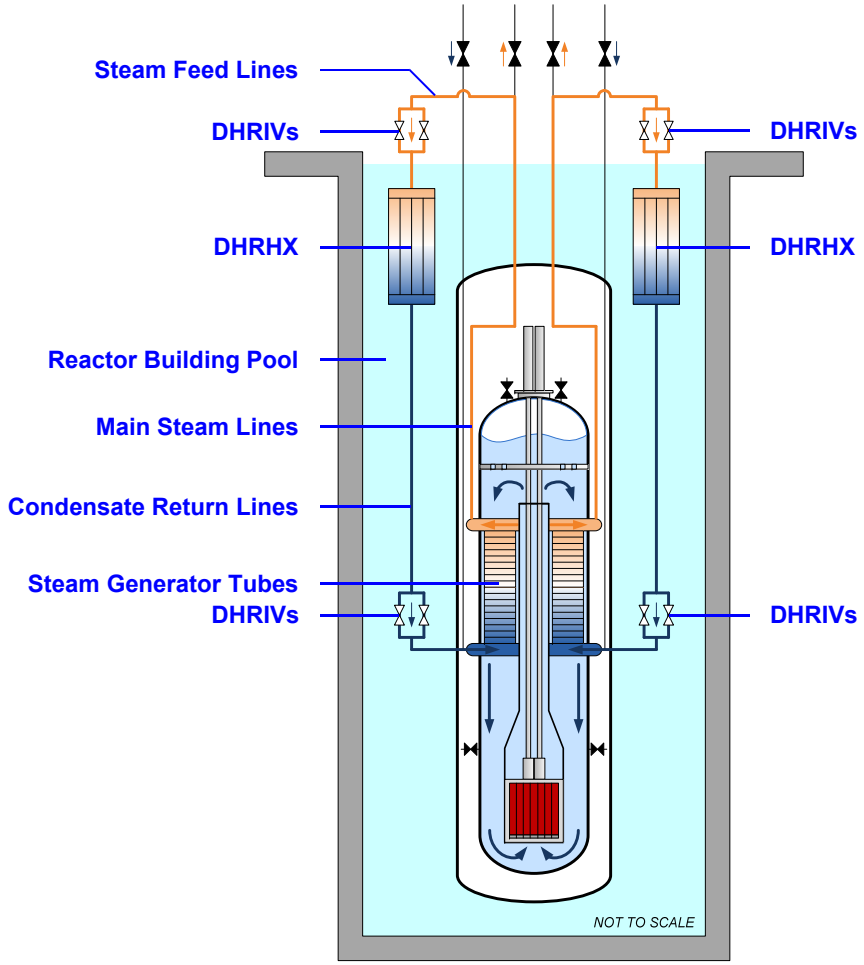
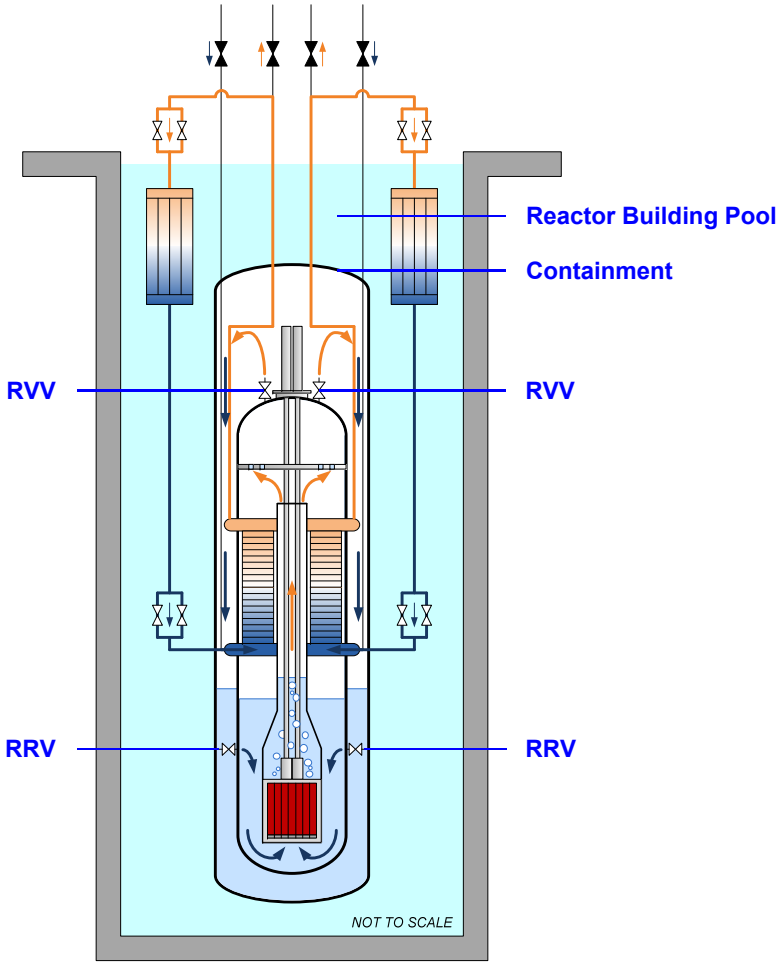
Step 4: Hardware (2/2)



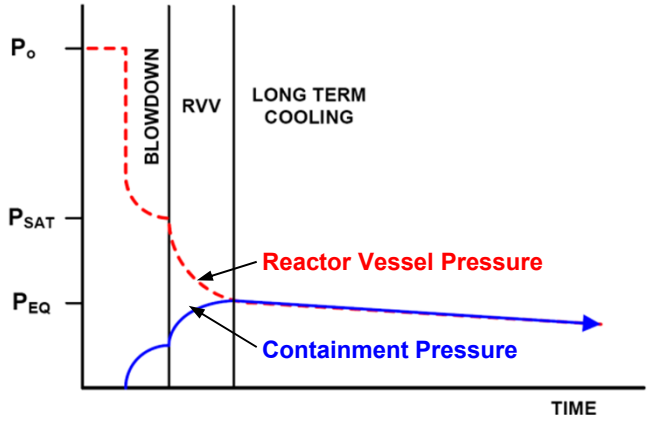
DHRS



Emergency Core Cooling System (ECCS) (Including DHRS)

Step 4: Scenario 1 (RVV Opening) (1/4)

NuScale SBLOCA



Scenario 1 RVV Opening

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Step 4: Scenario 1 (RVV Opening) (2/4)

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Step 4: Scenario 1 (RVV Opening) (3/4)

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Step 4: Scenario 1 (RVV Opening) (4/4)

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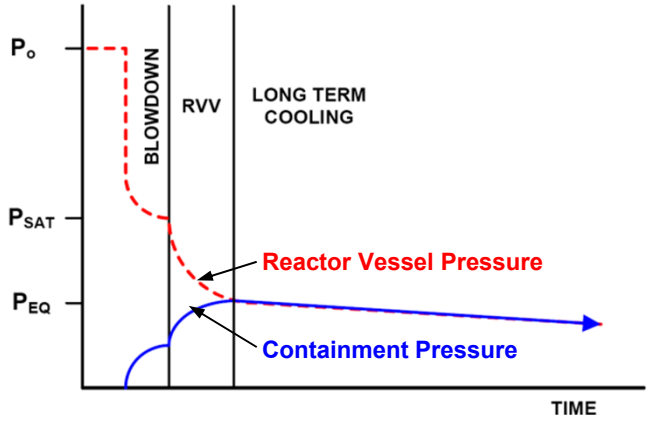
Step 4: Scenario 2 (RRV Opening) (1/4)

NuScale SBLOCA



Scenario 2 RRV Opening

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Step 4: Scenario 2 (RRV Opening) (2/4)

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Step 4: Scenario 2 (RRV Opening) (3/4)

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Step 4: Scenario 2 (RRV Opening) (4/4)

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Step 5: Figure of Merit

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Step 6: Phenomena Identification

The standard approach[2] in this step

- is based upon collective experience of the panelists.
- is informed by the background information of Step 3.
- works best if the panel is highly knowledgeable in
  - design.
  - processes and phenomena occurring during accidents.
- focuses on (generally during the PIRT meetings)
  - a list of potentially active systems.
  - a list of relevant components of each system.
  - identification of processes and phenomena in each component or both.
- prohibits phenomena evaluation (ranking) during the identification step.
- provides a precise, written definition of each phenomenon to:
  - help ensure each panelist has the same definition in mind when ranking the phenomenon (Step 7).
  - reduce inconsistencies.

[2] Brent E. Boyack and Gary E. Wilson, "Lessons Learned in Obtaining Efficient and Sufficient Applications of the PIRT Process," Best Estimates 2004, Washington, D.C., November 14-18, 2004.

Step 7: Importance Ranking

[2]

Importance	Definition	Application Outcomes
High (H)	Phenomenon has controlling impact on figure of merit.	Experimental simulation and analytical modeling with a high degree of accuracy is critical.
Medium (M)	Phenomenon has moderate impact on figure of merit.	Experimental simulation and/or analytical modeling with a moderate degree of accuracy is required.
Low (L)	Phenomenon has low impact on figure of merit.	Modeling must be present only to preserve functional dependencies.
Insignificant (I)	Phenomenon has no, or insignificant impact on figure of merit.	Modeling must be present only if functional dependencies are required.

[2] Brent E. Boyack and Gary E. Wilson, "Lessons Learned in Obtaining Efficient and Sufficient Applications of the PIRT Process," Best Estimates 2004, Washington, D.C., November 14-18, 2004.

Step 8: Knowledge Level Ranking

[2]

Knowledge Level	Definition
4	Fully known, small uncertainty
3	Known, moderate uncertainty
2	Partially known, large uncertainty
1	Very limited knowledge, uncertainty cannot be characterized

[2] Brent E. Boyack and Gary E. Wilson, "Lessons Learned in Obtaining Efficient and Sufficient Applications of the PIRT Process," Best Estimates 2004, Washington, D.C., November 14-18, 2004.

Step 9: Documentation

- Introduction
- PIRT Method Description
- Background Information (Database)
- Plant Description
- Scenario
- PIRT Results (essentially summary tables)
- Appendices
  - Brief Biographies of PIRT participants
  - Importance ranks and rationales
  - Knowledge levels and rationales

Panelists

Original PIRT (Experimentally Oriented)	Revised PIRT (Code/Application Oriented)
Dr. Graham Wallis, Chair	Dr. Graham Wallis, Chair
Dr. Lawrence Hochreiter	Dr. Steve Congdon
Dr. Mujid Kazimi	Dr. Tom George
Mr. Brent Boyack	Mr. Craig Peterson
Dr. Kord Smith	Mr. Gregg Swindlehurst
Dr. José Reyes	Dr. José Reyes
Dr. Kent Welter, Facilitator	Dr. Kent Welter, Facilitator
Dr. Eric Young, Assistant	Mr. Tristan McDonald, Assistant

Design Changes

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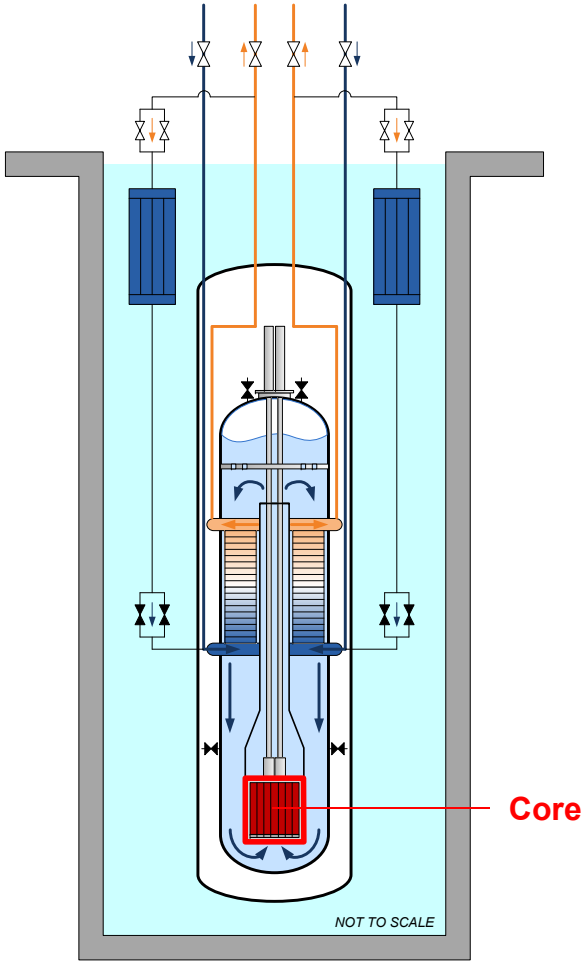
Core Phenomena



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Core (Revised PIRT)

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Core (Revised PIRT)

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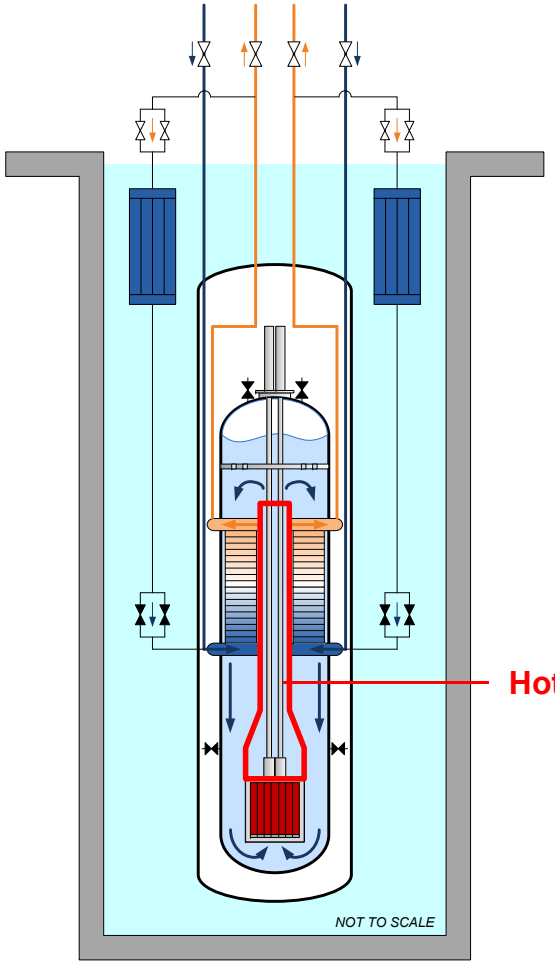
Hot Leg Riser Phenomena



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Hot Leg Riser (Revised PIRT)

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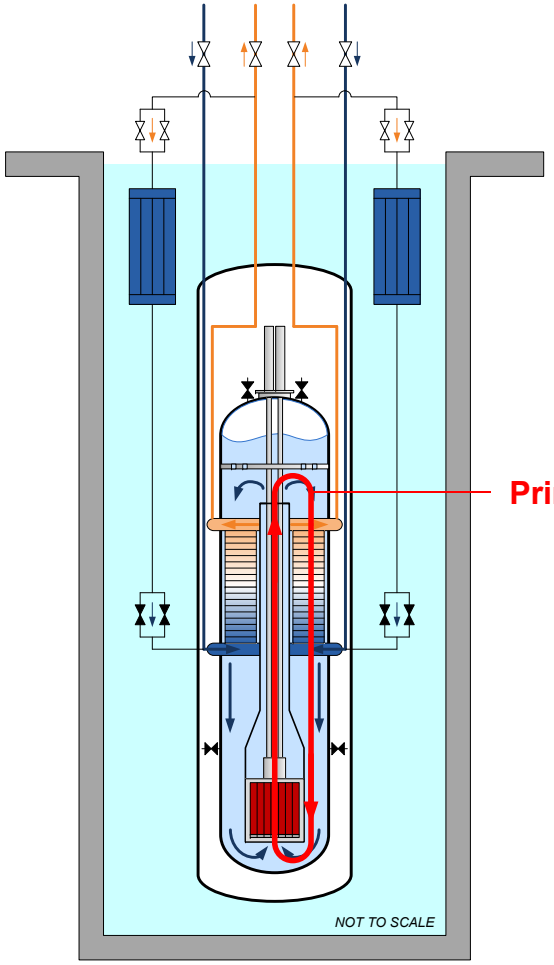
Primary Loop Phenomena



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Primary Loop (Revised PIRT)

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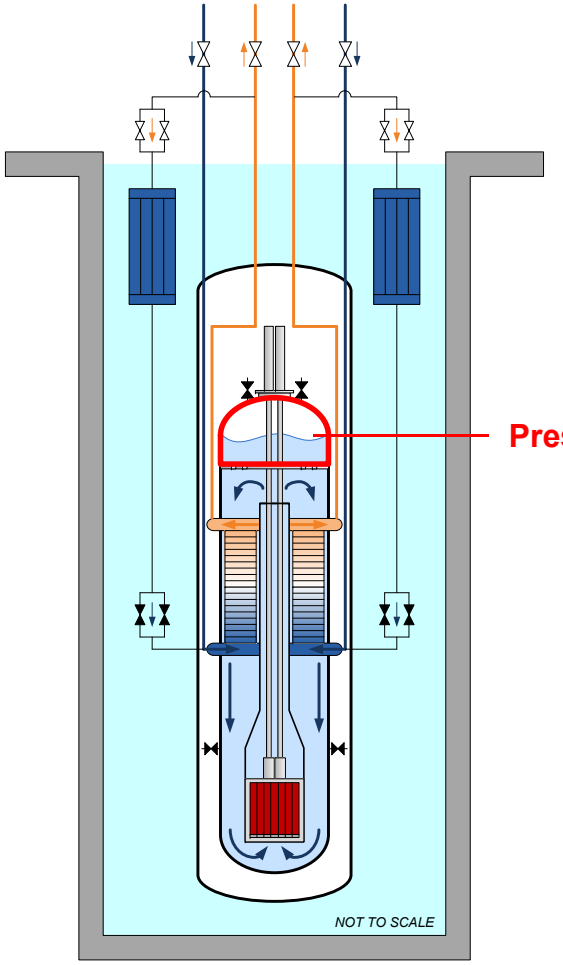
Pressurizer Phenomena



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Pressurizer (Revised PIRT)

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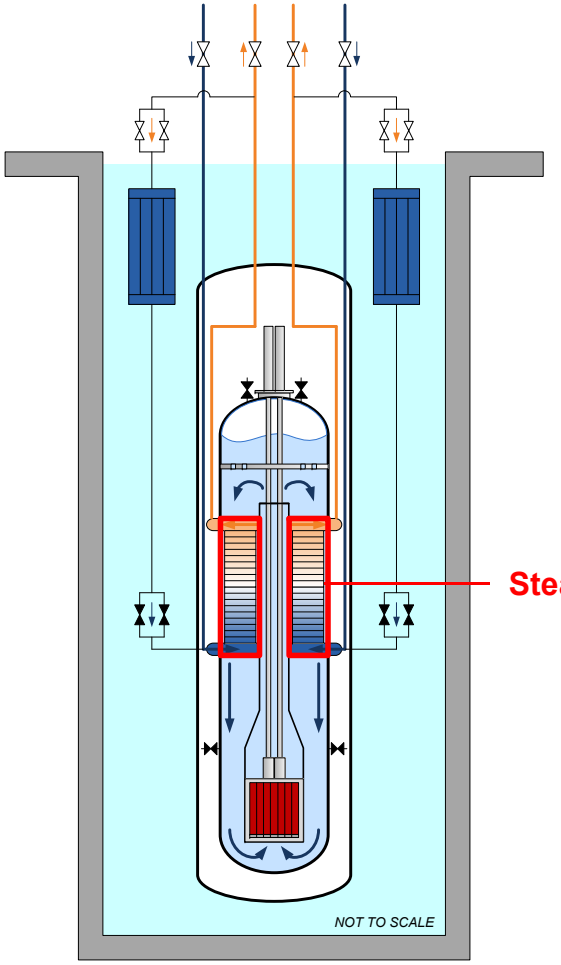
Steam Generator Phenomena



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Steam Generator (Revised PIRT)

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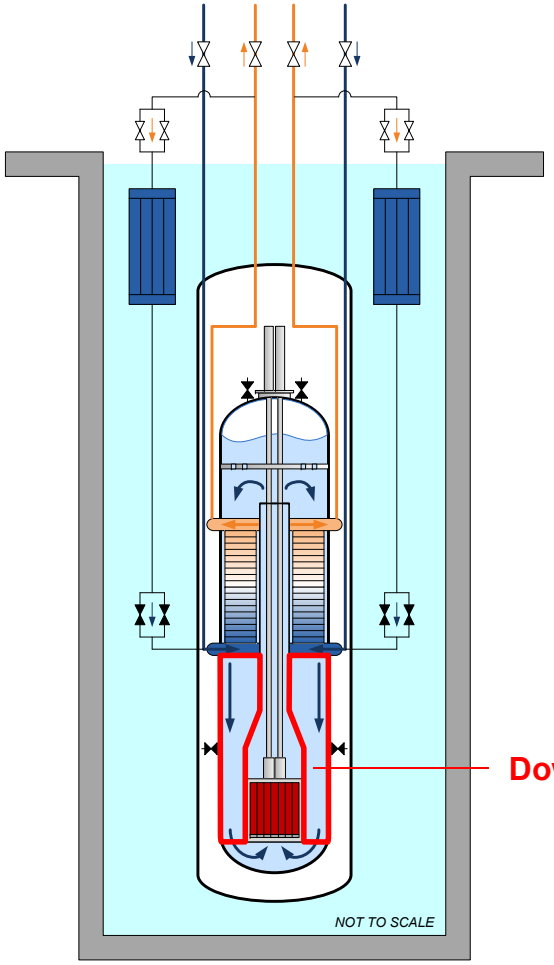
Downcomer Phenomena



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Downcomer (Revised PIRT)

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Lower Plenum Phenomena

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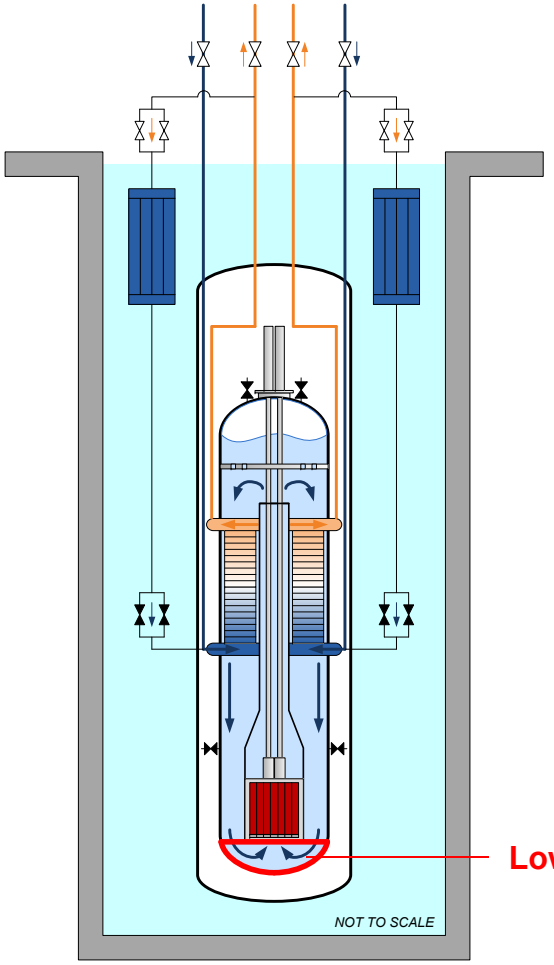

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Lower Plenum (Revised PIRT)

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Emergency Core Cooling System Phenomena

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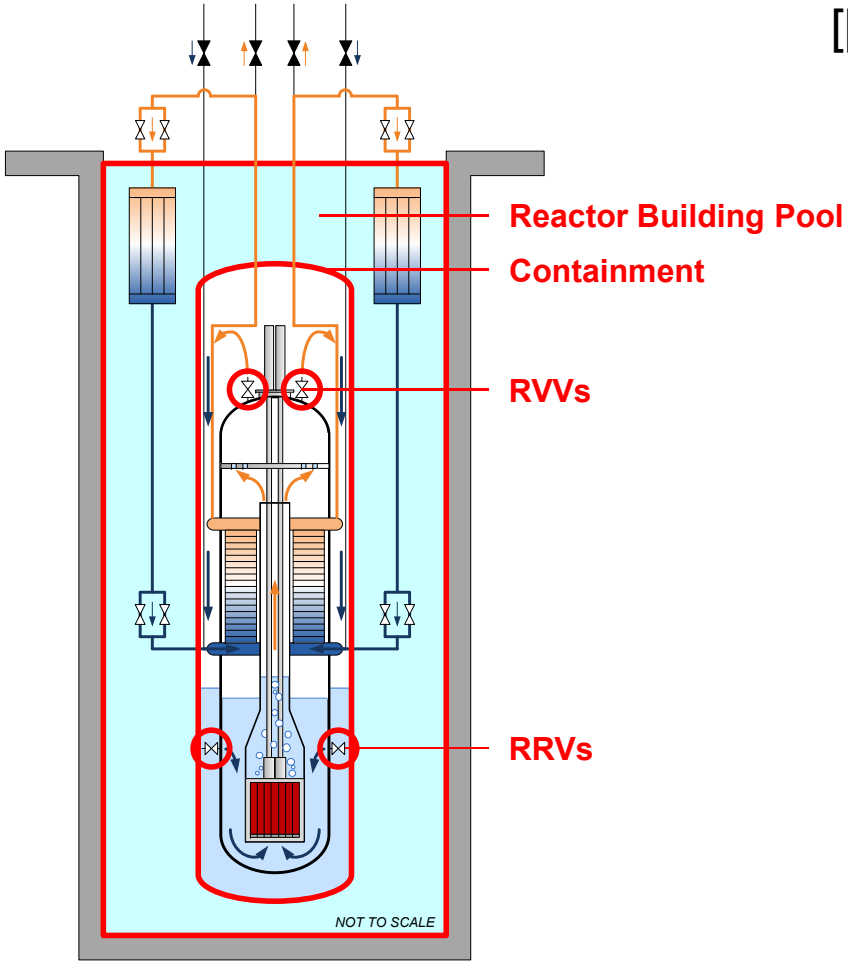

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Reactor Vent Valves (Revised PIRT)

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Reactor Recirculation Valves (Revised PIRT)

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Containment (Revised PIRT)

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Containment (Revised PIRT)

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Reactor Building Pool (Revised PIRT)

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Decay Heat Removal System Phenomena

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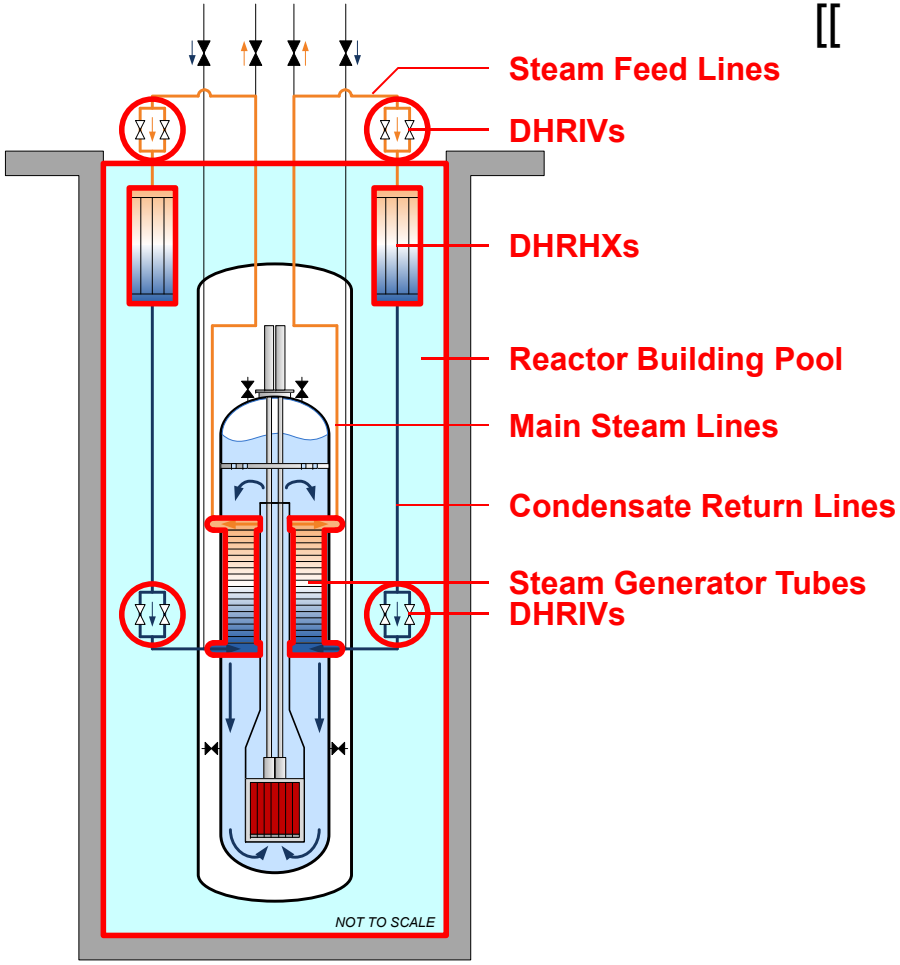

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Decay Heat Removal System (Revised PIRT)

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Summary – Separate Effects

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Summary – Integral Effects

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Conclusions

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