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NRC Meeting:
SMR-160 LOCA Exemption
Update #1

April 5, 2023

Meeting Agenda

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- Introductions – NRC Staff and Holtec Staff
- Purpose & Outcome
- Review of 10-19-22 Meeting
- Overview of Previous LOCA Rulemaking
- PIF and SGE Riser Design Overview
- Future Work

Purpose & Outcome

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PURPOSE: To give a high-level overview of the progress on the SMR-160 LOCA exemption justification to date.

OUTCOME: To ensure the staff understands our current progress and obtain any feedback, comments, and/or questions from the NRC staff on the detailed information provided in the DRAFT white paper.

Review of Previous Meeting

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- In 10/19/22 meeting SMR presented a potential LOCA exemption justification list [ML22663A432 (Meeting Summary) and ML22304A002 (Staff Observations)]
- NRC staff observations and feedback were added to the justification list
  - This included observations related to the forging process, system structural layout, NDE requirements, fabrication of materials including welds, weld residual stress, PWHT considerations, fatigue/thermal stratification issues, additional potential degradation mechanisms
- SMR has begun developing the material required for each item in the list

Overview of Previous LOCA Rulemaking Documents

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- NUREG-1829 (2008)
  - Estimating LOCA Frequencies Through the Elicitation Process
  - Notes:
    - Since LOCA rules were established additional NRC guidance and proposed rulemaking shows the need to be updated/risk-informed for new reactor designs
    - DEGB is widely recognized as an extremely unlikely event
    - Results show ruptures are a function of break size (e.g., 31" break freq is 7.5 E-08/rx-yr)

Simplified NUREG-1829 Table 1 – Total PWR LOCA Frequencies			
LOCA Size (gpm)		Eff. Break Size (inch)	End-of-Plant-License Estimate (per cal. Yr; 40-yr fleet avg Mean)
SBLOCA	>100	0.5	5.2 E-03
MBLOCA	>1,500	1.625	7.8 E-04
LBLOCA	>5,000	3	3.6 E-05
	>25K	7	3.6 E-06
	>100K	14	4.8 E-07
	>500K	31	7.5 E-08

Overview of Previous LOCA Rulemaking Documents

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- DG-1216 (2010)
  - Plant-Specific Applicability of TBS
  - Notes:
    - TBS used to delineate primary system pressure boundary breaks of different sizes (<TBS more likely, >TBS less likely)
    - The NUREG-1829 and NUREG-1903 results justify the presumed low frequency of primary passive system failures greater than the TBS
    - *The proposed TBS sizes for PWR plants ultimately correspond to the largest pipe sizes attached to the main reactor coolant loop*

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DG-1216 Quote

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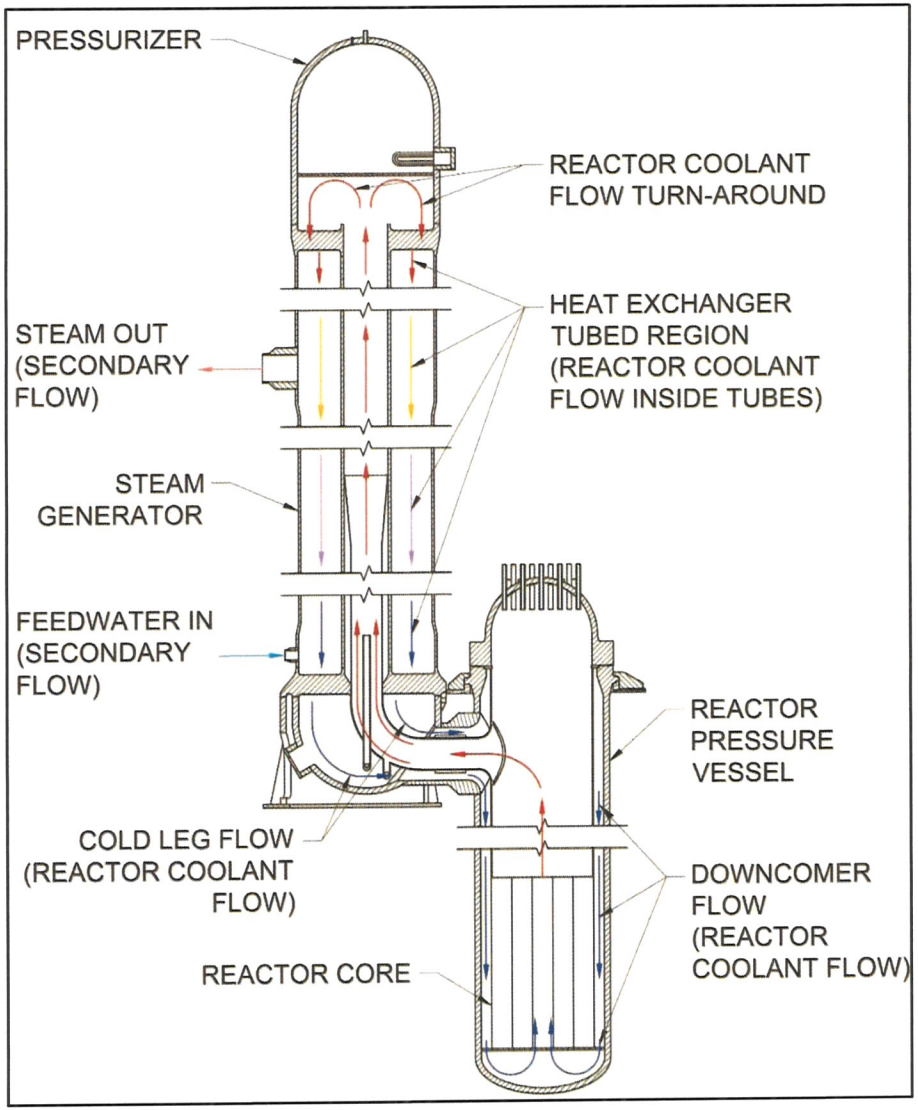
- The proposed TBS sizes… ultimately correspond to the largest pipe sizes attached to… the main reactor coolant loop in PWRs…. Therefore, the applicant's evaluation need only consider breaks in the [main reactor coolant loop] and in similarly or greater sized pressure boundary structural components, such as pumps, valves, the reactor pressure vessel, steam generators, and the associated nozzles connecting these components to the [main reactor coolant loop].

Integrated RCS



Planar Inter-vessel Forging (PIF) Overview

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SGE Riser Overview

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Materials

- All materials will meet ASME Code specifications
- Evaluating material vendors to identify potential improvements in quality and processing to increase overall material robustness

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Mechanical Design and Analysis

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- SMR compared stress intensity limits of the ASME Code piping and vessel sections and will apply the more conservative limits to the PIF and SGE riser locations

Stress Classification	Design	Service Level A	Service Level B	Service Level C The Greater of:	Service Level D The Lesser of:
P_m	S_m	No specific limit	$1.1S_m$	$1.2S_m$ or S_y	$0.7S_u$
P_m, ferritic material, pressure loadings alone	…		…	$1.1S_m$ or $0.9S_y$	…
P_L	$1.5S_m$		$1.65S_m$	$1.8S_m$ or $1.5\ S_y$	$1.05S_u$
$(P_m$ or $P_L) + P_b$	$1.5S_m$		$1.65S_m$	$1.8S_m$ or $1.5S_y$	$3.0S_m$ or $2.5S_y$

Mechanical Design and Analysis

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- SMR intends to analyze the PIF and SGE riser per the vessel section of the ASME Code as SMR believes analyzing these locations as portions of a vessel is more accurate as the entire system would be included in the analysis, whereas analyzing these locations as pipes would only consider the individual locations

- Question: Does the NRC have concerns with the vessel analysis approach?

PIF and SGE Riser Welds

- The weld design and requirements of the PIF and SGE riser are as follows:

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PIF and SGE Riser Welds

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PIF and SGE Riser Welds

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- SMR is considering whether inservice examination requirements from the vessel (volumetric) or pipe (volumetric and surface) sections should be applied
  - PIF – Concern that an additional surface inservice inspection requirement will contribute to higher worker dose
  - SGE riser – Liquid dye penetrant and magnetic particle examinations are not feasible given the location inside the SGE, currently evaluating feasibility of eddy current testing

- Question: Do surface inspections of these thick-walled locations merit these ALARA and technical issues?

Future Work – Operational Controls and Program

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- Reviewing and incorporating all the 'leakage-monitoring-related-positions' from RG 1.45, Guidance on Monitoring and Responding to RCS Leakage
- Generating Potential Technical Specifications, License Commitments, Potential Automatic actions, and Operator Actions
- Generating operational program considerations used to identify potential issues with RCPB integrity/leakage
- Assessing both in-service and shutdown inspection frequencies, surveillances, and potential real-time monitoring systems to assist with the early identification of any RCPB leakage (CVAP, LRD, App J)

Future Work – Leak Before Break

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- SMR work ongoing to develop and implement LBB methodology, plan to use as intended for a handful of locations
- Also intend to perform LBB analysis on PIF per NRC suggestion to potentially bolster exemption justification
- LBB does not seem appropriate for the SGE riser given the external environment is a pressurized fluid

- Question: Does the application of LBB methodology to the SGE riser makes sense? SMR is concerned about the ability to draw meaningful conclusions from this application.

Future Work – Weld Residual Stress

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- The NRC provided feedback during the 10/19/22 meeting that SMR should identify the impact of weld residual stresses for highly restrained areas such as portions of the PIF and SGE Riser
- SMR intends to perform localized post weld heat treatments to minimize weld residual stress in accordance with the ASME Code
- Since the post weld heat treatment will be performed in the field once installed, significant assumptions will need to be made at this time to provide the necessary inputs to perform an analysis of the WRS.

- Question: Does the NRC expect an in-depth analysis of WRS? SMR is concerned about justifying a number of assumptions that would be necessary for a high-fidelity analysis.

Future Work – Probabilistic Fracture Mechanics

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- Following RG 1.245, Preparing PFM Submittals (2022)
- GRIZZLY (INL)
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- xLPR (EPRI)
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- Question: What experience does the NRC staff have with the GRIZZLY code? Are there other PFM codes that the NRC staff has recent experience reviewing?

Future LOCA Exemption Justification Updates - Schedule

- Update #1 – 4/5/23
  - ✓ System Design Specifics
- Update #2 – 9/20/23
  - ✓ Operational Programs and Considerations
- Update #3 – 4Q23
  - ✓ Deterministic Fracture Analyses, LBB
- Update #4 – 1/2Q24
  - ✓ PFM codes, analysis, and methodologies
- Other updates as necessary pending results and NRC staff feedback

Open Forum