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Enhanced Risk-Informed Categorization Methodology for Pressure Boundary Components

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EPRI Project Manager

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REPORT SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) amended its regulations to provide an alternative approach for establishing the requirements for treatment of systems, structures, and components (SSCs) for nuclear power reactors using a risk-informed method of categorizing SSCs according to their safety significance. The NRC's 10 CFR 50.69 process allows a plant to categorize the safety significance of its SSCs using a robust categorization process defined in NEI00-04, *10 CFR 50.69 SSC Categorization Guideline,* as endorsed by NRC in Regulatory Guide 1.201. The risk-informed categorization process helps focus attention on SSCs that are the most important to plant safety while allowing increased operational flexibility for SSCs that are less important to plant safety. As experience has been gained with 10 CFR 50.69 categorization efforts, questions have arisen as to whether the existing methodology for pressure boundary components is excessively conservative and/or overly resource intensive relative to the value of insights developed.

Objective

The objective of this report is to develop an enhanced methodology for categorizing pressure boundary components in support of 10 CFR 50.69 applications.

Approach

EPRI initiated an effort to assess the existing methodology to determine if it was indeed excessively conservative and/or overly resource intensive. This effort included assessment of the existing process looking for excess conservatism or steps that were overly time-consuming given the level of insights obtained. Investigations were conducted into whether additional guidance could be developed, enhanced training developed, or modification to existing process implemented to address known issues. Based on the results of the investigations, an enhanced and streamlined approach for categorizing pressure boundary components was proposed.

Results

An enhanced methodology has been developed that provides a number of advantages compared with the existing approach for categorizing pressure boundary components. These include improvements in plant safety, reduced cost of categorization, and greater stability to the overall process.

Keywords

10 CFR 50.69
Passive categorization
Pressure boundary categorization
Risk-informed categorization

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Product Title: Enhanced Risk-Informed Categorization Methodology for Pressure Boundary Components

PRIMARY AUDIENCE: Individuals responsible for developing and implementing 10 CFR 50.69 programs

SECONDARY AUDIENCE: Individuals responsible for performing categorization using the 10 CFR 50.69 process

KEY RESEARCH QUESTION

Can an alternative process be developed to streamline the 10 CFR 50.69 categorization process for pressure boundary components?

RESEARCH OVERVIEW

The existing methodology for categorizing pressure boundary components was assessed to determine if there were improvement opportunities. This effort included assessment of the existing process looking for excess conservatism and steps that were overly time-consuming given the level of insights obtained. Investigations were conducted into whether additional guidance or enhanced training could be developed or whether modification to the existing process could address the issue. Depending upon the results of the investigations, the potential for developing a new and streamlined approach for categorizing pressure boundary components would also be investigated.

KEY FINDINGS

- It was determined that an enhanced methodology for categorizing pressure boundary components can be developed.
- The enhanced categorization methodology can be applied in a manner that reduces the cost of implementing 10 CFR 50.69 compared with the existing process.
- The enhanced categorization methodology also provides safety improvements that can be readily and cost-effectively identified and implemented.
- Because the enhanced categorization methodology identifies high safety-significant and low safety-significant (LSS) components up front, plant-specific application of alternative treatment on LSS components is significantly improved. For example:
  - Emergent issues on LSS components can be responded to more quickly rather than waiting for each individual system to be categorized.
  - Capital project planning will know in advance which components are LSS and therefore available for alternative treatment.

WHY THIS MATTERS

The new enhanced categorization process for pressure boundary components will reduce the cost of implementing a 10 CFR 50.69 program as compared with the existing categorization process. The new enhanced categorization process will improve plants' ability to implement alternative treatment (that is, cost reductions) on LSS components by saving calendar time in conducting the categorizations, thereby allowing more flexibility in responding to emergent issues, and by allowing for more long-term planning.

HOW TO APPLY RESULTS

Plants should compare their applicable plant programs to the prerequisites identified in Section 4.1. Once these prerequisites are confirmed to have been met, plants can implement the methodology contained in Section 4.2. Note: applicable licensee interactions with the plant's respective regulator may be required.

LEARNING AND ENGAGEMENT OPPORTUNITIES

Periodic workshops on 10 CRF 50.69–related topics are being held.

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ACRONYMS AND ABBREVIATIONS

AFW	auxiliary feedwater
ASME	American Society of Mechanical Engineers
BER	break exclusion region
BWR	boiling water reactor
CCDP	conditional core damage probability
CCW	component cooling water
CDF	core damage frequency
CLERP	conditional large early release probability
CR	control room
CST	condensate storage tank
CVCS	chemical and volume control system
DEGB	double-ended guillotine break
DID	defense in depth
ECCS	emergency core cooling system
EFW	emergency feedwater
EQ	equipment qualification
FAC	flow-accelerated corrosion
HELB	high-energy line break (synonymous with BER)
HPCI	high-pressure coolant injection
HPCS	high-pressure core spray
HSS	high safety-significant
HVAC	heating, ventilation, and air conditioning
IDP	integrated decision-making panel
IF	internal flooding
IPEEE	individual plant examination of external events
LAR	license amendment request

LERF	large early release frequency
LOCA	loss of coolant accident
LSS	low safety-significant
MFW	main feedwater
MOV	motor-operated valve
NEI	Nuclear Energy Institute
NNS	nonnuclear safety
NPS	nominal pipe size
NRC	U.S. Nuclear Regulatory Commission
PORV	power operated relief valve
PRA	probabilistic risk assessment
PWR	pressurized water reactor
RAW	risk achievement worth
RCS	reactor coolant system
RI-ISI	risk-informed in-service inspection
RI-RRA	risk-informed repair/replacement activities
RISC-1	risk-informed safety classification 1 (HSS and safety related)
RISC-2	risk-informed safety classification 2 (HSS and non-safety related)
RISC-3	risk-informed safety classification 3 (LSS and safety related)
RISC-4	risk-informed safety classification 4 (LSS and non-safety related)
RCPB	reactor coolant pressure boundary
RPV	reactor pressure vessel
RWST	refueling water storage tank
SCBA	self-contained breathing apparatus
SP	suppression pool
SPCL	success path component list
SPRA	seismic probabilistic risk assessment
SSC	system, structure, and/or component

SR	supporting requirement
SW	service water
UHS	ultimate heat sink

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1
INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) amended its regulations to provide an alternative approach for establishing the requirements for treatment of systems, structures, and components (SSCs) for nuclear power reactors using a risk-informed method of categorizing SSCs according to their safety significance. The 10 Code of Federal Regulations (CFR) 50.69 process [1] allows a plant to categorize SSCs according to their safety significance. A categorization process defined in Nuclear Energy Institute (NEI) 00-04 Rev. 0, *10 CFR 50.69 SSC Categorization Guideline* [2], has been endorsed, with clarifications by NRC in Regulatory Guide 1.201 [3]. The risk-informed categorization process helps focus attention on SSCs that are the most important to plant safety while allowing increased operational flexibility for SSCs that are less important to plant safety.

The process defined in NEI00-04 requires that all functions supported by the SSCs be categorized. With respect to categorization of SSCs having only a pressure-retaining function, or the pressure-retaining function of active components, NEI00-04 recommends using the process contained in American Society of Mechanical Engineers (ASME) Code Case N-660, "*Risk-Informed Safety Classification for Use in Risk-Informed Repair/Replacement Activities*" [4]. However, industry experience using N-660 identified the process as impractical and it was determined that additional guidance needed to be developed. To that end, Arkansas Nuclear One, Unit 2, volunteered to be an industry pilot plant demonstrating an updated methodology for categorizing pressure boundary components (that is, risk-informed repair/replacement activities [RI-RRA] methodology) [5, 6]. In this method, the component failure is assumed with a probability of 1.0, and only the consequence evaluation is performed. This methodology additionally applies deterministic considerations consistent with risk-informed decision-making principles (for example, defense in depth [DID] and safety margins) in determining the final safety significance of the component. The use of this method was initially approved for use in 10 CFR 50.69 applications by NRC in the final safety evaluation for Vogtle, Units 1 and 2, dated December 17, 2014 [7]. Since that time, each applicant for a 10 CFR 50.69 license amendment request (LAR) has used this process for categorizing pressure boundary components.

As experience was gained by a broader cross section of the industry, questions have arisen as to whether the existing methodology is too conservative and/or too resource intensive for the level of insights developed. In response to this concern, EPRI initiated an effort to assess the existing methodology to determine if it was indeed producing overly conservative results or requiring excessive resources. Based on the results of the investigations, an enhanced and streamlined approach for categorizing pressure boundary components was proposed.

To that end, this report provides a proposed enhanced approach for categorizing pressure boundary components for use in 10 CFR 50.69 applications. A second report is anticipated to be issued in 2020 that will provide additional background on the investigations that led to this new enhanced approach as well as providing implementation guidance.

2

10 CFR 50.69 CATEGORIZATION

2.1 10 CFR 50.69 Categorization Process

NEI00-04, Rev. 0 [2] as endorsed in Regulatory Guide 1.201 [3] is one acceptable method for conducting a risk-informed categorization of SSCs that provides evidence and confidence that SSCs will be categorized in a robust and integrated process consistent with 10 CFR 50.69(c)(1)(iv) [1]. The categorization process is performed for entire systems, one or more system at a time, to ensure that all functions (which are primarily a system-level attribute) for a given component within a given system are appropriately considered.

The process described in NEI00-04 and presented in Figure 2-1 contains a number of key elements, which are described in detail in [8] and are summarized as follows. These elements are used to arrive at a preliminary component categorization (that is, high safety-significant [HSS] or low safety-significant [LSS]):

- Full power internal events probabilistic risk assessment (PRA)
- Internal and external hazards
- Seven qualitative criteria in Section 9.2 of NEI00-04
- DID assessment
- Passive categorization methodology

The analyses that can be used to address the hazards in the first two items in the preceding list include:

- **Internal event risk analysis**. Full power internal events PRA, including internal flooding (IF)
- **Internal fire events**. EPRI Fire-Induced Vulnerability Evaluation [9] screening process or fire PRA.
- **Seismic events**. Success path component list (SPCL)[1] from an individual plant examination of external events (IPEEE) seismic margin analysis, seismic probability risk assessment (SPRA), or screening if the SPRA core damage frequency (CDF) is a small fraction of the internal events CDF (that is, <1%).
- **Other external events (for example, tornados and external floods)**. External (hazard) PRA model and/or IPEEE screening process.
- **Low power and shutdown risks**: Qualitative DID shutdown model for shutdown configuration risk management based on the framework for DID provided in NUMARC 91-06, "Guidance for Industry Actions to Assess Shutdown Management" [10].

[1] The term SPCL is used interchangeably in many seismic IPEEE documents with safe shutdown equipment list (SSEL).

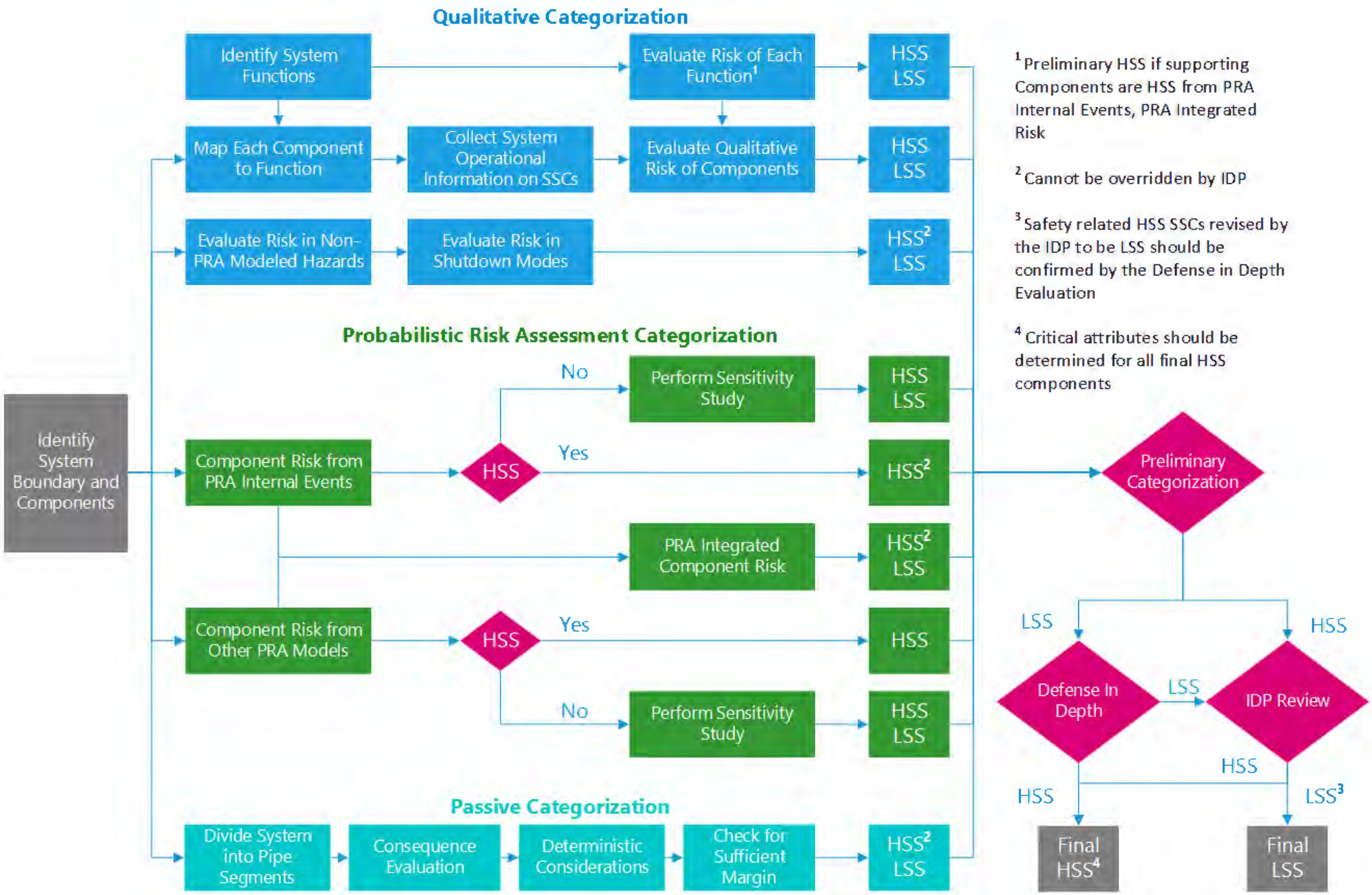


Figure 2-1
Categorization process overview [2]

With respect to the seven qualitative criteria contained in Section 9.2 of NEI00-04, the purpose of these considerations is to determine whether these functions/SSCs are not implicitly depended upon to maintain safe shutdown capability, prevention of core damage, and maintenance of containment integrity. Specifically, consideration is given to whether:

- Failure of the active function/SSC will not directly cause an initiating event that was originally screened out of the PRA based on anticipated low frequency of occurrence.
- Failure of the active function/SSC will not cause a loss of reactor coolant pressure boundary (RCPB) integrity resulting in leakage beyond normal makeup capability.
- Failure of the active function/SSC will not adversely affect the DID remaining to perform the function.
- The active function/SSC is not called out or relied upon in the plant emergency/abnormal operating procedures or similar guidance as the sole means for the successful performance of operator actions required to mitigate an accident or a transient.
- The active function/SSC is not called out or relied upon in the plant emergency/abnormal operating procedures or similar guidance as the sole means of achieving actions for assuring long-term containment integrity, monitoring of post-accident conditions, or offsite emergency planning activities.
- Failure of the active function/SSC will not prevent the plant from reaching or maintaining safe shutdown conditions, and the active function/SSC is not significant to safety during mode changes or shutdown.
- Failure of the active function/SSC that acts as a barrier to fission product release during plant operation or during severe accidents would not result in the implementation of offsite radiological protective actions.

As discussed in Sections 6 and 9 of NEI00-04 [2], in cases where the component is safety-related and found to be of low risk significance, it is appropriate to confirm that DID is preserved. This includes consideration of the events mitigated, the functions performed, the other systems that support those functions, and the complement of other plant capabilities that can be relied upon to prevent core damage and large, early release. Specific criteria are provided for assessing core damage DID, including preventing core damage and limiting the frequency of the events being mitigated (Section 6.1), and containment DID, including containment bypass, containment isolation, early hydrogen burns, and long-term containment integrity (Section 6.2).

Per NEI00-04, DID is maintained if the following occurs:

- Reasonable balance is preserved among prevention of core damage, prevention of containment failure or bypass, and mitigation of consequences of an offsite release.
- There is no overreliance on programmatic activities and operator actions to compensate for weaknesses in the plant design.
- System redundancy, independence, and diversity are preserved commensurate with the expected frequency of challenges, consequences of failure of the system, and associated uncertainties in determining these parameters.
- Potential for common cause failures is taken into account in the risk analysis categorization.
- The overall redundancy and diversity among the plant’s systems and barriers is sufficient to ensure that no significant increase in risk would occur.

Finally, using the existing process, pressure boundary components (that is, passive components and the passive function of active components) are evaluated using a consequence assessment approach where the component failure is assumed with a probability of 1.0 and only the consequence evaluation is performed. It relies on the conditional core damage and large early release probabilities associated with postulated ruptures. This approach is conservative compared with including the rupture frequency in the categorization because this approach does not take into account hazard frequency. Deterministic considerations (for example, DID and safety margins) are then also applied to determine the final safety significance from a passive perspective. Component supports are assigned the same safety significance as the highest passively ranked component within the bounds of the associated analytical pipe stress model.

By following the above process, the determination of safety significance through the various elements identified above is considered to provide a robust and integrated categorization of SSCs. The results of these elements are used as inputs to arrive at a preliminary component categorization (that is, HSS or LSS) that is then presented to the integrated decision-making panel (IDP), a multidiscipline panel of experts that reviews the results of the initial categorization and finalizes the categorization of the SSCs/functions. Note that the term *preliminary HSS or LSS* is synonymous with the NEI00-04 term *candidate HSS or LSS*. A component or function is preliminarily categorized as HSS if any element of the process results in a preliminary HSS determination in accordance with Table 2-1. Consistent with NEI00-04, the categorization of a component or function will only be *preliminary* until it has been confirmed by the IDP. Once the IDP confirms that the categorization process was followed appropriately, the final risk-informed safety classification (RISC) category can be assigned.

The IDP may direct and approve detailed categorization of components in accordance with NEI00-04 Section 10.2. The IDP may always elect to change a preliminary LSS component or function to HSS; however, the ability to change component categorization from preliminary HSS to LSS is limited. This ability is only available to the IDP for select process steps as described in NEI00-04 [2] and endorsed by RG1.201 [3]. Table 2-1 summarizes these IDP restrictions in NEI00-04. The steps of the process are performed at the function level, the component level, or both. This is also summarized in Table 2-1. A component is assigned its final RISC category upon approval by the IDP.

As a final note relative to the purpose of this report, the NEI00-04 section on integrated risk assessment includes the following.

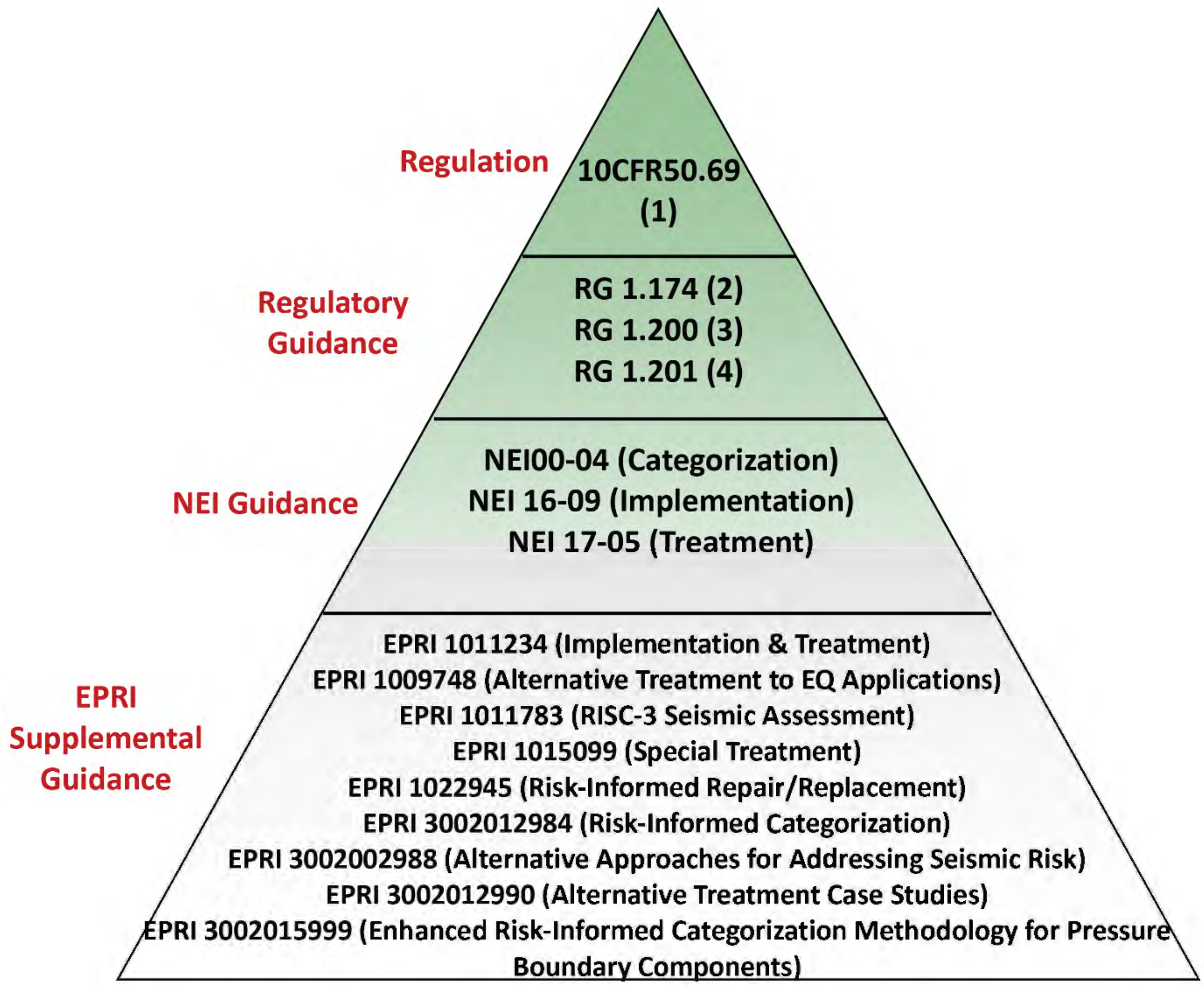
> Each risk contributor is initially evaluated separately in order to avoid reliance on a combined result that may mask the results of individual risk contributors. The potential masking is due to the significant differences in the methods, assumptions, conservatisms and uncertainties associated with the risk evaluation of each. In general, the quantification of risks due to external events and non-power operations tend to contain more conservatisms than internal events, at-power risks. As a result, performing the categorization simply on the basis of a mathematically combined total CDF/LERF would lead to inappropriate conclusions. However, it is desirable in a risk-informed process to understand safety significance from an overall perspective, especially for SSCs that were found to be safety-significant due to one or more of these risk contributors.

Table 2-1
IDP changes from preliminary HSS to LSS

Element	Categorization Step – NEI00-04 Section	Evaluation Level	IDP Change HSS to LSS	Drives Associated Functions
Risk (PRA modeled)	Internal Events Base Case – Section 5.1	Component	Not allowed	Yes
	Fire, Seismic, and Other External Events Base Case		Allowable	No
	PRA Sensitivity Studies		Allowable	No
	Integral PRA Assessment – Section 5.6		Not allowed	Yes
Risk (non-modeled)	Fire, Seismic and Other External Hazards	Component	Not allowed	No
	Shutdown – Section 5.5	Function/component	Not allowed	No
DID	Core Damage – Section 6.1	Function/component	Not allowed	Yes
	Containment – Section 6.2	Component	Not allowed	Yes
Qualitative criteria	Considerations – Section 9.2	Function	Allowable	N/A
Passive	Passive – Section 4	Segment/component	Not allowed	No

2.2 Relationship to the Rule and Other Guidance Documents

Figure 2-2 illustrates how this report relates to the 10 CFR 50.69 rule [1] and other guidance documents. Requirements for implementing risk-informed categorization and treatment of SSCs are described in 10 CFR 50.69 [1], the adoption of which is voluntary. The rule provides requirements for both phases of implementation: categorization and the resulting treatment allowances.



(1) 50.69 Risk-informed categorization and treatment of structures, systems, and components for nuclear power reactors
(2) An approach for using probabilistic risk assessment in risk-informed decisions on plant-specific changes to the licensing basis
(3) An approach for determining the technical adequacy of probabilistic risk assessment results for risk-informed activities
(4) Guidance for categorizing structures, systems, and components in nuclear power plants according to their safety significance

Figure 2-2
Relationship with the 10 CFR 50.69 rule and other guidance documents

3 OPTIONS EVALUATED AND KEY INSIGHTS AND CONSIDERATIONS

As mentioned earlier, some plants have chosen to voluntarily adopt 10 CFR 50.69 categorization efforts as part of an effort to increase operational and licensing efficiencies. As more plants have gained experience with the categorization process under 10 CFR 50.69, questions have arisen as to whether the existing methodology for categorizing pressure boundary components is too conservative and/or too resource intensive given the level of insights developed. In response to this question, EPRI initiated an effort to assess the existing methodology to determine if it was indeed producing too conservative results or requiring excessive resources. Based on the results of the investigations, an enhanced and streamlined approach for categorizing pressure boundary components was proposed.

This section briefly lists a number of options considered in addressing this industry need and provides insights into the decision to develop a new enhanced categorization process for pressure boundary components.

In Table 3-1, a number of the options considered is provided. Each option is identified with a number, title, and description. The strength and challenge/limitation for each option is then summarized. Finally, a conclusion/recommendation is provided.

Table 3-1
Summary of options considered

	Title	Description	Strengths	Limitations/Challenges	Initial Assessment
1	Streamline existing process				
1A	Treatment of standby systems	Streamline the existing process by providing additional direction/criteria for assessing the impact of failure of standby systems.	• Collapses medium, low, and none consequence ranks into one bin • Addresses skill set issue by removing some confusion • Does not require NRC interaction	• Still needs to assess spatial effects • Still needs a stand-alone assessment of standby system (that is, not extracted from existing PRA model/ documentation) • Doesn't address primary concerns (for example, resource requirements, conservatisms)	Minor cost savings and complexity reduction. Recommendation would be to enhance guidance.
1B	Clarify additional considerations	Add additional guidance and clarifications, with examples.	• Minimizes confusion • Does not require NRC interactions	• Still needs to address questions that do not typically provide much value (for example, LSS to HSS) • Doesn't address primary concerns (for example, resource requirements, conservatisms)	Minor cost saving and complexity reduction.
1C	Modify additional considerations	Modify and possibly delete some questions.	• Minimizes confusion • Focuses remaining questions on areas that will move LSS to HSS	• Does require NRC interactions • Doesn't address primary concerns (for example, resource requirements, conservatisms)	Minor cost saving and complexity reduction.

Table 3-1 (continued)
Summary of options considered

	Title	Description	Strengths	Limitations/Challenges	Initial Assessment
1D	Clarify guidance for addressing shutdown	Additional guidance/examples that highlight when shutdown aspects would drive LSS to HSS (not expected to be often).	• Minor resource and confusion savings • Does not require NRC interactions	Doesn't address primary concerns (for example, resource requirements, conservatisms)	Minor cost saving and complexity reduction.
2	Develop basis for eliminating the evaluation of shutdown	Develop a basis for showing that other plant activities are in place that control shutdown risk irrespective of an SSC's categorization (for example, RISC-1 versus RISC-3).	Minor resource and confusion savings for pressure boundary but potential large overall savings	Does require NRC interactions	Some cost saving and confusion reduction.
3	Adapt to more fully align with other risk-informed processes (for example, risk-informed in-service inspection [RI-ISI] process in TR-112657 Rev B-A) [11]	Incorporate failure probability/degradation mechanism process using existing/modified risk matrix. May require risk categories RC1-RC5 to be HSS.	More realistic than existing RI-RRA process that is strictly consequence based	• Still need to assess spatial effects • Still need a stand-alone assessment of standby system • Need to develop process and basis (for example, degradation mechanisms for non-piping components) • May need to perform delta risk calculation or sensitivity (NEI00-04) • NRC interactions required • Doesn't address resource requirements concern (may increase resource requirements)	Limited cost savings, will require further efforts.

Table 3-1 (continued)
Summary of options considered

	Title	Description	Strengths	Limitations/Challenges	Initial Assessment
4	Use of IF PRA				
4A	Use existing IF PRA with no modifications	Use RG1.200 compliant IF PRA (already a 10 CFR 50.69 LAR requirement) with no modification to NEI00-04 supplied metrics/criteria.	• Cheaper and faster • Few segments show up as high CDF/LERF contributors	• Does not address standby system pressure boundary failures (no current technical basis for exclusion) • Existing NEI00-04 risk metrics will make pressure boundary SSCs HSS (for example, risk achievement worth [RAW]>2.0) • NRC interactions required	• Requires additional work (for example, metric to use, conducting delta risk analysis). • Would need to assess how this would impact alternative treatment. Currently, assuming a failure probability of 1.0, prospective alternative treatments cannot increase this failure probability and therefore there is no need for sensitivity studies with the existing process. • While few segments typically show up as high CDF/LERF contributors, current metrics/criteria (for example, RAW> 2.0) would make many segments HSS (see Westinghouse Commercial Atomic Power-14572). • Could be resource intensive.

Table 3-1 (continued)
Summary of options considered

	Title	Description	Strengths	Limitations/Challenges	Initial Assessment
4B	Upgrade IF PRA study to include standby configurations	Upgrade existing IF PRA to address failures of standby system using existing pressure boundary metrics (for example, conditional core damage probability [CCDP]/CLERP).	• Complete risk-informed evaluation using upgraded PRA model • Does not require NRC interactions	• Treatment of standby failures (for example, failure probability versus frequency, exposure time) (See TR-112657.) • Large resources and new ground	Could be resource intensive.
4C	Upgrade IF PRA study to explicitly address standby configurations and existing NEI00-04 metrics	Upgrade existing IF PRA to address failures of standby system using NEI00-04 risk metrics and values (for example, RAW of 2.0).	Complete risk-informed evaluation using upgraded PRA model	• Treatment of standby failures (for example, failure probability versus frequency, exposure time) (See TR-112657.) • Large resources and new ground and requires NRC interactions • Requires risk sensitivity be conducted	Could be resource intensive.
4D	Upgrade IF PRA to explicitly address standby configurations and alternative metrics	Upgrade existing IF to address failures of standby system using alternative risk metrics and values (for example, Birnbaum).	Complete risk-informed evaluation using upgraded PRA model	• Treatment of standby failures (for example, failure probability versus frequency, exposure time) (See TR-112657.) • Large resources and new ground and requires NRC interactions • Requires risk sensitivity be conducted • Requires developing a basis for threshold value	Resource intensive.

Table 3-1 (continued)
Summary of options considered

	Title	Description	Strengths	Limitations/Challenges	Initial Assessment
4E	Upgrade IF PRA to explicitly address standby configurations and absolute risk metric	Upgrade existing IF to address failures of standby system using absolute risk metric (CDF and LERF < X = LSS)	Complete risk-informed evaluation using upgraded PRA model	• Treatment of standby failures (for example, failure prob. versus frequency, exposure time) (See TR-112657.) • Large resources and new ground and requires NRC interactions • Requires risk sensitivity be conducted	Resource intensive.
4F	Upgrade IF PRA to explicitly address standby configurations and absolute risk metric	Upgrade existing IF to address failures of standby system using absolute risk metric (CDF and LERF < X = LSS) and DID (for example, CCDP/CLERP).	• Complete risk-informed evaluation using upgraded PRA model • Quantitatively addresses DID	• Treatment of standby failures (for example, failure prob. versus frequency, exposure time) (See TR-112657.) • Large resources and new ground and requires NRC interactions • Requires risk sensitivity be conducted	Resource intensive.
5	Develop basis and revise break size assumptions	Apply double-ended guillotine break (DEGB) assumption to only applicable systems/ segments (for example, flow-accelerated corrosion (FAC), high-energy line break (HELB) locations) and use something less (for example, 1/2 pipe diameter by 1/2 pipe wall thickness) for low energy systems.	Reduces conservatism in assessing impacts (flooding, timing)	Doesn’t address primary concerns (for example, resource requirements, existing skill set)	Substantial industry experience with this approach not succeeding.

Table 3-1 (continued)
Summary of options considered

	Title	Description	Strengths	Limitations/Challenges	Initial Assessment
6	Develop basis and revise break size assumptions and CCDP metric	Apply DEGB and CCDP to only applicable systems/segments (for example, FAC, HELB) and use 1/2 pipe diameter by 1/2 pipe thickness and separate CCDP for low energy systems.	Reduces conservatism in assessing impacts (flooding, timing)	• Still need to assess spatial effects • Still needs a stand-alone assessment of standby system (that is, not extracted from existing PRA model/ documentation) • Requires NRC interactions • Doesn't address primary concerns (for example, resource requirements, skill set)	Substantial industry experience with this approach not succeeding.
7	Develop a holistic approach				
7A	Use streamlined RI-ISI approach (ASME Code Case N716-1)	Use existing N716-1 scope and process.	• Stable and predictable • Easily implemented, cost-effective	• Current basis for N716 does not address scope of 50.69 • No basis for applicability to some Class 2 systems and all Class 3 systems • Change in risk currently only addresses impact on in-service inspection (for example, missing quality assurance, repair/replacement activities, seismic)	See option 7E below

Table 3-1 (continued)
Summary of options considered

	Title	Description	Strengths	Limitations/Challenges	Initial Assessment
7A				• Process requires multiple owner-defined programs (for example, FAC, intergranular stress corrosion cracking-boiling water reactors, localized corrosion) • Requires NRC interactions • Requires additional work	
7B	Modify scope of ASME Code Case N716-1 to address scope of 50.69	Use N716-1 as starting point and develop generic set of missing Class 2 and all Class 3 systems. Keep existing plant-specific screening (CDF/LERF) threshold.	• Stable and predictable • Easily implemented, cost-effective • More than half of U.S. fleet using this method.	• No clear adequate experience/data to draw from • Need to consider supplementing missing data with plant-specific screening threshold • Need to address Class 2 and Class 3 standby systems • Need to consider whether CDF of 1E-06/year and LERF of 1E-07/year are the right thresholds for this option • Method needs to be developed and tested • Need NRC interaction	See option 7E below

Table 3-1 (continued)
Summary of options considered

	Title	Description	Strengths	Limitations/Challenges	Initial Assessment
7C	Modify scope of N716 to address scope of 50.69 and add CCDP/CLERP thresholds	Use N716-1 as a starting point and develop generic set of missing Class 2 and all Class 3 systems. Add CCDP/CLERP (that is, to addresses DID) to exiting plant-specific screening (CDF/LERF) threshold.	• Stable and predictable. • Easily implemented, cost-effective • More than half of U.S. fleet using this method	• There may not be adequate experience/data • Supplement data with plant-specific screening threshold. • How to address Class 2 and Class 3 standby systems • Are 1E-06/1E-07 the right thresholds for 50.69? • Method needs to be developed and tested • Need NRC interaction	See option 7E below
7D	Use streamlined RI-ISI approach (ASME Code Case N716-1) coupled with identification of what impacts the missing scope (for example, some Class 2 and all Class 3 systems)	Use existing N716-1 scope and process, coupled with programs that drive pressure boundary reliability.	• Stable and predictable • Easily implemented, cost-effective • More than half of U.S. fleet using this method	• Requires NRC interactions • Method needs to be developed and tested	See option 7E below

Table 3-1 (continued)
Summary of options considered

	Title	Description	Strengths	Limitations/Challenges	Initial Assessment
7E	Use streamlined RI-ISI approach (ASME Code Case N716-1), modified to address 50.69 scope (see 7C above) coupled with identification of what impacts missing scope (for example, some Class 2 and all Class 3 systems)	Use existing N716-1 scope and process, add additional 50.69 scope, coupled with programs/processes that drive pressure boundary reliability.	• Stable and predictable • Easily implemented, cost-effective • More than half of U.S. fleet using this method	• Requires NRC interactions • Method needs to be developed and tested	Selected. See Sections 4, 5, and 6 of this report.

As presented in Table 3-1, a number of options and variations of options were considered in addressing whether the existing methodology for categorizing pressure boundary components is too conservative and/or too resource intensive. Some of these options identified that additional guidance would be of use to the industry. Some of this guidance has already been provided to the industry and future EPRI-sponsored workshops will provide additional technology transfer opportunities.

The conclusion drawn from the work summarized here in section 3 is that there is the possibility to develop an enhanced categorization methodology for pressure boundary components. This new methodology is provided in section 4.

4
ENHANCED CATEGORIZATION PROCESS FOR PRESSURE BOUNDARY COMPONENTS

This section describes an alternative (enhanced) methodology for categorizing pressure boundary components in 10 CFR 50.69 applications.

As will be seen in the following pages, this new method contains a set of prerequisites and a predetermined set of HSS systems/subsystems coupled with a plant-specific search for pressure boundary components that need to be added to the predetermined HSS scope.

This alternative approach provides a number of advantages compared with the existing approach for categorizing pressure boundary components. These advantages include the following:

- **Full scope approach**. 10 CFR 50.69 allows for the categorization to be done for a single system or set of systems. This new approach requires that a full plant evaluation be conducted. That is, all safety-related and non-safety-related systems will be determined to be either HSS or LSS from a pressure boundary function perspective. This greatly enhances RISC-3 alternative treatment planning while, as discussed in the following paragraph, also providing safety improvement opportunities (for example, RISC-2 components).[2]
- **Identification of RISC-2 components**. As mentioned previously, this new approach requires a full plant evaluation. Thus, from a pressure boundary function perspective, this will identify all RISC-2 components—which is not currently required by the system-by-system categorization approach allowed by 10 CFR 50.69—thereby providing a safety benefit immediately upon implementation by reducing the need to assess each component on a system-by-system basis. That is, consistent with 10 CFR 50.69(d) and (e), licensees will need to ensure that RISC-2 components (for example, piping segments) are capable of performing their function (that is, pressure-retaining) consistent with the categorization process assumptions by evaluating the treatment being applied to these SSCs to ensure that it supports the key assumptions in the categorization process that relate to their assumed performance. And, going forward, licensees will need to make adjustments as necessary to either the categorization or treatment processes so that the categorization process and results are maintained valid.
- **Robust and stable**. By defining a set of prerequisites and a set of predetermined HSS systems/subsystems, minor changes to other inputs (for example, PRA updates, 50.69(e) feedback and process adjustment) will have minimal to no impact on the categorization results during the initial application or during subsequent periodic updates.

[2] For a definition of RISC-1, RISC-2, RISC-3, and RISC-4, see the Acronyms and Abbreviations section of this report.

- **Cost-effective**. On a plant-specific basis, the new categorization methodology is applied once, no matter how many systems are selected for full 10 CFR 50.69 categorization and alternative treatment. Additionally, if a licensee were to categorize five systems in Year X and then were to categorize another five systems in Year X+1, the list of HSS systems/subsystems from a pressure boundary perspective would not change. Obviously, this would have a positive impact on the cost of pressure boundary categorization. Additionally, as discussed previously, this would provide stability to the overall categorization scheme.

4.1 Prerequisites

Prior to implementing the categorization process contained in section 4.2, a licensee will need to assure that the following prerequisites have been met. Each requirement is listed below and explained in further detail in succeeding paragraphs.

- Prerequisite 1 – PRA technical adequacy
  - Robust internal events PRA model, including IF
- Prerequisite 2 – Integrity management
  - Robust program that addresses localized corrosion
  - Robust program that addresses FAC
  - Robust program that addresses erosion
- Prerequisite 3 – Protective measures for IF events

Prerequisite 1 – PRA technical adequacy IF

As stated previously, the plant needs to have a robust internal events PRA, including IF. A similar requirement was imposed upon the development of RI-ISI programs. To help determine if a plant had a PRA sufficient to develop an RI-ISI program, EPRI report 1021467, *Probabilistic Risk Assessment Technical Adequacy Guidance for Risk-Informed In-Service Inspection Programs,* [12] was developed. This report identifies which portions of the PRA (that is, supporting requirements [SRs]) apply to the development of RI-ISI programs and for those portions of the PRA that do apply to (RI-ISI) programs, what level of technical adequacy is needed.

EPRI report 1021467 has been reviewed to identify whether its technical justification and conclusions are also valid for the categorization of pressure boundary components for 10 CFR 50.69 purposes. That is, is a PRA that meets the requirements of 1021467 sufficient to support the categorization of pressure boundary components for 10 CFR 50.69 purposes?

As it pertains to 10 CFR 50.69, insights obtained from this review of EPRI report 1021467 include the following:

- RI-ISI and 10 CFR 50.69 both require a living program component (for example, 10 CFR 50.69(e) Feedback and Process Adjustment).
- EPRI report 1021467 was able to show that inclusion of external hazards (for example, seismic and internal fires) was not required in order to develop an RI-ISI program because their inclusion would not change the conclusions derived from the RI-ISI process. Because of the broad spectrum of programs that can be impacted by 10 CFR 50.69, this conclusion may

be overly optimistic for 10 CFR 50.69 categorization purposes. However, as NEI00-4 requires that external hazards be included in the overall categorization process, they do not need to be explicitly addressed as part of this new enhanced methodology for pressure boundary components. (Note: EPRI Report 3002012988, *Alternative Approaches for Addressing Seismic Risk in 10CFR50.69 Risk-Informed Categorization* [13], has been developed as an alternative to NEI00-04 and is under review by NRC for the Calvert Cliffs application [14].

- EPRI report 1021467 makes several statements that key assumptions and treatment of uncertainties will not significantly impact the results of the RI-ISI program. As to 10 CFR 50.69 applications, key uncertainties and assumptions are addressed as part of the LAR process, so an explicit consideration for this new methodology is not required. (Note: NEI has developed a 10 CFR 50.69 LAR template that incorporates lessons learned from industry/NRC interactions on this topic.)
- Regarding SR IF-B2, report 1021467 noted that RI-ISI only applied to piping. 10 CFR 50.69 can also apply to tanks, gaskets, fitting, and so on. As the requirements for this SR apply to all capability categories, there is no change is needed to support 10 CFR 50.69 applications.
- SR IF-C3b deals with inter-area propagation and barriers to inter-area propagation, including penetrations, doors, walls, hatchways, and heating, ventilation, and air conditioning (HVAC) ducts. One of the prerequisites of this enhanced methodology is that these barriers cannot be categorized as RISC-3 without an explicit evaluation of the barriers' impact on the pressure boundary categorization results.
- SR IF-D6 deals with the consideration of human-induced floods. 10 CFR 50.69 categorization results (HSS or LSS) will not negatively or positively impact these actions.

In conclusion, PRA models meeting the guidance of EPRI report 1021467 taken together with the overall 10 CFR 50.69 categorization process (NEI00-04, EPRI report 3002012988 [2, 13]), and the LAR submittal and review process provides required confidence that the plant-specific internal events PRA including IF is robust and capable of identifying any plant-specific outliers that should be defined as HSS.

Prerequisite 2 – Integrity management

The following aspects address key issues associated with the reliability of passive SSCs:

- **Robust program that addresses localized corrosion**. The plant shall have a robust program that addresses localized corrosion (for example, pitting and microbiologically influenced corrosion that follows the guidance contained in EPRI reports TR-103403, *Service Water System Corrosion and Deposition Sourcebook* [15]; 3002003190, *Engineering and Design Considerations for Service Water Chemical Addition Systems*; [16]; TR-102063, *Guide for the Examination of Service Water System Piping* [17], 1010059, *Service Water Piping Guideline* [18], and 1016456, *Recommendations for an Effective Program to Control the Degradation of Buried Pipe* [19]. Program health can be determined via self-assessments, benchmarking, or peer review.
- **Robust program that addresses FAC**. The plant shall have a robust program to address FAC that follows the recommendations contained in EPRI report 3002000563 *Recommendations for an Effective Flow-Accelerated Corrosion Program* [20]. This may include the use of standardized health reports such as those developed out of NEI Efficiency Bulletin 16-34, *Streamline Program Health Reporting* [21].

- **Robust program that addresses erosion**. The plant shall have a robust program to address erosion that follows the guidance of EPRI report 3002005530, *Recommendations for an Effective Program Against Erosive Attack* [22]. For a number of licensees, this may be addressed as part of a license renewal commitment. Additionally, some licensees may include erosion within their FAC program, whereas other licensees may choose to address erosion as a separate program.

Prerequisite 3 – Protective measures for IF events

Protective measures for IF events (that is, floor drains, flood alarm equipment, and barriers) shall not be categorized as LSS unless additional evaluations have been conducted to show that loss of these measures, or a subset of these measures, will not invalidate the HSS determination provided in section 4.2.

4.2 Predetermined HSS Passive SSCs

The following section describes the scope of systems, subsystems, and piping segments that have been predetermined to be HSS. Table 4-1 also identifies the scope of predetermined components together with a listing of additional clarifications and considerations that were used in defining this scope.

HSS components shall include the following:

1. Class 1 portions of the RCPB, with the exception of the following:
    a. In the event of postulated failure of the component during normal reactor operation, the reactor can be shut down and cooled down in an orderly manner, assuming makeup is provided by the reactor coolant makeup system.
    b. The component is or can be isolated from the reactor coolant system by two valves in series (both closed, both open, or one closed and the other open). Each open valve must be capable of automatic actuation and, assuming the other valve is open, its closure time must be such that, in the event of postulated failure of the component during normal reactor operation, each valve remains operable and the reactor can be shut down and cooled down in an orderly manner, assuming makeup is provided by the reactor coolant makeup system only.
2. Applicable portions of the shutdown cooling pressure boundary function. That is, Class 1 and 2 components of systems or portions of systems needed to use the normal shutdown cooling flow path in either of the following ways:
    a. As part of the RCPB from the reactor pressure vessel (RPV) to the second isolation valve (that is, farthest from the RPV) capable of remote closure, or to the containment penetration, whichever encompasses the larger number of welds
    b. As part of other systems or portions of systems from the RPV to the second isolation valve (that is, farthest from the RPV) capable of remote closure or to the containment penetration, whichever encompasses the larger number of welds

3. Class 2 portions of steam generators and Class 2 feedwater system components greater than nominal pipe size (NPS) 4 (DN 100) of pressurized water reactors (PWRs) from the steam generator to the outer containment isolation valve.
4. Components larger than NPS 4 (DN 100) within the break exclusion region (BER) for high-energy piping systems, as applicable.
5. Portions of the ultimate heat sink (UHS) flow path (for example, service water) whose failures will fail both trains (that is, unisolable failure of the UHS function). (Note: even if piping is isolated/independent, structures such as the service water pumphouse [for example, reservoir, bay] would be expected to be HSS.)
6. Tanks/vessels and connected piping and components up to the first isolation valve that support/provide inventory to multiple systems/functions (for example, refueling water storage tank [RWST] and containment sump for PWRs, suppression pool [SP] for boiling water reactors [BWRs]).
7. Condensate storage tank (CST) for auxiliary feedwater (AFW)/emergency feedwater (EFW) in a PWR unless there is a redundant independent reliable source (for example, auto switchover to service water supply to each train of AFW/EFW suction). This includes connected piping greater than 4 in. (101.6 mm) up to the first isolation valve in the AFW/EFW protected volume of the CST.
8. For PWR plants, low-volume, intermediate safety systems that typically consist of two physically independent trains (for example, component cooling water [CCW]) that are, on a plant-specific basis, physically connected. For example, loss of pressure boundary integrity of train A will drain train B as well.
9. Heat exchangers that if they fail (for example, tube or tubesheet failures) could allow reactor coolant to bypass primary containment.
10. Other heat exchangers—if not explicitly addressed in 11 through 13 below, other heat exchangers should be evaluated to determine if component failure (for example, tube or tubesheet) may impact multiple systems. If yes, the methodology and criteria of [5, 6] shall be used to determine HSS versus LSS assignment.
11. Any piping or component (including piping segments or components grouped or subsumed within existing plant initiating event groups) whose contributions to CDF is greater than 1E-06/year, or whose contribution to LERF is greater than 1E-07/year, based upon a plant-specific PRA model that includes pressure boundary failures (for example, pipe whip, jet impingement, spray, and inventory losses).
12. Any piping or component (including piping segments or components grouped or subsumed within existing plant initiating event groups) whose contributions to CDF is greater than 1E-08/year and the product of its CDF contribution times its associated CCDP is greater than 1E-08/year, based upon a plant-specific PRA of pressure boundary failures (for example, pipe whip, jet impingement, spray, and inventory losses). (See Figure 4-1.)

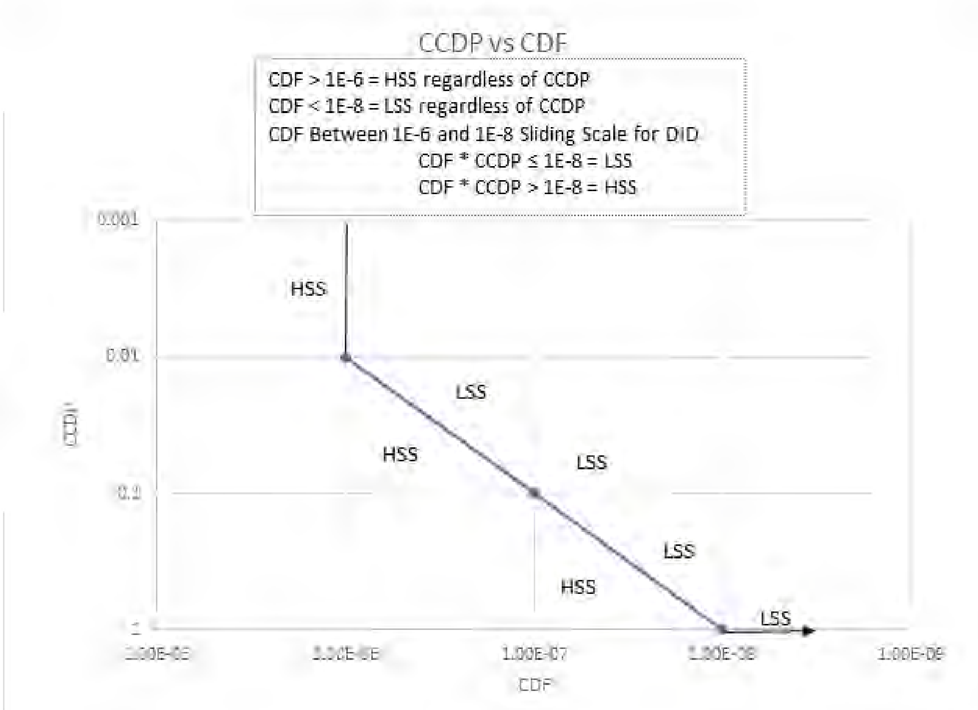


Figure 4-1
CCDP versus CDF threshold

13. Any piping or component (including piping segments or components grouped or subsumed within existing plant initiating event groups) whose contributions to LERF is greater than 1E-09/year and the product of its LERF contribution times its associated CLERP is greater than 1E-09/year, based upon a plant-specific PRA of pressure boundary failures (for example, pipe whip, jet impingement, spray, and inventory losses). (See Figure 4-2.)

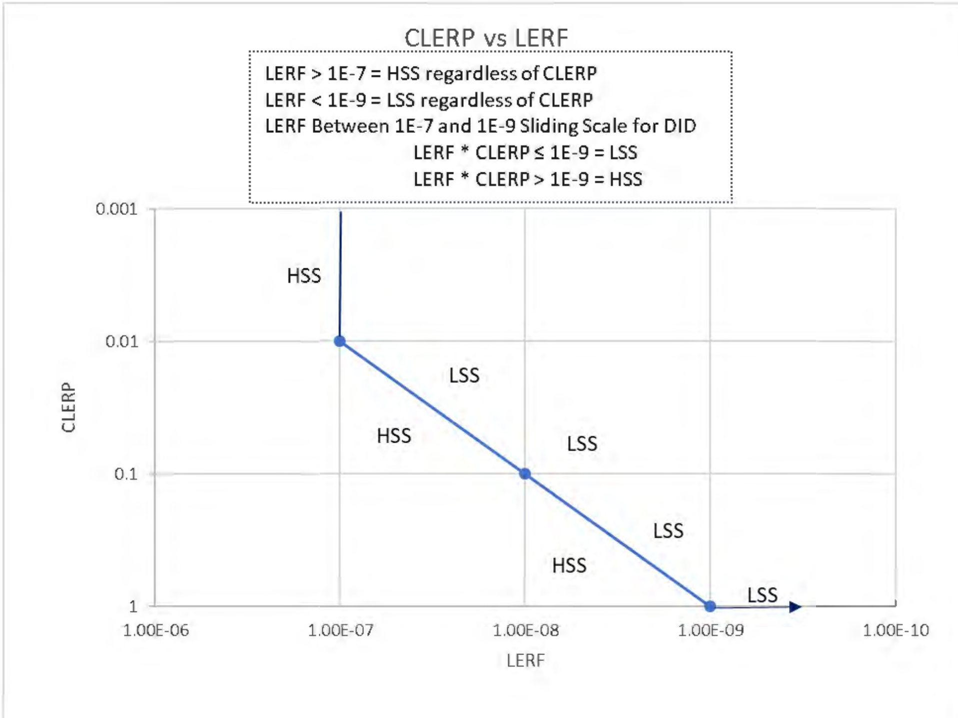


Figure 4-2
CLERP versus LERF threshold

14. Piping/component support boundaries. Any of the following options may be used:

   a. Supports (for example, component support, hanger, or snubber) may remain un-categorized until a need has been identified (for example, a significant repair/replacement or modification is required).

   b. A component support, hanger, or snubber shall have the same categorization as the highest ranked piping segment within the piping analytical model in which the support is included.

   c. A combination of restraints or supports such that the LSS piping and associated SSCs attached to the HSS piping are included in scope up to a boundary point that encompasses at least two supports in each of three orthogonal directions [23, 24].

Systems, subsystems, and segments that meet any of the criteria in the are to be categorized HSS. All other safety-related and non-safety-related systems, subsystems, and components not classified as HSS in accordance with the preceding list shall be categorized LSS.

Table 4-1
HSS criteria—considerations

No.	HSS Criteria	Premise	Additional Considerations
1	RCPB (Class 1)	Consistent with LARs approved to date	Some piping between the first and second isolation could be medium/low consequence (that is, possible RISC-3).
2	Applicable portions of the shutdown cooling pressure boundary function. Class 1 and 2 components of systems or portions of systems needed to use the normal shutdown cooling flow path either: (a) as part of the RCPB from the RPV to the second isolation valve (that is, farthest from the RPV) capable of remote closure, or to the containment penetration, whichever encompasses the larger number of welds, or (b) other systems or portions of systems from the RPV to the second isolation valve (that is, farthest from the RPV) capable of remote closure or to the containment penetration, whichever encompasses the larger number of components	Consistent with some of the insights from previous pressure boundary categorization efforts (for example, 10 CFR 50.69, RI-ISI, RI-RRA)	Some Class 2 components in PWRs will be HSS that might otherwise be LSS if other parts of NEI00-04 do not make HSS. But probably driven HSS by consideration of shutdown events.
3	Class 2 portions of steam generators and Class 2 feedwater system components greater than NPS 4 (DN 100) of PWRs from the steam generator to the outer containment isolation valve	Consistent with some of the insights from previous pressure boundary categorization efforts (for example, risk-informed break exclusion region, RI-RRA). High-energy system	Some components will be HSS per this enhanced methodology that might otherwise be LSS based on PRA and plant design.
4	Components larger than NPS 4 (DN 100) within the BER for high-energy piping systems as defined by the owner	Consistent with some of the insights from previous pressure boundary categorization efforts (for example, 10 CFR 50.69, RI-BE) High energy system Typically, cannot meet single failure criteria and/or equipment qualification (EQ) issue	Some components will be HSS that might otherwise be LSS based on PRA and plant design.

Table 4-1 (continued)
HSS criteria—considerations

No.	HSS Criteria	Premise	Additional Considerations
5	Portions of the ultimate heat sink flow path (for example, service water) whose failures will fail both trains (that is, fail the UHS function). (Note: even if piping is isolated/independent, the service water pumphouse [for example, reservoir, bay] would be expected to be HSS.)	Consistent with present passive categorization method where loss of safety function is loss of DID	This should be redundant to rows 11–13 below.
6	Tanks/vessels and connected piping and components up to the first isolation valve that support/provide inventory to multiple systems/functions (for example, RWST for PWRs, containment sumps, SP for BWR).	Consistent with present passive categorization method where loss of safety function is loss of DID	None
7	CST for AFW/EFW in a PWR unless there is a redundant independent reliable source (for example, auto switchover to service water supply to each train of AFW/EFW suction).	Consistent with present passive categorization method where loss of safety function is loss of DID	None
8	For PWR plants, low-volume, intermediate safety systems that typically consist of two physically independent (for example, component cooling water) trains that are, on a plant-specific basis, physically connected. For example, loss of pressure boundary integrity on train A will drain train B as well.	Relies on risk insights indicating plant designs with physically independent CCW trains (for example, 2 surge tanks) are LSS, while plants without separation are not.	Might be overly conservative, but PRA results presently indicate that total loss of CCW is a high consequence at most PWR plants.
9	Heat exchangers that if they fail (for example, tube or tubesheet failures) could allow reactor coolant outside primary containment.	Addresses important containment issues that might not be typically covered by PRA importance measures Confirmation of risk insight/ safety insights	May be covered by row 11 of this table (LE-D4 of [25]) except maybe during shutdown, which is typically not included in full power operation IF.
10	Other heat exchangers—if not explicitly addressed in rows 11– 14 of this table, other heat exchangers should be evaluated to determine if component failure (for example, tube or tubesheet) may impact multiple systems. If yes, the methodology and criteria of [5, 6] shall be used to determine HSS versus LSS assignment.	Experience to date: only applicable to service water (SW) floods	Experience to date: only applicable to SW floods. Add guidance from rows 11–13 of this table.

Table 4-1 (continued)
HSS criteria—considerations

No.	HSS Criteria	Premise	Additional Considerations
11	Any piping or component (including piping segments or components grouped or subsumed within existing plant initiating event groups) whose contribution to CDF is greater than 1E-06/year, or whose contribution to LERF is greater than 1E-07/year, based upon a plant-specific PRA of pressure boundary failures (for example, pipe whip, jet impingement, spray, and inventory losses). This may include Class 1 and 2 and Class 3, or non-class components.	Agreement from NRC based on N716 scope Consistent with risk-informed decision-making philosophy Safety improvement	Need to reexamine applicable SRs and capability categories.
12	Any piping or component (including piping segments or components grouped or subsumed within existing plant initiating event groups) whose contribution to CDF is greater than 1E-08/year and the product of its CDF contribution times its associated CCDP is greater than 1E-08/year, based upon a plant-specific PRA of pressure boundary failures (for example, pipe whip, jet impingement, spray, and inventory losses)	Consistent with risk-informed decision-making philosophy Safety improvement Incorporates DID	Requires additional minor spreadsheet calculations for CDF times CCDP.
13	Any piping or component (including piping segments or components grouped or subsumed within existing plant initiating event groups) whose contribution to LERF is greater than 1E-09 and the product of its LERF contribution times its associated CLERP is greater than 1E-09, based upon a plant-specific PRA of pressure boundary failures (for example, pipe whip, jet impingement, spray, and inventory losses).	Consistent with risk-informed decision-making philosophy Safety improvement Incorporates DID	Requires additional minor spreadsheet calculations for CDF times CCDP.

Table 4-1 (continued)
HSS criteria—considerations

No.	HSS Criteria	Premise	Additional Considerations
14	Piping/component support boundaries. Any of the following options may be used: (a) Supports (component support, hanger, or snubber) may remained un-categorized until a need has been identified (for example, a significant repair/replacement or modification is required). (b) A component support, hanger, or snubber shall have the same categorization as the highest ranked piping segment within the piping analytical model in which the support is included. (c) A combination of restraints or supports such that the LSS piping and associated SSCs attached to the HSS piping are included in scope up to a boundary point that encompasses at least two (2) supports in each of three (3) orthogonal directions.	Additional flexibility included in option (c) Consistent with previously NRC-approved positions (for example, license renewal, subsequent license renewal)	Options consistent with previous NRC approved positions.

5
REVIEW OF SYSTEMS AGAINST PROPOSED METHODOLOGY

As previously discussed, a report will be issued in 2020 providing additional implementation guidance on use of this methodology, including insights from the reviews done in order to develop this enhanced categorization methodology. As discussed previously, one task consisted of reviewing a number of plant-specific 10 CFR 50.69 system categorizations in order to develop insights into those systems/subsystems that are typically categorized as HSS and those that are typically categorized as LSS. To further the development of the enhanced methodology as well as to confirm its robustness, the proposed methodology was also compared with a list of plant systems, including systems that have not gone through a 10 CFR 50.69 categorization effort from a number of BWR and PWR plants. This group of plants consisted of multiple designs and included earlier and later vintage designs. The results of this review, which confirmed that the enhanced methodology defined in Section 4 is truly robust, are provided in sections 5.1 and 5.2.

Note: As stated above, the intent of this section is to provide additional confidence that the enhanced methodology contained in Section 4 is robust. Licensees following the methodology contained in Section 4 do not have to conduct the additional review contained in this section, Section 5.

5.1 BWR Systems Review

In Table 5-1, a comprehensive list of BWR systems is provided. A premise of this review is that the PRA, including the IF analysis (criteria 11−13 of Section 4), will capture the most significant pressure boundary failures. This evaluation was conducted to identify where pressure boundary failures may be important and require further consideration, either because the system is not a flood source or where 10 CFR 50.69 experience has indicated HSS assignment may be appropriate. The following summarizes the columns in the table:

- The *Passive* column asks whether the system contains any pressure boundary components. If the answer is *No*, the passive SSC categorization does not apply.
- The *PRA Insights* column provides insights into whether the system is typically modeled in the plant PRA (for example, as part of the initiating events and/or plant response models in the internal events PRA, including IF). As noted, many flood sources are usually screened out based on limited volume and/or location.
- The *50.69 Conclusions* column summarizes situations that may require additional consideration beyond IF. *LSS* indicates system importance based on PRA insights when the system is not considered a flood source. The following notes expand on these:
  1. **RCPB**. Class 1 portions of the RCPB are HSS. RCPB components classified as Class 2 are LSS (for example, within a plant's normal makeup capacity). Note that several systems connecting to the reactor coolant system (RCS) may also have Class 1 components depending on the plant-specific definition of system boundaries (for example, main steam, feedwater, residual heat removal, high-pressure coolant injection, reactor core isolation cooling, and core spray).

2. **Diesel generators and their support systems**. These are LSS unless determined to be HSS by section 4.2 (criteria 11−13). For ventilation systems, even for shared systems/subsystems, passive redundancy supports LSS assignment.

3. **Service water, or equivalent (for example, spray pond)**, **that interface with heat exchangers and coolers**. Components that interface with service water could be HSS even if the rest of the system is LSS. This determination can be made by considering the importance of service water piping that supplies the component.

4. **Systems that are potentially a significant fire source or important to fire mitigation**. These systems may need further evaluation to support an LSS conclusion. As discussed in section 2, other parts of the 10 CFR 50.69 categorization effort require that internal fires be explicitly addressed in the categorization process that addresses this issue.

5. **Suppression pool (SP)**. The SP and system connections up to the first remotely operated valve (for example, motor-operated valve [MOV]) in the control room (CR) are HSS because their failure can result in loss of primary emergency core cooling system (ECCS) makeup and containment bypass. It is recognized that many BWRs may be able to demonstrate LSS with the PRA by taking credit for the CST and other external makeup sources (for example, fire water, service water).

6. **Ventilation**. These systems, including CR habitability, may be modeled when important to equipment cooling, but this function is typically LSS because of redundancy and backup procedures, such as using portable equipment. However, CR habitability (protecting operators from several hazards) and other functions such as reactor building filtration (standby gas treatment) and isolation during a fuel handling accident are typically not modeled in the PRA. The frequency of challenge from these hazards is relatively low, so the issue has been whether there is a pressure boundary failure that fails the sole means of operator response (for example, no DID). Based on present experience, there is sufficient pressure boundary redundancy or there are backup actions such as using portable self-contained breathing apparatus (SCBA) to protect operations personnel. There are also redundant indications of hazards present.

7. **Floor drains and other flood mitigation equipment (for example, doors, hatches)**. These features have to be HSS unless the importance has been evaluated. Note that small lines and spray events may have been screened based on drains being present.

8. **Structures (service water bays, buildings, doors, and so on)**. Safety-related structures are not pressure boundary components.

Table 5-1
BWR systems

System	Passive	PRA Insights	50.69 Conclusions
Main steam		Initiating event and modeled In IF scope	LSS with exception of Class 1 unless determined otherwise by PRA/IF (note 1)
Standby diesel generators, including high-pressure core spray (HPCS)		Modeled In IF scope (support systems)	LSS (note 2, note 3) Support systems usually screen in IF except possibly the cooler interface with service water (note 3)
Meteorological monitoring	No		
Circulating water		Initiating event and modeled In IF scope	LSS unless IF determines otherwise
Acid treatment/hypochlorite		Not modeled In IF scope – usually screens	LSS unless IF determines otherwise
Service water		Initiating event and modeled In IF and typically important	LSS unless IF determines otherwise
Hydrogen water chemistry		Not modeled In IF scope – usually screens	LSS unless IF determines otherwise
Alternate decay heat removal		Not modeled (shutdown) In IF scope	LSS unless IF determines otherwise
Service water chemical treatment		Not modeled In IF scope – usually screens	LSS unless IF determines otherwise
Traveling water screens and wash disposal		Initiating event and modeled In IF scope – usually screens	LSS unless IF determines otherwise
Reactor building closed loop cooling		Initiating event and modeled In IF scope	LSS unless IF determines otherwise
Turbine closed loop cooling		Initiating event and modeled In IF scope	LSS unless IF determines otherwise

Table 5-1 (continued)
BWR systems

System	Passive	PRA Insights	50.69 Conclusions
Makeup water treatment		Not modeled In IF scope	LSS unless IF determines otherwise
Makeup water storage and transfer		Not modeled In IF scope	LSS unless IF determines otherwise
Process sampling		Not modeled In IF scope	LSS unless IF determines otherwise
Instrument and service air		Initiating event and modeled Not in IF scope	LSS
Moisture separator reheater		Initiating event In IF scope – usually screens	LSS unless IF determines otherwise
Breathing air		Not modeled and not IF source	LSS
Main turbine	No		
Turbine generator lube oil		Initiating event In IF scope – usually screens	LSS unless IF determines otherwise Fire source (note 4) usually screens
Generator hydrogen seal oil		Initiating event In IF scope – usually screens	LSS unless IF determines otherwise Fire source (note 4) usually screens
Main turbine electrohydraulic control		Initiating event In IF scope – usually screens	LSS unless IF determines otherwise
Generator isolated phase duct cooling		Initiating event In IF scope – usually screens	LSS unless IF determines otherwise
Auxiliary steam, condensate, and gland seal		Initiating event In IF scope – usually screens	LSS unless IF determines otherwise
Generator stator and exciter rectifier cooling		Initiating event In IF scope – usually screens	LSS unless IF determines otherwise

Table 5-1 (continued)
BWR systems

System	Passive	PRA Insights	50.69 Conclusions
Generator H2 and CO2		Initiating event Not in IF scope	Fire source (note 4) usually screens
Reactor recirculation		Loss of coolant accident (LOCA) initiating event is modeled	Class 1 is HSS Class 2, 3, and nonnuclear safety (NNS) are LSS (note 1)
Condensate and feedwater		Initiating event and modeled In IF scope	LSS with exception of Class 1 unless determined otherwise by PRA/IF (note 1)
Control rod drive		Initiating event and modeled In IF scope – usually screens	LSS unless IF determines otherwise
Residual heat removal		Modeled and initiator during shutdown In IF scope	LSS unless determined otherwise by PRA/IF Class 1 (note 1) and SP (note 5) are HSS
Low-pressure core spray		Modeled In IF scope	LSS unless determined otherwise by PRA/IF Class 1 (note 1) and SP (note 5) are HSS
HPCS or HPCI		Modeled In IF scope	LSS unless determined otherwise by PRA/IF Class 1 (note 1) and SP (note 5) are HSS
Nuclear boiler ADS and SRVs		Initiating event and modeled Not in IF scope	LSS
Reactor core isolation cooling		Modeled In IF scope	LSS unless determined otherwise by PRA/IF Class 1 (note 1) and SP (note 5) are HSS
Standby liquid control		Modeled In IF scope	LSS unless determined otherwise by PRA/IF Class 1 (note 1) is HSS
Redundant reactivity control	No		
Reactor water cleanup		Initiating event In IF scope	LSS unless determined otherwise by PRA/IF Class 1 (note 1) is HSS

Table 5-1 (continued)
BWR systems

System	Passive	PRA Insights	50.69 Conclusions
Spent fuel pool cooling and cleanup		Not modeled In IF scope	LSS unless IF determines otherwise. Design precludes uncovering fuel and time.
Fuel handling and reactor service equipment	No		
Condensate storage and transfer		Modeled In IF scope	LSS unless IF determines otherwise. SP provides redundant ECCS source of water.
Off-gas		Initiating event, not flooding source	LSS
Fire protection – water		Not modeled except fire mitigation In IF scope and can be important	LSS unless IF identifies otherwise and unless important to fire mitigation (note 4)
Fire protection – foam		Not modeled except fire mitigation Not flood source	LSS unless important to fire mitigation (note 4)
Fire protection – carbon dioxide		Not modeled except fire mitigation Not flood source	LSS unless important to fire mitigation (note 4)
Fire protection – halon		Not modeled except fire mitigation Not flood source	LSS unless important to fire mitigation (note 4)
Fire detection	No		
Auxiliary boiler		Not modeled In IF scope – usually screens	LSS unless IF determines otherwise
Hot water and glycol heating		Not modeled In IF scope – usually screens	LSS unless IF determines otherwise
Condensate demineralizer		Not modeled In IF scope – usually screens	LSS unless IF determines otherwise
Domestic water		Not modeled In IF scope – usually screens	LSS unless IF determines otherwise

Table 5-1 (continued)
BWR systems

System	Passive	PRA Insights	50.69 Conclusions
Sanitary plumbing		Not modeled In IF scope – usually screens	LSS unless IF determines otherwise
Reactor building ventilation		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise (note 3, note 6)
Control building ventilation		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise; CR habitability (note 3, note 6)
Standby switchgear/batter room ventilation		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise (note 3, note 6)
Normal switchgear building ventilation		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS
Ventilation – chilled water		Could be modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Turbine building ventilation		Not modeled and not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise
Radwaste building ventilation		Not modeled and not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise
Diesel generator building ventilation		Modeled Not in IF scope unless cooler interface with service water or CCW	LSS passive redundancy (note 2)
Screenwell and fire pump room ventilation		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise

Table 5-1 (continued)
BWR systems

System	Passive	PRA Insights	50.69 Conclusions
Electrical tunnels ventilation		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise
Auxiliary building ventilation		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise
Miscellaneous ventilation		Not modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise
Drywell cooling		Initiating event Not in IF scope (inside containment)	LSS
Primary containment ventilation, purge, and nitrogen		Modeled – containment isolation Not in IF scope	LSS – redundancy (note 6)
Standby gas treatment		Not modeled Not in IF scope	LSS – unless IF identifies otherwise – fuel handling accident (note 6)
DBA hydrogen recombiner		Not modeled Not in IF scope	LSS
Reactor building drains		Not modeled except possibly IF Not in IF scope	LSS – if credited in IF, need to check importance (note 7)
Turbine building drains		Not modeled except possibly IF Not in IF scope	LSS – if credited in IF, need to check importance (note 7)
Radwaste building drains		Not modeled and not flood source	LSS
Miscellaneous drains		Not modeled and not flood source	LSS
Drywell equipment and floor drains		Not modeled and not flood source	LSS
Main generator exciter, transformer, switchyard, and protection	No		

Table 5-1 (continued)
BWR systems

System	Passive	PRA Insights	50.69 Conclusions
Station electric feed and switchyard	No		
13.8KV AC power distribution	No		
4.16KV AC power distribution	No		
600V AC power distribution	No		
Uninterruptible power supplies	No		
Standby and emergency AC distribution	No		
Normal DC distribution	No		
24/48 volt DC distribution	No		
Emergency DC distribution	No		
HPCS 125VDC	No		
Station lighting	No		
Plant communications	No		
Remote shutdown	No		
Radiation monitoring	No		
Feedwater heaters and extraction steam		Initiator In IF scope – usually screens	LSS unless IF identifies otherwise
Containment leakage monitoring		Not modeled and not flood source – small connections to containment that screen	LSS
Containment atmosphere monitoring		Not modeled and not flood source – small connections to containment that screen	LSS
Primary containment isolation		Containment isolation modeled as well as LOCA outside containment	LSS due to redundancy except for SP (note 5) and determined by IF/PRA
Reactor building crane	No		

Table 5-1 (continued)
BWR systems

System	Passive	PRA Insights	50.69 Conclusions
Loose parts monitoring	No		
Condenser air removal		Initiating and modeled Not a flood source	LSS
Seismic monitoring	No		
Process computer	No		
Safety parameter display	No		
Neutron monitoring	No		
Traversing in-core probe		Modeling consideration for path outside containment, but screens	LSS
Rod worth minimizer	No		
Rod sequence control	No		
Reactor manual control and rod position indication	No		
Reactor protection system	No		
Buildings and structures		Not modeled and not flood source	Buildings/structures response to external hazards must be considered (note 8)

5.2 PWR Systems Review

In Table 5-2, a comprehensive list of PWR systems is provided. As previously discussed, a premise of this review is that the PRA, including the IF analysis (criteria 11−13 of Section 4), will capture the most significant pressure boundary failures. This evaluation was conducted to identify where pressure boundary failures may be important and require further consideration, either because the system is not a flood source or where 10 CFR 50.69 experience has indicated HSS assignment may be appropriate. The following summarizes the columns in the table:

- The *Passive* column asks whether the system contains any pressure boundary components. If the answer is *No*, there is no reason to evaluate further.
- The *PRA Insights* column provides insights into whether the system is typically modeled in the plant PRA (initiating event, mitigation model, IF). As noted, many flood sources usually screen out based on limited volume and/or location.
- The *50.69 Conclusions* column summarizes situations that may require additional consideration beyond IF. *LSS* indicates system importance based on PRA insights when the system is not considered a flood source. The following notes expand on these:

  1. **CST**. For plants without a physical backup connection to AFW (for example, service water), the CST and all connections that can drain the CST up to the AFW pump should be HSS due to loss of secondary cooling function. The main suction path pipe size drains the CST too quickly to credit isolation. For connections less than 4-in. (101.6 mm), there is time to isolate.

  2. **Diesel generators and their support systems**. These are LSS unless determined to be HSS by section 4.2 (criteria 11−13). For ventilation systems, even for shared systems/subsystems, passive redundancy supports LSS assignment.

  3. **Systems that are potentially a significant fire source or important to fire mitigation**. These systems may need further evaluation to support an LSS conclusion. As discussed in section 2, other parts of the 10 CFR 50.69 categorization effort require that internal fires be explicitly addressed in the categorization process that addresses this issue.

  4. **CCW**. Plants with two physically independent trains (for example, two surge tanks) are LSS because of redundancy. Plants that have active redundancy (for example, multiple pumps) but do not have pressure boundary redundancy are usually HSS.

  5. **Structures (for example, service water bays, buildings, and doors)**. Safety-related structures are not pressure boundary components.

  6. **RCPB**. Class 1 portions of the RCPB are HSS. RCPB components classified as Class 2 are LSS (for example, within a plant's normal makeup capacity). Note that several systems connecting to the RCS may also have Class 1 components depending on the plant-specific definition of system boundaries (for example, chemical and volume control system [CVCS] and ECCS).

7. **RWST**. This has been determined to be HSS at several plants based on standby evaluation and complete loss of the ECCS function. The scope includes all main piping connections from the RWST up to the various supported pumps (for example, ECCS, containment spray, and CVCS), which includes the main suction path pipe for sizes that drain the RWST too quickly to credit isolation.

8. **Containment sump**. Plants with a pipe within a pipe at the containment penetration and with an encapsulated MOV outside containment can categorize this piping as LSS because it takes two independent passive failures to cause a failure of concern. Plant designs without this feature would categorize this scope as HSS. Note that piping downstream of the MOV interfaces with the RWST and should be HSS per note 7.

9. **Service water, or equivalent (for example, spray pond), that interface with heat exchangers and coolers**. Components that interface with service water could be HSS even if the rest of the system is LSS. This determination can be made by considering the importance of IF service water piping that supplies the component.

10. **Ventilation**. These systems, including CR habitability, may be modeled when important to equipment cooling, but this function is typically LSS because of redundancy and backup procedures such as using portable equipment. However, CR habitability (protecting operators from several hazards) and other functions such as fuel building filtration and isolation during a fuel handling accident are typically not modeled in the PRA. The frequency of challenge from these hazards is relatively low, so the issue has been whether there is a passive failure that fails the sole means of operator response (for example, no DID). Based on present experience, there is sufficient passive redundancy or there are backup actions such as using portable SCBA to protect operations personnel. There are also redundant indications of hazards present. Finally, ventilation systems are very low pressure with major portions operating during normal operation; it is questionable whether these systems should be postulated to fail on demand in the first place.

11. **Floor drains and other flood mitigation equipment (for example, doors, hatches)**. These features have to be HSS unless the importance has been evaluated. Note that small lines and spray events may have been screened based on drains being present.

Table 5-2
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Auxiliary boiler		Not modeled Not in use during power operations	LSS
Auxiliary feedwater		Standby mitigation system Suction sources (for example, CST and SW) should be included in IF	At one plant CST was only source and was HSS based on standby evaluation IF screened the CST in the yard (note 1)
Condenser		Initiating event and main feedwater (MFW) model In IF scope – usually screens	LSS unless IF identifies otherwise
HP heater drains and vent		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
LP heater and vent		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Feedwater		Initiating event and MFW model In IF scope	LSS unless IF identifies otherwise
Gland seal water supply		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Feedwater pump injection and miscellaneous		Initiating event In IF scope – usually screens	LSS unless IF identifies otherwise
Condensate		Initiating event and MFW model In IF scope	LSS unless IF identifies otherwise
Condensate demineralizer		Not modeled In IF scope	LSS unless IF identifies otherwise
Startup and recirculation		Not modeled	LSS
Condensate storage and transfer		Initiating event and modeled In IF scope	At one plant CST was only source and was HSS based on standby evaluation. IF screened the CST in the yard (note 1).

Table 5-2 (continued)
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Condensate and feedwater treatment system/secondary chemistry control		Not modeled In IF scope	LSS unless IF identifies otherwise
Condenser vacuum (off-gas)		Initiating event, not flooding source	LSS
13800V normal AC auxiliary power distribution	No		
6900V normal AC auxiliary power distribution	No		
480V normal AC auxiliary power distribution	No		
6900V Class 1E AC auxiliary power distribution	No		
480V Class 1E AC auxiliary power distribution	No		
120V Class 1E AC vital power distribution	No		
Class 1E AC auxiliary power distribution	No		
480Y/277V normal AC lighting	No		
208Y/120V normal AC lighting	No		
208Y/120V standby AC lighting	No		
125V normal DC power distribution	No		
250V normal DC power distribution	No		
125V normal DC power distribution	No		
26V turbine DC power distribution	No		
24V DC power distribution	No		
125V Class 1E vital power distribution	No		
120V normal AC power distribution	No		
48V telephone AC power distribution	No		
120V computer AC power distribution	No		
120V instrument AC power distribution	No		

Table 5-2 (continued)
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Fuel oil dispenser		May be modeled with diesels In IF scope	LSS unless IF identifies otherwise (note 2)
Breathing air		Not modeled and not flood source	LSS
CO2 storage, fire protection, and purging		Not modeled except fire mitigation Not flood source	LSS unless important to fire mitigation (note 3)
Nitrogen		Not modeled and not flood source	LSS
Hydrogen storage and transfer		Not modeled and not flood source	LSS unless important fire initiator (note 3)
Nitrogen storage and transfer		Not modeled and not flood source	LSS
Annunciator	No		
Integrated control	No		
Engineered safety features actuation system (ESFAS)	No		
Backup scram	No		
Integrated control	No		
ECCS and reactor coolant leak detection		Not modeled and not flood source	LSS – redundancy for operators
Temperature monitoring	No		
Solid state control	No		
In-core monitoring	No		
Nuclear instrumentation/reactor protection system and protection system auxiliary cabinets	No		
Radiation monitoring		Not modeled and not flood source	LSS – redundancy for operators
Nonnuclear instrumentation/essential controls and instrumentation	No		
Environmental monitoring	No		

Table 5-2 (continued)
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Core loose parts monitoring	No		
Seismic instrumentation	No		
Component cooling		Initiating event and modeled In IF scope, but limited volume	Plants with two physically independent trains (for example, two surge tanks) are LSS (note 4) unless IF determines otherwise (note 9)
Control rod drive cooling water		Initiating event In IF scope, but limited volume	LSS unless IF identifies otherwise
Essential raw cooling water		Initiating event and modeled In IF scope and typically important	LSS unless IF identifies otherwise (note 9)
Heat rejection (cooling tower, main condenser circulation water)		Initiating event and modeled In IF scope and typically important	LSS unless IF identifies otherwise
Raw cooling water		Initiating event and modeled In IF scope and typically important	LSS unless IF identifies otherwise (note 9)
Lube oil		May be modeled with turbine feedwater In IF scope – usually screens	LSS unless IF identifies otherwise Fire source (note 3) usually screens
Access system	No		
Heat trace system	No		
Elevators, reactor building, turbine building, auxiliary building, and service and office building		Not modeled and not flood source	Buildings/structures response to external hazards must be considered (note 5)
Clothing decontamination	No		
Lab gas		Not modeled and not flood source	Fire source (note 3) usually screens
Material and equipment handling	No		
Machine shop equipment	No		

Table 5-2 (continued)
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Chemical addition and boron recovery		Not modeled except for CVCS In IF scope – usually screens	LSS unless IF identifies otherwise
Reactor coolant		LOCA initiating event is modeled Power operated relief valves (PORVs), safety valves are modeled	Class 1 is HSS Class 2, 3, and NNS are LSS (note 6)
Decay heat removal		Modeled In IF scope	RWST interface is HSS (note 7) LSS unless IF identifies otherwise (note 9)
Fuel handling/reactor service	No		
Containment isolation penetration/leak test		Containment isolation modeled as well as LOCA outside containment	LSS due to redundancy except containment sump (note 8) and determined by IF
Reactor coolant system drains and vents		LOCA initiating event is modeled PORVs, safety valves are modeled	Class 1 is HSS Class 2, 3, and NNS are LSS (note 6)
Core flooding and ECCS		Modeled In IF scope	RWST interface is HSS (note 7) (note 8) LSS unless IF identifies otherwise ECCS accumulators are inside containment and LSS due to redundancy
Spent fuel cooling and cleaning		Not modeled In IF scope	LSS due to design – design precludes draining and significant time (note 9)
Containment combustible gas control		Not modeled and not in IF scope	LSS
Control rod drive	No		
Reactor building (containment) spray		Modeled In IF scope	RWST interface is HSS (note 7) (note 8) LSS unless IF identifies otherwise (note 9)
Makeup and purification		Modeled In IF scope	RWST interface is HSS (note 7) LSS unless IF identifies otherwise
Annunciation and operations supporting	No		

Table 5-2 (continued)
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Sound-powered telephone	No		
Code call, alarm, and paging	No		
DACOADA and automatic dispatching control circuit	No		
Communication equipment alarm	No		
Miscellaneous intercom	No		
Microwave radio	No		
Closed circuit television	No		
Communication test and fire detection	No		
VHF radio	No		
Security	No		
Automatic telephone	No		
Reactor building		Not modeled and not flood source	Buildings/structures response to external hazards (note 5)
Condenser cleaning		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Demineralized water		Not modeled In IF scope	LSS unless IF identifies otherwise
Fire protection		Not modeled except fire mitigation In IF scope and can be important	LSS unless IF identifies otherwise and unless important to fire mitigation (note 3)
Diesel generator starting air		Modeled and not in IF scope	LSS (note 2)
Service air		Not modeled	LSS
Control air		Could be modeled and initiator Not in IF scope	LSS – fail-safe valves

Table 5-2 (continued)
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Essential air		Initiator and modeled Not in IF scope	LSS
Raw service water		Could be modeled (NNS) In IF scope and can be important	LSS unless IF identifies otherwise (note 9)
Emergency diesel generator		Modeled In IF scope (support systems)	LSS (note 2, note 9) Support systems usually screen in IF except possibly the cooler interface with service water (note 9)
Conduit and grounding	No		
Plant lighting	No		
Auxiliary boiler/auxiliary steam		Not modeled May not be in IF scope since standby, but not important	LSS
Extraction steam		Initiator In IF scope – usually screens	LSS unless IF identifies otherwise
Main and reheat steam		Initiator In IF scope – usually screens	LSS unless IF identifies otherwise
Main steam relief vents		Initiator and modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Main turbine instrument and control	No		
Turbine drains and miscellaneous piping		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Main generator excitation	No		
Generator hydrogen cooling		Initiator, not modeled Not in IF scope	Fire initiator (note 3) Confined to turbine building

Table 5-2 (continued)
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Generator stator cooling		Initiator, not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Main generator seal oil		Initiator, not modeled In IF scope – usually screens	LSS unless IF identifies otherwise Fire initiator (note 3) Confined to turbine building
Turbine steam seal water		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Miscellaneous turbine vents		Not modeled Not in IF scope	LSS
Auxiliary building trained areas heating and vent		Could be modeled as cooling Not in IF scope	LSS
Auxiliary building fuel handling area environmental control		Not modeled Not in IF scope	LSS
Auxiliary building common area environmental control		Not modeled Not in IF scope	LSS
Instrument shop HVAC		Not modeled Not in IF scope	LSS
Auxiliary building trained areas air conditioning		May be modeled – chilled water In IF scope – usually screens	LSS unless IF identifies otherwise (note 10)
Auxiliary building common area air conditioning		Not modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise (note 9) (note 10)
Diesel generator building HVAC		Modeled Not in IF scope unless cooler interface with service water or CCW	LSS (note 2) unless IF identifies otherwise (note 9)

Table 5-2 (continued)
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Reactor building vent and purge		Modeled – containment isolation Not in IF scope	LSS – redundancy (note 10)
Reactor building heating		Not modeled Not in IF scope unless interface with hot water system – usually screens	LSS unless IF identifies otherwise
Reactor building air conditioning		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF determines otherwise (note 9, note 10)
Control building environmental control		Could be modeled Not in IF scope	LSS – CR habitability (note 10)
Control building non-ESF HVAC		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise (note 9)
CR emergency air		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise (note 9) CR habitability (note 10)
Service and office building HVAC		Not modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise (note 9)
Intake pumping station HVAC		Could be modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise (note 9) (note 10)
Service building ventilation		Not modeled Not in IF scope unless cooler interface with service water or CCW	LSS unless IF identifies otherwise (note 9)

Table 5-2 (continued)
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Service building heating		Not modeled Not in IF scope unless interface with hot water system – usually screens	LSS unless IF identifies otherwise
Service building air conditioning		Not modeled Not in IF scope unless interface with chilled water – usually screens	LSS unless IF identifies otherwise (note 9)
Turbine building air conditioning		Not modeled Not in IF scope unless interface with chilled water – usually screens	LSS unless IF identifies otherwise
Turbine building hot water heating		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Reactor building secondary containment air cleanup		Not modeled Not in IF scope	LSS
Miscellaneous yard building heat and ventilation		Not modeled Not in IF scope	LSS
Waste disposal		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Equipment and floor drains		Not modeled except possibly IF Not in IF scope	LSS – If credited in IF, need to check importance (note 11)
Gaseous waste disposal		Not modeled Not in IF scope	LSS
Liquid radwaste disposal		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Heat rejection water treatment		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise

Table 5-2 (continued)
PWR systems

System	Passive	PRA Insights	50.69 Conclusions
Health physics lab ventilation		Not modeled Not in IF scope	LSS
Sanitary waste disposal		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
161-kV switchyard	No		
500-kV switchyard and AC power distribution	No		
500-kV/24kV AC main transformers	No		
Main generator load break switch	No		
Main generator isolated phase bus	No		
24kV/13.8kV and 6.9kV unit station service XFRs	No		
Hypochlorite		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Raw water chlorination		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Cask decontamination		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Potable water system		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Sampling and water quality		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Steam generator secondary side chemical cleaning		Not modeled In IF scope – usually screens	LSS unless IF identifies otherwise
Reactor building pressure leakage test		Not modeled Not in IF scope	LSS

6
RISK-INFORMED DECISION MAKING FOR CATEGORIZING PRESSURE BOUNDARY COMPONENTS

In risk-informed decision-making, licensing basis changes are expected to meet a set of key principles (see Figure 6-1).

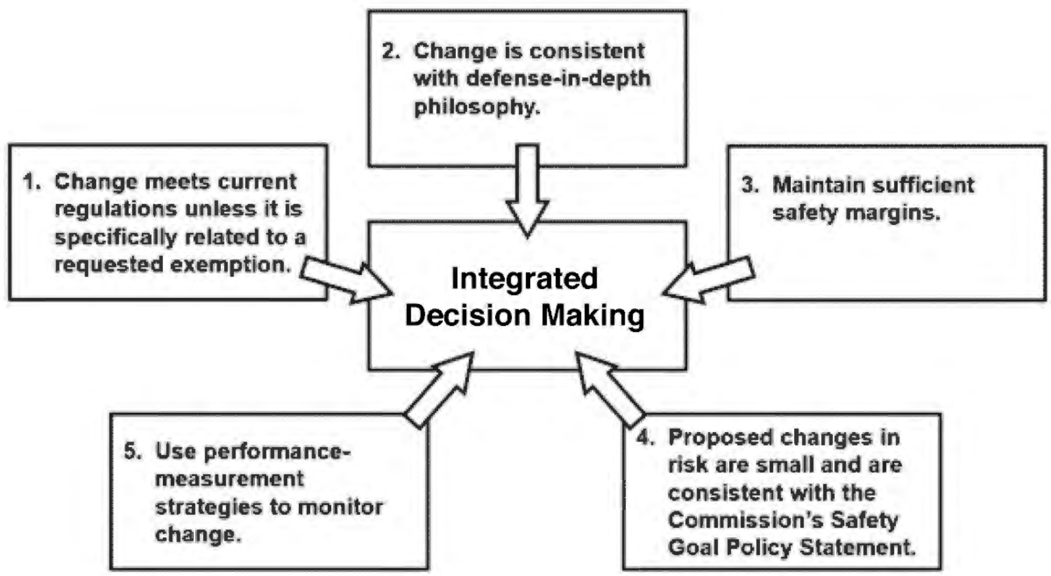


Figure 6-1
Principles guiding decision making
Source: Figure 2 of USNRC Regulatory Guide 1.174, revision 3

These principles and how they are met by this enhanced categorization process are as follow:

Principle 1. The proposed licensing basis change meets the current regulations unless it is explicitly related to a requested exemption (that is, a specific exemption under 10 CFR 50.12).

While 10 CFR 50.69 is an NRC-approved rule, the implementation vehicle is through a plant-specific LAR. 10 CFR 50.69(b)(2) identifies the type of information that must be contained in the LAR, including a description of the process for categorization of RISC–1, RISC–2, RISC–3, and RISC–4 SSCs.

Principle 2. The proposed licensing basis change is consistent with the DID philosophy.

- Piping systems in a nuclear power plant contribute to DID in two important ways: The piping of the RCPB provides one of the sets of barriers in the barrier DID arrangement. This barrier protects the release pathway from the reactor core to containment release pathways, and part of it is responsible for protecting against potential containment bypass pathways. This enhanced methodology requires that the RCPB be categorized as HSS.

- Second, piping contributes to DID in its role in the protection of the core through providing critical safety functions that require that piping system integrity. As can be seen in the preceding sections, the enhanced methodology requires that pressure boundary failures that would fail a critical safety function be categorized as HSS. These include those failures that would impact key inventory sources, plant-specific outliers that contribute to core damage or containment performance, and failure of the ultimate heat sink and component that can have intersystem impact (for example, heat exchangers).

Principle 3. The proposed licensing basis change maintains sufficient safety margins.

Existing safety analyses are not impacted by implementation of a 10 CFR 50.69 program. Nor are the design basis conditions and requirements for any safety-related SSCs changing. Further, the prerequisites associated with this enhanced methodology require that those operating practices and conditions that can challenge pressure boundary integrity are adequately controlled, thereby again assuring a reliable pressure boundary, regardless of a component’s categorization assignment.

Principle 4. When proposed licensing basis changes result in an increase in risk, the increases should be small and consistent with the intent of the Commission’s policy statement on safety goals for the operations of nuclear power plants.

The enhanced methodology proposed for categorizing pressure boundary components will have at most a negligible increase in risk and more than likely will result in a positive impact on plant safety. This is because the enhanced methodology requires that a full plant evaluation be conducted. That is, all safety-related and non-safety-related systems will be determined to be either HSS or LSS from a pressure boundary function perspective prior to any alternative treatment being applied.

Given that all RISC-2 components will have been identified, it is anticipated that an immediate safety benefit will occur upon implementation. That is, consistent with 10 CFR 50.69(d) and (e), licensees will need to ensure that RISC-2 components (for example, piping segments) are capable of performing their function (that is, pressure-retaining) consistent with the categorization process assumptions by evaluating the treatment being applied to these SSCs to ensure that it supports the key assumptions in the categorization process that relate to their assumed performance. And, going forward, licensees will need to make adjustments as necessary to either the categorization or treatment processes so that the categorization process and results are maintained valid.

Additionally, 10 CFR 50.69 requires that all RISC-3 SSCs continue to meet their design basis function under design basis conditions so that little to no change in reliability is anticipated for RISC-3 SSCs. Finally, the prerequisites associated with this enhanced methodology require that those operating practices and conditions that can challenge pressure boundary integrity are adequately controlled, thereby again assuring a reliable pressure boundary, regardless of a component’s categorization assignment.

Finally, in line with NEI00-04 and other related guidance, PRA insights and, where available, risk results are used, coupled with sufficient margin to confirm an LSS categorization. In line with the principles on DID and safety margin discussed previously, the PRA results and risk insights are considered along with engineering insights to ensure the robustness of the proposed enhanced categorization approach.

Principle 5: The impact of the proposed licensing basis change should be monitored using performance measurement strategies.

10 CFR 50.69(d)(2) requires that periodic inspection and testing activities must be conducted to determine that RISC-3 SSCs will remain capable of performing their safety-related functions under design basis conditions. Additionally, conditions that would prevent a RISC-3 SSC from performing its safety-related functions under design basis conditions must be corrected in a timely manner. For significant conditions adverse to quality, measures must be taken to provide reasonable confidence that the cause of the condition is determined, and corrective action taken to preclude repetition.

Further, the prerequisites associated with this enhanced methodology require that those operating practices and conditions that can challenge pressure boundary integrity are adequately controlled (monitored), thereby again assuring a reliable pressure boundary, regardless of a component's categorization assignment.

7 SUMMARY

The NRC amended its regulations to provide an alternative approach for establishing the requirements for treatment of SSCs for nuclear power reactors using a risk-informed method of categorizing SSCs according to their safety significance. This rule is 10 CFR 50.69, Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors. The risk-informed categorization process helps focus attention on SSCs that are the most important to plant safety while allowing increased operational flexibility for SSCs that are less important to plant safety.

As experience has been gained with this categorization methodology, questions have arisen as to whether the existing methodology is too conservative and/or too resource intensive for the level of insights developed. In response to this question, EPRI initiated an effort to assess the existing methodology to determine if it was indeed producing overly conservative results or requiring excessive resources. To that end, a proposed enhanced approach for categorizing pressure boundary components for use in 10 CFR 50.69 applications has been developed, which includes the following:

- A proposed methodology derived from insights gained from application of the existing methodology to the industry 10 CFR 50.69 pilot efforts as well as subsequent plant applications (that is, follow-on plants)
- Review and assessment of a listing of all SSCs that need to be categorized for passive SSC for both PWRs and BWRs
- Insights highlighting that a set of generic HSS SSCs can be identified that can be supplemental with a plant-specific search for HSS outliers

Further, future reports are anticipated to provide additional background on the investigations that led to this new enhanced approach as well as providing implementation guidance.

8
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