



Technology Inclusive Content of Application Project Public Meeting



July 30, 2020
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Agenda

Time	Topic	Presenter
10 -10:10 am	Introduction	NRC
10:10 -10:40 am	Responses to the NRC's comments on Industry's June 11, 2020, TICAP presentation	Southern
10:40 – 11:10 am	Discussion and results of regulation and general design criteria mapping	Southern
11:10 – 11:40 am	TICAP's proposed annotated outline for the NEI guidance document	Southern
11:40 - 1:00 pm	Extended break to allow for NRC to caucus internally before the meeting resumes in the afternoon	All
1:00 - 1:50 pm	Continuation of discussions from the morning session (if applicable) and questions from extended break	All
1:50 - 2:00 pm	Next meeting and concluding remarks	All

Technology Inclusive Content of Application Project (TICAP)

TICAP – Nuclear Regulatory Commission (NRC) Working Meeting
July 30, 2020

Outline of Today's Presentations



- Brief overview of TICAP (Steve Nesbit)
- Responses to the NRC comments on TICAP June 11th comments (Frank Akstulewicz)
- Mapping report update (Frank)
- Nuclear Energy Institute (NEI) guidance document (Steve)
- Update on the safety analysis report (SAR) outline (Steve)
- Tabletop exercise update (Brandon Chisholm)
- Next steps (Steve)



- **Product:** *Develop an endorsable Guidance Document that proposes an optional formulation of advanced reactor application content that*
 - *Benefits from the insights and knowledge gained through licensing and safely operating the current US-based nuclear fleet for over 40 years to ensure adequacy of proposed content requirements.*
 - *Is based on describing a technology-inclusive affirmative safety case that meets the underlying intent of the current requirements*
 - » *To optimize application content (add where additional content is needed and reduce where current content requirements are not commensurate with the contribution to risk)*
 - » *To provide the needed regulatory agility to accommodate review of spectrum of designs that are expected to submit licensing application,*
 - *Is risk-informed, performance-based to right size the required information in an application (based on the complexity of the safety case) to increase efficiency of generating and reviewing an application*
 - *Its scope is governed by the Licensing Modernization Project (LMP)-based safety case to facilitate a systematic, technically acceptable, and predictable process for developing a design's affirmative safety case*
 - *Provides similar information as is currently required from a light water reactor (LWR) applicant*

Background

LMP-Driven Application Content



- Project's Expected Outcomes:
 - A standardized content structure that facilitates efficient
 - » preparation by an applicant,
 - » review by the regulator, and
 - » maintenance by the licensee.
 - A content formulation that, based on the complexity of a design's safety case, optimizes
 - » the scope (the functions, the structures, systems, and components (SSCs), and the programmatic requirements that need to be discussed) based on what is relevant to the design specific safety case.
 - » the type of information to be provided (e.g., licensing basis events (LBEs), Required Safety Functions (RSFs), Safety-Related SSCs, Defense-in-Depth (DiD), etc.),
 - » level of detail to be provided
 - based on the importance of the functions and SSCs to the safety case (risk-informed, performance-based (RIPB) details).
 - based on the relevance to the safety determination



LMP-Based Affirmative Safety Case Definition - A collection of scientific, technical, administrative and managerial evidence which documents the basis that the performance objectives of the technology inclusive fundamental safety functions (FSFs) are met by a design during design specific anticipated operational occurrences (AOOs), design basis events (DBEs), beyond design basis events (BDBEs), and design basis accidents (DBAs) by

- Identifying design specific safety functions that are adequately performed by design specific SSCs and
- Establishing design specific features (programmatic (e.g., inspections) or physical (e.g., redundancy)) to provide reasonable assurance that credited SSC functions are reliably performed.

Foundation of the TICAP Affirmative Safety Case Description



The underlying intent of the current application content (within TICAP scope) is met by providing the LMP-Based Safety Case, anchored around principal design criteria (PDC), on the basis that

- » The LMP's approach to meeting the radiological risk performance objectives provides evidence that the underlying safety objectives of the regulations for providing "reasonable assurance of adequate protection . . . " are met.
- » "The principal design criteria establish the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety; that is, structures, systems, and components that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public" (*introduction to 10 CFR 50 Appendix A*)

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TICAP Responses to NRC Comments on Material Presented at the June 11, 2020 Working Meeting

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- General Reaction
 - Comments were supportive of TICAP discussion
 - Comments provided additional information that will be considered in ongoing efforts



Comment #1 - The overall approach described in the presentation appears to align with and logically build upon the NRC-endorsed methodology in Nuclear Energy Institute (NEI) 18-04, Revision 1, “Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development.” The use of the NEI 18-04 and related topics such as fundamental safety functions support a technology-inclusive approach to preparing an “affirmative safety case.” This in turn should support organizing the scope and level of detail for information as discussed in Regulatory Guide (RG) 1.233, Revision 0, “Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors.”

Response - We agree with the staff comment. The concepts presented were carefully taken from the methodology presented in NEI 18-04.

Response to NRC Comment 2



Comment #2 - The use of principal design criteria (PDC) for safety-related equipment within the approach described in the presentation aligns with NEI 18-04 and related initiatives that reflect a hierarchy or tiered structure for organizing information and establishing performance criteria for plant features and programmatic controls. This is an area that we can discuss in future meetings to work out how the hierarchy is described in terms of the interrelationships and terminology. It would be useful to provide example PDC and CDC at a future meeting to show the differences between the two and how they could: (1) align with fundamental safety functions and specific performance criteria (e.g., those related to required safety functions versus other design goals); (2) support the determining an appropriate level of detail in various parts of safety analysis reports; (3) support graded approaches to change control processes; and (4) provide added clarity to the distinctions made between plant features and programmatic controls in terms of their roles within an affirmative safety case.

Response: We agree with the comment. The intent of the June presentation was to initiate dialogue on the subject of level of detail and structure of the SAR. Some of the presentation material today will provide additional clarity for items (1) and (2). Items (3) and (4) will likely be discussed at future meetings and the subject of other TICAP activities.

Response to NRC Comment 3



Comment #3 - In terms of the proposed CDC concept or nonsafety-related with special treatment (NSRST) category, the associated design features or programmatic controls could contribute to providing prudent margins to ensure reasonable assurance of adequate protection. As discussed in RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," the safety goal subsidiary objectives have been used in the past help assess such "prudent margins". This generally aligns with the assessments in NEI 18-04 that are based on the frequency-consequence targets and the separate cumulative risk targets, which include the NRC safety goals. The staff would like to better understand if the industry's position is that design features or programmatic controls might also be provided as safety enhancements that further protect health or minimize danger to life or property as allowed under Section 161 of the Atomic Energy Act or as measures that provide margins used to justify proposed operational flexibilities based on a performance criteria established as design goals that are more restrictive than those used to determine required safety functions. As mentioned in the bullet above, we can discuss interrelationships and terminology at future meetings, but these discussions need not limit progress on the broader approach nor even on the guidance related to scope and level of detail for plant structures, systems, and components and related programmatic controls.

Response: We agree that additional discussion on the definition and use of the Complementary Design Criteria (CDC) will be necessary. As initially proposed, the CDC concept employs a view that design features or programmatic controls are provided as facility enhancements that can also provide some additional safety capabilities if the mainstream systems or structures should be unable to perform or the facility finds itself in a beyond design basis event. Through the LMP process, SSCs in the CDC category are provided for some other purpose than directly supporting the performance of required safety functions. If an SSC is necessary to fulfill a required safety function, then that SSC should be included in the set of SSCs in the PDC category. It is clearly not the intent that special treatment requirements for SSCs in the CDC category have design goals that are more restrictive than those used to demonstrate required safety functions. Additional discussion on the CDC category definitions and implementation is planned for later in this presentation.



Comment #4 - While agreeing that a reasonable presentation of an affirmative safety case should generally align with an applicant being able to “not provide evidence where certain functions ... are not needed,” there may be regulatory or policy reasons for an applicant to supplement the safety case and to some degree “prove the negative.” Examples could include the need to provide such an argument within an exemption request or first-of-a-kind adoption of major changes related to the role of operators and other facility personnel. In addition, as discussed during the meeting, the staff is developing a list of regulations that are applicable to non-LWRs and working to establish efficient processes for addressing exemptions to legally applicable but not technically relevant requirements.

Response: TICAP agrees with the underlying intent of Staff comment that

- a presentation of an affirmative safety case is generally adequate
- there is a need to address potential regulatory or policy reasons that may require an applicant to supplement the safety case



- TICAP believes that
 - The current content requirements are structured to provide information on the hazards and elements that impact the large LWR safety case (e.g., operator action).
 - The LMP-based safety case for a specific design is based on a thorough assessment of all the hazards and plant responses to these hazards. Therefore, it is consistent with the current requirements to include only those elements/potential hazards, and the SSCs and programs which are in place to address them. This logic is also consistent with the basis for approval of exemptions.
- TICAP supports the NRC effort to develop a list of regulations that are applicable to non-LWRs and would welcome the opportunity to comment on the list once made public. TICAP also is encouraged by the staff efforts to establish efficient processes for addressing exemptions. TICAP would also welcome the opportunity to comment on the processes once they are available for comment.



Comment 5 - Regarding the initial outline for the content of safety analysis reports (SARs), the interrelationships and dependencies between various sections of SARs, no matter how organized, might be better addressed using available information systems that go beyond typical chapter-section models. TICAP might also consider a systems engineering approach (function-system-component, with related performance criteria and verifications) instead of the initial division of descriptions by structures, systems, and components. Such an approach might help support the overall logic that starts out at the functional level, needs to determine appropriate scope and content for plant features, and support a more performance-based approach by defining programmatic controls to ensure capabilities and availabilities are maintained. The above are just suggested areas to explore while we are in the early stages of the project.

Response: TICAP welcomes the staff suggestion and will incorporate consideration of the systems-engineering approach into its discussions related to the possible format for an application that uses both fundamental safety functions and the LMP methodology.



Comment #6 - Regarding the mapping of how and how well the NEI 18-04-based safety case would align with the various regulations and align with 10 CFR Part 50 Appendix A General Design Criteria for a light water reactors, the staff views the exercise as a possibly useful communications tool. The mapping is not viewed as a critical activity for supporting the staff's review and possible endorsement of subsequent guidance on content of applications.

Response: TICAP acknowledges the staff's view about the mapping activities. Additional information about the results of the mapping activities is presented later in this presentation.



Comment #7 - As stated during the meeting, the staff would appreciate observing portions of the table top exercises tentatively targeted for August of 2020 as we did some of the table top exercises supporting the development of NEI 18-04. In any case, the staff would expect the submittal of summaries of the exercises as was provided for the table top exercises that supported the development of NEI 18-04.

Response: TICAP will have additional discussions with the NRC about observation of or participation in the tabletop exercises once more specifics become available.

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Mapping Report Update

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Regulation Mapping and General Design Criteria (GDC) Binning Objectives



- To provide the latest results of the regulation mapping activity which was performed to demonstrate that an affirmative safety case (which is based on meeting the performance objectives of the FSFs) meets the underlying intent of the current requirements/regulations
- To provide results of the GDC binning activity which was performed:
 - To examine the type of information which is required in GDC that are typically used to form the basis for the LWR PDC
 - To ensure that the same type of information will be provided by the TICAP proposed content of application formulation
- Regulation mapping and GDC binning activities are performed to
 - Benefit from the insights and knowledge gained through licensing and safely operating the current US-based nuclear fleet for over 40 years to ensure adequacy of proposed content requirements
 - Provide regulatory justification regarding reasonableness of an affirmative safety case (see TICAP response to the NRC's 4th comment on June 11th presentation)

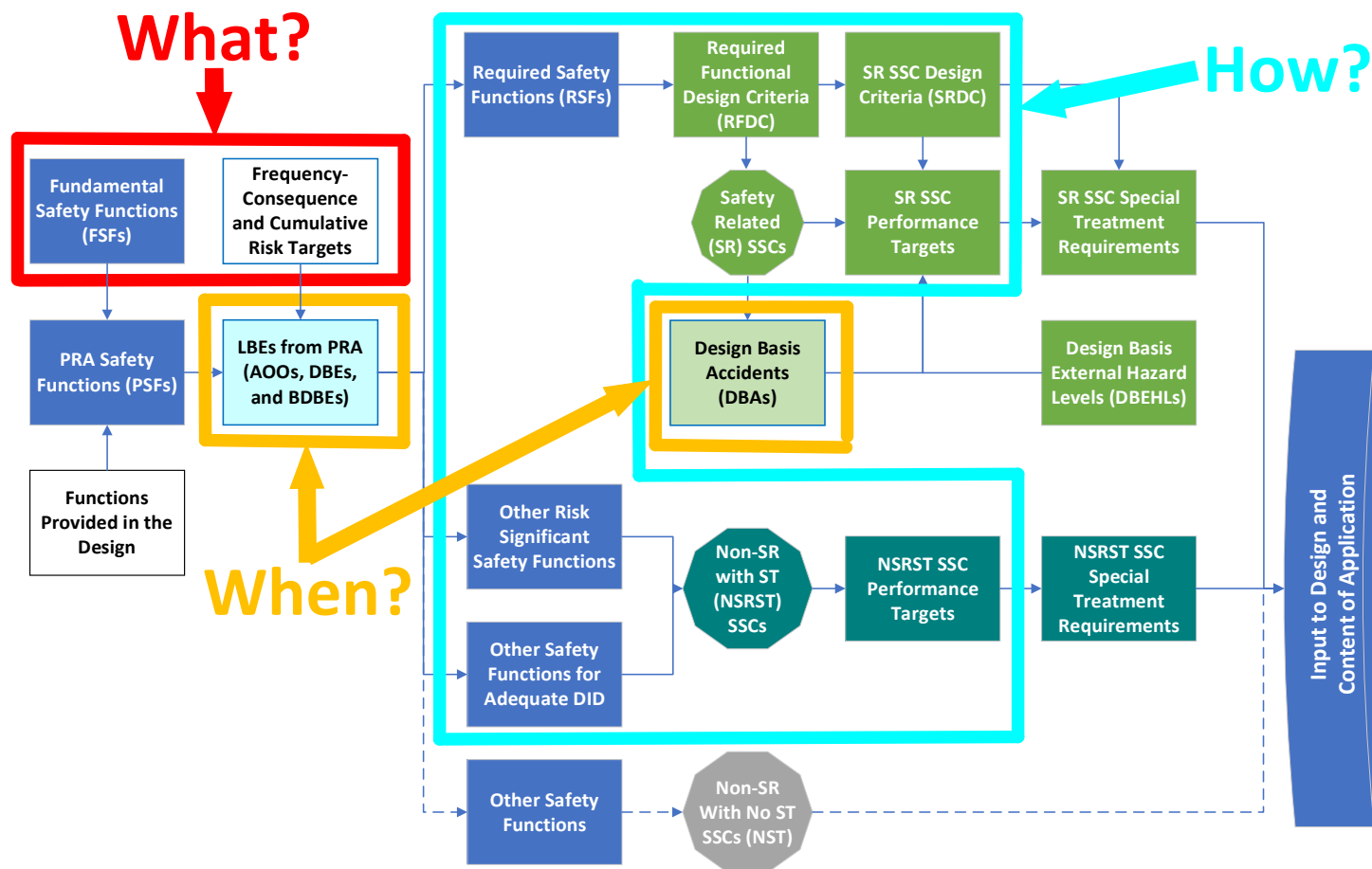
Foundation of the TICAP Affirmative Safety Case Description



To facilitate PDC-anchored articulation of the LMP-Based Safety Case, the constituents of the LMP process are labeled as follows:

- » **What** are the performance objectives for the FSFs?
- » **When** do the FSFs' performance objectives need to be demonstrated?
- » **How** do plant capabilities (functional and structural) demonstrate that the fundamental safety functions are met?
- » **How Well** do these capabilities need to be performed to provide reasonable assurance?

FSF²² Chart - When





- Principal Design Criteria
 - Support demonstration of fundamental safety functions
 - Are credited to perform RSFs for DBAs
 - Establish equipment classification as safety-related with appropriate treatment requirements
 - Establish the foundation for making the adequate protection determination
- Complementary Design Criteria
 - Are SSCs that provide additional means to perform required safety functions
 - Are not credited to perform RSFs for DBAs
 - Allow equipment to be classified as non-safety-related with special treatment requirements appropriate to the functions performed
 - Support plant functions related to risk significance or DID as defined in NEI 18-04.

Results of Mapping Activities



- The mapping efforts examined regulation sections in 10 CFR 50, the General Design Criteria (Appendix A to 10 CFR 50), and other Part 50 Appendices
 - 1. Regulation sections included in 10 CFR 50: 89
 - 2. Appendices to Part 50: 13
 - 3. General Design Criteria: 55
- Total regulation sections mapped from Part 50: 157

Results of Mapping Activities (cont.)



Relationship of mapped regulations to FSFs

1. Retaining Radioactive Materials	50
2. Controlling Reactivity	30
3. Removing Heat from the Reactor and Waste Stores	38
4. Programmatic	30
5. Administrative or Procedural	63

- Demonstrates that use of FSFs can provide a satisfactory licensing surrogate for the set of prescriptive regulations in the existing Part 50 LWR-centric regulations
- Highlights importance of the programmatic requirements (How Well) that assure that SSCs important to safety perform their required safety functions

Binning Process



- Used LWR GDC as trial PDC
- GDC only NRC approved set of design criteria that align somewhat with LMP developed information
- Used What, When, How and How Well questions and definitions to deconstruct GDC into binning categories
- Some GDC neatly fit into a specific category
- Some GDC contain elements of several categories
- Figure in Appendix to Mapping report uses color code to represent GDC information grouped into question categories



Results of the Binning of the LWR GDC are:

- a. Five GDC specify conditions other than the maximum hypothetical accident for when the GDC apply (GDC 10,15,19,29,60)
- b. Nineteen GDC will bin wholly into the How category – these GDC specify that certain capabilities are to be provided and explain the safety functions to be performed
- c. Seven GDC are hybrid GDC in that they specify that certain capabilities are to be provided and they also provide certain special treatment requirements for those SSCs
- d. Twenty-nine GDC can be wholly binned into the How Well category as they specify special treatment requirements for those SSCs

Results of Binning Activities (cont.)



There are 26 GDC that contained principal design criteria (those that define plant capabilities). The LWR SSCs so designated are:

1. Reactor inherent protection (GDC 11)
2. Suppression of reactor power oscillations (GDC 12)
3. Instrumentation systems (GDC 13)
4. Reactor coolant pressure boundary (GDC 14)
5. Reactor coolant system design (GDC 15)
6. Reactor containment and associated systems (GDC 16)
7. Electric power systems (GDC 17)
8. Control room (GDC 19)
9. Protection systems functions (GDC 20)
10. Two independent reactivity control systems (GDC 26)
11. Reactor coolant makeup system (GDC 33)
12. Residual heat removal system (GDC 34)
13. Emergency core cooling system (GDC 35)

Results of Binning Activities (cont.)



14. Containment heat removal system (GDC 38)
15. Containment atmosphere cleanup system (GDC 41)
16. Cooling water system (ultimate heat sink) (GDC 44)
17. Containment (GDC 50)
18. Piping systems penetrating containment (GDC 54)
19. Reactor coolant pressure boundary penetrating containment (GDC 55)
20. Primary containment isolation (GDC 56)
21. Closed system isolation (GDC 57)
22. Means to control releases of radioactive gases and liquids and handle solid wastes (GDC 60)
23. Fuel storage and handling and radioactivity control (GDC 61)
24. Prevention of criticality in fuel storage and handling (GDC 62)
25. Monitoring systems for fuel storage and handling areas (GDC 63)
26. Means for monitoring radioactive releases (GDC 64)



Key messages from the Binning process

- Binning demonstrates that use of PDC will result in identification of key SSCs that directly support meeting performance objectives of the FSFs
- Binning examples highlight key LWR SSCs that are safety-related and essential to the adequate protection findings of the current LWR fleet

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Draft Annotated Outline of the NEI Guidance Document

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NEI³² Guidance Document Annotated Outline



- NEI Guidance Document
 - Key product from TICAP
 - Guidance for structure, scope, and level of detail for portions of an advanced reactor safety analysis report (SAR) related to the affirmative safety case per NEI 18-04
 - To be submitted by NEI to the NRC around September 2021
- Annotated outline for NEI Guidance Document
 - Provides structure and description of work product
 - Helps focus intermediate work activities on final product
 - Vehicle for communication with stakeholders such as NRC

Draft Structure of Annotated Outline



- Introduction
 - Discussion of affirmative safety case approach
- NEI 18-04 Methodology (summary)
- Fundamental Safety Functions and General Design Criteria
- Safety Analysis Report Information
 - Section by section guidance for applicants
 - Assumes combined construction permit (CP) and operating license (OL) application with no early site permit or design certification (Part 52)
- Alternative Licensing Paths
 - Two step application with CP followed by OL (Part 50)
 - Design certification under Part 52

Draft Structure of Annotated Outline (cont.)



- Tabletop Exercises
- Summary and Conclusions
- Appendices
 - Fundamental Safety Function Mapping
 - General Design Criteria Binning

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Update on the SAR Outline

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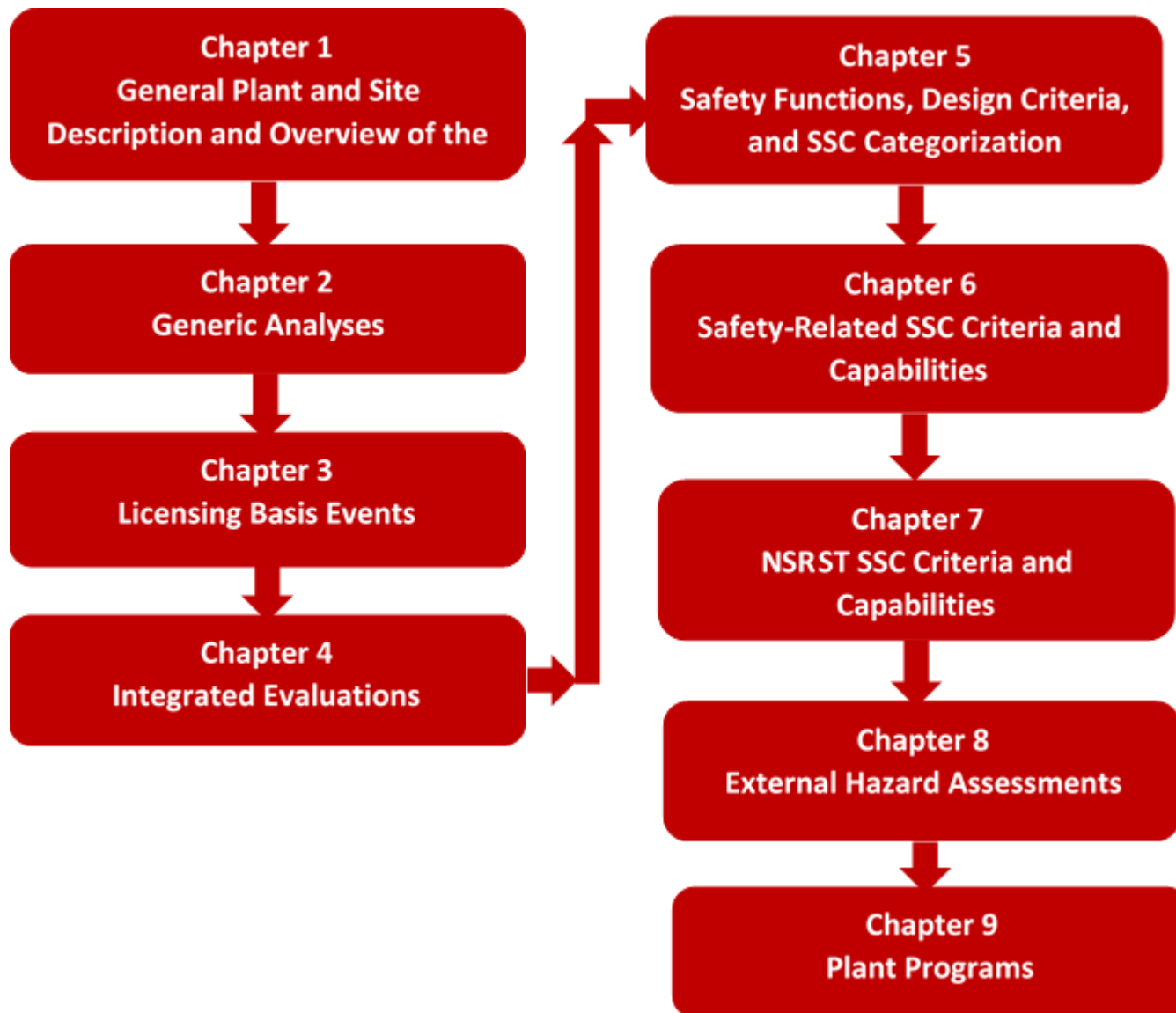


- Project's Expected Outcomes:
 - A standardized content structure that facilitates efficient
 - » preparation by an applicant,
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 - A content formulation that, based on the complexity of a design's safety case, optimizes
 - » the scope (the functions, the SSCs, and the programmatic requirements that need to be discussed) based on what is relevant to the design specific safety case;
 - » the type of information to be provided (e.g., LBEs, RSFs, safety-related SSCs, DiD, etc.); and
 - » level of detail to be provided
 - based on the importance of the functions and SSCs to the safety case (RIPB details).
 - based on the relevance to the safety determination.



- Advanced reactor technologies are varied
 - Safety cases will be different
 - SARs will be different
- Everything doesn't have to be in the SAR
 - Information not related to public health and safety detracts from focus
 - Document maintenance and facility change control benefit from a SAR without extraneous information
- NEI 18-04 is an iterative process
 - Outputs, not process, are the appropriate focus for the SAR
- Some content related to the safety case is expected to be in other documents, such as topical reports

Organization is Evolving



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Tabletop Exercises

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- Scope - Provide examples of an affirmative safety case through the use of Principal Design Criteria and Complementary Design Criteria
- Potential interactions with the NRC as observers
- Public release of results
- The following developers have expressed interest in participating
 - General Electric Hitachi - PRISM - solid fuel reactor in a pool of sodium coolant
 - Westinghouse – eVinci - solid fuel, heat pipe-cooled microreactor
 - Kairos – KP-FHR - fluoride salt-cooled reactor with pebble tristructural isotropic (TRISO) fuel
 - X-energy – Xe-100 helium-cooled reactor with pebble TRISO fuel
 - TerraPower – Molten Chloride Fast Reactor using liquid salt for both fuel and coolant



- Currently finalizing Tabletop Charter document
- Planned start date - September
 - Initiation Phase (August)
 - Planning Phase
 - Preparatory Phase (September)
 - Facilitation Phase
 - Wrap-up and Documentation Phase
 - Sharing Phase

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Next Steps

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- Send FSF Mapping report to NRC for review on August 7
 - Requesting NRC comments by August 24
- Develop content of application guidance
- Conduct tabletop exercises



Additional Questions?



AOO – Anticipated Operational Occurrence

BDBE – Beyond Design Basis Event

CDC – Complementary Design Criteria

CP – Construction Permit

DBA – Design Basis Accident

DBE – Design Basis Event

DID – Defense-in- Depth

FSF – Fundamental Safety Function

GDC – General Design Criteria

NEI – Nuclear Energy Institute

NRC – Nuclear Regulatory Commission

NSRST – Non-Safety-Related with Special Treatment

LBE – Licensing Basis Events

LWR – Light Water Reactor

LMP – Licensing Modernization Project

OL - Operating License

PDC – Principal Design Criteria

RG – Regulatory Guide

RIPB – Risk-informed, Performance-Based

RSF – Required Safety Functions

SAR – Safety Analysis Report

SSC – Structures, Systems, and Components

TICAP – Technology Inclusive Content of Application Project

TRISO – Tristructural Isotropic

⁴⁶Technology Inclusive Content of Application Project

Break

Future Meetings

2020 Tentative Schedule for Technology Inclusive Content of Application Project Public Meetings

August 27

September 24

October 22

November 19