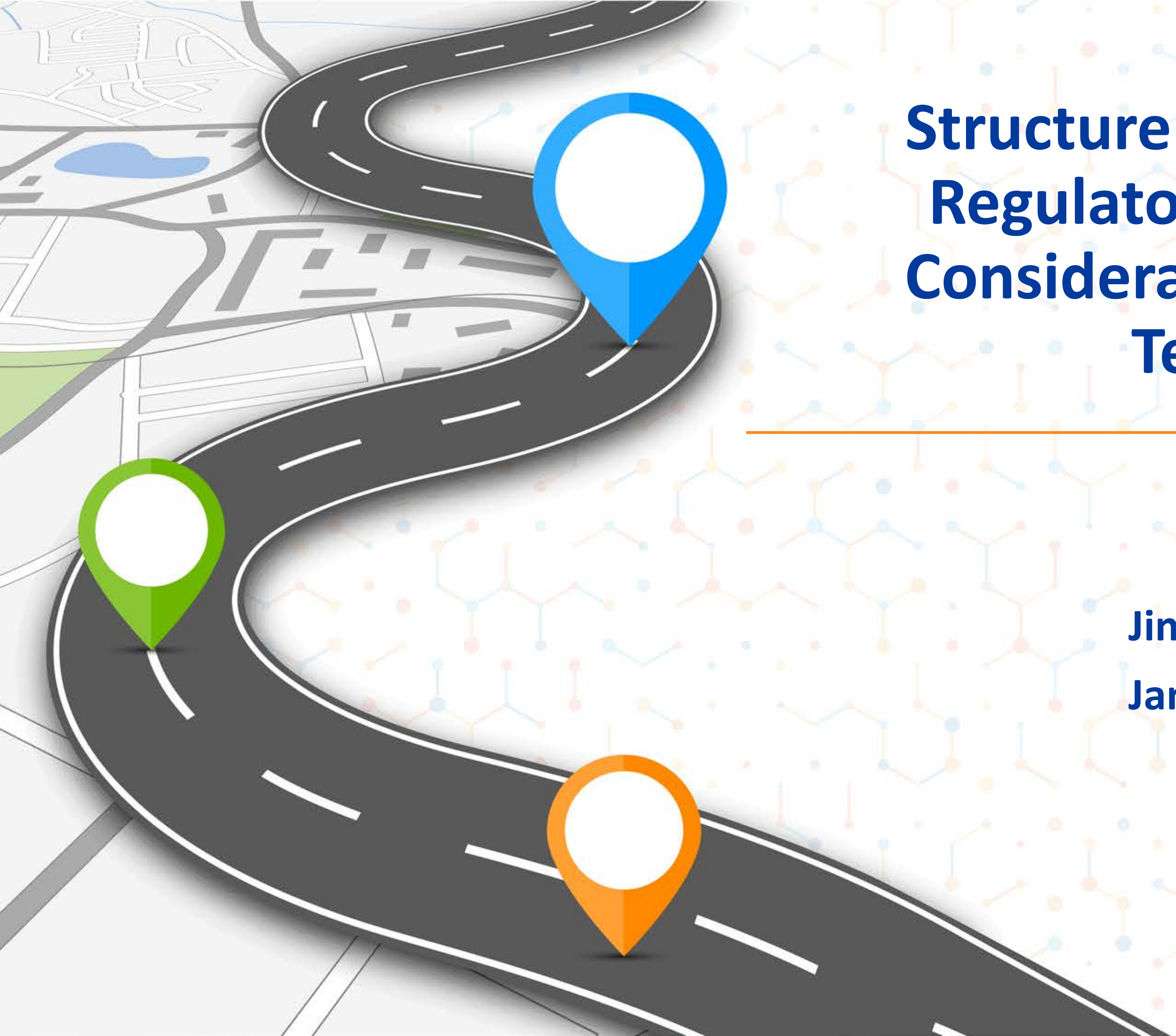

Structure of the Current NRC Regulatory Framework and Considerations for Advanced Technologies

Jim Kinsey, PE

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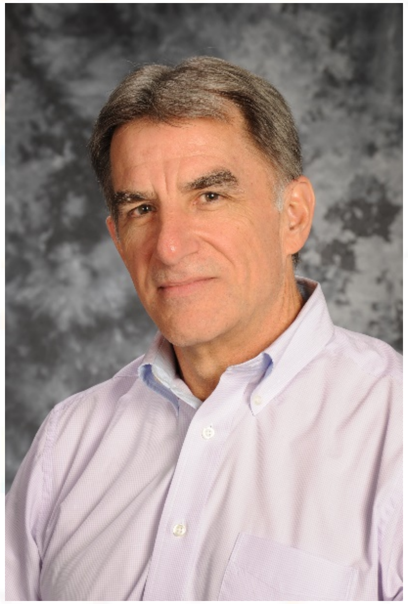
GAIN Gateway for Accelerated Innovation in Nuclear



Jim Kinsey
Regulatory Affairs,
Idaho National
Laboratory

Mr. Kinsey has over 40 years of experience in the nuclear industry, including significant commercial experience in licensing, regulatory affairs, system engineering and major project management. He has managed numerous industry licensing and regulatory affairs projects, including the licensing of GE-Hitachi's ESBWR advanced reactor design, and the development of successful recovery and re-start programs for commercial nuclear plants previously placed on the NRC's "Watch List". He also has considerable experience in supporting "day-to-day" commercial nuclear facility operation, including engineering management of safety systems, plant power uprate projects, outage management, and as a primary utility interface with both federal and state regulators.

At the Idaho National Laboratory, he is responsible for licensing strategy development and implementation in direct support of industry's near-term deployment of advanced nuclear technologies. In this role, he has led the development of a series of DOE/industry proposals resulting in key Commission policy changes and related updates to NRC's regulatory guidance, including acceptance of performance-based functional containment approaches, and the use of a risk-informed and performance-based approach for plant event identification and assessment.

Mr. Kinsey holds a Bachelor of Science degree in Nuclear Engineering from the University of Cincinnati and is a Licensed Professional Mechanical Engineer. He has also previously received a Senior Reactor Operator Certification for Boiling Water Reactors.

3 Major "Eras" of Regulatory Framework Development

CORRECTING for Operational Experience 1980 - TODAY

DEVELOPING the Independent Regulator 1975 - 1979

SEARCHING for the Regulator's Role 1954 - 1975

Summary of 3 Watershed Eras – Emerging Regulatory Role

1) Searching for the Regulator's Role
   - Atomic Energy Commission (AEC) is in the challenging position of being both nuclear industry promoter and regulator
   - Increased period of public activism
   - Safety reviews focused on power control and containment design, based on smaller demonstration reactor experience
   - Challenges included quality issues in numerous areas (design, hardware, construction, operations)

2) Developing the Independent Regulator
   - New agency establishing rules and guidance to implement its Independent Regulator role
   - In parallel, industry pushing Nuclear Regulatory Commission (NRC) for prescriptive requirements – "tell us what you want"
   - Creates an inappropriate paradigm of "if it's licensed, it's safe"

3) Correcting for Operational Experience
   - Design weaknesses
   - Various plant events highlighted the importance of operating practices, material selections, personnel training, etc.
   - Industry ramped up efforts to assess and improve in these areas
   - In parallel, NRC expanded the light water reactor (LWR)-centric regulatory framework and its oversight of day-to-day plant performance

Regulatory Framework "Patchwork"

- These watershed periods, and more recent updates, have resulted in what some refer to as a "patchwork" of regulatory requirements and implementing guidance that have been "added-on" or modified as time moves on

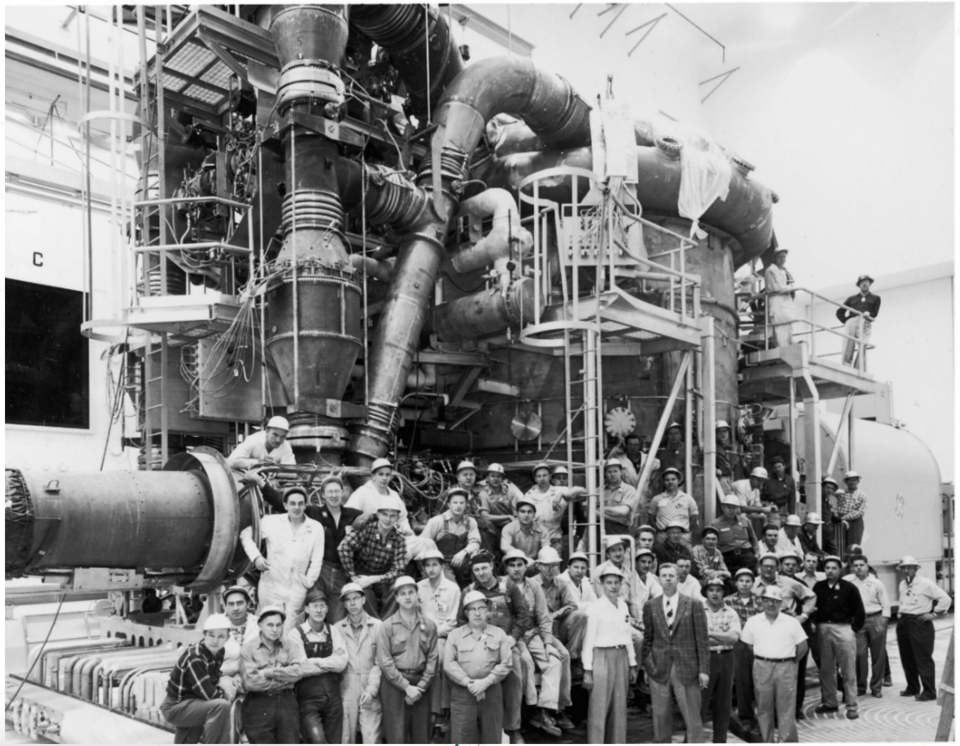
- The Regulatory Framework includes four major elements:
    1. Commission policy and underlying Energy Reorganization Act authorizing language
    2. Regulations and associated regulatory guidance
    3. Technology-specific licensing technical requirements for implementing those rules
    4. Processes used by NRC to review license applications and assess plant operations

- This "Regulatory Framework" has generally served the industry well and has provided adequate protection of the public
    - These mostly LWR-based documents reflect significant learning that can be evaluated for adaptation to advanced technologies
    - Provides an opportunity to reduce the important types of issues experienced by LWRs in the 60s, 70s, and 80s

Three Fundamental Safety Functions

- All commercial reactor facilities must establish an underlying and foundational safety basis (or “Safety Case”)

- The Safety Case establishes how the operation of the reactor design addresses the following three universally recognized fundamental safety functions when responding to a broad range of expected off-normal events and postulated accidents:
  - Control of reactivity (power control)
  - Reactor heat removal
  - Containment of radionuclides
- The regulatory requirements, guidance, and precedents associated with the existing regulatory framework “patchwork” generally all have some connection and/or underlying basis that ties back to one of these three fundamental functions



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Navigating the Patchwork – Safety Case First, Then Licensing

- History has highlighted that a primary focus on establishing a robust safety case for a reactor facility is the most effective approach to efficient licensing. The basic sequence:
    - Design the plant to provide robust safety while meeting owner/operator needs
    - Assess and prove that the safety case addresses NRC requirements with margin
    - Communicate this proof in a license application
    - Get licensed by NRC
    - Operate and maintain the facility inside the bounds of the safety case and associated licensing basis, maintaining safety and regulatory margins

- In concept, fulfilling the regulatory requirements (which are minimum expectations) and a successful license application review should be straightforward, if the design is robust.

- It should be noted that fulfilling regulatory requirements and obtaining an operating license do not make a reactor safe. Further, the operating phase can introduce challenges to the safety case, such as:
    - Unforeseen material degradations
    - Unexpected plant configurations or operating practices
    - Inadequate corrective action or maintenance programs

NRC License Applications & Responsibilities

- The license applicant is responsible for establishing and communicating how its Safety Case addresses regulatory requirements, including the safety margins that are being provided
  - The license applicant for the facility is the owner/operator, not the developer or designer.
  - Consequently, as the license holder, the owner/operator is solely responsible for reactor safety and the protection of the public and environment.

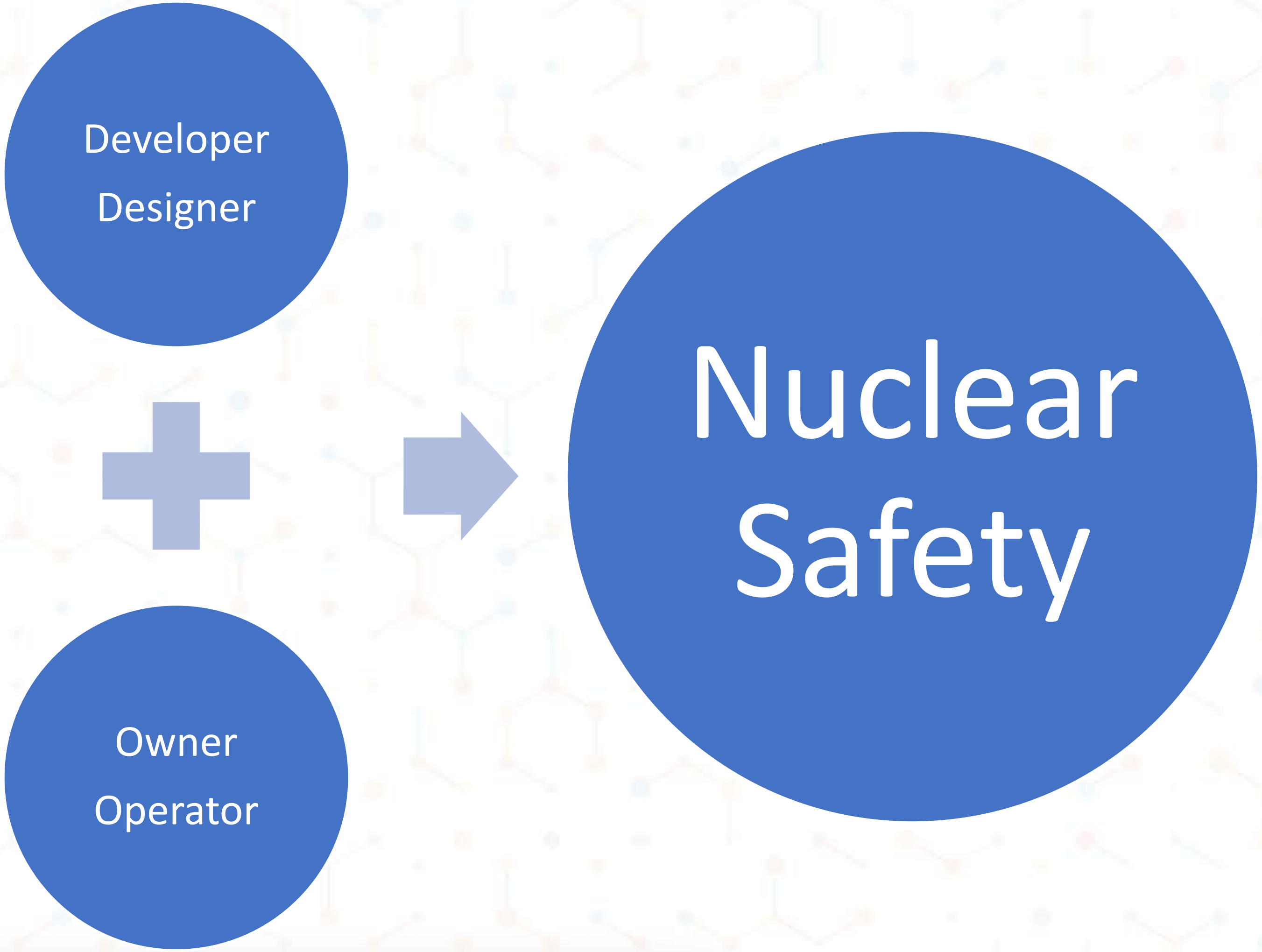
- NRC regulations require that licensing applications must contain:
  - *A description and safety assessment of the site and a safety assessment of the facility. It is expected that reactors will reflect through their design, construction, and operation an extremely low probability for accidents that could result in the release of significant quantities of radioactive fission products.*

- NRC's role is to review and confirm the applicant's safety assessment and conclusions
  - NRC has established processes and guidance for how this review is accomplished
  - It's not NRC's role to "tell us up-front what will pass," although accepted approaches and related acceptance criteria are provided in many key areas

NRC License Applications & Responsibilities

- Adequate design for nuclear safety is the responsibility of the developer/designer, with implementation and oversight by the owner/operator

- The owner is responsible for the safety of the reactor, and protection of the public and environment, in addition to requirements provided by the regulator



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Responsibilities – Insights From Past Experience

- Historically, developers often have not been sufficiently rigorous in establishing the safety case and ensuring its implementation in design, leaving (and accepting) NRC to impose its requirements as the answer.
- A focus on only the reactor and its support systems didn't adequately account for other factors and effects – external events, balance-of-plant effects, human-machine interfaces, effects of connected loads, etc.
- Historically, owners often have not been sufficiently demanding that the developer provide a design that fulfills the owner's operational needs and safety responsibilities, but rather accepted the interaction between the developer and NRC to correct shortfalls.
- The stakeholder community now has over 17,000 reactor-years of operating experience that can and should be utilized as a valuable input to the design and review processes.

LWR-Focused Framework & Advanced Technologies

- The existing LWR-focused regulatory framework presents both challenges and opportunities as we move forward with the development and deployment of advanced technologies

- For instance, during the first "watershed period," AEC added a regulatory requirement that all LWRs must have an Emergency Core Cooling System (ECCS) to provide reactor heat removal (1 of the 3 Fundamental Safety Functions) in the unlikely event of a loss-of-coolant accident
  - A large number of regulatory framework documents describe how to implement this requirement

- Advanced technologies still need to address this "remove reactor heat" Fundamental Safety Function. However, these designs frequently require an approach that's much different from ECCS when establishing the safety case

- To address these kinds of differences, NRC and industry are moving to a more "performance-based" regulatory structure
  - "Identify the intended outcome and industry will determine various ways to get there"
  - This is similar to the regulatory framework formulation concepts available during the early watershed days
  - We have an opportunity to apply those lessons learned to avoid devolvement to past regulatory compensatory imposition and prescriptive requirements

What's Planned for the Next Webinars in this Series?

Webinar #2: Understanding and Navigating Within the Existing Regulatory Framework

- What is the current "regulatory framework"?
- Overview of NRC document types and their hierarchy within that framework
- Review of how both applicants and NRC use those documents to assess reactor safety and protection of the public
- Processes and strategies for changing/adapting regulatory framework documents

Webinar #3: Identifying and Managing Regulatory Risk on the Paths to Successful Deployment

- Available NRC licensing pathways ("one-step," "two-step") and areas of regulatory risk within each pathway
- Use of the NRC's pre-application process to minimize regulatory risk

What More Can We Say?

We'd appreciate input from today's attendees regarding this webinar series and planned topics, so that we can adjust accordingly.

Send input to: GAINEvents@INL.gov

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Additional Information: Summary of NRC-DOE MOU for GAIN

- In addition to this webinar series, GAIN can provide insights and support in addressing a range of industry stakeholder questions and challenges associated with advanced technology licensing.

- A DOE-NRC Memo of Understanding (MOU) was established in conjunction with GAIN.
  - MOU Purpose: Assist industry stakeholders as they work to Understand and navigate the regulatory process
  - DOE is the lead for implementation, coordinated via GAIN
  - NRC is responsible for assisting DOE in providing stakeholders with accurate current information

- Stakeholders can review FAQs and request information or ask questions about the NRC's regulatory requirements and activities

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