

Information on Ongoing New Technology Initiatives

As part of its review, the Transformation Team focused particularly on new technologies as areas for potential agency transformation. In a few of these areas, this focused look revealed that the agency is already engaged in activities that will continue to move the agency forward in a manner and speed commensurate with the current state of these technologies. As a result of these activities, discussed in greater detail below, the Transformation Team has not recommended any further action.

I. Accident Tolerant Fuels

The U.S. Nuclear Regulatory Commission (NRC) staff has undertaken a number of ongoing initiatives to enable the efficient and effective licensing of accident tolerant fuel (ATF). The primary challenge to ATF licensing is the development of a technical basis through experimental work, along with updating the appropriate safety analysis codes quickly enough to support the industry's intended timeframe for using new fuel technologies. This technical basis is needed to develop sufficient knowledge to demonstrate the safety of new fuel designs, regardless of the regulatory framework. To help focus and prioritize the technical-basis development, the NRC is coordinating with the U.S. Department of Energy (DOE) and industry on a phenomena identification and ranking table expert elicitation process that will identify the most significant technical issues and failure modes expected for each ATF concept. In addition, the NRC staff has indicated that it is open to leveraging DOE and vendor codes, rather than updating NRC codes, and will pursue the most efficient and effective path forward. The staff also plans to update existing guidance that is largely technology specific for the current uranium dioxide-zirconium fuel system. It should be noted that, other than Title 10 of the *Code of Federal Regulations* (10 CFR) 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors" (without adoption of 50.46c), the underlying regulations in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," are technology neutral and are expected to be capable of supporting new fuel technologies. The NRC staff is working proactively in this area through strong engagement and communication with DOE and industry and by updating NRC guidance documents for new fuel designs.

Several additional initiatives are focused on progressing in the licensing process in parallel with the technical-basis development to limit the additional time for NRC approval. These activities include early NRC engagement with ongoing research to ensure the completeness of the data to be collected, a topical report change process to allow minor topical report modifications to be made without submittal to the NRC, and more extensive use of vendor inspections to expedite licensing reviews and provide NRC oversight for the topical report change process. Each of these initiatives will help position the NRC's regulatory framework to enable the efficient licensing of ATF.

The staff concluded that the ongoing initiatives remove barriers to the development of new fuel technology and, combined with a broader shift to risk-informed decisionmaking and other organizational tools recommended in this paper, will support the development of new fuel technologies within a timeframe consistent with their expected deployment.

II. Big Data

The NRC has more than 40 years of regulatory data in the form of letters, documents, reports, files, e-mails, and raw data stored in databases such as the Agencywide Documents Access and Management System, local drives, network drives, magnetic tape, microfiche, file cabinets, and boxes across the agency. These collections represent a vast amount of knowledge, but, because of the volume, disbursement, and various formats of the data, it can be difficult—if not impossible—to accurately leverage the knowledge from these sources. Big Data tools and concepts may be a way to resolve these challenges. The NRC has begun limited internal activities that leverage Big Data, including an Office of Nuclear Regulatory Research (RES) pilot program on the use of Big Data tools for probabilistic risk assessment and risk-informed decisionmaking, and an effort in the Office of Nuclear Reactor Regulation to develop the Operating Experience Data Analysis Tool to sort and display information from the Institute of Nuclear Power Operations Consolidated Events System to show equipment failure trends with an eye toward increasing inspector focus during baseline inspections.

All of these pilot programs could be expanded. RES, working with other offices, plans to perform a feasibility study to identify the potential benefits of the use of Big Data tools to manage and sort agency data as soon as the necessary resources are available. The Office of the Chief Information Officer will work with RES to develop a data governance and management process. To ensure the appropriate focus on these activities, the agency will appoint a Senior Executive Service champion for these efforts.

Meanwhile, the nuclear industry is piloting a number of Big Data projects, both industrywide and at individual plants or utilities. These include prognostics and health management software tools for predictive monitoring of plant systems and plant system failures, tools to optimize maintenance schedules for reactor plant components, and piloting internal plant wireless networks to allow additional sensors to monitor plant performance at a lower cost. Currently the industry has not identified potential future requests for regulatory changes as a result of their use of Big Data, but does anticipate such requests in the future.

The expanding use of sensor data for predictive analytics and other plant operations creates an opportunity for the NRC to evaluate the implications of potential future industry requests for the use of Big Data to support a change in regulatory requirements. As soon as resources are available, RES is poised to conduct a feasibility study on industry uses of Big Data and any potential regulatory implications. This study would focus on Big Data-driven predictive monitoring, focusing on its maturity, its regulatory implications, and the NRC staff's ability to assess it.

III. Flexibility for Early Design-Phase Regulatory Reviews

Over the past few years, the NRC has made tremendous strides in preparing for technology-inclusive regulatory reviews for non-light-water reactors (non-LWRs) in response to industry feedback. Of particular note, the staff issued the NRC Roadmap for Regulatory Reviews in 2017. During its development, the staff interacted extensively with industry on the scope and content of the document. The product included expressed industry needs at the time, such as options for: (1) staged licensing review, (2) early design or conceptual design reviews, (3) review or feedback on portions of designs through topical or technical reports, and (4) engagement plans for NRC reviews. Following the roadmap's issuance, the staff discussed the document in several public meetings, which are held approximately every 6 weeks with any

interested advanced reactor stakeholders. Even with these efforts, the Transformation Team received several suggestions that addressed the need for more information on NRC engagement and review options in the advanced reactor area. Suggestions for areas where additional explanation may be useful include how and when to engage the NRC staff; costs for review services; how to engage with the staff on regulatory planning with minimal or no fees; whether a portion of a design can be reviewed as a topical or technical report; and whether licensees can request a review size, review disciplines, and the timeframe to control costs. Several stakeholders suggested that the NRC contact the Canadian Nuclear Safety Commission to learn more about the vendor design review (VDR) process and possibly offer a similar process.

Most of the stakeholder suggestions are within the regulatory review options available to vendors today. However, these options and how to exercise them are apparently not well known. In fact, the current process for early NRC engagement is more flexible than some of the requested models, in that the NRC's preapplication processes are optional and do not stipulate defined components of the reviews or regulatory outcomes. For example, the NRC staff has communicated extensively with the Canadian regulatory staff to learn about the VDR process. It found that, although there are some differences, most of the review areas for the nuclear facility are similar. Likewise, although not as explicitly defined as a VDR process, the NRC can provide a similar review with an agreed-upon defined review scope, estimated costs and time frame, and regulatory feedback. Another suggestion concerned a staged licensing review process, and industry expressed interest in pursuing additional details about it. The NRC staff is actively working with industry to better define examples of how the process can work and options for regulatory outcomes to better communicate the availability of the NRC's current early design-review process.

A wide variety of U.S. vendors are currently developing a broad array of non-LWR designs and supporting technology. In addition to moving away from large LWRs, non-LWR designs are being considered for energy sources beyond typical electricity production, which are attached to the U.S. electrical grid. As a result of this grassroots nuclear effort, there are many vendors with little or no regulatory experience. To support new designers, DOE assists the promotion of nuclear power and has several initiatives, such as the national laboratory voucher program and other Gateway for Accelerating Innovation in Nuclear (GAIN)¹ activities. The NRC, as an independent regulator, does not promote or consult on design. However, the NRC does provide an explanation of regulations and feedback on meeting them. Of note, the NRC has completed preliminary safety evaluation reports or feedback for non-LWR designs. From the suggestions received, the Transformation Team understands that a regulatory review earlier in the process would be instrumental in helping designers make business decisions for design and research programs. Earlier feedback could also enable a designer to gain additional investor funds or support a future NRC application review.

The Regulatory Roadmap provided a much needed step forward in describing flexibilities that are within the current regulatory review process. The NRC can transform itself even further by providing an "open door" with review options that have yet to be applied and that could be very

¹ At present, Congress has several pieces of proposed legislation before it that would provide some funds—mostly through DOE programs—to assist vendors with early design reviews. Such legislation, if passed, would address stakeholder concerns about NRC licensing fees associated with early design reviews; the staff will continue to monitor the progress of the proposed legislation.

useful in meeting the needs of vendors. The Regulatory Roadmap could include additional regulatory review information such as the following:

- explaining the option(s) to engage with the staff on regulatory review planning with minimal or no fees;
- explaining the option(s) for reviewing a portion of a design through the use of topical or technical reports;
- explaining the options to discuss with the staff the ability to request and agree upon the review scope, disciplines, and timeframe to better control costs or meet other milestone needs;
- specifying that the NRC regulatory feedback could include agreement on, or added clarification of the following:
 - the vendor's understanding of anticipated applicable regulations;
 - the vendor's description of how the design meets the regulations;
 - the vendor's understanding of potential gaps, exemptions, and policy issues;
- adding example(s) of an early design phase or conceptual design review;
- adding example(s) or option(s) for vendors to better understand, request, and control their costs for review services;
- adding example(s) or option(s) of various types of regulatory feedback (e.g., written, oral, letter, safety evaluation);
- adding the NRC advanced reactor e-mail contact, which is already established for questions from the DOE GAIN Web site; and
- adding information on the appropriate DOE GAIN contacts on the NRC Web site.

The staff believes that there is value in expanding the Regulatory Roadmap in this manner to address stakeholder feedback, serve vendors that have yet to engage on regulatory issues, and demonstrate the NRC's commitment to enabling new technology. The staff will prioritize these efforts with other ongoing advanced reactor readiness activities.

IV. New Materials and Manufacturing Methods

The NRC staff is pursuing early engagement with ongoing industry research into advanced manufacturing methods, such as additive manufacturing (AM). Meanwhile, industry is planning to gain operating experience by initiating the use of AM in 2018 to fabricate components with low safety significance. The combination of building operating experience through limited low safety significance implementation and NRC engagement in research and codes and standards development is an ideal approach to ensuring the safe and secure use of new materials, which can provide the basis for future NRC approval in a broader range of applications. The NRC is currently developing an advanced manufacturing action plan that will address appropriate guidance updates and other activities.

For new high-temperature materials for advanced reactor designs, the NRC staff has been engaged in codes and standards development with the industry through the American Society of Mechanical Engineers (ASME). This active engagement will enable the agency to pursue regulatory approval by NRC endorsement in a regulatory guide, once the staff receives confirmation from external stakeholders that the current version of the relevant ASME Code section is adequate for the design purposes of potential non-LWR vendors.

The staff concluded that the industry's incremental approach, coupled with the staff's development of an action plan to guide agency activities and engagement with ASME Code development, will be sufficient to support the safe use of advanced materials and manufacturing techniques.