APPLICATION OF SYSTEMS ENGINEERING TO NRC'S HIGH-LEVEL WASTE REGULATORY PROGRAM

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ABSTRACT

The U. S. Nuclear Regulatory Commission (NRC) is implementing a systems engineering approach to its high-level radioactive waste regulatory program, aimed at ensuring a fully integrated set of activities carried out in a structured, responsible and defensible manner. This paper presents a discussion of why a systems engineering approach is needed for the NRC regulatory program and describes the systems engineering approaches being initiated within NRC's Division of Waste Management.

NEED FOR SYSTEMS ENGINEERING

The national goal to responsibly dispose the nation's high-level nuclear wastes safely and effectively for centuries to come poses complex and interrelated political, technical and procedural challenges. We can minimize the impact of these challenges into the licensing hearing process by ensuring that regulatory decisions are based on a comprehensive, well-structured, and defensible program that is executed with stringent quality controls. To do so, we must not only understand the nature of the technical challenges facing us, but we must give equal consideration to the procedural problems inherent in supporting the regulatory findings in an adjudicatory hearing.

Public acceptance of the process to site and construct a repository is required by the NWPA. For NRC regulatory actions and decisions to gain public acceptance, they must be perceived as technically sound and responsible. If we fail in this endeavor, every decision will likely be litigated with the obvious consequences.

In the case of a high-level waste repository, the key NRC regulatory decision is that DOE has or has not demonstrated, with reasonable assurance, compliance with NRC regulations contained in 10 CFR 60, including implementation of the EPA environmental standard set forth in 40 CFR 190. In essence, we must make decisions on the ability of natural systems and man-made systems to perform effectively for thousands of years. Although the technical staff may satisfy itself, the ultimate licensing decision is not made by the technical staff. For the repository, the decision will be made by the Commission itself after an adjudicatory hearing by the licensing board. The Nuclear Waste Policy Act of 1982 (NWPA) provides a statutory timetable of three years from receipt of DOE's license application to make this determination (with a possible one-year extension upon good cause). NRC's ability to meet this statutory requirement depends on how well we assess the technical and procedural challenges and how well we plan, integrate and structure our program now to meet the challenges, both present and future.

The ultimate disposition of the wastes requires an attempt to predict the performance of an isolation system that will rely on both natural and man-made barriers for thousands of years -- a task which inherently involves many uncertainties. The site characterization phase will provide us with measurements and observations on natural features and phenomena which have a bearing on long-term repository performance. However, there will likely remain, up to the licensing stage, performance uncertainties that will prove to be extremely difficult to quantify, reduce, or even identify. The waste package and engineered barrier issues are no less complex and are directly interrelated to the siting considerations. The issue facing NRC is what are the necessary and sufficient measurements, observations, and analytical methods that will support reaching a licensing decision for a geologic repository, with reasonable assurance, within the demanding timetable.

Along with a demanding timetable for conducting the technical review, we are also faced with substantial and complex challenges to streamline the licensing process. Not only is the statutory timetable for licensing far more stringent than any reactor licensing case, but we are also faced with an unprecedented level of involvement from parties funded by the Nuclear Waste Fund; a repository whose cost will be four to six times greater than the average reactor facility; and the handling of thirty to forty times more documents than in the average reactor licensing proceeding. In fact, according to NRC's Chief Administrative Judge, this case may well be the largest administrative proceeding ever conducted. NRC will be on the critical path of the national program during this time. NRC delays translate into additional costs. Therefore, given the magnitude of this licensing proceeding; the far-reaching impacts of program delays; and a licensing approach that, in the past at least, required about six years or more for a reactor licensing decision, our chances of success are not very high unless we implement reforms to streamline the licensing process.

The technical and procedural challenges described above reinforce the need for a comprehensive, fully integrated and well-focused program -- a situation well-suited for the discipline of systems engineering. This is not to say that systems engineering is the ultimate solution to the program's success. But without it, program success will suffer even greater uncertainty.

SYSTEMS ENGINEERING APPROACHES BEING IMPLEMENTED WITHIN NRC

We at NRC have identified two priority activities to which the systems engineering discipline will be applied. First, NRC will use the systems engineering discipline to develop an overall program architecture for the NRC NWPA program. The program architecture will be used as a blueprint for planning and integrating the staff's technical activities and the agency's activities to streamline the licensing process. Second, we will use the systems engineering discipline in an effort to develop state-of-the-art management information systems to support the staff's technical activities, including licensing review, and also to accommodate the massive administrative requirements of the high-level waste licensing proceeding.

NRC's waste management staff recognizes the potential benefits to be derived from application of the systems engineering discipline. In order to support our staff experience in this discipline, we have initiated action to establish a Federally Funded Research and Development Center (FFRDC) to provide expert systems engineering and integration support, as well as support in all required disciplines, to NRC over the long duration of the NWPA program. An FFRDC, sponsored solely by the NRC, will allow for a long-term commitment free from conflict of interest with the DOE and State and Tribal programs.

We will now discuss in more detail each of these activities.

Development of an Overall Program Architecture

A basic goal of systems engineering is structured and reasoned decisionmaking based on a master plan. In the construction of a building, for example, the master plan is documented on a blueprint, which sets forth the management-approved design, along with the necessary interface points, and serves to direct construction activities until they are completed. Construction activities should not deviate from the blueprint unless the blueprint has been officially revised and approved by management. Therefore, decisions are not made "by the seat of the pants." Instead, they are made in the context of the overall master plan, taking adequate consideration of the impacts, interfaces, schedules and resources involved in the decisions; and deviations from the master plan are fully documented. In fact, all major development *and* construction projects generally go through this type of management planning and control process, or at least they should. However, NRC is not tasked with the responsibility of designing and constructing a major facility. But, even so, NRC must still apply the same decisionmaking logic to its regulatory program in order to assure structured, responsible, and defensible regulatory decisions. We are now putting into place such a structured framework for program decisionmaking. Instead of calling it a "blueprint" or "master plan," we simply call it a "program architecture."

We envision the key elements of the technical program architecture to include, as a minimum, the following:

(1) approved goals and objectives of the regulatory program, e.g.,

- key findings to be made by NRC;
- data required by the staff to reach a recommendation on the findings;
- methods and controls to be used in gathering the data; and
- capabilities required by NRC to process the data to reach a recommendation, including an assessment of uncertainties;

(2) interfaces between program components;

(3) schedules and lead times dictated by legislation, current DOE schedules, and prudent management; and

(4) performance measures for feedback and management control.

A similar program architecture will be needed, as well, for planning and controlling the procedural reforms necessary to streamline the licensing process. In this case, the top level of the hierarchy might include the key steps of the licensing process, such as pre-licensing consultation, the the staff review phase, the discovery phase, and the hearing phase; as well as the interfaces between phases and the schedules and an allocation of time available under the NWPA for each phase. The lower part of the hierarchy might include the reform activities necessary to modify the current hearing process to conform to high-level waste licensing requirements, as well as the associated interfaces, resources, schedules and lead times.

Once such an architecture is in place for the technical and procedural activities, all major program decisions will be documented within the architecture. Changes to the architecture can only be made after they have been fully evaluated in terms of their impacts to the overall plan, interfaces, resources, and schedules and have been approved by management. Again, the key purpose in establishing such a formal and documented decisionmaking process is to assure that the technical and procedural aspects of our program are carried out in a structured, responsible, and defensible manner.

Development of State-of-the-Art Management Information Systems

NRC has programs currently underway to develop integrated state-of-the-art document and management information systems to support the regulatory program. These systems will not only provide the management tools necessary to display the program architecture and to conduct various program analyses, but will greatly facilitate the staff's technical activities, as well as the administrative and legal requirements of the licensing process. They will also provide useful tools for management feedback and control.

With respect to the program architecture, our goal is to have in place a fully automated program

architecture that will serve as the basis for program decisionmaking and will provide the capability to display for anyone at any time where the program stands in terms of goals, plans, milestones and schedules, as well as the current expected level of uncertainty associated with each licensing finding. It should provide the basis for determining the necessary program interfaces and should have the capability to allow "what if" analyses in terms of potential changes to resources, schedules and other parameters. Reports should be available in a variety of formats, such as milestone status reports on individual activities or management summary reports on the entire program. It should also provide a means to allow the public to see what NRC's program is all about. These are just a few examples of some of the characteristics we are searching for.

To support the staff's technical activities, we are developing a formal system to help manage the resolution of the many open items that need to be resolved before or during the the licensing proceeding. We call this system the Open Item Management System. An open item is defined by NRC as a situation, condition or concern pertaining to compliance with 10 CFR 60 that if left unresolved could present undue risk to public health and safety or if left unaddressed could hinder the NRC licensing process. Because of the number and complexity of the open items and the need for NRC to assure that relevant open items do not "fall through the cracks," we need an automated system and institutional procedures that will provide a formal, systematic and publicly documented means of tracking the identification and managing the resolution of open items that have the potential to be licensing issues.

As a first step in developing the Open Item Management System, NRC has successfully demonstrated a pilot program for identifying and tracking a limited number of technical open items related to the candidate repository site in Nevada. NRC will now begin to incrementally build a complete system, which will include all three candidate sites, as well as policy and procedural open items. The system will allow us to document and prioritize open items as they are identified from a variety of sources, including State and Tribal participation, DOE document reviews, NRC staff positions, meetings and workshops, correspondence, and others. Procedures will be developed to govern the evaluation of potential open items to determine that they are not duplicative and that they represent significant licensing concerns. If they do represent significant licensing concerns, they will be prioritized and entered into the system. The program architecture will be evaluated and modified as necessary to address new open items. The specific information to be tracked for each open item will include a summary of the item and how it originated, references of relevant documents, plans and schedules for resolving the open item; and if and how the item was actually resolved. There will also be a cross-reference to the applicable elements of the program architecture.

To facilitate the administrative and legal requirements of the high-level waste licensing process, we have two specific activities underway. In concert with DOE, we have successfully demon- a system for the full-text storage and retrieval of both text and images. DOE has agreed to develop and implement such a system for all parties to the licensing proceeding. We believe our success to date has not only demonstrated the feasibility of such a system, but has led us to pursue rulemaking to require that all parties to the licensing proceeding use the system. Together, the system and the rule hold the promise to reduce the time required for the initial discovery phase of the licensing hearing from years to months. NRC recently published its Notice of Intent to pursue this rulemaking through a negotiated rulemaking process. The rulemaking would be a change to NRC's rules of motion and practice, contained in 10 CFR Part 2, and would apply to the repository licensing process only. This will be the first attempt by NRC to use negotiated rulemaking. Under a negotiated rulemaking, the Commission invites representatives of those parties affected by the rule to convene as a Federal Advisory Committee and draft the proposed rule. It reflects NRC's commitment to involve the affected parties early so as to lead to public acceptance of our procedures.

Development of Contractor Expertise through a Federally Funded Research and Development Center

A major effort has been undertaken by NRC to contract for operation of an NRC-sponsored Federally Funded Research and Development Center (FFRDC). The establishment of an FFRDC, dedicated solely to NRC's high-level waste program, was approved by the Commission as a means to provide long-term continuity and expert contractor support free from conflict of interest with the DOE and the State and Tribal programs. The FFRDC, which we have entitled the "Center for Nuclear Waste Regulatory Analyses" (the Center), will provide technical assistance and research in all required disciplines under the NRC high-level waste program, focusing primarily on systems engineering. The Center will not only assist the NRC staff in implementing the activities described above, but will provide an ongoing systems engineering and integration role. A primary function will be to develop interface specifications for each required licensing finding.

By creating the Center, NRC is entering into a special relationship with a contractor for the duration of the NRC program under NWPA. For instance, this will be the first time a single contractor will have visibility of our entire program. The Center will be expected to remain totally knowledgeable of all aspects of the program and will be required to make its recommendations pertaining to major potential NRC staff positions. This will provide an opportunity for a "devil's advocate" review of all the factors leading to NRC staff positions before they become formalized recommendations to NRC's decisionmakers.

CONCLUSION

We have attempted to demonstrate the need for applying the systems engineering discipline to the NRC high-level waste program and discussed several activities underway to implement a systems engineering program. We described two priority activities; namely, development of a program architecture and development of state-of-the-art management information systems. We also described a major effort underway by NRC to establish a Federally Funded Research and Development Center to provide expert systems engineering and integration support to NRC over the long duration of the NWPA program.

Together, these activities offer a means of assuring that the technical and procedural aspects of the NRC program are carried out in a structured,

responsible and defensible manner. However, these systems engineering activities are new to NRC and their successful implementation will require a lot of hard work and dedication on the part of each staff member. While systems engineering may not guarantee flawless technical decisions and a three-year licensing decision time, the use of systems engineering will help provide greater confidence in the technical quality, timeliness and documentation of NRC decisions and will help reduce impediments to the licensing process.

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