Development of an Execution Strategy Analysis (ESA) Capability and Tool for the Management of Spent Nuclear Fuel (SNF) – 16575

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ABSTRACT

An Execution Strategy Analysis (ESA) capability and tool are being developed to evaluate alternative execution strategies for future deployment of a consolidated Interim Storage Facility using a consent-based siting process per the Administration's *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste (Strategy)*. Application of an ESA approach not only leverages but also goes beyond traditional project analysis tools. The ESA tool allows for ongoing performance assessment of the evolving project execution plan that takes into account significant assumptions, risks, and uncertainties throughout the project lifecycle. The ESA process and tool will be used to support the development of plans, budgets, and alternative execution/implementation strategies for meeting the goals of the *Strategy*. This paper describes the development of the ESA capability and tool and identifies the value of applying such a capability in implementing a long-term strategy for managing spent nuclear fuel and high-level radioactive waste.

INTRODUCTION

The US Department of Energy (DOE) Office of Nuclear Energy is conducting planning activities within the Nuclear Fuels Storage and Transportation Planning Project (NFST) to lay the groundwork for implementing interim storage, including associated transportation, per the Administration's *Strategy* [1], and to develop a foundation for a new nuclear waste management organization [2].

Beginning in mid-2013 the NFST began developing a dynamic simulation modeling capability for use in the analysis of alternative execution/implementation strategies and plans associated with an integrated nuclear waste management program. The initial focus is a consolidated Interim Storage Facility (ISF) using a consent-based siting process. The Execution Strategy Analysis (ESA) capability provides an approach and a tool for assessing the performance of potential alternative implementation strategies that takes into account significant assumptions, risks, and uncertainties throughout the project lifecycle. This effort also provides fully capable risk assessment and management tools and analyses to support improving the decision-making process.

The ESA capability is built to help answer questions related to the implementation of the integrated nuclear waste management system, including:

1. What are the implementation approaches to meet the goals in the Administration's *Strategy*?
2. What are the critical path milestones and activities to achieving those goals?
3. What are the interdependencies across program elements?
4. What are the key program risks and potential mitigation strategies?
5. What are the impacts of various constraints?
6. What are the long lead-time activities and when should they be started?
7. What near-term activities could be started to provide schedule benefits and reduce risks?

It must be recognized that there are multiple alternatives for implementing interim storage to meet the goals in the Administration's *Strategy*. Given that how implementation will ultimately occur is not known, the ESA is being used to evaluate a range of potential future implementation scenarios. The scenarios and the assumptions discussed in this paper should not be viewed as defining a path-forward to implementation or DOE policy, but rather as potential approaches whose performance attributes are being evaluated to inform future decisions regarding implementation.

Integration of ESA with other NFST System Analysis Tools

The NFST is developing and applying a variety of system analysis capabilities and tools for the identification and evaluation of options for the future phased and adaptive deployment of an integrated nuclear waste management system. System analysis and system engineering principles are being applied to evaluate an integrated approach to transportation, storage, and disposal in the nuclear waste management system with an emphasis on providing flexibility to respond to evolving national policy/direction. These analyses support the establishment of functional and operational requirements for the spent nuclear fuel (SNF) management system, provide the framework for future planning activities (e.g., transportation hardware procurements), and provide information to inform future decisions regarding strategies for accepting SNF from U.S. shutdown and operating commercial nuclear reactors.

Figure 1 demonstrates how system analysis tools developed within the framework of the NFST are integrated, and how ESA interacts with them.

UNF-ST&DARDS [3] provides a consistent, traceable source of data related to SNF and the ability to characterize the SNF and related systems (e.g., casks, canisters, etc.) at any time after discharge for use in evaluating an integrated nuclear waste management system.

Waste Management System Architecture Analyses (WMSA) [4] tools model the discharge of SNF from reactors, pool inventory changes, fuel handling operations (e.g., receipt of SNF at the ISF, repackaging of SNF into canisters or bare fuel casks), decay heat of SNF assemblies, and shipment requirements of the waste management system to provide system-wide logistics and cost information.

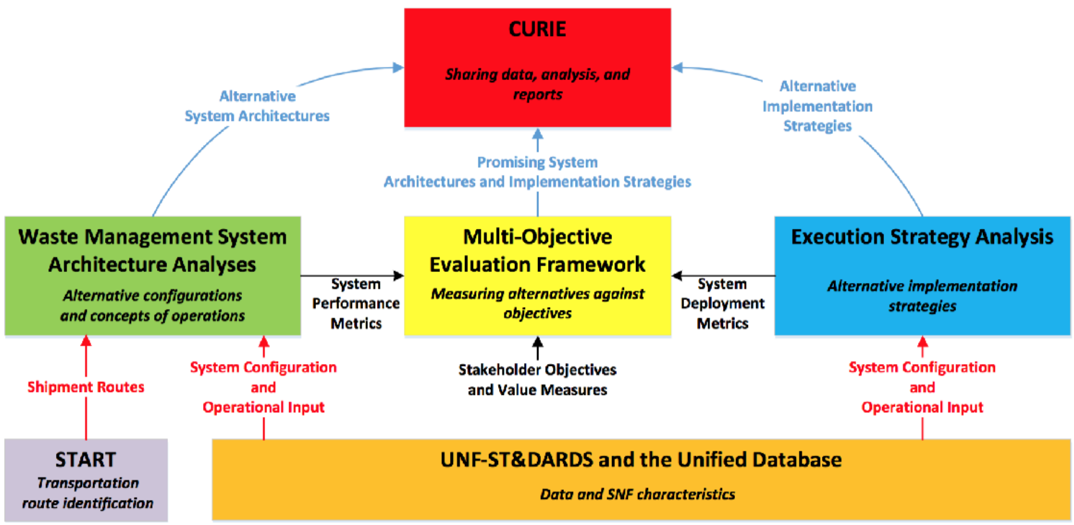

Fig. 1. NFST Integrated Nuclear Waste Management System Analysis Tools

Multi-Objective Evaluation Framework (MOEF) is a set of capabilities, methods, processes, and tools that provide a means to evaluate alternative scenarios and system architectures where there are multiple conflicting objectives and differing stakeholder perspectives that must be taken into account. The NFST MOEF and ESA efforts are closely linked (as shown on Figure 1) and the ESA capability provides information regarding how alternative implementation strategies perform in meeting the goals of the Administration's *Strategy.*

Centralized Used Fuel Resource for Information Exchange (CURIE) [5] website is a national resource that contains information on SNF that may be helpful to various stakeholders including industry/vendors, state and federal agencies, national laboratories, and the public. CURIE includes a calendar, the SNF image gallery, NFST featured documents, and external links to databases and websites.

THE ESA APPROACH

The ESA approach builds on traditional project management tools (i.e., Gantt charts) to provide additional insights into project lifecycle planning or implementation. It has been applied extensively in nuclear and non-nuclear projects not only in the U.S. but also internationally. The ESA capability provides a comprehensive, fully integrated systems planning process and tool, allowing for high-level total system integration that is achieved through dynamic simulation of project implementation with explicit consideration of uncertainties and risks. The ESA is built on the GoldSim [6] platform (Monte Carlo Simulation Software for Decision and Risk Analysis) and is used to identify and examine alternative strategies for achieving project objectives. This process and tool are helping to develop a sound, risk-informed basis for planning and informing future program execution decisions by the following actions:

- Capturing linkages among waste management program/project elements (e.g., transportation, component fabrication, facility construction, licensing/permitting).
- Capturing uncertainties associated with program/project activities.
- Capturing consequences of changing funding structures and priorities.
- Capturing technical and non-technical risks, including those due to linkages between nuclear waste management program elements.
- Identifying and tracking key metrics (i.e., cost, schedule, etc.).
- Quantifying the effects of uncertainties and risks on key metrics.
- Evaluating alternatives for prioritizing activities and evaluating mitigations.
- Helping to foresee the potential consequences of proposed decisions.
- Helping to identify opportunities for optimization or efficiency.
- Helping to improve the ability to reduce programmatic risks.

The ESA development effort has been driven by several goals, including:

1. Integration of existing concept information and associated risks from other NFST activities and tools.
2. Simulating the integrated project throughout its lifecycle at a high level.
3. Evaluating the performance of high level “what if” questions in areas such as: alternative funding levels, management approaches, strategies and priorities.
4. Calculating projections of how a particular strategy plays out and then comparing the alternatives using appropriate metrics.
5. Evaluating the probabilities of unplanned events and “soft” non-technical risks using a Monte Carlo simulation approach.
6. Determining the importance of uncertainties/risks that affect the success of a particular strategy and then evaluating potential mitigation actions.
7. Meeting transparency objectives for communication with a wide variety of stakeholders.

A key component of the ESA approach is the use of subject matter experts (SME) to capture and correlate key attributes such as activities, durations, costs, uncertainties, and risks. Little "hard information" is typically available related to alternative strategies and approaches that are either completely new, have not previously been implemented within the U.S. nuclear waste management context, or are an extrapolation of approaches that have been deployed. Therefore, subject matter expertise is essential to establish a credible simulation tool by providing the best data input possible in light of these practical constraints. Thus, SME input that augments the data and information that is available is the foundation of the ESA capability.

The Process of Development of the ESA Tool

The ESA approach is a top-down dynamic simulation model development effort. The approach is to develop the model in a different way than many projects are designed. The process starts with identifying "What is success?" and then works backwards, using precedence requirements to establish the logic of a project and how it should perform. The intent is to concentrate on the integration and coupling of all system components in a coherent way so that options can be weighed at a strategic level. Key activities are represented by approximations in high-level depictions and parameters; additional details are added as needed to capture important activities. The intent is to remain focused on total system performance without getting lost in what may prove to be unnecessary details at a strategic level.

The broad steps in the ESA process include [7]:

1. Identification of the requirements for successful project completion – creation of a Success Precedence Diagram (SPD).
2. Determining data requirements and data availability to support the choices of metrics by which success is measured (activities' durations and costs, in the case of ESA).
3. Mapping the project plan (if one exists) to the SPD, looking for gaps/omissions.
4. Identification of risks and quantification of uncertainties through the formal elicitation process.
5. Developing the initial dynamic simulation model (using GoldSim software as a platform).
6. Using the model to simulate project strategies and analyzing results to identify parameter sensitivities and importance factors for the key risk drivers affecting performance.
7. Iterating the model and refining execution strategies by evaluating mitigation or optimization activities.

For the NFST ESA model the desired outcome is the initiation of operations at an ISF, and the logic includes the following correlated activities [7]:

1. ISF siting.
2. ISF design.
3. Licensing, regulatory compliance, and permitting.
4. Transportation hardware acquisition.
5. Transportation planning (routing, emergency responder training).
6. ISF construction.
7. Transportation operations.
8. Stakeholder consultation and cooperation.

The ESA model produces these key outputs for the analyses of implementation scenarios [7]:

1. Probability distributions for key metrics including key milestones dates and program costs.
2. Annual spending profiles.
3. Key risk/uncertainty drivers for cost/schedule results.
4. The likelihood that activities and milestones are on the critical path.
5. Comparisons of individual project execution strategies without and with risks, not only individually but also between scenarios.

RECENT ESA ENHANCEMENTS

Initial analyses [7] of the ESA model's results confirmed the importance of the early start of non-site specific foundational activities. These early activities could accelerate the implementation schedule when full-scale deployment of a consolidated interim storage program in the U.S. begins. Key risks to implementing consolidated interim storage were identified also. This led to the creation of an integrated priority list of activities and associated budgets to inform annual planning.

Development of the ESA model is ongoing as alternative execution strategies and approaches are being identified and additional information is becoming available from other NFST activities. The ESA model is continuously being updated and/or enhanced to meet emerging needs of NFST and/or when new information becomes available.

Recent enhancements that have been made to the ESA model include developing and analyzing generic consent-based siting (CBS) scenario alternatives and schedule performance enhancement strategies. These enhancements are described below. Again, it must be recognized that there are multiple alternatives for implementing interim storage to meet the goals in the Administration's *Strategy* and the scenarios and the assumptions discussed in this paper should not be viewed as defining a path-forward to implementation or DOE policy, but rather as potential approaches whose performance attributes are being evaluated to inform future decisions regarding implementation.

Generic Siting Scenario Alternatives

The need to analyze potential consent-based siting scenarios and their impact on the overall program evolved from the first analysis results of the ESA model. The initial ESA model contained a very simplified representation of a CBS process. The initial results indicated that meeting the siting milestones was always on the critical path and key uncertainties and risks associated with consent-based siting had a very strong effect on ISF deployment. This indicated, using the top-down development approach described above, that a better representation of potential CBS processes was needed.

A small Siting Model Working Group (SMWG) composed of NFST SMEs was formed to develop and analyze representative siting scenarios. Starting with the review of different siting experiences in the U.S. and abroad, and seeking to be encompassing in nature, the SMWG identified a generic set of potential activities that could possibly be conducted.

This generic encompassing set of potential activities was used as a starting point for developing three general siting approaches that differ primarily in the number of activity steps selected: (1) Abbreviated; (2) Medium; and (3) Extended. The *Extended* approach is adapted from the Canadian siting model, the *Medium* is based on the Monitored Retrievable Storage (MRS) and Global Nuclear Energy Partnership (GNEP) efforts in the United States, and the *Abbreviated* is similar to the effort that was undertaken in Spain in the search for and selection of a consolidated storage facility site[1].

The major difference between the three approaches is in the duration and level of engagement during phases of development of the CBS process and exploration of interest (community studies possibly funded through grants) in potential volunteer communities. In other words, the difference is in the number of steps and duration of pre-negotiation engagement (prior to negotiating a consent agreement) assumed for each general siting approach. The assumptions, potential advantages, and possible disadvantages associated with each generic siting process are discussed below.

Extended pre-negotiation engagement process begins with general consultation about the siting process. Input from the general consultation is used to prepare a draft CBS process that is made available to the public and stakeholders for review and comments. The CBS process is then finalized based on the comments received, and additional consultations might be sought. Up to three rounds of community studies are available during the exploration of interest phase through

[1] It should be noted that prior to engaging in an official siting campaign, there was an extensive series of consultations among stakeholders that lasted about two years to discuss the principles for a siting process. While their siting effort might appear abbreviated, it was only partially so.

site evaluation, beginning with small initial community studies and increasing in scope and depth with each round.

The major comparative advantage of the Extended process is that there is a potential for an increased number of applicants that could successfully pass onto a subsequent phase (i.e., down-selection). The increased amount of up-front engagement might also help to further establish trust through the building of working relationships, and therefore increasing the likelihood for successful negotiations of a CBS agreement.

A major comparative disadvantage (or risk) is the potential to miss opportunities for negotiating and finalizing early agreements (as in the case where there is a volunteer that is ready to apply early).

Abbreviated pre-negotiation engagement process is characterized by very limited (if any) engagement on the development of the siting process itself. It is assumed that a draft of the CBS process is not made available for public review and comments in advance, but rather is developed based primarily on previous siting experiences (domestically and internationally). The CBS process description is assumed to become publicly available just prior to announcing the initiation of the siting process itself. It is assumed that only one round of community exploratory studies might be performed during the exploration of interest phase.

Major comparative advantages of the Abbreviated process include potential schedule and cost savings in early phases.   Such savings might be possible only if the defined CBS process is accepted. In the case of a significant negative reaction more time and resources may have to be spent re-establishing trust or perhaps even on starting the process over.

Major comparative disadvantages and risks include:

- Very limited time to gather and develop the necessary resources for conducting the CBS process (including acquiring needed expertise, team development and training).
- Increased potential that the imposed schedule constraints could cause a negative reaction that could stall the process.
- Limited opportunities to establish trust in the process, potentially leading to challenging negotiations.
- Potential to limit the number of volunteers.

Medium pre-negotiation engagement is characterized by initiating a dialogue of engagement on the CBS process with the issuance of a draft CBS process description. It differs from the extended process in that consultations on the process do not begin until after the draft process is issued. It is assumed that a siting process is developed based primarily on past experiences, and information is proposed and made available for public review and comments, after which it may be subsequently revised. It is also assumed that up to two rounds of exploratory community studies (first small, then larger in scope) would be conducted during the exploration of interest phase through to site evaluation.

As in the Abbreviated approach, the Medium approach offers potential schedule improvements and possibly lower front-end costs, but only if the process is accepted and no negative reaction occurs.

Comparative disadvantages and risks are similar to those of the Abbreviated approach.

Schedule Enhancement Opportunities

Initially, the ESA model was built using the concept of a sequential steps approach, whereby licensing starts only after one or more sites is selected, and construction starts only after a license is granted. However, an evaluation of the initial ESA model's logic structure and the results it provided led to the SMWG identification of potential schedule enhancement opportunities by running activities in parallel to some extent, rather than making them strictly sequential. These opportunities include: (1) commencing licensing early (at multiple potential sites) prior to final site selection; (2) commencing construction of some items early with NRC authorization prior to receipt of a final license; and (3) a combination of early licensing and early construction approaches. The inclusion of these potential scenarios included the presumption of acceptance by participants in the siting process and the regulators. The assumptions, potential advantages, and possible disadvantages associated with each schedule enhancement opportunity are discussed below.

Early Licensing assumes that once potential host sites are selected for further investigation as potential sites, a license application (LA) is submitted for each of the sites. The NRC license review process is assumed to occur after a draft Environmental Impact Statement (EIS) for the site/design alternatives under consideration is prepared and in parallel with remaining site-specific analyses and with negotiations with the potential host communities.

Licensing of multiple potential sites offers comparative advantages of having increased technically mature alternatives, as well as reducing the risk of delay in overall implementation resulting from unexpected licensing difficulties at any single site.

It is important to recognize that early licensing would likely be advantageous only if there is an agreement on particular design requirements and a design concept for each site. Otherwise all designs considered by a site would likely have to be included in the LA, which would increase the cost and time for both LA preparation and NRC review.

In addition, as negotiations towards a CBS agreement(s) and site selection progress, licenses or license applications for those sites that were not selected could be retained as backups or dropped from further consideration.

It is assumed that there would be sufficient resources to carry multiple design/licensing activities and that the NRC would have sufficient resources to concurrently review multiple license applications. However, it is recognized that the availability of resources for such a scenario is a major uncertainty and a lack of resources could cause delay.

Early Construction assumes that the NRC would authorize initiation of some construction before a license is granted. It is also assumed that a CBS agreement(s) has to be reached and any necessary decision documents must be in place before construction commences.

The approach offers a potential for acceleration of ISF deployment for all scenarios. However, there is a financial risk of late arriving licensing conditions that could require a significant change after construction has begun.

Self-Financed Volunteer

The SMWG also developed and analyzed a self-financed volunteer generic siting alternative for inclusion in the ESA model where a potential host:

- Has a designated site for an interim SNF storage facility, with some local support for the site, and some levels of state/regional support (initial consent);
- Designs, prepares and submits an environmental report (ER) and LA to NRC using its own resources and funding (independent of the Federal Government); and
- Seeks the Federal Government to take title to SNF and transport it to the storage site.

While analyzing self-financed volunteer scenarios the following assumptions for ESA modeling were made:

- A CBS process with other potential volunteers would continue when a self-financed volunteer approaches with a proposal.
- The process for National Environmental Policy Act (NEPA) compliance would be completed as required for a Federal Government decision on how and where to store commercial SNF.
- Any ongoing NRC NEPA actions/documents would be incorporated by reference to the extent possible.

Due to the many remaining unknowns and uncertainties in a self-financed volunteer approach, the SMWG developed three scenarios:

1. A separate EIS would be prepared for a self-financed volunteer to meet NEPA requirements for a Federal Government decision on how and where to store commercial SNF.
2. A self-financed volunteer would be included with all sites under consideration in the EIS that would be prepared to meet NEPA requirements for a Federal Government decision on how and where to store commercial SNF.
3. A license application (LA) would be processed by the NRC only after an agreement with the self-financed volunteer is in place (financial assurance).

The SMWG identified potential opportunities that could result from a self-financed volunteer approach that include no upfront costs for design/licensing, a potential schedule savings if an agreement with a self-financed volunteer could be quickly achieved, and additional options for meeting some program requirements.

The SMWG also identified risks and uncertainties that include:

- Storage services offered by the self-financed volunteer might not meet all programmatic needs.
- Possible need for consent agreements with host jurisdictions separate from and in addition to the arrangements with the self-financed volunteer.
- Uncertainties associated with the Federal Government taking title to SNF that would be stored at a private facility.
- Uncertainty associated with storage fees.
- The defined scope for the self-financed volunteer ISF could change the scope for other potential volunteers.

RESULTS AND INSIGHTS GAINED FROM THE ESA MODEL

It is recognized that there are multiple alternatives for deploying interim storage capacity to meet the goals in the Administration's *Strategy*. The CBS process would ultimately define the facility and its capabilities to be deployed at one or more sites. At a high level, the different deployment alternatives are as follows:

Co-located pilot and larger ISF: For this alternative, it is assumed that the pilot ISF and larger ISF would be deployed in a phased, step-wise manner. It is further assumed that the pilot ISF would be licensed first, and the larger ISF would be licensed through amendment(s) to the facility license. This assumption is made because it is envisioned that pilot ISF facilities (e.g., cask receipt facilities), would also be used by the larger ISF.

Separate pilot and larger ISF(s): For this alternative, it is assumed that the pilot ISF and one or more larger ISF(s) would also be deployed in a phased, step-wise manner, but each would be at a different site. It is assumed that the pilot ISF would be licensed first, with the larger ISF(s) licensed at a later date. This assumption is made because the facilities would be located at different sites having different conditions, and possibly utilizing different facility design concepts (i.e., storage methods, cask receipt facilities).

Co-located pilot/larger ISF and a separate larger ISF: For this alternative it is assumed that a pilot and larger ISF are co-located, along with yet another larger ISF located at a different site. The facilities would be deployed in a phased, step-wise manner. It is assumed that the pilot ISF would be licensed first, and the larger ISFs would be licensed at a later date. It is assumed that the co-located larger ISF would be licensed through amendment(s) to the pilot ISF license, while the separate larger ISF would be licensed at a later date.

The current version of the ESA model represents only the first alternative where it is assumed that a pilot and larger ISF would be co-located. Future work, described below, will implement the other alternatives into the ESA framework.

After the generic CBS and schedule enhancement opportunity scenarios described above were developed, the overall process for implementing the scenarios into the dynamic simulation model was followed (see [7] for details). This process included laying out the milestone and activity precedence structure and linkages to other programmatic milestones (i.e., design), estimating activity durations and costs (uncertain), and quantifying risks and consequences (also uncertain). This was all done by the SMWG in consultation with NFST SMEs. Once this was completed the ESA model was revised, simulations were executed, and the results were evaluated.

Several major assumptions were made, including:

- One or more sites are initially is selected for further investigation and possibly consent negotiations.
- One or more consent agreements are reached with a host community.
- No site-specific fatal flaws are identified with remaining candidate(s) during licensing.

The ESA model was used to analyze 12 scenarios consisting of different combinations of generic CBS and schedule enhancement opportunity alternatives, and three self-financed volunteer alternatives, as shown in Figure 2. Figure 3 provides an example of ESA results for when a pilot ISF would be operational for four of the siting and schedule enhancement opportunity scenarios. Figure 3a shows the results when only the uncertainties in activity durations are considered. Figure 3b shows the results when both the uncertainties in activity durations and the delay consequences associated with technical and non-technical risks are considered.

Type of Licensing / Construction	Pre-Negotiation Engagement											
	Abbreviated				Medium				Extended			
Seq. Licensing	X		X		X		X		X		X	
Early Licensing		X		X		X		X		X		X
Seq. Construction	X	X			X	X			X	X		
Early Construction			X	X			X	X			X	X

Notes: 1. X's indicate assumption made in a specific scenario. For example, the leftmost column is for an abbreviated pre-negotiation engagement – sequential licensing – sequential construction scenario.
2. The Self-Financed Volunteer scenarios are variants of any of the generic CBS and schedule opportunity alternatives shown on this matrix

Fig. 2. Matrix of Generic Consent-Based Siting and Schedule Enhancement Opportunity Alternatives Analyzed in the ESA Model

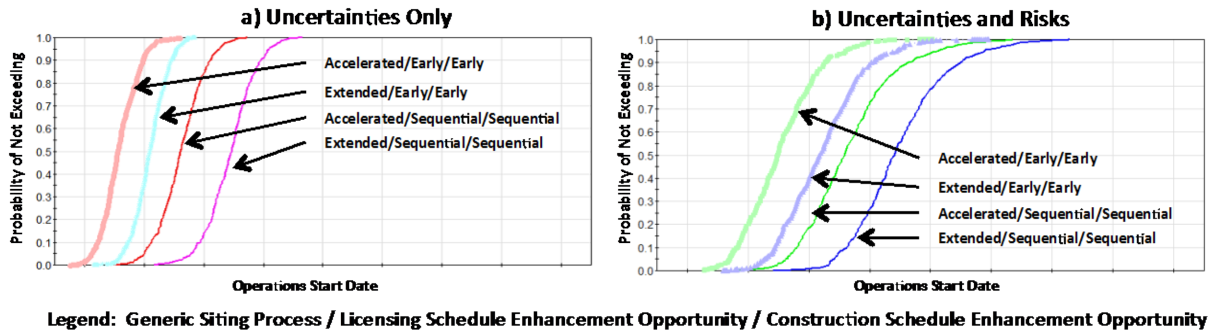

Fig. 3. Example ESA Results for Select Scenarios

Several insights were drawn from analyzing the ESA results.

- The approach that will ultimately be implemented for deploying an ISF, including the CBS process that will be followed and how the ISF would be licensed and constructed, will affect when it would be operational and how much it may cost. Since that approach will not be known until the CBS process is designed, in collaboration with stakeholders and the public, it is prudent to consider a broad range of potential alternatives in strategic planning activities.
- Uncertainties and risks have a significant effect on implementation strategies. Typical planning and scheduling efforts that focus only on best estimates for activity durations plus costs often fail to quantify and understand the impacts of uncertainty and risk. Uncertainty and risk should be explicitly considered in the evaluation of strategic implementation alternatives.
- The critical path to implement consolidated interim storage differs depending on the approach that will ultimately be implemented for deploying an ISF. Again, since that approach has yet to be defined it is not possible to determine which activities, such as facility design, siting, and establishing the transportation infrastructure, should have priority. As such, at the present time it is prudent to continue laying the groundwork for implementing interim storage in all areas necessary to ultimately meet the goals in the Administration's *Strategy*.

FUTURE ENHANCEMENTS OF THE ESA

ESA is one of the key NFST decision support capabilities that must be integrated with other NFST systems analysis tools to provide timely information that supports the development and analysis of program milestones and costs of strategies for siting, licensing, storage design, and construction options that are being developed. This list of key future ESA model enhancements for increased usefulness includes:

- The current version of the ESA model is not constrained by funding and only reports the cost of completing all the activities necessary for implementation of consolidated interim storage. Future plans involve the implementation of constrained funding logic to give analysts the ability to understand how such constraints would affect the different deployment strategies.

- As discussed above, the current version of the ESA model assumes that a pilot and larger ISF would be co-located. Future plans involve a re-structuring of the ESA model logic to represent other potential ISF deployment alternatives.
- Future plans involve incorporating recent information on design concepts for the processing and storage of dual-purpose canisters that could potentially be received at an ISF [8] to better understand how those storage design concepts would perform from a strategic deployment perspective.

CONCLUSION

The ESA capability and tool that have been developed and continue to be enhanced are key components of the NFST set of integrated nuclear waste management system analysis tools. These tools are being used to identify and evaluate potential future integrated nuclear waste management system architectures that could be deployed. The ESA approach leverages on and goes beyond traditional project analysis tools to allow for the evaluation of alternative strategies for implementing potential future integrated nuclear waste management system architectures, currently focusing on the deployment of consolidated interim storage for commercial SNF. ESA is being used to support the development of plans, budgets, and alternative execution/implementation strategies for meeting the goals of the Administration's *Strategy*.

It must again be recognized that there are multiple alternatives for implementing interim storage to meet the goals in the Administration's *Strategy*. Given that how implementation will ultimately occur is not known, the ESA is being used to evaluate a range of potential future implementation scenarios. The scenarios and the assumptions discussed in this paper should not be viewed as defining a path-forward to implementation or DOE policy, but rather as potential approaches whose performance attributes are being evaluated to inform future decisions regarding implementation.

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