POLICY ISSUE
INFORMATION

June 23. 2004 SECY-04-0103

FOR: The Commissioners

FROM: Luis A. Reyes
Executive Director for Operations

SUBJECT: STATUS OF RESPONSE TO THE JUNE 26, 2003, STAFF REQUIREMENTS MEMORANDUM ON POLICY ISSUES RELATED TO LICENSING NON-LIGHT WATER REACTOR DESIGNS

PURPOSE:

To provide a status report on the staff's response to the Commission direction on two policy issues in the subject staff requirements memorandum (SRM). These two issues include (1) the integrated risk posed by multiple reactors, and (2) containment versus confinement.

BACKGROUND:

In SECY-03-0047, "Policy Issues Related to Licensing Non-Light Water Reactor Designs," dated March 28, 2003 (ADAMS Accession No. ML030160002), the staff discussed options and provided recommendations for Commission consideration on seven policy issues fundamental to licensing non-light water reactor designs.

The Commission, (SRM dated June 26, 2003 ADAMS Accession No. ML031770124), approved the staff's recommendations on Issues 2, 4, 5, and 7. The staff's recommendation on Issue 3 was disapproved (with direction to only review international consensus codes and standards if they are part of an application). The Commission approved the staff's recommendations on

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Issue 1 with the exception of accounting for the integrated risk posed by multiple reactors, and did not approve the staff's recommendation on Issue 6. The Commission provided the following direction related to Issues 1 and 6:

- Issue 1 The staff should provide further details on the options for, and associated impacts of, requiring that modular reactor designs account for the integrated risk posed by multiple reactors.

- Issue 6 The staff should develop containment performance requirements and criteria working closely with industry experts (e.g., designers, Electric Power Research Institute, etc.) and other stakeholders regarding options in this area, taking into account such features as core, fuel, and cooling systems design. The staff should pursue the development of functional performance standards and then submit options and recommendations to the Commission on this important policy decision.

The approved issues are being implemented through the development of a technology-neutral, risk-informed and performance-based framework for new plant licensing. Development of this framework was discussed in SECY-03-0059, "NRC's Advanced Reactor Research Program," dated, April 18, 2003, (ADAMS Accession No. ML023310534). The framework is intended to provide the technical basis for improving the effectiveness and efficiency of new plant licensing in the longer term (beyond the advanced designs currently in the preapplication stage). The staff plans to provide (1) a status paper to the Commission in late August 2004, on the scope, content, and intended use of the framework and any new policy issues needing Commission direction, and (2) a draft framework with recommendations on the additional policy issues in December 2004. Stakeholder interaction has been and will continue to be a key factor in the development of this framework.

This paper provides a status report on the staff's effort to respond to the Commission direction on Issues 1 and 6.

DISCUSSION:

The status of the staff response to the Commission direction in the June 26, 2003, SRM on Issues 1 and 6 are contained in Attachments 1 and 2, respectively, to this paper. A summary of the status of those responses is provided below.

Issue 1: Integrated Risk

In performing risk assessments, the staff's practice has been to consider the risk to the public on a per reactor basis, regardless of the number or the megawatt thermal size of the reactors on a site. This was the case in the Individual Plant Examination program and continues to be the case in current risk-informed activities. As of this date, the maximum number of licensed reactors located on a single site is three, although there are sites where construction permits were granted for up to four reactors. Since many existing plants achieve a level of safety comparable to the Commission's Safety Goals, the integrated (i.e., cumulative) risk to the population around the site posed by these multiple reactors remains small. However, as the number of reactors on a site increases (particularly as may be the case for small modular reactor designs, where up to 8 smaller units together would equal the output of 1 large unit), the appropriateness of this practice needs to be considered as to whether or not small modular reactors should be treated differently.

Attachment 1, “Integrated Risk,” provides the status of the staff’s ongoing assessment on Issue 1 regarding the consideration of integrated risk for modular plants (i.e., the cumulative effect on risk to the population around a site of adding a large number of small reactors to the site to produce power equivalent to the power of a large unit). In this assessment, including the development of options and associated impacts, risk metrics associated with both accident prevention and accident mitigation are being considered. In development of options, the staff is looking at both the risk to the population around a site from individual reactors and the cumulative risk from all the reactors at the entire site.

The staff has also held discussions with the Advisory Committee on Reactor Safeguards (ACRS) on this issue. These discussions have elicited additional views on the treatment of integrated risk. The staff intends to consider the ACRS feedback in further assessing this issue, as well as to solicit additional stakeholder feedback on options and impacts. Options and a recommendation will be included in the paper planned for December 2004 on the technology-neutral framework for new plant licensing (discussed above).

Issue 6: Containment vs. Confinement (Containment Functional Performance Requirements)

The staff is still in the process of developing the necessary information to respond to the Commission’s direction on this issue. Attachment 2, provides a status report on the staff’s progress and on the approach currently being considered in this evaluation. Stakeholder input has been and will continue to be a key part of this evaluation. Public workshops were held on November 19, 2003, and January 14, 2004, and key points from those workshops are summarized in Attachment 3. Industry interest in pursuing this issue remains high. Currently, staff plans to complete this evaluation and provide options and a recommendation to the Commission in coordination with development of the risk-informed and performance-based technology-neutral framework for new plant licensing described in SECY-03-0059. This will allow the recommendation on containment vs. confinement to be closely integrated with the related issues of defense-in-depth, probabilistic selection of the licensing basis, scenario-specific source terms, and emergency preparedness (discussed in SECY-03-0047 and the June 26, 2003, SRM). The staff will also consider Commission policies and regulatory requirements related to physical protection in assessing potential options for non-LWR containment functional performance requirements and criteria. Accordingly, the staff’s response to the Commission’s direction on Issue 6 will be included in the paper planned for late 2004 (discussed above) on the new plant licensing framework development.

RESOURCES:

The plans discussed in this paper do not require additional resources for implementation. Implementation is included in budgeted activities related to development of a framework for new plant licensing and regulatory infrastructure development.

COORDINATION:

The Office of the General Counsel has no legal objection. The policy issues related to integrated risk and non-LWR containment functional performance requirements were discussed with ACRS on April 15, 2004, and their views on integrated risk are contained in a letter to Chairman Diaz, dated April 22, 2004 The staff acknowledges the views expressed by the ACRS, and they will be used to develop the options and recommendations for these policy issues as part of the framework for new plant licensing.

CONCLUSION:

The staff will complete its evaluation and provide options and recommendations to the Commission on the issues of integrated risk and containment in coordination with development of the technology-neutral framework for new plant licensing later this year.

/RA by Martin J. Virgilio Acting For/

Luis A. Reyes
Executive Director
for Operations

Attachments:
1. Integrated Risk
2. Non-LWR Containment Functional Performance Requirements
3. Workshop Summary - Key Points

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INTEGRATED RISK

Introduction

The Commission, in staff requirements memorandum (SRM) of June 26, 2003, requested that the staff provide further details on options for, and the associated impacts of, requiring that modular reactor designs account for the integrated risk (i.e., cumulative effect on risk to the population around a site) posed by the use of multiple small reactors to equal the power output of one large reactor. These reactor modules generally would be located in close proximity to one another on a single site. The use of modular reactor designs is considered by some in the industry to be an attractive alternative to large single units because of the potential inherent safety characteristics of some modular designs (e.g., passive decay heat removal) and potential economic advantages (e.g., increased use of factory fabrication and stepwise construction and operation to bring modules on line as needed). Accordingly, the use of modular designs could result in a large number of reactors located on a single site.

Background

Traditionally, it has been the staff's practice in making risk-informed decisions to consider risk on a per plant basis. This has been considered reasonable because of the limited number of plants on a site (maximum three) and because of the low risk generally posed by currently operating plants as indicated by staff and industry studies (e.g., NUREG-1150, "Individual Plant Examination Program"). However, it is recognized that the population around a site is exposed to the hazard of everything that is on that site. In promulgating the Safety Goal Policy in 1986, the terms "plant" and "site" were both used. Whether this was intended to address integrated risk or not is not clear, but is a consideration with respect to how to treat integrated risk. Nevertheless, with the potential for modular reactors in the future, it is appropriate to consider when and how (if at all) integrated risk should be addressed, since the number of reactors on a site could be significantly more than three.

In SECY-03-0047, "Policy Issues Related to Licensing Non-Light Water Reactor Designs," the staff recommended and the Commission approved (in a June 26, 2003 SRM) a process for licensing new plants that parallels that used in the design certification of the evolutionary and advanced Light Water Reactors (LWRs). This process is based upon the Commission's expectation that new reactor designs will be safer than currently operating LWRs and will comply with the Commission's Safety Goal Policy, and that the need for additional features to address uncertainties will be determined on a plant-specific basis, with Commission approval. Accordingly, the addition of a single new reactor to a site with currently operating reactors would not add substantially to the overall risk. However, in making the recommendation in SECY-03-0047, the staff recognized that the addition of a modular reactor design to a site could add a large number of reactors to the site and thus recommended they be treated differently in that their integrated risk be considered. The Commission, in its June 26, 2003, SRM, requested that the staff provide further details and options for this recommendation.

In response to the Commission's June 26, 2003, SRM, the staff has reviewed previous dockets for sites where multiple reactors were approved to see if and how the issue of integrated risk was addressed. NRC has issued operating licenses to sites for three reactors. (e.g., Palo Verde) and granted construction permits for four reactors at several sites (Shearon Harris, North Anna, Surry, Hartsville, and Vogtle). These construction permits were granted on the basis of safety evaluations and environmental impact statements. However, these safety evaluations and environmental impact statements did not consider the risk (individually or integrated) from accidents and, therefore, are not considered potential precedents. In all cases, the integrated affect of plant impacts on the environment from normal operation (e.g., thermal discharges, radiological releases from routine operation) were considered, but not the integrated risk from reactor accidents.

Discussion

Discussed below are three initial approaches for considering integrated risk in licensing decisions for modular reactors. The advantages, disadvantages, and impacts of each approach are discussed. In addressing integrated risk, risk associated with both accident prevention (e.g., core damage frequency[1]) and accident mitigation (e.g., large early release frequency[1]) are considered. A key factor is megawatt thermal power size of the reactor (i.e., reactor power level). Specifically, risk measures for accident prevention are considered to be independent of reactor power level (i.e., it is just as important to prevent core damage accidents in small reactors as it is in large reactors), whereas risk measures for accident mitigation may be dependent on reactor power level (i.e., the source term will vary). In this assessment, base case risk is that associated with a large reactor design (i.e., ~1300 Mwe).

No consideration of integrated risk

This approach would essentially maintain the status quo in that the risk information is developed and evaluated on a per reactor basis not a per site basis, in regulatory decisions related to reactors (licensing, license amendments, or oversight). This approach has been judged acceptable for currently operating plants given that current sites in the U.S. have a relatively small number of reactors (up to three) and many currently operating reactors achieve a level of safety comparable to that expressed in the Commission's Safety Goal Policy, thus ensuring their integrated risk is small. In the future, new reactor designs are expected to have significantly less risk (at least an order of magnitude lower based upon insights from reviews completed to date) than current operating reactors. If this expectation is realized, neither modular designs or large designs would individually contribute significant additional risk to public health and safety. This approach does not distinguish between large and small reactors and is reasonable if the number of modular reactors added to a site were limited, since it serves to limit integrated risk. Also, it can be argued that uncertainties in risk assessments could be larger than the cumulative risk obtained by combining the risk from all reactor modules. However, since uncertainties are to be considered in risk-informed decisions, this should not be a reason to ignore cumulative effects.

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[1] It should be noted that as part of work on a risk-informed process for new plant licensing, the staff is currently developing technology-neutral risk metrics for accident prevention and mitigation, recognizing that core damage frequency and large early release frequency may not be appropriate for non-LWRs. In this regard, the use of Level 3 risk assessment is also being evaluated.

This approach is consistent with an interpretation of the Commission's Safety Goal Policy that risk should be evaluated on an individual reactor basis and also have minimal impact on current practices being used in risk-informing reactor regulatory requirements and activities, which assess risk on an individual reactor basis.

Consideration of integrated frequency

This approach would require only consideration of integrated frequency in assessing all risk measures (prevention and mitigation) for new reactor licensing decisions, independent of reactor module power level. In effect, it requires that the frequency associated with the risk criteria applied to large reactor designs be reduced for modular designs in proportion to the number of reactor modules needed to equal the output of a large reactor. This approach ensures that the integrated frequency associated with accident prevention (e.g., core damage frequency) from modular reactors is no greater than the frequency associated with accident prevention for a large reactor on a per MW basis. The effect of reactor power level on risk criteria associated with accident mitigation, however, is not taken into account. This assumption will likely result in a de facto more stringent goal than intended by the Commission's Safety Goal Policy, which was derived on a per unit basis not a per site basis.

This approach broadens the frequency range of initiating events and event sequences which will have to be considered in a modular reactor risk assessment (as compared to a risk assessment for a large reactor). The need to consider a broader frequency range will occur since lower frequency events and event sequences will need to be considered to ensure that the lower frequency accident prevention and mitigation measures needed for each reactor module are adequately assessed. This approach is consistent with an interpretation of the Commission's Safety Goal Policy that risk should be evaluated on a per site basis.
This approach also requires some changes in current practices for risk-informed activities when applied to modular reactors to account for integrated risk.

Consideration of integrated risk (reactor power level and frequency)

This approach would recognize that accident prevention is important, regardless of reactor power level, whereas in many cases accident mitigation is related to reactor power level (i.e., the lower the reactor power, the fewer fission products are available for release to the environment and thus the more difficult it is to have a large release). Accordingly, the integrated frequency associated with accident prevention risk criteria will need to be taken into account for modular reactor designs (similar to the second approach). However, the integrated risk associated with accident mitigation risk criteria could take into consideration reactor module size. This approach recognizes the dependence of risk metrics associated with accident mitigation on reactor power level and will result in the integrated risk from multiple reactor modules being at least as low as the risk from an equivalent large reactor design. Therefore, it will address integrated risk most realistically.

Like the second approach, this approach requires that in assessing accident prevention, the risk assessment consider events and event sequences of low enough frequency to ensure that accident prevention measures can be adequately assessed. This approach also requires that whatever accident mitigation risk measures are applied to modular reactors, they include consideration of reactor power and that some practices for risk-informed activities will need to be modified to address integrated risk for modular reactors. In addition, this approach represents an interpretation of the Commission’s Safety Goal Policy that risk metrics associated with accident prevention and mitigation be assessed on a per site basis.

Future Plans

The staff plans to continue to evaluate the above approaches and the views received from the ACRS. Further stakeholder input will also be solicited and considered in the evaluation. Options and a recommendation on the issue of integrated risk for small, modular reactors will be coordinated with and included in the paper planned for late 2004 on the technology-neutral framework for new plant licensing.

NON-LWR CONTAINMENT FUNCTIONAL PERFORMANCE REQUIREMENTS

Introduction

The Commission, in its SRM of June 26, 2003, requested the staff to develop performance requirements and criteria for non-LWR containment designs, working closely with industry experts and other stakeholders regarding options in this area, and to take into account such design features as fuel, core, and cooling systems design. The Commission requested that the staff develop functional performance standards for non-LWR containment design and then submit options and recommendations to the Commission.

In response to the SRM, the staff initiated a study of non-LWR containment design information, including an assessment of the safety functions the containment may provide or support, and has taken steps to develop potential options for containment functional performance requirements and criteria.

Background

The functional roles of containment in protecting health and safety can vary significantly among non-LWR designs (e.g., high-temperature gas-cooled, liquid metal, molten salt). Containment functions are derived from the basic reactor-specific safety functions, such as controlling heat generation, removing heat, preventing chemical attack, and containing fission products. Differences in the derived containment functions and performance requirements also reflect differences in the integrated approach that is taken to optimize plant designs to meet a variety of objectives, including NRC regulatory requirements and safety expectations. The specific performance requirements and criteria that have been developed by designers for containment functions are also derived from and integrated with the requirements for other safety-related structures, systems, and components (SSCs) such as fuel, heat removal and coolant purification systems. Containment functional performance requirements and criteria are selected by designers so that the NRC's regulatory requirements (e.g., offsite dose limits) and designer objectives (e.g., meeting NRC safety goals, economics) are met. A non-LWR containment may be defined directly in terms of its derived functions, or indirectly in terms of the SSCs which carry out these functions. These SSCs are located within and compose "containment building system" (or "reactor building system") that resides between the reactor pressure boundary and the environment.

To meet NRC's health and safety acceptance criteria, LWR containment building system designs provide, among other functions, an essentially leak-tight barrier to the release of radioactive materials to the environment independent of the fuel barrier and reactor coolant pressure boundary barrier. This performance requirement reflects LWR technology in that a range of failures of the pressure boundary (i.e., the second barrier to the release of fission products) may cause the fuel (i.e., the first barrier to the release of fission products) to degrade or fail.

For some liquid metal reactor designs, the coolant itself can be highly radioactive and the fuel is not designed to maintain integrity in the absence of coolant. The designers of the liquid metal 4S reactor (i.e., a non-LWR), therefore, also propose a containment building system design that provides an essentially leak tight barrier in the event of an accident that results in the loss of the reactor coolant pressure barrier. However, for advanced HTGRs, the fuel, core, and cooling systems are being designed so that the coolant and internal surfaces within the pressure boundary system contain very limited radioactive material during normal operation and, the fuel remains a highly effective fission product barrier for, anticipated transients and accidents in the absence of coolant. As a result, advanced HTGR designers do not propose to meet health and safety acceptance criteria with a containment building system that provides an essentially leak-tight barrier to the release of radioactivity to the environment. Instead, advanced HTGR designers have proposed a vented low-pressure containment (VLPC) design with a leakage rate that is about two orders of magnitude higher than a conventional LWR containment but reduces radioactive material releases to the environment sufficiently to meet health and safety acceptance criteria (i.e., a “confinement” building). Although venting provides an initial release path to the environment for radioactivity contained within the coolant system, HTGR designers have stated that an unpressurized containment building enhances safety by removing the transport mechanism for fission products that may be released from the core later in a postulated depressurization accident. Advanced HTGR designs, therefore, propose a safety approach that would increase reliance on fuel integrity and the performance of other SSCs to prevent significant fission product release from the fuel, and decrease reliance on SSCs that mitigate significant fission product release. In this regard, preventing significant releases of fission products from the fuel is compatible with the ultimate objective of the Commission’s policy on advanced reactors according to which design approaches are expected to minimize the potential for severe accidents.

Defense-in-depth is fundamental to the NRC’s safety philosophy and is applicable to existing and advanced plants. It ensures that compensatory measures are in place to prevent and mitigate accidents to address uncertainties and also ensures that prevention is appropriately balanced with mitigation. The intent is to ensure that the accomplishment of key safety functions is not dependent on any single element of the plant design. Compared to current LWRs, advanced HTGR designs rely more on design characteristics or features that prevent or delay significant fission product transport from the fuel, core, and reactor pressure boundary (i.e., prevention), and rely much less on design characteristics or features that mitigate or delay radioactive material transport beyond the reactor pressure boundary to the environment (i.e., mitigation). However, for the most limiting accidents, mechanistic fission product transport barriers or delay characteristics and features both within the reactor coolant pressure boundary and beyond the reactor coolant pressure boundary, are generally needed to stay below the Environmental Protection Agency (EPA) guidelines for protective actions at the site boundary. The characteristics or features that significantly delay the transport of fission products may provide additional time for corrective actions to be implemented. For advanced HTGR designs, the long response time characteristic, therefore, may be viewed as an element of defense-in-depth because it provides significant substantial additional opportunity for accident management remedial actions in the course of most accident sequences. The staff is developing a technology-neutral description and process for assessing defense-in-depth for consideration by the Commission as a revision to the Policy Statement on the Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities. This description and process will be key considerations in the staff’s development and evaluation of options for containment functional performance requirements and criteria.

For LWRs, a conventional pressure-retaining, leak-tight containment building system provides significant independent mitigative defense-in-depth, to compensate for uncertainties. These involve uncertainties in initiating events, accident progressions, and accident phenomena which might result in, or increase the severity of, a core damage accident. By utilizing inherent, simple, passive, and reliable means to carry out safety functions, non-LWRs, such as advanced HTGRs, seek to reduce or eliminate many of the kinds of uncertainties that might lead to core damage accidents. Even so, because non-LWRs have not yet accumulated extensive operational and test experience, uncertainties in event probabilities and progressions, passive system performance, and fuel performance are likely to be major contributors to PRA and safety analysis uncertainties. Technology-specific and design-specific research and development, analyses, demonstration plant testing, quality assurance, and other programs are directed, in part, at understanding, quantifying, and reducing such uncertainties. Even so, the staff recognizes that, at the time of any non-LWR licensing review, completeness, modeling, and parameter uncertainties will remain, and will need to be addressed. This could include compensatory measures in the form of additional safety margin, periodic fuel testing to confirm fuel performance, security design or programmatic measures to reduce or minimize insider and outsider initiating event threats, or increased tests and periodic inspections of passive safety systems. Available margins between calculated offsite and onsite releases and release limits may also help compensate for uncertainties. Margins imposed by containment building system performance requirements and criteria for reducing releases to the environment may also be used to compensate for uncertainties. The Commission decision, in the June 26, 2003, SRM on SECY-03-0047, not to modify the emergency planning requirements for non-LWRs at this time may also be viewed as providing additional near-term defense-in-depth to compensate for uncertainties.

The Commission, in its June 26, 1990s SRM (ADAMS Accession No. ML003707885) for SECY-90-016, “Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements,” (ADAMS Accession No. ML003707849) stated that advanced reactor containment mitigation functional performance requirements should not be used by the staff to discourage accident prevention in advanced reactor designs. The staff recognizes that non-LWR containment building system functional performance requirements which provide a substantially higher standard than that required to meet the onsite and offsite radiological consequence acceptance criteria could discourage accident prevention. The defense-in-depth description and process being developed for Commission decision will provide a key input to the recommended requirements and criteria for containment functional performance.

Discussion

The staff is currently developing options for non-LWR containment building system functional performance requirements and criteria utilizing applicable Commission technical policies, NRC and industry documents, foreign and domestic technical information, and stakeholder input. The stakeholder input to date includes feedback from industry experts and other stakeholders received at public meetings on November 19, 2003, and January 14, 2004, and from the Nuclear Energy Institute, Westinghouse, and PBMR (Pty) Ltd., in letters dated January 30, February 3, and February 4, 2004, respectively. These stakeholder comments have been considered in the assessment of containment functions, the development of the preliminary options, and the evaluation of the pros and cons for these options. The staff also met with the ACRS on this issue and will consider their comments in further assessing this issue. The staff will also solicit additional stakeholder input on potential options and impacts.

Applicable Commission policy guidance includes the 1986 Policy Statement on Safety Goals for the Operation of Nuclear Power Plants, the 1985 Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants, the July 30, 1993, SRM (ADAMS Accession No. ML003760774) for SECY-93-0092, "Issues Pertaining to the Advanced Reactor (PRISM, MHTGR, and PIUS) and CANDU 3 Designs and Their Relationship to Current Regulatory Requirements" (ADAMS Accession No. ML040210725), the 1994 Policy Statement on the Regulation of Advanced Nuclear Power Plants, the 1995 Policy Statement on the Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities, the March 11, 1999, White Paper on Risk-informed and Performance-Based Regulation, and the June 26, 2003, SRM for SECY-03-0047, "Policy Issues Related to Licensing Non-Light Water Reactor Designs, and the June 26, 1990, SRM for SECY-90-016.

In SECY-93-0092 the staff addressed the confinement concept for advanced HTGRs by recommending that the acceptability of proposed containment building system designs be evaluated against a functional performance standard rather than a prescriptive criterion. Specifically the staff proposed that containment building system designs must be adequate to ensure that the onsite and offsite radionuclide release limits were met for the event categories within their design envelope. The Commission's July 30, 1993, SRM for SECY-93-0092 approved the staff's recommendation.

NRC and industry documents being considered in the development and assessment of options include NRC regulations for light-water reactors, non-LWR preapplication design and safety analysis reports and related documents and associated staff preliminary safety evaluation reports, and U.S. Department of Energy (DOE) and national laboratory plant design information that had been provided to the NRC for Generation IV non-LWRs. Also being reviewed are selected documents and information pertaining to the containment building system design and safety basis for foreign non-LWRs (e.g., the JAERI High Temperature Engineering Test Reactor and Gas Turbine High Temperature Reactor 300, the Institute of Nuclear Engineering Technology HTR-10, and the Toshiba liquid metal reactor). Based on this review, the staff has concluded that the functional role of non-LWR containment building systems depends on the design and technology and this can include in varying degree:

1. reducing radioactive releases to the environment
2. preventing or limiting potential core damage
3. removing heat to mitigate accident conditions and prevent vital equipment from exceeding design and safety limits
4. protecting vital equipment from internal and external events
5. protecting onsite workers from radiation
6. providing physical protection (i.e., security) for vital equipment

While none of the six functions is exclusively a containment building system function, the first three may be viewed as mitigative functions, while the latter three may be viewed as preventive functions.

To qualitatively evaluate options for containment building system functional performance requirements and criteria, the staff has developed the following preliminary metrics:

Does the option adequately accommodate all containment building system functions (e.g., are there potential adverse effects on plant safety, event consequences, or other containment building system functions)?

Would the option be expected to substantially improve plant safety by

- preventing certain types of accidents?
- significantly reducing fission product release to the environment?
- addressing known uncertainties?

Does the option account for plant risk (e.g., is it risk-informed, does it consider uncertainties)?

Does the option provide flexibility to the designer in meeting the event consequence acceptance criteria (e.g., could it discourage innovation or accident prevention)?

In addition, the staff considered each option from the following perspectives:

Is it technology-neutral and performance-based?

How does it compare to the design approach proposed by existing or prospective non-LWR plant designs?

Does it involve significant incremental costs without commensurate safety benefits?

Future Plans

The staff plans to develop and assess technology-neutral options for non-LWR containment building system functional performance requirements and criteria for reducing radioactive releases to the environment and will continue to assess the feasibility of establishing technology-neutral performance requirements and criteria for the other identified containment building system functions.

Currently, the staff plans to complete activities in this area and provide options and recommendations to the Commission in coordination with the development of a risk-informed technology-neutral framework for future plant licensing described in SECY-03-0059. This will allow the non-LWR containment options to be closely integrated with the defense-in-depth description, probabilistic selection of licensing basis events, scenario-specific source term, deterministic engineering judgement, and the treatment of uncertainties. It will also give the staff an opportunity to obtain further input and feedback from industry experts and other stakeholders in developing the options and recommendations in this area. The staff will also consider Commission policies and regulatory requirements related to physical protection in assessing potential options for non-LWR containment functional performance requirements and criteria. Accordingly, the staff's response to the Commission's questions on Issue 6 will be included in a paper to be provided later this year on framework development.

WORKSHOP SUMMARY - KEY POINTS

The staff held public workshops on November 19, 2003, and January 14, 2004, to discuss and solicit comments on the staff's initial efforts to develop functional performance requirements and criteria for the containment design of new non-light water reactors (LWRs).

The scope of the workshops addressed options and issues for developing criteria to address the following potential containment functional areas:

(1) Containing fission products
(2) Preventing and mitigating severe core damage accidents
(3) Removing heat during accidents
(4) Protecting safety equipment from natural phenomena, and dynamic effects
(5) Protecting onsite workers from radiation
(6) Physically protecting vital equipment (security events)

Key points raised by stakeholders at the workshops are summarized below.

Potential Containment Functional Performance Areas

- Workshop participants stated that there needed to be a clarification of reactor safety functions, containment safety functions, and where the two overlap.

- NRC should look at how to apply these safety functions to radiation outside of the core.

- Specific aspects of the containment building can only be addressed in the consideration of a specific technology and design, and generic requirements are not very practical at a low level.

- NRC should make functional performance requirements technology-neutral (within the non-LWR arena), but functional performance criteria should be done on a design-specific basis, and for now, the NRC should focus on high-temperature, gas-cooled reactors (HTGRs) in developing functional performance criteria.

- Functional performance areas 1 and 2 should be combined and modified so to "manage the release of fission products during accidents."

- Many of the functional performance areas are not exclusive functions of the containment and can be accomplished by other systems.

- "Containment" should refer to a structure and "containment building" and "reactor building" can be used interchangeably; i.e., the use of the word "containment" does not necessarily imply a building with pressure-retaining capability.

Contain Fission Products

- This functional area should be combined with the “Prevent and Mitigate Severe Core Damage Accidents” area, with some changes to the wording.
- NRC should not require a containment building to be pressure-retaining, or to have the capability to filter fission products. The regulations should focus on what dose acceptance criteria need to be met outside of the reactor/ containment building.
- NRC should give credit to design features that enhance operator recovery.
- Functional performance requirements need to account for the role of time in assessing functional performance requirements, and consider time available for taking mitigative actions.
- Stakeholders encouraged the NRC to understand the design philosophy of the new reactors and to take that (along with how to deal with very low core damage frequency) into consideration in determining the functional performance requirements.

Prevent and Mitigate Severe Core Damage Accidents

- NRC should allow the designers to have flexibility in dealing with uncertainties, and should not assume that the prevention of severe core damage (however it is defined) is a function of the containment building.
- If there is reasonable assurance of fuel quality, is a containment building a necessary element of defense-in-depth? Is a containment building with the capability to be pressure-retaining necessary just in case the fuel integrity is not as good as it was thought to be?
- There is no clear separation between prevention and mitigation. New reactor designs are not relying on just one thing to prevent accidents.
- NRC should focus on putting requirements on the conditions of an area immediately outside of the containment (or reactor) building, and not look at how those conditions are achieved. NRC should establish basic dose criteria that need to be met under accident conditions while allowing the designer flexibility in how to meet that criteria.
- In accounting for completeness uncertainties, the impacts on the integrated cost of the plant need to be considered.

Remove Heat During Accidents

- This function should not be assigned to the containment building as heat removal can be accomplished with other systems.
- Clarify whether this function is necessary for maintaining structural integrity of the containment building or whether it is important for the retention of fission products in the fuel.
- How much redundancy and diversity should be required for passive components?
- The reactor/containment building, no matter what it looks like, must accommodate and not interfere with heat removal and recovery actions for the purposes of maintaining fuel integrity, terminating fuel damage if such damage is underway, ensuring building and structural integrity, and facilitating recovery actions after an accident.

Protect Safety Equipment From Natural Phenomena and Dynamic Effects

- Stakeholders said they would prefer that this requirement not be assigned specifically to containment. The NRC should only require that provisions are provided within the systems structures, and components to protect against the adverse effects of natural phenomena.

Protect Onsite Workers from Radiation

- There need not be additional regulations for worker protection under accident conditions as the existing regulations are adequate. New plants should use something similar to the NEI Severe Accident Management Guidelines (SAMGs).
- This functional performance requirement should require the reactor (or containment) building to accommodate and not to interfere with recovery actions.

Physically Protect Vital Equipment (Security Events)

This topic was not discussed at the workshops.