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Sent: Wednesday, August 4, 2021 7:25 AM
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Subject: Transmittal of Advanced Reactor Content of Application Project - Risk Informed Inservice Inspection and Inservice Testing Draft White Paper Guidance
Attachments: ARCAP ISG Draft - Risk-Informed ISI-IST aug 2021.pdf

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Southern Company Services
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Mr. Afzali, Ms. Austgen, and Mr. Draffin,

The purpose of this email is to provide you with the attached Advanced Reactor Content of Application Project - Risk Informed Inservice Inspection and Inservice Testing Draft White Paper. The attached document will be referenced in the NRC staff presentations during an upcoming advanced reactor stakeholder meeting tentatively scheduled for August 26, 2021. This email will be captured in ADAMS and the email will be made publicly available so that interested stakeholders will have access to the information prior to the meeting.

If you have questions regarding the attached documents please contact me.

Sincerely,

Joe Sebrosky
Senior Project Manager
Advanced Reactor Policy Branch
Office of Nuclear Reactor Regulation
301-415-1132

Hearing Identifier: NRR_DRMA
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This draft staff white paper has been prepared and is being released to support ongoing public discussions. The guidance found in this draft white paper uses an interim staff guidance (ISG) format. The staff is considering using the ISG format in the near future to provide guidance to facilitate the near-term review of advanced reactor applications.

This paper has not been subject to NRC management and legal reviews and approvals, and its contents are subject to change and should not be interpreted as official agency positions.

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

DANU [XX]-ISG-[YYYY-##]

Advanced Reactor Content of Application

“Risk-Informed ISI/IST Programs”

Interim Staff Guidance

August X, 2021

DANU [XX]-ISG-[YYYY-##]
Advanced Reactor Content of Application
“Risk-Informed ISI/IST Programs”
Interim Staff Guidance

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INTERIM STAFF GUIDANCE

ADVANCED REACTOR CONTENT OF APPLICATION

"RISK-INFORMED ISI/IST PROGRAMS"

DANU-ISG-YYYY-##

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC, or Commission) staff prepared this interim staff guidance (ISG) to facilitate the review of advanced reactor applications for non-light water reactors (non-LWRs), stationary micro reactors and small modular LWRs submitting risk-informed applications for a construction permit (CP) or operating license (OL) under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," for a combined license (COL), a manufacturing license (ML), a design certification (DC) under 10 CFR Part 52, "Licenses, Certifications and Approvals for Nuclear Power Plants." The guidance in this ISG supports the review of the portion of an advanced reactor application associated with risk-informed inservice inspection and inservice testing (ISI/IST) programs. Guidance for the review of ISI/IST programs included in advanced reactor applications that employ risk insights but are not submitted as "risk-informed" ISI/IST programs will be considered for separate development.

It is anticipated that this guidance will be updated for the NRC staff review of advanced nuclear reactor license and permit applications submitted under 10 CFR Part 53, "Licensing and Regulation of Advanced Nuclear Reactors," when the regulation is issued.

BACKGROUND

This ISG is based on the advanced reactor content of application project (ARCAP) whose purpose is to develop technology-inclusive, risk-informed and performance-based application guidance. The ARCAP is broader than and encompasses the industry-led technology-inclusive content of application project (TICAP). The guidance found in this ISG supplements the guidance found in DANU-ISG-YYYY-##, "Advanced Reactor Content of Application Guidance," which provides a roadmap for developing all portions of an application. The guidance in this ISG is limited to the portion of an advanced reactor application associated with the review of risk-informed ISI/IST programs for the reactor plant applicant.

The 10 CFR Part 53 regulation is under development and, as such, the guidance found in this document is subject to change based on the outcome of this rulemaking. As the 10 CFR Part 53 requirements are developed, this ISG guidance will be supplemented, as necessary, to provide guidance for reviewing risk-informed ISI/IST programs to reflect any differences in requirements between Parts 50/52 and Part 53. The goal of the 10 CFR Part 53 rulemaking effort is to develop the regulatory infrastructure to support the licensing of advanced nuclear reactors. The term "advanced nuclear reactor", for purposes of this rulemaking, means a nuclear fission or fusion reactor with significant improvements compared to commercial nuclear reactors operating on the date of enactment of the "Energy Act of 2020" or under construction as of January 2019. This rulemaking would revise the NRC's regulations by adding a risk-informed, technology-inclusive regulatory framework for advanced nuclear reactors in response to a growing interest in possible licensing and deployment of advanced nuclear reactors and the related requirements of the Nuclear Energy Innovation and Modernization Act (NEIMA; Public Law 115-439) as amended by the Energy Act of 2020. Key documents related to the Part 53 rulemaking, including preliminary proposed rule language and stakeholder comments, can be found at Regulations.gov under Docket ID NRC-2019-0062.

RATIONALE

Note – this section will be updated with additional stakeholder interactions – expected during the monthly ARCAP meetings.

APPLICABILITY

This ISG is applicable to applicants for non-light water reactors (non-LWRs), stationary micro reactors and small modular LWRs submitting risk-informed applications for a CP or OL under 10 CFR Part 50 or for a COL, DC or ML under 10 CFR Part 52. Once the content of 10 CFR Part 53 is developed and this ISG is updated, where necessary, the guidance in the updated ISG will also apply to applicants for a power reactor CP, OL, COL, DC and ML under 10 CFR Part 53.

GUIDANCE

The guidance in this ISG describes the methods acceptable to the NRC staff for reviewing applications for risk-informed ISI and IST programs described by advanced reactor applicants as part of a licensing application. Currently, the requirements for ISI and IST programs are described in 10 CFR 50.55a. These requirements apply only to LWRs and are based upon requirements developed by the American Society of Mechanical Engineers (ASME). With the increased use of probabilistic risk information in the design and regulation of nuclear power plants, it is expected that applications for future nuclear power plants will include risk-informed ISI and IST programs. Note: guidance for alternative approaches that use risk information to focus traditional ISI and IST programs on the most important SSCs and adjust accordingly their inspection/testing frequencies is under development.

The purpose of risk-informed ISI programs for advanced reactors is to periodically monitor and track degradation (defects, corrosion, erosion) in welds and base metal of components and component supports within the scope of the risk-informed ISI program to determine their suitability for continued operation, consistent with the assumptions in a plant-specific probabilistic risk analysis (PRA). The current ISI programs for LWRs include inspections of ASME *Boiler and Pressure Vessel Code* (BPV Code) Class 1, 2 and 3 piping, safety-related pressure retaining components and component supports. Non-safety related but safety significant components are typically inspected as part of reliability assurance or maintenance programs.

The purpose of risk-informed IST programs for advanced reactors is to periodically measure, assess, and track the performance of components within the scope of the risk-informed IST program to confirm that their performance remains consistent with the assumptions in the plant-specific PRA. The current IST programs for water-cooled reactors include components consisting of pumps, valves, and dynamic restraints that perform safety functions. However, some advanced reactors might rely on different types of components with different terms than pumps, valves, and dynamic restraints such as fluid control devices.

In addition to conventional components, advanced reactors might include passive components (such as electromagnetic pumps and heat pipes) to perform active safety functions. In the context of this guidance, a passive component with an active safety function is defined as a component that performs a function to move or cease the movement of fluid, or to provide for the transfer of energy as part of a safety function. Examples of passive components with active safety functions are electromagnetic or magnetic flux pumps that provide for the movement of fluid without directly interacting with the fluid, and heat pipes that transfer energy from one location to another in performing a safety function to cool a reactor core. In addition to assessing the operational readiness of conventional pumps, valves and dynamic restraints in an advanced reactor, the scope of the risk-informed IST program will also include activities to assess degradation in the performance of passive components with active safety functions by such means as condition monitoring, surveillance, testing or inspection.

ISI/IST programs in current nuclear power plants are not established to address potential degradation of passive components that that perform an active safety function where such degradation might adversely impact their capability to perform the applicable safety functions. Advanced reactor applicants will need to develop and justify periodic condition monitoring, surveillance, testing, or inspection plans for such passive components.

The use of risk information in the formulation of risk-informed ISI/IST programs helps focus the program on the most risk significant structures, systems and components (SSCs), conditions and failure modes, as well as ensure that the inspection/testing frequency is sufficient to detect degradations in reliability and/or performance that could affect continued safe operation.

The acceptability of developing risk-informed ISI/IST programs is dependent on having a high quality, plant-specific PRA. Accordingly, before beginning a detailed review of the application, the reviewer should confirm that a plant-specific PRA has been used in the risk-informing process and that the PRA was developed using an NRC-endorsed PRA consensus standard, such as:

- ASME RA-Sb-2005, “Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications”, December 30, 2005, as endorsed by,
- US NRC Regulatory Guide (RG) 1.200, “Acceptability of Probabilistic Risk Assessment Results for Risk-Informed Activities”, Rev. 3, December 2020.

For non-LWRs, ASME/ANS RA-S-1.4-2021, “Probabilistic Risk Assessment Standard for Advanced Non-Light Water Reactor Nuclear Power Plants, is available, and the NRC staff is working to endorse it with necessary staff positions via a trial-use RG by the end of 2021.

Applications for an OL, COL, DC and ML may include descriptions of other programs in addition to risk-informed ISI/IST programs (e.g., maintenance, reliability assurance, and aging management). If the ISI or IST program is being used to satisfy any of these other programmatic requirements, this information should be described, along with justification for how the ISI or IST activities will satisfy those other programmatic requirements. This may be described in the ISI or IST program plan or in the application. The reviewer should also determine which other programs are being coordinated with the risk-informed ISI/IST programs and whether any parts of the risk-informed ISI/IST program are being incorporated into another program. If so, the reviewer should confirm that the proposed scope of the risk-informed ISI/IST programs is addressed when considering all programs together.

A nuclear power plant applicant may request implementation of 10 CFR 50.69, “Risk-Informed Categorization and Treatment of Structures, Systems, and Components for Nuclear Power Plants,” for risk-informed treatment of SSCs as an alternative to certain special treatment requirements (STRs) in the NRC regulations. The NRC regulations in 10 CFR 50.69 define risk-informed safety class (RISC) of SSCs as follows: (a) RISC-1 SSCs are safety-related SSCs that perform safety significant functions; (b) RISC-2 SSCs are nonsafety-related SSCs that perform safety significant functions; (c) RISC-3 SSCs are safety-related SSCs that perform low safety significant functions; and (d) RISC-4 SSCs are nonsafety-related SSCs that perform low safety significant functions. The NRC regulations in 10 CFR 50.69 indicate that if approved, an applicant or licensee may voluntarily comply with the requirements in 10 CFR 50.69 as an alternative to compliance with specific STRs for RISC-3 and RISC-4 SSCs. The STRs that may be replaced by the 10 CFR 50.69 requirements for RISC-3 and RISC-4 SSCs include certain ISI/IST requirements in 10 CFR 50.55a. If an advanced reactor application includes a request to implement 10 CFR 50.69, the reviewer should review the *Federal Register* notice dated November 22, 2004 (69 FRN 68008) for the 10 CFR 50.69 final rule, and the guidance and training materials prepared by the NRC staff for the review and evaluation of 10 CFR 50.69 programs.

One area of concern with risk-informed ISI/IST programs in new reactor applications is the limited availability of performance data for SSCs of new design or technology that are directly applicable to the new reactor. The NRC staff discussed this issue in NRC Regulatory Issue Summary (RIS) 2012-08 (Revision 1), “Developing Inservice Testing and Inservice Inspection Programs Under 10 CFR Part 52,” dated July 17, 2013. In particular, the NRC staff provided the following discussion of risk-informed ISI and IST programs for new plant applications:

> “On several occasions, the NRC staff has been asked to define its position on risk-informed IST and ISI program submittals during the COL application process. A COL applicant or licensee may submit risk-informed ISI and IST programs for NRC staff review and authorization as an alternative to the regulations as described in 10 CFR 50.55a. Pursuant to § 50.55a(a)(3), the COL applicant or licensee must demonstrate that either the risk informed ISI/IST program provides an acceptable level of quality and safety or that compliance with the current regulations would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.
>
> The risk-informed ISI/IST program may be submitted during the COL application phase or any time after the COL is issued. While there is no requirement that a conventional ISI or IST program be developed prior to the submittal of a risk-informed ISI or IST program, the NRC staff recognizes the challenges that COL applicants and licensees face when developing a full-scope risk-informed ISI or IST program for a new or advanced reactor design, particularly when new types of systems are introduced for which no plant-specific component performance data exist. One approach to address these challenges is for the COL applicant or licensee to have a conventional ISI or IST program in place or developed before preparing a risk-informed program. In this manner, the conventional ISI/IST program can be used as a baseline for comparison with the proposed risk-informed ISI/IST program and the impact of implementing risk insights can be clearly identified. Depending on the

extent of uncertainties with operating experience in advanced reactor designs, it might be necessary for a COL holder to implement a conventional ISI/IST program for a period of time to establish sufficient component performance data to ensure the appropriateness of the risk-informed ISI/IST inspection or testing methods."

The reviewer should consider the challenges discussed in RIS 2012-08 (Revision 1) when evaluating risk-informed ISI/IST programs described in an advanced reactor application.

The descriptions of the risk-informed ISI and IST programs in the application do not need to be as detailed as the descriptions in the program plans. However, the application should describe the method used for determining from the PRA the reliability targets and performance assumed for the individual components as well as a description of the methodology to be used to demonstrate, based on the proposed inspections and inspection frequencies, whether or not the reliability targets and performance assumptions are met.

The guidance in this ISG is divided into two parts: one for LWRs and one for non-LWRs. The sections below address each of these parts. For LWRs, this guidance is applicable to ISI/IST programs where the entire program or only a portion thereof is risk-informed. For the non-risk-informed portions of the ISI/IST programs, a description should be provided that identifies the SSCs included in the non-risk-informed portion of the program and the regulations and guidance being used.

For non-LWRs, this guidance assumes that the scope of the entire ISI/IST program will be risk-informed.

The guidance in this ISG is applicable to risk-informed applications for an OL, COL, DC or a ML. For a CP, the application may contain less detail than for an OL; however, the application should, as a minimum, identify for LWRs whether or not the risk-informed ISI/IST programs will cover all SSCs or only a selected portion, and the associated regulations, RGs, NUREGs, etc. to be complied with at the OL stage.

PART 1 – Risk-Informed ISI/IST for LWRs

a) <u>LWR ISI</u> - 10 CFR 50.55a(g), which incorporates by reference the ASME BPV Code, Section XI, Division 1, "Rules for Inservice Inspection of Nuclear Power Plant Components", including various Addenda and Code Cases, requires preservice and inservice inspection of ASME BPV Code Class 1, 2 and 3 piping, safety-related (SR) pressure retaining components (reactor coolant pressure boundary, containment), SR component supports and all non-Class 1, 2 and 3 piping whose failure could prevent SR SSCs from performing their safety function. Conditions on the use of Section XI are listed in 10 CFR 50.55a(b)(2). Quality Assurance (QA) requirements for the ISI program are provided in 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," and 10 CFR 50.55a(b)(2)(x). The NRC has also issued the following RG on the acceptability of the Code Cases, with applicable conditions, associated with ISI under Section XI:

- RG 1.147, "Inservice Inspection Code Case Acceptability, ASME, Section XI, Division 1, Rev. 19, October 2019.

RG 1.147 is incorporated by reference in the NRC regulations in 10 CFR 50.55a(b)(5).

As discussed below for the risk-informed IST Program, advanced LWR designs might rely on passive safety features to perform active safety functions. Therefore,, condition monitoring, surveillance, and inspection provisions for those passive safety features shouldbe addressed by expanding the current scope of the IST program. to include those passive components that perform an active safety function or whose failure could prevent other SSCs from performing their safety functions. This ISG assumes that the passive components with active safety functions will be addressed under an expanded risk-informed IST program, rather than the risk-informed ISI program.

Specific guidance for licensees of currently operating LWRs proposing to risk-inform their ISI program is provided in RG 1.178, "An Approach for Plant-Specific Risk-Informed Decisionmaking for Inservice Inspection of Piping," Rev. 1, September 2003. The use of RG 1.178 assumes that the starting point for developing the ISI program for operating LWRs was 10 CFR 50.55a(g). Therefore, it is considered reasonable to use RG 1.178 to assess new LWR applications proposing to risk-inform their ISI program. The requirements of 10 CFR 50.55a(g) would be considered the baseline ISI program against which risk-informed changes would be assessed. In addition, although RG 1.178 is limited to piping, the principles and criteria for risk-informed decision-making contained in RG 1.178 can be applied to other pressure retaining components, component supports and other piping whose failure could prevent SSCs from performing their safety function. These principles are intended to ensure:

- Defense-in-Depth (DID) is maintained
- Sufficient safety margins are maintained
- Any increase in risk caused by changes to the baseline ISI program is small and consistent with the Commission's Safety Goal Policy (51 FR 28044, August 4, 1986)
- Monitoring is performed to confirm the acceptability of the change

The industry has also issued the following guidance documents related to risk-informed ISI for piping which may be useful in reviewing an applicant's proposed risk-informed ISI program for piping:

- Electric Power Research Institute report: EPRI TR-112657, "Revised Risk-Informed Inservice Inspection Evaluation Procedure," Rev. B-A, December 1999
- Westinghouse Energy Systems report: WCAP-14572, "Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report," Rev. 1, February 1999

The applicant may describe a complete risk-informed ISI program or only a portion of it. The application needs to justify the risk-informed portion of the ISI program as discussed below; however, if the non-risk-informed portion of the program follows the requirements of 10 CFR 50.55a, no justification is required, unless alternatives are proposed.

The reviewer should determine the scope of the risk-informed ISI program and ensure that the PRA adequately models the components proposed for inclusion in the program. In this regard, the reviewer should also determine if the piping in the risk-informed ISI program is modelled in segments (as suggested in RG 1.178) to better identify the most risk significant locations and welds. The reviewer should evaluate how risk information is used to guide (a) the selection of the inspection intervals for the various components in the program, (b) the selection of components for inspection during any given inspection interval, and (c) how the selection process varies from inspection interval to inspection interval to cover all the components of interest.

In developing a risk-informed ISI program, the applicant may propose alternative approaches to the requirements in 10 CFR 50.55a(g). In such instances, the reviewer should determine whether the applicant has submitted alternative requests in accordance with 10 CFR 50.55a(z) as part of the application. Where alternative requests are submitted, the reviewer should prepare an evaluation of the applicant's justification for satisfying 10 CFR 50.55a(z) to determine whether the alternative may be authorized. An applicant may also submit exemption requests in accordance with 10 CFR 50.12. Where the application does not include a risk-informed ISI program for the full scope of plant SSCs, the reviewer will need to evaluate the plant SSCs outside the scope of the risk-informed ISI program using the guidance for implementation of ASME BPV Code, Section XI.

The ISI inspection techniques may include visual, ultrasonic, radiographic, eddy current, liquid penetrant and pressure testing. Key areas of concern are welds and base metal locations. Other areas of concern are high stress areas, areas susceptible to thermal or mechanical fatigue, thermal shrinkage cracking, stress corrosion cracking, flow accelerated corrosion and corrosion due to leakage of corrosive material. The reviewer should determine the degradation mechanisms identified for each component or component support in the ISI program and ensure that the program includes techniques to evaluate the types of degradation identified. The reviewer should also evaluate how risk information is used to guide the selection of the various locations for inspection during any given inspection interval and how the selection process varies from inspection interval to inspection interval to cover all the areas of interest.

The reviewer should determine that the inspection techniques included in the risk-informed ISI program are consistent with ASME BPV Code, Section XI, as incorporated by reference in 10 CFR 50.55a, and NRC approved BPV Code Cases and guidance. If the risk-informed ISI program proposes changes to the accepted inspection techniques, the reviewer should determine whether the applicant has submitted appropriate requests for an alternative or exemption that demonstrates that the proposed inspection technique is capable of detecting the degradation mechanism of concern. The inspection frequencies proposed in the risk-informed ISI program also need to be reviewed, along with their basis, and justification provided for all proposed changes to inspection frequencies identified in ASME BPV Code, Section XI, as incorporated by reference in 10 CFR 50.55a, and associated Code Cases as accepted in RG 1.147 and incorporated by reference in 10 CFR 50.55a, with appropriate alternative or exemption requests. Any proposed changes in inspection frequencies and/or techniques need to be based on maintaining the reliabilities assumed in the PRA.

The application should also describe the process to be followed when the ISI program identifies degradation has occurred. This should include tracking the degradation over time and, if necessary, taking actions such as expanding the inspections to other similar components or locations, reducing the time interval to the next inspection or taking corrective actions. The reviewer should review the process to ensure that it describes the criteria to be used to decide what additional actions to take to allow continued operation consistent with the licensing basis.

In reviewing the risk-informed ISI program, the reviewer should consider previous experience with risk-informed ISI and the use of RG 1.178. In addition, the reviewer may refer to Standard Review Plan (SRP) Section 3.9.8, "Standard Review Plan for the Review of Risk-Informed Inservice Inspection of Piping," September 2003, for additional detail regarding the review. The following paragraphs provide an overview of the guidance contained in RG 1.178 related to the principles to be applied in the review of risk-informed ISI programs for LWRs.

DID: In evaluating whether or not DID is maintained, the main concern is degradation in the reliability and integrity of the barriers that (a) prevent the release of radioactive material, (b) maintain the integrity of systems relied upon for reactor cooling and (c) if failed, could prevent SSCs from performing their safety function. Such degradation can lead to not having the lines of defense assumed as part of DID. The reviewer should evaluate the applicant's analysis of the proposed revisions to the baseline inspection frequency and/or inspection techniques to confirm that the reliability and integrity of the affected components remain consistent with the assumptions in the PRA. Also, the reviewer should confirm that the proposed revisions to the inspection frequency and/or inspection techniques will not affect the independence of the barriers or the balance between prevention and mitigation and that human actions are not being used to compensate for any SSC degradation that could result from extended inspection intervals or the use of new inspection techniques.

Safety Margins: For safety margins, the main concern is the change in the level of uncertainty associated with the reliability and/or integrity of the SSCs due to extended inspection intervals or the use of different inspection techniques from those specified in 10 CFR 50.55a(g). For example, the uncertainties can affect the degree to which flaws in the base metal or welds increase in size over time, the extent of corrosion or erosion that take place over time or the extent of other degradation mechanisms. The reviewer should evaluate how uncertainties were accounted for, whether or not they have been considered in the PRA and have they resulted in reduced safety margins. The reviewer should confirm that the increased uncertainties do not cause any safety criteria to be exceeded and that some margin to the safety criteria still remains.

Risk: The risk component of a risk-informed ISI program needs to consider changes in risk as compared to the baseline risk. The baseline risk would be the risk associated with an ISI program conforming to 10 CFR 50.55a(g). The change in risk would be the difference between the risk associated with the risk-informed ISI program and the baseline risk. The change in risk can be evaluated by considering multiple changes together or individually. The acceptability of the changes in risk can then be evaluated using an approach similar to that used in RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Rev. 2, May 2011. The acceptance criteria in RG 1.174 for evaluating changes in risk are specific to LWRs and can be used directly. When considering changes involving risk increases, the cumulative effect of multiple risk increases needs to be considered. The cumulative effect of the risk increases should not cause the risk criteria in RG 1.174 to be exceeded. In all cases, the reliability (and capability) associated with the components in risk-informed ISI program should be consistent with the assumptions in the PRA.

Monitoring: The reviewer should determine how the effectiveness of the risk-informed ISI program is to be monitored. This could include looking at trends in inspection results to see what degradation has occurred and whether or not the ISI program has identified these in a timely manner. If not, changes in inspection intervals or inspection techniques may be warranted. Criteria for making this determination should be part of the application and should be directed toward maintaining the assumptions in the PRA on component reliability.

Based on the above, the reviewer should determine whether the application followed the guidance in RG 1.178, or justified any deviations, and that the proposed risk-informed ISI program is in conformance with the principles contained in RG 1.178.

The reviewer also should confirm that QA is to be applied to the risk-informed ISI program in accordance with 10 CFR Part 50, Appendix B, and 10 CFR 50.55a(b)(2)(x). In addition, the reviewer should confirm that condition monitoring, surveillance and inspections, using the same techniques and equipment proposed for use in the risk-informed ISI program, will be conducted prior to the start of operation (preservice inspection) to establish a baseline for comparison to future inspection results. The reviewer should determine how the baseline inspection results will be used to determine what constitutes unacceptable degradation (i.e., how are acceptance criteria defined?). The reviewer also should confirm that the design provides space for accessibility of equipment, shielding and personnel to conduct the inspections.

In addition to evaluating changes to inspection intervals and techniques, risk information may also be used determine under what plant conditions the inspections are best performed (e.g., full power, shutdown, etc.). The goal is to conduct the inspections during the plant conditions that, combined with the inspection technique itself and its related constraints, provide the necessary performance information while minimizing risk to worker safety and the public in general. The reviewer should determine if the application has addressed this aspect of the program and, if not, has justification been provided.

b) <u>LWR IST</u> – The NRC regulations in 10 CFR 50.55a incorporate by reference the ASME *Operation and Maintenance of Nuclear Power Plants*, Division 1, OM Code: Section IST (OM)Code) with conditions. In 10 CFR 50.55a(f)(4), the NRC regulations specify that:

> Throughout the service life of a boiling or pressurized water-cooled nuclear power facility, pumps and valves that are within the scope of the ASME OM Code must meet the inservice test requirements (except design and access provisions) set forth in the ASME OM Code and addenda that become effective subsequent to editions and addenda specified in paragraphs (f)(2) and (3) of this section and that are incorporated by reference in paragraph (a)(1)(iv) of this section, to the extent practical within the limitations of design, geometry, and materials of construction of the components. The inservice test requirements for pumps and valves that are within the scope of the ASME OM Code but are not classified as ASME BPV Code Class 1, Class 2, or Class 3 may be satisfied as an augmented IST program in accordance with paragraph (f)(6)(ii) of this section without requesting relief under paragraph (f)(5) of this section or alternatives under paragraph (z) of this section.

Note also, that the ASME OM Code applies to all water-cooled reactors, not only LWR nuclear power plants.

Conditions on the use of the ASME OM Code are listed in 10 CFR 50.55a(b)(3). QA requirements for the IST program are specified in 10 CFR Part 50, Appendix B, and 10 CFR 50.55a(b)(3)(i). NRC has also issued the following RG on the acceptability of the Code Cases with conditions, as applicable, associated with the OM Code:

- RG 1.192, “Operation and Maintenance Code Case Acceptability, ASME OM Code,” Revision 3, October 2019.

RG 1.192 is incorporated by reference in the NRC regulations in 10 CFR 50.55a(b)(6).

In addition, the NRC has issued NUREG-1482, “Guidelines for Inservice Testing at Nuclear Power Plants,” Revision 3, July 2020, to clarify the NRC requirements related to IST programs for pumps, valves, and dynamic restraints.

ASME OM Code, Subsection ISTE, “Risk-Informed Inservice Testing of Components in Water-Cooled Reactor Nuclear Power Plants,” allows the establishment of a component safety categorization methodology and process for dividing the population of pumps and valves into high and low safety significant component categories for water-cooled reactors. Subsection ISTE notes that the component safety categorization methodology and process may result in additional components being included in the risk-informed IST program. Subsection ISTE specifies alternative risk-informed IST requirements for certain pumps and valves than the IST requirements in other subsections of the ASME OM Code. In 10 CFR 50.55a(b)(3)(viii), “OM Condition: Subsection ISTE,” the NRC specifies that licensees may not implement the risk-informed IST approach for pumps and valves specified in Subsection ISTE in the ASME OM Code up to and including the 2017 Edition without first obtaining NRC authorization as an alternative in accordance with 10 CFR 50.55a(z). The NRC included this condition for those previous ASME OM Code editions because certain aspects of the NRC guidance for risk-informed IST programs had not been included in those early versions of Subsection ISTE. In the recent proposed revision to 10 CFR 50.55a, the NRC proposes to allow the use of Subsection ISTE in the 2020 Edition of the ASME OM Code without conditions because of the revision of Subsection ISTE to be consistent with the NRC guidance for risk-informed IST programs. The NRC staff will consider any public comments on its proposed acceptance of Subsection ISTE in the 2020 Edition of the ASME OM Code prior to issuance of the final rule to revise 10 CFR 50.55a.

In addition to Subsection ISTE in the ASME OM Code, the NRC staff provides guidance for licensees of currently operating LWRs proposing to risk-inform their IST program in RG 1.175, “An Approach for Plant-Specific, Risk-Informed Decisionmaking: Inservice Testing,” August 1998. This guidance may also be used to assess requests in new advanced LWR applications for alternatives under 10 CFR 50.55a(z) or exemptions under 10 CFR 50.12 to implement risk-informed IST programs where Subsection ISTE of the ASME OM Code will not be implemented. In such instances, the requirements of the ASME OM Code as incorporated by reference in 10 CFR 50.55a would be considered the baseline IST program against which risk-informed changes would be assessed. The approach used in RG 1.175 to assess the acceptability of risk-informed changes to the requirements in 10 CFR 50.55a is to apply a risk-informed decision-making process in the review of changes. The risk-informed decision-making process evaluates the acceptability of the proposed changes to the IST program using the principles described in RG 1.175, which are intended to ensure:

- Defense-in-depth (DID) is maintained
- Sufficient safety margins are maintained

- Any increase in risk caused by changes to the baseline IST program is small and consistent with the Commission's Safety Goal Policy
- Monitoring is performed to confirm the acceptability of the change

The industry has also issued the following guidance documents related to LWR risk-informed IST which may be useful in reviewing an applicant's proposed risk-informed IST program:

- ASME Research Report CRDT-Vol. 40-2, "Risk-Based Inservice Testing – Development of Guidelines," 1996
- Nuclear Energy Institute Draft Report, "Industry Guideline for Risk-Based Inservice Testing," Revision B, March 19, 1996

The typical components in the risk-informed IST programs for LWRs include pumps, valves, and dynamic restraints such as:

- Motor operated valves
- Air operated valves
- Hydraulic operated valves
- Solenoid operated valves
- Check valves
- Manually operated valves
- Relief valves
- Pumps (motor and turbine operated)
- Dynamic restraints (snubbers)

In addition, advanced LWR designs may rely on passive components to perform active safety functions (such as electromagnetic pumps and heat pipes). The applicant will need to address the condition monitoring, surveillance, and testing of the passive components by expanding the current scope of the IST program. to include those passive components that perform a safety function or whose failure could prevent other SSCs from performing their safety functions.

For an advanced LWR, the applicant may describe a complete risk-informed IST program or may only risk-inform a portion of its IST program. The application needs to justify the risk-informed portion of the IST program as discussed below; however, if the non-risk-informed portion of the program follows the requirements in 10 CFR 50.55a, then no justification is required unless alternatives are proposed.

The reviewer should determine whether the scope of the risk-informed IST program is consistent with the plant-specific PRA. As discussed in ASME OM Code, Subsection ISTE, the scope of a risk-informed IST program extends beyond the traditional scope of the ASME OM Code specified in ASME OM Code, Subsection ISTA, paragraph ISTA-1100. In developing a risk-informed IST program, the applicant might need to develop alternatives to the requirements in 10 CFR 50.55a. The reviewer should determine whether the applicant has submitted alternative requests in accordance with 10 CFR 50.55a(z) as part of the application. Where alternative requests are submitted, the reviewer should prepare an evaluation of the applicant's justification for satisfying 10 CFR 50.55a(z) to determine whether the alternative may be authorized. An applicant may also submit an exemption request to certain requirements in 10 CFR 50.55a in accordance with 10 CFR 50.12. Where the advanced LWR application does not include a risk-informed IST program description for the full scope of plant SSCs, the reviewer will need to evaluate the plant SSCs outside the scope of the risk-informed IST program based on the IST requirements in the ASME OM Code as incorporated by 10 CFR 50.55a for components within the scope of the ASME OM Code. In addition, the reviewer might need to evaluate surveillance activities for passive components with active safety functions.

The risk-informed IST program is intended to assess the operational readiness of the components within the scope of the program. The risk-informed IST program may include various activities such as valve actuation (opening and closing times), relief valve actuation (opening and closing pressure), pump operation (flow rate, pressure), check valve (opening and closing, and leakage) and dynamic restraint operation. The ASME OM Code as incorporated by reference in 10 CFR 50.55a specifies requirements for IST activities for those components within the scope of the ASME OM Code. Where components are outside the scope of the ASME OM Code (e.g., passive components with active safety functions, or components beyond the criteria in paragraph ISTA-1100), the NRC staff reviews the applicant's justification for the risk-informed IST activities for those components. For example, test conditions should be as realistic as practical (e.g., pressure and temperature) so as to simulate actual operating conditions. Alternate testing techniques (e.g., bench testing of relief valves) should be defined where in place or at power testing is not feasible. Any proposed changes to IST frequency and/or IST techniques need to be based on maintaining component reliability and performance consistent with the assumptions in the PRA. The NRC regulations in 10 CFR 50.55a specify requirements for requesting relief from or alternatives to the IST requirements in the ASME OM Code as incorporated by reference in 10 CFR 50.55a.

Consistent with the requirements in the ASME OM Code as incorporated by reference in 10 CFR 50.55a, the application should also describe the process to be followed when the IST program identifies degradation or misalignment has occurred. This should include tracking the degradation over time and, if necessary, taking actions such as expanding the testing to other similar components, reducing the time interval between tests, or taking corrective actions to improve the component's performance. The reviewer should review the process to ensure that it describes the criteria to be used to decide what additional actions to take to allow continued operation consistent with the licensing basis.

As indicated previously, some advanced reactor designs might include passive components that perform active safety functions. The IST activities for these passive components is assumed to be addressed in this ISG by expanding the scope of the IST program. The reviewer should ensure that the applicant has proposed IST activities for these passive components that are capable of determining (through direct measurement and/or analysis) that the performance of these components is consistent with the safety analysis. For applicable passive components, the IST activities should assess the performance of the safety features. In general, passive safety components will either be in standby or in operation depending on the design. When in standby, the IST program should verify that the conditions (e.g., pressure, fluid level, and temperature) necessary to activate the feature and ensure it performs its safety function are present. When in operation, the IST program should verify that the performance (e.g., heat transfer and reactivity insertion) of the feature aligns with predicted performance. This may involve measuring inlet and outlet temperatures, flow rates, changes in power level or other appropriate parameters and using analysis to determine overall performance. For passive valves as defined in the ASME OM Code (i.e., valves that maintain their obturator position and do not need to change their state to accomplish their safety function), the IST program should verify that seat leakage requirements and position indication (remote and local) are consistent with the requirements in the ASME OM Code as incorporated by reference in 10 CFR 50.55a and the assumptions in the plant safety analysis.

The reviewer should evaluate how risk information is used to guide (a) the selection of the IST intervals for the various components in the program, (b) the selection of components for IST activities during any given interval, and (c) how the selection process varies from IST interval to IST interval to cover all the components of interest. Where IST intervals or techniques differ from those specified in the OM Code, justification should be available and submitted to the NRC in accordance with 10 CFR 50.55a as applicable.

In reviewing the risk-informed IST program, the reviewer should consider previous experience with risk-informed IST and the implementation of RG 1.175. In addition, the reviewer may refer to SRP Section 3.9.7, "Risk-Informed Inservice Testing," August 1998, for additional detail regarding the review. The following paragraphs provide an overview of the guidance contained in RG 1.175 related to the principles to be applied in the review of risk-informed IST programs for LWRs:

DID: In evaluating whether or not DID is maintained, the main concern is degradation of the equipment such that it will not perform as assumed in the PRA. Such degradation can lead to not having the lines of defense assumed as part of DID. The reviewer should evaluate the applicant's analysis of proposed revisions to the baseline testing frequency and/or testing techniques and confirm that the reliability and performance of the affected components remain consistent with the assumptions in the PRA. Also, the reviewer should confirm that the proposed revisions to the testing frequency and/or techniques will not affect the independence of barriers or the balance between prevention and mitigation. In addition, the reviewer should confirm that human actions are not being used to compensate for any equipment degradation that could result from extended testing intervals.

Safety Margins: For safety margins, the main concern is a change in the level of uncertainty associated with the performance of the equipment due to extended testing intervals and/or the use of different testing techniques from those specified in 10 CFR 50.55a(f). This uncertainty can affect the ability of the equipment to actuate when called upon, to deliver the required flow rate or pressure, to fully open or close when required, or to properly dampen vibration or seismic induced motion. The reviewer should evaluate whether these uncertainties have been accounted for in the PRA or whether reduced safety margins are the result. The reviewer should confirm that the uncertainties do not cause any safety criteria to be exceeded and that some margin to the safety criteria still remains.

Risk: The risk component of the risk-informed IST program needs to consider changes in risk as compared to the baseline risk. The baseline risk is that associated with an IST program conforming to the rules in 10 CFR 50.55a(f). The change in risk would be the difference between the baseline risk and the risk associated with the proposed risk-informed IST program. The change in risk can be evaluated by considering multiple changes together or individually. The acceptability of the changes in risk can be evaluated using an approach similar to that described in RG 1.174 as described in a) above. In all cases, the reliability (and capability) of the components in the risk-informed IST program should be consistent with the assumptions in the PRA.

Monitoring: The reviewer should determine how the results of the risk-informed IST program are to be monitored for effectiveness. This could include looking at trends in equipment performance based on actual in-service performance and performance during testing to see if degradation has occurred and whether or not the risk-informed IST program has identified these in a timely manner. If not, changes in testing intervals or testing techniques might be warranted. Criteria for making this determination should be part of the application and should be directed toward maintaining the assumptions in the PRA on equipment performance.

Based on the above, the reviewer should determine whether the application followed ASME OM Code, Subsection ISTE, based on its status in 10 CFR 50.55a, or the guidance in RG 1.175. The reviewer should ensure the NRC regulations in 10 CFR 50.55a are satisfied, alternatives are justified, or exemptions are processed, as applicable.

The reviewer should confirm that QA is to be applied to the program in accordance with 10 CFR Part 50, Appendix B, and 10 CFR 50.55a(b)(3)(i). In addition, the reviewer should confirm that testing, using the same techniques and equipment proposed for use in the risk-informed IST program, will be conducted prior to the start of operation (preservice testing) to establish a baseline for comparison to future testing results. The reviewer should determine how the baseline IST results will be used to determine what constitutes unacceptable degradation in performance (i.e., acceptance criteria).The reviewer also should confirm that the design provides space for accessibility of equipment, shielding and personnel to conduct the testing as required in 10 CFR 50.55a.

In addition to evaluating changes to IST intervals and techniques, risk information may also be used to help determine under what plant conditions the IST activities are best performed (e.g., full power, shutdown, etc.). The goal is to conduct the IST activities during the plant conditions that, combined with the technique itself and its related constraints, provide the necessary performance information while minimizing risk to worker safety and the public in general. The reviewer should determine if the application has addressed this aspect of the program and, if not, has justification been provided.

PART 2 – Risk-Informed ISI/IST for Non-LWRs

a) <u>Non-LWR ISI</u> – 10 CFR 50.55a does not contain requirements for non-LWR ISI. However, the following General Design Criteria (GDCs) contained in 10 CFR Part 50, Appendix A, are generally applicable to other types of reactors and require inspection in various areas:

- GDC # 32 "Inspection of Reactor Coolant Pressure Boundary"
- GDC # 36 "Inspection of Emergency Core Cooling System"
- GDC # 39 "Inspection of Containment Heat Removal System"
- GDC # 42 "Inspection of Containment Atmosphere Cleanup System"
- GDC # 45 "Inspection of Cooling Water System"
- GDC # 53 "Provisions for Containment Testing and Inspection"

In addition, as described in RG 1.232, "Guidance for Developing Principle Design Criteria for Non-Light Water Reactors," a set of Advanced Reactor Design Criteria (ARDCs) have been developed, based on the GDCs, for application to non-LWRs. These ARDCs also require inspection in various areas:

- ARDC # 32 “Inspection of Reactor Coolant Boundary”
- ARDC # 36 “Inspection of Emergency Core Cooling System”
- ARDC # 39 “Inspection of Containment Heat Removal System”
- ARDC # 42 “Inspection of Containment Atmosphere Cleanup System”
- ARDC # 45 “Inspection of Structural and Equipment Cooling Systems”
- ARDC # 53 “Provisions for Containment Testing and Inspection”

These ARDCs extend the application of ISI to non-LWRs. The areas covered in the above GDCs and ARDCs correspond to the basic safety functions contained in the ARCAP documents related to control of heat removal and release of radioactive material.

The scope of a risk-informed ISI program includes all piping, pressure retaining components and component supports that perform safety significant functions as well as piping whose failure could prevent SSCs from performing their safety function. Therefore, the reviewer should confirm that the scope of the risk-informed ISI program includes the safety related and safety significant piping and components consistent with the results of the plant-specific PRA.

As discussed in the LWR section, advanced reactors might contain passive components that perform active safety functions (such as heat pipes). The applicant should describe the condition monitoring, surveillance, and inspection activities for these safety significant passive components, the basis for the inspection activities, including inspection intervals, and ensure that they are part of the ISI program.

The scope of a risk-informed ISI program for non-LWRs needs to be based on a plant-specific PRA. The piping should be modelled in segments so as to better identify the most risk significant locations and welds. Accordingly, the reviewer should confirm that the PRA models the SSCs that are part of the ISI program. In addition, the reviewer should evaluate how risk information is used to guide (a) the selection of the various inspection locations during any given inspection interval, (b) the inspection frequency for each location, (c) the inspection technique to be used, and (d) how the selection process varies from inspection interval to inspection interval to cover all of the components of interest. Although applicable to LWRs, ASME BPV Code, Section XI, Division 1, might provide useful information on inspection techniques and frequencies.

In addition, the application should describe the process to be followed when the ISI program identifies degradation has occurred. This should include tracking degradation over time and, if necessary, taking actions such as expanding the inspections to other similar components or locations, reducing the time interval to the next inspection or taking corrective action. The reviewer should review the process to ensure that it describes the criteria to be used to decide what additional actions to take to allow continued operation consistent with the licensing basis.

In 2019, ASME issued BPV Code, Section XI, “Rules for Inservice Inspection of Nuclear Power Plant Components”, Division 2, “Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants.” Section XI, Division 2, is applicable to non-LWRs and the NRC is preparing draft RG-1383, “Acceptability of ASME Code, Section XI, Division 2, Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants,” endorsing (with conditions) the use of Section XI, Division 2, for non-LWR ISI.

Section XI, Division 2, does not call for a specific risk-informed ISI program to be implemented, but rather allows the applicant to propose a program specific to the technology of the non-LWR using expert panels and considering the degradation mechanisms applicable to the materials and the operating conditions of the design. In applying Section XI, Division 2, the application needs to describe how component reliability targets are derived from the PRA, how the components and their inspection intervals included in the program are selected and how the RIM strategies to be applied will be capable of demonstrating the reliability targets are met. Applicants may refer to ASME BPV Code, Section XI, Division1, as a source of information for inspection methods and frequencies, although the applicant is ultimately responsible for proposing a risk-informed ISI program applicable to their design and technology.

Section XI, Division 2, also contains acceptance criteria for the inspections. However, the acceptance criteria are only applicable in the temperature range allowed in ASME BPV Code, Section III, "Rules for Construction of Nuclear Facility Components," Division 1. For temperatures that exceed the range described in Section III, Division 1, the applicant will need to justify design specific acceptance criteria.

In conducting the review of an advanced reactor application describing a risk-informed ISI program for non-LWRs, the reviewer should consider the following aspects:

1) Is the application based on the use of an NRC-endorsed PRA standard?

2) Is the scope of the risk-informed ISI program consistent with the accepted PRA standard?

3) Does the application describe the degradation mechanisms applicable to the design and technology (materials, coolant, service conditions) and the SSCs to which they apply?

4) Was risk information used to determine and justify (a) the components included in the ISI program, (b) the inspections to be conducted for each component in the program and (c) the inspection frequency for each component in the program?

5) Are the inspection techniques proposed capable of detecting the degradations of interest, including the basis for that determination (e.g., previous experience)?

6) Is there a process identified to track degradation over time and to determine what actions, if any, are needed to respond to any degradation identified?

7) Are acceptance criteria for evaluating the results of the inspections described, and justified? The acceptance criteria should be consistent with and support the assumptions in the PRA regarding the frequency of leaks, the size of leaks, the location of leaks, allowable corrosion/erosion, the structural integrity of components and supports and limit any degradation to within the uncertainty assumed in the PRA for component integrity and reliability.

8) Are the inspection frequencies proposed for each inspection, including the basis for the inspection frequency, consistent with the assumptions in the PRA on reliability of the

SSCs? The inspection frequencies should be frequent enough to ensure that the SSC integrity and reliabilities remain within the uncertainties assumed in the PRA.

9) Is the QA to be applied to the program in accordance with 10 CFR Part 50, Appendix B or an acceptable approved alternative?

10) Has ASME developed provisions for ISI activities in non-LWRs?

In addition, the reviewer should confirm that condition monitoring, surveillance, and inspections, using the same techniques and equipment proposed for use in the risk-informed ISI program, will be conducted prior to the start of operation (preservice inspection) to establish a baseline for comparison to future inspection results. The review should also determine how the baseline inspection results will be used to determine what constitutes unacceptable degradation (i.e., how are acceptance criteria defined?). The reviewer also should confirm that the design provides space for accessibility of equipment, shielding and personnel to conduct the inspections.

The reviewer should determine how the results of the risk-informed ISI program are to be monitored for effectiveness. This could include looking at trends in any degradation detected and determining whether or not the inspection frequencies or inspection techniques should be changed. Criteria for making this determination should be proposed in the application.

The review should also determine whether risk information was used to determine under what plant conditions the inspections are best performed (e.g., full power, shutdown, etc.). The goal is to conduct the inspections during the plant conditions that, combined with the inspection technique itself and its related constraints, provide the necessary performance information while minimizing risk to worker safety and the public in general. The reviewer should determine if the application has addressed this aspect of the program and, if not, has justification been provided.

b) <u>Non-LWR IST</u> – The NRC regulations in 10 CFR 50.55a do not contain requirements for non-LWR IST programs. The ASME OM Code, Division 1, incorporated by reference in 10 CFR 50.55a applies to water-cooled reactors. ASME has initiated a task group to draft a new division of the ASME OM Code that will provide high-level requirements for IST activities for components in advanced reactors. The reviewer should determine the status of the ASME effort for guidance in the review of risk-informed IST programs described in advanced non-LWR applications.

However, the GDCs in 10 CFR Part 50, Appendix A, are generally applicable to other types of reactors and the following GDCs from 10 CFR Part 50, Appendix A, require testing in various areas:

- GDC # 1 "Quality Standards and Records"
- GDC # 4 "Environmental and Dynamic Effects Design Bases"
- GDC # 30 "Quality of Reactor Coolant Pressure Boundary"
- GDC # 37 "Testing of Emergency Core Cooling System"
- GDC # 40 "Testing of Containment Heat Removal System"
- GDC # 43 "Testing of Containment Atmosphere Cleanup System"
- GDC # 46 "Testing of Cooling Water System"

- GDC # 53 “Provisions for Containment Testing and Inspection”
- GDC # 61 “Fuel Storage and Handling and Radioactivity Control”

In addition, as described in RG 1.232, a set of ARDCs have been developed, based on the GDCs, for application to non-LWRs. These ARDCs also require testing in various areas.

- ARDC # 1 “Quality Standards and Records”
- ARDC # 4 “Environmental and Dynamic Effects Design Bases”
- ARDC # 30 “Quality of Reactor Coolant Boundary”
- ARDC # 37 “Testing of Emergency Core Cooling System”
- ARDC # 40 “Testing of Containment Heat Removal System”
- ARDC # 43 “Testing of Containment Atmosphere Cleanup System”
- ARDC # 46 “Testing of Structural and Equipment Cooling Systems”
- ARDC # 53 “Provisions for Containment Testing and Inspection”
- ARDC # 61 “ Fuel Storage and Handling and Radioactivity Control”

These ARDCs extend the application of IST to non-LWRs.The areas covered in the above GDCs and ARDCs correspond to the basic safety functions contained in the ARCAP documents related to control of heat removal and release of radioactive material.

The scope of a risk-informed IST program includes safety related and safety significant components that perform an active safety function and may include components, such as the following:

- Motor operated valves
- Air operated valves
- Hydraulic operated valves
- Solenoid operated valves
- Check valves
- Manually operated valves
- Explosively actuated valves
- Rupture disks
- Safety and Relief valves
- Pumps (motor and turbine operated)
- Dynamic Restraints (snubbers)

The advanced reactor applicant might use components that perform similar functions as those components listed above, but are identified by different descriptions (such as fluid moving or isolation components).

In addition, advanced reactor designs may rely on passive and inherent safety features to perform active safety functions. The applicant will need to incorporate IST activities for passive components that perform active safety functions (such as electromagnetic pumps and heat pipes) by expanding the current scope of the IST program. The reviewer should ensure that the applicant has described the IST activities applicable to such components and that those IST activities are capable of assessing (through direct measurement and/or analysis) the performance of the passive components.

The scope of the risk-informed IST program needs to be based on a plant-specific PRA. Based on component function and importance to safety, the reviewer should evaluate how risk information is used to guide (a) the selection of components for IST activities, (b) the specific IST activity to be performed for each component, (c) the IST frequency for each component, and (d) how the selection process varies from IST interval to IST interval to cover all the components of interest. In addition, the application needs to describe how component reliability targets and assumptions on component performance are derived from the PRA. Although applicable to water-cooled reactors, the ASME OM Code as incorporated by reference in 10 CFR 50.55a might provide helpful information on component testing for other fluid media. Note: ASME is developing OM-2 that might include passive components with active safety functions for non-LWRs.

The risk-informed IST program is intended to assess the operational readiness of components within the scope of the program. The risk-informed IST program may include various IST activities such as valve actuation (opening and closing times), relief valve actuation (opening and closing pressure), pump actuation (start time, flow rate, pressure, speed, differential pressure, discharge pressure, and vibration), check valve (opening and closing, and leakage) and dynamic restraint operation, as applicable to the advanced reactor design, as well as components that differ from those associated with LWRs. IST conditions should be as realistic as practical (e.g., pressure and temperature) so as to simulate actual operating conditions. Practical IST techniques (e.g., bench testing of relief valves) should be defined where in place or at power IST activities are not feasible.

For an advanced reactor design with passive components that perform active safety functions, the risk-informed IST program needs to include IST activities capable of assessing the operational readiness of those components to perform their active safety functions. In general, passive safety features will either be in standby or in operation depending on the design. When in standby, the IST program should verify that the conditions (e.g., pressure, fluid level, and temperature) necessary to activate the feature and ensure it performs its safety function are present. When in operation, the IST program should verify that the performance (e.g., heat transfer and reactivity insertion) of the feature aligns with predicted performance. This may involve measuring inlet and outlet temperatures, flow rates, changes in power level or other appropriate parameters, and using analysis to determine overall performance. For passive valves (i.e., valves that maintain their obturator position and do not need to change their state to accomplish their safety function), the IST program should verify that seat leakage and position indication (remote and local) are consistent with the assumptions in the plant safety analysis.

The application should also describe the process to be followed when the IST program identifies degradation or misalignment has occurred. This should include tracking degradation over time and, if necessary, taking actions such as expanding the IST activities to other similar components, reducing the time interval between IST activities or taking corrective action to improve the component’s performance. The reviewer should review the process to ensure that it describes the criteria to be used to decide what additional actions to take to allow continued operation consistent with the licensing basis.

In conducting a review of an advanced reactor application describing a risk-informed IST program for non-LWRs, the reviewer should consider the following aspects:

1) Is the application based upon the use of an NRC-endorsed PRA standard?

2) Is the scope of the risk-informed IST program consistent with the accepted PRA standard?

3) Does the application describe the degradation of concern for the technology being reviewed?

4) Are IST conditions and techniques defined for each component included in the risk-informed IST program and are the proposed IST techniques capable of detecting the degradation in performance of concern for each component?

5) Was risk information is used to determine and justify (a) the components included in the IST program, (b) the IST activities to be conducted for each component in the program, and (c) the frequency of IST activities for each component?

6) Is there a process identified to track degradation over time and to determine what actions, if any, are needed to respond to any degradation identified?

7) Are acceptance criteria established and justified for each component IST activity and are they consistent with the assumptions in the PRA on component reliability and performance? In general, the acceptance criteria should be based upon the uncertainties in component performance assumed in the PRA, such that any degradation in component performance is within the performance uncertainties assumed in the PRA.

8) Are the frequencies of the IST activities for each component within the scope of the risk-informed IST program consistent with maintaining the component reliability and performance within the assumptions in the PRA?. The IST intervals should provide reasonable assurance that the SSC reliabilities and performance remain within the uncertainties assumed in the PRA.

9) Is the QA to be applied to the program in accordance with 10 CFR Part 50, Appendix B?

10) Has ASME developed provisions for IST activities in non-LWRs?

The reviewer should confirm that testing, using the same techniques and equipment proposed for use in the risk-informed IST program, will be conducted prior to the start of operation (preservice testing) to establish a baseline for comparison to future IST results. The reviewer should determine how the baseline results will be used to determine what constitutes unacceptable degradation in performance (i.e., acceptance criteria). The reviewer also should confirm that the design provides space for accessibility of equipment, shielding, and personnel to conduct the testing.

The reviewer should determine how the risk-informed IST program is to be monitored for effectiveness. This could include looking at trends in any degradation detected and determining whether or not the IST intervals or techniques should be changed. Criteria for making this determination should be described in the advanced reactor application.

The reviewer should also determine whether risk information was used determine under what plant conditions the IST activities are best performed (e.g., full power, shutdown, etc.). The goal is to conduct the IST activity during the plant conditions that, combined with the IST technique itself and its related constraints, provide the necessary performance information while minimizing risk to worker safety and the public in general. The reviewer should determine if the application has addressed this aspect of the program and, if not, has justification been provided.

Organizational Responsibilities

In general, the nuclear power plant organizational responsibilities for risk-informed ISI/IST programs are the same regardless of whether or not the advanced reactor application is for ISI, IST, a LWR or a non-LWR. The application should describe the organizational responsibilities for conduct of the risk-informed ISI/IST programs that satisfy the NRC regulations, or justified alternatives or exemptions consistent with the processes specified in the NRC regulations. In general, the nuclear power plant organization is responsible for all aspects of the programs, although other parties (e.g., contractors) may conduct some of the inspections/testing under appropriate supervision. The nuclear power plant organizational responsibilities for risk-informed ISI/IST programs include:

- Defining the qualifications of the personnel managing, conducting, and reviewing the program results consistent with applicable codes/standards being used.
- Providing training, as necessary, to ensure that personnel are qualified to perform their functions.
- Developing the schedule, sequence, prerequisites, procedures, safety precautions and acceptance criteria for conducting the programs.
- Managing the programs, including coordination with other elements of the plant organization (e.g., operations, engineering) and other operational programs (e.g., reliability assurance program).
- Ensuring that QA is in accordance with 10 CFR Part 50, Appendix B, and 10 CFR 50.55a(b)(2)(x) for LWR ISI, 10 CFR Part 50, Appendix B and 10 CFR 50.55a(b)(3)(i) for LWR IST, and 10 CFR Part 50, Appendix B, for non-LWR ISI/IST.
- Providing a multi-discipline review team to evaluate and disposition the inspection/testing results, including initiating corrective action, as necessary, and evaluating any safety implications for continued plant operation.
- Preparation, approval, and retention of ISI/IST reports.
- Monitoring the long-term effectiveness of the risk-informed ISI/IST programs.

Acceptance Criteria

In reviewing the advanced reactor application that includes risk-informed ISI/IST programs, the reviewer should determine whether reasonable assurance exists that the requirements for conducting risk-informed ISI/IST programs are met for the design and technology under review. This determination should be based on whether the information provided in the application is sufficient to make a conclusion on the acceptability of the programs.

A) For a risk-informed ISI program:

1. The application clearly describes the applicable regulations and guidance documents used and provides justification for any alternatives or exemptions being requested.
2. The risk-informed ISI program was developed using a plant-specific PRA that is in conformance with an NRC-endorsed consensus standard.
3. Risk insights have been used to determine the scope of the program, the appropriate ISI activities and their frequencies, based on the relative safety importance of the components within the scope of the program.
4. A risk-informed decision-making process, which includes acceptance criteria, has
5. been used by the applicant in the evaluation of the acceptability of the program.
6. The proposed inspections are sufficient to detect, directly or through analysis,
7. degradation that could affect the ability of the components to perform their safety
8. functions consistent with assumptions in the PRA. A process exists to track and evaluate the inspection results and, if degradation is detected, to determine the appropriate course of action.
9. The risk-informed ISI program (expanded, as necessary, to address any passive components) address all SSCs within the scope of the program (including SSCs whose
    a. failure could prevent the accomplishment of a safety function), and the degradation
    b. mechanisms associated with their design. In addition, for LWRs where a full risk-informed ISI program is not included in the application, the components and the ISI associated with the non-risk-informed portion of the program is described, including for those passive components that perform active safety functions.
10. Pre-operational inspections, using the same techniques and equipment as will
    a. be used during the operational period, will be conducted to establish a baseline for
    b. comparison to future inspection results.
11. The design includes provisions for accessibility to conduct the inspections.
12. Organizational responsibilities are clearly described and are consistent with the codes/standards being used.
13. The QA to be applied to the program is consistent with 10 CFR 50.55a and 10 CFR 50, Appendix B, requirements.
14. The application clearly describes a multi-discipline process for reviewing the ISI program results and determining their acceptability.
15. The application describes a program for retention of ISI reports.
16. The application describes a process for monitoring the long-term effectiveness of the risk-informed ISI program.

B) For a risk-informed IST program:

1. The application clearly describes the applicable regulations and guidance documents used and provides justification for any alternatives or exemptions being requested.
2. The program was developed using a plant-specific PRA that is in conformance with an NRC-endorsed consensus standard,
3. Risk insights have been used to determine the scope of the program, the appropriate IST activities and their frequencies, based on the relative safety importance of the components within the scope of the program.

4. A risk-informed decision-making process, which includes acceptance criteria, has been used by the applicant in the evaluation of the acceptability of the program.
5. The proposed IST activities are sufficient to detect, directly or through analysis, degradation that could affect the ability of the components to perform their safety functions consistent with assumptions in the PRA. A process exists to track and evaluate the IST results and, if degradation is detected, to determine the appropriate course of action.
6. The risk-informed program (expanded, as necessary, to address any passive components with active safety functions) addresses all components within the scope of the program (including components whose failure could prevent the accomplishment of a safety function) and the potential for degradation in performance associated with their design. In addition, for LWRs where a full risk-informed IST program is not included in the application, the components and IST associated with the non-risk-informed portion of the program are described, including those passive components that perform active safety functions.
7. Pre-operational activities, using the same equipment and procedures as will be used during the operational period, will be conducted to establish a baseline for comparison to future test results,
8. The design includes provisions for accessibility to conduct the IST activities.
9. Organizational responsibilities are clearly described and are consistent with the codes and standards being used.
10. The QA to be applied to the program is consistent with 10 CFR 50.55a and 10 CFR Part 50, Appendix B, requirements.
11. The application clearly describes a multi-discipline process for reviewing the IST program results and determining their acceptability.
12. The application describes a program for retention of IST reports.
13. The application describes a process for monitoring the long-term effectiveness of the risk-informed IST program.

Based on the above acceptance criteria, the reviewer should be able to determine whether the risk-informed ISI/IST programs will provide sufficient data to detect degradation affecting the capability of components to perform their functions consistent with the assumptions in the PRA. From this information, a determination should be made regarding whether or not there is reasonable assurance that the risk-informed ISI/IST programs are in compliance with the applicable NRC requirements for a CP, OL, COL, DC or ML.

IMPLEMENTATION

The NRC staff will use the information discussed in this ISG in performing safety evaluations of risk-informed ISI/IST programs described in advanced reactor applications submitted under 10 CFR Part 50, 52 or 53.

[Identify how the information will facilitate staff review of license amendments, license renewal applications, etc.]

BACKFITTING AND ISSUE FINALITY DISCUSSION

[OGC provides this discussion, but the staff can propose text for OGC consideration].

Example: The NRC staff issuance of this ISG is not considered backfitting as defined in 10 CFR 50.109(a)(1), nor is it deemed to be in conflict with any of the issue finality provisions in 10 CFR Part 52.

CONGRESSIONAL REVIEW ACT

[OGC provides this discussion to support issuance of the final ISG. However, the staff can propose text for OGC consideration].

Example: This ISG is a rule as defined in the Congressional Review Act (5 U.S.C. §§ 801-808). However, the Office of Management and Budget has not found it to be a major rule as defined in the Congressional Review Act.

FINAL RESOLUTION

By [insert date], this information will be transitioned into [identify the appropriate regulatory process (Standard Review Plan (SRP), Regulatory Guide (RG))]. Following the transition of this guidance to the [SRP, RG], this ISG will be closed. .

APPENDIX

A. Resolution of Public Comments

APPENDIX A

Resolution of Public Comments

A notice of opportunity for public comment on this Interim Staff Guidance (ISG) was published in the *Federal Register* (*insert FR Citation #)* on [date] for a 30-60 day comment period. [Insert number of commenters] provided comments which were considered before issuance of this ISG in final form.

Comments on this ISG are available electronically at the NRC's electronic Reading Room at http://www.nrc.gov/reading-rm/adams.html. From this page, the public can gain entry into ADAMS, which provides text and image files of NRC's public documents. Comments were received from the following individuals or groups:

Letter No.	ADAMS No.	Commenter Affiliation	Commenter Name	Abbreviation
1				
2				
3				
4				
5				

The comments and the staff responses are provided below.

<u>Comment 1:</u> [Each comment summary must clearly identify the entity that submitted the comment and the comment itself].

<u>NRC Response:</u> Comment responses should begin with a direct statement of the NRC staff's position on a comment, e.g., "the NRC staff agrees with the comment" or the "NRC staff disagrees with the comment".

- If the NRC staff agrees, explain why and provide a clear statement as to how the relevant language was revised or supplemented to address the comment. Include the following language at the end of the comment response: "The final ISG was changed by <*describe the change; if necessary by quoting the newly revised language*>."
- If the NRC disagrees with a comment and no change was made to the generic communication, then explain why and provide the following language at the end of the comment response: "No change was made to the final ISG as a result of this comment."

APPENDIX B

References