DANU-ISG-2022-07

Advanced Reactor Content of Application Project

"Risk-Informed Inservice Inspection/Inservice Testing Programs for Non-LWRs"

Interim Staff Guidance

March 2024

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INTERIM STAFF GUIDANCE

ADVANCED REACTOR CONTENT OF APPLICATION PROJECT

"RISK-INFORMED INSERVICE INSPECTION/INSERVICE TESTING PROGRAMS FOR NON-LWRS"

DANU-ISG-2022-07

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC or Commission) staff is providing this interim staff guidance (ISG) for two reasons. First, this ISG provides guidance on the contents of applications to an applicant submitting a risk-informed, performance-based application 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" (Ref.1), or for a combined license (COL), a manufacturing license (ML), a standard design approval (SDA), or a design certification (DC) under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants" (Ref. 2), for a non-light-water reactor (non-LWR). The application guidance found in this ISG supports the development of the portion of a non-LWR application associated with an applicant's risk-informed inservice inspection (ISI) and inservice testing (IST) programs.[1] Second, this ISG provides guidance to the NRC staff on how to review such an application.

As of the date of this ISG, the NRC is developing a rule to amend 10 CFR Parts 50 and 52 (RIN 3150-AI66). The NRC staff notes this guidance may need to be updated to conform to changes to 10 CFR Parts 50 and 52, if any, adopted through that rulemaking. Further, as of the date of this ISG, the NRC is developing an optional performance-based, technology-inclusive regulatory framework for licensing nuclear power plants designated as 10 CFR Part 53, "Licensing and Regulation of Advanced Nuclear Reactors" (RIN 3150-AK31). After promulgation of those regulations, the NRC staff anticipates that this guidance will be updated and incorporated into the NRC's Regulatory Guide (RG) series or a NUREG series document to address content of application considerations specific to the licensing processes in this document.

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 for non-LWRs. The ARCAP is broader than, and encompasses, the industry-led technology-inclusive content of application project (TICAP). The guidance in this ISG supplements the guidance found in Division of Advanced Reactors and Non-power Production

[1] The NRC is issuing this ISG to describe methods that are acceptable to the NRC staff for implementing specific parts of the agency's regulations, to explain techniques that the NRC staff uses in evaluating specific issues or postulated events, and to describe information that the NRC staff needs in its review of applications for permits and licenses. The guidance in this ISG that pertains to applicants is not part of NRC regulations and compliance with it is not required. Methods and solutions that differ from those set forth in this ISG are acceptable if supported by a basis for the issuance or continuance of a permit or license by the Commission.

and Utilization Facilities (DANU)-ISG-2022-01, “Review of Risk-Informed, Technology-Inclusive Advanced Reactor Applications – Roadmap,” issued in February 2024 (Ref. 3), which provides a roadmap for developing all portions of an application for non-LWRs. The guidance in this ISG is limited to the portion of a non-LWR application associated with the risk-informed ISI and IST programs for the nuclear reactor plant applicant and the NRC staff review of that portion of the application.

RATIONALE

The current application guidance related to risk-informed ISI and IST programs is directly applicable only to light-water reactors (LWRs) and may not fully identify the information to be included in a non-LWR application or efficiently provide a technology-inclusive, risk-informed, and performance-based review approach for non-LWR technologies. This ISG serves as the non-LWR application guidance for risk-informed ISI and IST programs. This ISG provides both applicant content of application and the NRC staff review guidance.

APPLICABILITY

This ISG is applicable to applicants for non-LWR[2] permits and licenses that submit risk-informed, performance-based applications for CPs or OLs under 10 CFR Part 50 or for COLs, SDAs, DCs, or MLs under 10 CFR Part 52. This ISG is also applicable to the NRC staff reviewers of these applications.

PAPERWORK REDUCTION ACT

This ISG provides voluntary guidance for implementing the mandatory information collections in 10 CFR Parts 50, and 52 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et. Seq.). These information collections were approved by the Office of Management and Budget (OMB), approval numbers 3150-0011, and 3150-0151, respectively. Send comments regarding this information collection to the FOIA, Library, and Information Collections Branch (T6-A10M), U.S. Nuclear Regulatory Commission, Washington, DC 20555 0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the OMB reviewer at: OMB Office of Information and Regulatory Affairs (3150-0011, and 3150-0151), Attn: Desk Officer for the Nuclear Regulatory Commission, 725 17th Street, NW Washington, DC 20503.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the document requesting or requiring the collection displays a currently valid OMB control number.

GUIDANCE

This ISG describes the methods acceptable to the NRC staff for preparing and reviewing descriptions of risk-informed ISI and IST programs submitted by non-LWR applicants as part of

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[2] Applicants desiring to use this ISG for a light water reactor application should contact the NRC staff to hold pre-application discussions on their proposed approach.

licensing applications. Specifically, the following method, as supplemented by this ISG, is acceptable for this purpose:

- American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (BPV Code), Section XI, Division 2, "Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants," for risk-informed ISI programs as accepted in RG 1.246, "Acceptability of ASME Code, Section XI, Division 2, 'Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants,' for Non-Light Water Reactors."

Currently, the NRC regulatory 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 ASME that are incorporated by reference in 10 CFR 50.55a. With the increased use of probabilistic risk information in the design and regulation of nuclear power plants, the staff anticipates that new applications for nuclear power plants will include risk-informed ISI and IST programs. (The NRC is currently developing guidance for alternative approaches that use risk information to focus traditional ISI and IST programs on the most important structures, systems, and components (SSCs) and adjust their inspection and testing frequencies accordingly.) Appendix A of this ISG notes that ASME is also considering development of a new Code for Operations and Maintenance of Nuclear Power Plants (OM) Code (referred to as OM-2) that would provide IST provisions for fluid flow and control devices in non-LWR reactors. As noted in Appendix A, the NRC staff will adjust this ISG as appropriate if the Code is issued and endorsed by the NRC staff.

For this ISG, the NRC staff is assuming that applicants will be designing and qualifying their equipment to the latest applicable guidance and requirements developed by ASME and accepted by the NRC, such as ASME BPV Code, Section III, "Rules for Construction of Nuclear Facility Components," Division 5, "High Temperature Reactors" (Ref. 4), which is endorsed by RG 1.87, Revision 2, "Acceptability of ASME Code Section III, Division 5, 'High Temperature Reactors,'" (Ref. 5), and the ASME QME-1 standard, "Qualification of Active Mechanical Equipment Used in Nuclear Facilities" (Ref. 6), which is endorsed by RG 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants" (Ref. 7).

The purpose of a risk-informed ISI program is to assure the integrity of SSCs that perform a safety function. The ISI program provides data on the condition of such SSCs necessary for a licensee to adequately manage deterioration and aging effects. This is done by periodically monitoring and tracking degradation (defects, corrosion, erosion) in welds and base metal of components and component supports within the program's scope to determine their suitability for continued operation, consistent with the plant-specific probabilistic risk assessment (PRA). The current ISI programs for LWRs include inspections of ASME 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 a risk-informed IST program is to periodically measure, assess, and track the performance of components within the program's scope to confirm that their performance remains consistent with the plant-specific PRA. In addition, the IST program is intended to verify the operational readiness of pumps, valves, and snubbers within the scope of the program to perform their safety functions. The current IST programs for LWRs include components consisting of pumps, valves, and dynamic restraints (snubbers) that perform safety functions. As discussed below, some non-LWRs might rely on types of components other than pumps, valves, and dynamic restraints (snubbers), such as fluid control devices.

Components that Control Fluid without Mechanically Interacting with the Fluid

In addition to conventional components, non-LWRs might include components that perform active safety functions to control fluid flow without mechanically interacting with the controlled fluid. In the context of this guidance, such a component performs an active safety function insofar as it performs a function to move fluid, stop the movement of fluid, or transfer energy as part of a safety function. Examples of such components include electromagnetic or magnetic flux pumps, which move fluid without mechanical interaction with the fluid, and heat pipes, which transfer energy from one location to another in performing a safety function to cool a reactor core. The scope of the risk-informed ISI and IST programs for a non-LWR might also include activities to assess degradation of the components with active safety functions to control fluid flow without mechanically contacting the controlled fluid by such means including for example as condition monitoring, surveillance, testing, or inspection.

Currently operating nuclear power plants do not include components that perform active safety functions to control fluid flow without mechanically interacting with the controlled fluid. Therefore, ISI and/or IST programs at currently operating nuclear power plants do not address the degradation that could adversely affect the ability of such components to perform their safety functions. Non-LWR applicants will need to develop and justify periodic condition monitoring, surveillance, testing, or inspection plans for such components.

Novel concepts for non-LWRs, such as components that control fluid without mechanically interacting with the fluid, should be a focus of preapplication interactions with the NRC staff. Such interactions ensure the NRC staff understands the proposed design and the prospective applicant understands the level of detail needed to describe the novel concepts in the license application. For such interactions, a prospective applicant should consider the guidance associated with the design of safety-related or non-safety-related with special treatment SSCs (including DANU-ISG-2022-01 (Roadmap)), the inspections and testing covered by DANU-ISG-2022-007, and other available information (including consensus codes and standards). The prospective applicant should also consider any new IST codes for non-LWRs that recognize the potential use of components that move fluid or stop fluid from moving in non-LWRs based on design principles that significantly differ from those used to design typical pumps and valves used in currently operating nuclear power plants.

ISI/IST Personnel Hazards for Some Non-LWR Designs

Some non-LWR designs may have unique characteristics that result in additional hazards to plant personnel who perform ISI and IST activities; therefore, the performance of ISI and IST activities is an important consideration for those designs. One example of a technology with such additional hazards is the liquid-fueled molten salt reactor technology. Due to the high radiation contained throughout reactor coolant system piping, an extreme thermal environment, and maintenance activities that may involve draining and flushing the fuel salt, some level of remote ISI/IST capability may be necessary to mitigate the hazards to ISI/IST personnel.

Use of Risk Information

The use of risk information in formulating an ISI/IST program helps focus the program on the most risk-significant SSCs, conditions, and failure modes. It also helps ensure that the inspection and testing frequency is sufficient to detect reliability and performance degradation that could affect continued safe operation. For ML applicants, the application can be limited to describing (1) how the risk information will be used to identify the SSCs to be included in the ISI/IST programs, (2) the most risk-significant (as defined in NEI 18-04 Revision 1, "Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development" (Ref. 8)) locations for ISI, and (3) how the design incorporates sufficient access for ISI/IST equipment and personnel.[3] For multi-module plants, where the PRA and design are identical (or nearly so) for each module, the ISI/IST programs developed need only be submitted once and can be applied to each module.

<u>Behavior of Materials</u>

The available performance data for materials used for SSCs designated as safety-related and non-safety-related with special treatment for novel designs, or technologies might be limited; therefore, an OL or COL applicant will need to describe the ISI/IST measures and associated bases for those SSCs in the application. The development of ISI/IST measures for non-LWR designs may incorporate performance-based concepts similar to those developed for LWRs. Such performance-based approaches can address the limited operating experience that may be initially available for some designs and materials. These approaches might identify appropriate adjustments in the types and frequency of inspections and testing as operating experience is gained over the subsequent years and decades. Some consensus standards include provisions for the evaluation of performance information, such as ASME BPV Code, Section XI, Division 2, “Reliability Integrity Management (RIM) Program,” which requires reevaluation of the RIM program based on new information such as changes in SSC performance, new service-related degradation, and industry operating experience.

In addition, the ASME is revising ASME Standard QME-1, “Qualification of Active Mechanical Equipment Used in Nuclear Facilities,” to allow its more effective use for the qualification of components to be used in non-LWRs. The qualification process for components in non-LWRs will include the consideration of materials to be used in components in advanced reactors. When the ASME issues the revised QME-1 Standard, the NRC staff will consider whether to endorse it in RG 1.100, “Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants” or other appropriate guidance. During plant operations, the licensee should evaluate operating experience to determine if the unique operating experience of non-LWRs indicates the need for attention regarding the original qualification of materials used in non-LWRs. In addition, ISI/IST programs for non-LWRs might need to be updated based on lessons learned from SSC performance, service-related degradation, and operating experience.

Application Guidance

The development of an acceptable risk-informed ISI/IST program depends on having a high-quality, plant-specific PRA. Accordingly, the applicant should use a plant-specific PRA in the risk-informing process and develop the PRA using an NRC-endorsed PRA consensus standard. For non-LWRs, ASME/ANS RA-S-1.4-2021, “Probabilistic Risk Assessment Standard

[3] Nonetheless, in the context of design certification, the staff’s historical practice has been to consider portions of the ISI and IST programs that are deemed essential in making a safety determination regarding the design. Because the NRC findings on the design proposed in an ML application will resolve design issues in subsequent proceedings on applications referencing the manufactured reactor, the NRC staff anticipates that it will need to consider such ISI and IST information in reviewing the ML application.

for Advanced Non-Light Water Reactor Nuclear Power Plants" (Ref. 9), is available, as endorsed with exceptions and clarifications in RG 1.247, "Acceptability of Probabilistic Risk Assessment Results for Non-Light-Water Reactor Risk-Informed Activities" (for trial use), issued March 2022 (Ref. 10).

Applications for an OL, COL, DC, SDA, or ML may describe other programs in addition to risk-informed ISI/IST programs (e.g., programs for maintenance, reliability assurance, and aging management). If the ISI or IST program is being used to satisfy any of these other operational requirements, the applicant should state this and explain how the ISI or IST activities will satisfy such requirements. This may be done either in the ISI/IST program or in the application. The application should identify the relationships among the ISI/IST programs and other programs that have incorporated some aspects of ISI/IST, but the other programs need not be submitted as part of the ISI/IST submittal.

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 in the NRC regulations. The 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 specific special treatment requirements for low safety significant SSCs. The special treatment requirements that the 10 CFR 50.69 requirements may replace include certain ISI/IST requirements in 10 CFR 50.55a. The requirements in 10 CFR 50.69 were developed based on LWR technology. However, non-LWR applicants might consider the 10 CFR 50.69 approach as part of developing their risk-informed ISI/IST programs.[4]

Limited performance data may be available for SSCs of new designs or technologies; therefore, an OL or COL applicant will need to describe the ISI/IST measures and their bases for those components in the application.

The application does not need to describe the risk-informed ISI and IST programs in as much detail as the program plans. However, it should describe the methods for using the PRA to determine the reliability targets and performance assumptions for the individual components. The application should also describe the methodology to be used to verify, based on the proposed inspections and inspection frequencies, whether the reliability targets and performance assumptions are met.

Staff Review Guidance

Before beginning a detailed review of an application, the NRC staff reviewer should confirm that the applicant has used a plant-specific PRA in the risk-informing process and that the applicant developed the PRA using an NRC-endorsed PRA consensus standard.

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[4] Non-LWR applicants may use the Licensing Modernization Project (LMP) found in NEI 18-04, Revision 1, "Risk-Informed Performance-Based Guidance for Non Light Water Reactor Licensing Basis Development" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19241A336), as endorsed by RG 1.233, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light Water Reactors" (ML200091L698). Use of the LMP may obviate the need for a non-LWR applicant to implement 10 CFR 50.69 to risk-inform the categorization of SSCs because the LMP includes a risk-informed process for SSC classification.

The reviewer should determine which other programs (e.g., programs for maintenance, reliability assurance, and aging management) are being coordinated with the risk-informed ISI/IST programs and whether any parts of the risk-informed ISI/IST programs are being incorporated into another program. If so, the reviewer should confirm that all of the programs, taken together, cover the proposed scope of the risk-informed ISI/IST programs.

If the application includes a request to implement 10 CFR 50.69, the reviewer should consult the NRC's Statements of Consideration (SOC) on the 10 CFR 50.69 final rule in Volume 69 of the *Federal Register* (FR), page 68008 (69 FR 68008; November 22, 2004), and the guidance and training materials prepared by the NRC staff for the review and evaluation of 10 CFR 50.69 programs. However, the SOC states that the 10 CFR 50.69 rule does not include 10 CFR 50.36 in the list of special treatment requirements that may be replaced by the alternative 10 CFR 50.69 requirements for RISC-3 and RISC-4 SSCs when implementing a 10 CFR 50.69 license amendment.

The reviewer should consider the topics discussed in NRC Regulatory Issue Summary (RIS) 2012-08 (Revision 1), "Developing Inservice Testing and Inservice Inspection Programs Under 10 CFR Part 52," when evaluating risk informed- ISI/IST programs for a non-LWR application submitted under 10 CFR Part 50 or Part 52. Note: The reviewer should consider all the components described in RIS 2012-08.

<u>Organization of this ISG</u>

The guidance in this ISG is divided into three parts: one for ISI application and review guidance, one for IST application and review guidance, and one for organizational responsibilities and review guidance. This ISG provides guidance for ISI/IST programs that are entirely risk-informed. Partially risk-informed ISI or IST programs will need to be justified and will be reviewed on a case-by-case basis.

This ISG applies to risk-informed applications for CPs, OLs, COLs, DCs, SDAs, and MLs. An application for a CP may contain less detail than one for an OL; however, as a minimum, it should identify the governing regulations, and it should also identify the RGs, NUREGs, standards and other guidance the applicant intends to follow at the OL stage.

PART 1—Risk-Informed Inservice Inspection for Non-Light Water Reactors

Application Guidance

The regulations in 10 CFR 50.55a do not contain requirements for non-LWR ISI programs. However, the following general design criteria (GDC) in 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," are generally applicable to and provide guidance in establishing the principal design criteria for types of reactors other than water-cooled reactors governed by the GDC. The guidance in the below GDC indicates that SSCs should be designed to permit ISI 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 Principal Design Criteria for Non-Light-Water Reactors” (Ref. 11), the NRC has developed a set of non-LWR design criteria (Advanced Reactor Design Criteria (ARDC)), based on the GDC, for application to and insights for the development of principal design criteria for non-LWRs. The guidance in the following ARDC also indicate that SSCs should be designed to permit ISI 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 ARDC call for consideration of ISI activities in the design of non-LWR SSCs. The areas covered in the above GDC and ARDC correspond to the basic safety functions described in the ARCAP documents related to control of heat removal and release of radioactive material. Applications for an OL or a COL for a non-LWR must include provisions for ISI, among other things, in accordance with 10 CFR 50.34(b)(6)(iv) or 10 CFR 52.79(a)(29)(i), respectively. Applications for a CP may contain less detail than one for an OL, however, as a minimum, it should identify the governing regulations, and it should also identify the RGs, NUREGs, standards and other guidance the applicant intends to follow.

The scope of a risk-informed ISI program includes all piping, pressure-retaining components, and component supports that perform safety-significant (as defined in NEI 18-04) functions, as well as piping or other components whose failure could prevent SSCs from performing their safety functions. Therefore, the application should describe the scope of the proposed risk-informed ISI program. The scope of the program should include all safety-related and safety-significant piping and components (including supports and snubbers), consistent with the results of the plant-specific PRA.

As discussed earlier, non-LWRs may contain components that perform active safety functions to control fluid flow without mechanically interacting with the controlled fluid. The applicant should describe the condition monitoring, surveillance, and inspection activities for such safety-significant components; provide 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 modeled in segments to better allow for identification of the most risk-significant locations and welds. Accordingly, the application should describe how the PRA models the SSCs that are part of the ISI program. Specifically, the application should describe how risk information is used to guide (1) the selection of the inspection locations during each inspection interval, (2) the inspection frequency for each location, (3) the inspection technique to be used, and (4) how the selection process varies from one inspection interval to the next to cover all components of interest. Although intended for LWRs, the ASME BPV Code, Section XI, Division 1, might provide useful information on inspection techniques and frequencies within the conditions for which the ASME BPV Code specifies their use.

In addition, the application should describe the process to be followed when the ISI program identifies that degradation has occurred. This process should include tracking of the degradation over time. If necessary, it should also include 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 application should include the criteria for deciding what additional actions to take to allow continued operation consistent with the licensing basis.

In 2019, ASME issued BPV Code, Section XI, Division 2, "Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants" (Ref. 12). In RG 1.246, "Acceptability of ASME Code, Section XI, Division 2, 'Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants,' for Non-Light Water Reactors," (Ref. 13), the NRC endorsed (with conditions) the use of ASME BPV Code, Section XI, Division 2, for non-LWR ISI.

ASME BPV Code, Section XI, Division 2, allows the applicant to propose a program specific to the design and technology of the non-LWR, based on input from expert panels and considering the degradation mechanisms relevant to the materials and the operating conditions of the design. In following ASME BPV Code, Section XI, Division 2, the application needs to describe how component reliability targets are derived from the PRA, how the components in the program and the corresponding inspection intervals are selected, and how the applicant's reliability and integrity management strategies will be able to demonstrate that the reliability targets are met. Applicants may refer to ASME BPV Code, Section XI, Division 1, for information on inspection methods and frequencies within the conditions for which the Division 1 specifies their use, although each applicant is ultimately responsible for proposing a risk-informed ISI program appropriate for its own design and technology.

ASME BPV Code, Section XI, Division 2, also contains acceptance criteria for the inspections; however, these apply only in the temperature range allowed in ASME BPV Code, Section III, "Rules for Construction of Nuclear Facility Components," Division 1 (Ref. 14). Note that ASME has issued a flaw evaluation Code Case extending the acceptance criteria into the elevated temperature range. Unless the new ASME Code Case is approved by the NRC, appropriate justification for flaw evaluation acceptance criteria for any components that will be used in applications in which the temperature exceeds the temperature limits specified in the ASME BPV Code, Section III, Division 1, should be provided as part of the information to be included in an application.

Staff Review Guidance

The scope of a risk-informed ISI program should include all piping, pressure-retaining components, and component supports that perform safety-related and safety-significant functions, as well as piping or other components whose failure could prevent SSCs from performing their safety functions. Therefore, the NRC staff reviewer should confirm that the scope of the applicant's proposed risk-informed ISI program includes all safety-related and safety-significant piping and components (including supports and snubbers).

The reviewer should confirm that the PRA models all of the SSCs that are part of the ISI program and consider the degradation mechanisms associated with the materials, temperature, and coolant used in the design. In addition, the reviewer should evaluate how risk information is used to guide (1) the selection of the inspection locations during each inspection interval, (2) the inspection frequency for each location, (3) the inspection technique to be used, and (4) how the selection process varies from one inspection interval to the next to cover all components of interest.

The reviewer should confirm that the application clearly describes the applicable regulations, codes and standards, and other guidance documents used in the development of the ISI program, and that provides justification for any alternatives or exemptions.

In reviewing a non-LWR application that describes a risk-informed ISI program, the reviewer should consider the following:

(1) Is the application based on the use of an NRC-endorsed PRA standard, such as described in RG 1.247 and ASME/ANS RA-S-1.4-2021? Are any deviations from the RG or standard described and justified?

(2) Does the application describe the degradation mechanisms (e.g., corrosion, high temperature creep, thermal cycling) applicable to the design and technology (e.g., materials, coolant, service conditions) and list the SSCs to which they apply?

(3) Does the application describe how risk information was 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, including how components will be selected at each inspection interval so that, over time, all components will receive testing?

(4) Are the proposed inspection techniques capable of detecting the degradation types of interest, and does the application provide the basis for that determination (e.g., previous experience)?

(5) Does the application identify a multi-disciplinary process for reviewing inspection results and determining what, if any, corrective action should be taken as a result of any degradation identified? The reviewer should verify that the description of the process includes the criteria for deciding what additional actions to take to allow continued operation consistent with the licensing basis.

(6) Does the application describe and justify acceptance criteria for evaluating inspection results? Are the acceptance criteria consistent with the values used in the PRA for the frequency of leaks, the size of leaks, the location of leaks, allowable corrosion and erosion, and the structural integrity of components and supports? Do the acceptance criteria limit any degradation to within the uncertainty of the values used in the PRA for the parameters that determine component integrity and reliability?

(7) Are the frequencies proposed for each inspection, as well as their bases, consistent with the PRA results on SSC reliability? Inspections should be frequent enough to ensure that SSC integrity and reliability remain within the uncertainties in values of the parameters used in the PRA.

(8) Does the application describe a program for retention of ISI records?

(9) Is the QA to be applied to the program consistent with RG 1.246?

(10) Has ASME BPV Code, Section XI, Division 2, along with RG 1.246, been used in developing the provisions for the ISI?

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

The reviewer should determine how the applicant will monitor the effectiveness of the risk-informed ISI program. Monitoring could include looking at trends in degradation detected to determine whether to change inspection frequencies or techniques.

The reviewer should verify that the applicant has described the ISI activities applicable to components that perform active safety functions to control fluid flow without mechanically interacting with the controlled fluid, and that these ISI activities are capable of assessing (through direct measurement or analysis) the degradation of such components.

The review should also verify whether risk information was used to determine the plant conditions under which inspections are best performed (e.g., full power or shutdown). The goal is to conduct inspections under the plant conditions that, given the inspection techniques and related constraints, provide the necessary performance information while minimizing risks to workers and the general public. The reviewer should determine whether the application has addressed this aspect of the program or has justified not doing so.

Based on the above, the reviewer should be able to determine whether the risk-informed ISI program will provide data sufficient to detect degradation affecting each subject component's ability to perform its safety functions consistent with the PRA and whether the application complies with the applicable requirements for a CP, OL, COL, DC, SDA, or ML.

Part 2 – Risk-Informed Inservice Testing for Non-Light-Water Reactors

Application Guidance

The regulations in 10 CFR 50.55a do not contain requirements for non-LWR IST programs. The ASME OM Code, Division 1, as incorporated by reference in 10 CFR 50.55a, applies to water-cooled reactors. As noted in Appendix A, ASME is developing the OM-2 Code that will provide high-level requirements for IST activities for components in non-LWRs.

However, the following GDC in 10 CFR Part 50, Appendix A, are generally applicable to and provide guidance in establishing the principal design criteria for types of reactors other than water-cooled reactors governed by the GDC. The guidance in the below GDC indicates that SSCs should be designed to permit IST 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, the NRC has developed a set of ARDC, based on the GDC, for non-LWRs. The guidance in the following ARDC also indicate that SSCs should be designed to permit IST 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 ARDC call for consideration of IST activities in the design of non-LWR SSCs. The areas covered in the above GDC and ARDC correspond to the basic safety functions covered in the ARCAP documents related to control of heat generation, control of heat removal, and release of radioactive material. Applications for an OL or a COL for a non-LWR must include provisions for IST, among other things, in accordance with 10 CFR 50.34(b)(6)(iv) or 10 CFR 52.79(a)(29)(i), respectively. An application for a CP may contain less detail than one for an OL, however, as a minimum, it should identify the governing regulations, and it should also identify the RGs, NUREGs, standards, and other guidance the applicant intends to follow at the OL stage.

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

- motor-operated valves
- air-operated valves
- hydraulic-operated valves
- solenoid-operated valves
- check valves
- manually operated valves
- pyrotechnic-actuated valves
- rupture disks
- safety and relief valves
- pumps (motor- and turbine-operated)
- dynamic restraints (snubbers)

Non-LWR reactor applicants should identify safety-related and safety-significant components that perform functions similar to those of the components listed above but have different names (such as fluid-moving or fluid isolation components) as within the scope of the IST program.

In addition, non-LWR reactor designs may rely on new types of safety features to accomplish active safety functions. The applicant will need to incorporate IST activities for components that perform active safety functions to control fluid flow without mechanically interacting with the controlled fluid (such as electromagnetic pumps and heat pipes) by expanding the scope of the IST program. The application should describe the IST activities applicable to such components and how these IST activities are capable of assessing (through direct measurement or analysis) the performance of such 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 application should describe 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 one IST interval to the next to cover all 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 may provide helpful information on component testing for other fluid media within the conditions under which it specifies testing. At the time of the initial issue of this ISG, ASME is considering the development of the OM-2 Code for non-LWRs. As noted in Appendix A, the NRC staff will adjust this ISG, as appropriate, if the Code is issued and endorsed by the NRC staff.

The application should explain why the proposed risk-informed IST program is adequate to assess the operational readiness of the components within the scope of the program. The program may include various 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 performance (opening and closing), valve leakage, and dynamic restraint (snubber) operation (examination, functional testing, and service life monitoring), as applicable to the non-LWR reactor design. It may also include testing of components other than those associated with LWRs. To simulate actual operating conditions, the application should propose IST conditions (e.g., pressure and temperature) that are as realistic as practical. The application should describe practical IST techniques (e.g., bench testing of relief valves) if in-place or at-power IST activities are not feasible.

For a non-LWR reactor design with components that perform active safety functions to control fluid flow without mechanically interacting with the controlled fluid, 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. For a component in standby, the application should describe how the IST program provides for testing the component at the conditions (e.g., pressure, fluid level, and temperature) necessary to activate the feature and ensuring that it performs its safety function when so tested. For a component in operation, the application should describe how the IST program verifies that the performance of the component (e.g., heat transfer and reactivity insertion) aligns with predicted performance. This may involve measuring inlet and outlet temperatures, flow rates, changes in power level, or other appropriate parameters and analyzing these to determine overall performance. For valves that maintain their obturator positions and do not need to change their state to accomplish their safety functions (e.g., isolation valves that remain closed during plant operation), the application should describe how the IST program verifies that seat leakage and position indication (remote and local) are consistent with the plant safety analysis.

The application should also describe the process to be followed when the IST program identifies that degradation or misalignment has occurred. This process should include tracking of the degradation over time. It should also include 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 if the testing results warrant such action.

Staff Review Guidance

The scope of a risk-informed IST program should include all safety-related and safety-significant SSCs that perform active safety functions. Therefore, the NRC reviewer should confirm that the scope of the proposed risk-informed IST program includes all safety-related and safety-significant SSCs identified by the PRA that perform an active safety function.

The reviewer should also confirm that the PRA models all of the SSCs that are part of the IST program. In addition, the reviewer should evaluate how the risk information from the PRA and a risk-informed decision-making process was used to guide (1) the selection of the SSCs included in the program, (2) the testing frequency for each SSC included in the program, (3) the testing technique to be used for each SSC, and (4) how the selection of the SSCs for testing varies from one testing interval to the next to cover all SSCs of interest.

The reviewer should confirm that the application clearly describes the applicable regulations, codes and standards, and other guidance documents used in developing the IST program and provides justification for any alternatives or exemptions.

In reviewing a non-LWR application that describes a risk-informed IST program, the reviewer should also consider the following:

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

(2) Does the application describe the important types of degradation for the design and technology being reviewed?

(3) Does the application define the IST conditions and testing techniques for each component included in the risk-informed IST program? Are the proposed IST testing techniques capable of detecting (directly or through analysis) the relevant degradation in performance for each component?

(4) Does the application describe how risk information was 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, including how components will be selected for testing at each testing interval so that, over time, all components will receive testing? For components of a new or unique design, sampling may not be sufficient to confirm their performance and additional testing may be warranted.

(5) Does the application describe a multidisciplinary process for reviewing IST results and determining what, if any, corrective action is needed. The reviewer should verify that the description of the process includes the criteria for deciding what additional actions to take to allow continued operation consistent with the licensing basis.

(6) Does the application describe and justify acceptance criteria for evaluating IST results for each component? Are these acceptance criteria consistent with the values used in the PRA for parameters that determine component reliability and performance? Are the acceptance criteria based on the performance uncertainties in the PRA and do they limit any degradation to within these levels of uncertainty?

(7) Are the frequencies of the IST activities for each component within the scope of the risk-informed IST program consistent with maintaining the component's reliability and performance within the PRA results? The IST intervals should provide assurance that SSC reliability and performance remain within the uncertainties in the PRA.

(8) Does the application describe a program for retention of IST records?

(9) Is the QA to be applied to the program in accordance with 10 CFR Part 50, Appendix B or is an exemption to these requirements justified?

(10) Has ASME developed provisions for IST activities in non-LWRs? The reviewer should determine the status of the ASME effort for guidance in the review of risk-informed IST programs in non-LWR applications.

The reviewer should confirm that, to establish a baseline for comparison to future IST results, the preservice testing program described in the application will use the same techniques and equipment proposed for use in the risk-informed IST program. 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 applicant will monitor the long-term effectiveness of the risk-informed IST program. Monitoring could include looking at trends in degradation detected to determine whether to change the IST intervals or techniques.

The reviewer should verify that the applicant has described the IST activities applicable to components that perform active safety functions to control fluid flow without mechanically interacting with the controlled fluid, and that these IST activities are capable of assessing (through direct measurement or analysis) the performance of such components.

The reviewer should also verify whether risk information was used to determine the plant conditions under which IST activities are best performed (e.g., full power or shutdown). The goal is to conduct IST activities under the plant conditions that, given the IST techniques and related constraints, provide the necessary performance information while minimizing risks to workers and the general public. The reviewer should determine whether the application has addressed this aspect of the program or has justified not doing so.

Based on the above, the reviewer should be able to determine whether the risk-informed IST program will provide data sufficient to detect degradation affecting each subject component's ability to perform its safety functions consistent with the PRA and whether the application complies with the applicable requirements for a CP, OL, COL, DC, SDA, or ML.

PART 3—Organizational Responsibilities

Application Guidance

A nuclear power plant licensee's organizational responsibility for risk-informed ISI/IST programs is broadly the same regardless of whether the program is for ISI or IST activities. The application should describe an organizational structure that satisfies the NRC regulations for conducting risk-informed ISI/IST programs or should identify and justify 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 or testing under appropriate supervision. The application should describe organizational responsibilities for risk-informed ISI/IST programs include the following:

- defining the qualifications of the personnel managing, conducting, and reviewing the program results, consistent with the codes and 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., the reliability assurance program)

- ensuring that QA is in accordance with 10 CFR Part 50, Appendix B, or that an exemption to these requirements is justified

- providing a multidisciplinary review team to evaluate and disposition inspection and testing results, initiate corrective action as necessary, and evaluate any safety implications for continued plant operation

- preparing, approving, and retaining ISI/IST reports

- monitoring the long-term effectiveness of the risk-informed ISI/IST programs

Staff Review Guidance

The NRC reviewer should confirm that the application clearly describes the applicant's organizational responsibilities and that they are consistent with the application guidance in Part 3 above.

The reviewer should confirm that if the application commits to using one or more consensus codes and standards in the development of the ISI or IST programs, and any organizational responsibilities contained in those codes and standards are also described in the application.

IMPLEMENTATION

The NRC staff will use the information discussed in this ISG to review non-LWR applications for CPs, OLs, DCs, COLs, SDAs, and MLs under 10 CFR Part 50 and 10 CFR Part 52. The NRC staff intends to incorporate this guidance in updated form in the RG or NUREG series, as appropriate.

BACKFITTING AND ISSUE FINALITY DISCUSSION

The NRC staff may use DANU-ISG-2022-07 as a reference in its regulatory processes, such as licensing, inspection, or enforcement. However, the NRC staff does not intend to use the guidance in this ISG to support the NRC staff actions in a manner that would constitute backfitting as that term is defined in 10 CFR 50.109, “Backfitting,” and as described in NRC Management Directive 8.4, “Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests” (Ref. 15), nor does the NRC staff intend to use the guidance to affect the issue finality of an approval under 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants.” The staff also does not intend to use the guidance to support the NRC staff actions in a manner that constitutes forward fitting as that term is defined and described in Management Directive 8.4. If a licensee believes that the NRC is using this ISG in a manner inconsistent with the discussion in this paragraph, then the licensee may file a backfitting or forward fitting appeal with the NRC in accordance with the process in Management Directive 8.4.

CONGRESSIONAL REVIEW ACT

DANU-ISG-2022-07, “Risk-informed Inservice Inspection/Inservice Testing Programs for Non-LWRs,’” 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

The NRC staff will transition the information and guidance in this ISG into the RG or NUREG series, as appropriate. Following the transition of all pertinent information and guidance in this document into the RG or NUREG series, or other appropriate guidance, this ISG will be closed.

ACRONYMS

ARCAP	advanced reactor content of application project
ARDC	advanced reactor design criterion/a
ASME	American Society of Mechanical Engineers
BPV Code	*Boiler and Pressure Vessel Code*
CFR	*Code of Federal Regulations*
COL	combined license
CP	construction permit
DC	design certification
GDC	general design criterion/a
ISG	interim staff guidance
ISI	inservice inspection
IST	inservice testing
LWR	light-water reactor

ML	manufacturing license
NRC	U.S. Nuclear Regulatory Commission
OL	operating license
OM Code	*Operation and Maintenance of Nuclear Power Plants*
PRA	probabilistic risk assessment
QA	quality assurance
RIM	reliability and integrity management
RISC	risk-informed safety class
RG	regulatory guide
SDA	standard design approval
SOC	statement of considerations
SSC	structure, system, or component

REFERENCES

1 Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, “Domestic Licensing of Production and Utilization Facilities.”

2 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants.”

3 U.S. Nuclear Regulatory Commission, DANU-ISG-2022-01, “Review of Risk-Informed, Technology-Inclusive Advanced Reactor Applications - Roadmap,” March 2024 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML23277A139).

4 American Society of Mechanical Engineers (ASME), Section III, “Rules for Construction of Nuclear Facility Components, Division 5, ‘High Temperature Reactors’”, July 1, 2021.

5 U.S. Nuclear Regulatory Commission, Regulatory Guide 1.87, Revision 2, “Acceptability of ASME Code Section III, Division 5, ‘High Temperature Reactors,’” Washington, DC

6 ASME, QME-1, “Qualification of Active Mechanical Equipment Used in Nuclear Facilities,” January 2017.

7 U.S. Nuclear Regulatory Commission, Regulatory Guide 1.100, “Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants,” Washington, DC

8 NEI 18-04, Revision 1, "Risk-Informed Performance-Based Guidance for Non Light Water Reactor Licensing Basis Development" (ADAMS Accession No. ML19241A336)

9 ASME/American Nuclear Society, ASME/ANS RA-S-1.4-2021, “Probabilistic Risk Assessment Standard for Advanced Non-Light-Water Reactor Nuclear Power Plants,” February 2021.

10 U.S. Nuclear Regulatory Commission, Regulatory Guide 1.247 (for trial use), “Acceptability of Probabilistic Risk Assessment Results for Non-Light-Water Reactor Risk-Informed Activities,” Revision 0, March 2022 (ADAMS Accession No. ML21235A008).

11 U.S. Nuclear Regulatory Commission, Regulatory Guide 1.232, “Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors,” Revision 0, April 2018 (ADAMS Accession No. ML17325A611).

12 ASME *Boiler and Pressure Vessel Code*, 2019 Edition, 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.”

13 U.S. Nuclear Regulatory Commission, Regulatory Guide 1.246, “Acceptability of ASME Code, Section XI, Division 2, “Requirements for Reliability and Integrity Management Programs for Nuclear Power Plants for Non-Light-Water Reactors,” Washington, DC

14 ASME *Boiler and Pressure Vessel Code*, Section III, “Rules for Construction of Nuclear Facility Components,” Division 1.

15 U.S. Nuclear Regulatory Commission, Management Directive 8.4, “Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests.”

Appendix A - Draft Advanced Reactor Content of Application Project (ARCAP) Guidance Documents Under Development as of February 2024

The purpose of this Appendix is to identify the draft guidance document that is under consideration for future updates to this ARCAP interim staff guidance (ISG) document. This draft document is under development and has not received a complete staff review; therefore, it does not represent official NRC staff positions. If an applicant relies on this draft document, it will be at risk that a final NRC position will conflict with the position provided in the draft document. The table below lists the guidance under development that has the potential to cause the ARCAP ISG to be updated to reflect the final version of the draft document listed in the second column.

Item #	Draft Document Being Considered for Possible Update	Comments
1	American Society of Mechanical Engineers (ASME) is developing “Code for Operations and Maintenance of Nuclear Power Plants” (referred to as OM-2). This Code would provide IST provisions for fluid flow and control devices in non-LWRs.	The NRC staff is monitoring the development of this OM-2 Code and plans to consider developing a regulatory guide that would endorse this code (once it is issued as final) with appropriate exceptions, clarifications, and additions. The new ASME OM-2 Code may be available when non-LWR applicants are preparing to develop their plant-specific IST programs. If a CP applicant seeks to use codes and standards the NRC staff has not endorsed, the applicant is encouraged to engage the staff on that topic during pre-application interactions. Nonetheless, a subsequent OL application must reference NRC staff-approved codes and standards or justify the use of codes and standards the NRC staff has not previously approved. Further, the NRC staff will consider granting design finality requested for unendorsed codes or standards in a CP application only if the application includes information sufficient for the NRC staff to approve the use of the code or standard for the purpose requested in the application. Any portion of the design affected by a draft code (if not approved on an application-specific basis) is not eligible for a design finality determination.