

# NRC INSPECTION MANUAL

IRIB

## INSPECTION PROCEDURE 71111 ATTACHMENT 21M

### COMPREHENSIVE ENGINEERING TEAM INSPECTION (CETI)

Effective Date: **July 1, 2025**

PROGRAM APPLICABILITY: IMC 2515 App A

CORNERSTONE:           Initiating Events  
                              Barrier Integrity  
                              Mitigating Systems

INSPECTION BASES:       See IMC 0308, Attachment 2

#### SAMPLE REQUIREMENTS:

Sample Requirements		Minimum Baseline Sample Completion Requirements		Budgeted Range	
Sample Type	Section(s)	Frequency	Sample Size (per site)	Samples (per site)	Hours per Site
Structures, Systems, and Components (SSCs)	03.01	Quadrennially	5 <sup>4</sup>	7 - 12	420+/- 63
Modifications	03.02		2 <sup>1</sup>		
10 CFR 50.59 Evaluations/Screening	03.03		7	7-19	
Operating Experience Samples	03.04		1	1-3	

#### 71111.21M-01           INSPECTION OBJECTIVE

01.01 To verify that risk-significant SSCs or systems classified as Regulatory Treatment of Non Safety Systems (RTNSS)<sup>2,3</sup> that are of high or intermediate importance (for AP1000

<sup>1</sup> Credit for a 10 CFR 50.59 sample can be taken if the modification includes a 10 CFR 50.59 evaluation.

<sup>2</sup> RTNSS is discussed in section C.IV.9 "Regulatory Treatment of Nonsafety Systems" of Regulatory Guide 1.206, "Applications for Nuclear Power Plants" (ADAMS Package Accession No. ML070720184).

<sup>3</sup> Henceforth, when this inspection procedure is applied to passive reactor designs such as AP1000, where this procedure refers to SSCs, that includes both SSCs and systems that are classified as RTNSS. In addition, where this procedure refers to risk significance (e.g., risk-significant SSCs or functions), also include SSCs and functions of systems classified as RTNSS that are of high or intermediate importance, which may not be risk significant, but are included in inspection procedures because of the importance of these systems to defense-in-depth.

<sup>4</sup> A heat exchanger and/or the site Ultimate Heat Sink can be selected as an SSC sample(s), but not required.

designs) have been maintained and will operate within their design and licensing bases requirements.

- 01.02 To verify that modifications to risk-significant SSCs do not introduce conditions that adversely impact the ability of SSCs to perform their design and licensing bases functions.
- 01.03 To verify that the design basis, licensing basis, and performance capability of SSCs have not been adversely impacted by changes introduced through degraded conditions and other activities.
- 01.04 To verify the licensee appropriately implements the requirements of 10 CFR 50.59.

#### 71111.21M-02 GENERAL GUIDANCE

This inspection verifies that licensee activities did not introduce latent conditions to plant SSCs and that SSCs will operate within their design and licensing bases requirements and as assumed in the site-specific PRA analysis (as applicable). This inspection reviews design changes, operations, maintenance practices, testing, problem identification and resolution, aging management program implementation, and modifications. Inspector focus should be on how these changes impacted the ability of the SSC to perform its risk-significant functions.

When selecting documents (such as test results, maintenance work orders, condition reports, operability reviews, etc.) inspectors should select documents issued since the last performance of this inspection.

Select samples in accordance with the Sample Requirements table. Where possible, samples should consist of risk-significant SSCs modifications, and 50.59 safety evaluations. Should a heat exchanger or ultimate heat sink be selected as an SSC sample, refer to appendix E of this inspection procedure for requirements and specific inspection.

#### 02.01 Inspection Planning and Team Preparation

The team leader should plan the inspection in advance to ensure the resources needed to support the team's preparation and execution are available. This planning activity includes the collection of the information needed to finalize the inspection samples and become familiar with the plant SSCs, licensee specific programs, processes, and procedures, as necessary, to conduct an effective and efficient inspection. It should also involve ensuring information technology resource sharing protocols between the licensee and inspection team have been discussed, and site access arrangements have been finalized. The collection of information may be accomplished with an on-site visit and/or a request for information approximately four to eight weeks prior to the in-office/remote preparation week.

The team preparation and inspection timeline is as follows:

- Week 1 In-office/remote preparation/finalization of inspection samples.
- Week 2 Entrance meeting and start on-site inspection.
- Week 3 In-office/remote inspection, preparation and documentation.
- Week 4 End of on-site inspection and exit meeting.
- Week 5 Documentation of inspection results.

Regions may revise the above schedule as long as the inspection objective(s) are met and resource estimate is considered.

## 02.02 Sample Selection

The resident inspector staff, the Nuclear Reactor Regulation project manager, and regional Senior Reactor Analyst (SRA) should be engaged in sample selection. Inspectors are highly encourage to utilize internal databases maintained by the Operating Experience Branch in the Division of Reactor Oversight such as the Generic Communication/Inspection Procedure crosswalk for sample selection, or utilize the non-public Standardized Plant Analysis Risk (SPAR) dashboard (<https://app.powerbigov.us/reportEmbed?reportId=b23f350b-751b-4db9-91ed-5537530db865&autoAuth=true&ctid=e8d01475-c3b5-436a-a065-5def4c64f52e&config=eyJjbHVzdGVyVXJsIjoiaHR0cHM6Ly93YWJpLXVzLWdvdi12aXJnaW5pYS1yZWVpcmVjdC5hbmFseXNpcy51c2dvdmNsb3VkYXBpLm5ldC8ifQ%3D%3D?chromeless=true>). Aging-related sample information can be found using the Component Operational Experience Degradation and Aging Management Program database maintained by the NRC Office of Research.

A heat exchanger and/or the site Ultimate Heat Sink can be selected as a sample(s) for this procedure. Inspectors should refer to Inspection Procedure 71111.07 "Heat Exchanger/Sink Performance" for inspection guidance if this area is selected for review.

For plants with a renewed license, inspectors should consider examining aging management activities that may have resulted in additional or different requirements. The applicable aging management programs may include, but are not limited to: Open-Cycle Cooling Water, Closed Treated Water Systems, Water Chemistry, Selective Leaching and Buried and Underground Piping and Tanks. Additionally, licensees may have conducted one-time and internal surface inspections of components in the cooling water systems associated with the heat exchangers or the ultimate heat sink. These inspections would have been in accordance with the One-time Inspection and Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components aging management programs.

To the extent possible, inspection samples selected should support a synergistic interdisciplinary review such that the SSCs being reviewed allow for multiple engineering disciplines to be reviewed, involve a complex generic issue involving major plant design changes, or needed to mitigate specific accident scenarios.

Use the following considerations when selecting SSCs and modifications:

a. System Approach

Identify the most risk significant systems and select components in the risk significant systems based on their risk. Factors discussed in the risk-informed paragraphs below as applicable, should be used in developing the selection. Many facilities maintain a list of most risk significant systems.

Consider the use of new digital technologies that have a common programmable base for several different applications. Ensure that the controller is suitable for the safety related SSC, including the potential for common mode failures. Also, consider identified deficiencies in the licensee's corrective action program, corrective maintenance, and operating experience as factors for determining whether a component should be selected.

b. Risk-Informed Considerations

The team leader may obtain a list of potential risk-significant inspection samples and operator actions from the SRA in the regional office. Additionally, the team leader may obtain a sortable (i.e. by risk importance measure) listing of potential inspection samples from the licensee. Although the methods used to identify risk-significant samples will depend on the type and quality of the licensee's risk assessment tools, the following criteria should be considered:

- Risk Achievement Worth (RAW): The RAW is the factor by which the plant's core damage frequency increases if the component or operator action of interest is assumed to fail. SSCs and actions with a RAW value of 1.3 or greater should be given priority; however, a lower threshold may be used if desired.
- Risk Reduction Worth (RRW): The RRW is the factor by which the plant's core damage frequency decreases if the component or operator action is assumed to be successful. Components or operator actions with a RRW value of 1.005 or greater should be given priority; however, a lower threshold may be used if desired.
- Birnbaum: The Birnbaum value equates roughly to a change in annualized CDF assuming an SSC is failed, so this is one of the most useful risk-significant measures. Using this metric, the SRA and the inspectors are able to quickly identify risk-significant SSCs and human actions, i.e., those that are greater than  $1E-6$ .
- Subjective risk rankings based on engineering or expert panel judgment such as those performed to identify risk-significant SSCs for the licensee's Maintenance Rule program. These subjective risk rankings typically are performed to establish the risk significance of equipment that may not be fully modeled in the licensee's probabilistic risk assessment (PRA).
- Consider LERF; external events (e.g., fire, seismic, flood); and shutdown risk.

c. Event Scenario-Based Considerations

Consider evaluating the sequences from several licensing basis events that are also initiating events in the SPAR model, i.e. LOOP, LOCA, Transient. Using the Events and Condition Assessment Module of SAPHIRE, the SRA could evaluate the CCDP of each

event and the team leader and SRA could then collaboratively consider selecting the components represented by the basic events in the top sequences.

1. Review the licensee's most current PRA model, the NRC's SPAR model and the Risk-Informed Site-Specific Significance Determination Process (SDP) Notebook to select components associated with accident sequences. These accident sequences can be segmented into the following broad categories – the initiating event frequency, and the mitigation equipment/functions, which include operator actions for using or recovering the mitigation equipment. Each of these categories should be inspected.
  2. For the initiating event (IE) category review the mechanisms that have caused the IE at this and other facilities. For some IEs there will be a large number of previous events. In that case take a sampling emphasizing the site-specific ones and the most current that would be applicable to the reactor type. Include in the inspection any alarms and indications that could alert operators to take actions prior to the occurrence of initiating events.
  3. For the mitigating equipment (ME) category translate the basic events of the dominant cutsets of the PRA model into specific components. Begin with the component importance measure, for example Birnbaum, to gauge its risk worth. This numerical result is the increase in risk for the component being out of service for one year (see appendix E for example scenarios).
  4. Consideration should also be given to the following factors:
    - (a) What is a reasonable exposure time?
    - (b) Is this a standby or normally operating component?
    - (c) How well does the normal operating condition mirror the accident conditions?
    - (d) What level of confidence does the periodic testing give in terms of accident performance?
    - (e) What is the potential failure mechanism involved?
    - (f) Do Technical Specifications govern how long the component can be out of service?
    - (g) Is recovery from the component's failure reasonable?
- d. Operating Experience Considerations

The sample selection process should consider internal and external operating experience information that may challenge SSC performance at the plant. Operating experience sources may include, but are not limited to, NRC generic communications, licensee event reports, specific plant operating experience, 10 CFR Part 21 reports, previous inspection findings and NRC internal operating experience, and vendor communications.

e. Margin Considerations

The inspection sample selection should consider low margin and modifications that have the potential to reduce margin. Although the methods used to identify margin will depend on the type and quality of the information available during the sample selection process, the following criteria could be considered:

- Analytical (design) margin is the margin in the design calculations related to the assumed performance of the SSC identified in design analyses compared to the performance of the SSCs during testing. For example, the analytical margin for a pump compares flow and head required for the pump to perform its function against the calculated capacity of the equipment. These design margin values can be extracted from the licensee's design analyses. The margin between the design performance of SSCs and actual performance can be extracted from test results.
- Operating margin refers to SSCs required to be operated during high risk and/or time critical operations. For example, during an accident sequence, the plant may take credit for rapid operator actions to manually control equipment and the operating margin compares the operator response assumed in the analysis against the expected or validated operator response.
- Maintenance margin refers to the physical condition and reliability of the SSC being reviewed. Review of system health reports, corrective action documents, operating experience, and discussions with plant personnel can identify SSCs with a history of failures. For example, an isolation valve with a history of significant leakage could reduce the margin in a fluid system.
- Complexity margin is a subjective evaluation of the complexity of the design associated with the sample being considered. A more complex design may be more vulnerable to failures, and is more likely to include a design error that could result in a potential common mode failure. For example, an incorrect setpoint modification in the controls for a component could be applied to both trains of redundant equipment, resulting in both trains being vulnerable to failure.

f. Modification Considerations

The team leader may consider modifications when identifying inspection samples. This consideration should include whether the modifications have the potential to reduce margin, involve substantial interdisciplinary interfaces, other consequential changes, and/or new design or operational characteristics. Substantial modifications performed since the last inspection should be considered for sample selection and assessed for risk significance. Consideration should also be given to degraded and non-conforming conditions by selecting evaluations or screenings associated with operability evaluations and temporary modifications. The team leader can also consider coordinating with resident inspectors and review inspection reports to determine whether temporary modifications have been inspected under IP 71111.08 since the last CETI (previously DBAI) inspection.

For the purpose of this Inspection Procedure (IP), the term "modification" includes equivalency evaluations, commercial grade dedications, and changes to SSCs, procedures, set points, calculations, designs, and/or licensing bases.

g. Safety Evaluation/Screens Sample Considerations

Samples should be of such complexity that the change could affect either the license basis or the 10 CFR 50.2 Design Basis. Consideration should also be given to degraded and non-conforming conditions by selecting evaluations or screenings associated with operability evaluations and temporary modifications. Since lists of changes provided by the licensee will not necessarily indicate the complexity and scope of a change, a number of changes should be reviewed prior to the inspection to meet the “complexity” criteria contained in this section. An initial review of these changes for complexity prior to the inspection could result in a smaller final list of samples.

h. Problem Identification and Resolution Considerations

For the samples selected for inspection, verify that the licensee is identifying engineering design issues and problems and entering them in their corrective action program. Obtain a brief description of all corrective action documents written against the components and modifications selected for inspection. Have the licensee sort by system, component, significance (use licensee’s significance determination assigned to the corrective action document) and followed by adequate description of the deficiency identified in order to determine whether a copy of the full corrective action document is desired for additional review by the team.

Sample the effectiveness of corrective actions taken by the licensee to issues identified during previous CDBI and DBA inspections and determine their effectiveness.

Provide a list of corrective action documents which were written to resolve issues identified by the current DBA inspection team in the section of the inspection report attachment commonly titled “List of Documents Reviewed.”

71111.21M-03            INSPECTION SAMPLES

03.01 **Verify that the selected SSCs have been maintained and will operate within their design and licensing bases requirements.**

Specific Guidance

1. Review supporting design documentation (e.g., drawings, calculations, and design specifications) and licensing basis information (license, final safety analysis report (FSAR), Technical Specifications, safety evaluation report, commitments, etc.) in conjunction with PRA information to ensure the inspection line of questioning is risk--informed.
2. Focus on those attributes that are not fully demonstrated by testing, have not received recent in-depth NRC review, or are critical for the component function. See appendix A of this procedure for a list of attributes to consider.
3. Verify that operator actions associated with the selected SSCs can be accomplished as assumed in the licensee’s design basis or as assumed in the licensee’s PRA analysis. Emphasis should be placed on Time Critical Operator Actions and those Human Error Probabilities with high risk significance, e.g. Birnbaum value  $\geq 1E-6$ .

Consider expected harsh or inhospitable environmental conditions, specific operator training necessary to carry out procedural actions, any additional support personnel and/or equipment required by the operator to carry out actions, and time available to complete an action based on safety analyses and the methods used by the licensee to verify and validate that the required actions can be completed within the available time. This verification may include observing demonstrations in the field or simulator that validate operator actions for a given event or accident condition.

The team, in agreement with the licensee's operating training organization, should take efforts to keep the actions and any action specific document request confidential to ensure operator action reviews are impartial.

4. Verify that the licensee is identifying and correcting degraded plant conditions.

Review any operability evaluations related to the selected samples. Review any compensatory measures to verify if the measures are in place, will work as intended, and are appropriately controlled. If operability is not justified, determine impact on any Technical Specification Limiting Conditions for Operations. Refer to Inspection Manual Chapter 0326, "Operability Determinations," for guidance.

Review outstanding engineering issues, including open/deferred or canceled engineering action items, temporary modifications, operator workarounds, and items that are tracked by the operations or engineering departments. Verify reasonable assurance that the SSC will continue to meet its intended function despite these considerations.

Review issues for 10 CFR 50.59 applicability.

5. Identify and review applicable internal and external operating experience for the SSC selected.

Independently review related internal and external operating experience for the SSC selected and determine the potential impact on the ability of the SSC to function. Review the licensee's evaluation of the applicable operating experience. Verify the licensee captured the applicable operating experience in the corrective action program and independently determine if the licensee's resolution was appropriate for the circumstances. (e.g. applicable 10 CFR Part 21 reports)

6. Verify required testing was completed and demonstrated the SSCs will perform within the range of required performance for the potential plant and environmental conditions.

Review testing records to verify the selected SSC performance is in accordance with acceptance criteria that reflects the potential range of pressure, temperature, level of the RCS as well as radiological, heat, humidity, etc. of the surrounding area. Verify performance trends are appropriately assessed and documented.

7. Verify preventive maintenance (PM) activities support the selected SSC capability to perform risk-significant safety functions. Verify the licensee has appropriate PM procedures for the SSC and PM activities are implemented in accordance with those procedures.

Review procedures for establishing, implementing, and maintaining PM requirements. Verify the licensee has appropriate PM procedures and that PM activities are implemented in accordance with those procedures. Verify that PM activities are performed as scheduled. When not performed as scheduled, verify that management controls were followed to defer and/or reschedule the PM. Equipment failures should be evaluated to assess PM frequency to support SSC capability to perform their intended functions. Ensure maintenance activities are consistent with the licensee's maintenance rule implementation program.

8. Review repetitive or similar maintenance work requests which could be an indicator of a design deficiency or degraded condition.

From maintenance work order history, review for patterns of repetitive maintenance activities that involve replacing or repairing subcomponents on a repetitive basis that may have implications regarding SSC capability and availability to perform as intended during design basis conditions.

9. Verify SSCs are managed in accordance with aging management programs established pursuant to 10 CFR Part 54, if applicable.

Identify the aging management programs applicable to the SSC sample. Verify the licensee is effectively implementing the applicable aging management programs. Consider any commitments they may have outlined in the supporting NRC safety evaluation report.

10. Perform a walkdown of the SSC to observe the as-built configuration and material condition. If areas are not accessible, review licensee records for those areas that indicate the as-built configuration and material condition.

If a walkdown is performed, inspect for deficient conditions such as corrosion, missing fasteners, cracks, and degraded insulation. Obtain records, if available, of inspections for those areas which are not normally accessible. Applicable guidance for a walkdown is contained in IP 71111.04, "Equipment Alignment."

11. Interview licensee staff, as necessary.

### 03.02 Changes and Modification

- a. **Verify that design bases, licensing bases, and performance capability of SSCs have not been adversely affected by modifications.**

#### Specific Guidance

If a commercial grade dedication package is selected for sample under this section, utilize guidance in IP 43004, Inspection of Commercial Grade Dedication Programs, to complete sections below.

1. Verify post-modification testing demonstrates the following:
  - unintended system interactions will not occur;
  - SSC performance characteristics, which could have been affected by the modification;

- modification design assumptions were appropriate; and
  - modification test acceptance criteria were met.
2. Verify supporting design and licensing documents were updated consistent with the modification.

Verify the licensee incorporated changes into procedures and supporting documentation to ensure continued performance capability of the SSC. These include:

- Operational procedures such as routine, abnormal and emergency operating and alarm response procedures
  - Licensed operator training materials
  - Maintenance, PM, and testing procedures
  - Calculations, design specifications, the FSAR, Technical Specifications, TRM, and drawings
3. Verify that other risk-significant functions were not adversely affected by the modification.
- Verify that other risk-significant plant features, such as structural, fire protection, flooding, environmental qualification, and security related features were not adversely impacted by the modification. Also verify PRA functions were not adversely affected by the modification.
4. Verify that affected maintenance and test procedures were updated and/or new maintenance and test documentation was established and implemented.
5. Perform a walkdown of the modification. If areas are not accessible, review licensee records for those areas.
6. Interview licensee staff, as necessary.

**b. Verify that the requirements of 10 CFR 50.59 were met prior to implementing the proposed change, test, or experiment.**

Specific Guidance

Regulatory Guide (RG) 1.187 "Guidance for Implementation of 10 CFR 50.59, Changes, Tests, and Experiments," states that Revision 1 of NEI 96-07, "Guidelines for 10 CFR 50.59 Evaluations" (ML003771157) provides methods that are acceptable to the NRC staff for complying with the provisions of 10 CFR 50.59. NEI has also published NEI 96-07, Revision 1, Appendix E, "User's Guide for NEI 96-7, Revision 1, Guidelines for 10 CFR 50.59 Implementation." However, NEI 96-07, Revision 1, Appendix E has not been reviewed or endorsed by the NRC. Also reference Inspection Manual Chapter (IMC) 0335 "Changes, Tests, and Experiments" for additional guidance.

Verify the applicability determination/screening correctly determined whether a 10 CFR 50.59 evaluation was or was not required. If the change, test, or experiment involved an 10 CFR 50.59 evaluation, refer to section 03.03 for inspection requirements.

### 03.03 10 CFR 50.59 Samples

- a. **Verify the licensee appropriately assessed changes, tests, or experiments that were made to risk-important SSCs within the scope of 10 CFR 50.59.**

#### Specific Guidance

Select evaluations performed in accordance with 10 CFR 50.59. The resident inspector staff and the Nuclear Reactor Regulation project manager should be consulted for recommendations on sample selection. Substantial changes performed since the last inspection should be reviewed as samples. Samples should be of such complexity that the change affects either the license basis or the 10 CFR 50.2 Design Basis.

Consideration should also be given to degraded and non-conforming conditions by selecting evaluations or screenings associated with operability evaluations and temporary modifications.

- b. **Verify that when changes, tests, or experiments were made, evaluations were performed in accordance with 10 CFR 50.59. Verify that the licensee has appropriately concluded that the change, test or experiment can be accomplished without obtaining a license amendment.**
- c. **Verify that safety issues related to the changes, tests, or experiments have been resolved.**

#### Specific Guidance

Regulatory Guide (RG) 1.187 "Guidance for Implementation of 10 CFR 50.59, Changes, Tests, and Experiments," states that Revision 1 of NEI 96-07, "Guidelines for 10 CFR 50.59 Evaluations" provides methods that are acceptable to the NRC staff for complying with the provisions of 10 CFR 50.59. NEI has also published a NEI 96-07, Revision 1, Appendix E, "User's Guide for NEI 96-7, Revision 1, Guidelines for 10 CFR 50.59 Implementation." However, NEI 96-07, Revision 1, Appendix E has not been reviewed or endorsed by the NRC. Also reference Inspection Manual Chapter (IMC) 0335 "Changes, Tests, and Experiments" for additional guidance.

- d. **Verify the licensee submitted a license amendment request if a change to Technical Specifications was required.**
- e. **Verify the applicability determination/screen correctly determined whether a 10 CFR 50.59 evaluation was or was not required.**
- f. **Verify 10 CFR 50.59 evaluations were performed in accordance with 10 CFR 50.59.**
- g. **Verify the licensee updated FSAR sections in accordance with 10 CFR 50.71(e).**

#### Specific Guidance

Compare updated FSAR sections to previous revision of FSAR. Verify the affected license basis of the plant prior to the change. Review prior revisions.

### 03.04 Operating Experience Sample(s)

- a. **Verify that the licensee has evaluated the operating experience issue and entered the item into the site corrective action program as required by site procedures.**

#### Specific Guidance

Some of the operating experience selected should cover initiating events and barrier integrity cornerstones. Assess how the licensee evaluated and dispositioned each item. The focus should be on ensuring that the conditions discussed in the operating experience either are not applicable, or have been adequately addressed by the licensee to ensure operability of the component. To the extent practical, acquire objective evidence that the operating experience item has been resolved, beyond a written licensee evaluation. For example, if the operating experience item necessitated a procedure change, verify that the procedure was changed. If the operating experience necessitated modification of a component, verify that the modification was completed. The NRC has developed several operating experience databases managed by the Operating Experience Branch in the Division of Reactor Safety and the Office of Research that should be consulted when identifying inspection target areas.

#### 71111.21M-04 RESOURCE ESTIMATE

The inspection procedure is estimated to take approximately 420 +/- 15 percent hours of NRC's direct inspection effort every cycle. This is based on a multi-disciplinary team comprised of a team leader and five regional inspectors (i.e., one operations/maintenance and four engineering inspectors).

#### 71111.21M-05 PROCEDURE COMPLETION

Inspection of the minimum sample size will constitute completion of this procedure in the Reactor Program System – Inspections . The minimum sample size consists of 15 samples regardless of the number of units at the site.

#### 71111.21M-06 REFERENCES

10 CFR 50 Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"

10 CFR 50.2, "Design Basis"

10 CFR 50.59, "Changes, test, and experiments"

10 CFR 50.71, "Maintenance of records, making of reports"

IMC 0326, "Operability Determinations"

IP 43004, "Inspection of Commercial-Grade Dedication Programs"

IP 71111.04, "Equipment Alignment"

IP 71111.15, "Operability Determinations and Functionality Assessments"

IP 71111.18, "Plant Modifications"

IP 71111.24, "Testing and Maintenance of Equipment Important to Risk"

NEI 96-07, "Guidance for 10 CFR 50.59 Implementation," Revision 1 (Nov. 2000)  
(ML003771157)

NRC Regulatory Guide 1.187, "Guidance for Implementation of 10 CFR 50.59, Changes, Test,  
and Experiments," Revision 2, June 2020 (ML20125A730)

NUREG-1801 Final Report, "Generic Aging Lessons Learned (GALL) Report," Revision 2  
(ML103490041)

SECY-22-0053, "Recommendation for Modifying the Reactor Oversight Process Engineering  
Inspections **Periodicity**"

END

## Appendix A: Component Review Attributes

<u>Attributes</u>	<u>Inspection Activity</u>
Process Medium	Verify that process medium will be available and unimpeded during accident/event conditions.
water air electrical signal	<ul style="list-style-type: none"><li>• Example: For an auxiliary feedwater pump, verify that the alternate water source will be available under accident conditions.</li><li>• Example: For emergency core cooling system piping, verify that the piping is kept free of voids as required by design bases or Technical Specifications.</li></ul>
Energy Source	Verify energy sources, including those used for control functions, will be available and adequate during accident/event conditions
electricity steam fuel + air air	<ul style="list-style-type: none"><li>• Example: For a diesel-driven auxiliary feedwater pump, verify that diesel fuel is sufficient for the duration of the accident.</li><li>• Example: For an air-operated pressurizer power-operated relief valve (PORV), verify that either a sufficient air reservoir will exist or instrument air will be available to support feed and bleed operation.</li><li>• Example: For a standby direct-current (DC) battery, verify adequacy of battery capacity.</li></ul>
Controls	Verify component controls will be functional and provide desired control during accident/event conditions.
initiation actions control actions shutdown actions	<ul style="list-style-type: none"><li>• Example: For refueling water storage tank level instrumentation providing signals for suction swap-over to injection recirculation, verify that the setpoint established to ensure sufficient water inventory and prevent loss of required net positive suction head is acceptable.</li></ul>
Operator Actions	Verify operating procedures (normal, abnormal, or emergency) are consistent with operator actions for accident/event conditions.
initiation monitoring control shutdown	<ul style="list-style-type: none"><li>• Example: If accident analyses assume containment fan coolers are running in slow speed, verify that procedures include checking this requirement.</li><li>• Example: If accident analyses assume that containment spray will be manually initiated within a certain time, verify that procedures ensure manual initiation within assumed time and that testing performed to validate the procedures was consistent with design basis assumptions.</li></ul>

<u>Attributes</u>	<u>Inspection Activity</u>
Operator Actions	Verify instrumentation and alarms are available to operators for making necessary decisions
initiation monitoring control shutdown	<ul style="list-style-type: none"> <li>• Example: For swap-over from injection to recirculation, verify that alarms and level instrumentation provide operators with sufficient information to perform the task.</li> </ul>
Heat Removal	Verify that heat will be adequately removed from major components
cooling water ventilation	<ul style="list-style-type: none"> <li>• Example: For an emergency diesel generator, verify heat removal through service water will be sufficient for extended operation.</li> </ul>
Installed Configuration	Verify, by walkdown or other means, that components' installed configuration will support its design basis function under accident/event conditions
elevations flowpath components	<ul style="list-style-type: none"> <li>• Example: Verify level or pressure instrumentation installation is consistent with instrument setpoint calculations.</li> </ul> <p>Verify that component configurations have been maintained to be consistent with design assumptions.</p>
Operation	<p>Verify that component operation and alignments are consistent with design and licensing basis assumptions</p> <ul style="list-style-type: none"> <li>• Example: For containment spray system components, verify emergency operating procedure changes have not impacted design assumptions and requirements.</li> <li>• Example: For service water system components, verify flow balancing will ensure adequate heat transfer to support accident mitigation</li> </ul>
Design  calculations procedures plant modifications	<p>Verify that design bases and design assumptions have been appropriately translated into design calculations and procedures.</p> <p>Also, verify that performance capability of selected components have not been degraded through modifications.</p>

<u>Attributes</u>	<u>Inspection Activity</u>
Testing	<p>Verify that acceptance criteria for tested parameters are supported by calculations or other engineering documents to ensure that design and licensing bases are met.</p>
flowrate pressure temperature voltage current	<ul style="list-style-type: none"> <li>• Example: Verify that flowrate acceptance criterion is correlated to the flowrate required under accident conditions with associated head losses, taking setpoint tolerances and instrument inaccuracies into account.</li> </ul> <p>Verify that individual tests and/or analyses validate component operation under accident/event conditions.</p> <ul style="list-style-type: none"> <li>• Example: Verify that the emergency diesel generator (EDG) sequencer testing properly simulates accident conditions and the equipment response is in accordance with design requirements.</li> </ul>
Component Degradation	<p>Verify that potential degradation is monitored or prevented.</p> <ul style="list-style-type: none"> <li>• Example: For ice condensers, verify that inspection activities ensure air channels have been maintained consistent with design assumptions.</li> </ul> <p>Verify that component replacement is consistent with inservice/equipment qualification life.</p> <p>Verify that the numbers of cycles are appropriately tracked for operating cycle sensitive components.</p> <p>Verify that the activities established in the aging management programs to identify, address, and/or prevent aging effects (such as loss of material, loss of preload, or cracking) are being performed. Consult with the regional license renewal point of contact for support if needed.</p>

<u>Attributes</u>	<u>Inspection Activity</u>
Equipment/ Environmental Qualification	Verify that equipment qualification is suitable for the environment expected under all conditions.
Temperature Humidity Radiation Pressure Voltage Vibration	<ul style="list-style-type: none"> <li>• Example: Verify equipment is qualified for room temperatures under accident conditions.</li> </ul>
Equipment Protection	Verify equipment is adequately protected.
Fire Flood Missile High energy line break HVAC Freezing Water intrusion/spray	<ul style="list-style-type: none"> <li>• Example: Verify freeze protection adequate for condensate storage tank (CST) level instrumentation.</li> <li>• Example: Verify that conditions and modifications identified by the licensee's high energy line break analysis have been implemented to protect selected highly risk-significant components.</li> </ul>
Component Inputs/Outputs	<p>Verify that component inputs and outputs are suitable for application and will be acceptable under accident/event conditions.</p> <ul style="list-style-type: none"> <li>• Example: Verify that valve fails in the safe configuration.</li> <li>• Example: Verify that required inputs to components, such as coolant flow, electrical voltage, and control air necessary for proper component operation are provided.</li> </ul>

## Appendix B: Component Design Review Considerations

### Valves

1. Are the permissive interlocks appropriate?
2. Will the valve function at the pressures and differential pressures that will exist during transient/accident conditions?
3. Will the control and indication power supply be adequate for system function?
4. Is the control logic consistent with the system functional requirements?
5. What manual actions are required to back up and/or correct a degraded function?

### Pumps

1. Is the pump capable of supplying required flow at required pressures under transient/accident conditions?
2. Is adequate net positive suction head (NPSH) available under all operating conditions?
3. Is the permissive interlock and control logic appropriate for the system function?
4. Is the pump control adequately designed for automatic operation?
5. When manual control is required, do the operating procedures appropriately describe necessary operator actions?
6. What manual actions are required to back up and/or correct a degraded function?
7. Has the motive power required for the pump during transient/accident conditions been correctly estimated and included in the normal and emergency power supplies?
8. Do vendor data and specifications support sustained operations at low flow rates?
9. Is the design and quality of bearing and seal cooling systems acceptable?

### Instrumentation

1. Are the required plant parameters used as inputs to the initiation and control system?
2. If operator intervention is required in certain scenarios, have appropriate alarms and indications been provided?
3. Are the range, accuracy, and setpoint of instrumentation adequate?
4. Are the specified surveillance and calibrations of such instrumentation acceptable?
5. Are the essential instruments, including instrumentation panel, adequately protected from the effects of spraying and wetting as required by the facility licensing basis?
6. Are conduits leading to essential instrument and control panels adequately sealed to prevent water intrusion?

### Circuit Breakers and Fuses

1. Is the breaker control logic adequate to fulfill the functional requirements?
2. Is the short circuit rating in accordance with the short circuit duty and breaker coordination requirements?
3. Are the breakers and fuses properly rated for the load current capability?
4. Are breakers and fuses properly rated for DC operation?

### Cables

1. Are cables rated to handle full load at the environmental temperature expected?
2. Are cables properly rated for short circuit capability?
3. Are cables properly restrained/mounted/braced for ground-fault currents?
4. Are cables properly rated for voltage requirements for the loads?
5. If submerged or exposed to prolong periods of moisture, are the cables qualified for submergence?

### Electrical Loads

1. Have electrical loads been analyzed to function properly under the expected lowest and highest voltage conditions?
2. Have loads been analyzed for their inrush and full load currents?
3. Have loads been analyzed for their electrical protection requirements?

### Motor Control Centers (MCCs)

1. Is the MCC adequately protected from the effects of spraying and wetting as required by the facility licensing basis?
2. Are cables and conduits leading to and from the MCC adequately sealed to prevent water intrusion?
3. Is the MCC preventive maintenance (i.e., visual inspection, cleaning and lubrication of the bus/stab contact surface, thermography) adequate and up-to-date?
4. Is there adequate ventilation for the MCC? What potential heat sources are in the area?
5. Is there evidence of any current or previous water leakage from above (i.e., pooling, drip bags, catch containers, staining, or deficiency tags)?

### As-built System

1. Are service water flow capacities sufficient with the minimum number of pumps available under accident conditions?
2. Have modified equipment components falling under the scope of 10 CFR 50.49 been thoroughly evaluated for environmental equipment qualification considerations such as temperature, radiation, and humidity?
3. Are the modifications to the system consistent with the original design and licensing bases?

## Appendix C: Component Walkdown Considerations

1. Is the installed component consistent with the piping and instrument diagram?
2. Will equipment and instrumentation elevations support the design function?
3. Has adequate sloping of piping and instrument tubing been provided?
4. Are required equipment protection barriers (such as walls) and systems (such as freeze protection) in place and intact?
5. Does the location of the equipment make it susceptible to flooding, fire, high energy line breaks, or other environmental concerns?
6. Has adequate physical separation/electrical isolation been provided?
7. Are there any non-seismic structures or components surrounding the components which require evaluation for impact upon the selected component?
8. Does the location of equipment facilitate manual operator action and is sufficient lighting available, if required?
9. Are baseplates, hangers, supports and struts installed properly?
10. Are there indications of degradations of equipment?
11. Are the motor-operated valve operators and check valves (particularly lift check valves) installed in the orientation required by the manufacturer?

## Appendix D: Sources Of Information

<u>Information</u>	<u>Suggested Sources</u>
Design Bases	Updated Final Safety Analysis Report (UFSAR) Design Basis Documentation System Descriptions Design Calculations Design Analyses Piping & Instrumentation Drawings Significant Design Drawings Significant Surveillance Procedures Pre-operational Test Documents Vendor Manuals
Licensing Bases	NRC Regulations Plant Technical Specifications UFSAR NRC Safety Evaluation Reports Generic Aging Lessons Learned (GALL) Report, NUREG-1801 Final Report, Revision 2 ( <a href="#">ML103490041</a> )
Applicable Accidents/Events	UFSAR Individual Plant Examination PRA analyses Emergency Operating Procedures (EOPs)
System Changes	System Modification Packages (including post modification test documents) 10 CFR 50.59 Safety Evaluations Temporary Modifications Work Requests Setpoint Changes EOP Changes
Industry Experience	Licensee Event Reports Bulletins Generic Letters Information Notices
PRA Information	Individual Plant Examinations (IPE) or Updated PRA model results Risk-informed inspection notebooks Risk importance rankings for SSCs Dominant accident sequences Important operator actions Individual Plant Examinations for External Events

## Appendix E: Heat Exchanger/Heat Sink Samples

### Heat Exchanger (Service Water Cooled)

**Verify that the selected service water cooled heat exchanger(s) remain capable of performing their intended safety functions.**

#### Specific Guidance

This section is applicable only to heat exchangers cooled by service water (e.g., those cooled directly by raw water).

- a. For the selected heat exchangers that are directly cooled by the service water system, verify that testing, inspection, maintenance, and monitoring of biotic fouling and macrofouling programs are singularly or in combination adequate to ensure proper heat transfer.
- b. Review the method and results of heat exchanger performance testing or equivalent methods to verify performance. Verify the following items, as applicable:
  1. The selected test methodology is consistent with accepted industry practices, or equivalent.
  2. Test conditions (e.g., differential temperatures, differential pressures, and flows) are consistent with the selected methodology.
  3. Test acceptance criteria (e.g., fouling factors, heat transfer coefficients) are consistent with the design basis values.
  4. Test results have appropriately considered differences between testing conditions and design conditions (functional testing at design heat removal rate may not be practical). Test results need to be extrapolated to the heat exchanger design conditions.
  5. Frequency of testing based on trending of test results is sufficient (based on trending data) to detect degradation prior to loss of heat removal capabilities below design basis values. Test result trends which show a step change in heat exchanger performance should be justified.
  6. Test results have considered test instrument inaccuracies and differences. Test instruments should be calibrated and set on appropriate range for the parameters to be measured; otherwise small measurement errors could affect the test results. The required accuracy of the instruments depends on the margins available between the calculated parameter based on the test results and the limiting design condition.
  7. Tube and shell side heat loads are equal if adequate information is available in test results to calculate these two values.
- c. For inspection/cleaning, review the methods and results of heat exchanger performance inspections or observe the actual inspection/cleaning. Refer to either design assumptions in calculations or parameters on design data sheets that can be evaluated by observation, review of licensee inspection records, or review of procedural operation

limits. Verify the following first three steps 1 thru 3, if conducting the review and the last step 4 only if actually observing the inspection/cleaning:

1. Methods used to inspect, and clean heat exchangers are consistent with as-found conditions identified and expected degradation trends and industry standards. Methods are adequate, based on identified degradation trends, if they ensure no loss of capability between scheduled inspections or cleanings.
2. Inspection and cleaning activities have established acceptance criteria and are consistent with industry standards. Acceptance criteria considers fouling factor and heat transfer coefficient, consistent with design assumptions and as-found conditions. The inspection and cleaning frequency is consistent with as-found conditions and identified trends. Based on the inspection and/or cleaning frequency, and the identified trends, the acceptance criteria are adequate to ensure no loss of operability or functionality during scheduled in-service period.
3. As-found results are recorded, evaluated, and appropriately dispositioned such that the as-left condition is acceptable. Changes in trends are identified and evaluated. The licensee has evaluated the as-left condition and determined, based on frequency and trend, the heat exchanger would remain operable (or identified limitations to ensure operable but degraded) through the in-service period until the next inspection.
4. If observing the inspection/cleaning then perform the following:
  - (a) Prior to cleaning, inspect the extent of fouling and blockage of tubes. Look for indications that bypass flow may be occurring due to divider plate wear on heat exchanger inlet and/or outlet end bell(s).
  - (b) Inspect the condition of the cleaned surfaces.
  - (c) Verify that the actual number of installed tube plugs agree with the recorded tube plug data, as documented in controlled drawings and heat transfer calculations.
  - (d) Verify that both ends of the same tube are plugged.
  - (e) Look for indications of macrofouling, including live or dead mussels and clams, plant material, or silt. Indications of macrofouling include accumulation of silt or sediment, live or dead mussels or clams, aquatic material (e.g., fish, algae, grass, kelp, etc.), and foreign material from maintenance or construction activities (i.e., gasket material or other debris).
  - (f) Verify end bell and flange gaskets are properly installed. Verify the use of sealants in combination with gaskets.
  - (g) Verify end bell orientation is correct after final installation. Improper end bell orientation can significantly reduce or isolate flow to an otherwise functional heat exchanger.
- d. Verify condition and operation are consistent with design assumptions in heat transfer calculations, and as described in the final safety analysis report. The inspector can refer to either design assumptions in calculations or parameters on design data sheets that

can be evaluated by observation, review of licensee inspection records, or review of procedural operating limits. Verify that the as-found condition of the heat exchanger tube inner surfaces is consistent with the fouling factor used in design calculations, or credited in design basis documents or the Updated Final Safety Analysis Report (UFSAR).

- e. Verify the licensee has evaluated the potential for water hammer in susceptible heat exchangers and undertaken appropriate measures to address it. Heat exchangers susceptible to water hammer include but are not limited to heat exchangers kept isolated in standby or dry lay-up, heat exchangers that can partially drain during design basis events (i.e., loss of offsite power (LOOP) or loss of coolant accident (LOCA)), such as containment air coolers, and containment heat exchangers in which flow is temporarily stopped following a station blackout or other event.
- f. Verify adequate controls and operational limits are in place to prevent heat exchanger degradation due to excessive flow induced vibration during operation. Heat exchangers that exhibit excessive flow induced vibration may be susceptible to potential damage to their tubes or tube sheets. Such heat exchangers may be identified based on direct observation during high flow conditions (i.e., tube rattle), issues identified in corrective action documents (e.g., vibration during operation, unexpected or excessive tube damage), issues identified during interviews of licensee staff, and administrative limits procedurally established to limit flow according to manufacturer's recommendations or engineering calculations. Additionally, review system flow balance results and individual heat exchanger flow data. Verify the licensee is maintaining the calculated flow through each heat exchanger.
- g. Review, if available, periodic flow testing at or near maximum design flow for redundant and infrequently used heat exchangers.
- h. Verify that the number of plugged tubes are within pre-established limits, based on heat transfer capacity and design heat transfer assumptions, and are appropriately accounted for in heat exchanger performance calculations.
- i. Review, if available, eddy current test reports and visual inspection records, to determine the structural integrity of the heat exchanger.

#### Heat Exchanger (Closed Loop)

**Verify that the selected closed loop heat exchanger(s) remain capable of performing their intended safety functions.**

#### Specific Guidance

This section is applicable only to heat exchanges that are cooled by closed cooling water systems (e.g., RHR heat exchangers not directly connected to the service water system). These heat exchangers are directly cooled by a closed cooling water system, and either indirectly cooled by the service water system, or cooled directly by an air radiator. Examples of risk significant or safety related heat exchangers that are air cooled at some nuclear

plants (i.e., no reliance on the service water system or UHS) include station blackout diesel generator, emergency diesel generator, or instrument air compressors.

For the selected heat exchangers that are directly cooled by a closed loop cooling water system, verify the following items:

- a. Condition and operation are consistent with design assumptions in heat transfer calculations. Design assumptions used in calculations and parameters on design data sheets can be compared to observations, inspection records, and operating procedure limits.
- b. Potential for water hammer in susceptible heat exchangers has been evaluated and appropriately addressed. Heat exchangers susceptible to water hammer include those heat exchangers kept isolated in standby or dry lay-up and heat exchangers that can partially drain during design basis events (i.e., LOOP or LOCA), such as containment air coolers.
- c. Controls and operational limits are in place to prevent heat exchanger degradation due to excessive flow induced vibration during operation. Heat exchangers that exhibit excessive flow induced vibration may be susceptible to potential damage to their tubes or tube sheets. Such heat exchangers may be identified based on direct observation during high flow conditions (i.e., tube rattle), issues identified in corrective-action documents (e.g., vibration during operation, unexpected or excessive tube damage), and issues identified during interviews of licensee staff. Administrative limits are procedurally established to limit flow according to manufacturer's recommendations or engineering calculations.
- d. Chemical treatment programs for corrosion control were consistent with industry standards, and are controlled, tested, and evaluated. Chemical treatment programs should be consistent with industry standards. Treatment results should be evaluated for adverse effects on heat exchangers or other system components, should consider stress corrosion cracking, and should conform to licensee established acceptance criteria. Chemical treatments should be conducted as scheduled, controlled, and the results monitored, trended, and evaluated.
- e. Available periodic flow testing at or near maximum design flow for redundant and infrequently used heat exchangers meets design specifications. System flow balance results and individual heat exchanger flow data should be reviewed to check that the licensee is maintaining the calculated flow through each heat exchanger.
- f. The number of plugged tubes are within pre-established limits, based on heat transfer capacity and design heat transfer assumptions, and are appropriately accounted for in heat exchanger performance calculations.
- g. Available eddy current test reports and visual inspection records indicate the structural integrity of the heat exchanger is maintained during operation.

## Ultimate Heat Sink

**Verify that the UHS remains capable of performing its intended safety functions.**

### Specific Guidance

This section is applicable only to UHS. For each UHS selected, verify the performance of UHS and their subcomponents like piping, intake screens, pumps, valves, etc. by tests or other equivalent methods. For heat sinks, the issue is their availability and accessibility to the in-plant cooling water systems. The UHS and its subcomponents should be assessed to gain reasonable assurance that they are capable of performing their intended risk significant or safety functions.

Perform at least two of the following five items below (i.e., a, b, c, d, and e) for each selected UHS.

- a. For an UHS such as a forced draft cooling tower or spray pond, perform a system walkdown and review licensee records to verify the following items, as applicable:
  1. Sufficient reservoir capacity.
  2. Periodic monitoring and trending of sediment build-up.
  3. Adjacent non-seismic or non-safety-related structures cannot degrade or block safety-related flow paths, during a severe weather or seismic event.
  4. Periodic performance monitoring of heat transfer capability.
  5. Periodic performance monitoring of the UHS structural integrity.
- b. Review operation of service water system and UHS.
  1. Review design changes to the service water system and the UHS. Review of changes or modifications to ensure that key design basis requirements were considered as inputs and maintained. Consideration may be given to reviewing planned modifications as well as age-related changes that have the potential to adversely impact the UHS design basis including intake structures, reservoir and dam material conditions.
  2. Review licensee procedures for a loss of the service water system or UHS. Verify that instrumentation, which is relied upon for decision making, is available and functional. Procedures should include specific guidance for a loss of intake structure, loss of all service water pumps, or pipe rupture, as applicable. Intake bay water level instrumentation may be used by emergency operating procedures (EOPs) and Emergency Plan emergency action levels (EAL), during abnormal or emergency conditions. Locations for measuring the technical specification UHS water level and the emergency plan EAL UHS water level should be effectively the same.
  3. Review licensee controls to prevent clogging due to macrofouling. Verify that macrofouling is adequately monitored, trended, and controlled, consistent with maintenance program frequencies and assumptions. Verification can be satisfied by test results, observation, or other equivalent methods that verify the UHS and sub-components can accommodate maximum system flow. During 2004 to 2006,

industry operating experience showed several events involving foreign material intrusion into the systems. These events included clogging of system piping, heat exchangers, strainers, and trash racks due to intrusion of aquatic life (e.g., fish, algae, grass, kelp, etc.), floating or submerged river debris, or entrained silt and sediment. Additional considerations include over-population of small fish that could be pulled into the system, live or dead zebra mussels or Asiatic clams, and other foreign material from maintenance or construction activities (i.e., gasket material, or other debris).

GL 89-13 recommended that once per refueling outage, a visual inspection for macroscopic biological fouling, sediment, and corrosion, and for removal of any accumulation. Some licensees have made commitments pursuant to GL 89-13 to minimize the potential for clogging equipment. Susceptible components may include heat exchangers with small diameter tubes, or small passages in flat plate style heat exchangers, valves or heat exchangers with low velocity flow rates, valves or heat exchangers in low elevation locations, and valves that are typically closed in dead legs.

4. If applicable, verify biocide treatments, for biotic control, were conducted as scheduled, controlled, and the results monitored, trended, and evaluated. The biocide treatment program should be consistent with industry standards. Treatment results should conform to licensee established acceptance criteria and maintain satisfactory biotic control. In addition, microbiological induced corrosion (MIC) should be monitored, trended, and controlled.
  5. For fixed volume UHS (i.e., not a river, lake, or ocean), verify adequate chemistry monitoring to ensure adequate pH, calcium hardness, etc. are maintained. Inadequate chemistry monitoring or control can result in calcium plate-out on hot heat exchanger tubes during a design basis event. Langeliers Index is a common water quality chemistry analysis which can be used to reduce the likelihood of degrading the heat transfer coefficient due to calcium deposits.
  6. Strong-pump weak-pump interaction. For susceptible system designs, verify the licensee monitors pump performance for potential strong-pump weak-pump interaction, during routine system operation and testing, and following pump maintenance. System design is susceptible to strong-pump weak-pump interaction whenever two (or more) centrifugal pumps operate in parallel and share a common minimum flow line. If one of the pumps is stronger (i.e., has a higher developed head for the same flow rate) than the other, the weaker pump may be dead-headed when the pumps are operating under low flow conditions, such as the mini-flow mode. Compare vendor pump curves, or pump curves developed during system testing, for differences in pump discharge pressure at the same flow rates. Review licensee's response to Bulletin 88-04. During single pump testing, compare pump head at low flow rates. Review licensee's system hydraulic model, for assumptions on mini-flow, or case studies with parallel pumps operating in the mini-flow mode.
- c. Review performance testing of service water system and UHS.
1. Review performance tests, such as ASME inservice tests, for a sample of pumps, tower fans, and valves in the service water system. The flushing and flow testing provisions of GL 89-13 also apply to service water cross-tie lines between units. In addition, pump runout conditions should not be present with the minimum number of

pumps operating with worst-case alignment on non-safety related loads. Refer to IP 71111.24, "Testing and Maintenance of Equipment Important to Risk," for additional guidance.

2. Review service water flow balance test results for adverse effects. Compare flow balance results to system configuration and flow assumptions during design basis accident conditions. System flow balance data should be consistent with key design assumptions, such as flow coefficients, pressure drops across components and piping during accident alignment configurations, rated heat removal flow rates, and total system flow specifications.
  3. Review periodic testing, inspection, or monitoring of valves that interface with safety-related service water and non-safety related (i.e., non-ASME class 3) or non-seismic piping systems to verify adequate isolation capability during a design basis event. Verify that the licensee's methodology is adequate for the leakage rate assumptions in their design basis (i.e., flow divergence or UHS total volume).
  4. Verify performance of risk significant non-safety related functions, such as back-up cooling to turbine building or reactor building closed cooling water systems, air compressors, or turbine driven auxiliary feedwater systems.
- d. Perform a system walkdown and review documentation for the selected service water and/or closed cooling water systems to verify the following items, as applicable:
1. For buried or inaccessible piping, review the licensee's pipe testing, inspection, or monitoring program to verify structural integrity, and ensure that any leakage or degradation has been appropriately identified and dispositioned. Piping inspection and monitoring programs should include periodic checks of riser penetrations (e.g., a vertical pipe coming up through a cement floor or foundation) and should also include checks of inspection manways on large bore piping (e.g., where the manway attaches to the pipe).
  2. Review, if available, ultrasonic test results and/or visual inspections to determine the structural integrity of the piping.
  3. Review licensee's disposition of any active thru wall pipe leaks, including completed or planned corrective actions and structural evaluations.
  4. Review history of thru wall pipe leakage to identify any adverse trends since the last NRC inspection (i.e., about two to three years).
  5. For closed cooling water systems, review operating logs or interview operators or system engineers, to identify adverse make-up trends that could be indicative of excessive leakage out of the closed system. Perform a walkdown of the system, including the head or surge tank to verify system integrity and material condition.
  6. Review the periodic inspection program used to detect protective coating failure, corrosion, and erosion.
  7. For deep draft vertical pumps, review operational history and IST vibration monitoring results for adverse trends. Common deep draft vertical pump problems include, shaft coupling failures due to corrosion, corrosion of shaft ends and/or

coupling bolts has led to elongation of shaft, and resulted in pump damage (IN 07-05), shaft bearing cooling problems, inability to detect pump degradation, and backward pump rotation with pump off or standby, which can result in fatigue failure of shaft coupling when pump is started. Numerous failures have resulted from misalignment, imbalance, installation errors, and intergranular stress corrosion cracking (IGSCC), and operating experience includes Bulletin 79-15, and Information Notices 80-07, 93-68, 94-45, and 07-05.

- e. Perform a walkdown and review documentation for the service water intake structure to verify the following items, as applicable:
  - 1. Proper functioning of traveling screens (typically non-safety-related) and strainers (typically safety related), including strainer backwash function. Review maintenance and operating history for the traveling screens and strainers to identify any adverse trends, such as repetitive shear pin failures. Also review history of trash rack blockage and trash rack cleaning frequency. Determine if intake fouling or blockage has resulted in any reactor power reductions. Review operating and abnormal procedures to determine whether guidance permits strainer bypass, even for temporary periods, for corrective maintenance. If so, then independently review licensee's evaluation of this condition regarding potential adverse impact on downstream structures, systems and components (SSCs), such as heat exchangers or coolers with small diameter tubes, because of fouling. For strainers, key inspection items may include check whether operators monitor strainer motor running amperage and compare readings when clogging is suspected, check how strainer backwash flow is verified, measured, or observed, and check that automatic strainer backwash is functional, if available. For those strainer systems which are not safety-related, ensure procedures address service water operability if these strainers become clogged during a loss of power event.
  - 2. Structural integrity of component mounts has not degraded (i.e., due to excessive corrosion). Review the periodic inspection program for the service water intake structure (recommended by GL 89-13). The inspection program should include silt monitoring and verification of continued component structural integrity, including underwater components (i.e., vortex preventer, trash rack, etc.).
  - 3. Service water pump bay silt accumulation is monitored, trended, and maintained at an acceptable level.
  - 4. Service water pump bay water level instruments are functional and routinely monitored. Assess operational controls to prevent excessive drawdown of the service water intake bay water level, with associated loss of service water pump suction because of clogging, fouling, or blockage of screens or racks. Operators should be able to identify lowering intake bay level before the Emergency Plan EAL value is reached. Abnormal operating procedure should direct sequential steps (e.g., sequential tripping of service water or circulating water pumps, or reducing reactor power) prior to reaching the EAL. Review should include indication, annunciation, and manual operator actions (operator response) for traveling screens, trash racks, and circulating water pumps.
  - 5. Assess functionality during adverse weather conditions (e.g. algae bloom, grass intrusion, storm debris, icing, frazil ice formation, high temperatures, etc.). If the facility is in an area that is susceptible to frazil ice, then assess licensee's ability to

identify or mitigate frazil ice conditions. Determine whether licensee has procedures to deal with adverse weather conditions. Coordinate the performance of this step with the performance of IP 71111.01, "Adverse Weather Protection." This inspection should also ensure that UHS water temperature is monitored and has not exceeded licensing or design basis limiting values. Causal factors that have resulted in intake structure blockage have included environmental changes, such as storm and wind effects, aquatic life, frazzle ice, sand, silt, and crude oil from spills. Conditions which may allow frazil ice formation include, water temperature near freezing, low intake water level, windy conditions, and no ice cap on river or lake.

6. For underwater weir walls, intended to limit silt or sand intake, verify whether water could flow around, rather than over, the weir wall during periods of river or lake low water level. Verify that the licensee has evaluated the potential of silt introduction during periods of low flow/level or that the height of the wall is appropriate.

#### UHS Containment Device or Dam

**Verify that the UHS Containment Device or Dam remain capable of performing its intended safety functions.**

#### Specific Guidance

If the UHS containment device or dam is not licensee owned, ensure advance notice is provided to allow preparations for visual inspection when appropriate. Consideration for more frequent inspection should be made if there is known or suspected degradation.

- a. For an above-ground UHS encapsulated by embankments, weirs or excavated side slopes, conduct walk-downs and/or review the licensee's methods and results to verify that:
  1. The toe of the weir or embankment is not experiencing unacceptable seepage of water and the crest of the dam is not showing unacceptable settlement. Erosion could lead to loss of structural integrity.
  2. The rip rap protection placed on excavated side slopes remains in place, and vegetation along the slopes is maintained to prevent adverse impact on the embankment. Loss of shoreline protection can lead to a changing shoreline resulting in UHS capacity that is less than the design. Large vegetation, such as tree roots or burrowing animals can weaken the integrity of the embankments. Similarly, decayed tree roots can allow formation of a water channel in the embankment that weakens the integrity.
  3. If available, review the results from any licensee or third-party dam inspections used to monitor the integrity or performance of the heat sink. The NRC's Dam Safety Officer may be able to provide additional guidance.
  4. Verify sufficient reservoir capacity. Changing shorelines or sediment intrusion can reduce UHS capacity. Lessons learned from plant inspections include: degradation of the shoreline by vegetation growth can cause compacted clay to degrade and slump into the heat sink reducing capacity. Insufficient number of measurements

taken of the depth of water may not identify significant debris or sediment build-up in the UHS.

- b. For underwater UHS weirs, structures, or excavations, the inspection should identify settlement or movement indicating loss of structural integrity and/or capacity. The height of water over the crest of the weir should be constant in cases where the licensee takes these measurements to verify capacity. Review licensee inspection methods and results to verify that:
  - 1. Any possible settlement or movement does not affect the structural integrity and/or capacity.
  - 2. Sediment intrusion does not reduce capacity.

Attachment 1: Revision History for IP 71111.21M

Commitment Tracking Number	Accession Number Issue Date Change Notice	Description of Change	Description of Training Required and Completion Date	Comment Resolution and Closed Feedback Form Accession Number (Pre-Decisional, Non-Public Information)
N/A	ML15154A586 07/28/15	Initial Issuance of the inspection procedure. Researched commitments for 4 years and found none.	No	N/A
N/A	ML15302A004 11/24/15 CN 15-026	Reissued inspection procedure after incorporating regional comments	No	N/A
N/A	ML16238A320 DRAFT CN 16-XXX	Revised inspection procedure to address internal and external comments from conducting the eight CDBI pilot inspections and also to address FFs -1989; -2072; and -2172.  Made draft version public prior to final version being issued to allow viewing of potential inspections starting CY 2017.	No	ML16239A088 71111.21-1989 ML16342C117 71111.21-2072 ML16342AC141 71111.21-2172 ML16342C383
N/A	ML16340B000 12/08/16 CN 16-032	Changes associated with ML16238A320  A new ADAMS Accession Number was created to address a non-concurrence on the changes proposed by version of the IP associated with ML16238A320. Completed non-concurrence package can be found in ML16341C689. No additional changes were made to this IP.	No	ML16239A088 71111.21-1989 ML16342C117 71111.21-2072 ML16342AC141 71111.21-2172 ML16342C383  See non-concurrence package ML16341C689.

Commitment Tracking Number	Accession Number Issue Date Change Notice	Description of Change	Description of Training Required and Completion Date	Comment Resolution and Closed Feedback Form Accession Number (Pre-Decisional, Non-Public Information)
N/A	ML19084A030 10/07/22 CN 22-021	Major procedural change. The procedure changes from a Design Basis Assurance Inspection to a Comprehensive Engineering Team inspection. Revised inspection procedure following engineering working group evaluation of all engineering inspections. The updated procedure incorporates the 50.59 inspection (IP 711111.17T) and triennial portions of the Heat Sink Performance inspection (IP 71111.07). Researched commitments for 4 years and found none.	Training on procedural changes- TBD	ML22154A451 ML19105A679  71111.21M-2348 ML19116A011
N/A	ML25070A077 06/27/25 CN 25-024	Reducing inspection team size from 7 to 6 inspectors, adjusted sample ranges to make that achievable.	N/A	ML25071A390