ATTACHMENT 71111.21

INSPECTABLE AREA: Component Design Bases Inspection

INSPECTION BASES: Inspection of component design bases verifies the initial design and subsequent modifications and provides monitoring of the capability of the selected components and operator actions to perform their design bases functions. As plants age, their design bases may be difficult to determine and an important design feature may be altered or disabled during a modification. The plant risk assessment model assumes the capability of safety systems and components to perform their intended safety function successfully. This inspectable area verifies aspects of the Initiating Events, Mitigating Systems and Barrier Integrity cornerstones for which there are no indicators to measure performance.

LEVEL OF EFFORT: Review 15-20 risk-significant and low design margin components, 3-5 relatively high risk operator actions and 4 - 6 operating experience issues.

71111.21-01 INSPECTION OBJECTIVE

To verify that design bases have been correctly implemented for the selected risk-significant components and that operating procedures and operator actions are consistent with design and licensing bases. This is to ensure that selected components are capable of performing their intended safety functions.

71111.21-02 INSPECTION REQUIREMENTS AND GUIDANCE

02.01 Sample Selection. During the on-site pre-inspection visit and the first week of in-office preparation week, select 15-20 risk-significant/low margin components and 3-5 risk-significant operator actions, and 4 - 6 risk-significant operating experience issues related to the selected components as well as generic or common cause issues that are not related to the selected samples for review. To the extent practical, the components selected should be grouped into discrete systems to allow for easier inspection; however, specific limits or boundaries should not be used during the sample selection process to limit the number of systems involved. The sample selection will be based on a risk-informed and low margin approach to identify the highly risk-significant components and operator actions at the facility. A senior reactor analyst (SRA) and site resident inspector should participate during the component selection phase of the inspection.

Although the methods used to identify the highly risk-significant components and operator actions will be dependent on the type and quality of the licensee’s risk assessment tools, the following criteria should be considered:

- 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 considered for inclusion in the inspection sample. A lower threshold may be used if desired.

- 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. Components and actions with a RAW value of 2 or greater should be considered for inclusion within the inspection sample. A lower threshold may be used if desired.

- Delta CDF or Delta LERF Data: Components or operator actions which increase the delta CDF or delta LERF by an order of magnitude should be considered for inclusion within the inspection sample. Likewise, components or actions that increase the initiating event likelihood by an order of magnitude should also be considered (e.g. service water system). For Delta LERF as an example, in plants with ice condenser containment designs certain accident sequences (e.g. station blackout) result in a dominant risk increase from Delta LERF versus Delta CDF. These sequences can be found by looking in the "LERF Factor" column of the plant's pre-solved phase 2 SDP notebook. Contact the Division of Risk Assessment of NRR for this information.

- Subjective risk rankings based on engineering or expert panel judgement such as those performed to identify risk significant structures, systems, and components 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.

- The use of dominant accident sequences in PRAs to select components may be appropriate for SSCs that are more significant to LERF than CDF; external events (e.g., fire, seismic, flood) than internal events (e.g., LOCAs); or risk during shutdown than during normal operation.

- Other risk criteria established by the team leader and SRA (e.g. operating experience, engineering judgment, etc.).

In identifying specific inspection areas for the margin review, the team should broadly assess component and operator attributes necessary to meet the probabilistic risk assessment functional success criteria. For example, if the sample selection review identifies a specific pump failure to start or run as risk- significant, margin review activities should consider all conditions that could reasonably cause loss of pump flow (e.g. clogged suction strainer, loss of motive power, inadequate net positive suction head, valve misalignment or failure, etc.).

The margin review should evaluate the impact of plant modifications or licensing basis changes on available margin. Consider licensing changes that can reduce safety analysis margins, such as extended power uprates. Contact the NRR licensing project manager to obtain this information.

The following attributes should be considered in evaluating component margin.

Analytical (design) margin is the margin in the design calculations related to the performance of the component. For example, the analytical margin for a pump includes flow and head required for the pump to perform its function compared to the calculated capacity of the equipment. For valves required to change position, valve thrust margin and stroke time margin should be considered. For an emergency diesel generator or battery, the capacity margin should be considered. These design margin values can be extracted from the licensee's design analyses. The margin between the design performance of components and actual performance can be extracted from test results. Evaluate test alignments for components to verify that acceptance criteria are appropriate for accident conditions that may differ from the test condition.

Operations margin refers to components required to be operated during high risk and/or time critical operations. During a station blackout, the plant may take credit for rapid operator actions to manually control equipment. The operation of equipment may be dependent on operator actions within specific time limits. For example, operators may be required to realign the charging pumps within a specific time to prevent a reactor coolant pump seal LOCA in a PWR if cooling water is lost. Some valve stroke times are critical to perform their functions. In these cases, operators would have little time to recover if the component did not respond as expected.

Maintenance margin refers to the physical condition and reliability of the components being reviewed. The plant PRA may not reflect the actual reliability of the installed components. Review of system health reports, condition reports, operating experience, and discussions with plant personnel can identify components with a history of failures. For example, an isolation valve with a history of significant leakage could reduce the margin in a fluid system. Unreliable HVAC components could affect critical equipment in the area. Review maintenance rule history and obtain input from the Resident Inspectors.

Complexity margin is a subjective evaluation of the complexity of the design associated with the component 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 in the controls for a component could be applied to both trains of redundant equipment, resulting in both trains being vulnerable to failure.

The SRA can provide valuable insight regarding which accident scenarios contribute to the risk associated with a specific component. Component margin reviews should be performed for scenarios that contribute to the high risk for the component. For example, the failure of a (PWR) turbine driven auxiliary feedwater pump during a station blackout event may result in very high risk, while the failure of the same pump during a LOCA event may have low risk. The margin review should focus on required performance of the component during "high risk" scenarios.

Select a mixture of component types to ensure the inspection is sufficiently broad in scope and involves various plant programs. High risk components tend to be clustered in a few plant systems. Select components that reflect a reasonable number of systems to inspect efficiently. Components spread over 5 to 10 systems is reasonable. Select some components that are related to the selected operator actions.

02.02 Components and Operator Actions

a. Design Review: The design inspection verifies that components will function as required and support the proper operation of associated systems. Verify the appropriateness of design assumptions, boundary conditions, and models. Independent calculations by inspectors may be required to verify appropriateness of the licensee's analysis methods.

Determine whether the design basis is met by the installed and tested configuration. Review the original purpose of the design and the manner/conditions under which the system will be required to function during transients and accidents. If UFSAR information was used as inputs for design or procedures, these inputs should be verified to be consistent with the design bases. Review interfaces between safety related and non-safety related components.

Select a sample of inspection attributes for review and verify the design bases of selected components. Selection of inspection attributes should 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. Appendix 1, "Component Review Attributes," lists attributes needed for a component to perform its required function. The listing is not all inclusive and should be modified based on the selected components. Verify that the component condition and tested capability is consistent with the design bases. Appendix 2, "Component Condition and Capability," lists applicable attributes that could be inspected. Appendix 3 lists component design review considerations.

b. Reliability Review and Walkdown: Review outstanding repetitive maintenance work requests and deficiencies that could affect the ability of the components to perform their functions. Review outstanding design issues, including open/deferred or canceled engineering action items, temporary modifications, operator workarounds, and items that are tracked by the operations or engineering departments. Perform a walkdown inspection to identify equipment alignment discrepancies. Inspect for deficient conditions such as corrosion, missing fasteners, cracks, and degraded insulation. See Appendix 4.

Review significant corrective action documents for the last four years, including degraded/deficient conditions. Review adequacy of licensee technical evaluation (corrective action program evaluations, engineering evaluations, operability determinations). Determine if operability is justified and problems are properly identified/corrected. Verify that the licensee considered other degraded conditions and their impact on compensatory measures for the condition being evaluated. See Inspection Procedure 71152, "Identification and Resolution of Problems," for additional guidance on corrective actions.

If operability is justified, no further review is required. If the operability evaluation involves compensatory measures, determine 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 LCOs. Refer to Part 9900 Technical Guidance, STSODP, "Operability

Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety," for additional information.

c. Operating Procedures and Operator Actions: For the selected components and operator actions, walk-through a sample of associated system operating procedures at the functional level with a plant operator. This includes normal, abnormal, and emergency operating procedures. Verify that the procedures are consistent with engineering inputs and assumptions and the operators are able to implement the procedures from the main control panel and the alternate shutdown or local control panels and the key components and equipment are accessible for normal and emergency operation. If any special equipment is required to perform these procedures, determine if the equipment is available and in good working order. Verify that the knowledge level of the operators is adequate concerning equipment location and operation.

Consider the following attributes to verify the adequacy of the operating procedures to support the design and verify that key operator actions can be performed within the constraints of the design analyses.

- the specific operator actions required;
- the potentially harsh or inhospitable environmental conditions expected;
- a general discussion of the ingress/egress paths taken by the operators to accomplish functions;
- the procedural guidance for required actions;
- the specific operator training necessary to carry out actions, including any operator qualifications required to carry out actions;
- any additional support personnel and/or equipment required by the operator to carry out actions;
- a description of information required by the control room staff to determine whether such operator action is required, including qualified instrumentation used to diagnose the situation and to verify that the required action has successfully been taken;
- the ability to recover from credible errors in performance of manual actions, and the expected time required to make such a recovery;
- consideration of the risk significance of the proposed operator actions;
- the time available to complete an action based on safety analyses and the methods used by the license to verify and validate that the required actions can be completed within the available time. This review area should include a field walkdown to validate the licensee's timing assumptions. Particular attention should be given to time dependent actions that must be accomplished outside the control room by auxiliary equipment operators; and

- observe demonstrations or training in the simulator that validate operator actions for a given event or accident condition.

d. Permanent Plant Modification Review: For a sample of applicable modifications, verify that design bases, licensing bases, and performance capability of components have not been degraded through modifications. Review the design adequacy of the modification by performing the activities identified in Section 02.02.a and IP 71111.17, "Permanent Plant Modifications."

Verify that the licensee has considered the conditions under which they may make changes to the facility or procedures or conduct tests or experiments without prior NRC approval. Verify that the licensee has appropriately concluded that the change, test or experiment can be accomplished without obtaining a license amendment. For the changes, tests, or experiments that the licensee determined that evaluations were not required, verify that the licensee's conclusions were correct and consistent with 10 CFR 50.59. Refer to IP 71111.02, "Evaluation of Changes, Tests, or Experiments," for more information.

Determine whether post-modification testing establishes operability by verifying:

- that unintended system interactions will not occur.
- that SSC performance characteristics, which could have been affected by the modification, meet the design bases.
- the appropriateness of modification design assumptions.
- modification test acceptance criteria have been met.

e. Operating Experience Review: Review 4 - 6 operating experience issues related to the selected components as well as generic or common cause issues that are not related to the components. 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 required a procedure change, verify that the procedure was changed. If the operating experience required modification of a component, verify that the modification was completed.

02.03 Inspection Schedule. The inspection time line is as follows:

Week 1	On-site preparation/sample selection.
Week 2	In-office preparation/finalizing samples for inspection.
Week 3	On-site inspection of selected samples.
Week 4	In-office preparation/inspection activities.

Week 5	On-site inspection of selected samples.
Week 6	Last week of on-site inspection of selected samples.
Week 7	Documentation of inspection results.

Regions may revise the above as long as the below resource estimate and the contractor Statement of Work are not exceeded. The team leader require additional time to prepare for the inspection and after the inspection to integrate the report input.

71111.21-03 RESOURCE ESTIMATE

The inspection procedure is estimated to take 408 hours NRC effort (plus or minus 15%). This is based on a multi-disciplinary team comprised of a team leader and two to three regional inspectors (operations and engineering). In addition, the team includes two contractor design specialists in the mechanical and electrical/instrumentation and control disciplines.

71111.21-04 COMPLETION STATUS

Inspection of the minimum sample size will constitute completion of this procedure in the RPS. That minimum sample size consists of 15 component reviews, three operator actions and four operating experience issues, regardless of the number of units at the site.

71111.21-05 REFERENCES

1. IP 71111.04, “Equipment Alignment.”
2. IP 71111.15, “Operability Evaluations.”
3. IP 71111.17, “Permanent Plant Modifications.”
4. IP71111.02, “Evaluation of Changes, Tests, or Experiments.”
5. IP 71111.22, “Surveillance Testing.”
6. IP 71152, “Identification and Resolution of Problems.”
7. IP 93801, “Safety System Functional Inspection (SSFI).”
8. Information Notice 97-078, “Crediting of Operator Actions in Place of Automatic Actions and Modifications of Operator Actions, Including Response Times.”
9. SECY-04-0071, dated April 29, 2004 (ML040970328).
10. SECY-05-0118, dated July 1, 2005 (ML051390465).

END

Appendix 1, Component Review Attributes

Attributes	Inspection Activity
Process Medium • water • air • electrical signal	Verify that process medium will be available and unimpeded during accident/event conditions. • Example: For an auxiliary feedwater pump, verify that the alternate water source will be available under accident conditions. • Example: For emergency core cooling system piping, verify that the piping is kept free of voids as required by design bases or Technical Specifications.
Energy Source • electricity • steam • fuel + air • air	Verify energy sources, including those used for control functions, will be available and adequate during accident/event conditions • Example: For a diesel driven auxiliary feedwater pump, verify that diesel fuel is sufficient for the duration of the accident. • Example: For an air-operated pressurizer PORV, verify that either sufficient reservoir air will exist or instrument air will be available to support feed and bleed operation. • Example: For a standby DC battery, verify adequacy of battery capacity.
Controls • initiation actions • control actions • shutdown actions	Verify component controls will be functional and provide desired control during accident/event conditions. • Example: For refueling water storage tank level instrumentation providing signal for suction swap-over to containment sump, verify that the setpoint established to ensure sufficient water inventory and prevent loss of required net positive suction head is acceptable.
Operator Actions • initiation • monitoring • control • shutdown	Verify operating procedures (normal, abnormal, or emergency) are consistent with operator actions for accident/event conditions. • Example: If accident analyses assume containment fan coolers are running in slow speed, verify that procedures include checking this requirement. • 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. Verify instrumentation and alarms are available to operators for

Attributes	Inspection Activity
	making necessary decisions. • Example: For swap-over from injection to recirculation, verify that alarms and level instrumentation provide operators with sufficient information to perform the task.
Heat Removal • cooling water • ventilation	Verify that heat will be adequately removed from major components • Example: For an emergency diesel generator, verify heat removal through service water will be sufficient for extended operation.

Appendix 2, Component Condition and Capability

Attributes	Inspection Activity
Installed Configuration • elevations • flowpath components	Verify, by walkdown or other means, that components' installed configuration will support its design basis function under accident/event conditions • Example: Verify level or pressure instrumentation installation is consistent with instrument setpoint calculations. Verify that component configurations have been maintained to be consistent with design assumptions.
Operation	Verify that component operation and alignments are consistent with design and licensing basis assumptions • Example: For containment spray system components, verify emergency operating procedure changes have not impacted design assumptions and requirements. • Example: For service water system components, verify flow balancing will ensure adequate heat transfer to support accident mitigation.
Design • calculations • procedures • plant modifications	Verify that design bases and design assumptions have been appropriately translated into design calculations and procedures. Also, verify that performance capability of selected components have not been degraded through modifications.
Testing • flowrate • pressure • temperature • voltage • current	Verify that acceptance criteria for tested parameters are supported by calculations or other engineering documents to ensure that design and licensing bases are met. • 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. Verify that individual tests and/or analyses validate component operation under accident/event conditions. • Example: Verify that EDG sequencer testing properly simulates accident conditions and the equipment response is in accordance with design requirements.

Component Degradation	Verify that potential degradation is monitored or prevented. • Example: For ice condensers, verify that inspection activities ensure air channels have been maintained consistent with design assumptions. Verify that component replacement is consistent with inservice/equipment qualification life. Verify that the numbers of cycles are appropriately tracked for operating cycle sensitive components.

Equipment/ Environmental Qualification • Temperature • Humidity • Radiation • Pressure • Voltage • Vibration	Verify that equipment qualification is suitable for the environment expected under all conditions. • Example: Verify equipment is qualified for room temperatures under accident conditions.
Equipment Protection • fire • flood • missile • high energy line break • HVAC • freezing	Verify equipment is adequately protected. • Example: Verify freeze protection adequate for CST level instrumentation. • 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.
Component Inputs/Outputs	Verify that component inputs and outputs are suitable for application and will be acceptable under accident/event conditions. • Example: Verify that valve fails in the safe configuration. • Example: Verify that required inputs to components, such as coolant flow, electrical voltage, and control air necessary for proper component operation are provided.
Operating Experience	Verify that applicable insights from operating experience have been applied to the selected components. • Example: Verify that component functioned appropriately when challenged during transients

Appendix 3, 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

6. Is the pump capable of supplying required flow at required pressures under transient/accident conditions?

7. Is adequate net positive suction head (NPSH) available under all operating conditions?

8 Is the permissive interlock and control logic appropriate for the system function?

9. Is the pump control adequately designed for automatic operation?

10. When manual control is required, do the operating procedures appropriately describe necessary operator actions?

11. What manual actions are required to back up and/or correct a degraded function?

12. Has the motive power required for the pump during transient/accident conditions been correctly estimated and included in the normal and emergency power supplies?

13. Do vendor data and specifications support sustained operations at low flow rates?

14. Is the design and quality of bearing and seal cooling systems acceptable?

Instrumentation

15. Are the required plant parameters used as inputs to the initiation and control system?

16. If operator intervention is required in certain scenarios, have appropriate alarms and indications been provided?

17. Are the range, accuracy, and setpoint of instrumentation adequate?

18. Are the specified surveillance and calibrations of such instrumentation acceptable?

Circuit Breakers and Fuses

19. Is the breaker control logic adequate to fulfill the functional requirements?

20. Is the short circuit rating in accordance with the short circuit duty?

21. Are the breakers and fuses properly rated for the load current capability?

22. Are breakers and fuses properly rated for DC operation?

Cables

23. Are cables rated to handle full load at the environmental temperature expected?

24. Are cables properly rated for short circuit capability?

25. Are cables properly rated for voltage requirements for the loads?

Electrical Loads

26. Have electrical loads been analyzed to function properly under the expected lowest and highest voltage conditions?

27. Have loads been analyzed for their inrush and full load currents?

28. Have loads been analyzed for their electrical protection requirements?

As-built System

29. Are service water flow capacities sufficient with the minimum number of pumps available under accident conditions?

30. 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?

31. Are the modifications to the system consistent with the original design and licensing bases?

Appendix 4, Component Walkdown Considerations

(a). Is the installed component consistent with the piping and instrument diagram?

(b). Will equipment and instrumentation elevations support the design function?

(c). Has adequate sloping of piping and instrument tubing been provided?

(d). Are required equipment protection barriers (such as walls) and systems (such as freeze protection) in place and intact?

(e). Does the location of the equipment make it susceptible to flooding, fire, high energy line breaks, or other environmental concerns?

(f). Has adequate physical separation/electrical isolation been provided?

(g). Are there any non-seismic structures or components surrounding the components which require evaluation for impact upon the selected component?

(h). Does the location of equipment facilitate manual operator action, if required?

(i). Are baseplates, hangers, supports and struts installed properly?

(j). Are there indications of degradations of equipment ?

(k). Are the motor-operated valve operators and check valves (particularly lift check valves) installed in the orientation required by the manufacturer?

Appendix 5, Sources of Information.

Information	Suggested Sources
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
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 6

Revision History for IP 71111.21

Commitment Tracking Number	Issue Date	Description of Change	Training Needed	Training Completion Date	Comm Acces
N/A	06/22/06	Revision history reviewed for last four years	No	N/A	N/A
None	06/22/06	IP 71111.21 has been revised to clarify the margin review step of sample selection and also, the inspection resources.	No	N/A	ML06