U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER™ iPWR DESIGN

14.3.5 INSTRUMENTATION AND CONTROLS - INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of instrumentation and controls

Secondary - None

I. AREAS OF REVIEW

This Design Specific Review Standard (DSRS) section addresses inspections, tests, analyses, and acceptance criteria (ITAAC) related to the instrumentation and control (I&C) systems. ITAAC information is contained in Tier 1 information from the design control document (DCD) of a design certification (DC) application.

The ITAAC review includes a review of the design commitments to be verified by ITAAC inspection. For DC applications, these design commitments also define the scope of the certified design. The design commitments are identified in Design Descriptions that establish the scope of ITAAC. For DC applications and for COL applications that reference a DC, these Design Descriptions and ITAAC are contained in the Tier 1 portion of the DCD. For COL applications that do not reference a DC, these design commitments may be described in ITAAC Design Descriptions, or identified by ITAAC references to the application.

The review of I&C ITAAC should be coordinated with the review of the applicant's I&C systems design as described in Chapter 7 of the DSRS. It is recognized that the review of ITAAC is performed after review of the application against acceptance criteria contained in Chapter 7 of the DSRS. Furthermore, the ITAAC are reviewed to assure that all systems, structures, and components (SSCs) in this area of review are identified and addressed as appropriate.

The specific areas of review are as follows:

1. Tier 1 information on I&C systems involving reactor protection and control, engineered safety features actuation, and other systems using I&C equipment.

2. Tier 1 information related to design process of digital I&C systems.

3. Key interface requirements related to I&C issues.

4. Functional requirements of IEEE Std. 603-1991 and the General Design Criteria when implementing the safety system.

ADAMS Accession No. ML122325A091

5. For a DC application:

   A. The staff reviews the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the Atomic Energy Act, and the NRC's regulations.

   B. The staff reviews the justification that compliance with the interface requirements is verifiable through ITAAC. The staff also reviews the method that is to be used for verification of the interface requirements.

Review Interfaces

Other listed DSRS sections interface with this section as follows:

1. SRP Section 14.3 provides general guidance on review interfaces.

2. Acceptability of ITAAC information regarding the ability of SSCs to withstand various natural phenomena is reviewed under DSRS Section 14.3.2.

3. Acceptability of ITAAC information for electrical systems and components is reviewed under DSRS Section 14.3.6.

4. Acceptability of ITAAC information for plant systems including heating, ventilation, and air conditioning (HVAC) design, containment isolation, and selected aspects of the containment design is reviewed under DSRS Section 14.3.7.

5. Acceptability of ITAAC information for reactor systems DSRS Section 14.3.4.

6. Acceptability of ITAAC information for radiation protection is reviewed under DSRS Section 14.3.8.

7. Acceptability of ITAAC information for human factors is reviewed under DSRS Section 14.3.9.

8. Acceptability of ITAAC information for emergency preparedness is reviewed under DSRS section 14.3.10.

9. Acceptability of ITAAC information for containment systems is reviewed under DSRS Section 14.3.11.

10. The identification of risk significant I&C is reviewed under DSRS Section 19.0.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following

Commission regulations:

1. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations;

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for review described in this DSRS section. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. Identifying the differences between this DSRS section and the design features, analytical techniques, and procedural measures proposed for the facility, and discussing how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria, is sufficient to meet the intent of 10 CFR 52.47(a)(9), "Contents of applications; technical information."

1. The methodology for selecting SSCs that will be subject to ITAAC as well as the criteria for establishing the necessary and sufficient ITAAC should be appropriate for and consistently applied to I&C systems.

2. Tier 1 design descriptions and ITAAC design descriptions should describe the top-level I&C design features and performance characteristics that are significant to safety. For safety systems, this should include a description of system purpose, safety functions, equipment quality (e.g., meet the functional requirements of IEEE Std. 603-1991 and the digital system life cycle design process), automatic decision-making and trip logic functions, manual initiation functions, and design features (e.g., system architecture) provided to achieve high functional reliability.

   The functions and characteristics of other I&C systems important to safety should also be discussed to the extent that the functions and characteristics are necessary to support remote shutdown, support required operator actions or assessment of plant conditions and safety system performance, maintain safety systems in a state that assures their availability during an accident, minimize or mitigate control system failures that would interfere with or cause unnecessary challenges to safety systems, or provide diverse back-up to safety systems.

   SRP Section 14.3, Appendix A, Subsection B.1, provides additional guidance on the content of Tier 1 design descriptions, ITAAC design descriptions, or ITAAC references to the application.

3. ITAAC should identify the significant features of the I&C systems on which the staff is relying to assure compliance with each NRC requirement identified in DSRS Chapter 7. Tests, analyses, and acceptance criteria associated with each design commitment should, when taken together, be sufficient to provide reasonable assurance that the final as-built I&C system fulfills NRC requirements.

SRP Section 14.3, Appendix A, Subsection B.2, provides additional guidance on the expected scope, content, and format of ITAAC.

4. Tier 1 design descriptions and ITAAC design commitments should be based on and consistent with the Tier 2 material.

5. The passive-designed reactors use safety systems that employ passive means (natural forces), such as gravity, natural circulation, condensation and evaporation, and stored energy, for accident mitigation. These designs also include active systems that provide defense-in-depth capabilities for reactor-coolant makeup and decay heat removal. These active systems are the first line of defense to reduce challenges to the passive systems in the event of transients or plant upsets. SECY-95-132, "Policy and Technical Issues Associated with The Regulatory Treatment of Non-Safety Systems (RTNSS) in Passive Plant Designs (SECY-94-084)," provides certain guidance and positions for ensuring consistent and complete treatment of those systems that might be classified as non-safety-related by the designer or applicant but are important to safety or otherwise provide defense-in-depth functions.

   Applicable regulatory guidance from the Commission for selected policy and technical issues related to particular design should be followed. For the severe accident analyses, the basis for the staff's review for the evolutionary and passive standard designs was the Commission guidance related to SECY-90-016, "Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements." SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs," generically presents guidance and NRC positions on evolutionary and passive LWR design certification issues. For guidance, positions, and issues related to specific designs, guidance is available in such documents as SECY-97-044, "Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design," or SECY-92-327, "Reviews of Inspections, Test, Analyses, and Acceptance Criteria (ITAAC).

6. Commission regulations and policy mandate a number of specific "programs" applicable to certain SSCs; however, ITAAC is the only programmatic requirement specifically addressed in this DSRS.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this DSRS section is discussed in the following paragraphs:

1. The relevance of the methodology for selecting SSCs that will be subject to ITAAC and the criteria for establishing the necessary and sufficient ITAAC should be considered from the perspective of each type of system within the scope of DC or COL applications. The accepted methodology should be applied consistently to all systems in the scope.

2. Key functions and performance requirements should be identified as a basis for identifying SSCs that should be within the scope of the ITAAC.

3. To confirm that I&C functions have been constructed in accordance with NRC rules and regulations, the ITAAC as a whole should address each regulatory requirement. The reviewer should understand the basis for any exceptions to this principle.

4. ITAAC should be consistent with the more complete description of the basis for plant safety.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified DSRS acceptance criteria. For deviations from these specific acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

1. Follow the General Review Procedures of SRP Section 14.3. Assure that the Tier 1 material and ITAAC design descriptions are consistent with SRP Section 14.3, Appendix A.

2. Assure that Tier 1 information is consistent with DCD Tier 2 information. Figures and diagrams should be reviewed to assure that they accurately depict the functional arrangement and requirements of the systems. The reviewer should use the requirements listed in DSRS Chapter 7 as an aid in establishing consistent and comprehensive treatment of issues.

   In general, each design commitment made to fulfill the technical requirements of 10 CFR Part 50 identified in DSRS Chapter 7 should be included or provide justification with the technical basis for omission. It is permissible to develop general bases (e.g., selection criteria) that provide the basis for multiple omissions.

   Note that it is not necessary that the ITAAC explicitly verify each regulatory requirement. In some cases, commitments to design features may address one or more regulatory requirements, and consequently the ITAAC verifies the associated requirement by verifying proper implementation of the design feature. For example, a DC application may commit to a specific protection system architecture and demonstrate that the architectural arrangement of functional blocks, channels, and divisions is sufficient to assure compliance with the single failure criterion. Thus, ITAAC that confirm that the functional arrangement of the as-built protection system is as described in the design description provides reasonable assurance that system meets the single-failure criterion. The reviewer should be certain to understand these relationships, but it is not necessary that the ITAAC or referenced Design Descriptions explicitly describe them.

3. Assure that the I&C systems are clearly described in design descriptions and ITAAC design commitments. For safety systems, this should include a description of system purpose, safety functions, equipment quality, equipment qualification, automatic decision-making and trip logic functions, manual initiation functions, and design features (e.g., system architecture) provided to achieve high functional reliability. The functions

and characteristics of other I&C systems important to safety should also be discussed to the extent that the functions and characteristics are necessary to support remote shutdown, support required operator actions or assessment of plant conditions or safety system performance, maintain safety systems in a state that assures their availability during an accident, minimize or mitigate control system failures that would interfere with or cause unnecessary challenges to safety systems, or provide diverse back-up to protection systems.

4. The reviewer should assure that appropriate guidance is provided to other organizations such that I&C issues in the ITAAC and associated design descriptions are treated in a consistent manner among organizations.

5. The reviewer should assure that the standard ITAAC entries in SRP Section 14.3, Appendix D related to I&C items, are included in the appropriate systems of the standard design. In particular, the reviewer should assure consistent application and treatment of the standard ITAAC entries for basic configuration ITAAC (environmental qualification aspects) and independence for electrical and I&C systems.

6. The reviewer should assure that design features from the resolutions of selected technical and policy issues for the design are adequately addressed in Tier 1 material, ITAAC design descriptions, or ITAAC references to the application, based on safety significance. Assure that the appropriate NRC guidance, requirements, bases, and resolutions for these items are documented clearly in the safety evaluation report (SER).

7. The staff may designate selected information in Tier 2 of the application that, if considered for a change, requires NRC approval prior to implementation. This information is known as “Tier 2*.” The reviewer should assure that Tier 2* material is identified and that appropriate expiration dates are set.

8. Coordinate with the organization responsible for review of reactor systems to confirm that protective, control, display, and interlock functions are consistent with the accident analysis, the operating requirements of the I&C systems, and the requirements of 10 CFR 50, Appendix A, General Design Criteria (GDC) 10, 15, 28, 33, 34, and 35. I&C system ITAAC confirm that the accepted functions are implemented in the as-built design.

9. Coordinate with the organization responsible for the review of plant systems which evaluates the ITAAC for the auxiliary supporting features and other auxiliary features to demonstrate that they satisfy the applicable acceptance criteria including the operating requirements of the supported system and the requirements of GDC 41 and 44. These features include, for example, compressed (instrument) air, cooling water, boration, lighting, heating, and air conditioning.

10. Coordinate with the organization responsible for the review of containment systems which evaluates the ITAAC for the containment ventilation and atmospheric control systems provided to maintain required environmental conditions for I&C equipment located inside containment.

11. Coordinate with the organization responsible for the review of containment and severe accidents which confirms that protective, control, display, and interlock functions associated with containment systems and severe accidents are consistent with the accident analysis, operating requirements, and GDC 16 and 38. I&C system ITAAC confirm that the accepted functions are implemented in the as-built design.

12. Coordinate with the organization responsible for the review of electrical systems which evaluates the ITAAC demonstrating (1) physical separation for cabling and electrical power equipment, (2) that power is supplied to redundant systems by appropriate redundant sources, and (3) the adequacy of the I&C associated with the proper functioning of the onsite and offsite power systems.

13. Coordinate with the organization responsible for the review of environmental qualification which evaluates the ITAAC relating to environmental qualification of I&C equipment.

14. Coordinate with the organization responsible for the review of seismic qualification which reviews the ITAAC relating to seismic qualification demonstration for I&C equipment.

15. Coordinate with the organization responsible for the review of human-system interfaces which evaluates the ITAAC demonstrating the adequacy of the human factors aspects of the design, such as arrangement and location of I&C equipment, the capabilities of the I&C to support execution of the operating procedures and emergency response guides, and that qualified plant staff and training required to operate I&C equipment have been provided.

16. The reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the application meets the acceptance criteria.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

1. The reviewer verifies that sufficient information has been provided to satisfy SRP Section 14.3 and this DSRS section, and concludes that the ITAAC are acceptable.

2. The findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements) and COL action items relevant to this DSRS section.

V. IMPLEMENTATION

The staff will use this DSRS section in performing safety evaluations of mPower^{TM}-specific design certification (DC), combined license (COL), or early site permit (ESP) applications submitted by applicants pursuant to 10 CFR Part 52. The staff will use the method described herein to evaluate conformance with Commission regulations.

Because of the numerous design differences between the mPower™ and large light-water nuclear reactor power plants, and in accordance with the direction given by the Commission in SRM- COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010 (ML102510405), to develop risk-informed licensing review plans for each of the small modular reactor (SMR) reviews including the associated pre-application activities, the staff has developed the content of this DSRS section as an alternative method for mPower™ -specific DC, COL, or ESP applications submitted pursuant to 10 CFR Part 52 to comply with 10 CFR 52.47(a)(9), "Contents of applications; technical information."

This regulation states, in part, that the application must contain "an evaluation of the standard plant design against the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application." The content of this DSRS section has been accepted as an alternative method for complying with 10 CFR 52.47(a)(9) as long as the mPower™ DCD FSAR does not deviate significantly from the design assumptions made by the NRC staff while preparing this DSRS section. The application must identify and describe all differences between the standard plant design and this DSRS section, and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria. If the design assumptions in the DC application deviate significantly from the DSRS, the staff will use the SRP as specified in 10 CFR 52.47 (a)(9). Alternatively, the staff may revise the DSRS section in order to address new design assumptions. The same approach may be used to meet the requirements of 10 CFR 52.17 (a)(1)(xii) and 10 CFR 52.79 (a)(41), for ESP and COL applications, respectively.

VI. REFERENCES

All of the references in DSRS Section 14.3.5, "Instrumentation and Controls – ITAAC," may be found in Appendix D, of Chapter 7.