U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

BRANCH TECHNICAL POSITION 18-1[1]

GUIDANCE FOR EVALUATING MINIMUM INVENTORY OF ALARMS, CONTROLS, AND DISPLAYS FOR NEW LIGHT WATER REACTOR PLANT DESIGNS

The following Branch Technical Position (BTP) is to be cited as the acceptance criteria for the minimum inventory of controls, displays, and alarms (Standard Review Plan (SRP) Chapter 18, Section II.A.7, second paragraph, item 8) for those standard designs that have not been certified prior to the date of this BTP.

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of human factors engineering (HFE)

Secondary - Organization responsible for the review of instrumentation and controls (I&C)
Organization responsible for the review of probabilistic risk assessment (PRA)
Organization responsible for the review of emergency operating procedure (EOP) technical guidelines

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[1] This BTP supersedes staff guidance on minimum inventory of displays, alarms, and controls, contained in NUREG-0800, Chapter 14, Section 14.3.9, page 14.3.9-5, Appendix C. I.A.vi, second paragraph, first sentence, Appendix C. I.B.v. (March 2007) and Digital Instrumentation and Controls Interim Staff Guidance (DI&C-ISG-05), dated November 3, 2008).

A. BACKGROUND

The concept of minimum inventory originated as part of the U.S. Nuclear Regulatory Commission's (NRC's) general resolution of the level of control room design detail to be provided by design certification (DC) applicants as stated in SECY 92-053, "Use of Design Acceptance Criteria during 10 CFR Part 52 Design Certification Reviews." For the control room design area, the staff developed a two-part approach for reviewing the human system interfaces (HSIs) of a control room design. The first part of the staff's method was to perform a detailed review "to establish the minimum inventory of fixed alarms, displays, and controls, necessary for the operators to implement the EOPs and to carry out those human actions shown to be important from the applicant's PRA. This minimum inventory will be included in the DC."

The second part of the staff's review method included using design acceptance criteria (DAC) to ensure that a systematic approach to incorporate human factors principles was used to complete the design of operator workstations in the control room. The staff viewed this approach as being "similar to the Three Mile Island action plan requirements, for the conduct of a detailed control room design review, with the exception that human factors will be considered in the design development process."

The staff proposed the DAC as a series of inspections, tests, analyses, and acceptance criteria (ITAAC) which are specified in the certified design, but prepared so that they are "phased to the development of a detailed [control room] design and subsequent construction. NRC inspections at key points during detailed design development and construction would confirm adequate implementation of the ITAAC (DAC)."

1. Regulatory Basis

   Title 10 of the *Code of Federal Regulations*, 50.34(f) (10 CFR Part 50.34(f)) requires, in part, that instrumentation be provided in the control room to measure, record, and read out variables for accident monitoring conditions.

   10 CFR 50.55a(h)(3) requires, in part, that applications filed on or after May 13, 1999, for construction permits and operating licenses under 10 CFR Part 50, and for design approvals, DCs, and combined licenses under 10 CFR Part 52, must meet the requirements for safety systems in Institute of Electrical and Electronics Engineers (IEEE) Std. 603-1991 and the correction sheet dated January 30, 1995. IEEE Std. 603-1991 describes minimum functional design criteria acceptable to the NRC staff for the I&C design of safety systems used in nuclear power plants.

   10 CFR Part 50, Appendix A, General Design Criterion (GDC) 13, "Instrumentation and Control" requires, in part, that instrumentation be provided in the control room to monitor variables and systems and controls to maintain the variables within prescribed operating limits.

   10 CFR Part 50, Appendix A, GDC 19, "Control Room" requires, in part, that a control room be provided from which actions can be taken to operate the nuclear power unit safely and that equipment be provided outside the control room with the design

capability for prompt hot shutdown of the reactor and a potential capability for subsequent cold shutdown.

10 CFR Part 52 requires, in part, compliance with technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), including HFE-related items such as control room design.

2. Relevant Guidance

SECY-92-053 discusses, in part, a minimum inventory of fixed alarms, controls, and displays as part of DC.

SECY-93-087 discusses, in part, staff positions on the level of detail issue, defense against common-mode failures using analog or digital backup instrumentation, and the role of the operator in passive plant designs.

Regulatory Guide (RG) 1.97, Revision 4 describes a method acceptable to the NRC staff for providing instrumentation to monitor variables for accident conditions. RG 1.97, Revision 4 endorses IEEE Std. 497-2002.

NUREG-0711, Revision 2 describes a method acceptable to the staff of providing an HFE program to include the development of an inventory of HSIs for the main control room (MCR) and remote shutdown facility (RSF).

SRP Chapter 7 describes, in part, staff guidance for the review of I&C aspects of new plant designs.

SRP Chapter 18 describes, in part, staff guidance for the review of HFE aspects of new plant designs.

SRP Section 19.0 describes, in part, staff guidance for the review of the PRA and severe accident analysis performed for new plant designs.

IEEE Std. 497-2002 describes a method acceptable to the NRC staff for providing instrumentation to monitor variables for accident conditions that are endorsed by the NRC by RG 1.97, Revision 4.

3. Purpose

The purpose of this BTP is to provide guidance to the staff for evaluating a DC applicant's implementation plan and proposed ITAAC for developing a minimum inventory of HSIs for the MCR and RSF.

B. BRANCH TECHNICAL POSITION

1. Introduction

A *minimum inventory* is a set of HSIs (i.e., alarms, controls, and displays) needed to safely shut down the reactor and maintain it in a safe condition. This includes the HSIs in the MCR and, for instances when evacuation of the MCR becomes necessary, the alternative HSIs located outside the MCR (i.e., in the RSF) to ensure the reactor can be shut down safely and maintained in a safe condition.

Since issuing SECY-92-053, the staff has gained additional experience in the DC reviews of new plants. In regard to minimum inventories, the staff currently considers an implementation plan level of detail (comparable to plans prepared for NUREG-0711 elements), combined with appropriate ITAAC (DAC), to be sufficient for the staff to make a finding of reasonable assurance of safety before issuing a DC. The execution of the implementation plan (i.e., the minimum inventory for the MCR and RSF) will be inspected/reviewed by the staff as part of the ITAAC (DAC) closure process. As part of this process, the NRC staff will also inspect the as-built HSIs. This BTP provides the staff with regulatory guidance and acceptance criteria to evaluate an applicant's proposed methodology to develop minimum inventories of HSIs for the MCR and RSF and ensure that the applicant's proposed ITAAC (DAC) will (1) verify that the MCR and RSF minimum inventories were developed according to the implementation plan in the approved DC document and correctly and completely incorporated in the as-built design and (2) validate that the as-built MCR and RSF minimum inventories support operator performance of those EOP actions and PRA critical operator actions necessary to bring the reactor to a safe shutdown condition and maintain it in a safe shutdown condition.

2. Definitions

The MCR minimum inventory is that set of MCR HSIs needed by operators to bring the reactor to a safe shutdown condition and maintain it in a safe shutdown condition.

The RSF minimum inventory is that set of remote shutdown HSIs needed by operators, upon MCR evacuation, to bring the reactor to a safe shutdown condition and maintain it in a safe shutdown condition.

3. Review Information

The information to be reviewed is the applicant's implementation plan for developing the minimum inventory of HSIs for the MCR and RSF and the applicant's proposed ITAAC to verify and validate acceptable implementation of the MCR and RSF minimum inventories.

4. Acceptance Criteria

Applicants for new plant DC should include with the FSAR, Chapter 18, "Human Factors

Engineering" Tier 2* information,[2] an implementation plan to develop the minimum inventory for the MCR and RSF of those HSIs that the operator needs to:

a. perform manual actions credited in the plant's EOPs that are necessary to bring the reactor to a safe shutdown condition and maintain it in a safe shutdown condition

b. perform manual actions determined to be critical by the applicant's PRA and that are needed by operators to bring the reactor to a safe shutdown condition and maintain it in a safe shutdown condition.

The implementation plan should provide the applicant's proposed methodology for meeting the acceptance criteria. It should contain a level of detail sufficient for individuals experienced in the technical disciplines needed to develop a minimum inventory to satisfactorily execute the plan. At a minimum, the implementation plan should include a description of the methodology, and identify the source documents and applicable guidance that the applicant will use to:

- identify those manual actions credited in the plant's EOPs that are necessary to bring the reactor to a safe shutdown condition and maintain it in a safe shutdown condition

- identify those manual actions determined to be critical by the applicant's PRA and that are needed by operators to bring the reactor to a safe shutdown condition and maintain it in a safe shutdown condition

- determine the plant process parameter(s) (e.g., containment pressure, feedwater flow) associated with initiating and carrying out each manual action

- apply the HSI design process (i.e., NUREG-0711, Chapter 8, "Human System Interface Design," NUREG-0700, etc.) to developing the MCR and RSF minimum inventory HSIs

- ensure adequate availability and reliability of the MCR and RSF minimum inventories to support safe shutdown and the ability to maintain safe shutdown.

The implementation plan also should identify the technical qualifications of the individuals responsible for developing the MCR and RSF minimum inventories.

Applicants for new plant DC should include with the FSAR Tier 1 information,[3] ITAAC for both the MCR and RSF minimum inventories. The ITAAC should:

a. verify that the implementation plan methodology contained in the approved DC was correctly used to develop the MCR and RSF minimum inventories

[2] See NUREG-0800, Chapter 14, Section 14.3, for definition of Tier 2* information.
[3] See NUREG-0800, Chapter 14, Section 14.3, for definition of Tier 1 information.

b. verify that the as-built MCR and RSF contain, as a minimum, the HSIs identified through the use of the implementation plan methodology in the approved DC

c. validate that the as-built MCR and RSF minimum inventories support operator performance of those EOP actions and PRA critical operator actions necessary to bring the reactor to a safe shutdown condition and maintain it in a safe shutdown condition.

5. Review Procedures

The staff's review and approval of the implementation plan and associated ITAAC for the MCR and RSF minimum inventories of HSIs will be multi-disciplinary. To determine the acceptability of the implementation plan, the staff should use, at a minimum, the following:

- guidance applicable to determining the acceptability of the methodology that will be used to identify the EOP operator actions that will be necessary to safely shutdown the reactor and maintain it in a safe shutdown condition (e.g., generic or design-specific technical guidelines and bases documents; EOPs, or system design descriptions for transient and accident mitigation; NUREG-0800, Chapter 13; NUREG-0899)

- guidance applicable to determining the acceptability of the methodology that will be used to identify the critical operator actions in the applicant's Level 1 and Level 2 PRA results (considering all modeled initiating events and operating modes) that will be necessary to safely shutdown the reactor and maintain it in a safe shutdown condition (e.g., NUREG-0800, Chapter 19)

- guidance applicable to determining acceptability of the methodology that will be used to determine which plant process parameters will be included in the MCR and RSF minimum inventories to support the operator actions necessary to safely shutdown the reactor and maintain it in a safe shutdown condition (e.g., NUREG-0800, Chapter 7, BTP 7-10; RG 1.97, Revision 4; SECY-93-087)

- guidance applicable to determining the acceptability of the methodology that will be used for the selection and design of HSIs that will be included by the applicant in the MCR and RSF minimum inventories (e.g., NUREG-0800, Chapter 18; NUREG-0700)

- guidance applicable to determining the acceptability of the methodology that will be used to ensure adequate availability and reliability of the MCR and RSF minimum inventories (e.g., NUREG-0800, Appendix 7-C; IEEE Std. 603-1991; NUREG-0800, BTP 7-10; RG 1.97, Revision 4; NUREG-0800, Section 17.4).

To determine the acceptability of the applicant's proposed ITAAC, the staff should use, as a minimum, applicable guidance in NUREG-0711, Chapter 11, "Human Factors Verification and Validation," to review the proposed ITAAC and verify that they will be adequate to:

a. verify that the implementation plan methodology contained in the approved DC was correctly used to develop the minimum MCR and RSF minimum inventories

b. verify that the as-built MCR and RSF contain, as a minimum, the HSIs identified through the use of the implementation plan methodology in the approved DC

c. validate that the as-built MCR and RSF minimum inventories support operator performance of those EOP actions and PRA critical operator actions necessary to bring the reactor to a safe shutdown condition and maintain it in a safe shutdown condition.

The staff should coordinate its review with the organization responsible for review of I&C to ensure that adequate availability and reliability of the MCR and RSF minimum inventories are verified through reviews conducted in accordance with SRP Section 14.3.5.

C. REFERENCES

1. NRC (2006), "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," RG 1.97, Revision 4, Washington, D.C.

2. NRC (2004), "Human Factors Engineering Program Review Model," NUREG-0711, Revision 2, Washington, D.C.

3. NRC (1992), "Use of Design Acceptance Criteria during 10 CFR Part 52 Design Certification Process," SECY-92-053, Washington, D.C.

4. IEEE (1991), "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations," IEEE Std. 603-1991, New York.

5. NRC (2002), "Human-System Interface Design Review Guideline," NUREG-0700, Revision 2, Washington, D.C.

6. NRC (1993), "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," SECY-93-087.

7. IEEE (2002), "IEEE Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations," IEEE Std. 497-2002, New York.

8. NRC (1982), "Guidelines for the Preparation of Emergency Operating Procedures," NUREG-0899, Washington, D.C.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

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