U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 7.5 SAFETY-RELATED DISPLAY INSTRUMENTATION

REVIEW RESPONSIBILITIES

Primary - Electrical, Instrumentation and Control Systems Branch (EICSB)

Secondary - Reactor Systems Branch (RSB)
Core Performance Branch (CPB)
Auxiliary and Power Conversion Systems Branch (APCSB)
Mechanical Engineering Branch (MEB)
Quality Assurance Branch (QAB)
Containment Systems Branch (CSB)

I. AREAS OF REVIEW

Information presented in the applicant's safety analysis report (SAR) is reviewed by the staff to determine that the design of safety-related display instrumentation (SRDI) required for safe functioning of the plant during operating and accident conditions is in conformance with applicable regulations, guides, branch technical positions, and industry standards and is consistent with the accident analysis assumptions of Chapter 15 of the SAR. For construction permit (CP) applications, the applicant's descriptive information for the SRDI should include commitments to meet applicable requirements and should present full justification for any exceptions taken.

For operating license (OL) reviews, the information presented should include the following:

1. Tables of system variables and components to be indicated and recorded (including accuracies and ranges of instruments).

2. Functional control diagrams or other means of illustrating the redundancy of monitored variable and component sensors and channels, the capability for sensor checks, and the means for verifying operability of monitoring system channels.

3. Electrical distribution diagrams illustrating electrical isolation of redundant sensors and channels.

4. Physical layout drawings illustrating separation of redundant indicating instruments.

5. Component and module quality and performance documentation, with particular emphasis on equipment used for post-accident monitoring.

6. Descriptions of the means for identifying redundant elements (such as cable, cable tray, component, module, and interconnecting wiring identifications).

7. Schematic and control panel display diagrams illustrating system level automatic bypass indication for deliberately bypassed safety-related components or systems.

Other EICSB areas of review associated with SRDI systems that are covered elsewhere are as follows:

1. Environmental design and qualification testing of electrical equipment are addressed in Standard Review Plan 3.11.

2. Technical specification requirements imposed upon the operation of the SRDI are discussed in Standard Review Plan 7.1.

The RSB identifies any changes or corrections to the listing of engineered safety feature and reactor coolant system variables and components that require indication, by examining the tables of SAR Section 7.5 that describe the information display (including accuracy and range requirements of indicating instrumentation) required by the operator to perform manual safety functions. The CPB identifies any changes or corrections to the listing of reactor variables that require indication, and the APCSB identifies "balance of plant" variables and components that require indication and, where necessary, states the required locations of the indicators.

The MEB reviews, in SAR Section 3.10, the criteria for seismic qualification and the test and analysis procedures and methods to assure the operability of the SRDI.

The QAB reviews, in SAR Chapter 17, the quality assurance procedures to be used by the applicant in the design, construction, installation, and maintenance of the SRDI.

II. ACCEPTANCE CRITERIA

The safety related display instrumentation design is acceptable when it can be concluded that it conforms to the criteria listed in Table 7-1 and that the operator will be provided with sufficient information to perform required manual safety functions should such action be necessary. Specific points with regard to these criteria are detailed below.

1. The SRDI should cover appropriate variables, consistent with the assumptions for accident analyses and with the information needs of the operators in normal, transient, and accident conditions. The design of the SRDI should conform to the recommendations of Branch Technical Position EICSB 23. The accuracy and range of indicating instrumentation should be consistent with the assumptions of the accident analyses. Any exceptions to these requirements will be referred to the appropriate branch for resolution on an individual case basis.

2. All monitoring channels should be redundant, to assure that wrong indication due to device malfunction will not cause false action or inaction on the part of the operator. Identification malfunctions can be identified by cross checking between redundant channels.

3. Redundant channels of indicating instrumentation should be isolated physically and electrically to assure that a single failure will not result in complete loss of information about a monitored variable. Single failures might include such possible faults as shorting or opening circuits or interconnecting signal or power cables. It also includes single credible malfunctions or events that might cause a number of subsequent component, module, or channel failures. The post-accident SRDI should be capable of operating from onsite power. If signals from the post-accident monitoring equipment are used for control, the required isolation devices will be classified as part of the post-accident monitoring instrumentation. No credible failure at the output of an isolation device should prevent the associated monitoring channel from meeting minimum performance requirements considered in the design bases.

4. Capability should be provided for checking, with a high degree of confidence, the operational availability of each system input sensor during reactor operation. An acceptable way of accomplishing this would be by:
   a. Perturbating the monitored variable and observing the resulting indications.
   b. Introducing and varying a substitute input to the sensor of the same nature as the measured variable.
   c. Cross checking between channels that bear a known relationship to each other and that have readouts available.

   For channels which monitor a normally static parameter, provisions should be made to allow periodic testing in accordance with Regulatory Guide 1.22, thereby verifying channel operability.

5. An indication system should be provided covering bypassed or deliberately inoperable conditions of safety systems. Guidelines for the indication system are provided in Regulatory Guide 1.47 and Branch Technical Position EICSB 21.

6. Cables, cable trays, components, modules, and interconnecting wiring should be identified. The method used for identification and the scheme used to distinguish between redundant cables, cable trays, components, modules, and interconnecting wiring are acceptable if they are in accordance with the recommendations of Regulatory Guide 1.75.

7. Components and modules should be of a quality consistent with the reliability requirements for safety-related systems. An acceptable quality would be that of components and modules that have been previously used in similar service conditions and have demonstrated low maintenance requirements and failure rates. Other means to demonstrate acceptable quality would be through analysis and testing of components and modules, in accordance with criteria cited in Table 7-1.

8. In order to assure that the requirements of General Design Criterion 1, "Quality Standards and Records," are met in the SRDI, the quality assurance program must satisfy the requirements of IEEE Std 336-1971, as amplified by Regulatory Guide 1.30.

9. For those areas of review identified in Section I of this plan as being the responsibility of other branches, the acceptance criteria are included in the applicable sections of the review plans of those branches.

III. REVIEW PROCEDURES

The objectives in the review of the SRDI are to determine that the plant display instrumentation is designed, constructed, and installed in accordance with the design criteria outlined in Section II of this plan. In the CP review, the descriptive information, including the design bases and their relation to the criteria, preliminary analyses, piping and instrumentation diagrams (P&ID's), functional control diagrams, preliminary electrical diagrams, and preliminary physical arrangement drawings are examined to determine that there is reasonable assurance that the final implementation will meet all criteria. At the OL stage, the objectives are verified by review of the tables of variables and components to be monitored, indicated, and recorded; functional control diagrams, P&ID's, and electrical distribution diagrams; physical layout drawings; component and module quality considerations; the identification scheme for redundant systems; and the procedures for maintenance and checking of the availability of each system.

In certain instances, it will be the reviewer's judgement that for a specific case under review, emphasis should be placed on specific aspects of the design, while other aspects of the design need not receive the same emphasis and in-depth review. Typical reasons for such a non-uniform placement of emphasis are the introduction of new design features or the utilization in the design of design features previously reviewed and found acceptable.

The review steps are as follows:

1. Based on information provided by the RSB, CPB, CSB, and APCSB with regard to variables that need to be monitored and on Branch Technical Position EICSB 21 the list of monitored variables (if available) in the SAR is checked for sufficiency. In addition, the accuracy and range of the monitors are checked against the plant accident analyses as noted in II.1, above.

2. Functional control diagrams and P&ID's are reviewed to establish that the redundancy is sufficient, so that false indication due to malfunction of an indicating device should not lead to an undesirable manual action. In reviewing the P&ID's, the reviewer verifies that redundant sensors for each monitored variable are identified. After establishing sensor redundancy, the functional control diagrams are reviewed to ascertain that redundancy is maintained through the system logic down to the indicating devices.

3. Since independence from offsite power is required for post-accident SRDI, emphasis is placed on the electrical distribution system supplying power to post-accident SRDI.

Electrical distribution diagrams are reviewed to establish that redundant instrument channels are supplied from redundant electrical distribution channels of the emergency power supply. In addition, electrical schematic diagrams (as appropriate) are reviewed to ascertain that there is no interconnecting wiring between redundant channels whose failure (open or short circuit) could cause the simultaneous loss of redundant channels. Also, through the schematic diagrams, the reviewer ascertains that devices that isolate signals used for both safety indication and control are properly identified as part of the safety system and that a failure at the output of the isolation device does not prevent the associated monitoring channel from performing its safety function. Qualification of isolation devices is covered in the review of Sections 3.10 and 3.11 of the SAR.

4. Physical layout drawings (such as control room panel layouts, local panel layouts, sensor locations, instrument cabinet layout drawings, penetration drawings, and cable routing drawings) are reviewed to establish that physical independence is maintained between redundant channels of the SRDI. The control room panel layout drawings are examined to determine that the minimum separation distance between redundant equipment and circuits internal to the control boards is in accordance with Section 5.6 of Regulatory Guide 1.75. Local panel layout drawings are examined on the same basis. Sensor location drawings are examined to determine that the connections to the process system are sufficiently separated, in accordance with Section 5.8 of Regulatory Guide 1.75, to assure functional capability despite any single design basis event. The separation recommendations of Section 5.6 of this guide also apply to instrument cabinets (the layout drawings are examined to determine that the minimum separation distance between redundant equipment and circuits internal to the cabinets is provided). The procedure for review of penetration drawings and cable routing drawings is discussed in SRP 8.3.

5. With regard to the quality of components, there are at present no specific criteria to judge the quality of equipment used in the SRDI. However, Appendix B to 10 CFR Part 50 provides some guidance from which a judgment may be made of the quality of equipment required for the SRDI.

6. The procedure for reviewing the identification scheme proposed by the applicant to distinguisn between redundant reactor protection system elements (including SRDI) is described in SRP 7.3.

7. The applicant's final design and installation of the SRDI is examined (schematic diagrams, wiring diagrams, installation drawings, etc.) to determine that the system includes the capability of periodic tests or checks to assure availability during operation.

IV. EVALUATION FINDINGS

The reviewer confirms that sufficient information has been provided and the review supports conclusions of the following type, to be included in the staff's safety evaluation report:

"The safety-related display instrumentation provides the operator with information on the status of the plant to allow manual safety actions to be performed whenever necessary. The scope of review of safety-related display instrumentation included tables of system variables and component states to be indicated, functional control diagrams (CP and OL), electrical and physical layout drawings (OL), and descriptive information. The review has included the applicant's proposed design criteria and design bases, including that for indication of bypassed or inoperable safety-related systems. The review also has included the applicant's analyses of the manner in which the design of safety-related display instrumentation conforms to the proposed design criteria.

"The basis for acceptance in the staff review has been conformance of the applicant's designs, design criteria, and design bases for safety-related display instrumentation to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, branch technical positions, and industry standards. These are listed in Table 7-1.

"The staff concludes that the design of safety-related display instrumentation for the _____ plant conforms to applicable regulations, guides, technical positions, and industry standards and is acceptable."

V. REFERENCES

1. Standard Review Plan Table 7-1, "Acceptance Criteria for Controls."

2. Standard Review Plan Appendix 7-A, "Branch Technical Positions (EICSB)."

SRP 7.6