U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

9.3.1 COMPRESSED AIR SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - None

I. AREAS OF REVIEW

The compressed air system (CAS) provides air to safety-related equipment and also to plant equipment used only for normal facility operation. ASB reviews the entire compressed air system since there may be cases where two systems or subsystems are provided, i.e., a safety-related compressed air system (SRCAS), and a station service system for nonsafety-related equipment. If the two systems are interconnected, then the area of review will extend from the safety-related portion to the outermost isolation valve on all interconnections between the two systems. If the systems are not connected, then the review will be limited to the SRCAS. The ASB reviews the SRCAS to ensure conformance with the requirements of General Design Criteria 1, 2, and 5.

1. ASB reviews the systems to identify the safety-related air-operated devices that are supplied by the system and whether each requires a source of supply air in order to perform the safety-related function.

2. ASB then reviews the systems to determine that a failure of a component or the loss of a compressed air source does not negate functioning of a safety-related system.

3. The ASB reviews the system to determine that the effects of failure of non-seismic Category I equipment or components will not affect the functioning of the SRCAS.

4. ASB reviews the design of the SRCAS with respect to the following:

   a. Capability to isolate portions or components of the system in case of component malfunction.

b. Instrumentation and control features provided to determine and verify that the system is operating in a correct mode (e.g., valve position indication, pressure).

c. Capability of the system to function in the event of adverse environmental phenomena, abnormal operational requirements, or accident conditions such as a loss-of-coolant accident (LOCA) or main steam line break concurrent with loss of offsite power.

d. Capability of the system to supply clean, dry, oil-free instrument air.

5. ASB also performs the following reviews under the SRP sections indicated:

a. Review of flood protection is performed under SRP Section 3.4.1,

b. Review of the protection against internally generated missiles is performed under SRP Section 3.5.1.1,

c. Review of the structures, systems, and components to be protected against externally generated missiles is performed under SRP Section 3.5.2, and

d. Review of high- and moderate-energy pipe breaks is performed under SRP Section 3.6.1.

In addition, the ASB will coordinate other branches' evaluations that interface with the overall review of the system as follows: The Structural Engineering Branch (SEB) will determine the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles as part of its primary review responsibility for SRP Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1 through 3.7.4, 3.8.4 and 3.8.5. The Mechanical Engineering Branch (MEB) determines that the components, piping, and structures are designed in accordance with applicable codes and standards as part of its primary review responsibility for SRP Sections 3.9.1 through 3.9.3. The MEB also determines the acceptability of the seismic and quality group classifications for system components as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2. The MEB also reviews the adequacy of the inservice testing program of pumps and valves as part of their primary review responsibility for SRP Section 3.9.6. The Materials Engineering Branch (MTEB) verifies that inservice inspection requirements are met for system components as part of its primary review responsibility for SRP Section 6.6 and, upon request, verifies the compatibility of the materials of construction with service conditions. The Instrumentation and Control Systems Branch (ICSB) and the Power Systems Branch (PSB) will determine the adequacy of the design, installation, inspection, and testing of all essential electrical components, system controls, and instrumentation as part of their primary review responsibility for SRP Sections 7.1 and 8.1, respectively. The Equipment Qualifications Branch (EQB) reviews the seismic qualification of Category I instrumentation and electrical equipment and the environmental qualification of mechanical and electrical equipment as part of its primary review responsibility for SRP Sections 3.10 and 3.11, respectively. The review for Fire Protection, Technical Specification, and Quality Assurance are coordinated and

performed by the Chemical Engineering Branch, Licensing Guidance Branch, and Quality Assurance Branch as part of their primary review responsibility for SRP Sections 9.5.1, 16.0, and 17.0, respectively.

For those areas of review identified above as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections identified as the primary review responsibility of those branches.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the safety-related compressed air system, as described in the applicant's Safety Analysis Report (SAR), is based on specific general design criteria and regulatory guides. The design of the SRCAS is acceptable if the integrated design of the system is in accordance with the following criteria:

1. General Design Criterion 1, as related to systems and components important to safety being designed, fabricated, and tested to quality standards commensurate with the importance of the safety functions to be performed. Acceptance is based on meeting ANSI MC 11.1-1976 (ISA S7.3), as related to minimum instrument air quality standards, meeting the guidance of Regulatory Guide 1.68.3 as related to testing of instrument air system.

2. General Design Criterion 2, as related to the safety-related compressed air system being capable of withstanding the effects of earthquakes. Acceptance is based on meeting the guidance of Regulatory Guide 1.29, Position C-1, if any portion is deemed to be safety-related, and Position C-2, for nonsafety-related functions.

3. General Design Criterion 5, as related to the capability of shared systems and components important to safety to perform required safety functions.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the recommendations and requirements given in subsection II of this SRP section. For operating license (OL) reviews, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The procedures for OL reviews include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

Upon request from the primary reviewer, the coordinating review branches will provide input for the areas of review stated in subsection I of this SRP section. The primary reviewer obtains and uses such input as required to ensure that this review procedure is complete.

As a result of various CAS designs provided for different plants, there will be variations in system requirements. For the purpose of this SRP section, a typical system is assumed that has two independent systems, the plant service air system and a safety-related compressed air system (SRCAS). For cases where there are variations from this arrangement, the reviewer adjusts the review procedures given below. However, the system design would be required to meet the recommendations and requirements in subsection II of this SRP section. The reviewer will select and emphasize material from this SRP section as appropriate for a particular case.

1. The SAR is reviewed to identify from information in the system description section and the piping and instrumentation diagrams (P&IDs) the SRCAS equipment used for normal operation and for safety feature operation. The reviewer determines that the systems affected by the loss of offsite power and subsequent loss of air supply will fail in a safe position.

2. The system P&IDs, layout drawings, and component descriptions and characteristics are reviewed to determine the following:

   a. Essential portions of the SRCAS are correctly identified and are isolable from the nonessential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical division between each portion. System drawings are also reviewed to verify that they show the means for accomplishing isolation and the system description is reviewed to identify minimum performance requirements of the isolation valves. For the typical system, the drawings and descriptions are reviewed to verify that two automatically operated isolation valves in series separate the nonessential from the essential portions and components.

   b. Essential portions of the SRCAS, including the isolation valves separating essential from nonessential portions, are classified Quality Group C and seismic Category I. Component and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed by the ASB to verify that the above classifications have been included, and that the P&IDs indicate points of change in any design classification. The review for seismic design is performed by the SEB and the review for seismic and quality classification is performed by the MEB as indicated in subsection I of this SRP section.

   The SRCAS is reviewed to verify the system meets ANSI MC 11.1-1976, (ISA-S7.3):

   1. The dew point at line pressure for outdoor installations (where any part of the instrument air system is exposed to the outdoor atmosphere) shall be at least 10°C (18°F) below the minimum local recorded ambient temperature at the plant site. The dew point at line pressure for indoor installations (where the entire instrument air system is installed indoors) shall be at least 10°C (18°F) below the minimum temperature to which any part of the instrument air system is exposed at any season of the year. In no case should the dew point at line pressure for indoor installation exceed 2°C (approximately 35°F).

2. The maximum particle size in the air stream at the instrument shall be three (3) micrometers.

3. The maximum total oil or hydrocarbon content, exclusive of noncondensables, shall be as close to zero (0) w/w or v/v as possible; and under no circumstances shall it exceed one (1) ppm w/w or v/v under normal operating conditions.

4. The instrument air shall be free of all corrosive contaminants and hazardous gases, flammable or toxic, which may be drawn into the instrument airstream. A regular periodic check should be made to assure high quality instrument air.

An acceptable SRCAS consists of non-oil lubricated (dry) compressors and automatic molecular sieve air dryers with input and output filters.

3. The reviewer verifies that the system has been designed so that system function will be maintained, as required, in the event of adverse environmental phenomena, certain pipe breaks, or a loss of offsite power. The reviewer evaluates the system using engineering judgment and the results of failure modes and effects analyses to determine that:

   a. The failure of nonessential portions of the system or of other systems not designed to seismic Category I standards and located close to essential portions of the SRCAS, or of nonseismic Category I structures that house, support, or are close to the SRCAS, will not preclude operation of the essential portions of the SRCAS. Statements in the SAR to the effect that the above conditions are met are acceptable.

   b. The essential portions of the SRCAS are protected from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles. The location and the design of the system, structures, or cubicles are reviewed to determine that the degree of protection is adequate. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected, or that components of the system will be located in individual cubicles or rooms that will withstand the effects of tornado winds, flooding, and missiles is acceptable. The details of this portion of the review are contained in the Chapter 3 SRP sections.

   c. An adequate SRCAS air supply source is available, considering the loss of offsite power. If the minimum performance requirements stated in the SAR are met, the system design will be acceptable assuming a concurrent failure of a single active component, including an emergency power source. Statements in the SAR and the results of failure modes and effects analyses are considered to ensure that the system meets these requirements. These will be acceptable verification of system functional reliability.

4. The descriptive information, P&IDs, SRCAS drawings, and failure modes and effects analyses in the SAR are reviewed to ensure that the SRCAS portion of the compressed air system will function following design basis accidents assuming a concurrent single active failure. The reviewer evaluates the information presented in the SAR to determine the ability of required components to function, traces the availability of these components on

system drawings, and checks that the SAR contains verification that minimum compressed air flow requirements are met for each degraded situation for the required time spans. For each case the design will be acceptable if minimum system requirements are met.

5. The reviewer verifies that an adequate maintenance and periodic testing program is planned to ensure continuous reliable functioning of SRCAS.

IV. EVALUATION FINDINGS

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

The compressed air system includes all components and piping and the points of connection or interfaces with other systems. The safety-related compressed air system requires a continuous air supply to safety-related components and is classified seismic Category I and Quality Group C.

The basis for acceptance in the staff review has been conformance of the applicant's design and design criteria for the safety-related compressed air system to the Commission's regulation as set forth in the general design criteria, and to applicable regulatory guides, staff technical positions, and industry standards.

The staff concludes that the design of the compressed air system is acceptable and conforms to the requirements of General Design Criteria 1, 2, and 5 with respect to quality standards, seismic design, and sharing of systems and components. This conclusion is based on the following:

1. The applicant has met the requirements of General Design Criterion 1 with respect to quality standards by meeting ANSI MC 11.1-1976 (ISA S7.3) as related to minimum instrument air quality standards and meeting Regulatory Guide 1.68.3 as related to testing of instrument air systems.

2. The applicant has met the requirements of General Design Criterion 2 with respect to seismic design by meeting Regulatory Position C-1 or C-2 in Regulatory Guide 1.29.

3. The applicant has met the requirements of General Design Criterion 5 with respect to the capability of shared systems and components important to safety to perform required safety functions since a failure in the system will not impair the system's safety function for either unit.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guide.

VI. REFERENCES

1. General Design Criterion 1, "Quality Standards and Records," of Appendix A to 10 CFR Part 50.

2. General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," of Appendix A to 10 CFR Part 50.

3. General Design Criterion 5, "Sharing of Structures, Systems, and Components," of Appendix A to 10 CFR Part 50.

4. Regulatory Guide 1.29, "Seismic Design Classification."

5. ANSI MC 11.1-1976 (ISA-S7.3), "Quality Standard for Instrument Air."

6. Regulatory Guide 1.68.3, "Preoperational Testing of Instrument Air Systems" (formerly Regulatory Guide 1.80).