NUREG/CR-6752
INEEL/EXT-01-01127

A Comparative Analysis of Special Treatment Requirements for Systems, Structures, and Components (SSCs) of Nuclear Power Plants With Commercial Requirements of Non-Nuclear Power Plants

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Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

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Manuscript Completed: September 2001
Date Published: January 2002

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NRC Job Code J2828

ABSTRACT

This report describes a comparative analysis between the special treatment requirements applied to systems, structures, and components in nuclear power plants and commercial requirements applied to systems, structures, and components in non-nuclear power plants. This comparative analysis focused on the practices applied to systems, structures, and components in nonsafety related applications (balance-of-plant) at nuclear plants with additional information on non-nuclear power facilities. Site visit information, other nuclear power plant information, and regulatory documents were used to perform a critical process evaluation. The typical life cycle of nuclear systems, structures, and components was divided into four critical stages, and the processes affecting each of these stages were identified. The critical attributes of each of these processes were then identified so that the differences between nuclear and balance-of-plant approaches could be studied. Evaluations characterized any significant differences between the nuclear processes, attributes, and special treatment rules (applicable codes and standards) and the corresponding nuclear balance-of-plant, or commercial processes, attributes, and applicable codes and standards as they relate to providing reasonable confidence of component functionality. Component specific commercial codes and standards were reviewed for 33 different components that are typically required to comply with special treatment rules. The conclusions obtained during this project were divided into three categories: State and Federal Requirements Commercial Practice; Differences in Special Treatment Rules and Commercial Practices; and Use of Commercial Codes, Standards, and Practices for RISC-3 Systems, Structures, and Components. One conclusion states that commercial standards by themselves are not adequate to provide reasonable confidence of functionality; however, using a combination of detailed engineering specifications, plant processes and procedures, and multilevel quality assurance programs that augment commercial requirements, but provide less rigor than that described in Code of Federal Regulation 10 Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," might be a potential way to establish reasonable confidence of functionality.

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EXECUTIVE SUMMARY

The Nuclear Regulatory Commission (NRC) has recommended that risk-informed approaches to the application of special treatment rules, such as those addressing quality assurance, codes and standards, seismic events, environmental qualification, environmental conditions, and natural phenomena, be developed. One option is to change the regulatory scope for systems, structures, and components (SSCs) needing special treatment. This option would not change the design bases for a plant or the design-basis accidents that establish the design conditions for SSCs. Safety-related SSCs that are of low safety significance would move from special treatment to normal industrial (or commercial grade) treatment. They would still be expected to perform their design function, but without the additional margin, assurance, or documentation currently required for safety-related SSCs.

This report provides a comparative analysis between the special treatment rules applied to SSCs in nuclear power plants and commercial requirements applied in non-nuclear power plants, or nuclear balance-of-plant (BOP), or both in an effort to understand the extent to which commercial processes and requirements assure safety-related but low safety significant SSCs will perform their design functions.

Information contained in this report was gathered during visits to two nuclear utilities, one architect/engineering firm, and two component manufacturers, and through review of commercial codes and standards. Contacted personnel typically included procurement managers, quality assurance managers, plant operators, and maintenance engineers. During utility and vendor visits, all phases of the SSC life cycle were discussed including component design, manufacture, installation, and operation. A review of commonly available commercial component codes and standards was performed to determine if they addressed the special treatment rules.

Nuclear power plant documents were used to develop a list of processes and attributes that are affected by special treatment rules. The typical SSC life cycle was subdivided into four stages: design, procurement, installation, and operation. These SSC life-cycle stages were used and typical nuclear power plant activities were reviewed to establish the list of processes. Attributes were identified and assigned to the appropriate SSC life-cycle stage under the applicable process. Processes and attributes were categorized as either critical or noncritical based on expert opinion. Processes and attributes that were judged to have a significant effect on component functionality were categorized as critical. It was found that applying the definition of a critical process or attribute (those requirements that are individually or jointly necessary to reasonably ensure functionality of a SSC) is difficult because it is easy to think of a scenario or example where each process and attribute is necessary to assure functionality.

Evaluations were performed to characterize any significant differences between the nuclear processes, attributes, and special treatment rules (applicable codes and standards) and the corresponding nuclear BOP, or commercial processes, attributes, and applicable codes and standards, or both as they relate to providing reasonable confidence of a component's functionality. Component

specific commercial codes and standards were reviewed for 33 different components that are typically required to comply with special treatment rules. The codes and standards were obtained from discussions with vendors, standard specifications, and the knowledge and experience of the authors. The most applicable codes and standards for the individual components were selected. Many of them referenced other codes and standards, but it was beyond the scope of this work to review all of these referenced codes and standards.

Conclusions

State and Federal Requirements

1. There are few actual commercial requirements to cover BOP equipment and processes. Most importantly, state laws (with the exception of South Carolina) require the use of the American Society of Mechanical Engineers (ASME) Code for boilers and pressure vessels (e.g., B31.1, Section I, or Section VIII), and other pressure boundary equipment.

2. Most Western states dictate the use of the Uniform Building Code that requires seismic analysis. Eastern states use the National Building Code, while Southern states use the Standard Building Code. These national building codes typically require some seismic analysis and could potentially provide an alternative for the seismic special treatment rules. However, use of these codes may result in a change to the design basis of the plant.

3. Most requirements and processes for BOP equipment are not implemented by state or federal law. Nuclear utilities visited typically apply commercially available standards and make limited use of their own nuclear processes and manufacturers' recommendations to cover the BOP equipment. However, the authors note that these BOP practices may vary from plant to plant and should not be construed as equivalent to processes applied to safety-related components.

4. There are no BOP equipment requirements for a quality assurance program, although ASME Code Sections I and VIII state quality requirements for boilers and pressure vessels, and external piping for boilers and pressure vessels. Some engineering firms and equipment manufacturers use International Organization for Standardization (ISO) 9001 as a quality assurance program basis for BOP equipment. As with all commercial standards not imposed by local and state laws or ordinances, compliance with ISO 9001 is voluntary. Use of this standard is not universal in the commercial industry and its implementation has been found to vary due to the variety of organizations responsible for certifying ISO 9001 programs.

5. Standards for manufacturing valves (e.g., ASME B16.34) are not required to be used as long as the valves are used within the specified pressure-temperature ratings (see B31.1, Section 107). However, some BOP equipment manufacturers commonly use these standards.

Commercial Practice

1. Commercial practice varies widely from almost no processes for some industries to a higher quality of processes similar to, but not nearly as rigorous as those for nuclear safety-related equipment.

2. Since state or federal law does not cover most processes for BOP equipment, utilities use commercially available standards and/or their own procedures and practices to cover many of the processes. Consequently, the processes may vary widely from plant to plant.

3. There are no recommendations for BOP motor-operated valve (MOV) qualifications that correspond to the recommendations contained in Generic Letter (GL) 89-10 and GL 96-05. Therefore, typical commercial practices do not focus on demonstration of MOV functionality under worst-case conditions and are not concerned with identifying MOV-related performance degradations that may affect the acceptability of established control switch settings.

4. To minimize confusion, the two visited nuclear utilities prefer to use many of the nuclear processes for BOP equipment. These utilities preferred not to introduce additional procedures or processes.

5. San Onofre Nuclear Generating Station and Commonwealth Edison personnel indicated that plant processes developed from a quality assurance program in 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," are selectively used for some BOP equipment. The BOP processes are primarily driven by economic concerns, and therefore are typically less rigorous than those required for nuclear safety-related processes. For example, one utility used its plant modification control process to replace an office building HVAC unit. Clearly the controls on this replacement would be less than those used for a nuclear safety-related SSC, but greater than what would be required in the commercial world.

Differences in Special Treatment Rules and Commercial Practice

1. For the majority of the components evaluated there were significant differences in the commercial standards and the special treatment rules. Many of the commercial standards do not require a Quality Assurance program and were not developed to consider all of the life-cycle stages of an SSC. The standards were narrowly focused on one process such as design.

2. Many of the commercial standards focused on design requirements, manufacturing, or testing. Although the requirements are often different, there seemed to be little difference in providing reasonable confidence of functionality between commercial standards requirements and the special treatment rules for these processes. This does not mean that the requirements were the same, that there were no significant physical differences in nuclear and commercial products, or that commercial

standards could be used without plant processes. Even in instances where there were no significant differences in a process, commercial standards may not be adequate and must be supplemented. For example, a commercial standard might adequately require the consideration of design requirements, but specific design conditions must be implemented by a detailed equipment specification.

3. The critical nature of some of the processes and attributes is component specific. For example, functional testing and design verification are much more important for active than for passive SSCs.

Use of Commercial Codes, Standards, and Practices for RISC-3 SSCs

1. Commercial standards by themselves are not adequate to provide reasonable confidence of functionality. Implementing measures that use a combination of detailed engineering specifications, plant processes and procedures, and multilevel QA programs, which provide for less rigor than required by 10 CFR 50, Appendix B, but that augment commercial requirements, might be one potential way to establish reasonable confidence of functionality.

2. Most of the process attributes were evaluated as critical for establishing reasonable confidence of SSC functionality. However, not all special treatment requirements are necessary to achieve reasonable confidence of component functionality. This is especially true for the process attributes that provide confirmation of component functionality, such as the documentation-related process attributes. Many of the special treatment rules are from 10 CFR 50, Appendix B. While some sort of quality program is needed for reasonable confidence of SSC functionality, a full quality assurance program as defined in 10 CFR 50, Appendix B does not seem to be warranted for RISC-3 SSCs.

3. Plant processes will have a significant effect on providing reasonable confidence of functionality of components. Determination of the adequacy of the commercial standards and reduced plant processes would have to be evaluated on a plant-by-plant basis. It was beyond the scope of this project to evaluate the adequacy of BOP processes used by plants.

4. Some utility personnel indicated that a form of commercial dedication for RISC-3 components would be beneficial. They believed that using the original equipment manufacturer and operating history would give reasonable confidence of functionality of replacement parts or SSCs.

5. One critical attribute was the design specification. If this document includes detailed requirements (e.g., functional, environmental, loads, materials, quality, etc.), then it is more likely that the correct product (manufactured according to the design requirements) will be selected. For example, if the design requirements state that a solenoid operated valve (SOV) must function in a radiation environment, then a commercially available SOV (which would probably have major

physical differences from a nuclear SOV, including materials not designed for radiation environments) would not be selected.

6. For the NRC to allow the use of commercial practices to procure RISC-3 replacement SSCs, they would have to rely heavily on the good judgment of nuclear utilities and provide minimum requirements for the processes used. This may result in relatively little documentation or in-plant testing or inspections to provide reasonable confidence of functionality when compared to nuclear processes.

ACRONYMS

AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BOP	balance-of-plant
CFR	Code of Federal Regulations
EQ	Environmental Qualification
GDC	general design criteria
GL	Generic Letter
HVAC	heating, ventilation, and air conditioning
ICS	Industrial Control and Systems (NEMA)
IEEE	Institute of Electrical and Electronic Engineers
IESNA	Illuminating Engineering Society of North
IP&D	instructions, procedures, and drawings
ISA	Instrument Society of America
ISI	in-service inspection
ISO	International Organization for Standardization
IST	in-service testing
LSS	low safety significance
MCC	motor control center
MCCB	molded case circuit breakers
MIL-SPEC	military specification
MOV	motor-operated valve
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRC	Nuclear Regulatory Commission
OM	operation and maintenance
PTC	Performance Test Code
QA	quality assurance
RG	Regulatory Guide
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
SOV	solenoid-operated valve
SP	Standard Practice
SSC	systems, structures, and components
TEMA	Tubular Exchanger Manufacturers Association
UBC	Uniform Building Code
UL	Underwriters Laboratory

A Comparative Analysis of Special Treatment Requirements for Systems, Structures, and Components of Nuclear Power Plants with Commercial Requirements of Non-Nuclear Power Plants

1. INTRODUCTION

The Nuclear Regulatory Commission (NRC) has recommended that risk-informed approaches to the application of special treatment rules, such as those addressing quality assurance, codes and standards, seismic events, environmental qualification, environmental conditions, and natural phenomena, be developed. One option is to change the regulatory scope for systems, structures, and components (SSCs) needing special treatment. Safety-related SSCs that are of low safety significance would move from special treatment to normal industrial (or commercial grade) treatment. They would still be expected to perform their design function, although without the additional margin, assurance, or documentation currently required for safety-related SSCs.

This report provides a comparative analysis between the special treatment rules applied to SSCs in nuclear power plants and commercial requirements applied in non-nuclear power plants and nuclear balance-of-plant (BOP) in an effort to understand the extent to which commercial processes and requirements assure that safety-related but low safety significant SSCs will perform their design functions. The scope of this review is based on the following special treatment requirements, which include supporting documentation, such as the NRC Standard Review Plan and Regulatory Guides.

- 10 CFR 50.55a, American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Sections III and XI, Operation and Maintenance (OM) Codes, and generic letters related to motor-operated valves (MOVs).
- 10 CFR 50.49 (environmental qualification of electric equipment).
- 10 CFR 50, Appendix A, (General Design Criteria [GDC] 1, 2, 4, 45, and 46) and Appendices B and S.
- 10 CFR 100, and Appendix A to Part 100.

This comparative analysis focused on the practices applied to SSCs in nonsafety related applications at nuclear plants with additional information on non-nuclear power facilities.

1.1 Background

In SECY-98-300, the NRC staff recommended under Option 2 that risk-informed approaches to the application of special treatment requirements be developed. This option addressed implementing changes to the regulatory scope for SSCs needing special treatment. Option 2 did not change the design bases for the plant or the design-basis accidents that establish the design conditions for SSCs. Safety-related SSCs that are of low safety significance (RISC-3) would move from special treatment to normal industrial (or commercial grade) treatment. In SECY-99-256 the staff indicated that RISC 3 SSCs would receive sufficient regulatory treatment such that the functionality of these SSCs would be maintained, albeit at a reduced level of assurance, and that this level of assurance may be provided by the licensee's commercial programs.

In order to verify that the licensee's commercial programs provide an acceptable level of assurance that components will meet their functional requirements, one needs to understand the extent to which normal industrial (or commercial grade) treatments, such as design standards or practices, provide a basis for assuring that a component's or group of components' functional requirements will be satisfied, albeit at a reduced level of assurance than would be provided by having those components subject to the various regulatory special treatment requirements. For example, it is necessary to understand for various types of components, how licensees' processes for procuring commercial grade SSCs and the associated commercial standards assure the functional capability of the component.

1.2 Methodology

Information contained in this report was gathered through reviewing commercial codes and standards, and during visits to two nuclear utilities, one architectural engineering firm, and two component manufacturers. Contacted personnel typically included procurement managers, quality assurance managers, plant operators, and maintenance engineers. During the utility and vendor visits, all phases of the SSC life cycle were discussed including component design, manufacture, installation, and operation. Nuclear power plant documents were used to develop a list of processes and attributes that are affected by special treatment rules. To facilitate this activity, a process was defined as:

> "...one of several steps needed to be carried out in completing the design, procurement, installation, or operation of an SSC;"

and attributes were defined as:

> "...the requirements that may be needed to complete the process. Each attribute cannot be broken logically into a smaller similar attribute, but may contain more than a single step or requirement."

The typical SSC life cycle was subdivided into four stages: design, procurement, installation, and operation. The SSC life-cycle stages were used and typical nuclear power plant activities were reviewed to establish the list of processes. Attributes were identified and assigned to the appropriate SSC life-cycle stage under the applicable process. Processes and attributes were categorized as either critical or noncritical based on expert opinion. Processes and attributes that were judged to have a significant effect on component functionality were categorized as critical. It was found that applying the definition of a critical process or attribute (those requirements that individually or jointly are necessary to reasonably ensure functionality of a SSC) is difficult because it is easy to think of a scenario or example where every process or attribute is necessary to assure functionality.

Evaluations were performed to characterize any significant differences between the nuclear processes, attributes, and special treatment rules (i.e., applicable codes and standards) and the corresponding nuclear BOP, or commercial processes, attributes, and applicable codes and standards, or both as they relate to providing reasonable confidence of a component's functionality. Component specific commercial codes and standards were reviewed for 33 different components to determine if they addressed he special treatment rules. The codes and standards were obtained from discussions with vendors, standard specifications, and the knowledge and experience of the authors. The most applicable codes and standards for the individual components were selected. Many of these codes and standards referenced other codes and standards, but it was beyond the scope of this work to review all of these referenced codes and standards.

2. UTILITY AND VENDOR VISITS

To learn the differences in the treatment of nuclear safety systems, nuclear balance-of-plant (BOP), and commercial (e.g., fossil power plant) SSCs with regard to practices (procurement, installation, and maintenance) it is important to gain knowledge from firms (architectural engineers, component vendors, and electric utilities) that have experience with both nuclear and nonnuclear practices. Discussions were held with personnel from two utilities, one architect-engineering firm, and two component manufacturers. Contacted personnel typically included procurement managers, quality assurance managers, plant operators, and maintenance engineers. The following sections summarize the conclusions obtained from these visits.

2.1 Commonwealth Edison (ComEd)

Nuclear processes are used for BOP equipment and other site processes. ComEd representatives noted that creating another process that must be followed is not wanted. Relying on a single process (e.g., using a modification package for BOP components) to perform similar tasks on safety-related and nonsafety-related components decreases the likelihood of human error. This concept is also applied to the procurement of spare parts. If an item has both a safety-related and nonsafety-related application, a cost analysis is performed to determine whether to buy both safety and non-safety, only safety, or only nonsafety and perform commercial dedication when the component is needed in a safety application.

Environmental qualification (EQ) accounts for less than 1% of the parts purchased by ComEd. Utility representatives did not believe that it is cost effective to dedicate commercial components for use in harsh environments.

If a component is classified as a RISC-3, Low Safety Significance (LSS) Safety-Related, ComEd has a draft process that is used to effectively accept items for safety-related use based on the manufacturers application of industry standards.

2.2 San Onofre Nuclear Generating Station (SONGS)

San Onofre Nuclear Generating Station (SONGS) and ComEd have laboratories that are used to commercially dedicate piece parts used in safety-related components. These laboratories can be used with revised processes to easily dedicate commercial components for RISC-3, LSS applications. Significant savings would be anticipated for ASME pressure boundary and seismic components.

Utility representatives would also like to use the nuclear commercial dedication process for procurement of RISC-3, LSS components. They suggested that the commercial dedication process be changed to allow the original equipment manufacturer and history to be used as a basis for component dedication.

2.3 Sargent & Lundy

Sargent & Lundy implemented an International Organization for Standardization (ISO) 9001 program in 1998 for both nuclear safety-related and other work. Sargent & Lundy personnel indicated that this implementation was easy for the nuclear projects. However, implementation for fossil and other types of projects was more complicated, since the quality programs implemented were more project-specific.

Members of fossil projects indicated that there is little process control at many fossil power plants. Areas mentioned included a lack of equipment configuration control. For example, drawings may not be maintained to reflect the as-built condition. In addition, some equipment is used at fossil power plants without formal qualification and with little supporting quality documentation.

Nonetheless, Sargent & Lundy has few differences between the design controls for nuclear projects and other projects. While a fossil project typically will write fewer procedures and generate fewer records than a nuclear project, design bases are maintained for both. For example, there are no differences in the design requirements for drawings on either type of project. The only difference in the requirements for design calculations is that the reviewer of a calculation supporting a fossil powered plant does not have to be as independent as the reviewer of a calculation for a nuclear project.

The discussions on practices at fossil powered plants suggest the existence of a wide variation in the meaning of the term "commercial practice."

2.4 CCI Valves

CCI is a specialty valve manufacturer that produces one-of-a-kind valves to solve specific customer needs. CCI's manufacturing processes use some commercial codes (ASME B31.1 and ASME B16.34) if the customer specifies no codes. Therefore, these codes form the basis for CCI's lowest quality levels. CCI also uses the same documentation traveler system for both commercial and nuclear components. There appear to be few significant differences between the quality of safety-related and nonsafety-related components at CCI. However, our observations may not be representative of other valve manufacturers who produce commonly available off-the-shelf valve products.

CCI uses mostly analysis (and some limited testing) to ensure seismic capability for commercial applications. Seismic spectra and shaker tables are only used to address nuclear component seismic requirements. Fraudulent components are an industry problem and CCI avoids purchasing specific types of parts from some countries. For example, care must be exercised when purchasing bolting material and flanges.

2.5 ASCO Solenoid Valves

ASCO maintains a different product line for commercial and nuclear components. There are some significant differences in the construction of nuclear and commercial components. Examples include the use of heavier supports for nuclear seismic components, use of metal instead of plastic in nuclear components, the use of different elastomers, and the use of larger coils in solenoid valves used in nuclear applications.

The manufacturer can modify commercial solenoid valves without changing the model number. ASCO believes it would be difficult, if not impossible, to commercially dedicate their commercial solenoid valves for nuclear application due to the materials used and the variability in piece parts. ASCO personnel stated that they do not endorse or support the use of commercial solenoid valves for safety-related applications.

2.6 Discussions with ITT Barton and Reliance Motors

Telephone conversations held by the NRC with ITT Barton (pressure transmitters) and Reliance Motors indicated that there was a significant difference between nuclear and commercial products manufactured by these companies.

ITT Barton personnel noted that piece-part substitution is allowed on commercial pressure transmitters and that commercial transmitters are much less rugged than the nuclear grade components.

Reliance personnel noted that their nuclear motors are completely different from their commercial products. Nuclear-grade ac motors have a unique square-frame motor design where the stator is laminated into the frame as opposed to being pressed-in. Nuclear-grade motors have different insulation materials that are of higher quality and use specific varnish on the windings. These motors also use a different type of bearing grease and the elastomer seals are made of Viton as opposed to the Neoprene used in commercial motors. In addition, nuclear motors and the associated component parts receive additional dedication and qualification testing.

3. CRITICAL PROCESS EVALUATION

3.1 Process Descriptions

Nuclear power plant documents were used to develop the list of processes that are affected by special treatment requirements. The typical SSC life cycle was subdivided into the following stages:

1. Design Stage
2. Procurement Stage
3. Installation Stage
4. Operation Stage.

The SSC life-cycle stages were used and typical nuclear power plant activities were reviewed to establish the list of processes that are described in Section 3.1.1. Attributes were identified and assigned to the appropriate SSC life cycle stage under the applicable process. The current listing of processes versus SSC life-cycle stages is presented in Table 1 (see Appendix A).

3.1.1 Processes Common to All Life-Cycle Stages of a SSC

Documentation (Process 1) is the process used to construct the "birth to death" historical record of an SSC as it progresses through the stages of its life cycle. Thus, this process is common to all stages of a SSC life cycle as indicated in Table 1. Typical nuclear power plant licenses require various levels of detail in the required documentation depending on the safety significance of the SSC being considered.

Quality Assurance (Process 2) is required in all stages of the life cycle of an SSC. This process provides for the program, personnel, procedures, and management attention that is used to assure that all activities (design, installation, maintenance, repair, etc.) related to an SSC are performed in a manner that maintains the appropriate level of performance, quality, and safety.

Procedure Control (Process 3) is the process used to specify and document how work will be done. Procedure control is used in all stages of the SSC life cycle. Procedures control and prescribe how quality activities are to be accomplished. Procedure control is used to specify how the design activities are accomplished, specify how procurement is accomplished, specify how installation is done, and how plants are operated.

Testing, Inspection, and Examination (Process 4) constitutes the process in which the SSC is verified to meet its design performance and quality requirements. Some of the attributes for these processes are common to all stages of the SSC life cycle. These include program requirements to ensure that the SSC will perform as designed, that written procedures have adequate acceptance criteria, and that test results are documented and evaluated.

3.1.2 Design Stage

Design Requirements (Process 5) constitutes the process in which the many types of information needed to specify the design are identified and assembled. These include the performance, functions, and operating modes that will be required of the SSC.

Analysis (Process 6) constitutes the computational process used to assure the safety and functionality of the design. In this process, the design is analytically evaluated according to the requirements of the applicable codes and standards, and it is verified that the design meets these requirements.

Design Verification (Process 7) is the process that provides assurance that an SSC will perform its functions throughout its required lifetime under all anticipated normal, abnormal, and accident conditions. These conditions include equipment operations, normal and accident environments, and external effects such as floods and earthquakes. Design verification may include EQ as required by 10 CFR 50.49.

Design Control (Process 8) delineates the process by which the activities related to the design of an SSC are controlled. The attributes for this process are intended to assure that the appropriate level of detail is devoted to design activities, design acceptability, approval, etc.

3.1.3 Procurement Stage

Procurement Initiation (Process 9) constitutes the process in which the many types of information needed to procure an SSC are identified and assembled. These include an approved procurement specification, appropriate references to regulatory and other requirements, qualification requirements, and assurance that contractors and vendors have an adequate quality assurance program.

Manufacturing (Process 10) constitutes the process in which the SSC is fabricated by the vendor. In this process, the information generated from the design process is used to produce and assemble the SSC. These include the required procedures and standards, the state and composition of the raw materials, and the methods and processes used to transform the raw materials into the finished SSC.

Shipping, Storage, and Handling (Process 11) of SSCs may occur in the procurement, installation, and operation stages of an SSC's life cycle. The attributes of this process establish measures that assure proper identification, protective measures, and environments. This is done so that the SSCs will arrive at the installation and operation stages without damage and with identifiable components so that traceability can be maintained throughout the SSC's life cycle.

Receipt Inspection (Process 12) is the process used in the Procurement Stage of a SSC life cycle to assure and document that the correct component specified and ordered from a manufacturer is received at a plant site in good condition.

3.1.4 Installation Stage

Installation (Process 13) constitutes the process in which the SSC is physically placed into its operational position in the plant. This includes structural attachment for support, functional linkages to other SSCs, and electrical, hydraulic, or pneumatic connections for actuation and control. These include the required procedures and standards, and qualification of procedures and personnel.

3.1.5 Operation Stage

Monitoring (Process 14) constitutes the process in which SSC performance is periodically evaluated during plant operation. These include requirements to evaluate performance and component degradations, identify and correct nonconformances, and document root causes.

Repair, Replacement, or Modification (Process 15) is the process used in the operation stage of the life cycle to correct problems with the SSC. Repair activities are performed on existing installed SSCs to correct problems. Replacement is a process of replacing-in-kind to correct problems. Modification is used to replace SSCs with a new type of updated or different SSC, For example, a valve shown to perform inadequately in service would be modified with a different type valve shown to provide more satisfactory service.

Maintenance (Process 16) can be both a preventative and corrective process. Preventative maintenance processes are used to assure the functionality of SSCs. Corrective maintenance processes are used to repair and replace SSCs.

Trending (Process 17) constitutes the process in which SSC performance data obtained from the monitoring process and component failure data are analyzed with respect to time. This analysis provides a basis for future retest frequencies and helps identify common-cause component problems.

Corrective Actions (Process 18) is the program used in the Operation Stage of the life cycle to identify problems and the appropriate actions necessary to correct the problems. Corrective actions are monitored to ensure effectiveness.

3.1.6 Table 2 - Critical Process/Attribute Evaluation

Appendix A, Table 2 provides a detailed listing of each of the 18 processes and their associated attributes that are affected by special treatment requirements. The table includes a reference to the associated special treatment rules, the determination of process and attribute criticality, and the basis for that determination.

Most of the process' attributes were found to be critical to giving reasonable confidence of SSC functionality (see Table 2). However, for most of the critical attributes, reasonable confidence could be achieved with fewer requirements than stated in the special treatment rules. This was true more for the attributes giving assurance of functionality, such as documentation, than for those that directly demonstrate functionality, such as component testing. Many of these special treatment rules are from 10 CFR 50, Appendix B. While some sort of quality program is needed for reasonable confidence of SSC functionality, a full 10 CFR 50, Appendix B program does not seem to be warranted for RISC-3 components.

In a few cases, process attributes contributed only a minor increase in confidence of SSC functionality. An example of this is management reviews of quality activities. While management should be aware of quality issues, if the engineering department has an effective corrective action program, this should give reasonable confidence of SSC functionality, and the management reviews would only add an incremental increase in confidence of functionality.

In other cases, a process attribute was judged to be noncritical if there were alternate ways to satisfy the attribute. An example of this would be the design verification process. All of the methods cannot be critical since only one of them needs to be satisfied. In this case, only the method judged to be the lowest level of verification was selected as critical, the alternate methods were judged noncritical.

One critical attribute that was assumed to be in place was the design specification. If the design specification states the functional, environmental, and load requirements correctly, then commercial practices would lead to a product selection that was manufactured according to the design requirements. For example, if the design requirements state that a solenoid-operated valve (SOV) must function in a radiation environment, then a commercially available SOV with materials not designed for radiation environments would not be selected. If the existing general design requirements were used (excluding the requirement that the replacement component be nuclear grade), then an SSC incapable of functioning properly in a nuclear environment would not be procured.

4. COMPONENT COMPARATIVE ANALYSIS

The data and information previously compiled were used to compare the nuclear processes, attributes, and special treatment requirements (i.e., applicable codes and standards) for a number of component types to those that could be used for commercial procurement, installation, maintenance, etc. The BOP and commercial codes and standards were identified from discussions with utilities, vendors, standard specifications, and the knowledge and experience of the authors. We selected the most applicable codes and standards for the individual components. Many of these codes and standards referenced other codes and standards and it was beyond the scope of this work to review all these referenced documents.

Evaluations were performed to characterize any significant differences between the nuclear processes, attributes, and special treatment requirements (applicable codes and standards) and the corresponding BOP and commercial processes, attributes, and applicable codes and standards as they relate to providing reasonable confidence of the component's functionality. These evaluations were based on the following important points:

- The components addressed are listed in the plant's licensing basis as safety-related components and will remain so listed even if reclassified as "RISC-3" components.

- It is assumed that the design requirements of any components reclassified as "RISC-3" will not change. For example, the loads (e.g., pressure, thermal, seismic, etc.) and environmental requirements originally specified as applicable to any given component would still be applicable after reclassification.

- It was assumed that good engineering practice would continue to be applied for any components that could be acquired using commercial processes and codes and standards after classification to "RISC-3." Thus, the importance of a comprehensive engineering specification for each SSC would remain. For example, the requirements included in the specification will be used to determine whether a "catalog item" is acceptable for a replacement component or whether a vendor's "nuclear grade" component must still be used.

- The evaluations performed for the components included in the subsections below were based on consideration of the processes that would apply to uses of both the special treatment rules and of BOP or commercial codes and standards. Thus, these evaluations do not represent product-to-product comparisons, such as a nuclear grade solenoid valve compared to a commercial solenoid valve.

- Likewise, the evaluation descriptions do not imply or represent a detailed line-by-line comparison of nuclear requirements to corresponding applicable commercial requirements. For example, it was observed that the quality assurance (QA) requirements of Section III of the ASME Code are more comprehensive than those recommended in Section VIII. The evaluation conducted was sufficient to confirm that significant differences existed without performing a complete match-up comparison of each specific requirement.

- The objective of Task 4 is to identify differences that significantly affect reasonable confidence of functionality between processes required by special treatment rules and the requirements of component-specific commercial codes and standards. In some cases there may be differences in the special treatment rule and the corresponding commercial code requirement; however, in our expert opinion some of these differences would not significantly affect reasonable confidence of the functionality of the component.

The evaluations contained in the following subsections briefly address the differences between commercial codes and standards and process attributes required by special treatment rules. All components had at least a few differences that were judged to significantly affect reasonable confidence of functionality. However, most components had some processes where the identified differences did not significantly affect reasonable confidence of functionality. Examples of this were more frequently found in the design requirements, manufacturing, installation, and maintenance processes. These judgments did not ignore the fact that the special treatment rule requirements and the commercial standard requirements are not the same. These judgments simply indicate that the differences would not significantly affect reasonable confidence of the functionality of the component. As an example, consider the design requirements process for piping. The special treatment rule requirements (10 CFR 50.55a) involve Section III of the ASME Code whereas the commonly used commercial code is ASME B31.1. Examination of the piping rules contained in both standards show that there are differing requirements, for example, stress limits. Section III has limits for four load levels, but since these are equal to or greater than the B31.1 stress limits, the B31.1 limits should give reasonable confidence of functionality. The Section III Class I fatigue rules are also significantly different, but again it was concluded that the B31.1 rules would give reasonable confidence of functionality.

It is recognized that corresponding nuclear products and commercial products may differ even though a process, such as design requirements, is judged to have no differences that significantly affect reasonable confidence of functionality when commercial standards are used. For example, if MIL-SPEC (military specification) MIL-S-4040E was followed for SOVs, a specification would be developed that identified all the applicable conditions of temperature, pressure, seismic vibration, etc. A SOV for commercial applications would not be specified to operate in conditions identical to nuclear applications. The commercial SOV would not be required to withstand radiation fields; other conditions, such as pressure, temperature, and seismic vibrations, may be less demanding than those present in a nuclear in-containment environment. Yet when applied to a nuclear SOV, the same standard would lead to a specification that identified radiation and the other applicable environmental conditions (e.g., temperature, pressure, and seismic vibration, etc.). Consequently, the commercial valve will use some plastic parts where the nuclear valve uses metal parts. In addition, the nuclear valve's elastomers will be different because of the requirement to endure radiation exposure. Therefore, the two valves would be noticeably different even though they were designed using the same process, and the commercial valve may not be acceptable for the nuclear application.

Analysis of the information contained in the following subsections indicate that for all of the components evaluated, significant differences between the special treatment rule requirements and the requirements contained in the component specific commercial codes and standards existed for most of the critical processes. For example, the component specific commercial codes and standards reviewed had few, if any, specific requirements governing such processes as QA, procedural control, and design verification. Similar observations were made for most of the other critical processes when applied to the components evaluated. This indicates that component specific commercial codes and standards alone do not provide the necessary processes to assure reasonable confidence of functionality. The evaluations contained in Table 2 also indicate that additional measures would be needed to reinforce the requirements of commercial codes and standards used in the procurement of RISC3 SSCs.

The utility representatives we contacted stated that processes developed to implement nuclear codes, standards, and special treatment requirements are often selectively used (with reduced requirements where appropriate) for BOP SSCs to provide reasonable confidence of functionality. QA programs that provide classifications less rigorous than those required by the special treatment rules but with augmented requirements above commercial standards could be one approach to providing reasonable confidence of functionality.

4.1 ISO 9001

ISO 9001-94 is an international quality standard that is available for application to BOP nuclear and commercial grade components. As with all such commercial standards, certification of a manufacturer's ISO 9001 program is strictly voluntary. Although ISO 9001 uses a different numbering system and somewhat different titles, the basic aspects of the quality program, such as Design Control, are similar to those quality program requirements included in 10 CFR 50, Appendix B. Comparison of the requirements of ISO 9001 versus those of 10 CFR 50, Appendix B will show many similarities, but differences also exist. For example, some regulatory requirements contained in Criterion III (Design Control) of 10 CFR 50, Appendix B are not addressed at the same level of rigor and detail in ISO 9001. In some cases these differences may not be critical contributors to establishing or maintaining the functionality of low risk SSCs.

As mentioned above, use of an ISO 9001 Quality Assurance program is voluntary. Adoption and certification of ISO 9001 Quality Assurance programs have been increasing throughout the commercial sector, but it has also been observed that the implementation of these programs has been somewhat uneven and inconsistent. This is partly attributed to the variety of organizations performing the certification activities.

4.2 Centrifugal Pumps

4.2.1 Commercial Standard

ASME B73-1M, ANSI/API 610, NFPA/T3.9.21, UBC, ASCE 7, and NEC.

4.2.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME III, XI, in-service testing [IST], OM)
- 10 CFR 50, GDC 45 and 46, and Appendix B
- 10 CFR 100, Appendix A

4.2.3 Centrifugal Pump Synopsis

Guidance from the chemical, petroleum, or fire protection codes could be used as commercial pump standards. If the design specification states the functional, environmental, and load requirements, the commercial codes give adequate general directions on how to manufacture and test a pump. For example, ASME B72-1M and Performance Test Code (PTC) 7.1 give instructions on functional testing. Commercial seismic requirements are covered by standards such as the UBC and ASCE 7 that specify seismic requirements different than nuclear codes, but nevertheless give reasonable confidence of functionality. Quality and equipment qualification requirements are not thoroughly addressed in commercial codes, although ISO 9001 would cover quality requirements if specified. A few documentation requirements are given in ASME B73-1M. It is expected that the pump instruction manual would cover installation and in-service testing.

4.2.4 Commercial Standards Comparison with Nuclear Processes

Documentation: There is no universally used commercial standard requiring documentation. ASME B73-1M requires documents including drawings, performance curves, and an instruction manual.

Quality Assurance: There is no universally used commercial standard requiring a quality assurance program.

Procedures: There is no universally used commercial standard requiring the use of procedures.

Testing, Inspection, and Examination: ASME B73-1M requires a shop hydro test of casings, coverings, and jackets at 1.5 times the design pressure. Performance tests are required to be conducted in accordance with HI 1.6, "Testing for Centrifugal Pumps" of the Hydraulic Institute Standards. Commercial standards cover functional testing of pumps. No in-service inspection (ISI), such as for welds, is required.

Design Requirements: A design specification will exist for each SSC that should include all design requirements. No significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: The seismic analysis methods in commercial standards are equivalent static methods.

Design Verification: There is no universally used commercial standard requiring design verification.

Design Control: There is no universally used commercial standard requiring design control.

Procurement: There is no universally used procurement standard.

Manufacturing: No significant differences that would effect the reasonable confidence of component functionality were identified.

Shipping, Storage, and Handling: There is no universally used commercial standard requiring shipping, storage, and handling.

Receipt Inspection: There is no universally used commercial standard requiring receipt inspection.

Installation: Installation instructions are included in the manufacturer's instruction manual.

Monitoring: There is no universally used commercial standard requiring monitoring.

Repair, Replacement, or Modification: There is no universally used commercial standard requiring repair, replacement, or modification.

Maintenance: There is no universally used commercial standard requiring maintenance.

Trending: There is no universally used commercial standard requiring trending.

Corrective Action: There is no universally used commercial standard requiring corrective action.

4.3 Positive Displacement Pumps

4.3.1 Commercial Standard

ANSI/(NFPA) T3.9.17 R2-1997; ANSI(NFPA) B93.95M; API Standards 674, 675, and 676; ASME PTC 7.1; UBC; ASCE 7; and NEC.

4.3.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME III, XI, IST, OM)
- 10 CFR 50, GDC 45 and 46, Appendix B
- 10 CFR 100, Appendix A

4.3.3 Positive Displacement Pump Synopsis

Guidance from the chemical, petroleum, or fire protection codes could be used as commercial pump standards. If the design specification states the functional, environmental, and load requirements, the commercial codes give adequate general directions on how to manufacture and test a pump. For example, ASME B72-1M and PTC 7.1 give instructions on functional testing. Commercial seismic requirements are covered by standards such as the UBC and ASCE 7 that specify seismic requirements different from nuclear codes, but give reasonable confidence of functionality. Quality and equipment qualification requirements are not thoroughly addressed in commercial codes, although ISO 9001 would cover quality requirements if specified. It is expected that the pump instruction manual would cover installation and in-service testing.

4.3.4 Commercial Standards Comparison with Nuclear Processes

Documentation: There is no universally used commercial standard requiring documentation.

Quality Assurance: There is no universally used commercial standard requiring a Quality Assurance Program.

Procedures: There is no universally used commercial standard requiring the use of procedures.

Testing, Inspection, and Examination: Commercial standards cover functional testing of pumps. No ISI, such as for welds, is required.

Design Requirements: A design specification will exist for each SSC that should include all design requirements. No significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: The seismic analysis methods in commercial standards are equivalent static methods.

Design Verification: There is no universally used commercial standard requiring design verification.

Design Control: There is no universally used commercial standard requiring design control.

Procurement: There is no universally used commercial procurement standard.

Manufacturing: No significant differences that would affect the reasonable confidence of component functionality were identified.

Shipping, Storage, and Handling: There is no universally used commercial standard requiring shipping, storage, and handling.

Receipt Inspection: There is no universally used commercial standard requiring receipt inspection.

Installation: No significant differences that would affect the reasonable confidence of component functionality were identified.

Monitoring: There is no universally used commercial standard requiring monitoring.

Repair, Replacement, or Modification: There is no universally used commercial standard requiring repair, replacement, or modification.

Maintenance: There is no universally used commercial standard requiring maintenance.

Trending: There is no universally used commercial standard requiring trending.

Corrective Action: There is no universally used commercial standard requiring corrective action.

4.4 Valves

4.4.1 Commercial Standard

American Society of Mechanical Engineers, 1996, Valves - Flanged Threaded and Welding End, ASME B16.34.

4.4.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME III, IST, OM, Generic Letters (GLs) 89-10, and 96-05)
- 10 CFR 50, GDC-45 and 46 and Appendix B
- 10 CFR 100, Appendix A

4.4.3 Related Nuclear Guidance

- ASME Qualification of Active Mechanical Equipment Used in Nuclear Power Plants (QME-1).

4.4.4 Valve Synopsis

Valves are subject to pressure boundary requirements of ASME Sections III and XI, in-service testing requirements, quality assurance requirements, seismic requirements, and GDC 45 and 46. When special treatment requirements are compared to commercial codes and standards (ASME B16.34) there are significant differences in all processes except design requirements and manufacturing. ASME B16.34 does include specific pressure test requirements to ensure that the pressure boundary integrity is not violated and also contains specific manufacturing requirements. Even though ASME B16.34 addresses design and manufacturing issues, several special treatment requirements are not addressed, and therefore, ASME B16.34 is not adequate to provide reasonable confidence of valve functionality. However, other industry quality assurance programs and other plant processes may be used to provide reasonable confidence of functionality.

4.4.5 Commercial Standards Comparison with Nuclear Processes

Documentation: ASME B16.34 does not include any requirements that address the documentation required for construction of commercial valves.

Quality Assurance: Annex H of ASME B16.34 specifies that products manufactured using this standard be produced using a Quality Assurance program that follows the principles of ISO 9001. However, Annex H is nonmandatory and is provided for information purposes only.

Procedures: ASME B16.34 includes procedures for radiography (Annex B), magnetic particle examination (Annex C), liquid penetrant examination (Annex D), and ultrasonic examination (Annex E). These examination procedures typically include acceptance criteria. However, they do not address other 10 CFR 50, Appendix B concerns, such as requiring procedural control (other examination standards are referenced), ensuring that prerequisites are met, or including quality hold points. Procedural requirements for valve manufacture are not specified.

Testing, Inspection, and Examination: ASME B16.34 specifies the test requirements for surface examinations and shell pressure tests. Welds must receive nondestructive examination in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division I. For valves designed to isolate flow, a closure (seat-leakage) test is required. However, the valve is not stroked under worst-case pressure and flow conditions. No in-service testing (IST) is required. ASME B16.34 states that the need for periodic inspections is the responsibility of the user.

Design Requirements: No significant differences that would affect the reasonable confidence of component functionality were identified. ASME B16.34 does include specific pressure test requirements to ensure that the pressure boundary integrity is not violated.

Analysis: ASME B16.34 does not include any personnel qualification or checking requirements related to the construction of commercial valves.

Design Verification: ASME B16.34 does not include any requirements that addresses design verification during the construction of commercial valves.

Design Control: ASME B16.34 does not include any requirements that addresses design control during the construction of commercial valves.

Procurement: ASME B16.34 requires that valve body and bonnet components be constructed of materials in accordance with American Society of Testing and Materials (ASTM) specifications or ASME Boiler and Pressure Vessel Code section II. The criteria for selection of materials are not considered to be in the scope of ASME B16.34.

Manufacturing: No significant differences that would affect the reasonable confidence of component functionality were identified. ASME B16.34 includes many requirements controlling the materials and manufacturing process.

Shipping, Storage, and Handling: ASME B16.34 does not include any requirements that address the shipping, storage, and handling of commercial valves.

Receipt Inspection: ASME B16.34 does not include any requirements that address the receipt inspection of commercial valves.

Installation: ASME B16.34 does not include any requirements that address the installation of commercial valves.

Monitoring: ASME B16.34 does not include any requirements that address the monitoring of commercial valve performance once installed in the plant.

Repair, Replacement, or Modification: ASME B16.34 does not include any requirements that address the repair, replacement, or modification of commercial valves.

Maintenance: ASME B16.34 does not include any requirements that address the maintenance of commercial valves.

Trending: ASME B16.34 does not include any requirements that address the performance trending of commercial valves.

Corrective Action: ASME B16.34 does not include any requirements to implement a corrective action program for commercial valves.

4.5 Valve Operators

4.5.1 Commercial Standard

Valve specifications were reviewed and discussions were held with valve and actuator manufacturers to identify commercial codes or standards that apply to valve operators. Based on these efforts, no commercial codes or standards were identified. Valve operators do not form a part of the system pressure boundary (ASME B31.1) and are not addressed by ASME B16.34. Therefore, no comparison was performed for valve operators.

4.5.2 Special Treatment Requirements

- 10 CFR 50.49
- 10 CFR 50.55a (ASME III, IST, OM, GL 89-10, GL 96-05)
- 10 CFR 50, GDC 45 and 46, and Appendix B
- 10 CFR 100, Appendix A

4.5.3 Valve Operator Synopsis

Valve operators are subject to pressure boundary requirements of ASME Sections III and XI, In-service Testing requirements, Quality Assurance requirements, seismic requirements, environmental qualification requirements, and GDC 45 and 46. No commercial codes or standards were identified. However, it should be noted that valve actuator manufacturers, such as Limitorque, typically provide specific actuator sizing and setting guidelines in their technical manuals.

4.5.4 Commercial Standards Comparison with Nuclear Processes

As noted above, no comparison is possible due to the apparent lack of commercial codes or standards.

4.6 Solenoid Operated Valves

4.6.1 Commercial Standard

MIL-SPEC MIL-S-4040E addressed specification and design/production testing of electrical solenoids used to actuate various devices. The standard requires that a specification be supplied by the user as a part of the procurement process. The valve portion of a solenoid valve is addressed in Section 4.4, Valves.

4.6.2 Special Treatment Requirements

- 10 CFR 50.49, Environmental Qualification
- 10 CFR 50, GDC 1, 2, 4, and 10, and Appendix B
- 10 CFR 100, Appendix A

4.6.3 Solenoid Valve Synopsis

Solenoid operated valves are typically located in areas that are subject to accident conditions and, therefore, must meet EQ requirements as well as the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards there are significant differences in all processes except design requirements and design verification. The commercial standard reviewed (MIL-SPEC MIL-S-4040E) requires specifying and verifying all the conditions that would be required at a nuclear power plant, except for radiation. While radiation is not included in the things to be considered, the thoroughness of the standard and the assumed existence of a specification will assure that radiation will be considered when it is an environmental condition for the solenoid.

4.6.4 Commercial Standards Comparison with Nuclear Processes

Documentation: Other government documents are referenced. However, documentation, including the control of documentation that is required of the manufacturer and subsequently during installation and operation is not addressed.

Quality Assurance: The reviewed standards do not address quality assurance programs. Quality assurance is addressed with regard to testing and inspections.

Procedures: The standard does not address requirements for procedures.

Testing, Inspection, and Examination: The MIL-SPEC requires inspections and testing to assure that the solenoids will perform as required. The testing considerations include verifying electrical and mechanical characteristics under conditions of temperature, sprays, shock, vibrations, acceleration, thermal shock, sand and dust, and explosions. Visual and mechanical inspections are also required. Testing during post installation and during the operational phase is not addressed.

Design Requirements: The standard requires specifying nearly all the conditions that would be required at a nuclear power plant. While radiation is not included in the things to be considered, the thoroughness of the standard and the assumed existence of a specification will assure that radiation will be considered when it is an environmental condition for the solenoid.

Analysis: The reviewed standards do not address the analysis process.

Design Verification: Design verification for all specified conditions is addressed. While radiation is not included in the things to be considered, the thoroughness of the standard and the assumed existence of a specification will assure that radiation will be considered when it is an environmental condition for the solenoid.

Design Control: The reviewed standards do not address design control attributes.

Procurement: The standards could lead to development of procurement specifications. However, other procurement attributes, such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: Except for determining how many sample are to be tested and the production testing, the manufacturing process is not addressed.

Shipping, Storage, and Handling: Shipping, storage, and handling is not addressed.

Receipt: Receipt is not addressed by the standard.

Installation: The standard does not address the process of installation.

Monitoring: The reviewed standard does not address the monitoring process.

Repair, Replacement, or Modification: The reviewed standards do not address repair, replacement, or modification.

Maintenance: Maintenance of solenoids is not addressed.

Trending: The standard does not address the trending process.

Corrective Action: Corrective actions are not addressed.

4.7 Piping

4.7.1 Commercial Standard

ASME/ANSI B31.1

4.7.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME III, ISI)
- 10 CFR 50, Appendix B
- 10 CFR 100, Appendix A

4.7.3 Piping Synopsis

Piping systems and components serve as the pressure boundary for the systems needed to transport fluids throughout power plants. The design requirements for an individual piping system are generally governed by the intended service (primary coolant system, component cooling water, etc.), magnitude of the loads imposed, the types of loads expected (thermal expansion, seismic, etc.), the environments imposed by the routing and location of the system, and other application specific parameters. The design requirement differences between the special treatment rules applicable to piping and the rules contained in commercially available standards do not result in a significant reduction of confidence in the assurance of piping system functionality. As an example, ASME Section III does include more stringent requirements; however, higher stress limits are allowed. Whereas B31.1 has less stringent requirements; but the allowable stresses are more conservative. On balance, well-designed piping systems are routinely designed using both approaches. Likewise, the differences in the special treatment rules and commercial standards addressing the manufacturing operations for piping systems and the operations needed to install them do not result in a significant reduction of confidence in the assurance of piping system functionality. However, as detailed in the subsections below, significant differences between the special treatment rule requirements and the available commercial standards do exist in the other critical processes.

4.7.4 Commercial Standards Comparison with Nuclear Processes

Documentation: There is no universally used commercial standard requiring documentation.

Quality Assurance: There is no universally used commercial standard requiring a quality assurance program.

Procedures: B31.1 only requires welding procedures.

Testing, Inspection, and Examination: B31.1 has manufacturing and installation testing, inspection, and examination for welds. No ISI is required.

Design Requirements: No significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: B31.1 has no personnel qualification or checking requirements.

Design Verification: There is no universally used commercial standard requiring design verification.

Design Control: There is no universally used commercial standard requiring design control.

Procurement: B31.1 requires specified material and manufacturing methods.

Manufacturing: No significant differences that would affect the reasonable confidence of component functionality were identified.

Shipping, Storage, and Handling: There is no universally used commercial standard requiring shipping, storage, and handling.

Receipt Inspection: There is no universally used commercial standard requiring receipt inspection.

Installation: No significant differences that would affect the reasonable confidence of component functionality were identified.

Monitoring: There is no universally used commercial standard requiring monitoring.

Repair, Replacement, or Modification: There is no universally used commercial standard requiring repair, replacement, or modification.

Maintenance: There is no universally used commercial standard requiring maintenance.

Trending: There is no universally used commercial standard requiring trending.

Corrective Action: There is no universally used commercial standard requiring corrective action.

4.8 Pressure Vessels

4.8.1 Commercial Standard

ASME Section VIII.

4.8.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME Section III)
- 10 CFR 50, GDC 1 and 2, and Appendices B and S.

4.8.3 Pressure Vessel Synopsis

The design requirements for an individual pressure vessel are generally governed by the intended service, such as magnitude of the loads imposed, the types of loads expected, such as pressure, temperature, seismic, etc., and other application specific parameters. The design requirements differences between the special treatment rules applicable to pressure vessels and the rules contained in commercially available standards do not result in a significant reduction of confidence in the assurance of vessel functionality. For example, ASME Section III does include more stringent requirements, but higher stress limits are allowed. Whereas Section VIII has less stringent requirements, but the allowable stresses are more conservative. On balance, well designed vessels are routinely designed using both approaches. In fact, the reactor pressure vessels used in several of the early nuclear power plants were designed using the Section VIII rules. Likewise, the differences in the special treatment rules and commercial standards addressing the manufacturing operations for piping systems and the operations needed to install them do not result in a significant reduction of confidence in the assurance of vessel functionality. However, as detailed in the subsections below, significant differences between the special treatment rule requirements and the available commercial standards do exist in the other critical processes.

4.8.4 Commercial Standards Comparison with Nuclear Processes

Documentation: ASME Sec VIII does require a quality assurance program; however, the level of documentation required is generally much less than that required by ASME Section III and that required under 10 CFR 50, Appendix B.

Quality Assurance: ASME Section VIII, Appendix 10 requires a quality assurance program. However, the program requirements do not match those contained in 10 CFR 50, Appendix B; for example, testing is not addressed.

Procedures: ASME Section VIII, Appendix 10 requires a quality assurance program that includes provisions for procedures that will ensure that the latest versions of drawings, design calculations, and specifications are available. However, 10 CFR 50, Appendix B includes much more detailed requirements regarding the contents of written procedures and the appropriate approval process for procedures.

Testing, Inspection, and Examination: The testing, inspection, and examination requirements contained in Section VIII do not address items such as personnel qualification, continued training and certification, etc. in comparable detail to 10 CFR 50, Appendix B.

Design Requirements: No significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: Section VIII has no personnel qualification or checking requirements.

Design Verification: Section VIII has no universally design verification requirements.

Design Control: ASME Section VIII, Appendix 10 requires a quality assurance program that includes provisions for procedures that will ensure that the latest versions of drawings, design calculations, and specifications are available. 10 CFR 50, Appendix B includes much more detailed requirements on design control (e.g., design interfaces and coordination, design change control, etc.).

Procurement: 10 CFR 50, Appendix B requires that vendors provide components under a 10 CFR 50, Appendix B quality assurance program. Section VIII of the ASME Code does not have similarly stringent requirements. If ISO 9001 is used, then the topics in the special treatment rule roughly have corresponding ISO 9001 attributes.

Manufacturing: No significant differences that would affect the reasonable confidence of component functionality were identified.

Shipping, Storage, and Handling: Section VIII of the ASME Code does not include as rigorous requirements on shipping, storage, and handling, such as measures to prevent use of incorrect parts or components, as those found in 10 CFR 50, Appendix B.

Receipt Inspection: The guidelines contained in Section VIII are not comparable to the level of detail contained in 10 CFR 50, Appendix B. These differences are mainly in the areas of the level or record keeping required.

Installation: No significant differences that would affect the reasonable confidence of component functionality were identified.

Monitoring: Section VIII of the ASME Code contains no guidance on this topic that is comparable to the requirements of 10 CFR 50, Appendix B.

Repair, Replacement, or Modification: Section VIII of the ASME Code contains some guidance on the repair of material defects; however, these requirements are not comparable to the level of detail contained in 10 CFR 50, Appendix B.

Maintenance: Section VIII of the ASME Code contains no guidance on this topic comparable to that included in 10 CFR 50, Appendix B.

Trending: Section VIII of the ASME Code contains no guidance on this topic comparable to that included in 10 CFR 50, Appendix B.

Corrective Action: Section VIII of the ASME Code contains no guidance on this topic comparable to that included in 10 CFR 50, Appendix B.

4.9 Containment Penetrations

4.9.1 Commercial Standard

ASME Section VIII was reviewed and no electrical commercial penetration standard could be found. Section VIII requirements for nozzles and nozzle reinforcements are somewhat related to containment penetrations, but there are many differences.

4.9.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME Section III and Section XI)
- 10 CFR 50, GDC 1, 2, and 4, and Appendices B and S.

4.9.3 Containment Penetration Synopsis

Containment penetrations are subject to pressure boundary requirements of ASME Code Sections III and XI, QA requirements, GDC 1, GDC 2, and GDC 4. Containment penetrations provide for integrity of the containment structure for both mechanical and electrical penetration. No directly applicable commercial standard was found for the mechanical and electrical penetrations. Section VIII was reviewed because nozzles and nozzle reinforcements are somewhat similar to a mechanical penetration. There were significant differences in all of the critical processes for the containment penetrations. The commercial standard is not adequate to provide reasonable confidence of functionality. However, alternate QA programs and other plant processes could be used to provide reasonable confidence of functionality.

4.9.4 Commercial Standards Comparison with Nuclear Processes

Documentation: ASME Section VIII does require a quality assurance program; however, the level of documentation required is generally much less than that required by ASME Section III and that are required under a 10 CFR 50, Appendix B quality assurance program.

Quality Assurance: ASME Section VIII, Appendix 10 requires a quality assurance program. However, the program requirements do not match those contained in 10 CFR 50, Appendix B; for example, testing is not addressed.

Procedures: ASME Section VIII, Appendix 10 requires a quality assurance program that includes provisions for procedures that will ensure that the latest versions of drawings, design calculations, and specifications are available. However, 10 CFR 50, Appendix B includes much more detailed requirements regarding the contents of written procedures and the appropriate approval process for procedures.

Testing, Inspection, and Examination: The testing, inspection, and examination requirements contained in Section VIII do not address items such as personnel qualification, continued training and certification, etc., in comparable detail to 10 CFR 50, Appendix B.

Design Requirements: Nozzles and reinforcements on pressure vessels are similar to containment penetrations, but there appear to be too many differences to conclude that design requirements are similar.

Analysis: Section VIII has no personnel qualification or checking requirements.

Design Verification: Section VIII has no universal design verification requirements.

Design Control: ASME Section VIII, Appendix 10 requires a quality assurance program that includes provisions for procedures that will ensure that the latest versions of drawings, design calculations, and specifications are available. 10 CFR 50, Appendix B includes much more detailed requirements on design control, such as design interfaces and coordination, design change control, etc.

Procurement: 10 CFR 50, Appendix B requires that vendors provide components under an Appendix B Quality Assurance program. Section VIII of the ASME Code does not have similarly stringent requirements.

Manufacturing: Manufacturing requirements of Section VIII are roughly similar to the containment penetration requirements, but there are differences.

Shipping, Storage, and Handling: Section VIII of the ASME Code does not include as rigorous requirements on shipping, storage, and handling, such as measures to prevent use of incorrect parts or components, as those found in 10 CFR 50, Appendix B.

Receipt Inspection: The guidelines contained in Section VIII are not comparable to the level of detail contained in 10 CFR 50, Appendix B. These differences are mainly in the areas of the level or record keeping required.

Installation: There are numerous differences in Section VIII and the containment installation process.

Monitoring: Section VIII of the ASME Code contains no guidance on this topic that is comparable to the requirements of 10 CFR 50, Appendix B.

Repair, Replacement, or Modification: Section VIII of the ASME Code contains some guidance on the repair of material defects; however, these requirements are not comparable to the level of detail contained in 10 CFR 50, Appendix B.

Maintenance: Section VIII of the ASME Code contains no guidance on this topic comparable to that included in 10 CFR 50, Appendix B.

Trending: Section VIII of the ASME Code contains no guidance on this topic comparable to that included in 10 CFR 50, Appendix B.

Corrective Action: Section VIII of the ASME Code contains no guidance on this topic comparable to that included in 10 CFR 50, Appendix B.

4.10 Tanks

4.10.1 Commercial Standard

ANSI/AWWA D100-96 (Welded Steel Tanks for Water Storage).

4.10.2 Special Treatment Requirements

- 10 CFR 50, GDC 1 and 2, and Appendices B and S

4.10.3 Tanks Synopsis

The design requirements for an individual tank are generally governed by the intended service, such as water storage; magnitude of the loads imposed; the types of loads expected, such as pressure, temperature, seismic, etc.; and other application specific parameters. The design requirements differences between the special treatment rules applicable to tanks and the rules contained in commercially available standards do not result in a significant reduction of confidence in the assurance of tank functionality. Likewise, the differences in the special treatment rules and commercial standards addressing the manufacturing operations tanks and the operations needed to install them do not result in a significant reduction of confidence in the assurance of vessel functionality. However, as detailed in the subsections below, significant differences between the special treatment rule requirements and the available commercial standards do exist in the other critical processes.

4.10.4 Commercial Standards Comparison with Nuclear Processes

Documentation: ANSI/AWWA D100-96 includes requirements for the documentation of welder qualification and weld inspections. In addition, the recommendation is made that tank drawings certified by a registered professional engineer be provided to the purchaser. Other than the limited areas cited, ANSI/AWWA D100-96 has no specific documentation requirements.

Quality Assurance: ANSI/AWWA D100-96 does not include requirements for a quality assurance program.

Procedures: ANSI/AWWA D100-96 includes the requirement for the qualification of welding procedures. Other than the limited area cited, ANSI/AWWA D100-96 has no specific procedural control requirements.

Testing, Inspection, and Examination: ANSI/AWWA D100-96 addresses testing, inspection, and examination only from the perspective of shop and field inspection of welds.

Design Requirements: No significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: ANSI/AWWA D100-96 has no requirements for personnel qualification, analysis checking, or functionality assurance.

Design Verification: ANSI/AWWA D100-96 has no requirements for design verification.

Design Control: ANSI/AWWA D100-96 has no requirements for design control.

Procurement: ANSI/AWWA D100-96 includes recommendations on items that should be included in the purchasing specification; however, these are not requirements. No requirements for vendor quality assurance programs, vendor qualification, etc., are included.

Manufacturing: No significant differences that would affect the reasonable confidence of component functionality were identified.

Shipping, Storage, and Handling: ANSI/AWWA D100-96 does not address the shipping, storage, and handling of tanks, tank sections, or components.

Receipt Inspection: ANSI/AWWA D100-96 does not address this topic.

Installation: No significant differences that would affect the reasonable confidence of component functionality were identified.

Monitoring: ANSI/AWWA D100-96 does not address this topic.

Repair, Replacement, or Modification: Except for the repair of defective welds, ANSI/AWWA D100-96 does not address this topic.

Maintenance: ANSI/AWWA D100-96 does not address this topic.

Trending: ANSI/AWWA D100-96 does not address this topic.

Corrective Action: ANSI/AWWA D100-96 does not address this topic.

4.11 Heat Exchangers

4.11.1 Commercial Standard

Standards of the Tubular Exchanger Manufacturers Association (TEMA), Seventh Edition, 1988. The vessel or pressure boundary components can be, if specified, manufactured and stamped to ASME Code Section VIII. This evaluation addresses only the TEMA standard. The TEMA provides design information, guidelines, brief shipping information, and recommended good practices for heat exchangers.

4.11.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME III)
- 10 CFR 50, GDC 1, 2, 45, and 46, and Appendix B
- 10 CFR 100, Appendix A

The TEMA standard does not address quality assurance. If so specified, the vessel can be built to Section VIII and stamped, but there are no in-service inspection requirements. The standard suggests considering all loading, including seismic loads. Equipment qualification would not be applicable for this mechanical component.

4.11.3 Heat Exchanger Synopsis

Heat exchangers are subject to pressure boundary requirements of ASME Code Sections III and XI, QA requirements, GDC 1, 2, 4, 45, and 46. The commercial standards of the TEMA, Seventh Edition, 1988, was reviewed. Commercial heat exchangers can be ordered to ASME Code Section VIII if required by an equipment specification. The TEMA standard addressed design requirements, analysis, and maintenance. These processes must be required by a component specification and implemented by plant procedures. Quality assurance and the other critical processes were not addressed by the standard. However, alternate QA programs and other plant processes could be used to provide reasonable confidence of functionality.

4.11.4 Commercial Standards Comparison with Nuclear Processes

Documentation: The TEMA standard only addresses drawings and requires the manufacture to furnish copies of the ASME Manufacture's Data Report for stamped exchangers.

Quality Assurance: The TEMA standard requires no program.

Procedures: The TEMA standard does not address the detailed shop operations and leaves this to the discretion of the manufacturer.

Testing, Inspection, and Examination: There are no specific requirements for inspection or testing. The purchaser should specify the inspection, testing, or examination that should be accomplished on the heat exchanged.

Design Requirements: The TEMA standard does have detailed design requirements and recommendations.

Analysis: The TEMA standard provides detailed analysis recommendations.

Design Verification: The TEMA standard does not address verification.

Design Control: The TEMA standard does not address design control.

Procurement: A specification sheet example is provided as a recommendation, but little detail is provided on how to complete the specification sheet.

Manufacturing: Inspections points, personnel qualification, permitted materials, welding and joining are not discussed, but would be covered by ASME Code Section VIII for a stamped vessel.

Shipping, Storage, and Handling: Preparation for shipping of heat exchangers is covered briefly, but the TEMA standard does not cover many of the attributes.

Receipt: The TEMA standard does not cover receipt of heat exchangers.

Installation: Clearances, foundations, bolting, and leveling are discussed, but not all attributes are addressed by the TEMA standard.

Monitoring: The TEMA standard does not address monitoring.

Repair, Replacement, or Modification: The TEMA standard does not address repair and replacement or modification.

Maintenance: An extensive section on maintenance is included in the TEMA standard.

Trending: The standard does not address trending.

Corrective Action: This area is not addressed by the standard.

4.12 Pipe Supports

4.12.1 Commercial Standard

ASME B31.1, MSS SP-58, AISC Manual of Steel Construction, and MSS SP-89.

4.12.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME Section III, Subsection NF)
- 10 CFR 50, Appendix B
- 10 CFR 100, Appendix A

4.12.3 Pipe Support Synopsis

Piping supports are generally constructed of standard components such as spring hangers with associated standard clamps and fittings, which are fabricated from structural steel members or a combination of standard components and structural steel members such as a snubber attached to a structural steel column anchored to the floor. The design requirements for an individual support are generally governed by the magnitude of the loads imposed, the types of loads expected, such as thermal expansion, seismic, etc., the location of the support, and other application specific parameters. The differences in design requirements between the special treatment rules applicable to pipe supports and the rules contained in commercially available standards do not result in a significant reduction of confidence in the assurance of pipe support functionality. Likewise, the differences in the special treatment rules and commercial standards addressing the manufacturing operations to fabricate the support and the operations needed to install the support do not result in a significant reduction of confidence in the assurance of pipe support functionality. However, as detailed in the subsections below, significant differences between the special treatment rule requirements and the available commercial standards do exist in the other critical processes.

4.12.4 Commercial Standards Comparison with Nuclear Processes

Documentation: There is no universally used commercial standard requiring documentation. In fact, documentation is not specifically required by B31.1 except in the area of weld records. Similarly, the AISC Steel Manual and MSS Standard Practices (SPs) do not specifically require documentation.

Quality Assurance: There is no universally used commercial standard requiring a quality assurance program. B31.1 does not specifically require a quality assurance program, and AISC does offer a Quality Certification designation. However, this is voluntary. MSS SP-89 recommends that quality control should be exercised over the procurement of raw materials, fabrication procedures, and dimensions, but these are not requirements.

Procedures: Except for welding, B31.1 does not require use of written procedures. The other commercial standards are similar in this regard.

Testing, Inspection, and Examination: MSS SP 58 places any requirements for testing, inspection, and examination on the purchaser of the component. The AISC Code of Standard Practice contains no specific testing, inspection, or examination requirements. Under AISC, any such requirements would have to be specifically stated in the owner's specifications. MSS SP-89 does include recommendations for three categories of tests (design proof tests, qualification tests, and calibration tests) for pipe hanger components. However, it is not stated that these are required tests. MSS SP-89 also recommends that there should be an inspection program and suggests in-process inspection points, but again, these are recommendations, not requirements.

Design Requirements: No significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: B31.1, AISC, and the MSS SPs have no personnel qualification or checking requirements.

Design Verification: There is no universally used commercial standard requiring design verification. Neither B31.1, MSS SP-58, the AISC Manual of Steel Construction nor MSS SP-89 address design verification.

Design Control: There is no universally used commercial standard requiring design control. Neither B31.1, MSS SP-58, the AISC Manual of Steel Construction nor MSS SP-89 address design control.

Procurement: Neither B31.1, MSS SP-58, or the AISC Manual of Steel Construction contain specific procurement requirements.

Manufacturing: No significant differences that would affect the reasonable confidence of component functionality were identified.

Shipping, Storage, and Handling: Neither B31.1, MSS SP-58, nor the AISC Manual of Steel Construction contain specific shipping, storage, and handling requirements. Similarly, MSS SP-89 only contains very general recommendations for packaging, marking, shipping, receiving, and storage.

Receipt Inspection: Neither B31.1, MSS SP 58, nor the AISC Manual of Steel Construction contain specific requirements that address receipt inspection. MSS SP-89 only contains very general recommendations for packaging, marking, shipping, receiving, and storage.

Installation: No significant differences that would affect the reasonable confidence of component functionality were identified.

Monitoring: There is no universally used commercial standard requiring monitoring. Neither B31.1, MSS SP-58, nor the AISC Manual of Steel Construction contain specific requirements that address this topic.

Repair, Replacement, or Modification: There is no universally used commercial standard addressing repair, replacement, or modification. B31.1 and MSS SP-58 provide limited guidance on weld repairs. The AISC Manual of Steel Construction contains no specific requirements that address this topic.

Maintenance: There is no universally used commercial standard addressing maintenance. Neither B31.1, MSS SP-58, nor the AISC Manual of Steel Construction contain specific requirements that address this topic.

Trending: There is no universally used commercial standard requiring trending. Neither B31.1, MSS SP-58, nor the AISC Manual of Steel Construction contain specific requirements that address this topic.

Corrective Action: There is no universally used commercial standard addressing corrective action. Neither B31.1, MSS SP-58, nor the AISC Manual of Steel Construction contain specific requirements that address this topic.

4.13 Vessel and Tank Supports

4.13.1 Commercial Standard

AISC Manual of Steel Construction.

4.13.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME Section III, Subsection NF)
- 10 CFR 50, Appendix B
- 10 CFR 100, Appendix A

4.13.3 Vessel and Tank Support Synopsis

Vessel and tank supports are generally fabricated from either structural steel members or plate steel components, depending on the configuration of the vessel or tank (leg, column, or skirt supported, etc.). The design requirements for an individual support system are generally governed by the magnitude of the loads imposed, the types of loads expected,(thermal expansion, seismic, etc.), the location of the vessel or tank, and other application specific parameters. The design requirements differences between the special treatment rules applicable to vessel or tank supports and the rules contained in commercially available standards do not result in a significant reduction of confidence in the assurance of pipe support functionality. Likewise, the differences in the special treatment rules and commercial standards addressing the manufacturing operations to fabricate the support and the operations needed to install the support do not result in a significant reduction of confidence in the assurance of pipe support functionality. However, as detailed in the subsections below, significant differences between the special treatment rule requirements and the available commercial standards do exist in the other critical processes.

4.13.4 Commercial Standards Comparison with Nuclear Processes

Documentation: There is no universally used commercial standard requiring documentation. The AISC Steel Manual does not specifically require documentation.

Quality Assurance: There is no universally used commercial standard requiring a quality assurance program. AISC does offer a Quality Certification designation; however, this is voluntary.

Procedures: AISC does not require use of written procedures.

Testing, Inspection, and Examination: The AISC Code of Standard Practice contains no specific testing, inspection, or examination requirements. Under AISC, any such requirements would have to be specifically stated in the owner's specifications.

Design Requirements: No significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: AISC has no personnel qualification or checking requirements.

Design Verification: There is no universally used commercial standard requiring design verification. The AISC Manual of Steel Construction does not address design verification.

Design Control: There is no universally used commercial standard requiring design control. The AISC Manual of Steel Construction does not address design control.

Procurement: The AISC Manual of Steel Construction contains no specific procurement requirements.

Manufacturing: No significant differences that would affect the reasonable confidence of component functionality were identified.

Shipping, Storage, and Handling: The AISC Manual of Steel Construction contains no specific shipping, storage, or handling requirements.

Receipt Inspection: The AISC Manual of Steel Construction contains no specific requirements that address receipt inspection.

Installation: No significant differences that would affect the reasonable confidence of component functionality were identified.

Monitoring: There is no universally used commercial standard requiring monitoring. The AISC Manual of Steel Construction contains no specific requirements that address this topic.

Repair, Replacement, or Modification: There is no universally used commercial standard requiring repair, replacement, or modification. The AISC Manual of Steel Construction contains no specific requirements that address this topic.

Maintenance: There is no universally used commercial standard requiring maintenance. The AISC Manual of Steel Construction contains no specific requirements that address this topic.

Trending: There is no universally used commercial standard requiring trending. The AISC Manual of Steel Construction contains no specific requirements that address this topic.

Corrective Action: There is no universally used commercial standard requiring corrective action. The AISC Manual of Steel Construction contains no specific requirements that address this topic.

4.14 Gaskets

4.14.1 Commercial Standard

Gaskets are designed and manufactured to ASME Standard 16.21, Nonmetallic Flat Gaskets for Pipe Flanges, ASME Standard ASME B16.20-1998, Metallic Gaskets for Pipe Flanges, Ring-Joint, Spiral-Wound, and Jacketed; ASME B16.20a-1994 Addenda to B16.2, and ASME B16.20b-1997 Addenda to B16.20. The gaskets can, if specified, be manufactured to Section VIII, but is not required. Therefore, this evaluation will only address the B16 series of ASME standards.

4.14.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, 45, and 46, and Appendix B
- 10 CFR 100, Appendix A

4.14.3 Gasket Synopsis

Gaskets are subject to QA, seismic, and all of the GDCs, since these components provide pressure boundary integrity for piping systems, heat removal systems, and vessels. The commercial standards provide adequate design requirements when specified in design specifications using specific plant application design requirements. The other critical processes are not addressed. However, alternate QA programs and other plant processes could be used to provide reasonable confidence of functionality.

4.14.4 Commercial Standards Comparison with Nuclear Processes

Documentation: The standards address marking of gaskets to indicate material type, flange size, etc., but do not address other documentation.

Quality Assurance: Standard B16.20 mentions ISO 9000 in Nonmandatory Annex A, Quality System Program.

Procedures: The standards do not address procedures.

Testing, Inspection, and Examination: The standards do not address the testing, inspection, and examination of gaskets.

Design Requirements: The standards provide design information about gaskets.

Analysis: Analysis is not mentioned in the standards.

Design Verification: Design verification is not mentioned in the standards.

Design Control: The standards do not address design control.

Procurement: The standards do not address procurement.

Manufacturing: Dimensions, tolerances, and materials are mentioned, but no detailed manufacturing information is provided on gaskets.

Shipping, Storage, and Handling: Shipping, storage, and handling requirements are not mentioned in the standards.

Receipt Inspection: Receipt inspection of gaskets is not mentioned in the standard.

Installation: Gasket compression and tolerances are mentioned in the standards.

Monitoring: Monitoring is not mentioned in the standards.

Repair, Replacement, or Modification: Repair, replacement, or modification requirements are not mentioned in the standards.

Maintenance: The standards do not address maintenance of gaskets.

Trending: Trending is not mentioned in the standards.

Corrective Action: Corrective action is not mentioned in the standards.

4.15 Air Compressors

4.15.1 Commercial Standard

American Society Mechanical Engineers, 1995, Safety Standard for Air Compressor Systems, ASME B19.1. This standard provides safety guidelines for the design, installation, and operation of air compressor systems. Several other component-specific standards are referenced, but are not addressed in this analysis.

4.15.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME III, IST, OM)
- 10 CFR 50, GDC 45 and 46 and Appendix B
- 10 CFR 100, Appendix A

4.15.3 Air Compressor Synopsis

Air compressor systems are typically designed to ASME B19.1. They are also subject to the quality, seismic, and equipment qualification special treatment rules and may be subject to pressure boundary requirements of ASME Section III. When special treatment requirements are compared to commercial codes and standards (ASME B19.1) there are significant differences in all processes. For example, while ASME B19.1 includes extensive air compressor equipment performance requirements to address safety in all areas of air compressor operation, it assumes that the compressor is designed in accordance with recognized standards and specifications. Verification of design capacity is not required. System performance requirements and seismic issues are not addressed. Test requirements are left up to the manufacturer. Therefore, ASME B19.1 is not adequate to provide reasonable confidence of valve functionality. However, other industry quality assurance programs and other plant processes may be used to provide reasonable confidence of functionality.

4.15.4 Commercial Standards Comparison with Nuclear Processes

Documentation: ASME B19.1 does not include any requirements that addresses the documentation associated with the design, installation, or operation of air compressor systems.

Quality Assurance: ASME B19.1 does not include any requirements that addresses the quality assurance process associated with the design, installation, or operation of air compressor systems.

Procedures: ASME B19.1 requires that comprehensive maintenance and operating procedures be implemented. These procedures should be based on the manufacturer's recommendations. ASME B19.1 does not address procedural quality control issues or the use of acceptance criteria.

Testing, Inspection, and Examination: ASME B19.1 specifies that testing should be performed in accordance with the manufacturer s recommendations. Test records are required to be maintained and reviewed regularly. However, the standard does not address the test program development, qualification of test personnel, the test methods to be used, the types of testing to be performed, or the acceptance criteria to be applied.

Design Requirements: ASME B19.1 includes extensive air compressor equipment performance requirements to address safety in all areas of air compressor operation. These requirements focus on the proper design of the safety equipment such as pressure relief devices, high temperature shutdown devices, protective guards, and over-speed controls, and the air piping systems. ASME B19.1 assumes that qualified engineers in accordance with recognized standards and specifications design the compressor itself. System performance requirements and seismic issues are not addressed.

Analysis: ASME B19.1 does not include any personnel qualification or checking requirements related to the design, installation, or operation of air compressor systems.

Design Verification: ASME B19.1 does not include any requirements to verify the design adequacy of the air compressor equipment except to verify that manufacturer's recommendations and all appropriate safety codes have been met regarding safety and protection of personnel.

Design Control: ASME B19.1 does not include any requirements that address the design control process associated with air compressor systems.

Procurement: ASME B19.1 does not include any requirements that address the procurement process associated with air compressor systems.

Manufacturing: ASME B19.1 does not include any requirements that address the manufacturing of air compressor systems.

Shipping, Storage, and Handling: ASME B19.1 does not include any requirements that address the shipping, storage, and handling processes associated with air compressor systems.

Receipt Inspection: ASME B19.1 does not include any requirements that address receipt inspections of air compressor systems.

Installation: ASME B19.1 does not include any requirements that address installation of air compressor systems.

Monitoring: ASME B19.1 notes that operational and maintenance records can be an important diagnostic tool. However, the standard only requires that records be kept and that they be reviewed regularly. ASME B19.1 does not require a formal monitoring program that identifies equipment degradation and performs root cause analysis.

Repair, Replacement, or Modification: ASME B19.1 does not include any requirements that address the repair, replacement, or modification of air compressor systems.

Maintenance: ASME B19.1 requires that a maintenance program be implemented that addresses routine maintenance, preventive maintenance, troubleshooting, and overhaul using the manufacturer's instructions as the basis. ASME B19.1 does not address qualification of replacement parts.

Trending: ASME B19.1 does not include any requirements that address the performance trending of air compressor systems.

Corrective Action: ASME B19.1 does not include any requirements to implement a corrective action program for air compressor systems.

4.16 HVAC

4.16.1 Commercial Standard

UBC, ASCE 7, ASHRAE 52, UL 900, SMACNA, NFPA 90A, and AWS D1.1.

4.16.2 Special Treatment Requirements

- 10 CFR 20
- 10 CFR 50.49
- 10 CFR 50, GDC 45 and 46, and Appendix B
- 10 CFR 100, Appendix A

4.16.3 Related Nuclear Guidance

- ASME Nuclear Power Plant Air-Cleaning Units Components (ASME N509) and Testing of Nuclear Air-Treatment Systems (N510) for design and testing of HVAC equipment.

4.16.4 HVAC Synopsis

Nuclear HVAC systems are typically designed and tested to ASME Nuclear Codes N509, N510, and AG-1. They are also subject to the quality, seismic, and equipment qualification special treatment rules. Since HVAC systems are comprised of a number of components such as ducting, fans, and filters, several commercial standards relate to their construction. Commercial seismic requirements are covered by standards such as the UBC and ASCE 7 which specify seismic requirements different than nuclear codes, but nevertheless give reasonable confidence of functionality. Quality and equipment qualification requirements are not addressed in commercial codes, although ISO 9001 would cover quality requirements if specified. Testing of filters is covered in commercial codes, so if the design specification gives the filtration efficiency (including radiation) requirements, this area should be adequately covered. Guidance on welding is given in the American Society of Welding codes, but there are no in-service weld test requirements.

4.16.5 Commercial Standards Comparison with Nuclear Processes

Documentation: There is no universally used commercial standard requiring documentation.

Quality Assurance: There is no universally used commercial standard requiring a quality assurance program.

Procedures: There is no universally used commercial standard requiring the use of procedures.

Testing, Inspection, and Examination: ASHRAE 52 and UL 900 give methods for testing air cleaning efficiency. SMACNA gives guidance on leakage testing. AWS D1.1 gives guidance on welding manufacturing, but no ISI is required for welds.

Design Requirements: Commercial HEPA (high-efficiency particulate air) filters and absorbers are not specifically designed to remove radioactive particles. The requirement for radioactive particle removal would have to be included in the design specification, but there are no qualification requirements for equipment such as local transmitters, hand switches, limit switches, instrumentation, or alarms in commercial practice.

Analysis: The seismic analysis methods in commercial standards are equivalent static methods.

Design Verification: There is no universally used commercial standard requiring design verification.

Design Control: There is no universally used commercial standard requiring design control.

Procurement: There is no universally used commercial procurement standard.

Manufacturing: No significant differences that would affect the reasonable confidence of component functionality were identified.

Shipping, Storage, and Handling: There is no universally used commercial standard requiring shipping, storage, and handling.

Receipt Inspection: There is no universally used commercial standard requiring receipt inspection.

Installation: No significant differences that would affect the reasonable confidence of component functionality were identified.

Monitoring: There is no universally used commercial standard requiring monitoring.

Repair, Replacement, or Modification: There is no universally used commercial standard requiring repair, replacement, or modification.

Maintenance: There is no universally used commercial standard requiring maintenance.

Trending: There is no universally used commercial standard requiring trending.

Corrective Action: There is no universally used commercial standard requiring corrective action.

4.17 Rupture Disks

4.17.1 Commercial Standard

ASME Section VIII.

4.17.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME Section III)
- 10 CFR 50, GDC 1 and 2, and Appendices B and S

4.17.3 Rupture Disk Synopsis

Design requirements for commercial rupture disks can be found in Section VIII of the ASME Code. A comparison of ASME Section III versus Section VIII for rupture disks is very similar to the description in Section 6.8.3 for pressure vessels. Section VIII requires a quality assurance program, but the requirements are not as stringent as those in Section III. Other industry standards or individual plant processes may be used to provide reasonable confidence of functionality. There are sufficient design, manufacturing, and testing requirements in Section VIII to provide reasonable confidence of functionality.

4.17.4 Commercial Standards Comparison with Nuclear Processes

Documentation: ASME Section VIII does require a quality assurance program; however, the level of documentation required is generally much less than that required by ASME Section III, or that required under 10 CFR 50, Appendix B.

Quality Assurance: ASME Section VIII, Appendix 10 requires a quality assurance program; however, the program requirements do not match those contained in 10 CFR 50, Appendix B. For example, testing is not addressed.

Procedures: ASME Section VIII, Appendix 10 requires a quality assurance program that includes provisions for procedures that will ensure that the latest versions of drawings, design calculations, and specifications are available, but 10 CFR 50, Appendix B includes much more detailed requirements regarding the contents of written procedures and the appropriate approval process for procedures.

Testing, Inspection, and Examination: The testing, inspection, and examination requirements contained in Section VIII do not address items such as personnel qualification, continued training and certification, etc., in comparable detail to 10 CFR 50, Appendix B.

Design Requirements: No significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: Section VIII has no personnel qualification or checking requirements.

Design Verification: Section VIII has no universally design verification requirements.

Design Control: ASME Section VIII, Appendix 10 requires a quality assurance program that includes provisions for procedures to ensure that the latest versions of drawings, design calculations, and specifications are available. 10 CFR 50, Appendix B includes more detailed design control requirements on design interfaces and coordination, design change control, etc.

Procurement: 10 CFR 50, Appendix B requires that vendors provide components under an Appendix B Quality Assurance program. Section VIII of the ASME Code does not have similarly stringent requirements.

Manufacturing: No significant differences that would affect the reasonable confidence of component functionality were identified.

Shipping, Storage, and Handling: No significant differences that would affect the reasonable confidence of component functionality were identified.

Receipt Inspection: The guidelines contained in Section VIII are not comparable to the level of detail contained in 10 CFR 50, Appendix B. These differences are mainly in the areas of the level of record keeping required.

Installation: No significant differences that would affect the reasonable confidence of component functionality were identified.

Monitoring: Section VIII of the ASME Code contains no guidance on this topic that is comparable to the requirements of 10 CFR 50, Appendix B.

Repair, Replacement, or Modification: Section VIII of the ASME Code contains some guidance on repairing material defects; however, these requirements are not comparable to the level of detail contained in 10 CFR 50, Appendix B.

Maintenance: Section VIII of the ASME Code contains no guidance on this topic comparable to that included in 10 CFR 50, Appendix B.

Trending: Section VIII of the ASME Code contains no guidance on this topic comparable to that included in 10 CFR 50, Appendix B.

Corrective Action: Section VIII of the ASME Code contains no guidance on this topic comparable to that included in 10 CFR 50, Appendix B.

4.18 Ion Exchangers

4.18.1 Commercial Standard

The applicable commercial standard was ASME PTC 31-1973, Ion Exchange Equipment, Performance Test Code. Pressure boundary components could be ordered as noncode or ASME Code Sections VIII or X. ASME Code Section VIII and X are not evaluated since they are not required to be used.

4.18.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, and 4, and Appendix B
- 10 CFR 100, Appendix A

4.18.3 Ion Exchanger Synopsis

Ion exchangers are typically used as components to clean up water used in plant systems. Ion exchanger components must maintain pressure boundary integrity so must be designed for seismic conditions, designed to ASME Code Section III, and inspected to ASME Section XI. GDC 1, 2, and 4 and QA requirements would apply. Seismic analysis and ASME Section VIII vessel should be adequate to provide reasonable confidence of functionality for the pressure boundary. The commercial standard, ASME Ion Exchange Equipment Performance Test Code (ASME PTC31-1973) only addressed testing of the ion exchange process. These tests should be adequate when implemented by a specification for manufacturer and procedures for in-plant testing, inspection, and examination of the ion exchange process. None of the other processes were adequately addressed by the standard. However, alternate QA programs and other plant processes could be used to provide reasonable confidence of functionality.

4.18.4 Commercial Standards Comparison with Nuclear Processes

Documentation: There are no requirements for documentation in PCT31-1973.

Quality Assurance: There are no quality assurance requirements in PCT31-1973.

Procedures: There are no requirements for procedures in PCT31-1973.

Testing, Inspection, and Examination: PCT31-1973 specifically requires tests of ion exchanger components.

Design Requirements: There are no design requirements in PCT31-1973.

Analysis: There are no analysis requirements in PCT31-1973.

Design Verification: There are no requirements for design verification in PCT31-1973.

Design Control: There are no requirements for design control in PCT31-1973.

Procurement: There are no procurement requirements in PCT31-1973.

Manufacturing: There are no manufacturing requirements in PCT31-1973.

Shipping, Storage, and Handling: There are no shipping, storage, and handling requirements in PCT31-1973.

Receipt: There are no receipt inspection requirements in PCT31-1973.

Installation: There are no installation requirements in PCT31-1973.

Monitoring: There is nothing that requires PCT31-1973 being used for monitoring the performance of the ion exchange component. Not all of the attributes of this process would be met.

Repair, Replacement, or Modification: PCT31-1973 does not address repair, replacement, or modification issues.

Maintenance: PCT31-1973 does not address maintenance issues.

Trending: There is no requirement for equipment trending in PCT31-1973.

Corrective Action: There is no requirement for corrective action in PCT31-1973.

4.19 Bolts

4.19.1 Commercial Standard

ASME Section VIII, ANSI B18.2.1 (dimensional requirements only).

4.19.2 Special Treatment Requirements

- 10 CFR 50.55a (ASME Section III)
- 10 CFR 50, Appendix B.

4.19.3 Bolts Synopsis

The bolts addressed in this subsection are those commonly used in power plants for such applications as securing flanged piping component connections, attaching valve operators to valve bonnets, completing structural connections in piping support structural members, etc. Both the special treatment rules and commercial standards impose material requirements and design rules for bolted joints. Thus, the design requirement differences between the special treatment rules applicable to these bolts and the rules contained in commercially available standards do not result in a significant reduction of confidence in the assurance of bolt (or bolted joint) functionality. Likewise, the differences in the special treatment rules and commercial standards addressing the manufacturing or installation do not result in a significant reduction of confidence in the assurance of pipe support functionality. However, as detailed in the subsections below, significant differences between the special treatment rule requirements and the available commercial standards do exist in the other critical processes.

4.19.4 Commercial Standards Comparison with Nuclear Processes

Documentation: The documentation requirements of Section VIII are less stringent than those imposed by Section III.

Quality Assurance: Appendix 10 of Section VIII contains mandatory quality control system requirements. Whereas this appendix addresses some of the same topics as 10 CFR 50, Appendix B, such as authority and responsibility, the same elements are not all addressed and comparable level of detail is not included in Appendix 10 of Section VIII.

Procedures: Appendix 10 of Section VIII contains requirements for procedures that ensure that the latest drawings and specifications are used; however, these requirements are not equivalent to those of 10 CFR 50, Appendix B.

Testing, Inspection, and Examination: Appendix 10 of Section VIII contains requirements for examination and inspection. However, the requirements only specify the description of fabrication stages where inspections are to be performed. These requirements are not equivalent to those of 10 CFR 50, Appendix B.

Design Requirements: No significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: Appendix 10 of Section VIII has no personnel qualification or checking requirements for analyses.

Design Verification: Appendix 10 of Section VIII has no design verification requirements.

Design Control: Appendix 10 of Section VIII does not address design control.

Procurement: Section VIII of the ASME Code does not contain specific procurement requirements.

Manufacturing: No significant differences that would affect the reasonable confidence of component functionality were identified.

Shipping, Storage, and Handling: Section VIII of the ASME Code does not contain specific shipping, storage, and handling requirements.

Receipt Inspection: Section VIII of the ASME Code contains no specific requirements that address receipt inspection.

Installation: No significant differences that would affect the reasonable confidence of component functionality were identified.

Monitoring: Section VIII of the ASME Code contains no specific requirements that address this topic.

Repair, Replacement, or Modification: Neither Section III or Section VIII of the ASME Code address repair, replacement, or modification of bolting.

Maintenance: Section VIII of the ASME Code contains no specific requirements that address this topic relative to bolting.

Trending: Section VIII of the ASME Code contains no specific requirements that address this topic relative to bolting.

Corrective Action: Section VIII of the ASME Code contains no specific requirements that address this topic relative to bolting.

4.20 Anchor Bolts

4.20.1 Commercial Standard

Standard Industry Practices, ISO 9001 (the major manufacturer's catalog consulted listed the company as ISO 9001 certified).

4.20.2 Special Treatment Requirements

- 10 CFR 50, Appendix B.

4.20.3 Related Nuclear Guidance

- American Concrete Institute ACI-349 series (Reinforced Concrete Design for Thermal Effects on Nuclear Power Plant Structures, Embedment Design Examples, Evaluation of Existing Nuclear Safety Related Concrete Structures, and Code Requirements for Nuclear Safety Related Concrete Structures & Commentary) for anchor bolt design.

- NRC IE Bulletins, such as 79-02, provide the NRC staff position for anchor bolt design.

4.20.4 Anchor Bolts Synopsis

The anchor bolts addressed in this subsection are those commonly referred to as concrete anchor bolts. These fasteners may be of a type that are located during construction ("cast in place") or of the wedge or sleeve type that are inserted in a hole drilled in the concrete floor or wall at the desired location subsequent to concrete placement. These bolts are most often used to secure components such as piping support base plates, electrical cabinets, pump supports, etc., to the plant building structure. Both the special treatment rules and commercial standards impose material requirements and design rules for bolted joints. Thus, the design requirement differences between the special treatment rules applicable to these bolts and the rules contained in commercially available standards do not result in a significant reduction of confidence in the assurance of bolt (or bolted joint) functionality. Likewise, the differences in the special treatment rules and commercial standards addressing manufacturing do not result in a significant reduction of confidence in the assurance of pipe support functionality. Parameters such as edge distance, embedment depth, etc., that are shown in both the nuclear and commercial codes and standards generally agree with the manufacturer's installation instructions; thus, no significant differences in installation requirements that would affect the confidence of anchor bolt functionality were identified. However, as detailed in the subsections below, significant differences between the special treatment rule requirements and the available commercial standards do exist in the other critical processes.

4.20.5 Commercial Standards Comparison with Nuclear Processes

Documentation: There is no universally used commercial standard requiring documentation.

Quality Assurance: There is no universally used commercial standard requiring a quality assurance program.

Procedures: Manufacturer's installation procedures are available; however, there is no requirement for the used of documented and controlled installation procedures.

Testing, Inspection, and Examination: There is no universally used commercial standard requiring a testing, inspection, or examination program for anchor bolts. No ISI is required.

Design Requirements: No significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: There are no universally applicable standards governing the analysis of anchor bolts, personnel qualifications, or checking requirements.

Design Verification: There is no universally used commercial standard requiring design verification.

Design Control: There is no universally used commercial standard requiring design control.

Procurement: B31.1 requires specified material and manufacturing methods.

Manufacturing: There were no significant differences that would affect the reasonable confidence of component functionality identified.

Shipping, Storage, and Handling: There is no universally used commercial standard requiring shipping, storage, and handling.

Receipt Inspection: There is no universally used commercial standard requiring receipt inspection.

Installation: There were no significant differences that would affect the reasonable confidence of component functionality identified.

Monitoring: There is no universally used commercial standard requiring monitoring.

Repair, Replacement, or Modification: There is no universally used commercial standard requiring repair, replacement, or modification.

Maintenance: There is no universally used commercial standard requiring maintenance.

Trending: There is no universally used commercial standard requiring trending.

Corrective Action: There is no universally used commercial standard requiring corrective action.

4.21 Lighting

4.21.1 Commercial Standard

The Illuminating Engineering Society of North (IESNA) Lighting Handbook provides reference and application information for lighting, UL Standards 676, 844, 1598, and 1994 that address underwater, hazardous locations, nonhazardous locations, and low-level and marking lighting systems. SAE J 95 and J 96 address headlamps and flashing warning lamps for industrial equipment.

4.21.2 Special Treatment Requirements

- 10 CFR 50.49
- 10 CFR 50, GDC 1, 2, and 4, and Appendix B
- 10 CFR 100, Appendix A.

4.21.3 Lighting Synopsis

Some lighting is located in areas that are subject to accident conditions. That lighting must meet EQ requirements as well as the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards there are significant differences in all processes except design requirements, maintenance, and trending. The IESNA Lighting Handbook contains basic lighting requirements that must be met by all lighting systems, and design requirements addressed by the combination of the reviewed standards (IESNA Lighting Handbook, UL Standards 676, 844, 1598, and 1994) should lead to a full set of design requirements. Maintenance of lighting systems is covered in Chapter 32 of the IESNA Lighting Handbook, which also contains information, charts, and figures, etc., that support trending light output. This information is used to plan for the maintenance and/or replacement of system components.

4.21.4 Commercial Standards Comparison with Nuclear Processes

Documentation: The reviewed standards to do not address documentation requirements.

Quality Assurance: The reviewed standards do not address quality assurance programs.

Procedures: Procedures are not identified. Manufacturing facilities are certified to be acceptable suppliers of equipment using plant inspections and the acceptance of the facility's quality assurance program.

Testing, Inspection, and Examination: All the reviewed UL standards require testing to certify the equipment. Certificates indicating that the equipment meets the requirements of each standard are affixed to each unit. Routine testing during the operational phase is not addressed.

Design Requirements: The IESNA Lighting Handbook contains basic lighting requirements that all lighting systems must meet. The design requirements addressed by the combination of the reviewed standards should lead to a full set of design requirements.

Analysis: The reviewed standards do not address the analysis process.

Design Verification: Testing required by the UL standards provides for design verification of safety related lighting. However, seismic events are not included.

Design Control: The reviewed standards do not address design control attributes.

Procurement: The standards could lead to development of procurement specifications. However other procurement attributes, such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: The manufacturing process is not addressed by the reviewed standards.

Shipping, Storage, and Handling: The reviewed standards do not address the shipping, storage, and handling of lighting equipment.

Receipt: The reviewed standards do not address receipt inspection of lighting equipment.

Installation: The reviewed standards do not address installation of lighting equipment. Special considerations in lighting systems installation are generally detailed in the installation documents that are not included in the reviewed standards.

Monitoring: The reviewed standards do not address the monitoring process.

Repair, Replacement, or Modification: The reviewed standards do not address the programmatic aspects of repair, replacement, or modification of lighting systems.

Maintenance: Maintenance of lighting systems is covered in Chapter 32 of the IESNA Lighting Handbook.

Trending: The IESNA Lighting Handbook contains information, charts, and figures, etc., that show trending in light output. This information is used to plan for the maintenance and replacement of system components.

Corrective Action: Examples are given in the IESNA Lighting Handbook that show how trending information is used to plan for the maintenance and replacement of system components. The reviewed standards do not address the corrective action process.

4.22 Alarms

4.22.1 Commercial Standard

Commercial codes and standards that relate to control room applications were not identified. NFPA 101 addresses alarms related to life safety systems. ANSI/UL 294 address alarms as they relate to access control systems. However, these codes are not considered applicable to industrial process control applications.

4.22.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, and 4, and Appendix B
- 10 CFR 100, Appendix A

4.22.3 Alarms Synopsis

Alarms are not located in areas that are subjected to accident conditions and, therefore, are not required to meet EQ requirements. However, alarms must meet the requirements of GDC 2, GDC 4, and QA. Commercial codes and standards that relate to control room applications were not identified. NFPA 101 addresses alarms related to life safety systems. ANSI/UL 294 address alarms as they relate to access control systems. However, these codes are not considered to be applicable to industrial process control applications.

4.22.4 Commercial Standards Comparison with Nuclear Processes

No codes or standards applicable to industrial process control applications were identified.

4.23 Electrical Switchgear

4.23.1 Commercial Standard

Institute of Electrical and Electronic Engineers (IEEE) 1015 and C37.13 are application guides for low voltage circuit breakers, while C37.010 is an application guide for high voltage circuit breakers. IEEE C37.09 is a test procedure for high-voltage circuit breakers.

4.23.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, 4, and 10, and Appendix B
- 10 CFR 100 Appendix A

4.23.3 Electrical Switchgear Synopsis

Electrical switchgear is not typically located in areas that are subjected to accident conditions, and is therefore not required to meet EQ requirements. However, electrical switchgear must meet the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards there are significant differences in all processes except design requirements, design verification, and maintenance. The combination of commercial standards reviewed (IEEE 1015, C37.13, C37, 010, and C37.09) includes design requirements needed to assure functionality. Verification of these design requirements is also included by standards that address testing requirements. IEEE standards such as 1015 provide recommended maintenance for circuit breakers and address the significant attributes of this process.

4.23.4 Commercial Standards Comparison with Nuclear Processes

Documentation: IEEE 1015 states that maintenance records should be maintained and IEEE C37.09 states that test reports should be written and also provides some guidance regarding the content of the reports. Other documentation requirements are not addressed in the standards reviewed.

Quality Assurance: The reviewed standards do not address quality assurance programs.

Procedures: IEEE 1015 references testing and maintenance procedures for low-voltage circuit breakers and IEEE C37.09 is a test procedure for some ac high-voltage circuit breakers. These standards do identify that test procedures should be used. However, procedures for processes such as manufacturing and installation are not addressed.

Testing, Inspection, and Examination: The reviewed standards do not address attributes such as control of test equipment, program development, independent assessments and verification, and test frequencies.

Design Requirements: IEEE standards such as 1015, C37.10, and C37.13 are application standards that could lead to development of performance specifications. IEEE C37.09 identifies design tests that could be required. The combination of these would include design requirements needed to assure functionality.

Analysis: The standards reviewed are not significantly related to analyses. IEEE C37.10 does provide some system analysis that is necessary to properly identify some technical details, such as short circuit current and X/R ratios.

Design Verification: IEEE standards such as C37.09 provide for design and production tests. IEEE C37.010 states that for breakers applied to locations with known seismic activity the withstand requirements of C37.81 (seismic qualification of metal-enclosed Class1E breakers) should be specified.

Design Control: The reviewed IEEE standards do not address design control attributes.

Procurement: IEEE standards such as 1015, C37.10, and C37.13 are application standards that could lead to development of procurement specifications. However, other procurement attributes, such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: IEEE standards such as C37.09 provide for production testing. However, other aspects of manufacturing are not addressed.

Shipping, Storage, and Handling: The standards reviewed do not address this process.

Receipt: IEEE standards such as C37.09 provide for acceptance testing. Otherwise, receipt inspection is not addressed.

Installation: The standards reviewed do not address having procedures and qualified personnel for installing the circuit breakers.

Monitoring: Testing to determine if performance degradation has occurred is included in IEEE standards such as conformance testing in IEEE C37.09. However attributes such as root cause analysis, corrective action, and identification of conditions adverse to operability are not addressed in the reviewed standards.

Repair, Replacement, or Modification: The standards reviewed address repair, replacement and modifications.

Maintenance: IEEE standards such as 1015 provide recommended maintenance for circuit breakers and address the significant attributes of this process.

Trending: Trending of test results is not addressed by the standards reviewed.

Corrective Action: Corrective action is not addressed by the standards reviewed.

4.24 Molded Case Circuit Breakers

4.24.1 Commercial Standard

IEEE 1015 is an application standard for low voltage circuit breakers, including molded case circuit breakers that addresses rating and testing, selection considerations, acceptance, and maintenance. UL 489 addresses construction, ratings, and testing of molded case circuit breakers. The UL standard is particularly concerned with those things that could involve a risk of fire, electric shock, or injury to people.

4.24.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, 4, and 10, and Appendix B
- 10 CFR 100 Appendix A

4.24.3 Molded Case Circuit Breaker Synopsis

Molded Case Circuit Breakers (MCCB) are not typically located in areas that are subjected to accident conditions and, therefore, are not required to meet EQ requirements. However, MCCB must meet the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards there are significant differences in all processes except design requirements and maintenance. The combination of commercial standards reviewed (IEEE 1015 and UL 489) will provide information that leads to development of performance specifications. The combination of these would provide design requirements needed to assure functionality. IEEE 1015 provides recommended maintenance for circuit breakers and addresses the significant attributes of the maintenance process.

4.24.4 Commercial Standards Comparison with Nuclear Processes

Documentation: IEEE 1015 states that maintenance records should be maintained. Other documentation requirements are not addressed in the standards reviewed.

Quality Assurance: The reviewed standards do not address quality assurance programs.

Procedures: IEEE 1015 references testing and maintenance procedures for low voltage circuit breakers. UL 489 identifies tests that should be run, their acceptance criteria, and the testing sequence. No actual procedures are provided. These standards identify that test procedures should be used. However, procedures for processes such as manufacturing and installation are not addressed.

Testing, Inspection, and Examination: UL 489 only addresses testing to verify that the circuit breakers will perform as specified. Acceptance and periodic in plant testing is not addressed. IEEE 1015 addresses tests that verify over-current, short circuit, and shunt trips. Visual examinations and personnel training are also addressed. Control of test equipment is not addressed. Attributes such as program development, independent assessments, and verification, and test frequencies are not specifically identified.

Design Requirements: Standards such as IEEE 1015 and UL 489 provide information that could lead to development of performance specifications. The combination of these would provide design requirements needed to assure functionality.

Analysis: The standards reviewed are not significantly related to analyses. IEEE 1015 does provide some system analysis that is necessary to properly identify some technical details, such as short circuit current and X/R ratios.

Design Verification: UL 489 provides for design verification tests and IEEE 1015 describes tests to verify trip settings, however seismic conditions are not addressed in these tests.

Design Control: The reviewed standards do not address design control attributes.

Procurement: The reviewed standards could lead to development of procurement specifications. However, other procurement attributes, such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: UL 489 provides some construction details and tests to verify the design meets significant requirements. However, attributes related to control of the manufacturing process are not addressed.

Shipping, Storage, and Handling: The standards reviewed do not address this process.

Receipt: The standards reviewed do not address this process.

Installation: The standards reviewed do not address this process.

Monitoring: Testing to determine if performance degradation has occurred is included in IEEE 1015. However, attributes such as root cause analysis, corrective action, and identification of conditions adverse to operability are not addressed in the reviewed standards.

Repair, Replacement, or Modification: The standards reviewed do not address this process.

Maintenance: IEEE 1015 provides recommended maintenance for circuit breakers and addresses the significant attributes of this process.

Trending: Trending of test results is not addressed by the standards reviewed.

Corrective Action: Corrective action is not addressed by the standards reviewed.

4.25 Transformers

4.25.1 Commercial Standard

IEEE C57,12.00, C57.12.01 and C57.12.26 and ANSI C57.12.22 provide general requirements for pad mounted, dry type and liquid immersed transformers. IEEE C57.93 addresses installation of liquid immersed transformers; IEEE C 57.94 addresses installation, application, operation, and maintenance of dry type transformers; and IEEE C57.12.91 addresses testing of dry type transformers.

4.25.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, 4, and 10, and Appendix B
- 10 CFR 100, Appendix A

4.25.3 Transformer Synopsis

Transformers are not typically located in areas that are subjected to accident conditions and, therefore, are not required to meet the requirements of EQ. However, transformers must meet the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards there are significant differences in all processes except design requirements and maintenance. The combination of commercial standards reviewed (IEEE C57.12.00, C57.12.01, C57.12.26, C57.12.91, C57.93, and C 57.94 and ANSI C57.12.22) would provide information that could lead to development of performance specifications. IEEE C57.12.00, C57.12.01, and C57.12.91 address ratings, configuration, short circuit requirements, dielectric, impedance, and construction. Seismic requirements are addressed as an unusual service condition in IEEE C57.12.00 and C57.12.01. Maintenance of liquid immersed transformers is addressed in IEEE C57.93 and for dry type transformers in IEEE C57.94.

4.25.4 Commercial Standards Comparison with Nuclear Processes

Documentation: IEEE C57.12.91 addresses a test report. Otherwise, the reviewed standards do not address other types of documentation or control of documentation.

Quality Assurance: The reviewed standards do not address quality assurance programs.

Procedures: Testing requirements are defined but no actual procedures are addressed.

Testing, Inspection, and Examination: The reviewed standards either directly address or reference other standards that address both design, and routine testing of transformers. Control of test equipment and personnel training is not addressed. Attributes such as program development, independent assessments, and verification, and test frequencies are not identified.

Design Requirements: IEEE C57.12.00, C57.12.01, and C57.12.91 address ratings, configuration, short circuit requirements, dielectric, impedance, and construction. Seismic requirements are addressed as an unusual service condition in IEEE C57.12.00 and C57.12.01.

Analysis: The reviewed standards do not address the analysis process.

Design Verification: Testing to verify design parameters is generally addressed in IEEE C57.12 and C57.12.01, and specific tests are identified in IEEE C57.12.91. However, testing or analysis to verify seismic design considerations is not addressed.

Design Control: The reviewed standards do not address design control attributes.

Procurement: The standards could lead to development of procurement specifications. However, other procurement attributes, such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: Manufacturing is not addressed by the reviewed standards.

Shipping, Storage, and Handling: All the reviewed standards, except IEEE C57.12.91, address shipping and storage considerations such as electrical configuration and orientation. Procedures for identification and control of equipment are not generally addressed.

Receipt: The documentation aspects of receipt are not addressed by the reviewed standards.

Installation: Installation instructions, documentation, and personnel qualification are not addressed in the reviewed standards.

Monitoring: The reviewed standard does not address the monitoring process.

Repair, Replacement, or Modification: The reviewed standards do not address repair, replacement, or modification of transformers.

Maintenance: Maintenance of liquid immersed transformers is addressed in IEEE C57.93 and for dry-type transformers in IEEE C57.94.

Trending: The reviewed standard does not address the trending process.

Corrective Action: IEEE C57.93 and C57.94 address drying of the core insulation. However, the reviewed standards do not address the corrective action process.

4.26 Motors

4.26.1 Commercial Standard

IEEE 112 addresses testing of polyphase induction motors, IEEE 432 provides a guide for insulation maintenance of rotating machinery, and IEEE 841 addresses motors in the petroleum and chemical industry that are in severe duty situations. ANSI C50.41 and National Electrical Manufactures Association (NEMA) MG 2 provide guidance oriented more toward manufacturing and application of motors.

4.26.2 Special Treatment Requirements

- 10 CFR 50 .49
- 10 CFR 50, GDC 1, 2, 4, and 10, and Appendix B
- 10 CFR 100 Appendix A

4.26.3 Motor Synopsis

Motors may be located in areas that are subject to accident conditions and those must meet EQ requirements as well as the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards there are significant differences in all processes except design requirements and maintenance. The commercial standards reviewed (IEEE 112, 432, and 841, ANSI C50.41 and NEMA MG 2) provide information from which design requirements could be specified. The combination of these would include design requirements needed to assure functionality. IEEE 432 provides recommended maintenance for motors and addresses the significant attributes of the maintenance process.

4.26.4 Commercial Standards Comparison with Nuclear Processes

Documentation: The IEEE standards do not address documentation. However, ANSI C50.41 does address general documentation requirements as well as documentation of motor data, performance curves, performance data, motor accessories, test reports, drawings, and instruction manuals. Other documentation requirements are not addressed in the standards reviewed.

Quality Assurance: The reviewed standards do not address quality assurance programs.

Procedures: While specific tests are identified in IEEE 112 and 432, procedures are more general and not detailed. Procedures for processes other than testing, such as manufacturing, are not provided and procedure control and approval are not addressed.

Testing, Inspection, and Examination: All the reviewed standards have some requirements for testing, inspection, and examination. These tests include nearly all phases of an electrical motor. Control of test equipment and personnel training is not addressed. Attributes such as program development, independent assessments, and verification, and test frequencies are not specifically identified.

Design Requirements: Standards such as IEEE 842, ANSI C50.42, and NEMA MG 2 provide information from which design requirements could be specified. The combination of these would include design requirements needed to assure functionality.

Analysis: The standards reviewed are not significantly related to analyses. IEEE 112 and ANSI C50.41 provide guidance for calculating some motor performance characteristics using data gathered during the specified tests.

Design Verification: Testing as described above will provide verification of motor performance characteristics during normal operations. However, these tests do not address Environmental qualification and verification of the ability to withstand seismic events.

Design Control: The reviewed standards do not address design control attributes.

Procurement: The reviewed standards could lead to development of procurement specifications. However, other procurement attributes, such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: ANSI 50.41 and NEMA MG 2 provide some construction details and tests to verify the design meets significant requirements. However, attributes related to control of the manufacturing process are not addressed.

Shipping, Storage, and Handling: The standards reviewed do not address this process.

Receipt: The standards reviewed do not address this process.

Installation: NEMA MG 2 addresses some aspects of installation, such as safety in machine installation. Safety considerations of protection, grounding, wiring connections, flammable materials, rotating parts, maximum speed of drive components, and lifting are addressed. Qualification of personnel and procedures, proper anchors, and alignment of the motor to the load are not addressed.

Monitoring: Testing to determine if performance degradation has occurred is included in IEEE 112. However, attributes such as root cause analysis, corrective action, and identification of conditions adverse to operability are not addressed in the reviewed standards.

Repair, Replacement, or Modification: The standards reviewed do not address this process.

Maintenance: IEEE 432 provides recommended maintenance for motors and addresses the significant attributes of this process.

Trending: Trending of test results is not addressed by the standards reviewed.

Corrective Action: Corrective action is not addressed by the standards reviewed.

4.27 Motor Control Centers

4.27.1 Commercial Standard

ANSI C37.50 addresses low-voltage circuit breakers used in enclosures; NEMA Industrial Control and Systems (ICS) 2.3 provides instructions for handing, installation, operation, and maintenance of motor control centers; and NEMA ICS 1 has general applicability to industrial control and systems, including Motor Control Centers (MCCs).

4.27.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, and 4, and Appendix B
- 10 CFR 100 Appendix A

4.27.3 Motor Control Center Synopsis

Motor Control Centers (MCC) are not typically located in areas that are subjected to accident conditions and, therefore, are not required to meet EQ requirements. However, MCCs must meet the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards there are significant differences in all processes except design requirements, installation, and maintenance. While the combination of commercial standards reviewed (ANSI C37.50, NEMA ICS 1, and NEMA ICS 2.3) does not provide specific details, consideration for performance requirements, including environmental and seismic conditions, is addressed. Design requirements for circuit breakers are discussed separately in this report. NEMA ICS 1 requires installation in accordance with the NEC, which among other things requires that personnel be qualified to perform their tasks. NEMA ICS 2.3 includes extensive instructions for installation of MCCs including the requirement to follow the manufacturer's instructions. Maintenance of MCCs is addressed in NEMA ICS 1 and NEMA ICS 2.3.

4.27.4 Commercial Standards Comparison with Nuclear Processes

Documentation: NEMA ICS 1 defines standards for naming and symbols on drawings. Otherwise, the reviewed standards do not address other types of documentation or control of documentation.

Quality Assurance: The reviewed standards do not address quality assurance programs.

Procedures: Testing procedures are provided in ANSI C.37.50 and NEMA ICS 1. The reviewed standards do not address other types of procedures or control of procedures.

Testing, Inspection, and Examination: ANSI 37.50 identifies extensive design and production tests. Routine testing and examination, such as would be performed during the operational phase, are not addressed. Control of test equipment and personnel training are not addressed. Attributes such as program development, independent assessments, verification, and test frequencies are not identified.

Design Requirements: While specific details are not provided, consideration for performance requirements, including environmental and seismic conditions, is addressed. Design requirements for circuit breakers are discussed separately in this report.

Analysis: The reviewed standards do not address the analysis process.

Design Verification: ANSI C37.50 verifies design parameters for circuit breakers and NEMA ICS 1 addresses testing to verify performance requirements. However, testing or analysis of MCCs to verify the ability to withstand seismic events is not included.

Design Control: The reviewed standards do not address design control attributes.

Procurement: The standards could lead to development of procurement specifications. However other procurement attributes, such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: ANSI C37.50 addresses production testing of low voltage circuit breakers. However, the manufacturing process is not addressed by the reviewed standards.

Shipping, Storage, and Handling: NEMA ICS 1 addresses storage and handling and NEMA ICS 2.3 addresses handling of equipment. Shipping is not addressed. Procedures for identification and control of equipment are not addressed.

Receipt: Some visual inspection of MCCs is addressed in NEMA ICS 2.3. The planning and documentation aspects of receipt are not addressed by the reviewed standards.

Installation: NEMA ICS 1 requires installation in accordance with the NEC, which among other things requires that personnel be qualified to perform their tasks. NEMA ICS 2.3 includes extensive instructions for installing MCCs, including the requirement to follow the manufacturer's instructions.

Monitoring: The reviewed standard does not address the monitoring process.

Repair, Replacement, or Modification: The reviewed standards do not address the programmatic aspects of repair, replacement, or modification of MCCs.

Maintenance: Maintenance of MCCs is addressed in NEMA ICS 1 and NEMA ICS 2.3.

Trending: The reviewed standards do not address the trending process.

Corrective Action: ANSI C37.50 only addresses actions resulting from production test failures and NEMA ICS 2.3 only addresses maintenance after a fault has occurred. The reviewed standards do not address the corrective action process.

4.28 Electrical Cabling

4.28.1 Commercial Standard

IEEE 576 and 1185 address installation of electrical cables in the petroleum/chemical industry and power generating stations, respectively; NEMA WC-3, 5, 7, and 8 address the manufacturing of cables; the NEC provides requirements for assuring public safety in the selection, installation, and termination of cables.

4.28.2 Special Treatment Requirements

- 10 CFR 50.49
- 10 CFR 50, GDC 1, 2, 4, and 10, and Appendix B
- 10 CFR 100 Appendix A

4.28.3 Electrical Cabling Synopsis

Electrical Cables is typically located in areas that are subject to accident conditions and, therefore, must meet EQ requirements as well as the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards there are significant differences in all processes except installation. Of the commercial standards reviewed (IEEE 576 and 1185, NEMA WC-3, 5, 7, and 8, the NEC), IEEE 576 and 1185 and the NEC provide installation requirements, including cable pulling requirements, protection of cables (conduit and cable trays), conduit fill requirements, and termination requirements. The NEC also addresses qualification of personnel. These standards address the significant attributes of the installation process.

4.28.4 Commercial Standards Comparison with Nuclear Processes

Documentation: The reviewed standards do not address documentation.

Quality Assurance: The reviewed standards do not address quality assurance programs.

Procedures: The NEMA standards provide procedures for testing cables. However, procedures are not provided for manufacturing. Procedural controls and approvals are not addressed.

Testing, Inspection, and Examination: The NEMA standard addresses testing to assure that the cables perform as required. While aging of cables is addressed, synergistic effects of radiation, moisture, and temperature are not considered. Testing for processes other than manufacturing, such as receiving inspection, post installation, and during operation, are not addressed. Control of test equipment and personnel training is not addressed. Attributes such as program development, independent assessments, and verification, and test frequencies are not specifically identified.

Design Requirements: The NEMA standards address most design requirements. However, nuclear plant accident conditions are not addressed.

Analysis: The standards reviewed are not significantly related to analyses.

Design Verification: Testing as described above will provide verification of motor performance characteristics during normal operations. However, these tests do not address the requirements of environmental qualification.

Design Control: The reviewed standards do not address design control attributes.

Procurement: The reviewed standards could lead to development of procurement specifications. However, other procurement attributes such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: The NEMA standards provide many manufacturing details and tests to verify the design meets significant requirements. However, attributes related to control of the manufacturing process are not addressed.

Shipping, Storage, and Handling: The standards reviewed do not address this process.

Receipt: The standards reviewed do not address this process.

Installation: IEEE 576 and 1185 and the NEC provide installation requirements including cable pulling requirements, protection of cables (conduit and cable trays), conduit fill requirements, and termination requirements. The NEC also addresses qualification of personnel. These standards address the significant attributes of this process.

Monitoring: The standards reviewed do not address routine monitoring of cable conditions.

Repair, Replacement, or Modification: The standards reviewed do not address repair, replacement, or modification.

Maintenance: The standards reviewed do not address maintenance.

Trending: The standards reviewed do not address trending of test results.

Corrective Action: The standards reviewed do not address corrective actions.

4.29 Motor-Generator Units

4.29.1 Commercial Standard

The commercial standard reviewed was NEMA, Standards Publication MG2, "Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators," 1989.

4.29.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, and 4 and Appendix B
- 10 CFR 50.49
- 10 CFR 100, Appendix A

4.29.3 Motor Generator Synopsis

Motor generator components are subject to QA, seismic, possibly some EQ requirements, and GDC 1, 2, and 4. The commercial standard—NEMA, Standards Publication MG2, "Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators," 1989, was reviewed. There were little significant differences between the special treatment requirements and the commercial standard for the maintenance process. However, the maintenance process must be implemented by the plant procedures. There were significant differences between the other critical processes and the commercial standard. However, alternate QA programs and other plant processes could be used to provide reasonable confidence of functionality.

4.29.4 Commercial Standards Comparison with Nuclear Processes

Documentation: Documentation is not addressed in this standard.

Quality Assurance: Quality assurance is not addressed in this standard.

Procedures: Procedures are not addressed in this standard.

Testing, Inspection, and Examination: Testing, inspection. and examination is discussed in the standard but not all the attributes are required. For example, qualified personnel and independent assessments are not addressed.

Design Requirements: The standard addresses design criteria but no detailed design requirements.

Analysis: Analysis methods are not mentioned in the standard.

Design Verification: Design verification is not mentioned in the standard.

Design Control: Design control is not mentioned in the standard.

Procurement: Procurement is not mentioned in the standard.

Manufacturing: Construction and manufacturing of motor-generators are mentioned, but items such as personnel qualification, permitted materials, repair requirements, are not mentioned.

Shipping, Storage, and Handling: Shipping, storage, and handling is not mentioned in the standard.

Receipt: Receipt of components is not mentioned in the standard.

Installation: Installation is mentioned but not items like qualification of procedures and personnel.

Monitoring: Monitoring of vibration, noise, periodic inspections and tests are recommended, but there is no requirement for root cause evaluation to identify and correct adverse conditions.

Repair, Replacement, or Modification: Repair is mentioned in the standard, but only general concepts are discussed such as "replacement part be of equal or better than that of the original part." Items such as verification and inspection of repair are not mentioned.

Maintenance: Maintenance is mentioned in the standard with recommendations to use qualified personnel, qualified parts, etc. This meets the requirements of the process and attributes.

Trending: Trending is not mentioned in the standard.

Corrective Action: Corrective actions such as developing a program, feedback, obtaining input from trending, documenting performance and completing actions, and controlling backlog are not mentioned in the standard.

4.30 Diesel Generators

4.30.1 Commercial Standard

The National Fire Protection Association, 1999 Edition, Standard for Emergency and Standby Power Systems, NFPA 110, is the overall specification standard. This standard provides guidelines for the assembly, installation, and performance of electrical power systems to supply critical essential needs during outages of the primary power source. Several other subcomponent-specific standards are referenced, but are not addressed in this analysis.

4.30.2 Special Treatment Requirements

- 10 CFR 50, GDC 45 and 46, and Appendix B
- 10 CFR 50.55a (ASME III, IST, OM)
- 10 CFR 100, Appendix A

4.30.3 Diesel Generator Synopsis

Diesel generator systems are typically designed to NFPA 110. At a nuclear facility, they are subject to the quality assurance, seismic, and pressure boundary requirements of ASME Section III and the in-service testing requirements of Section XI. Based on review of NFPA 110, commercial codes and standards may be used for designing and testing, inspection, and examination of diesel generating systems. For example, NFPA 110 contains many testing requirements that are similar to the testing performed at nuclear facilities. In addition, NFPA 110 includes equipment performance requirements for all parts of the diesel generator system (e.g., design performance requirements for the fuel supply system, instrumentation and alarms, diesel starting equipment, battery chargers, control equipment, cooling systems, and electrical generators and transfer switches). NFPA 110 also requires that diesel generators in seismic risk areas have components that are capable of performing their intended function during and after being subjected to the anticipated seismic shock. However, significant differences still exist between special treatment requirements and NFPA 110 for all other special treatment rule processes. Given that some of the remaining processes are critical for providing reasonable confidence of component functionality, NFPA 110 is not adequate to provide that confidence in all areas. However, other industry quality assurance programs and other plant processes may be used to provide the additional necessary confidence.

4.30.4 Commercial Standards Comparison with Nuclear Processes

Documentation: In general, documentation requirements in NFPA 110 are limited to documenting the specifics associated with the acceptance testing, periodic testing, and post-maintenance testing. Instruction manuals are required to be located near the equipment. A routine maintenance and operational test program is required to be documented. Written records for inspections, test, exercising, operation, and repairs are to be maintained on the premises.

Quality Assurance: NFPA 110 does not include any requirements that address the quality assurance process associated with the design, procurement, or installation of diesel generators.

Procedures: NFPA 110 requires that the routine maintenance and operation testing program be based on the manufacturer's recommendations, that one set of procedures be located near the equipment, and that a second set of procedures be kept in a different secure location. NFPA 110 does not address the use of quality hold points.

Testing, Inspection, and Examination: NFPA 110 specifies the full load acceptance test requirements, including the required test sequence, the parameters to be recorded, and acceptance criteria that must be met. The implementation of a routine maintenance and operation testing program is required immediately after the completion of the initial acceptance test program or after completion of any repairs that impact the unit's operational reliability. Sample maintenance schedules and testing logs are included in the standard. Therefore, no significant differences that would affect the reasonable confidence of component functionality were identified.

Design Requirements: NFPA 110 includes extensive equipment performance requirements for all parts of the diesel generator system. For example, design performance requirements are specified for the fuel supply system, instrumentation and alarms, diesel starting equipment, battery chargers, control equipment, cooling systems, and electrical generators and transfer switches. In many cases, specific acceptance criteria are included. NFPA 110 requires that diesel generators in seismic risk areas have components that are capable of performing their intended function during and after being subjected to the anticipated seismic shock. Therefore, no significant differences that would affect the reasonable confidence of component functionality were identified.

Analysis: NFPA 110 does not include any personnel qualification or checking requirements related to the design, procurement, or installation of diesel generators.

Design Verification: As noted in the Testing, Inspection, and Examination section, NFPA 110 does include acceptance test requirements that serve to verify the design adequacy of the equipment. However, this type of testing does not verify if the diesel generator system will function during seismic events.

Design Control: NFPA 110 does not include any requirements that address the design control process associated with diesel generators.

Procurement: NFPA 110 does not include any requirements that address the procurement process associated with diesel generators.

Manufacturing: NFPA 110 does not include any requirements that address the manufacturing of diesel generators.

Shipping, Storage, and Handling: NFPA 110 does not include any requirements that address the shipping, storage, and handling processes associated with diesel generators.

Receipt Inspection: NFPA 110 states that the manufacturer provides at least two sets of instruction manuals. Receipt inspections are not required, but system acceptance is based on load test performance. Inspections at the manufacturer's facility are not required.

Installation: NFPA 110 includes several installation requirements for diesel generators. Some of these requirements address the equipment enclosure (heating, cooling, and ventilation), mounting requirements to minimize vibration, the diesel cooling system, the fuel system, and the exhaust system. However, the standard does not address personnel qualifications, welding and joining requirements, and alignment/joining requirements (some of these attributes may not be critical for a diesel generator set).

Monitoring: NFPA 110 requires that periodic performance testing be performed and that unsatisfactory conditions and corrective actions be documented. However, root cause analysis and feedback of the root cause analysis results are not required.

Repair, Replacement, or Modification: NFPA 110 does not include any requirements that address the repair, replacement, or modification of diesel generators except to require post-maintenance testing if the maintenance activity could affect system functionality.

Maintenance: NFPA 110 requires that a routine maintenance program be implemented immediately after the completion of the initial acceptance test program. NFPA 110 does not address the qualification of replacement parts.

Trending: NFPA 110 does not include any requirements that address the performance trending of diesel generators.

Corrective Action: NFPA 110 does not include any requirements to implement a corrective action program for diesel generators except that corrective actions should be documented.

4.31 Batteries

4.31.1 Commercial Standard

IEEE 450 addresses maintenance, testing, and replacement of lead acid batteries; IEEE 484 addresses design and installation; and IEEE 485 focuses on sizing of batteries. These standards, when combined, cover the life cycle of batteries.

4.31.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, and 4, and Appendix B
- 10 CFR 100 Appendix A

4.31.3 Battery Synopsis

Batteries are not typically located in areas that are subjected to accident conditions and, therefore, are not required to meet EQ requirements. However, batteries must meet the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards (IEEE 450, 484 and 485) there are significant differences in all processes except monitoring, repair, replacement, or modification, trending, and corrective action. IEEE 450 addresses monitoring of battery performance and status. IEEE 450 addresses replacement of batteries. Batteries are not repaired or modified. The applicable attributes of the repair, replacement, or modification process are addressed. IEEE 450 addresses trending of test results in order to provide sufficient time to procure replacement batteries. IEEE 450 also addresses corrective action for insufficient charge, unequal voltages, low electrolyte level, and poor connection resistance.

4.31.4 Commercial Standards Comparison with Nuclear Processes

Documentation: The reviewed standards contain requirements to document the results of sizing, testing, and maintenance activities. Retrievability and retention of records are not addressed.

Quality Assurance: The reviewed standards do not address quality assurance programs.

Procedures: Procedures and examples are provided in the IEEE standards for sizing, testing, and maintenance activities. However, procedures are not provided for manufacturing. Procedure control and approval are not addressed.

Testing, Inspection, and Examination: IEEE 450 addresses testing and inspection of batteries. Design verification, acceptance, and performance are covered by the tests and inspections of this standard. Testing to verify the ability to withstand seismic events is not included. Control of test equipment and personnel training is not addressed. Attributes such as program development, independent assessments, and verification, and test frequencies are not specifically identified.

Design Requirements: IEEE 484 and 485 address design requirements for battery sizing and installation. Seismic requirements for battery racks are addressed. Seismic requirements for the batteries are not addressed.

Analysis: The standards reviewed are not significantly related to analyses. However, analyses related to sizing and testing is addressed. Analyses related to the design of the battery, such as seismic considerations, are not addressed.

Design Verification: Testing as described above will provide verification of battery performance characteristics during normal operations. However, these tests do not address seismic requirements of batteries, but do address seismic requirements of the battery racks.

Design Control: The reviewed standards do not address design control attributes.

Procurement: The reviewed standards could lead to development of procurement specifications. However, other procurement attributes, such as control of vendors and approval of procurement documents, are not addressed.

Manufacturing: The reviewed standards do not address design control attributes.

Shipping, Storage, and Handling: Handling and storage of batteries is addressed in IEEE 484. However shipping, procedures, and control of the processes are not addressed.

Receipt: IEEE 484 identifies visual receiving inspections that should be performed. Identification of the documentation that should be included and control of this documentation is not addressed.

Installation: IEEE 450 and 484 provide installation instructions regarding intercell connections, cable connections, rack assembly, cell mounting, freshening charges, and connection to the dc system. Control of procedures and qualification of personnel are not addressed.

Monitoring: IEEE 450 addresses monitoring of battery performance and status.

Repair, Replacement, or Modification: IEEE 450 addresses replacement of batteries. Batteries are not repaired or modified. The applicable attributes of this process are addressed.

Maintenance: The standards reviewed do not address this process.

Trending: Trending of test results is addressed by IEEE 450 in order to provide sufficient time to procure replacement batteries.

Corrective Action: IEEE 450 addresses corrective action for insufficient charge, unequal voltages, low electrolyte level, and poor connection resistance.

4.32 Battery Chargers

4.32.1 Commercial Standard

IEEE 946 addresses design of dc auxiliary power systems and includes battery chargers in the scope of the standard. NEMA PE 5 addresses design and testing of battery chargers at the production facility.

4.32.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, and 4, and Appendix B
- 10 CFR 100 Appendix A

4.32.3 Battery Charger Synopsis

Battery chargers are not typically located in areas that are subjected to accident conditions and, therefore, are not required to meet EQ requirements. However, battery chargers must meet the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards (IEEE 946 NEMA PE 5) there are significant differences in all processes except design requirements and design verification. The reviewed standards address design requirements for battery chargers. The standards address how many chargers are needed, determining the rated output, the ac input characteristics, the dc output characteristics, supervisory controls and alarms, environmental conditions including seismic events, and mechanical design. Testing as described in the standards will provide verification of battery charger performance characteristics during normal and unusual operations. While these tests do not specifically address seismic requirements, NEMA PE 5 states that design tests demonstrate that battery chargers conform to the PE 5 specifications, which does include seismic events.

4.32.4 Commercial Standards Comparison with Nuclear Processes

Documentation: NEMA PE 5 contains requirements for the content of instruction manuals. However, other types of documentation or control of documentation is not addressed in the reviewed standards.

Quality Assurance: The reviewed standards do not address quality assurance programs.

Procedures: IEEE 946 provides specific formulas and sample calculations for determining the rating of the battery charger. However, procedures are not provided for manufacturing, installation, or testing. Procedure control and approval are not addressed.

Testing, Inspection, and Examination: NEMA PE 5 addresses design and production testing. Testing to verify the ability to withstand seismic events is not specifically included. Testing during the installation and operational phase is not addressed by the reviewed standards. Control of test equipment and personnel training are not addressed. Attributes such as program development, independent assessments, and verification, and test frequencies are not specifically identified.

Design Requirements: The reviewed standards address design requirements for battery chargers. The standards address how many chargers are needed, determining the rated output, the ac input characteristics, the dc output characteristics, supervisory controls and alarms, environmental conditions including seismic events, and mechanical design.

Analysis: The standards reviewed are not significantly related to analyses. However, analyses related to sizing and testing is addressed. Analyses related to the design of the battery, such as seismic considerations, are not addressed.

Design Verification: Testing as described above will provide verification of battery charger performance characteristics during normal and unusual operations. While these tests do not specifically address seismic requirements, NEMA PE 5 states that design tests demonstrate that battery chargers conform to the PE 5 specifications, which does include seismic events.

Design Control: The reviewed standards do not address design control attributes.

Procurement: The reviewed standards could lead to development of procurement specifications. However, other procurement attributes, such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: The reviewed standards do not address the manufacturing process.

Shipping, Storage, and Handling: The reviewed standards do not address shipping, storage, and handling attributes.

Receipt: The reviewed standards do not address the receipt process.

Installation: The reviewed standards do not address the installation process.

Monitoring: The reviewed standards do not address the monitoring process.

Repair, Replacement, or Modification: The reviewed standards do not address repair, replacement, or modification of battery chargers.

Maintenance: The reviewed standards do not address maintenance of battery chargers.

Trending: The reviewed standards do not address the trending process.

Corrective Action: The reviewed standards do not address the corrective action process.

4.33 Inverters

4.33.1 Commercial Standard

UL-924 addresses design requirements, performance, and design and production testing of inverters. However, seismic considerations are not specifically addressed. UL-924 is primarily concerned with features that affect the risk of fire, electric shock, or injury to people.

4.33.2 Special Treatment Requirements

- 10 CFR 50, GDC 1, 2, 4, and 10, and Appendix B
- 10 CFR 100, Appendix A

4.33.3 Inverter Synopsis

Inverters are not typically located in areas that are subjected to accident conditions and, therefore, are not required to meet EQ requirements. However, inverters must meet the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards (UL-924) there are significant differences in all processes. UL-924 addresses design requirements, performance, and design and production testing of inverters. However, significant process attributes such as seismic considerations control of the processes are not addressed. UL-924 is primarily concerned with features that affect the risk of fire, electric shock, or injury to people.

4.33.4 Commercial Standards Comparison with Nuclear Processes

Documentation: UL-924 contains requirements for the content of instruction manuals. However, other types of documentation or control of documentation are not addressed.

Quality Assurance: UL-924 does not address quality assurance programs.

Procedures: UL-924 does not address procedures, procedure control, or procedure approval.

Testing, Inspection, and Examination: UL-924 addresses manufacturing and production testing. Testing to verify the ability to withstand seismic events is not specifically included. Testing during the installation and operational phase is not addressed by the reviewed standards. Control of test equipment and personnel training is not addressed. Attributes such as program development, independent assessments, and verification, and test frequencies are not identified.

Design Requirements: Design requirements for performance and physical/mechanical considerations are provided by UL-924. However, seismic events are not discussed.

Analysis: UL-924 does not address the analysis process for inverters.

Design Verification: Testing as described above will provide verification of inverter performance characteristics during normal and some abnormal conditions. The tests described in UL-924 do not address seismic events.

Design Control: UL-924 does not address design control attributes.

Procurement: UL-924 could lead to development of procurement specifications. However, other procurement attributes, such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: Many construction details are addressed. Details include frame and enclosure considerations, mounting, corrosion resistance, insulation, mounting of piece parts, wiring, grounding, coil windings, transformers, self-diagnostics, printed circuit boards, and spacing. Procedures and control of the manufacturing process are not addressed.

Shipping, Storage, and Handling: The reviewed standard does not address shipping, storage, and handling attributes.

Receipt: UL-924 does not address the receipt process.

Installation: The reviewed standard does not address the installation process.

Monitoring: The reviewed standard does not address the monitoring process.

Repair, Replacement, or Modification: UL-924 does not address repair, replacement, or modification of battery chargers.

Maintenance: UL-924 does not address maintenance of battery chargers.

Trending: The reviewed standard does not address the trending process.

Corrective Action: The reviewed standard does not address the corrective action process.

4.34 Process Instrumentation

4.34.1 Commercial Standard

ISA S37.6 addresses specification and tests for potentiometric pressure transducers.

4.34.2 Special Treatment Requirements

- 10 CFR 50.49
- 10 CFR 50, GDC 1, 2, 4, and 10, and Appendix B
- 10 CFR 100, Appendix A

4.34.3 Process Instrumentation Synopsis

Process instrumentation is often located in areas that are subject to accident conditions and, therefore, must meet EQ requirements as well as the requirements of GDC 2, GDC 4, and QA. When special treatment requirements are compared to commercial codes and standards there are significant differences in all processes except design requirements and design verification. The commercial standard reviewed (ISA S37.6) provides comprehensive mechanical, electrical, and performance requirements. Qualification testing, including environments and vibration/seismic conditions, will provide verification of pressure transducer performance.

4.34.4 Commercial Standards Comparison with Nuclear Processes

Documentation: The ISA standard provides test report forms. However, other types of documentation or control of documentation are not addressed.

Quality Assurance: ISA S37.6 does not address quality assurance programs.

Procedures: Testing is to be performed in accordance with procedures, and sample data sheets are provided. However, specific procedures, procedure control, or procedure approvals are not addressed.

Testing, Inspection, and Examination: ISA S37.6 addresses acceptance tests and calibrations, qualification tests, and manufacturing and production testing. Testing during the installation and operational phase is not addressed. Control of test equipment and personnel training is not addressed. Attributes such as program development, independent assessments, and verification, and test frequencies are not identified.

Design Requirements: Comprehensive mechanical, electrical, and performance requirements are provided.

Analysis: The ISA standard does not address the analysis process.

Design Verification: Qualification testing, including environments and vibration/seismic conditions, will provide verification of pressure transducer performance.

Design Control: ISA S37.6 does not address design control attributes.

Procurement: ISA S37.6 could lead to development of procurement specifications. However, other procurement attributes, such as control of vendors and approval of procurement documents are not addressed.

Manufacturing: ISA S37.6 does not address Manufacturing.

Shipping, Storage, and Handling: The reviewed standard does not address shipping, storage, and handling attributes.

Receipt: ISA S37.6 does not address the receipt process.

Installation: The reviewed standard does not address the installation process.

Monitoring: The reviewed standard does not address the monitoring process.

Repair, Replacement, or Modification: ISA S37.6 does not address repair, replacement, or modification of pressure transducers.

Maintenance: The reviewed standards do not address maintenance.

Trending: The reviewed standard does not address the trending process.

Corrective Action: The reviewed standard does not address the corrective action process.

5. SUMMARY AND CONCLUSIONS

5.1 Component Comparative Analysis Conclusions

Section 4.0 highlights the existence of significant differences in nuclear processes and commercial standards for a number of components. We obtained the commercial codes and standards from discussions with vendors, standard specifications, and the knowledge and experience of the authors. We selected the most applicable commercial codes and standards for the individual components. For the components examined, the commercial codes and standards were not judged to provide a level of rigor equivalent to that provided by the nuclear special treatment rules. The evaluation showed that in most cases the commercial codes and standards focus on limited areas such as approved materials, welding procedures and qualification, etc., while neglecting the "big picture" as viewed from an overall systematic or project view. The application of ANSI B31.1 for piping design can be used as an illustrative example. B31.1 provides requirements for acceptable materials, welding qualification and weld testing. However, this standard contains only the recommendation that a QA program be instituted and applied to the piping systems that might be constructed under its rules. The application of an overall QA program is not a requirement.

Discussions with utility representatives combined with the information in Section 4.0 lead to the conclusion that commercial codes and standards alone do not provide the processes necessary to provide reasonable confidence of functionality. Several company representatives indicated that processes developed to implement nuclear codes, standards, and special treatment rules are selectively used for BOP equipment to provide reasonable confidence of functionality.

In Table 2, an evaluation was made for each individual attribute as to whether the attribute was judged to be critical or noncritical to provide reasonable confidence of functionality. The evaluation is necessarily based on expert opinion. The definition of critical included not only that the SSC would be functional, but also that reasonable confidence of functionality could be demonstrated. This exercise was very difficult because the outcome of the judgment might not be the same for every type of SSC, and one could propose a scenario or example where every attribute might be necessary to provide confidence of functionality. Nevertheless, a judgment was made for each, and the basis for the judgment was described in the right-hand column of the table. Seemingly almost identical attributes may have been judged critical in one process but not in another because of only slight differences in requirements and interpretation. The result was that 147 attributes were judged critical and 23 were judged noncritical.

The overall conclusions from Table 2 (Appendix A) are that most of the attributes were judged critical and that commercial codes and standards by themselves were insufficient to provide reasonable confidence of SSC functionality. However, the critical attributes missing in commercial codes and standards could be supplied by (1) measures such as utilization of detailed engineering specifications, (2) plant processes and procedures, (3) multilevel QA programs that provide less rigor than 10 CFR 50, Appendix B, but augment commercial requirements, or (4) a combination of these approaches. Therefore, for the NRC to allow the nuclear industry to use commercial practices for procurement of replacement RISC-3 SSCs, they would have to rely heavily on the good judgment and internal processes of the nuclear plants, realizing that there may be minimal documentation or in-service test/inspection results to give reasonable confidence of functionality.

The authors' general evaluation for the 18 processes is as follows:

- For some mechanical components such as pumps and valves, there are ASME standards (such as B16 and B73) which manufacturers commonly use for design requirements, analysis, and manufacturing (Processes 5, 6, and 10). Electrical equipment is typically installed to standards such as the NEC.

- ISO 9001 or the utilities' own procedures are used to specify the degree of quality (processes 1, 2, 3, 8, 9, 11, and 12).

- The manufacturer's equipment manuals and national standards for some components are used for installation, inspection, testing, maintenance, and repair (processes 4, 13, 15, and 16).

- Processes for which there seem to be no generally used commercial standards, procedures, or practices, unless indicated by a specific utility, are equipment qualification, monitoring, trending, and corrective action (processes 7, 14, 17, and 18).

5.2 Overall Project Conclusions (Includes All Tasks)

5.2.1 State and Federal Requirements

- Nuclear safety-related SSCs are regulated by the special treatment rules.

- There are few actual commercial requirements to cover BOP equipment and processes. Most importantly, state laws (with the exception of South Carolina) require the use of the ASME Code for boilers and pressure vessels (e.g., B31.1, Section I, or Section VIII) and other pressure boundary equipment.

- Most Western states dictate the use of the UBC, which requires seismic analysis. Eastern states use the National Building Code, while Southern states use the Standard Building Code. The national building codes typically require some seismic analysis and could potentially provide an alternative for the seismic special treatment rules. However, use of these codes may result in a change to the design basis of the plant.

- Most requirements and processes for BOP equipment are not implemented by state or federal law. Nuclear utilities visited typically apply commercially available standards and make limited use their own nuclear processes and manufacturers' recommendations to cover the BOP equipment. However, the authors note that these BOP practices may vary from plant to plant and should not be construed as equivalent to processes applied to safety-related components.

- There are no BOP equipment requirements for a quality assurance program, although ASME Code Sections I and VIII state quality requirements for boilers and pressure vessels, and associated external piping. Some engineering firms and equipment manufacturers use ISO 9001 as a quality assurance program basis for BOP equipment. As with all commercial standards not imposed by state and local laws or ordinances, compliance with ISO 9001 is voluntary. Use of this standard is not universal in the commercial industry and its implementation has been found to vary due to the variety of organizations responsible for certifying ISO 9001 programs.

- Standards, such as ASME B16.34, for manufacturing valves are not required to be used as long as the valves are used within the specified pressure-temperature ratings (see B31.1, Section 107). However, some BOP equipment manufacturers commonly use these standards.

5.2.2 Commercial Practice

- Commercial practice varies widely, from almost no processes for some industries to a higher quality of processes similar to, but not nearly as rigorous as those for nuclear safety-related equipment.

- Since state or federal law does not cover most processes for BOP equipment, utilities use commercially available standards, or their own procedures and practices, or both to cover many of the processes. Consequently, the processes may vary widely from plant to plant.

- There are no recommendations for BOP motor-operated valve (MOV) qualifications that correspond to the recommendations contained in Generic Letters (GL) 89-10 and 96-05. Therefore, typical commercial practices do not focus on demonstration of MOV functionality under worst-case conditions and are not concerned with identifying MOV-related performance degradations that may affect the acceptability of established control switch settings.

- To minimize confusion, the two nuclear utilities we visited prefer to use many of the nuclear processes for BOP equipment. These utilities preferred not to introduce additional procedures or processes.

- SONGS and ComEd personnel indicated that plant processes developed from 10 CFR 50, Appendix B are selectively used for some BOP equipment. The BOP processes are primarily driven by economic concerns, and therefore are typically less rigorous than those required for nuclear safety-related processes. For example, one utility used its plant modification control process to replace an office building HVAC unit. Clearly the controls on this replacement would be less than those used for a nuclear safety-related SSC, but greater than what would be required in the commercial world.

5.2.3 Differences in Special Treatment Rules and Commercial Practice

- For the majority of the components evaluated, there were significant differences in the commercial standards and the special treatment rules. Many of the commercial standards do not require a QA program and were not developed to consider all of the life-cycle stages of an SSC. The standards were narrowly focused on one process such as design.

- Many of the commercial standards are focused on design requirements, manufacturing or testing. Although the requirements are often different, there seemed to be little difference in providing reasonable confidence of functionality between commercial standards requirements and the special treatment rules for these processes. This does not mean that the requirements were the same, that there were no significant physical differences in nuclear and commercial products, or that commercial standards could be used without plant processes. Even in instances where there were no significant differences in a process, commercial standards may not be adequate and must be supplemented. For example, a commercial standard might adequately require the consideration of design requirements, but specific design conditions must be implemented by a detailed equipment specification.

- The critical nature of some of the processes and attributes is component specific. For example, functional testing and design verification are much more important for active than for passive SSCs.

5.2.4 Use of Commercial Codes, Standards, and Practices for RISC-3 SSCs

- Commercial standards by themselves are not adequate to provide reasonable confidence of functionality. Measures such as using a combination of detailed engineering specifications, plant processes and procedures, and multilevel QA programs that provide for less rigor than required for the full 10 CFR 50, Appendix B, but augment commercial requirements might be one potential way to establish reasonable confidence of functionality.

- Most of the attributes were found to be critical to establish reasonable confidence of SSC functionality. However, reasonable confidence could be achieved for most of the critical attributes with fewer requirements than stated in the special treatment rules. This was true more for the attributes giving assurance of functionality such as documentation than for those that directly demonstrated functionality, such as SSC testing. Many of the special treatment rules are from 10 CFR 50, Appendix B, Quality Assurance. While some sort of quality program is needed for reasonable confidence of SSC functionality, a full Appendix B program does not seem to be warranted for RISC-3 SSCs.

- Plant processes will have a significant effect on providing reasonable confidence of component functionality, but the adequacy of the commercial standards and reduced plant processes would have to be evaluated on a plant-by-plant basis. It was beyond the scope of this project to evaluate the adequacy of BOP processes used by plants.

- Some utility personnel indicated that a form of commercial dedication for RISC-3 components would be beneficial. They believed that using the original equipment manufacturer and operating history would give reasonable confidence of functionality of replacement parts or SSCs.

- One attribute that was assumed to be in place and was judged very critical was the design specification. If this document includes detailed requirements (functional, environmental, loads, materials, quality, etc.), then it is much more likely that the correct product (manufactured according to the design requirements) will be selected. For example, if the design requirements state that an SOV must function in a radiation environment, then a commercially available SOV (which would probably have major physical differences from a nuclear SOV, including materials not designed for radiation environments) would not be selected.

- For the NRC to allow commercial practices to be used for procuring RISC-3 replacement SSCs, the NRC would have to rely heavily on the good judgement of nuclear utilities and provide minimum requirements for the processes used. This may result in relatively little documentation or in-plant testing or inspections to give reasonable confidence of functionality when compared to nuclear processes.

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7. GLOSSARY

Attributes: the requirements that may be needed to complete the process. Each attribute cannot be broken logically into a smaller similar attribute, but may contain more than a single step or requirement.

Commercial Dedication: process undertaken to provide reasonable confidence that a commercial grade item to be used as a basic component will perform its intended safety function and, in this respect, is deemed equivalent to an item designed and manufactured under a 10 CFR Part 50, Appendix B, quality assurance program.

Commercial Practice: practice where components are specified, ordered, manufactured, delivered, installed, operated, tested/inspected, etc., at non-nuclear facilities and for BOP components at nuclear power plants.

Critical Processes/Attributes: those requirements that (individually or jointly) are necessary to reasonably ensure functionality of a SSC.

Noncritical Process/Attribute: provides a relatively small increase in the assurance of component functionality.

Process: one of several steps needed to be carried out in completing the design, procurement, installation, or operation of an SSC.

Regulatory Attributes: those requirements of a process that ensure that one or more special treatment requirements are satisfied.

Special Treatment Requirements: the requirements that are imposed on structures, systems, and components that go beyond industry-established requirements for equipment classified as commercial grade that provide additional confidence that the equipment is capable of meeting its functional requirements under design basis conditions. This review considered the following special treatment requirements:

- 10 CFR 50.55a, [ASME BPV (Sections III and XI), OM Codes, and generic letters related to Motor-Operated Valves (MOVs)].
- 10 CFR 50.49, (Environmental Qualification of electrical components)
- 10 CFR Part 50 Appendix A, (GDC 1, 2, 4, 45, and 46.
- 10 CFR Part 50 Appendix B, (Quality Assurance
- 10 CFR Part 50 Appendix S (Seismic)
- 10 CFR Part 100 and Appendix A to Part 100 (Seismic)

APPENDIX A

TABLES

Table 1. Processes In Life-Cycle Stages[1] of a SSC.

Design Stage	Procurement Stage	Installation Stage	Operation Stage
1 Documentation [2]			
2 Quality Assurance (QA) [2]			
3 Procedures [2]			
4 Testing, Inspection, and Examination [2]			
5 Design Requirements	9 Procurement Initiation	13 Installation	14 Monitoring
6 Analysis	10 Manufacturing		15 Repair, Replacement, or Modification
7 Design Verification	11 Shipping, Storage, and Handling		16 Maintenance
8 Design Control	12 Receipt Inspection		17 Trending
			18 Corrective Actions

1. Decontamination & Decommissioning is another stage but is not being addressed because it is beyond the operating life of the SSC.
2. These processes are common to all life-cycle stages of SSCs; however, some attributes may be unique to specific life-cycle stages.

Table 2. Critical Process/Attribute Evaluation.

	Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
1	**Documentation**			
a	Maintain sufficient records	IWA 6000 50.49 (j) RG 1.89 IEEE 323 GDC 1 Part 50 App B	Critical	Without sufficient appropriate records, qualification or applicability of SSC for intended function cannot be demonstrated.
B	Type of records to be retained	NCA-1000, 3000 NB-3000 NB/NC/ND-4000, 5000, 7000, App V IST A, B & C OM-App I 50.49 (j) RG 1.89 IEEE 323 GDC 1 Part 50 App B	Critical	Without sufficient appropriate records, qualification or applicability of SSC for intended function cannot be demonstrated.
c	Inspection records requirements	NB-2000 IWA 4000, 6000 IST A Part 50 App B	Critical	Inspection records must contain the appropriate information (e.g., weld inspection data) to support functionality of the SSC.
d	Records shall be identifiable and retrievable	IWA 6000 IST A 50.49 (j) RG 1.89 IEEE 323 Part 50 App B	Critical	Records must be identifiable and retrievable to properly support the documentation of SSC functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
e Record retention requirements	IWA 6000 IST A, B & C, OM-App I Part 50 App B RG 1.28	Critical	Records supporting the functionality of critical SSCs should be retained for the operating life of the SSC to properly document functionality.
f Documented IP&D	Part 50 App B	Critical	Documented instructions, procedures, and drawings directly affect the consistent application of requirements.
g Activities accomplished in accordance with IP&D	IWA 4000 OM-App I Part 50 App B	Critical	Accomplishing activities in accordance with documented instructions, procedures, and drawings directly affect the consistent application of requirements.
h Acceptance criteria included in IP&D	OM-App I GL 89-10 d. Part 50 App B	Critical	Including acceptance criteria in IP&D provides a documented basis for critical parameters (e.g., bolt torquing requirements) that directly affect the SSC functionality.
i IP&D issuance & revision control	Part 50 App B	Critical	Issuance of IP&Ds to the correct personnel ensures that critical information affecting the confidence of SSC functionality is provided to the proper groups and personnel.
j Document approval	Part 50 App B	Critical	Issuance of IP&Ds to the correct review personnel ensures that IP&Ds contain critical information affecting the confidence of functionality.
k IP&D distribution & location	Part 50 App B	Critical	Distribution of IP&Ds to the correct groups and personnel ensures that critical information affecting the confidence of SSC functionality is provided to the necessary personnel and is readily available when needed.
l IP&D change, review, & approval	Part 50 App B	Critical	Controlling the IP&D revision, review, and approval process ensures that critical parameters are included and maintained.
m Maintain Current SSC Setup Requirements	50.55a(b)(3)(ii) GL 96-05 Part 50 App B	Critical	Maintenance of critical parameters (e.g., pressure relief set points) is crucial to the correct functioning of critical systems and components.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
2 Quality Assurance			
a Implement Quality Assurance Program	NCA-4000, 8000 IST A GDC 1 Part 50 App B RG 1.54, 1.116	Critical	An appropriate QA program will ensure that activities affecting the functionality of critical SSCs are performed in such a manner that functionality is preserved or enhanced. Documentation of these activities serves to demonstrate the continued functionality.
b Documented IP&Ds	Part 50 App B	Critical	Documented instructions, procedures, and drawings directly affect the consistent application of requirements.
c Coverage for life	IST A Part 50 App B	Critical	Records supporting the functionality of critical SSCs should be retained for the operating life of the SSC to properly document functionality.
d Identification (list) of covered SSCs	IST A, B & C Part 50 App B	Critical	Safe operation depends upon the identification of critical SSCs so that their design, procurement, qualification, installation, operation, maintenance, etc. are accomplished in a manner such that SSC functionality is maintained.
e Organizations involved identified	Part 50 App B	Critical	All organizations that may be involved in the life cycle (e.g., design, analysis, procurement, operation, maintenance, etc.) of a critical SSC should be included in the coverage of the QA plan.
f Program with graded approach	IWA 4000 Part 50 App B	Critical	A graded approach ensures that the appropriate attention to detail is given to establishing and maintaining the functionality of critical SSCs.
g Activities accomplished under controlled conditions	Part 50 App B	Critical	Where necessary and/or appropriate, accomplishing activities affecting critical SSCs under controlled conditions (e.g., leak rate testing) can be crucial to maintaining the functionality of the SSC.
h Special controls, processes, etc	Part 50 App B	Critical	The use of special controls and/or processes can be crucial to establishing and maintaining the functionality of critical SSCs.
i Personnel training/qualification	NCA-3000 IST A, OM-App I Part 50 App B	Critical	Proper training and qualification of personnel (e.g., reactor operators, maintenance personnel, etc.) directly affect the functionality of critical SSCs.
j Management reviews	Part 50 App B	Noncritical	Management review of activities affecting the functionality of critical SSCs is important. However, assuming that all other critical attributes are accomplished correctly, management review would contribute less to maintaining functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
k Planned and periodic audits	NCA-3000 IST A Part 50 App B RG 1.28	Critical	The completion of audits on a regular schedule is important to identifying any breakdowns or weaknesses in activities affecting the functionality of critical SSCs.
l Audit performance	IST A Part 50 App B	Critical	The completion of audits on a regular schedule is important to identifying any breakdowns or weaknesses in activities affecting the functionality of critical SSCs.
m Documentation & review of audit results	IST A Part 50 App B	Noncritical	Documentation and review of audit results are important. However, assuming that all other critical attributes are accomplished correctly, the review of audit results could contribute a lesser amount to maintaining functionality.
n Follow-up action	Part 50 App B	Critical	It is critical that follow-up actions be taken to maintain or restore the functionality of critical SSCs whenever the necessity for any such action is identified.
o Quality Assurance Organization	Part 50 App B	Critical	The organization of the QA plan to include all appropriate personnel, organizations, and activities has a direct effect on the functionality of the critical SSCs.
3 Procedures			
a Describe activities affecting quality	Part 50 App B	Critical	Safe operation depends upon the identification of critical SSCs so their design, procurement, qualification, installation, operation, maintenance, etc., are accomplished in a manner such that SSC functionality is maintained.
b Require procedural control	Part 50 App B	Critical	Accomplishing activities in accordance with documented instructions, procedures, and drawings directly affect the consistent application of requirements.
c Include acceptance criteria	OM-App I GL 89-10 d. Part 50 App B	Critical	Including acceptance criteria in IP&Ds provides a documented basis for critical parameters (e.g., pipe wall thickness) that directly affects the SSC functionality.
d Ensure prerequisites are met	Part 50 App B	Critical	Ensuring prerequisite requirements (e.g., assembly order, test set-ups, etc.) are satisfied will have a direct effect on the functionality of some critical components.
e Include quality hold points	Part 50 App B	Critical	Provision of quality assurance inspection hold points in procedures is a critical step in providing a high level of confidence in component functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
4 **Testing, Inspection, and Examination (T/I/E)**[2]			
a Identify T/I/E program scope	NCA-5000 IWA 2000 RG 1.65 IST A, B & C, OM-App I GL 89-10 c. Part 50 App B	Critical	The identification of the T/I/E program scope is important to ensure that all of the necessary components are included and receive the tests, inspections, and examinations that are necessary for reasonable confidence of component functionality.
b Develop T/I/E program	IWA 2000 IST A, B & C, OM-App I & II GL 89-10 c. 50.55a(b)(3)(ii) GL 96-05 GDC 1 Part 50 App B	Critical	The development of the T/I/E program is critical to ensuring that the proper actions are applied to the plant components. The program establishes the requirements and identifies those departments that are responsible for completion of the requirements. However, not all of the special treatment requirements for program development are necessary for RISC-3 components. For example, the program requirements/responsibilities may be located in several existing documents instead of being organized into a separate, stand-alone document.
c Qualified T/I/E personnel	NB/NC/ND-5000 IWA 2000 IST A, OM-App I Part 50 App B	Critical	Unqualified personnel may incorrectly assess component functionality. However, some of the administrative requirements contained in the special treatment rules could be reduced. For example, some of the training record retention requirements could be reduced or removed.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
d T/I/E methods identified	NB/NC/ND-2000 IWA 2000 IST B & C, OM-App I & II GL 89-10 c. & f. Part 50 App B GDC 45 & 46	Critical	Having the most effective T/I/E methods identified in the program requirements ensures they are used and provide reasonable confidence of component functionality.
e Inspectors perform independent assessments	IWA 2000 IST A, OM-App I Part 50 App B	Noncritical	As long as qualified personnel perform the assessments, having the worker perform the assessment would have a small effect on reasonable confidence of component functionality.
f Tests performed IAW procedures	IST A & B, OM-App I Part 50 App B	Critical	Procedural compliance is critical for ensuring that tests effectively determine component functionality. Therefore, complying with procedures is necessary for providing reasonable confidence of component functionality.
g Verify each operation where quality is necessary	Part 50 App B	Critical	Verifying test results provides assurance that the test conclusions provide reasonable confidence of component functionality.
h Control of test equipment	NCA-3000 NB/NC/ND-6000 IST B & C, OM-App I Part 50 App B	Critical	Improperly controlled test equipment could have a direct effect on the assurance of component functionality.
i Verify proper installation	IST B & C, OM-App I Part 50 App B	Critical	Proper component installation is critical to component functionality.
j Verify specified characteristics are maintained	IST B, OM-App II Part 50 App B	Critical	Verifying component characteristics is important to maintaining reasonable confidence of component functionality.
k Preoperational/ preservice tests	IST B & C, OM-App I Part 50 App B	Critical	Testing is important for providing reasonable confidence of component functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
l Pressure tests	NB/NC/ND-3000, 6000 IWA 5000 IST C Part 50 App B GDC 45 & 46	Critical	Testing is important for providing reasonable confidence of component functionality.
m Operational/ Inservice tests	RG 1.12, 1.14, 1.52 IST A, B & C OM-App I & II Part 50 App B 50.55a(b)(3)(ii) GL 96-05	Critical	Testing is important for providing reasonable confidence of component functionality.
n Design-basis tests	NB/NC/ND-2000, 5000 GL 89-10 c. Part 50 App B	Critical	Testing is important for providing reasonable confidence of component functionality.
o Post maintenance tests	IST B & C OM-App I GL 89-10 f. Part 50 App B	Critical	Testing is important for providing reasonable confidence of component functionality.
p Document & evaluate test results	IST B & C OM-App I & II GL 89-10 c. 50.55a(b)(3)(ii) GL 96-05 Part 50 App B	Critical	Proper evaluation of test results is important for providing reasonable confidence of component functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
q Acceptance criteria	Section III App VI, NB/NC/ND-5000 IWA 3000 IST B & C, OM-App I 50.55a(b)(3)(ii) GL 96-05 GL 89-10 c. Part 50 App B	Critical	Acceptance criteria are needed for proper evaluation of test results and are important for providing reasonable confidence of component functionality.
r Flaw characterization	IWA 3000 Part 50 App B	Critical	Flaw evaluations are necessary corrective actions to assure functionality.
s Evaluate retest frequencies	IST B & C OM-App I & II Part 50 App B	Noncritical	Evaluating retest frequencies has a small effect on the assurance of component functionality.
t T/I/E frequencies identified	IST A, B & C, OM-App I & II	Critical	Identification of T/I/E frequencies is necessary to ensure that functional verifications occur at the proper intervals before degradation causes a component to be inoperable. Therefore, performing actions at the proper frequency provides reasonable confidence of component functionality.
u T/I/E parameters identified	IST A, B & C, OM-App I	Critical	Identification of T/I/E parameters ensures that the characteristics associated with component functionality are verified. Therefore, this action provides reasonable confidence of component functionality.
v Corrective action	IST B & C, OM-App I 50.55a(b)(3)(ii) GL 96-05	Critical	Taking proper corrective actions is important for providing reasonable confidence of component functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
5 Design Requirements			
a. Design specification	NCA-3000, App XXIII IWA 4000 GDC 1 Part 50 App B	Critical	There should be a design specification to identify the operating requirements for the component. Professional Engineer certification is not critical.
b Performance requirements	NB/NC/ND-7000 RG 1.45, 1.52, 1.148, 1.14, 1.12 Part 50 App B	Critical	The design specification should list the performance requirements to ensure functionality.
c Normal operating conditions	NB/NC/ND-3000 GDC 2 & 4	Critical	The design specification should list the normal operating conditions to ensure functionality.
d Accident conditions	NB/NC/ND-3000 GDC 2 & 4	Critical	The design specification should list the accident conditions to ensure functionality if operation of the component is required during and subsequent to the accident.
e Natural phenomena	NB/NC/ND-3000 GDC 2 Part 50 App S RG 1.29 100.23(d) Part 100 App A	Critical	The design specification should list the accident conditions to ensure functionality if operation of the component is required during and subsequent to the accident.
f Seismic input spectra	Part 50 App S RG1.60, 1.122 100.23(c) 100.23(d) Part 100 App A	Noncritical	The component can be analyzed using an equivalent static method that is a conservative alternative to dynamic methods in which a spectrum is needed.
g Loads	NCA-2000 NB/NC/ND-3000 Part 50 App S Part 100 App A	Critical	The design specification should list the loading requirements to provide reasonable confidence of component functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
h Acceptance criteria	NB/NC/ND-3000 Part 50 App B	Critical	The design specification should list the acceptance criteria to provide confidence of component functionality.
i Quality Standards	Part 50 App B	Critical	Quality requirements to ensure functionality should be specified in plant procedures or documents.
j Inspection and test capability	NB/NC/ND-3000, 7000 IST A, B & C GDC 45 & 46	Critical	This attribute would only be noncritical if inspection and testing were not required for the component.
k Operating Limits	IST B	Critical	The pump manufacturer's design limits should be included in the test procedures.
6 Analysis			
a Personnel qualification	OM-App I Sect. III APP XXIII Part 50 App B	Critical	However, the analysis does not necessarily have to be performed by a Professional Engineer to provide confidence of component functionality.
b Checking and independent verification	Part 50 App B	Critical	An independent analysis review by a separate reviewer is needed to ensure that the analysis is correct.
c Safety Assurance	NB/NC/ND-3000 Part 50 App B Part 50 App S	Critical	Corrosion allowances and analyses are needed.
d Functionality Assurance	RG 1.89 IEEE 323 Part 50 App B Part 50 App S Part 100 App A	Critical	Functionality assurance is needed to provide reasonable confidence of component functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
e Type of analysis	NB-3000, APP II OM-App II Part 50 App S RG 1.60, 1.61, 1.92 Part 100 App A	Critical	The type of analysis should be compatible with the component and loads analyzed.
f Acceptance criteria	NB/NC/ND-3000 IST B & C Part 50 App B	Critical	Meeting allowable limits is critical.
7 **Design Verification**			
a List of covered equip	50.49 (d) RG 1.89, App E IEEE 323 Part 50 App B	Critical	The covered equipment should be identified.
b Environmental conditions	NB/NC/ND-3000 50.49 (e) GDC 4 RG 1.52; 1.89 IEEE 323 Part 50 App B	Critical	The environmental conditions to be tested should be identified.
c Dynamic effects	NB/NC/ND-3000 GDC 4 RG 1.45;1.89 IEEE 323 Part 50 App B Part 50 App S Part 100 App A	Critical	The dynamic effects to be tested should be identified.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
d Natural Phenomena	NB/NC/ND-3000 GDC 2 RG 1.100 IEEE 344 Part 50 App B Part 100 App A	Critical	The natural phenomena to be tested should be identified.
e Test procedures, plans, and profiles	RG 1.89 IEEE 323 RG 1.100 IEEE 344 Part 50 App B Part 100 App A	Critical	A test plan is critical.
f Test identical under identical conditions Or	NB/NC/ND-7000 GL 89-10 c. 50 49 (f)(1) RG 1.89 IEEE 323 RG 1.100 IEEE 344 Part 50 App B Part 100 App A	Noncritical	Since j is the minimal alternative, this item is noncritical.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
g Test identical equipment under similar conditions Or	GL 89-10 c. 50.49 (f)(1) RG 1.89 IEEE 323 RG 1.100 IEEE 344 Part 50 App B Part 100 App A	Noncritical	Since j is the minimal alternative, this item is noncritical.
h Test similar equipment with supporting analysis Or	GL 89-10 f. 50 49 (f)(2) RG 1.89 IEEE 323 1.100 IEEE 344 Part 50 App B Part 100 App A	Noncritical	Since j is the minimal alternative, this item is noncritical.
i Verify by experience with supporting analysis Or	GL 89-10 f. 50.49 (f)(3) RG 1.89 IEEE 323 RG 1.100 IEEE 344 Part 50 App B Part 100 App A	Noncritical	Since j is the minimal alternative, this item is noncritical.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
j Verify using analysis in combination with partial type test data	50 49 (f)(4) RG 1.89 IEEE 323 RG1.100 IEEE 344 Part 50 App B Part 100 App A	Critical	Since this is the lowest level qualification method, it is critical for establishing reasonable confidence that the SSC will function during the specified conditions.
k Continuing qualification	50.55a(b)(3)(ii) GL 96-05 RG 1.89 IEEE 323 Part 50 App B	Critical	If components have not been verified to their full design life, continuing qualification is needed.
l Modifications during qualification	RG 1.89 IEEE 323 Part 50 App B	Critical	Control of modifications during qualification is needed to ensure like-for-like is being tested.
8 Design Control			
a Regulatory requirements and design bases in IP&Ds	Part 50 App B III	Critical	Including regulatory requirements, design bases, and acceptance criteria in IP&Ds provides a documented basis for critical parameters (e.g., pipe wall thickness) that directly affects the SSC functionality.
b Quality standards specified	GDC 1 Part 50 App B	Critical	Specification of the applicable quality standards has a direct effect on ensuring the functionality of an SSC design.
c Applicability of materials, parts, equipment, and processes assured	Part 50 App B	Critical	Use of correct and appropriate materials, parts, and equipment has a direct effect on the functionality of critical SSCs.
d Design interfaces and coordination ensured	Part 50 App B	Critical	All appropriate disciplines (e.g., operations, maintenance, structural analysis, thermal-hydraulics, etc.) must be included in the design process to ensure the intended function and continued functionality of critical SSCs.
e Design verification	GL 89-10 c. GDC 1 Part 50 App B	Critical	Design verification makes a direct contribution to the functionality of critical SSCs by ensuring that all critical parameters have been considered in the design and all specified acceptance criteria are met.

Table 2. (continued).

	Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
f	Verification independence	Part 50 App B	Noncritical	Complete independence of the person or team performing the design verification can be a valuable contributor to increasing the confidence in a design. However, this attribute contributes less to ensuring functionality assuming that all other aspects of the procedural control and quality program are followed.
g	Prototype testing conditions	Part 50 App B	Critical	Selection and application of the appropriate test conditions have a direct effect in demonstrating the functionality of critical SSCs.
h	Design control applicability	Part 50 App B	Critical	Design control of critical SSCs is crucial in preventing unapproved and undocumented design changes and/or component modifications that would have a direct effect on functionality.
i	Design change control	Part 50 App B	Critical	Controlling the design revision, review and approval process ensures that critical parameters are considered and appropriately included in the revised design.
j	Personnel qualification	Part 50 App B	Critical	Proper training and qualification of personnel (e.g., reactor operators, maintenance personnel, design analysts, etc.) directly affects the functionality of critical SSCs.
k	Software qualification	Part 50 App B	Noncritical	Software appropriate to the design function (e.g., piping analysis) should be used. However, this attribute contributes less to ensuring functionality assuming that all other aspects (e.g., design verification) of the procedural control and quality program are followed. For example, alternate methods such as utilization of hand calculations or verification of results by use of an alternate computer code (e.g., use of ANSYS to verify ABAQUS results) are well known accepted methods to demonstrate software qualification.
9	**Procurement Initiation**			
a	Approved specification	Part 50 App B	Critical	A specification is necessary to augment many standards and codes for specific application at a plant. Specific component requirements for temperature and pressure would be contained in the specification. Approvals, review requirements, etc. required by Appendix B would need to be less rigorous for low risk components.
b	Specifies qualified equipment	Part 50 App B	Critical	Qualified equipment may be necessary for applications such as seismic, EQ, pressure boundary components. Less rigor could be used for appendix components. For example, pressure boundary components may not need to be "N" stamped.
c	Vendor Qualification	Part 50 App B	Critical	Vendor qualification was mentioned as being critical in providing reasonable confidence of functionality for some components. Less rigor could be used for appendix components. For example, pressure boundary components may not need to be "N" stamped.
d	Reference design and regulatory bases	Part 50 App B	Noncritical	Just referencing the bases is not sufficient to affect reasonable confidence of functionality. The component specification can require seismic and other special treatment requirement conditions.
e	Contractors/vendors App B program	Part 50 App B	Noncritical	Other quality assurance programs can help provide reasonable confidence of component functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
f Equipment/material/ services compliance with specifications	Part 50 App B	Critical	Equipment not complying with the specification may not operate under accident conditions. For low risk components less strict compliance with the specification should be allowed.
g Source evaluation and selection	Part 50 App B	Critical	Source or vendor evaluation and selection may be necessary to provide reasonable confidence of functionality for some components such as bolting, elastomers, and flanges as indicated by some vendors (CCI Valves and ASCO Valve) . For low risk components, less rigor in source and vendor evaluation could be allowed.
h Evidence of quality furnished	Part 50 App B	Critical	Some evidence of quality should be supplied, but for low risk components less rigor should be required.
10 Manufacturing			
a Inspection points/procedures	Part 50 App B	Critical	Inspection during manufacture is necessary to provide reasonable confidence of component functionality.
b Material control and certification	NCA-3000 Part 50 App B	Critical	Acceptable material control is required to assure reasonable functionality. Material certification may be less stringent than required by the special treatment rules to provide reasonable confidence of component functionality.
c Quality and Dimensional Standards	NB/NC/ND-3000 GDC 1 Part 50 App B	Critical	Quality and dimensional standards should be applied in the manufacturing process.
d Personnel qualification	NB/NC/ND-4000 Part 50 App B	Critical	Qualification of personnel welding and assembling components is necessary for providing reasonable confidence of component functionality.
e Permitted materials	NCA-1000 NB/NC/ND-2000 RG 1.36, 1.65, 1.14, 1.31 Part 50 App B	Critical	The materials used must be controlled to provide reasonable confidence of component functionality.
f Material processes	NB/NC/ND-2000, 4000 RG 1.44 Part 50 App B	Critical	The material processes used must be controlled to provide reasonable confidence of component functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
g Welding and joining	NCA-3000 NB/NC/ND-4000 RG 1.34, 1.43 Part 50 App B	Critical	The welding and joining used must be controlled to provide reasonable confidence of component functionality.
h Configuration	NB/NC/ND-3000, 4000, App XI Part 50 App B	Critical	Components must be configured and aligned properly to provide reasonable confidence of component functionality.
i Alignment and tolerances	NB/NC/ND-4000 Part 50 App B	Critical	Parts must be alignment and assembled correctly to provide reasonable confidence of component functionality.
j Repair requirements	NB/NC/ND-2000 Part 50 App B	Critical	Parts must be repaired correctly to provide reasonable confidence of component functionality.
k Properly marked	NCA-8000, 3000 NB/NC/ND-3000, 4000, 7000 Part 50 App B	Critical	The parts must be identified, but the marking may be less stringent than required by the special treatment rules. For example, the component can be marked other than by an ASME nameplate.
l Periodic QC assessment	Part 50 App B	Critical	Periodic audits of the vendor's QA program provide the owner confidence that the components are being manufactured properly.
m Property control measures	Part 50 App B	Critical	Control of material and parts is important to ensure that the component is manufactured properly.
n Nonconforming items	NCA-3000 Part 50 App B	Critical	Nonconforming items should not be used.
o Acceptance testing	IST B & C	Noncritical	OMa-1988, Part 6, paragraph 7.1 (Pumps), and Part 10, paragraph 6.1, requires the owner to obtain a copy of the manufacturer's test report "if available." Since the testing reports are to be supplied "if available," this offers only a small increase in assurance.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
11 Shipping, Storage, and Handling (S/S/H)			
a Control S/S/H	Part 50 App B RG 1.38	Critical	Not controlling S/S/H could lead to a degradation of the component. Less requirements and documentation could be allowed for low risk components.
b S/S/H per procedures	Part 50 App B	Critical	Some components require special shipping, storage, or handling requirements to maintain functionality. For example, some lubricants have specified shelf life. These lubricants may be necessary to ensure functionality of components such as motor-operated valves. These requirements could be reduced for low risk components.
c Special protective environments	Part 50 App B	Critical	Protective environments are necessary for functionality for some components, for example, components can oxidize (rust). Less rigor in these requirements could be allowed for low risk components.
d Lockout/tagout	Part 50 App B	Noncritical	Lockout/tagout generally is used to protect personnel and is less likely used to protect equipment.
e Identification and control of material, parts, and components	Part 50 App B	Critical	Because of the difference in some commercial components compared with nuclear grade components, identification and control or material and parts are critical. Vendors (ASCO, Barton) indicated that there was a significant difference between nuclear and non-nuclear components. However, less rigor could be required for low risk components.
f Maintain traceability	Part 50 App B	Critical	Traceability documentation of a part is critical to prove a material source, part heat treatment, testing, inspection, and other attributes necessary to assure functionality. Less rigorous and detailed traceability documentation may be needed for low risk components.
g Measures designed to prevent use of incorrect or defective material, parts, or components	Part 50 App B	Critical	Measures to control shelf life are necessary to assure defective parts are not used. Less rigor and control could be allowed for low risk components.
h Maintain components and equipment in qualified condition	Part 50 App B	Critical	See 11g.
i Parts inventory control	Part 50 App B	Critical	Parts control is similar to 11c above in that inventory control is related to component storage environment that may be necessary for component functionality.
j Consumable control	Part 50 App B	Critical	Items such as grease or oil should be controlled since these lubricants will affect reasonable confidence of component functionality. Low risk components may require rigor for control of consumable items.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
12 Receipt Inspection			
a Documentation included	Part 50 App B	Critical	Documentation is necessary to provide assurance that a component will meet the specified requirements. For low-risk components, the documentation requirements could be reduced.
b Inspection at manufacturer's facility	Part 50 App B	Noncritical	Inspection at the manufacturer's facility is not necessary to assure reasonable confidence of component functionality since an installation test could be used. Inspection at a manufacturer's facility may be a financial issue in that installation of a faulty component could be costly.
c Receipt examination	OM-App I Part 50 App B	Critical	Receipt examination is necessary to assure the part is as ordered and not damaged in shipping. Rigor could be reduced for low risk components.
d Procurement requirements on site before installation	Part 50 App B	Noncritical	Having every piece of paper on-site before the component can be installed is not necessary for reasonable confidence of component functionality. Assurance of component quality and manufacturing attributes could be supplied in other ways. For example, a catalog number may indicate component capability to meet design conditions.
e Specification requirements retained at plant site	Part 50 App B	Noncritical	Specification requirements could be maintained anywhere.
13 Installation			
a Standards (industry, quality)	GDC 1 Part 50 App B	Noncritical	Industry standards alone do not provide reasonable confidence of component functionality. A specification or vendor recommendations may be more important than a standard.
b Qualification of procedures and personnel	Part 50 App B	Critical	Adequately qualified and trained personnel and qualified procedures are necessary to provide reasonable confidence of component functionality. Plants should have more flexibility on the use of a qualified procedure and personnel for low risk components.
c Welding and joining	NCA-3000 NB/NC/ND-4000 RG 1.34, 1.43 Part 50 App B	Critical	Qualified procedures and personnel are necessary to provide reasonable confidence of functionality for welding and joining operations. Strict adherence to the ASME Code may not be necessary for low risk components.
d Alignment and tolerances	NB/NC/ND-4000 Part 50 App B	Critical	Adequate alignment and tolerances are necessary to assure that equipment will operate. Alignment and tolerance documentation and requirements could be relaxed for low risk components.
e Configuration	NB/NC/ND-3000, 4000, App XI RG 1.12	Critical	Maintaining the correct size valve operator, proper size motors, etc. is necessary to provide reasonable confidence of component functionality. Reduced rigor in configuration control could be allowed for low risk components.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
14 Monitoring			
a Maintain SSC performance requirements	IST B & C 50.55a(b)(3)(ii) GL 96-05 Part 50 App B	Critical	Maintaining component performance requirements is important for reasonable confidence of component functionality.
b Determine SSC performance degradations	IST B & C OM-App II 50.55a(b)(3)(ii) GL 96-05 Part 50 App B	Critical	It is important to know what factors affect component performance and the rate at which performance degrades to provide reasonable confidence of component functionality.
c Identify & correct conditions adverse to operability	IST C 50.55a(b)(3)(ii) GL 96-05 Part 50 App B	Critical	Implementing corrective actions can significantly affect the reasonable confidence of component functionality.
d Determine/correct root or apparent cause to prevent reoccurrence	IST C, OM-App II 50.55a(b)(3)(ii) GL 96-05 Part 50 App B	Critical	Implementing a corrective action based on a root cause analysis can significantly affect the reasonable confidence of component functionality.
e Document root or apparent cause & report to management	50.55a(b)(3)(ii) GL 96-05 Part 50 App B	Noncritical	As long as root causes are identified and corrective actions are implemented, documenting these items and reporting them to management will provide a small increase in the reasonable confidence of component functionality.
f Feedback into corrective action	50.55a(b0(3)(ii) GL 96-05	Critical	The feedback of corrective actions and lessons learned is critical to maintaining component functionality. Therefore, it is necessary for maintaining reasonable confidence of component functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
15 Repair, Replacement, or Modification			
a Stock Rotation	IWA 4000 Part 50 App B	Critical	Stock rotation is necessary to assure that shelf life and storage recommendations are followed. For example, lubricants must be controlled to assure functionality of motor-operated valves. A stock program could be less rigorous for low risk components.
b Mechanical clamping devices requirements	IWA 4000 Part 50 App B	Critical	When mechanical clamping devices are necessary, requirements should be followed to provide reasonable confidence of component functionality. Requirements may be relaxed for low risk components.
c Stamping requirements	IWA 4000 Part 50 App B	Noncritical	Stamping requirements alone are not necessary to provide reasonable confidence of component functionality. Use of non "N" stamped items could be allowed for low risk items.
d Verification and inspection documentation	IWA 4000 Part 50 App B	Critical	Verification and inspection documentation is necessary to provide reasonable confidence of functionality. The level of documentation could be relaxed for low risk components.
e Material substitution	IWA 4000 Part 50 App B	Critical	The correct material is necessary to provide reasonable confidence of component functionality since the wrong material may prevent functionality. Requirements could be reduced for low risk components.
f Failure/flaw evaluations and corrective actions	Part 50 App B	Critical	Failure and flaw evaluations are necessary corrective actions to provide reasonable confidence of component functionality. Failure and flaw evaluation programs could be less rigorous for low risk significant components
g Examination and testing	IWA 4000 IST B & C Part 50 App B	Critical	Post maintenance (repair or replacement) examination and testing is necessary to provide reasonable confidence of component functionality. Less rigor may be required for low-risk components.
h Welding, brazing, metal removal, and installation	IWA 4000 Part 50 App B	Critical	Proper welding, brazing, metal removal techniques are necessary to maintain pressure boundary integrity and provide reasonable confidence of component functionality. Less rigor may be required for low risk components.
i Heat exchanger tubing requirements, plugging, repair, sleeving, replacement	IWA 4000 Part 50 App B	Critical	Proper heat exchanger repair, plugging, etc., are necessary to provide reasonable confidence of component functionality. Less rigor may be required for low-risk components.
j Maintain qualified configuration	Part 50 App B	Critical	Maintaining equipment qualification, properly sized valve operators, etc., are necessary to provide reasonable confidence of component functionality. A less rigorous configuration control program could be allowed for low risk components.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
k Use qualified components	50.49 (k)(1) RG 1.89 Part 50 App B	Critical	Use of the correct component is necessary to provide reasonable confidence of functionality. For low-risk components, a particular code that may not be critical, for example, a B31.1 piping component may be satisfactory to provide reasonable confidence of functionality.
L Modifications	Part 50 App B	Critical	Adequate modification is necessary to provide reasonable confidence of component functionality. However, for low risk components the modification program could be less rigorous.
m Inspection agency	IWA 4000	Noncritical	An inspection agency does not provide reasonable confidence of component functionality.
16 Maintenance			
a Maintain specified characteristics	IST B & C 50.55a(b)(3)(ii). GL 96-05 RG 1.33, 1.12, 1.52 Part 50 App B	Critical	Maintaining a component's performance characteristics is important for reasonable confidence of component functionality.
b Replacement equipment must be fully qualified	50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Critical	Qualified equipment may be necessary for applications such as seismic, environmental qualification, and pressure boundary components.
17 Trending			
a Develop Trending program	OM-App I 50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Critical	The development of the Trending program is important for monitoring the performance of plant components over time. The program establishes the requirements and identifies the departments that are responsible for completion of the requirements. However, not all of the special treatment requirements for program development are necessary for RISC-3 components. For example, the program requirements/responsibilities may be less-formally documented in several existing documents instead of being organized into a separate, stand-alone document.
b Gather SSC performance data	IST B & C OM-App II 50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Critical	Gathering the appropriate component performance data is the basis for an effective trending program.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
c Analyze SSC performance trends	OM-App II 50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Critical	Analysis of component performance data is necessary for an effective trending program.
d Develop trend report	50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Critical	Development of a formal report of the trend results does not provide reasonable confidence of component functionality.
e Feedback and implementation of trending results	50.55a(b)(3)(ii). GL 96-05	Critical	Implementing corrective actions based on trend results can significantly affect reasonable confidence of component functionality.
18 Corrective Actions			
a Develop corrective action program	50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Critical	The development of the Corrective Action program is important for issues affecting component functionality. The program establishes the requirements and identifies those departments that are responsible for completion of the requirements. However, not all of the special treatment requirements for program development are necessary for RISC-3 components. For example, the program requirements/responsibilities may be less-formally documented and possibly fewer parameters would require trending as compared to high-risk safety-related components.
b Obtain input from testing in operation, inspection, examination maintenance, monitoring and trending	IST B & C, OM-App II 50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Critical	Gathering the various program inputs is necessary for determining the corrective actions necessary for providing reasonable confidence of component functionality.
c Implement actions to address input	50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Critical	Taking proper corrective actions for nonconforming conditions is important for providing reasonable confidence of component functionality.
d Document performance and completion of actions	IST B & C, OM-App I 50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Noncritical	As long as the appropriate corrective actions are taken, the documentation of these actions does not affect reasonable confidence of component functionality.

Table 2. (continued).

Regulatory (Nuclear) Special Treatment Processes and Attributes	Regulatory Requirements and Guidelines	Critical or Noncritical Evaluation	Evaluation Basis
e Control backlog of actions	50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Noncritical	As long as the appropriate corrective actions are taken, the documentation associated with tracking these actions does not affect reasonable confidence of component functionality.
f Incorporate results into plant programs	OM-App II 50.55a(b)(3)(ii). GL 96-05 Part 50 App B	Critical	Implementing the corrective actions and lessons learned from past problems is critical for maintaining component functionality.

NRC FORM 335 (2-89) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG/CR-6752
INEEL/EXT-01-01127

2. TITLE AND SUBTITLE

A Comparative Analysis of Special Treatment Requirements for Systems, Structures, and Components (SSCs) of Nuclear Power Plants With Commercial Requirements of Non-Nuclear Power Plants

3. DATE REPORT PUBLISHED

MONTH	YEAR
January	2002

4. FIN OR GRANT NUMBER

J2828

5. AUTHOR(S)

J.H. Phillips, J.L. Edson, M.R. Holbrook, M.E. Nitzel, A.G. Ware

6. TYPE OF REPORT

Technical

7. PERIOD COVERED *(Inclusive Dates)*

8. PERFORMING ORGANIZATION - NAME AND ADDRESS *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)*

Idaho National Engineering and Environmental Laboratory
Idaho Falls, ID 83415-3129

9. SPONSORING ORGANIZATION - NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

Division of Engineering
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

10. SUPPLEMENTARY NOTES

D.C. Fischer, NRC Project Manager

11. ABSTRACT *(200 words or less)*

This report describes a comparative analysis between the special treatment requirements applied to SSCs in nuclear power plants and commercial requirements applied to SSCs in non-nuclear power plants. This comparative analysis focused on the practices applied to SSCs in non-safety related applications [balance-of-plant (BOP)] at nuclear plants with additional information on non-nuclear power facilities. Site visit information, other nuclear power plant information, and regulatory documents were used to perform a critical process evaluation. The typical nuclear SSC life cycle was divided into four critical stages and the processes affecting each of these stages were identified. The critical attributes of each of these processes were then identified so that the differences between nuclear and BOP approaches could be studied. Evaluations characterized any significant differences between the nuclear processes, attributes, and special treatment rules (i.e., applicable codes and standards) and the corresponding nuclear BOP and/or commercial processes, attributes, and applicable codes and standards as they relate to providing reasonable confidence of component functionality. Component specific commercial codes and standards were reviewed for thirty-three different components that are typically required to comply with special treatment rules. The conclusions obtained during this project were divided into the categories of State and Federal Requirements, Commercial Practice, Differences in Special Treatment Rules and Commercial Practice, and Use of Commercial Codes, Standards, and Practices for RISC-3 SSCs. For example, one conclusion states that commercial standards by themselves are not adequate to provide reasonable confidence of functionality. However, measures such as utilizing a combination of detailed engineering specifications, plant processes and procedures, and multi-level QA programs that augment commercial requirements (but provide for less rigor then required for the full 10 CFR 50 Appendix B QA program) might be one potential way to establish reasonable confidence of functionality.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

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13. AVAILABILITY STATEMENT

unlimited

14. SECURITY CLASSIFICATION

(This Page) unclassified

(This Report) unclassified

15. NUMBER OF PAGES

16. PRICE

Printed on recycled paper

Federal Recycling Program

NRC FORM 335
(2-89)
NRCM 1102,
3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

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JANUARY 2002