11.0 PLANT SYSTEMS

11.1 PURPOSE OF REVIEW

The purpose of this review is to determine that the plant systems--systems that are identified as items relied on for safety pursuant to the proposed 10 CFR Part 70 and encompassed by the hazard and accident analyses of the Integrated Safety Assessment (ISA)--will be available and reliable to perform their intended safety function when needed. Examples of plant systems are: (a) a ventilation system necessary to provide certain decontamination functions for normal, off-normal, and accident conditions; (b) a cooling system necessary to provide a heat sink to prevent certain process elements from exceeding temperature limits; and (c) an electrical distribution system necessary to support various items relied on for safety.

11.2 RESPONSIBILITY FOR REVIEW

<u>Primary:</u> Discipline specific engineers

<u>Secondary:</u> Chemical Process Engineer, Health Physicist, Fire Protection Specialist, Human Factors Engineer

<u>Supporting:</u> Primary Reviewers of SRP Sections 1.1 and 13.1, and Chapters 2, 3, 4 and 14
Primary Reviewers of Applicable Sections of SRP Chapter 15

11.3 AREAS OF REVIEW

The review for the construction approval should focus on the layout and design of the plant systems, their components, and any related information considering the present stage of the applicant's design process. The review for the license application should focus on design modifications and any other system features not adequately described during the construction approval review.

Also, the review for the licensee application for operations should encompass the adequacy of the design and operation of plant systems identified in the ISA Summary as items relied on for safety such as electrical and ventilation systems.

The license application for operations documentation, to be reviewed by the staff, should include specific items listed below for each system. The documentation for construction approval should address the following items to the extent possible considering the stage of design information available.

Plant Systems

A. Safety Function

   i. Identification of safety function as related to the performance requirements of proposed §70.61 and the ISA;

   ii. Functional requirements stemming from the baseline design criteria (BDC) and the ISA process including environmental design considerations (temperature, pressure, humidity, etc., resulting from normal, off-normal, and accident operating conditions) for items relied on for safety with site factors (including natural phenomena that occur infrequently and conditions that are continuously present), redundancy, independence, defense-in-depth, and reliability/availability goals (including continued operation of plant systems that perform essential utility services).

B. System Description

   i. Purpose (safety and non-safety);

   ii. System design, including performance features;

   iii. Structures (including their materials, shielding, and physical protection) and components;

   iv. Instrumentation and controls (manual and automatic);

   v. System interfaces;

   vi. Drawings (including arrangements, plans, elevations, and sections for structures), specifications, and procedures;

   vii. Assurance measures including applicable industrial codes and standards, environmental qualification, quality assurance, inspection, testing, and maintenance.

C. Safety Analysis

   i. How functional requirements are satisfied by system design;

   ii. How non-safety features do not prevent the plant system from performing its intended safety function;

   iii. How long-term performance, testing, and maintenance features are addressed;

   iv. How potential failure modes are analyzed including consideration of communication failures, common-mode failures and human errors;

   v. How material-related failure modes are analyzed to include the effects of corrosion, erosion, and fatigue under normal, off-normal, and accident conditions.

vi. How data, information, and evaluations are developed as a result of site-related investigations, studies of historical data, and any newly developed information addressing the geology, seismology, hydrology, meteorology, and geotechnical aspects of the site as well as site proximity events considered as natural phenomena events (such as earthquakes, high winds, tornadoes, tornado missiles and floods) and other external events (such as nearby transportation accidents, airplane crashes, fires external to the facility) that may produce conditions that could influence the performance of plant facilities that are necessary to protect health and minimize danger to life or property.

Because the results of the ISA identify the items relied on for safety that form the safety functions discussed above, the primary reviewer should also review the ISA Summary (see SRP Chapter 5) to determine which plant systems have been identified as items relied on for safety, their safety categories, their assumed operating modes and conditions, the impact of their inoperability, and any related limiting operations or plant mode restrictions. The review should also encompass any additional assumptions used in ISA qualitative/quantitative evaluations related to performance requirements for plant systems such as redundancy, independence, reliability, quality, etc.

11.4 ACCEPTANCE CRITERIA

As part of the application for construction approval, the applicant should commit to providing plant systems which meet or exceed the acceptance criteria in the following subsections of this SRP section.

11.4.1 Regulatory Requirements

The staff's requirements applicable to all plant systems are the following:

10 CFR Part 70.22, specifically relating to the requirement that the applicant is to provide a description of the equipment and facilities and propose procedures to protect health and minimize danger to life and property.

10 CFR Part 70.23, specifically relating to the requirement that the Commission determine that the proposed equipment, facilities, and procedures are adequate to protect health and minimize danger to life and property.

10 CFR Part 70.61(e), as proposed, specifically relating to the requirement that each engineered or administrative control or control system that is needed to meet the performance requirements be designated as an item relied on for safety.

10 CFR Part 70.62, as proposed, specifically relating to the establishment and maintenance of a safety program and to the performance of an ISA.

10 CFR Part 70.64, as proposed, specifically relating to the application of BDC and defense-in-depth practices to new facilities or new processes at existing facilities.

11.4.2 Electrical Systems

11.4.2.1 Regulatory Guidance

The regulatory guidance and associated industry standards that provide guidance for implementing and satisfying the regulatory requirements and acceptance criteria for electrical systems are:

NUREG-0800, Standard Review Plan, Chapter 8, “Electric Power,” Table 8-1, Acceptance Criteria and Guidelines for Electric Power Systems, U. S. Nuclear Regulatory Commission.

NRC Regulatory Guides for Division 1, Power Reactors, and associated Institute of Electrical and Electronic Engineers (IEEE) Standards encompassing the design, installation, and testing of equipment and components such as emergency diesel generators, batteries and cables in electrical systems performing safety functions.

Although the above documents apply to nuclear power plants, they provide background information, provide guidance which the staff expects to be applied to the MOX fuel fabrication facilities, and address subjects that the reviewer must verify have been adequately considered by the applicant.

11.4.2.2 Regulatory Acceptance Criteria

The reviewer should find the applicant’s electrical systems' design and operation acceptable if they satisfy the requirements listed in Section 11.4.1 and follow the relevant guidelines mentioned under Section 11.4.2.1. The requirements and guidelines for electrical systems are those related to the BDC and defense-in-depth. Typically, these include specific design considerations such as two physically independent offsite power sources with redundant and independent onsite ac and dc power sources that are designed with:

- Test, calibration, and in-service surveillance capabilities;
- Electrical and physical separation;
- No single failure vulnerability;
- Sufficient capacity and capability;
- Adequate protective relaying and breaker control;
- Status monitoring;
- Proper equipment qualification, quality assurance, and reliability; and
- Adequate design for natural phenomena.

Additionally, the electrical systems' design and operation should fulfill the functional requirements determined from the ISA and the electrical systems should be available and reliable to perform their intended safety function when needed.

11.4.3 Instrumentation and Control Systems

11.4.3.1 Regulatory Guidance

The regulatory guidance and associated industry standards that provide guidance for implementing and satisfying the regulatory requirements and acceptance criteria for instrument and control systems are:

NUREG-0800, Standard Review Plan, Chapter 7, “Instrumentation and Controls,” U. S. Nuclear Regulatory Commission.

NRC Regulatory Guides for Division 1, Power Reactors, and associated IEEE Standards encompassing the design, installation, and testing of equipment, components, and computer software in instrumentation and control systems performing safety functions.

Although the above documents apply to nuclear power plants, they provide background information, provide guidance which the staff expects to be applied to the MOX fuel fabrication facilities, and address subjects that the reviewer must verify have been adequately considered by the applicant.

11.4.3.2 Regulatory Acceptance Criteria

The reviewer should find the applicant’s instrumentation and control systems' design and operation acceptable if they satisfy the requirements listed in Section 11.4.1 and follow the relevant guidelines mentioned under Section 11.4.3.1. The requirements and guidelines for instrumentation and control systems are those related to the BDC and defense-in-depth. Typically, these include specific design considerations such as redundant and/or diverse instrument channels with coincident logic providing automatic actuation with additional manual operation capability. The instrument channels are designed with:

- Test, calibration, and in-service surveillance capabilities;
- Electrical, physical, and control/protection separation;
- No single failure vulnerability;
- Adequate instrument spans, setpoints, and control ranges;
- Fail safe failure mode;
- Status monitoring;
- Proper equipment qualification, quality assurance, and reliability; and
- Adequate design for natural phenomena.

Additionally, the instrumentation and control systems' design and operation should fulfill the functional requirements determined from the ISA and the instrumentation and control systems should be available and reliable to perform their intended safety function when needed.

11.4.4 Cooling Water System

11.4.4.1 Regulatory Guidance

None, at present, specific to MOX fuel fabrication facilities.

11.4.4.2 Regulatory Acceptance Criteria

The reviewer should find the applicant's cooling water system's design and operation acceptable if they satisfy the requirements listed in Section 11.4.1. The requirements and guidelines for the cooling water system are those related to the BDC and defense-in-depth. Typically, the cooling water system is designed to demonstrate:

A. Transfer of heat loads from safety-related structures, systems, and components to an appropriate heat sink under normal, off-normal, and accident conditions;

B. Adequate water supply under normal, off-normal, and accident conditions;

C. Adequate component redundancy; the capability to isolate components, systems, or piping for maintaining system safety function under varying system configuration; and the capability of integrated system control;

D. Supporting management measures (including tests and other verification methods) ensure the structural integrity and system leak tightness (including the prevention of cross-contamination (radioactive and chemical)), the operability and adequate performance of active system components, and the capability of the system to perform required functions during normal and accident situations;

E. Capability for withstanding environmental hazards resulting from pipe line breaks and dynamic effects associated with flow instability and attendant loads such as water hammer or cavitation and measures to prevent such dynamic conditions from occurring;

F. Capacity and capability for detecting leaks and cross-contamination (radioactive and chemical); for inservice component inspection and system maintenance; and for operational functional testing of the system and its components.

G. A quality assurance program is established for the design, construction, testing, operation, and maintenance of all structures and components of the cooling water system that are identified as items relied on for safety in accordance with the criteria in Chapter 15.1, "Quality Assurance," and Appendix F of this SRP.

H. The cooling water system and its components which are identified as items relied on for safety are designed to withstand the effects of tornadoes, tornado missiles, earthquakes, floods, and any other appropriate severe natural phenomena in accordance with criteria established in the ISA.

Additionally, the cooling water system's design and operation should fulfill the functional requirements determined from the ISA, and the cooling water system should be available and reliable to perform its intended safety function when needed.

11.4.5 Ventilation Systems

11.4.5.1 Regulatory Guidance

The regulatory guidance and associated industry standards that provide guidance for implementing and satisfying the regulatory requirements and acceptance criteria for ventilation systems are:

NUREG-0800, Standard Review Plan, Chapters 9.4.1, “Control Room Area Ventilation System,” 9.4.3, “Auxiliary and Radwaste Area Ventilation System,” and 9.4.5, “Engineered Safety Feature Ventilation System,” and Regulatory Guides as cited in the acceptance criteria of these chapters.

Although the above documents apply to nuclear power plants, they provide background information, provide guidance which the staff expects to be applied to the MOX fuel fabrication facilities, and address subjects that the reviewer must verify have been adequately considered by the applicant.

Applicable DOE standards and industry codes and standards issued by the American National Standards Institute, American Society of Mechanical Engineers, Air Movement and Control Association, American Society of Heating, Refrigerating and Air-Conditioning Engineers, National Fire Protection Association, and Underwriters Laboratories.

11.4.5.2 Regulatory Acceptance Criteria

The reviewer should find the applicant’s ventilation systems' design and operation acceptable if they satisfy the requirements listed in Section 11.4.1 and follow the relevant guidelines mentioned under Section 11.4.5.1.   The requirements and guidelines for ventilation systems are those related to the BDC and defense-in-depth.

Typically, specific design considerations for ventilation systems are:

A. Confinement of radioactive contamination by zones and pressure differentials

   i. Confinement of radioactive material is provided by multiple zones with each zone bounded by barriers such as vessel, glovebox, building, and internal room walls.

   ii. The systems have the capability to direct ventilation air from areas of low radioactivity to areas of progressively higher radioactivity. Devices are provided to control and indicate pressure differentials between confinement zones. Alarms are provided to indicate when pressure differentials are not maintained in a prescribed range.

   iii. The systems have the capability to detect the need for isolation and to isolate portions of the systems relied on for safety in the event of failures or malfunctions elsewhere in the systems. The isolated systems have the capability to function under such conditions.

   iv. Supply air fans are interlocked with an exhaust air plenum pressure sensor to prevent supply fan operation unless the exhaust fans are running. This will prevent pressurization of any process room or area should exhaust ventilation fail.

   v. Additional design guidance may be found in Regulatory Guides 1.140, “Design, Testing and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants,” and 1.52, “Design, Testing, and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Absorption Units of Light-Water-Cooled Nuclear Power Plants."

B. Test, calibration, and in-service surveillance capabilities

   i. Provisions are made so that components of ventilation systems can be tested periodically for operability and required functional performance. The provisions include capability for periodic measurement of air flows in exhaust ducts and or at equipment, hoods, and exhaust ducts.

   ii. The capability is also provided to test, under conditions as close to design as practicable, the operating sequence that would bring ventilation systems into action, including the transfer to alternate power sources and the design airflow delivery capability.

   iii. Additional test guidance may be found in Regulatory Guides 1.140, “Design, Testing and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants,” and 1.52, “Design, Testing, and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Absorption Units of Light-Water-Cooled Nuclear Power Plants.”

C. Redundancy of fans, dampers, and power supplies and no single failure vulnerability

   i. There are two automatically operated isolation dampers in series to separate nonessential portions of the system from essential portions.

   ii. Essential components and subsystems are able to function in the event of loss of offsite power. In the event of the failure of a single active component (equipment or control device) or loss of offsite power, the resulting systems flow capacity will not cause the loss of preferred direction of air flow from areas of low potential radioactivity to areas of higher potential radioactivity.

   iii. The systems are capable of automatically actuating components not operating under normal conditions or actuating standby components (redundant equipment) in the event of failure or malfunction, as needed.

D. Sufficient capacity and capability

   i. The heating and cooling functions of the ventilation systems are sufficient to maintain a suitable temperature range in the areas serviced, assuming proper performance of equipment contained in those areas.

   ii. Equipment identified as items relied on for safety are capable of functioning under the worst anticipated ventilation systems' performance.

   iii. The systems are capable of preventing the accumulation of flammable or explosive gases from processes within the facility.

   iv. The systems are capable of controlling airborne particulate material (dust) accumulation.

   v. Ventilation systems are capable of operating during a normal power outage at capacities required to maintain confinement of contaminants.

E. Monitoring and alarms

   i. All exhausting ducts and stacks which may contain plutonium contaminants are provided with two monitoring systems: a continuous air monitoring system (CAMS) and a fixed sampler. The probes for sampling purposes are designed for isokinetic sampling and located to obtain representative samples. Each system is connected to an emergency power supply. The continuous stack sampler alerts cognizant personnel through an audible and visual annunciator if the airborne radioactive effluents reach prescribed limits.

   ii. Air monitoring and warning systems (including CAMS) are installed in areas where radioactive material is handled. Air sampling heads provide a representative of the potential airborne radioactivity being breathed.

iii. Duct runs and flow distributers assure uniform representative air flow past monitoring and sampling stations as well as through filter installations.

iv. Acceptance criteria for air monitoring and warning systems specific to radiation safety for design features, the radiation protection program, and effluent monitoring can be found in Sections 9.1.4.4.3(C), 9.2.4.5, and 10.4.3.B of this SRP.

F. Environmental qualification and quality assurance

i. The ventilation systems, including detectors, monitoring systems, and controls, are qualified for all expected and credible severe environments in which the systems are expected to function.

ii. A quality assurance program is established for the design, construction, testing, operation, and maintenance of all structures, systems, and components of the ventilation systems that are identified as items relied on for safety in accordance with the criteria in Chapter 15.1, "Quality Assurance," and Appendix F of this SRP.

G. Adequate design for natural phenomena

i. The ventilation systems and their components which are identified as items relied on for safety are designed to withstand the effects of tornadoes, tornado missiles, earthquakes, floods, and any other appropriate severe natural phenomena in accordance with criteria established in the ISA.

ii. Design considerations are also made for protection from offsite releases of toxic chemicals as a result of natural phenomena, if appropriate.

H. Appropriate fire protection and smoke control

i. The ventilation systems are designed to withstand any credible fire and explosion and continue to act as confinement barriers.

ii. Ventilation systems are capable of operating during a fire in the areas they ventilate and safely handle products of combustion through appropriate ventilation channels. A supply air system remains operational; however, the option to discontinue air supply to the involved spaces is maintained.

iii. The materials of construction for the ventilation systems are fire resistant to protect against fires occurring within or without the systems. Approved smoke and heat detectors are provided in the system.

iv. Detailed fire protection guidance for filter plenums is found in Appendix D of this SRP.

I. Assuring a safe air supply to the control room and other occupied areas

i. The ventilation systems confine and prevent uncontrolled release of radioactive aerosols, noxious fumes, and vapors into rooms and areas normally occupied by personnel.

ii. There is continuous monitoring of recirculated air to occupied areas and diversion of contaminated air to a once-through exhaust system if allowable radiation standards are exceeded.

iii. The control room heating and cooling subsystems are capable of maintaining a suitable ambient temperature for control room personnel and equipment.

iv. There are provisions to isolate portions of the system in the event of fires, failures, and malfunctions.

v. The ventilation systems are capable of keeping essential equipment in the control room operational under the worst anticipated degraded conditions of the ventilation system.

vi. The control room ventilation has provisions for an internal recirculation filtering mode or can discharge airborne contaminants from the control room area using a once-through ventilation mode, as applicable.

vii. Applicable guidance may also be found in Regulatory Guide 1.78, “Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release,” and Regulatory Guide 1.95, “Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release.”

J. Removal and replacement of filters and other expected maintenance is designed to permit only minimum exposure of personnel to radioactivity.

i. Items relied on for safety allow for routine in-place testing of high efficiency particulate air (HEPA) filtration systems as outlined in ASME N510.

ii. Potential doses from expected maintenance of ventilation systems can be minimized by providing ready access to the systems, by providing space to permit the activities to be accomplished expeditiously, by separating filter banks and components to reduce exposures to radiation from adjacent banks and components, and by providing sufficient space to accommodate auxiliary ventilation of shielding of components.

iii. Additional guidance may also be found in Chapter 9.0, “Radiation Safety,” of this SRP and Regulatory Guide 8.8, “Information Relevant to Ensuring that Occupational Exposures at Nuclear Power Stations will be as Low as is Reasonably Achievable.”

K. Gloveboxes and process enclosures

i. Gloveboxes are constructed using the highest quality of materials and workmanship to assure total containment and minimize leakage. Gloveboxes are constructed of non-combustible materials. (see Chapter 7.0 of this SRP).

ii. The design of enclosures is based on downdraft ventilation flow to minimize the spread of fire. Heat detectors and combustible gas and vapor detection meters are provided on gloveboxes or enclosures where fire or explosion hazards exist. An inerting environment or automatic suppression are provided in these boxes or enclosures. Where automatic suppression is not provided, fire detectors are installed and provisions made for manual fire suppression. (See Chapter 7.0 of this SRP.)

iii. Small gloveboxes or enclosure systems supplied with gases under positive pressure have positive-acting pressure-relief devices (discharging into an exhaust system) to prevent overpressurization. Further, should these systems be recirculating, all necessary cleanup and detection equipment for noxious, corrosive, or explosive vapors or gases are considered.

iv. The minimum instrumentation for a glovebox or enclosure ventilation system includes devices to indicate the pressure differential between the box or enclosure and the surrounding work area, the filter resistance, and the exhaust flow rate from the box or enclosure. (The applicant should specify the maximum operable pressure differential.) When box operations are not in full-time attendance for a continuous process, a sensor is provided to monitor abnormal pressure or temperature and alarm at a point where cognizant personnel are stationed.

Additionally, the ventilation systems' design and operation should fulfill all of the functional requirements determined from the ISA, and the systems should be available with adequate reliability to perform all of their intended safety functions when needed.

11.4.6 Civil-Structural Systems

The civil-structural systems include the buildings and support structures of the facilities that are to house, support, confine, or contain the various other plant systems, components, and equipment associated with licensed nuclear materials or hazardous chemicals associated with licensed nuclear materials that may adversely affect items relied on for safety.

11.4.6.1 Regulatory Guidance

The regulatory guidance and associated industry standards that provide guidance for implementing and satisfying the regulatory requirements and acceptance criteria for civil-structural systems are:

RG 1.132, “Site Investigations for Foundations of Nuclear Power Plants”

RG 1.138, “Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants”

In addition to regulatory guides, other sources of guidance are industry consensus standards such as:

ANSI/ANS-2.11-1978(R1989), “Guidelines for Evaluating Site-Related Geotechnical Parameters at Nuclear Power Plant Sites”

ANSI/ANS-2.19-1981(R1990), “Guidelines for Establishing Site-Related Parameters for Site Selection and Design of an Independent Spent Fuel Storage Installation (Water Pool Type)”

These documents provide guidance on the considerations that influence the array of natural phenomena that must be considered in the group of external events as well as the determination of site related technical information. Additionally these documents identify the subjects that the reviewer should verify that the applicant has appropriately integrated into the design of the facility. Other regulatory guides and industry consensus documents are listed below:

RG 1.60, “Design Response Spectra for Seismic Design of Nuclear Power Plants”

RG 1.61, “Damping Values for Seismic Design of Nuclear Power Plants”

RG 1.76, “Design Basis Tornado for Nuclear Power Plants”

RG 1.91, “Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants”

RG 1.92, “Combining Modal Responses and Spatial Components in Seismic Response Analysis”

RG 1.117, “Tornado Design Classification”

RG 1.122, “Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components”

RG 1.165, “Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion”

ANSI/ANS-2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites"

ASCE 1-82, "Guidelines for Design and Analysis of Nuclear Safety-Related Earth Structures"

ASCE 4-86, "Seismic Analysis of Safety-Related Nuclear Structures"

ASCE 7-95, "Minimum Design Loads for Buildings and Other Structures"

For most of the structural materials that will be utilized in the civil-structural systems, there are existing design codes or standards that are based on using allowable stresses or on using a strength approach with load or resistance factors. The list of regulatory guides and industry codes and standards that may have been used by the applicant is provided below:

RG 1.142, "Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments)"

ACI 349-97, "Code Requirement for Nuclear Safety-Related Concrete Structures"

AISC N690-84, "Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities"

Although some of the above documents apply to nuclear power plants, they provide background information, provide guidance which the staff expects to be applied to the MOX fuel fabrication facilities, and address subjects that the reviewer must verify have been adequately considered by the applicant.

The governing building code should be considered as a guidance document in that it will prescribe absolute minimum requirements for the civil-structural systems independent of the facility requirements resulting from the ISA. Embedded within the building codes or other standards and documents that are incorporated by reference, there can be guidance regarding the design, analysis, construction, and testing portions of all of the elements for consideration described above. Listed below are the major national building codes which may become a single building code in 2000. One of these documents, or a local building code, will govern as the minimum requirement for all civil-structural systems at the facility. These building codes are listed below:

BOCA, Building Officials and Code Administrators International, Inc.

SBC, Southern Building Code Congress International, Inc.

UBC, International Conference of Building Officials

IBC, International Code Council, Inc. (to release the International Building Code 2000 that will replace the three major U.S. building codes)

11.4.6.2 Regulatory Acceptance Criteria

The reviewer should find the applicant's civil-structural systems' design and operation acceptable if it satisfies the requirements listed in Section 11.4.1 and follows the relevant guidelines mentioned under Section 11.4.6.1. The requirements and guidelines for the civil-structural systems are those related to the BDC and defense-in-depth.

If civil-structural systems are involved in the prevention or mitigation of the consequences of any of the events or accidents, there should be a clear linkage identified between the structural performance requirements and the condition or event and its consequence. The magnitude of the parameters defining the site factors and all the accidents, events, and conditions of operation may vary for the different safety categories. It is expected that these values will be related to the results of the ISA. These parameters must then be translated into structural loads, structural movements, or other structural parameters that are capable of providing input to the definition of a physical model of the environment in which the civil-structural system must perform. Some of the parameters are considered as being deterministic while others are considered to be risk-based as a result of the ISA. For example, the return period or frequency of a specific design event should be reflected in, or derived from, the ISA (see Appendix B).

Since many of the input parameters may occur simultaneously, it is necessary that there are identifiable combinations of these parameters in the form of loading combinations defined for the facility. These loading combinations should be linked to the results of the ISA. The resulting load combinations should be clearly identified as representing the unique set of loading functions for the facility at the site that form part of the design bases of the facility. In addition, the reviewer should verify that the minimum requirements of the governing building code for the facility have been incorporated into the design bases. The reviewer should verify the acceptability of the loads, loading conditions, and the analysis models used in the design phase.

The reviewer should verify that the application provides the bases for sizing the various structural elements and members of the civil-structural systems. This aspect of the design basis can be used to quantify the safety margins that may be provided based on the loads and load combinations identified as a result of the ISA for the various operational and accident event scenarios. The reviewer should ascertain how the portion of these safety margins that arise from the sizing of individual structural members have been addressed in Chapter 5.0 of this SRP when the ISA was performed.

The reviewer should verify that a quality assurance program is established for the design, construction, testing, operation, and maintenance of all components of the civil-structural systems that are identified as items relied on for safety in accordance with the criteria in Chapter 15.1, "Quality Assurance," and Appendix F of this SRP. The reviewer should also ensure that the civil-structural systems and their components, which are identified as items relied on for safety, are adequately designed for natural phenomena including the capability to withstand the effects of tornadoes, tornado missiles, earthquakes, floods, and any other appropriate severe natural phenomena in accordance with criteria established in the ISA.

Overall, the reviewer must ensure that all the relevant parameters have been incorporated into the design and the design reflects the supplemental design bases of the other plant systems as well as the requirements of facility operations and the baseline design criteria. Additionally, the civil-structural systems' design and operation should fulfill all of the functional requirements determined from the ISA and the systems should be available with adequate reliability to perform all of their intended safety functions when needed.

11.4.7 Material Transport System (Pumps and Valves)

11.4.7.1 Regulatory Guidance

The regulatory guidance and associated industry standards that provide guidance for implementing and satisfying the regulatory requirements and acceptance criteria for the material transport system are:

NRC Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants." This regulatory guide provides a quality group classification scheme to classify, design, fabricate, and test the material transport system components in accordance with Section III of the ASME Boiler and Pressure Vessel Code.

Although the above document applies to nuclear power plants, it provides background information, provides guidance which the staff expects to be applied to the MOX fuel fabrication facilities, and addresses subjects that the reviewer must verify have been adequately considered by the applicant.

Additional guidance is provided in Department of Energy Standard 1128-98, "Guide of Good Practices for Occupational Radiological Protection in Plutonium Facilities," Section C.4.3.1, "Piping and Valves."

11.4.7.2 Regulatory Acceptance Criteria

The reviewer should find the applicant's material transport system's design and operation acceptable if it satisfies the requirements listed in Section 11.4.1 and follows the relevant guidelines mentioned under Section 11.4.7.1. The requirements and guidelines for the material transport system are those related to the BDC and defense-in-depth. Typically, the material transport system is designed to demonstrate:

A. Adequate capacity to handle the expected volume of radioactive material during normal operating and accident conditions;

B. Redundancy or diversity of components required to prevent the release of radioactive materials to the environment or needed for the safe operation of the material transport system;

C. The material transport system can be safely shutdown during normal operations and accident conditions. Provisions for emergency power are included for critical process components.

D. Tank and piping systems are of welded construction to the fullest extent possible.

E. Tank and piping systems are designed to take advantage of gravity flow to reduce the potential for contamination associated with pumping and pressurization.

F. The design of the material transport system assures that accidental criticality will not occur under normal operating conditions or under credible accident conditions.

G. All components of the system expected to be in contact with strong acids or caustics are corrosion resistant.

H. Use of traps is avoided, and the piping is designed to minimize entrapment and buildup of solids in the system.

I. Systems and devices are evaluated to determine the need for hoods, gloveboxes, and shielding for personnel protection. Generally, wet processing operations involving gram quantities of plutonium and operations involving 50 micrograms or more of plutonium in respirable form are conducted in a glovebox. (See Chapter 9.0 of this SRP)

J. Surface finishes in the work area are of materials which have satisfactory decontamination characteristics for their particular application.

K. A quality assurance program is established for the design, construction, testing, operation, and maintenance of all components of the material transport system, that are identified as items relied on for safety, in accordance with the criteria in Chapter 15.1, “Quality Assurance,” and Appendix F of this SRP.

L. Material transport system components, which are identified as items relied on for safety, are adequately designed for natural phenomena including the capability to withstand the effects of tornados, tornado missiles, earthquakes, floods, and any other appropriate severe natural phenomena in accordance with criteria established in the ISA.

Additionally, the material transport system's design and operation should fulfill all of the functional requirements determined from the ISA and the system should be available with adequate reliability to perform all of its intended safety functions when needed.

11.4.8 Heavy Lift Cranes

11.4.8.1 Regulatory Guidance

The regulatory guidance and associated industry standards that provide guidance for implementing and satisfying the regulatory requirements and acceptance criteria for heavy lift cranes are:

NRC Regulatory Guide 1.13, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants." This regulatory guide provides design criteria for cranes used in handling heavy loads, specifically refueling casks.

Although the above document applies to nuclear power plants, it provides background information, provides guidance which the staff expects to be applied to the MOX fuel fabrication facilities, and addresses subjects that the reviewer must verify have been adequately considered by the applicant.

ANSI/ANS 57.7-1988, “Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type),” provides further design criteria:

11.4.8.2 Regulatory Acceptance Criteria

The reviewer should find the applicant’s design and operation of cranes for lifting heavy loads acceptable if they satisfy the requirements listed in Section 11.4.1 and follow the relevant guidelines mentioned under Section 11.4.8.1. The requirements and guidelines for heavy lift cranes are those related to the BDC and defense-in-depth. Typically, heavy lift cranes are designed to demonstrate:

A. The handling equipment is designed in accordance with the American National Standard for Overhead Hoists, ANSI/AMSE B30.16-1987.

B. The purchase of equipment and materials is based on the codes and standards which represent a level of capability to meet the design requirements specified in American National Standard Lightning Protection Code, ANSI NFPA 78-1986, and the Specifications for Overhead Traveling Cranes, CMAA 70.

C. Cranes capable of carrying heavy loads are prevented, preferably by design rather than by interlocks, from moving over safety and containment systems.

D. Cranes are designed to provide single failure-proof handling of heavy loads, so that a single failure will not result in loss of capability of the crane-handling system to perform its safety function.

E. The crane structures and their support equipment are designed to withstand all design loads while remaining in place.

F. The crane system design is based on an analysis that considers personnel safety and the confinement of radioactive material under conditions of system failure and misoperation.

G. A quality assurance program is established for the design, construction, testing, operation, and maintenance of all structures and components of the heavy lift cranes, that are identified as items relied on for safety, in accordance with the criteria in Chapter 15.1, “Quality Assurance,” and Appendix F of this SRP.

H. Heavy lift crane structures and components, which are identified as items relied on for safety, are adequately designed for natural phenomena including the capability to withstand the effects of tornadoes, tornado missiles, earthquakes, floods, and any other appropriate severe natural phenomena in accordance with criteria established in the ISA.

Additionally, the design and operation of heavy lift cranes should fulfill all of the functional requirements determined from the ISA and the heavy lift cranes should be available with adequate reliability to perform all of their intended safety functions when needed.

11.5 REVIEW PROCEDURES

11.5.1 Acceptance Review

The primary reviewer should perform an acceptance review to determine if the application (construction or license) adequately addresses the specific items in Section 11.3, “Areas of Review.”

Guidance specific to the application for construction approval and the license application for operations is provided below:

A. Application for Construction Approval

Specifically, the application for construction approval should contain the applicant's commitments to provide plant systems which meet or exceed the acceptance criteria in Section 11.4 and should also address the layout and design of the plant systems, their components, and any related information considering the present stage of the applicant’s design process.

B. License Application for Operations

Specifically, the license application for operations should address the items described in Section 11.3 in full and update the information provide with the application for construction approval to encompass design modifications and any other system features not adequately described during the construction approval review.

If the primary reviewer verifies that plant systems are adequately addressed, the primary reviewer should accept the application for the safety evaluation in Section 11.5.2. If the primary reviewer identifies significant deficiencies in the material provided, the primary reviewer should request that the applicant submit additional information prior to the start of the safety evaluation.

Plant Systems

The secondary and supporting reviewers should confirm that the described plant systems are consistent with descriptions in other sections of the application. Information provided for plant systems should be of comparable quality and detail and should not contradict or adversely impact information contained in other sections of the application.

11.5.2 Safety Evaluation

After determining that the application is acceptable for review in accordance with either Section 11.5.1(A) (application for construction approval) or Section 11.5.1(B) (license application for operations), the primary reviewer should perform a safety evaluation against the acceptance criteria described in Section 11.4. On the basis of its review, the staff may request that the applicant provide additional information or modify the application to meet the acceptance criteria in SRP Section 11.4.

Guidance specific to the application for construction approval and the license application for operations is provided below:

A. Application for Construction Approval

   The primary reviewer should verify the applicant's commitment to provide plant systems that meet or exceed the acceptance criteria in Section 11.4. The primary reviewer should focus on the layout and design of the plant systems, their components, and any related information considering the present stage of the applicant's design process.

B. License Application for Operations

   The primary reviewer should establish that the applicant's plant systems' designs and operations provide reasonable assurance that the plant systems satisfy the acceptance criteria in Section 11.4 and will be available and reliable to perform their intended safety functions when needed. Also the primary reviewer should ensure that adequate documentation is provided in the ISA Summary for all plant systems that are identified as items relied on for safety.

   Secondary and supporting reviewers should confirm that the provisions made in the application for plant systems are in accordance and consistent with their specified sections of the SRP. For example, the review performed by the primary reviewer of Chapter 15 of this SRP--as a supporting reviewer--should encompass the adequacy of management measures applied to plant systems. The reviewer of radiation safety under Chapter 9 should evaluate the design and operation of plant systems, such as the ventilation systems and certain instrumentation and controls, with regards to adequate radiation protection. The reviewer of human factors under Chapter 12 should confirm that the principles of human factors engineering are applied to the instrumentation and control systems' design. Also, the primary reviewer of Chapter 5 should determine the adequacy of items relied on for safety (including plant systems) to assure that the likelihood and consequences of identified accidents meet the performance requirements of the proposed 10 CFR 70.61.

For an existing facility being reviewed for a license amendment or renewal, the NRC reviewers may wish to visit the site and facility personnel in order to gain a better understanding of the represented plant systems and their intended safety functions. For a planned facility, the NRC reviewers may wish to meet with the design team in order to gain a better understanding of the process, its potential hazards, and safety approaches.

When the safety evaluation is complete, the primary reviewer--with assistance from the other reviewers--should prepare the plant systems' input for the Safety Evaluation Report (SER) as described in Section 11.6 using the acceptance criteria from Section 11.4. The secondary reviewers should coordinate the plant systems input with the balance of the reviews and the SER.

11.6 EVALUATION FINDINGS

The primary reviewer should document the safety evaluation by preparing material suitable for inclusion in the Safety Evaluation Report (SER). The primary reviewer should describe the review, explain the basis for the findings, and state the conclusions.

The staff could document the safety evaluation for construction approval by stating that the applicant has committed to providing plant systems which meet or exceed the acceptance criteria in Section 11.4.

The staff could document a safety evaluation for the license application for operations as follows:

> *The staff evaluated ..... [Insert a summary statement of what was evaluated and why the reviewer finds the submittal acceptable.] Based on the review of the license application, the NRC staff concluded that the applicant's plant systems' designs and operations satisfy the staff's acceptance criteria and are adequately available and reliable to perform their intended safety functions when needed. In doing so the applicant has satisfactorily addressed the applicable regulatory requirements including the performance requirements, the baseline design criteria, and the defense-in-depth practices contained in the proposed 10 CFR Part 70.*

11.7 REFERENCES

A. NUREG-0800, Standard Review Plan, Chapter 8, “Electric Power,” Table 8-1, Acceptance Criterial and Guidelines for Electric Power Systems, U. S. Nuclear Regulatory Commission.

B. IEEE Nuclear Power Standards Collection, published by the Institute of Electrical and Electronics Engineers, Inc.

C. NUREG-0800, Standard Review Plan, Chapter 7, "Instrumentation and Controls," U. S. Nuclear Regulatory Commission.

D. NUREG-0800, Standard Review Plan, Chapter 9, “Auxiliary Systems,” U. S. Nuclear Regulatory Commission.