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U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

6.0 CHEMICAL PROCESS SAFETY

6.1 PURPOSE OF REVIEW

The primary purpose of the review is to determine with reasonable assurance that the applicant has designed a facility that will provide adequate protection against chemical hazards related to the storage, handling, and processing of licensed materials. The facility design must adequately protect the health and safety of workers and the public during normal operations and during credible accident conditions from chemical risks produced by licensed material and hazardous chemicals produced from licensed material. It must also protect against plant conditions that could affect the safety of licensed materials and thus present an increased radiation risk (e.g., release of a chemical that could incapacitate operators and preclude their entry to an area of the plant handling licensed materials).

Chemical safety issues are initially evaluated as part of the applicant's "ISA Summary." The ISA Summary must evaluate credible accident sequences at the facility; identify IROFS to prevent the occurrence or to mitigate the consequences of accidents; and include the management measures that provide reasonable assurance of the availability and reliability of IROFS, when needed. Before assessing the applicant's facility design to protect against chemical hazards, the reviewer should first review the license application, "Facility and Process Description" (SRP Chapter 1.1), and the "ISA Summary" (Chapter 3), to gain familiarity with:

- Process information and accident sequences leading to conditions that could pose chemical hazards;
- Specific IROFS, to prevent or mitigate such chemical hazards; and
- Management measures recommended, ensuring the IROFS will be available and reliable, when required.

6.2 RESPONSIBILITY FOR REVIEW

Primary: Chemical Process Safety Reviewer (all sections of this chapter)

Supporting: Licensing Project Manager
Fuel Cycle Facility Inspection Staff (as needed)
Health Physicist (for 10 CFR Part 20 uranium and transuranic toxicity issues)
Primary Reviewers of Chapters 1.0, 3.0, 8.0, and Chapter 11.0

6.3 AREAS OF REVIEW

10 CFR 70.62(a), requires an applicant to establish and maintain a safety program that will adequately protect worker and public health and safety and the environment from the chemical hazards from licensed material. The staff recommends that a separate chapter describing the chemical process safety function be provided. Note: This does not necessarily require the establishment of a separate chemical process safety program, but the applicant must demonstrate that chemical hazards and accident sequences that affect licensed materials be considered and adequately prevented or mitigated. Applicants are required to conduct an ISA and provide an ISA Summary that meets the requirements of section 70.65.

The staff's chemical process safety review should focus on the chemical safety-related accident sequences described in the "ISA Summary" (SRP Chapter 3.0) and the corresponding "Management Measures" (SRP Chapter 11.0) to confirm that the applicant's equipment, facilities and management measures are adequate to protect against releases and chemical exposures of licensed material, hazardous chemicals produced from licensed material, and chemical risks produced from plant conditions that affect the safety of licensed materials. The review will verify that any grading of IROFS or management measures proposed by the applicant in accordance with 10 CFR 70.62(a) is commensurate with the accident risk that the IROFS are designed to reduce.

The NRC-Occupational Safety and Health Administration (OSHA) Memorandum of Understanding (MOU) directs the NRC to oversee chemical safety issues related to: (a) radiation risk produced by licensed materials; (b) chemical risk produced by licensed materials; and (c) plant conditions that affect or may affect the safety of licensed materials and thus present an increased radiation risk to workers, the public, and the environment. The NRC does not oversee plant conditions that absolutely do not affect or involve the safety of licensed materials.

Specific areas to be reviewed by the staff include:

1. Chemical Process Description – including process chemistry, flow diagrams, major process steps, and major pieces of equipment. The narrative description of the site, facility, and processes with respect to chemical safety for normal operations.

2. Chemical Accident Sequences – including unmitigated accident sequences involving hazardous chemicals and licensed materials, and interpretation of the quantitative chemical risk levels.

3. Chemical Accident Consequences – including interpretation of the qualitative chemical risk levels, assumptions, bases, and methods used to forecast the consequences of accidents for workers and the public, identified in the ISA Summary, that involve hazardous chemicals and licensed materials.

4. Chemical Process IROFS – including identification and description of the adequacy of items relied on for (chemical) safety.

5. Chemical Process Management Measures – including management measures to assure the reliability and availability of IROFS (chemical process safety).

6. Safety Grading – including, if applicable, grading of IROFS and their associated management measures.

7. Verify, with the reviewer of Chapter 8.0, the coordination of chemical process safety and emergency management.
8. The applicant's commitment to retain records for chemical process safety compliance and reporting commitments for chemical releases.

9. The applicant's commitment to adhere to the 10 CFR 70.64 chemical baseline design criteria for new facilities or new processes at existing facilities that require a license amendment under 10 CFR 70.72 (as applicable).

10. The applicant's commitment to refer, to the facility's corrective action function, any unacceptable performance deficiency.

6.4 ACCEPTANCE CRITERIA

6.4.1 Regulatory Requirements

The regulatory basis for the review should be the general and additional contents of an application for chemical process safety, as required by 10 CFR 70.22, and 70.65. In addition, the chemical process safety review should be conducted to provide reasonable assurance of compliance with 10 CFR 70.61, 70.62, and 10 CFR 70.64, for new facilities or new processes, at existing facilities, that requires a license amendment under 10 CFR 70.72.

6.4.2 Regulatory Guidance

Relevant regulatory guidance for chemical process safety includes:

1. NUREG-1513, "Integrated Safety Analysis Guidance Document," latest revision.

2. NUREG-1601, "Chemical Process Safety at Fuel Cycle Facilities," 1997.

3. NUREG/CR-6410, "Nuclear Fuel Cycle Facility Accident Analysis Handbook," 1998.

6.4.3 Regulatory Acceptance Criteria

The reviewer should find the applicant's chemical process safety information acceptable if it provides reasonable assurance that the following acceptance criteria are adequately addressed and satisfied. The applicant may elect to incorporate some or all the requested chemical

process information in the “Facility and Process Description” (SRP Chapter 1.1), or ISA Summary, rather than in this section. Either approach is acceptable, so long as the information is adequately cross-referenced.

Also, the applicant should describe commitments to maintain chemical process safety records, and describe applicable commitments for “Audits and Assessments” and ”Incident Investigation” for detection and correction of any unacceptable performance deficiencies in accordance with the section on “Management Measures” (SRP Chapter 11.0).

6.4.3.1 Process Chemical Risk and Accident Sequences

The applicant’s descriptions of facility processes and chemical accident sequences are acceptable if they contain the following information:

(a) Process descriptions of sufficient detail are provided to support an understanding of chemical process hazards (including radiological hazards caused by or involving chemical accidents) and to allow development of potential accident sequences.

(b) The applicant provides an adequate list of the consequences and likelihoods of accident sequences, identified in the ISA Summary, involving hazardous chemicals produced from licensed material, and chemical risks produced by plant conditions that affect the safety of licensed materials. Each accident sequence should include the chemical hazard evaluation that identifies potential interactions of process chemicals with associated confinement vessels, process equipment, and plant personnel. The hazard evaluation should use appropriate, accepted methods. The applicant provides reasonable assurance that applicable accident sequences identified in the ISA Summary are consistent with actions provided in “Emergency Management” (SRP Chapter 8.0).

(c) The applicant identifies and uses appropriate techniques and valid assumptions in estimating the concentrations or in predicting the “toxic” footprint for releases of hazardous chemicals produced from licensed material, or from abnormal plant conditions, that could affect the safety of licensed materials. The applicant uses “Performance Requirements,” criteria as described in 10 CFR 70.61(b) and 70.61(c).

(d) Source-term and vapor-dispersion models used to calculate the concentration of uranium hexafluoride (UF_6) and its reaction products conform to guidance on the applicability of models provided in NUREG/CR-6481, “Review of Models Used for Determining Consequences of UF_6 Release.”

(e) If dispersion models are used to determine whether a release of chemicals might affect worker or public health and safety, the applicant provides evidence that the models used are appropriate to the application and that the assumed input data lead to a conservative estimate of potential consequences. Consequence analyses conform to the guidance on atmospheric and consequence modeling found in NUREG/CR-6410, “Nuclear Fuel Cycle Facility Accident Analysis Handbook,” 1998.

(f) The applicant has proposed appropriate chemical exposure standards to assess chemical consequences. Acceptable exposure standards include, but are not limited to: Emergency Response Planning Guidelines (ERPGs) established by the American Industrial Hygiene Association; Acute Exposure Guideline Levels (AEGLs), established by the National Advisory Committee for Acute Guideline Levels for Hazardous Substances; exposure limits established by OSHA; or exposure limits contained in International Standards Organization (ISO) standards. If the applicant does not use a published exposure standard, or if a chemical has an unknown exposure standard, the applicant may propose an alternate exposure standard accompanied by supporting documentation to justify selection of such an alternative. Note: 10 CFR 70.61, "Performance Requirements," are for "acute chemical exposures," and OSHA permissible exposure limits (PELS) are typically time-weighted average (TWA) values. Consequently, for ISA purposes only, acute chemical release limits may not be adjusted, using the TWA calculation, where concentration and time of exposure are used, unless a rational basis is provided in the ISA Summary.

6.4.3.2 IROFS and Management Measures

The license application should identify the design basis that provides chemical process safety for normal operations. A description could include specified features such as materials of construction, sizing, system fabrication, and process control schemes. Based on a comparison of the unmitigated chemical consequences determined in Section 6.4.3.1, with the performance criteria of 10 CFR 70.61, the applicant should identify (in the ISA Summary) chemical process safety controls (i.e., IROFS) suitable to prevent or mitigate potential accidents. IROFS also should be identified for those accident sequences containing a chemical system/process failure that may ultimately lead to radiological consequences that exceed the performance requirements. If the applicant has elected to apply a graded approach to safety in accordance with 10 CFR 70.62(a), the reviewer should establish that the grading of IROFS is appropriate and sufficient to protect against chemical process risks. For example, the applicant should consider reliance on passive controls over active systems and consider defense-in-depth in accordance with 10 CFR 70.64(b). To reduce common mode failures, the applicant should favor design features that use independent sources of motive force for items such as control actuators, jet pumps, eductors, and ejectors. Fail-safe controls are preferred unless safety concerns preclude this approach.

Management measures to assure the availability and reliability of such IROFS, when they are required to perform their safety functions, must also be described. Management measures may be graded commensurate with risk.

The applicant must also address the following:

(a) The application should describe the engineering approach, basis, or schemes employed for maintaining safety in normal operations.

(b) The ISA Summary includes the following information: identification of the administrative and engineered controls to prevent or mitigate chemical process risks, the hazard being mitigated, and the risk category. The applicant should also explain how the controls and management measures have been graded commensurate with the reduction in risk that the controls are designed to achieve.

(c) The application should describe the management measures proposed to assure IROFS are available and reliable when required by satisfying the following criteria:

(i) Engineered Controls: procedures to ensure the reliable operation of engineered controls should be briefly described (e.g., inspection and testing procedures and frequencies, calibration programs, functional tests, corrective and preventive maintenance programs, criteria for acceptable test results, etc.).

(ii) Administrative Controls: procedures to ensure that administrative controls will be correctly implemented, when required, should be briefly described (e.g., employee training and qualification in operating procedures, refresher training, safe work practices, development of standard operating procedures, training program evaluation, etc.).

6.4.3.3 Requirements for New Facilities or New Processes at Existing Facilities

The application should address the baseline design criteria (BDC) for new facilities or new processes at existing facilities that require a license amendment under 10 CFR 70.72. NUREG-1601, Section 2.4, "Design Basis," contains a list of items that should be considered in an adequate facility design. With respect to chemical process safety, the application should be considered acceptable if it includes information listed below (or references other sections of the application):

(a) A brief description of how the ISA was performed for the new process, including its use and relationship to the performance requirements in 10 CFR 70.61, the BDC, and a defense-in-depth strategy for higher-risk accident sequences. Acceptable principles for defense-in-depth of the chemical process safety design would be those that support hierarchy of controls with preference for prevention, mitigation, and operator intervention (in that order). For example, limiting inventory of on-site chemicals would be a preferential, preventive practice for limiting chemical safety-related accidents.

(b) The descriptions of proposed facility-specific or process-specific relaxations or additions to BDC, along with justifications for relaxations.

(c) In the ISA Summary, a description of how the chemical safety BDC were applied in establishing the design principles, features, and control systems of the new process.

6.5 PROCEDURES FOR REVIEW

6.5.1 Acceptance Review

The Primary Reviewer should evaluate the application to determine whether it addresses the topics in Section 6.3, “Areas of Review.” If significant deficiencies are identified, the applicant should be requested to submit additional material before the start of the safety evaluation.

6.5.2 Safety Evaluation

After determining that the application is acceptable for review in accordance with Section 6.5.1, the primary reviewer will perform a safety evaluation against the ”Acceptance Criteria” described in Section 6.4. If, during the course of the safety evaluation, the primary reviewer determines a need for additional information, the primary reviewer coordinates a request for additional information with the licensing project manager. The reviewer should ascertain that the chemical process safety approach is consistent with other sections of the application, including the ISA Summary (SRP Chapter 3); “Radiation Safety” (SRP Chapter 4); “Emergency Management” (SRP Chapter 8); and “Management Measures” (SRP Chapter 11.0). For example, the reviewer should determine that the chemical safety program will not have unacceptable or adverse impacts on the radiological safety at the facility.

For an existing facility the reviewer may consult cognizant NRC inspectors to identify and resolve any issue of concern related to the licensing review. For a planned facility the reviewers may wish to consult with the facility design team to gain a better understanding of the process, its potential hazards, and safety approaches.

The Primary Reviewer will prepare a Safety Evaluation Report (SER) for the Licensing Project Manager in support of the licensing action.

6.5.2.1 Process Chemical Risks and Accident Sequences

The results of the ISA form the basis for the chemical process safety evaluation. The reviewer should review the chemical risks identified in the ISA Summary and ensure that the level of safety is reflected in the design and operational plans for the facility. The reviewer should establish that the applicant’s facility design, operations, and IROFS pertaining to chemical safety provide reasonable assurance that they will function as intended and provide for the safe handling of licensed material at the facility. The reviewer should review the mechanisms that will allow the applicant to identify and correct potential problems.

The reviewer will make an independent judgment of the comparative risks assigned by the applicant to accident sequences identified in the ISA Summary, based on risk relative to other sequences (competing risks); the complexity of the sequence; plant operating history; and general industry performance. The review may encompass examination of a selected number of lower-risk chemical safety-related accident sequences not contained in the ISA Summary, to validate the risk threshold criteria used by the applicant in reporting sequences in the ISA Summary.

6.5.2.2 IROFS and Management Measures

The staff reviews the chemical process safety IROFS to ensure their adequacy in protecting against all unmitigated sequences identified in the ISA Summary.

If the applicant has applied a graded approach to safety, the reviewer should establish that the grading of IROFS or "Management Measures," is appropriate and sufficient to protect against chemical process risks.

6.5.2.3 Requirements for New Facilities or New Processes at Existing Facilities

The staff reviews the applicant's commitments to adhere to the BDC, in 10 CFR 70.64(a), for the design of new facilities or new processes, at existing facilities, that require a license amendment under 10 CFR 70.72.

6.6 EVALUATION FINDINGS

The reviewer writes an SER addressing each topic reviewed and explains why the NRC staff has reasonable assurance that the chemical safety part of the application is acceptable. License conditions may be proposed to impose requirements where the application is deficient. In cases where the SER is drafted in advance of resolving all outstanding chemical process safety issues, the reviewer documents the review as described below and includes a list of open issues that require resolution before the staff finding of reasonable assurance. For partial reviews, revisions, and process changes, the reviewer will use applicable sections of the acceptance criteria, and the SER will be written to reflect what portions were not reviewed and the chemical process safety significance, if any. On completion of the review, NRC staff may impose temporary or limited time license conditions to authorize short-duration activities. For certain functions and requirements that concern safety or regulatory issues, a license condition may be imposed and remain in effect until removed by an amendment or license renewal.

The SER should include a summary statement of what was evaluated and the basis for the reviewer's conclusions. The following kinds of statements and conclusions will be included in the staff SER:

> The staff has evaluated the licensee's application using criteria listed previously. Based on the review of the license application, the NRC staff concluded that the applicant has adequately described and assessed accident consequences having potentially significant chemical consequences and effects that could result from the handling, storage, or processing of licensed materials. A hazard analysis has been conducted that identified and evaluated those chemical process hazards and potential accidents, and established safety controls that provide reasonable assurance for safe facility operation. To ensure that the performance requirements in 10 CFR Part 70 are met, the applicant will provide reasonable assurance that controls are maintained available and reliable when required to perform their safety functions. The staff has reviewed these safety

controls and the applicant's plan for managing chemical process safety and finds them acceptable.

The staff concludes that the applicant's plan for managing chemical process safety and the chemical process safety controls meet the requirements of 10 CFR Part 70, and provides reasonable assurance that the health and safety of the public will be protected.

6.7 REFERENCES

Center for Chemical Process Safety, "Guidelines for the Technical Management of Chemical Process Safety," American Institute of Chemical Engineers, New York, 1989, Chapter 11, as revised.

Chemical Manufacturers Association, "Responsible Care®, Process Safety Code of Management Practices," Washington, 1990.

U.S. Code of Federal Regulations, Title 10, Part 70, "Domestic Licensing of Special Nuclear Material," U.S. Government Printing Office, Washington, D.C., as revised.

U.S. Code of Federal Regulations, Title 29, Part 1910.119, "Process Safety Management of Highly Hazardous Chemicals," U.S. Government Printing Office, Washington, D.C., as revised.

U.S. Nuclear Regulatory Commission, Manual Chapter 2603, "Inspection of the Nuclear Chemical Process Safety Program at Fuel Cycle Facilities," as revised.

U.S. Nuclear Regulatory Commission/Occupational Safety and Health Administration, "Memorandum of Understanding between the Nuclear Regulatory Commission and the Occupational Safety and Health Administration, 'Worker Protection at NRC-Licensed Facilities,'" Federal Register No. 53, October 31, 1988.

U.S. Nuclear Regulatory Commission, "Chemical Process Safety at Fuel Cycle Facilities," NUREG-1601, 1997.

U.S. Nuclear Regulatory Commission, "Integrated Safety Analysis Guidance Document," NUREG-1513, latest revision.

U.S. Nuclear Regulatory Commission, "Nuclear Fuel Cycle Facility Accident Analysis Handbook," NUREG/CR-6410, 1998.

U.S. Nuclear Regulatory Commission, "Review of Models Used for Determining Consequences of UF_6 Release," NUREG/CR-6481, as revised.