6 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 credible accident conditions from the chemical risks of licensed material and from hazardous chemicals produced from licensed material. It must also protect against facility 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 facility where licensed materials are handled).

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 Section 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
- recommended management measures for ensuring that 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, 3, 8 and 11 of this SRP

6.3 AREAS OF REVIEW

An applicant is required by 10 CFR 70.62(a) to establish and maintain a safety program that will adequately protect worker, public health and safety, and the environment from the chemical hazards from licensed material. The applicant is not necessarily required to establish a separate chemical process safety program, but the applicant must demonstrate that chemical hazards and accident sequences that affect licensed material be considered and adequately prevented or mitigated. Applicants are required to conduct an ISA and provide an ISA Summary that meets the requirements of 10 CFR 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) and the corresponding management measures (SRP Chapter 11) 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 of plant conditions that affect the safety of licensed material. The review must 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 Memorandum of Understanding (MOU) between the NRC and the Occupational Safety and Health Administration (OSHA) directs the NRC to oversee chemical safety issues related to (a) radiation risks of licensed materials, (b) chemical risks of licensed materials, and (c) plant conditions that affect or may affect the safety of licensed materials and thus increase 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.

The staff's review should cover the following specifications:

(1) the chemical process description, (the narrative description of the site, facility, and processes with respect to chemical safety for normal operations) including process chemistry, flow diagrams, major process steps, and major pieces of equipment

(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, identified in the ISA Summary, including the applicant's interpretation of the qualitative chemical risk levels and the assumptions, bases, and methods the applicant used to forecast the consequences to workers and the public of accidents that involve hazardous chemicals and licensed materials

(4) chemical process IROFS, including a list of the adequacy of items relied on for chemical safety and justification of their adequacy

(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) the coordination of chemical process safety and emergency management (to be verified by contacting the reviewer of chapters)

(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 for new processes at an existing facility requiring a license amendment under 10 CFR 70.72 (as applicable)

(10) the applicant's commitment to refer any unacceptable performance deficiency to the facility's corrective action function

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 an existing facility, requiring a license amendment under 10 CFR 70.72.

6.4.2 Regulatory Guidance

The following regulatory guidance is relevant to chemical process safety:

- NUREG-1513, "Integrated Safety Analysis Guidance Document," 2001.
- NUREG-1601, "Chemical Process Safety at Fuel Cycle Facilities," 1997.
- 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 Facility and Process Description (SRP Section 1.1), or the ISA Summary, rather than in this section. Either approach is acceptable, so long as the information is adequately cross-referenced.

The applicant should also describe commitments to maintain chemical process safety records, and describe applicable commitments to "audits and assessments" and "incident investigation" for detecting and correcting of any unacceptable performance deficiencies in accordance with the SRP chapters on "Management Measures" (Chapter 11).

6.4.3.1 Process Chemical Risk and Accident Sequences

The applicant's descriptions of facility processes and chemical accident sequences are acceptable if:

(1) Process descriptions are sufficiently detailed to allow an understanding of the chemical process hazards (including radiological hazards caused by, or involving chemical accidents) and to allow development of potential accident sequences.

(2) The applicant provides an adequate list of the consequences and likelihoods of accident sequences identified in the ISA Summary as involving hazardous chemicals produced from licensed material and chemical risks of plant conditions that affect the safety of licensed materials. Each accident sequence should include a chemical hazard

evaluation of potential interactions of process chemicals with confinement vessels, process equipment, and facility personnel. The hazard evaluation should use appropriate accepted methods. The applicant provides reasonable assurance that measures to mitigate the consequences of accident sequences identified in the ISA Summary are consistent with actions described in "Emergency Management" (SRP Chapter 8).

(3) 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 by abnormal plant conditions that could affect the safety of licensed materials. The applicant uses the performance requirements criteria as described in 10 CFR 70.61(b) and 70.61(c).

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

(5) 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 in NUREG/CR-6410, "Nuclear Fuel Cycle Facility Accident Analysis Handbook," 1998.

(6) The applicant has proposed appropriate chemical exposure standards to assess chemical consequences. Acceptable exposure standards include, but are not limited to, The Emergency Response Planning Guidelines (ERPGs) established by the American Industrial Hygiene Association, the Acute Exposure Guideline Levels (AEGLs) established by the National Advisory Committee for Acute Guideline Levels for Hazardous Substances, the exposure limits established by OSHA, and the exposure limits contained in International Organization for Standardization (ISO) standards. If the applicant does not use a published exposure standard or knows of no exposure standard for a chemical, the applicant may propose an alternative exposure standard accompanied by supporting documentation to justify the 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, acute chemical release limits may not be adjusted by the TWA calculation (which involves concentration and duration of exposure) 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 for chemical process safety for normal operation and describe 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 or process failure that may ultimately

lead to radiological consequences that exceed the performance requirements. If the applicant takes 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 of active systems and 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.

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

The application must contain other information:

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

(2) the ISA Summary must identify the administrative and engineered controls to prevent or mitigate a chemical process risk, the hazard being mitigated, and the risk category. The applicant should also explain how any safety grading of IROFS and management measures has been made and how such grading is commensurate with the reduction in risk that the IROFS are designed to achieve.

(3) the application should demonstrate the management measures proposed to assure IROFS are available and reliable when required by briefly describing:

   (a) its procedures to ensure the reliable operation of engineered controls (e.g., inspection and testing procedures and frequencies, calibration programs, functional tests, corrective and preventive maintenance programs, criteria for acceptable test results).

   (b) its procedures to ensure that administrative controls will be correctly implemented, when required (e.g., employee training and qualification in operating procedures, refresher training, safe work practices, development of standard operating procedures, training program evaluation).

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 the information listed below (or references other sections of the application):

(1) the applicant briefly describes how the ISA was performed for the new process, and from the ISA satisfies principles to the BDC and the performance requirements in 10 CFR 70.61, and applies defense-in-depth to higher-risk accident sequences. Acceptable principles for defense-in-depth of the chemical process safety design are

those that support a hierarchy of controls: prevention, mitigation, and operator intervention in order of preference. For example, limiting inventory of onsite chemicals is preventive and is the preferred a preferential, preventive practice for avoiding chemical safety-related accidents

(2) the applicant describes proposed facility-specific or process-specific relaxations or additions to BDC, along with justifications for relaxations

(3) the ISA Summary contains 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). 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 issues 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 are 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 the operational plans for the facility. The reviewer should establish that the applicant's facility design, operations, and IROFS for 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.

In return, to validate the criteria used by the applicant in reporting sequences in the ISA Summary, the reviewer will make an independent judgment of the comparative risks assigned by the applicant to accident sequences identified in the ISA Summary. The judgement is based on risk relative to other sequences (competing risks), the complexity of the sequence, facility operating history, and general industry performance. The review may cover a selected number of lower risk chemical safety-related accident sequences not identified 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 an existing facility 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 uses applicable sections of the acceptance criteria, and the SER notes areas that were not reviewed and the chemical process safety significance, if any. On completion of the review, NRC staff may impose temporary 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 SER should include statements like the following:

> The staff has evaluated the application using the criteria listed previously. Based on the review of the license application, the NRC staff has concluded that the applicant has adequately described and assessed accident consequences that could result from the handling, storage, or processing of licensed materials and that could have potentially significant chemical consequences and effects. The applicant has constructed hazard analysis that identified and evaluated those chemical process hazards and potential accidents and established safety controls to provide reasonable assurance of safe facility operation. To ensure that the performance requirements in 10 CFR Part 70 are met, the applicant has provided 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, 2001.

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.

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