PROPOSED REVISION OF SRP (NUREG-1520) CHAPTER 6
INCORPORATING RECOMMENDATIONS
OF THE
NUCLEAR ENERGY INSTITUTE
(AUGUST, 1999)

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 nuclear material. 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 radioactive materials and thus present an increased radiation risk (e.g. release of a gas that could incapacitate or suffocate operators and preclude their entry to an area of the plant handling radioactive materials).

An additional purpose of the review is to verify with reasonable assurance that the areas of NRC responsibility, as specified in the NRC-OSHA Memorandum of Understanding (MOU) dated October 31, 1988, in the area of chemical process safety, are properly implemented by the applicant.

Chemical safety issues were initially evaluated as part of the applicant's Integrated Safety Analysis (ISA). The ISA evaluated credible accident sequences at the facility, identified items relied on for safety to prevent their occurrence or to mitigate their consequences and recommended management measures to ensure the availability and reliability of items relied on for safety, when needed. Prior to assessing the applicant's facility design to protect against chemical hazards, the reviewer should first consult the ISA Summary (Chapter 3) to gain familiarity with:

(1) accident sequences leading to conditions that could pose chemical hazards
(2) specific items relied on for safety to prevent or mitigate such chemical hazards
(3) management measures recommended to ensure the items relied on for safety will be available and reliable when required

In summary, the object of the chemical process safety review is determination that the applicant's facility design and items relied on for safety provide reasonable assurance of chemical safety at the facility for routine operations, off-normal conditions and credible, potential accidents.

6.2 RESPONSIBILITY FOR REVIEW

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

Secondary: None

Supporting: Project Manager and Fuel Facility Inspection Staff (as needed)
Health Physicist (for Part 20 uranium toxicity issues)

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 of licensed material. This does not necessarily require the establishment of a separate chemical process safety program, but it does require that chemical hazards and accident sequences that affect licensed materials be considered and adequately prevented or mitigated. The staff's chemical safety review should focus on the chemical safety-related accident sequences described in the ISA Summary (SRP Section 3.0) and the corresponding management measures (SRP Section 11.0) to confirm that the applicant's equipment, facilities and procedures 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 radioactive materials. Also to be reviewed is the applicant's demonstration that items identified as relied on for safety would adequately mitigate or prevent such accident sequences. The review will verify that any grading of items relied on for safety or management measures proposed by the applicant in accordance with 10 CFR 70.62(a) are commensurate with the accident risk that the controls are designed to reduce.

The NRC-OSHA MOU directs the NRC to oversee chemical safety issues related to: (a) radiation risk produced by radioactive materials; (b) chemical risk produced by radioactive materials; and (c) plant conditions which affect or may affect the safety of radioactive materials and thus present an increased radiation risk to workers, the public and the environment. The NRC does not oversee plant conditions which result in an occupational risk, but do not affect the safe use 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

2. Chemical Accident Sequences – including unmitigated accident sequences involving hazardous chemicals and licensed materials and interpretation of the qualitative 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 Items Relied on For Safety – 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 items relied on for (chemical) safety.

6. Safety Grading – including, if applicable, grading of items relied on for safety and their associated management measures

7. The applicant's commitment to retain records for chemical process safety compliance and reporting commitments for chemical releases.

8. 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).

9. The applicant's commitment to refer to the facility's corrective action program 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 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, as well as 10 CFR 70.64, for new facilities or new processes at existing facilities that require a license amendment under 10 CFR 70.72.

6.4.2 Regulatory Guidance

Relevant regulatory guidance for chemical process safety includes:

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

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

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

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 of the requested chemical process information in the Facility and Process Description (SRP Chapter 1.1) or ISA Summary (SRP Chapter 3) rather than in this section. Either approach is acceptable so long as the information is adequately cross-referenced.

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 effect the safety of radioactive 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.

c. The applicant identifies and uses appropriate techniques and valid assumptions in estimating the concentrations of hazardous chemicals produced from licensed material or predicting the "toxic" footprint for releases from abnormal plant condition that affects the safety of radioactive materials for comparison with the "Performance Requirements", 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 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 proposes 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 the Occupational Safety and Health Administration 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 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 Items Relied on for Safety and Management Measures

The application should identify the design basis that provides safety for normal operations. A description could include specified features such as materials of construction, sizing, system fabrication, and process control schemes. Based upon a comparison of the unmitigated

chemical consequences determined in 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., items relied on for safety) suitable to prevent or mitigate potential accidents. Items relied on for safety 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 items relied on for safety or management measures 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. To reduce common mode failures, the applicant should favor design features that utilize 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 items relied on for safety when they are required to perform their safety functions must also be described in the application. 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 and the risk category. If applicable, 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 items relied on for safety are available and reliable when required by satisfying the following criteria:

a) 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.)

b) 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, , safety 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 if items that should be considered in an adequate facility design. With respect to chemical safety, the application should be considered acceptable if it includes (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 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 preferred, 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 justification for relaxation.

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 REVIEW PROCEDURES

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 §6.5.1, the primary reviewer will perform a safety evaluation against the Acceptance Criteria described in §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 safety approach is consistent with other sections of the application including the ISA Summary (SRP Chapter 3), radiation safety (SRP Chapter 4) and emergency management (SRP Chapter 7). For example, the reviewer should determine that the chemical safety program will not have unacceptably 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 deemed necessary by the ISA is reflected in the design and operational plans for the facility. The reviewer should establish that the applicant's facility design, operations and items relied on for safety 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 focus will be on sequences which would exceed the performance requirements of 10 CFR 70.61 if they were not mitigated or prevented by one or more items relied on for safety. 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 assigning sequences to the ISA summary.

6.5.2.2 Items Relied on for Safety and Management Measures

The staff reviews the chemical process safety items relied on for safety 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 items relied on for safety 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 applicants commitments to adhere to the baseline design criteria 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. The SER should include a summary statement of what was evaluated and the basis for the reviewer' conclusions. The following kinds of statements and conclusions will be included in the staff SER:

> The staff has 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 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 radioactive materials. A hazard analysis has been conducted that identified and evaluated those chemical process hazards and potential accidents, and established safety controls to ensure safe facility operation. To ensure that the performance requirements in 10 CFR Part 70 are met, the applicant will ensure 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 provide reasonable assurance that the health and safety of the public will be protected.

6.7 REFERENCES

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

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.

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

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

NUREG/CR-6481, *"Review of Models Used for Determining Consequences of UF_6 Release"*, as revised.

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

Ref: I\Files\Part 70\SRP (June 1999 Version) Sec 6.msw (Final)