5.0 HAZARD/ACCIDENT ANALYSIS

5.1 Purpose of Review

The purpose of this review of the hazard/accident analysis (H/AA) is to establish reasonable assurance that the applicant has performed a systematic evaluation of the gaseous diffusion facility and its processes to determine that: (1) all hazards and credible accidents associated with deviations from normal processing, internally initiated events (e.g., explosions, fires), and externally initiated events (e.g., floods, high winds, earthquakes) that could result in unacceptable consequences to the public, facility workers, and the environment have been identified and evaluated; and (2) physical and administrative controls are identified that will provide reasonable assurance, through preventive and/or mitigative measures, that identified hazards do not result in unacceptable consequences.

5.2 Responsibility for Review

Primary: Certification Project Manager

Secondary: Reviewers of Standard Review Plan Chapters 4.0 and 6.0

Supporting: Resident Inspector Staff

5.3 Areas of Review

A summary of the H/AA is reviewed to provide assurance that a systematic evaluation of the hazards and credible accidents has been performed. The review boundaries include those accidents that result in a release of radioactive material or an inadvertent criticality event. Accidents that result in the release of hazardous chemicals are reviewed only when they result from the certified processing of radioactive materials or have the potential to adversely affect radiological safety. An event sequence having radiological consequences less than 10 CFR Part 20 limits and toxic consequences, if any, less than 29 CFR Part 1910 Subpart Z limits, would not require further consideration within the hazard analysis. The staff reviews the H/AA summary to ensure conformance with the requirements of 10 CFR 76.85.

5.4 Review Procedures

5.4.1 Acceptance Review

The staff review should start with the primary reviewer's determination that sufficient information has been provided in the contents of the application to satisfy the requirements in 10 CFR 76.35, "Contents of Application," and 10 CFR 76.36, "Renewals," with respect to the H/AA for

GDP facilities—see SRP Section 5.5.1, “Regulatory Requirements”—and that topics discussed in SRP Section 5.3, “Areas of Review,” have been addressed.

The staff also reviews the financial mechanisms and accompanying documentation submitted by the applicant by comparing them with Regulatory Guide (RG) 1.70, “Standard Format and Content of Safety Analysis Reports for Light Water Reactors,” 1983.

On the basis of its review, the staff requests that the applicant provide additional information or modify the submittal to meet the acceptance criteria in Section 5.5 of this SRP.

5.4.2 Evaluation

The staff reviews the applicant’s description of the site for the gaseous diffusion plant to determine if adequate information is presented to provide an understanding of those factors such as geography, meteorology, seismology, and demography that could pose a hazard to the facility (see SRP Section 1.1, “Site Description”). Specific external hazards (such as location of nearby airports, rail lines, port facilities, other nuclear or chemical facilities, dams, rivers, etc.) should be identified in the application by the reviewer. The reviewer should also look for identification of severe weather conditions and other external factors such as hurricanes, earthquakes, floods, high winds, and tornadoes that are specific threats to the site.

The staff reviews the applicant’s description of the facility to determine if the features that could affect potential accidents and their consequences are adequately discussed (see SRP Section 1.1, “Site Description,” and SRP Chapter 4.0, “Facility and Process Description”). The reviewer should verify that information describing the location and arrangement of buildings at the site and their distance from the site boundary is provided. The reviewer should determine that the construction of the facility is justified on the basis that (a) the facility construction is sufficient to withstand the effects of credible external events that could occur at the site, or (b) the consequences of such credible external events are acceptable, given their expected frequency of occurrence.

The staff reviews (SRP Chapter 4.0, “Facility and Process Description”) the applicant’s description of each process analyzed in the H/AA to determine that it provides an adequate understanding of process function and theory, as well as major component function and operation. The staff also reviews information provided on process design, equipment, and instrumentation, and process operating ranges and limits to determine that it is sufficient to understand the results of the H/AA.

The staff reviews the applicant’s description of the H/AA methodology selected to verify that the applicant has provided a cogent description of the methodology (i.e., the methods used for hazard identification, hazard analysis and accident identification, accident consequence determination, and accident analysis) and the bases for its choice. The reviewer verifies that the acceptance criteria in SRP Section 5.5.3, item 4, are satisfied.

The staff reviews the narrative and tabular summary of the results of the H/AA to determine if the information provided is complete and satisfies the acceptance criteria in SRP Section 5.5.3, item 5. The information reviewed includes:

1. Description of the hazards and the resulting potential accidents caused by deviations from normal operations, internally initiated events (e.g., explosions, fires), and externally initiated events (e.g., floods, high winds, earthquakes).

2. A listing of hazardous materials and conditions; also a table showing interactions between materials and between materials and conditions that could result in a hazardous situation.

3. A listing of the potential accidents that could result from the hazards identified in SRP Section 5.5.3, item 5.a, including the consequences of each accident.

4. Description of the unmitigated consequences of each potential accident to facility workers and the public.

5. Comparison of the unmitigated consequences of each accident with the defined "consequences of concern" (industry accepted thresholds for radiological or toxic chemical exposure; see Appendix C for proposed thresholds and consequences of concern).

6. Description of the accident sequence for each major potential accident (i.e., an accident sequence with consequences that exceed defined thresholds, starting with the initiating event through the accident end state).

7. For each accident identified in SRP Section 5.5.3, item 5.b, that has been demonstrated or is assumed to have consequences in excess of defined thresholds, a logic diagram (or other appropriate technique) that identifies the independent failure events required to cause the accident.

The staff reviews the administrative and physical safety controls and engineered safety features identified in the H/AA to determine if they satisfy the acceptance criteria provided in SRP Section 5.5.3, item 5. These criteria specify the number, quality, and reliability of the controls needed to prevent or mitigate the consequences of identified accidents.

The staff reviews the administrative controls that are proposed to ensure the integrity (conduct and maintenance) of the H/AA as a continuously current and accurate design basis for the facility safety program. The reviewer verifies that the controls include procedures for H/AA performance and update, review responsibility, documentation, and record maintenance. Refer to SRP Section 2.8, "Configuration Management," for additional guidance.

On the basis of its review, the staff may request that the applicant provide additional information or modify the submittal to meet the acceptance criteria in SRP Section 5.5.

The final step in the review is the primary staff reviewer's writing of a Compliance Evaluation Report (CER) that summarizes the conduct of the review, identifies what material in the application forms the basis for a finding of reasonable assurance with respect to the

acceptance criteria, and presents the bases for certificate conditions that may be necessary to conclude that reasonable assurance is achieved.

5.5 Acceptance Criteria

5.5.1 Regulatory Requirements

H/AA requirements are specified in 10 CFR 76.85.

5.5.2 Regulatory Guidance

Guidance applicable to performing an H/AA and documenting the results may be found in Regulatory Guide (RG) 1.70, "Standard Format and Content of Safety Analysis Reports for Light Water Reactors," 1983.

5.5.3 Regulatory Review Criteria

1. The staff should use the following regulatory review criteria or information demonstrating acceptable alternatives in its review of the application. Acceptability should be based on the following:

    a. The description of the site (see SRP Section 1.1, "Site Description") is considered acceptable if the following safety-related information is included or referenced in the application:

    b. Population information based on recent census data to show population distribution as a function of distance from the facility.

    c. A discussion of natural phenomena (e.g., tornadoes, hurricanes, earthquakes) and other external events that could have an adverse impact on safety. The discussion should indicate which events are considered to be incredible and the basis for that determination.

2. For purposes of the H/AA, the description of the facility is considered acceptable if the features considered to be important to safety are identified and described. If such information is available elsewhere in the recertification application, reference to the appropriate sections is considered acceptable. The information provided supports an overall understanding of the facility structure and its general arrangement as it pertains to the H/AA. At a minimum, the features to be identified and briefly described are as follows:

    a. The facility location and the distance from the site boundary.

    b. Engineering analyses regarding the ability of the facility to withstand the effects of credible external events identified in SRP Section 5.3, item 1.

c. The location and arrangement of buildings on the facility site.

3. The description of the processes analyzed as part of the H/AA is considered acceptable if the information reviewed from SRP Chapter 4.0, "Facility and Process Description," was considered acceptable. The information provided should adequately support an overall understanding of the facility process operations as they pertain to the H/AA.

4. The descriptive summary of the H/AA methodology is considered acceptable if the reviewer determines that the applicant has provided a cogent description of the methodology (i.e., the methods used for hazard identification, hazard analysis and accident identification, accident consequence determination, and accident sequence evaluation) and the bases for its selection. Specific acceptance criteria for the H/AA methodology are:

   a. The hazard identification method selected is considered acceptable if it:

      (1) Provides a list of materials (radioactive, fissile, flammable, and toxic) and/or conditions that could result in hazardous situations (e.g., loss of containment of licensed nuclear material). The list includes maximum intended inventory amounts and the location of the hazardous materials at the facility.[1] The hazard identification should focus on nonstandard industrial hazards and those standard hazards that impact the safe operation of the facility. Most highly hazardous chemicals should be addressed in the chemical safety program (see SRP Chapter 10.0, "Chemical Safety").

      (2) Determines potential interactions between materials or between materials and conditions that could result in hazardous situations.

   b. The hazard analysis method selected is considered acceptable if:

      (1) Its selection is consistent with the guidance provided in RG 1.70, "Standard Format and Content of Safety Analysis Reports for Light Water Reactors," 1983. Justification and references for methods not addressed in the RG should be provided.

      (2) It analyzes the hazards identified in SRP Section 5.5.3, item 5.a. Any hazards eliminated from further consideration should be identified and justified.

[1] At a minimum, the following hazardous chemicals should be included in the inventory list if present onsite: ammonia, fines (UO_2 dust), flammable liquids and gases, fluorine, hydrofluoric acid, hydrogen, nitric acid, organic solvents, propane, uranium hexafluoride, Zircaloy.

(3) It provides reasonable assurance that all significant accident sequences (including the controls used to prevent or mitigate the accidents) that could result in radiological and certain chemical consequences[2] are identified.

(4) It takes into account the interactions of identified hazards and proposed controls to ensure that the overall level of risk at the facility is minimized.

(5) It addresses all modes of operation, including startup, operation, shutdown, and maintenance.

(6) It addresses hazards resulting from process deviations (e.g., high temperature, high pressure), internal (to the facility) initiators (e.g., fires, explosions), and possible credible external events (e.g., floods, high winds, earthquakes, airplane crashes). Justification should be provided for an applicant's determination that certain events are incredible and, therefore, not subject to analysis in the H/AA.

c. For each accident identified in SRP Section 5.5.3, item 5.b, that has been demonstrated or assumed to result in a criticality event or exceeded consequences of concern, an accident analysis method is used to identify and demonstrate the adequacy of controls implemented to provide protection. The accident analysis method is considered acceptable if:

(1) Its selection is consistent with the guidance provided in RG 1.70. Justification and references for methods not addressed in RG 1.70 should be provided.

(2) It is able to demonstrate adherence to the double contingency principle or identifies the administrative controls and/or systems, structures, and components (SSCs) relied upon to not exceed the consequences of concern and the absence of common mode failures.

5. The narrative description and tabular summary of the results of the H/AA are acceptable if the following criteria are met:

a. The hazard identification method provides:

(1) A list of materials (radioactive, fissile, flammable, and toxic) or conditions that could result in hazardous situations. The list includes maximum intended inventory amounts and the location of hazardous materials at the site. Some of this information may exist in other documents and may be referenced.

[2] The release of hazardous chemicals is of regulatory concern to the U.S. Nuclear Regulatory Commission only to the extent that such hazardous releases result from the processing of licensed nuclear material or have the potential to adversely affect radiological safety.

(2) A table showing potential interactions between materials or between materials and conditions that could result in hazardous situations.

b. The hazard analysis method provides a tabular summary description of the potential accidents that could result from deviations from normal operations, internally initiated events (e.g., explosions, fires), and externally initiated events (e.g., floods, high winds, earthquakes). The description lists deviations from normal operations, the causes of such deviations, the unmitigated consequences of the resulting accidents, the controls or barriers expected to prevent or mitigate the accidents, and the level of quality and reliability established for each control. The listing clearly indicates the linkage between each individual cause, the resulting consequence, and the control(s) used to prevent or mitigate the consequence. The magnitude of each consequence may either be evaluated (see SRP Section 5.5.3, item 5.c) or assumed to exceed the consequences of concern.

c. The application of the consequence evaluation method(s) to the accidents identified in SRP Section 5.5.3, item 5.b, is demonstrated by the applicant in the appropriate safety sections of the recertification application (i.e., SRP Chapter 8.0, "Nuclear Criticality Safety," or SRP Chapter 10.0, "Chemical Safety").

d. For each accident identified in SRP Section 5.5.3, item 5.b, that has been demonstrated or assumed to have consequences in excess of the consequences of concern for unlikely and highly unlikely events, the accident analysis methodology clearly identifies through an operational analysis, using logic diagrams or other appropriate techniques, the independent failure events required to cause the accident. This information is needed to demonstrate adherence to the double contingency principle or to identify and demonstrate the adequacy of the administrative controls and/or SSCs relied upon to not exceed the industry-accepted thresholds for radiological or toxic chemical exposure and the absence of common mode failures.

6. The review from SRP Chapter 6.0, "Technical Safety Requirements," should determine the adequacy of the barriers or controls used to ensure safe operation of the facility.

7. The review from SRP Section 2.8, "Configuration Management," should determine the adequacy of the administrative controls used to ensure the integrity of the H/AA.

The regulatory requirements, regulatory guidance, and regulatory review criteria applicable to this SRP are listed in the following sections.

5.6 Evaluation Findings

The staff's review should verify that sufficient information has been provided in the application to satisfy the intent of requirements in 10 CFR 76.35, "Contents of Application," and 10 CFR 76.36, "Renewals," with respect to the hazard/accident analysis and that the information

provided is consistent with the guidance in this SRP. On the basis of this information, the staff should be able to conclude that this evaluation is complete.

The staff could document the evaluation of the application as follows:

> *The staff has reviewed the hazard/accident analysis for [name of facility] according to SRP Sections 5.3, 5.4, and 5.5. In addition, the applicant has [the reviewer will describe the bases for this conclusion, addressing areas that were reviewed and a discussion of how the acceptance criteria have been met. The reviewer should include a description and bases of the methodology used in the H/AA, a description of the consequences of concern used in screening the scenarios, a summary of the major scenarios, and a summary of the operational analysis and how the systems important to safety were identified through the operational analysis.]*
>
> *On the basis of its review, the NRC staff has concluded that the hazard/accident analysis description is acceptable to support recertification.*

5.7 References

American National Standards Institute/American Nuclear Society (ANSI/ANS). ANSI/ANS–51.1–1983, "Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants." ANS: La Grange Park, Illinois. 1983

Code of Federal Regulations, *Title 10, Energy,* Part 20, "Radiation Protection."

_____. *Title 10, Energy,* Part 76, "Certification of Gaseous Diffusion Plants."

_____. *Title 29, Labor,* Part 1910.119, "Process Safety Management of Highly Hazardous Chemicals."

5.8 Definitions

The following definitions are provided to help the reviewer understand the concepts given in this section:

Credible Initiating (or Secondary) Event: An initiating (or secondary) event that is not incredible. Any event sequence that consists of credible initiating and secondary events must be addressed in the H/AA. A graded (number and quality) level of controls/barriers should be implemented commensurate with the consequences that could result from such an event sequence. Credible events will include postulated failures of instrumentation and sensors designed to control equipment or initiate process alarms.

Event Sequence: A sequence of occurrences, consisting of an initiating event and secondary events, that would result in a release of radioactive material and, in some cases, nonradioactive

but toxic substance(s), that could result in adverse consequences to human health or the environment.

External Event: An initiating (or secondary) event for which the likelihood of occurrence cannot be altered by the plant manager. This would include all natural phenomena events as well as events such as airplane crashes, explosions, toxic releases, and fires occurring near the plant site.

Incredible Initiating (or Secondary) Event: As part of an event sequence, an initiating (or secondary) event that is so unlikely that additional controls/barriers are not needed to prevent the occurrence of the event sequence or mitigate its consequences. An event sequence may be characterized by a claimed incredible initiating (or secondary) event. Justification must be provided for the characterization. If justified, the event sequence will be considered incredible and will not need to be further addressed in the H/AA. Failure of an engineered or administrative control should not be considered incredible.

Internal Event: An initiating (or secondary) event for which the likelihood of occurrence can be affected by actions of the Plant Manager. This would include all events resulting from deviations from normal process operating conditions, in addition to accidents (e.g., fires or explosions) resulting from conditions at the facility site.

Natural Phenomena Event: Earthquakes, floods, tornadoes, tsunamis, hurricanes, etc. Natural phenomena events, depending on their probability of occurrence, may be credible or incredible.

Unmitigated Consequences: Those consequences that result assuming that engineered or administrative controls or barriers are not available to prevent or mitigate an accident.