EXAMPLE PROCESS HAZARD ANALYSIS OF A DEPARTMENT OF ENERGY WATER CHLORINATION PROCESS

1.0 INTRODUCTION

On February 24, 1992, the Occupational Safety and Health Administration (OSHA) released a revised version of Section 29 Code of Federal Regulations (CFR) Part 1910 that added Section 1910.119, entitled "Process Safety Management of Highly Hazardous Chemicals" (the PSM Rule). Because U.S. Department of Energy (DOE) Orders 5480.4 and 5483. 1A prescribe OSHA 29 CFR 1910 as a standard in DOE, the PSM Rule is mandatory in the DOE complex.

A major element in the PSM Rule is the process hazard analysis (PrHA), which is required for all chemical processes covered by the PSM Rule. The PrHA element of the PSM Rule requires the selection and application of appropriate hazard analysis methods to systematically identify hazards and potential accident scenarios associated with processes involving highly hazardous chemicals (HHCs).

The analysis in this report is an example PrHA performed to meet the requirements of the PSM Rule. The PrHA method used in this example is the hazard and operability (HAZOP) study, and the process studied is the new Hanford 300-Area Water Treatment Facility chlorination process, which is currently in the design stage. The HAZOP study was conducted on May 18-21, 1993, by a team from the Westinghouse Hanford Company (WHC), Battelle-Columbus, the DOE, and Pacific Northwest Laboratory (PNL). The chlorination process was chosen as the example process because it is common to many DOE sites, and because quantities of chlorine at those sites generally exceed the OSHA threshold quantities (TQs).

The report is organized into 13 sections and 5 appendices. Section 2.0 summarizes the requirements of the PSM Rule for performing PrHAs. Section 3.0 describes the scope and assumptions used in the analysis. Section 4.0 presents a list of recommendations and action items developed during the HAZOP study. Section 5.0 is an overview of the Hanford 300-Area Water Treatment Facility chlorination process, including process diagrams.

Section 6.0 contains brief descriptions of previous incidents at the Hanford 300-Area Water Treatment Facility involving the old chlorination process, and Section 7.0 summarizes the hazards of chlorine. Section 8.0 describes the HAZOP study method, and Section 9.0 lists the HAZOP team members and their roles.

Section 10.0 describes the location of the Hanford 300-Area Water Treatment Facility in relation to the public and to employees. Section 11.0 presents a brief discussion of the possible causes of human errors identified during the HAZOP study. The HAZOP summary is presented in Section 12.0, and Section 13.0 contains the study references.

Appendix A of this report contains the procedure for change-out of chlorine cylinders. The HAZOP study worksheets are provided in Appendix B. The effects of chlorine releases are estimated in Appendix C. Appendix D contains a Material Safety Data Sheet for chlorine. Appendix E presents the resumes of the HAZOP study team members.

2.0 SCOPE OF ANALYSIS

This report illustrates the use of the process hazard analysis (PrHA) required by the Occupational Safety and Health Administration (OSHA) rule 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals" (the PSM Rule). The Hanford 300-Area Water Treatment Facility chlorination process was selected for analysis because it is a process common to many U.S. Department of Energy (DOE) sites, and quantities of chlorine at those sites generally exceed the OSHA threshold quantities (TQs). The analysis method selected was the hazard and operability (HAZOP) study.

The HAZOP study was performed on the new chlorination process design at the Hanford 300-Area Water Treatment Facility. At the time of the study, the new system was partially installed but not operating. The HAZOP study consisted of four full-day sessions and covered both the chlorination process and the procedures for change-out of chlorine cylinders. The worksheets in Appendix B document the HAZOP study.

The study assumed that the chlorination process was essential and that questions regarding elimination or replacement of chlorine with other types of disinfection technologies were outside of scope. Although a separate seismic analysis was not performed, seismic failures were considered similar to existing HAZOP study scenarios (e.g., line, valve, and cylinder failures).

Additional information regarding the PSM Rule and the performance of PrHAs is available in the *DOE Guideline: Preliminary Guide for Conformance with OSHA's Rule for Process Safety Management of Highly Hazardous Chemicals* (Draft, DOE/EH, March 1993), and the *DOE Guideline: Guide for Chemical Process Hazard Analysis* (Draft, DOE/EH, March 1993).

3.0 PROCESS HAZARD ANALYSIS REQUIREMENTS

This section provides a general overview of the process safety management (PSM) requirements and objectives for conducting process hazard analyses (PrHAs) under the Occupational Safety and Health Administration (OSHA) rule 29 CFR 1910.119, the PSM Rule. This section would not normally be included in a PrHA. Rather, in its place would be a section discussing the specific objectives that management wished to accomplish in the PrHA.

3.1 Objectives

The objective of the PSM rule is to protect employees by preventing or minimizing the consequences and impacts of chemical accidents involving highly hazardous chemicals (HHCs). This objective is partly fulfilled by performance of PrHAs to identify hazards and recommend safety improvements in the design and operation of chemical processes. The scope and level of detail of a PrHA must be appropriate to the complexity of the chemical process being evaluated. A PrHA should

- Identify the hazards of a process
- Evaluate previous process incidents that had the potential to cause catastrophic consequences or impacts in the workplace
- Evaluate the engineering and/or administrative controls applicable to the process hazards and their interrelationships (e.g., detection methods for releases)
- Identify the consequences of failure of engineering and/or administrative controls
- Review facility siting issues
- Evaluate the importance of human factors on the likelihood and/or consequences of process accidents
- Evaluate qualitatively the range of possible safety and health effects on employees from failure of engineering and/or administrative controls
- Identify procedural or process safety improvements to better control process hazards.

3.2 Review Team

The PSM Rule requires that a PrHA be conducted by a team consisting of the following individuals:

- At least one member with expertise in engineering and process operations
- At least one member with experience and knowledge specific to the process being evaluated
- A team leader knowledgeable in the specific PrHA methodology being used.

3.3 Schedule

If facilities have more than one process covered by the PSM Rule, facility management must determine and document the priority order for conducting PrHAs for all the covered processes. The order for completing PrHAs should be based on a rationale that includes such considerations as

- The extent of the process hazard
- The number of potentially affected employees
- The age of the process
- The operating history of the process.

PrHAs for processes covered by the PSM Rule must be completed according to the following schedule:

- No less than 25 percent by May 26, 1994
- No less than 50 percent by May 26, 1995
- No less than 75 percent by May 26, 1996
- All of the initial PrHAs (100 percent) by May 26, 1997.

PrHAs completed after May 26, 1987, that meet the requirements of the PSM Rule are acceptable as initial PrHAs. They must be updated and revalidated in accordance with the PSM Rule requirements.

3.4 Methodology

The PrHA element of the PSM Rule requires the selection and application of appropriate hazard analysis methods to systematically identify hazards and related accident scenarios associated with highly hazardous chemicals. Although the PSM Rule allows the use of several different methods, it requires that the selection of a particular method be based on consideration of the process being analyzed. One or more of the following methods, or

an appropriate equivalent method, must be used: what-if study, checklist, what-if/checklist, HAZOP study, failure mode and effects analysis, and/or fault tree analysis.

3.5 Recommendations and Updates

The resolution of PrHA findings and recommendations are not part of a PrHA, *per se*. However, an employer must establish a system to promptly address a PrHA team's findings and recommendations. A schedule for resolutions must be established to assure that all recommendations are resolved and documented. All actions taken as a result of PrHA findings must be completed as soon as possible and must be reported to employees involved in the process and to any other individuals affected by the recommendations or actions.

Every 5 years the PrHA must be updated to ensure it is consistent with the current process, configuration, and operation. The PrHA, related updates, and the documented resolution of the recommendations are required to be maintained for the life of the process.