HNF-13971
Rev. 0

Plutonium Finishing Plant Residual Chemical Hazards Assessment Report

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Fluor Hanford
P.O. Box 1000
Richland, Washington

Contractor for the U.S. Department of Energy
Richland Operations Office under Contract DE-AC06-96RL13200

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PLUTONIUM FINISHING PLANT RESIDUAL CHEMICAL HAZARDS ASSESSMENT REPORT

December 10, 2002

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ACRONYMS

CHA	chemical hazards assessment
CFR	Code of Federal Regulations
D&D	decontamination and decommissioning
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DTS	deficiency tracking system
Ecology	Washington State Department of Ecology
FEB	Facility Evaluation Board
FH	Fluor Hanford
FVA	Facility Vulnerability Assessment
FY	fiscal year
HEDL	Hanford Engineering Development Laboratory
HEPA	high-efficiency particulate air
ISMS	Integrated Environmental, Safety and Health Management System
IPMP	Integrated Project Management Plan
PFP	Plutonium Finishing Plant
PHMC	Project Hanford Management Contract
PRF	Plutonium Reclamation Facility
PV	pressure vessel
RADTU	radioactive acid digestion test unit
RCHA	residual chemical hazards assessment
RCRA	Resource Conservation and Recovery Act of 1976
RECUPLEX	recovery of uranium and plutonium by extraction
RMA	remote mechanical A
RMC	remote mechanical C
SAR	safety analysis report
TBP-CCl_4	tri-butyl phosphate- carbon tetrachloride
TPA	Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)

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PLUTONIUM FINISHING PLANT RESIDUAL CHEMICAL HAZARDS ASSESSMENT REPORT

EXECUTIVE SUMMARY

Fluor Hanford has performed this assessment of the chemical safety status of the equipment associated with process, support, utility, and waste systems at the Plutonium Finishing Plant. This assessment is designated as the Plutonium Finishing Plant Residual Chemical Hazards Assessment. The assessment focused particular emphasis on the idle and inactive plant systems, though active areas also were examined to the extent that these were examined during the facility vulnerability assessment conducted in 1998. Remaining active systems were not examined as these are managed under permit conditions, work packages, procedures, and policies consistent with the Integrated Environmental, Safety and Health Management System. This report documents the details and findings of the assessment.

The Plutonium Finishing Plant is located in the 200 West Area of the Hanford Site (Figure 1). The Plutonium Finishing Plant consists of several large and small buildings that are grouped to form the processing complex. The Plutonium Finishing Plant activities are focused on the stabilization and packaging of plutonium-bearing materials left from plutonium weapons material processing. Decontamination and decommissioning planning recently has been completed and the Plutonium Finishing Plant is slated for decommissioning to slab-on-grade.

The assessment effort was initiated to ensure personnel safety, to facilitate safe decommissioning activities, and to satisfy Milestone M-83-21, "*Submit to the Washington State Department of Ecology a PFP Residual Chemical Hazards Assessment as a Primary Document*", cited in *Hanford Federal Facility Agreement and Consent Order,* (89-10, Ecology, EPA, DOE-RL), Change Control Form M-83-01-03, approved October 29, 2002. The milestone states:

> "Submit to the Washington State Department of Ecology a PFP residual chemical hazards assessment as a primary document. The subject document will list the processing equipment including tanks, piping, and waste lines that may contain residual chemicals and an evaluation of the associated hazards. The document will describe the evaluation, criteria, and process. It will also categorize the items based on risk to human health and the environment, include considerations on whether response actions are required, and provide a schedule for actions necessary to address significant risks prior to final deactivation. The methodology for defining the categories will be described in the document."

The residual chemical hazards assessment was performed at the plant by a dedicated team of personnel with appropriate training and extensive Plutonium Finishing Plant experience. The residual chemical hazard assessment began with an item-by-item examination of the results from the previous facility vulnerability assessment (HNF-3262, *Facility Vulnerability Assessment, Phase 3, Final Report*) with particular attention to conditions that had received relatively high (less favorable) rankings. This beginning was selected as a sensible approach to establishing a basis for review. Additional items were added to the residual chemical hazards assessment for review as a result of plant walkdowns and an extended vessel inventory.

The residual chemical hazards assessment focused on evaluating risk associated with Plutonium Finishing Plant process equipment, including tanks, piping, and waste lines that could contain residual chemicals. Considerations were given to the potential severity of hazards such as the potential of physical injury to humans, potential exposure to humans, and significance of secondary impact. Another important factor considered was the likelihood of occurrence. The likelihood of occurrence depends on design, operation, containment vessel condition, emergency planning and safety basis, and maintenance and inspection. A mathematical expression was developed to quantify relative risk. The relative risk was expressed as a numerical product of the two quantities representing the severity and the likelihood of occurrence.

Response actions were determined based on the relative risk values and engineering judgment. Vessels were classified into three categories: (1) high priority items, (2) other/work scheduled items (which include completed items), and (3) deferred items. No item was found to have a significant risk that required response actions prior to final deactivation. Items are designated as 'high priority' because of their relative risk values or engineering judgment. These items have actions identified for completion in the near term. These items require passive controls to ensure personnel safety, and mitigation of the condition was judged to be the most prudent action. Other/Work scheduled items are those items scheduled for work as part of Plutonium Finishing Plant's cost effective work practices even though none are required prior deactivation. Other/Work scheduled items include completed items that either have been removed or mitigated to a safe configuration until decontamination and decommissioning. Deferred items are items posing minimal risk and their removal can be deferred safely until decontamination and decommissioning.

Vessel category information is summarized as follows:

- Significant risk items: 0
- Total items identified and evaluated: 309
- Total high priority items: 6
- Total other/work scheduled items: 84
- Total deferred items: 219

The final disposition of all residual chemicals residing in inactive process equipment will occur with the decommissioning of the Plutonium Finishing Plant complex.

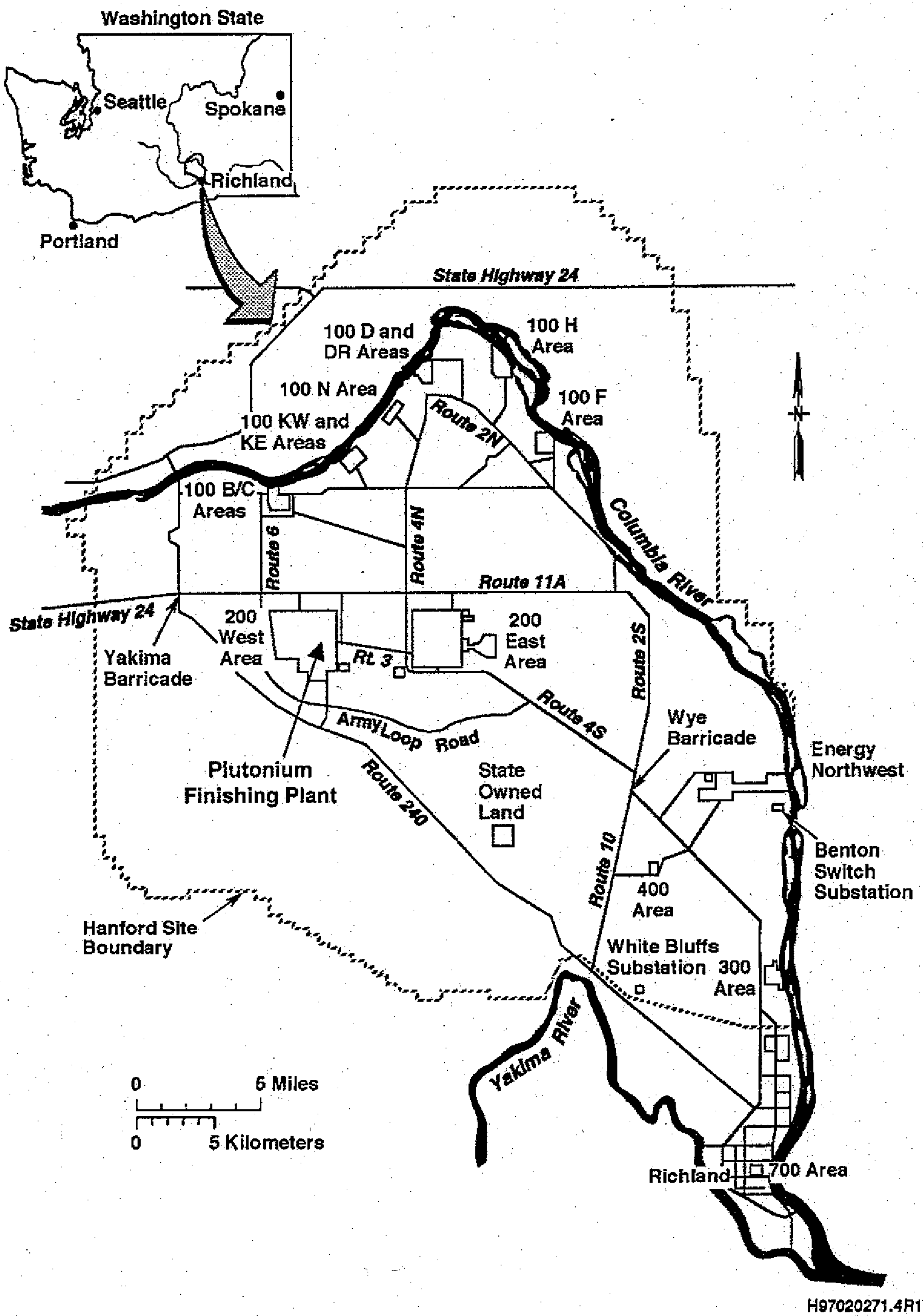

Figure 1. Hanford Site.

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1.0 INTRODUCTION

An assessment of the chemical hazards of the Plutonium Finishing Plant (PFP) systems, called the PFP Residual Chemical Hazards Assessment (RCHA), has been completed. This report provides the results of that assessment and is organized in the following manner.

Section 1.0 provides an overview of the RCHA purpose and describes the assessment scope, the approach taken, and gives a brief description of the various PFP facilities of interest.

Section 2.0 provides background on previous chemical and radiological vulnerability assessments conducted at PFP, with emphasis on the Facility Vulnerability Assessment (FVA) of 1998 (HNF-3262).

Section 3.0 contains a description of the vessel identification and documents the evaluation criteria and processes used during the RCHA. Evaluation criteria and relative risk ranking methods based on risk to human health and the environment also are discussed.

Section 4.0 focuses on four areas that posed some difficulties to physical inspections.

Section 5.0 provides the results of the assessment. Severity and likelihood distributions for the items evaluated by this assessment are presented. The vessel categories used to group items are described in this section. No significant risks requiring response actions prior to final deactivation were found.

Section 6.0 summarizes the results of the assessment.

Appendix A contains a technical paper providing an explanation of the FVA methodology, which was adopted by the RCHA.

The *Plutonium Finishing Plant Residual Chemical Hazards Assessment Data* (HNF-13940, December 2002) contains the listing of process equipment (including tanks, piping, and waste lines) evaluated by the RCHA. Items are listed with associated individual identification numbers, building and room numbers, chemicals, status, and controls. Associated hazards of equipment containing residual chemicals are evaluated in the RCHA database from which the PFP RCHA data report (HNF-13940) is derived. Relative risk values are provided. The PFP RCHA data report (HNF-13940) is issued separately from this assessment report.

1.1 PURPOSE

The RCHA was performed to assess risk relative to human health and the environment, to ensure personnel safety prior to decommissioning activities, to provide safety information for personnel performing decommissioning, and to satisfy the requirements of the *Hanford Federal Facility Agreement and Consent Order* [Tri-Party Agreement (TPA)] Milestone M-83-21, "*Submit to the Washington State Department of Ecology a PFP Residual Chemical Hazards Assessment as a Primary Document*", (Change Control Form M-83-01-03).

The requirements of TPA Milestone M-83-21 include the following:

- Listing processing equipment (including tanks, piping, and waste lines) that may contain residual chemicals (HNF-13940)
- Evaluating the associated hazards of equipment containing residual chemicals (HNF-13940)
- Documenting the evaluation criteria and process used (Section 3.0)
- Categorizing items relative to risk to human health and the environment (Sections 3.0 and 5.0)
- Determining which items require response actions prior to final deactivation (Section 5.0)
- Providing a schedule for any response actions required prior to final deactivation (Section 5.0).

1.2 SCOPE

The scope of the RCHA was to include all inactive process system elements at PFP that could contain residual hazardous chemicals. These elements were termed 'items' and each item was given a specific identification number. These items consisted of all items identified at PFP during the FVA (HNF-3262), items added during the RCHA plant physical inspections, and items identified as a result of a PFP process vessel review. Although inactive systems were emphasized, certain active system components were included in the scope of the RCHA, if those components previously had been identified in the FVA. Remaining active systems were not examined as these are managed under permit conditions or work packages, procedures, and policies consistent with the Integrated Environmental, Safety and Health Management System (ISMS).

The scope of this assessment includes identification of hazards and vulnerabilities relative to risk to human health and the environment that exist at PFP as a result of the chemicals remaining in the inactive systems in the former processing areas. This assessment also includes evaluation of the reactive nature of the chemical, as well as the risks associated with changes to chemicals due to aging, evaporation or leakage, and inadvertent combination with chemicals in associated systems. Changes in system configuration were noted on a graded approach and the condition of vessels was considered in the evaluation as needed. Documentation of the evaluation criteria and processes used, along with schedules for items requiring response actions prior to final deactivation, also are required.

Outside of the scope of this assessment are criticality concerns and general vulnerabilities associated with continued storage of certain forms of plutonium. Plutonium related vulnerabilities and corrective actions are described in other documents such as "*Implementation Plan for the Remediation of Nuclear Materials in the Defense Nuclear Facilities Complex*", Revision 3, May 31, 2000 [response to Defense Nuclear Facilities Safety Board (DNFSB) recommendations 1994-1 and 2000-1], "*An Implementation Plan for Stabilization and Storage of Nuclear Material, the Department of Energy Plan in Response to DNFSB Recommendation 2000-1*", Revision 2, July 2002. The latter contains the schedule for stabilization and packaging materials to meet "*Stabilization, Packaging, and Storage of Plutonium-Bearing Material*", DOE-STD-3013-2000, September 2000.

1.3 APPROACH

To accomplish a comprehensive assessment, a team of safety, process engineering, chemical engineering, and technical specialists was assembled. The scope of the assessment was defined and team members were divided into two groups: the physical inspection or 'walkdown' team and the vessel inventory team. The physical inspection team conducted a 'walkdown' or physical inspection of all items, except for those in areas difficult to access. Areas difficult to physically inspect were researched separately for work plans and work packages that described their shutdown configuration. The vessel inventory team combined existing vessel lists and reviewed engineering drawings and plant documents. Vessel information was incorporated into the physical inspection team scope of items to evaluate.

1.4 DESCRIPTION OF PFP PROCESS FACILITIES

Historically, PFP operations involved the recovery and chemical conversion of plutonium. The primary purpose was to provide conversion of plutonium nitrate solutions from the Hanford Site chemical separations plants into a variety of usable and shippable forms, primarily metal 'buttons' and components for nuclear weapons. As certain process operations were concluded, cleanout actions always were not accomplished. In some cases, no cleanout of vessels and process lines was attempted. This left residual chemicals in some vessels and process lines and resulted in the need for chemical hazard evaluations.

PFP consists of one primary processing building (234-5Z) and several ancillary buildings, including 232-Z, 236-Z, 241-Z, 242-Z, 243-Z, 270-Z, 291-Z, 2736-Z, 2736-ZA, and 2736-ZB. Of these structures, the process facilities, 234-5Z, 236-Z, 241-Z, 242-Z, and 243-Z were reviewed in detail for this assessment because these buildings contain the chemical process equipment. Descriptive information for these buildings is provided. Non-process buildings were not emphasized because of their administrative or vault storage purpose and lack of residual chemicals.

The 241-Z-361 settling tank is included in the RCHA. The tank was an item reviewed in the FVA. This tank is the subject of a current engineering evaluation/cost analysis. Characterization of the tank has been completed.

234-5Z Plutonium Fabrication Facility – The 234-5Z Building was designed to provide plutonium conversion and fabrication capabilities. This building housed the remote mechanical A (RMA) and remote mechanical C (RMC) lines in which plutonium nitrate solution was converted to plutonium metal. Additionally, the 234-5Z Building housed the RECUPLEX (recovery of uranium and plutonium by extraction) process. This process used tributyl phosphate diluted with carbon tetrachloride to recover plutonium and uranium from liquid process waste streams.

236-Z Plutonium Reclamation Facility – The 236-Z Plutonium Reclamation Facility (PRF) was built to recover plutonium from various processes at PFP, which resulted in plutonium 'scrap'. The PRF process used a continuous organic treatment and recycle process to recover the plutonium from the 'scrap'. The solvent extractant developed was tri-butyl phosphate-carbon tetrachloride (TBP-CCl_4).

The plutonium recovery process relied on the dissolution of plutonium-bearing scrap in acid and eventual extraction of the plutonium though 'counter currently contacting the plutonium' in the liquid phase with the TBP-CCl_4. This caused the plutonium to enter the organic phase, leaving contaminants behind and allowing the plutonium to be recovered. These activities occurred primarily in the PRF canyon. The PRF ceased operations in 1989. A training run in anticipation of a re-start was conducted at the PRF in 1994; however, the PRF never was restarted. Currently, the PRF areas are shutdown awaiting decommissioning activities.

232-Z Waste Incinerator Facility – The 232-Z Building housed a contaminated waste recovery process, commonly referred to as the 'incinerator'. The 232-Z Building presently is undergoing decontamination and decommissioning (D&D) activities. The purpose of the incinerator was to incinerate combustible waste contaminated with plutonium and to recover the plutonium from the resultant ash. The plutonium was recovered through acid leaching of the ash.

241-Z Tank Farm Waste Disposal Building – The 241-Z Building provides accumulation, sampling, and treatment of low-level liquid waste effluent streams from the 234-5Z Building. Designated as a waste treatment and storage area, the 241-Z Building consists of a belowgrade reinforced concrete structure with a sheet-metal enclosure over the top that provides weather protection. There are active and inactive tanks enclosed in the vault. The Part A permit application governs the active tanks and was approved by the Washington State Department of Ecology (Ecology) on July 5, 2000 (DOE/RL-88-21, *Hanford Facility Dangerous Waste Part A Permit Application*). The building consists of five separate ventilated belowgrade cells, each containing a 17,000-liter vessel used to accumulate liquid waste before treatment (pH adjustment) and transfer to the Double-Shell Tank System. The 241-Z-361 settling tank is associated with this building.

242-Z Waste Treatment Facility – The 242-Z Waste Treatment Facility was constructed as part of the on-going waste treatment and americium recovery effort to reclaim plutonium from liquid waste resulting from processes in the 234-5Z, 232-Z and 236-Z Buildings. The facility houses a control room, chemical feed tanks, a cation exchange column, a solvent exchange column, and two waste receiving tanks. The plutonium and americium were recovered from liquid waste through the use of specialized ion exchange resins.

243-Z Low-Level Waste Treatment Facility – The 243-Z Building is an active low-level liquid waste treatment facility. The 243-Z Building receives very low activity wastewater from various PFP operations and transfers the wastewater to the 200 Area Effluent Treatment Facility.

2.0 BACKGROUND

Prompted by a chemical explosion in the PRF in May of 1997, Fluor Hanford (FH) began a series of efforts and initiatives to identify the cause(s) of the event and to enhance management and operating systems to minimize the possibility of a similar occurrence.

2.1 PREVIOUS ASSESSMENTS

The following four major chemical and radiological vulnerability assessments at PFP have been conducted since 1997.

- Hydroxylamine Nitrate Assessment (Correspondence FDH-9754835AR2, L. K. Trent (FH) to S. A. Sieracki, (DOE-RL), "*Contract No. DE-AC06-96RL13200 – Initial Facility Chemical Inventory Evaluation,*" dated June 23, 1997)

  Hydroxylamine nitrate stored at all areas was located and disposed or treated. Field walkdowns were conducted to identify other potentially reactive chemicals in storage and to ensure that the storage conditions did not present hazards.

- Chemical Hazard Assessment (HNF-SD-CP-HA-001, *Plutonium Finishing Plant Chemical Hazards Assessment*, Rev. 0), August 1997

  The purpose of this assessment was to conduct a complete chemical inventory assessment. The scope included identification of hazards and vulnerabilities existing at PFP "as a result of the chemical properties of materials remaining at the facility" through reactivity or changes because of aging, evaporation, leakage, or inadvertent contamination. This information was assembled into data packages that were reviewed by plutonium process support laboratory chemists to confirm that all chemicals listed, and combinations of chemicals, had no additional vulnerabilities introduced through changes in physical or chemical properties.

- DuPont independent review of potentially dangerous chemicals (Correspondence FDH-9852216, Michael K. Yates [FH] to W. F. Heer [B&W Hanford Company], "*Hazardous Chemicals,*" dated March 13, 1998)

  DuPont Safety and Environmental Management Services was contracted to conduct an independent review of potentially dangerous chemicals.

- Facility Vulnerability Assessment (HNF-3262), January 1999

  The FVA for Project Hanford Management Contract (PHMC) facilities was planned and designed specifically to identify conditions not adequately understood and analyzed or that did not have adequate controls that could endanger the health and safety of personnel and the public through injury or exposure to hazardous chemical or radiological material. The FVA criteria and methodology explicitly took into account the generic complex-wide vulnerabilities that were identified in a 1994 U.S. Department of Energy (DOE) chemical vulnerability assessment (*U.S. Department of Energy, Chemical Safety Vulnerability Working Group Report*, DOE/EH-0396P, September 1994).

  The FVA was intended to provide a one-time evaluation of plant conditions. Other systems such as the Chemical Management System and the ISMS were viewed as the appropriate mechanisms for managing PFP chemicals and assessment corrective actions. The Chemical Management System was put in place to track and control chemical inventories including the purchase, management, storage, and disposal. Facility level corrective actions from the FVA are managed through the ISMS and tracked through the deficiency tracking system (DTS).

The FVA is discussed further in the following section because the RCHA began with an examination of the FVA results.

Subsequent to the mentioned assessments, Ecology conducted an assessment from June 14 through September 7, 2000. Ecology recommended that the U.S. Department of Energy, Richland Operations Office (DOE-RL) initiate TPA negotiations between the agencies. The TPA negotiations were initiated and completed. Milestone M-83-21 requires this assessment (RCHA) to be a part of the negotiated agreements.

2.2 Facility Vulnerability Assessment

In August 1997, a DOE Secretarial Directive was issued (U.S. Department of Energy, DOE Headquarters Memorandum, from Secretary Frederico Peña for Program Secretarial Officers and Field Element Managers, Subject: *DOE Response to the May 14, 1997 Explosion at Hanford's Plutonium Reclamation Facility,* August 4, 1997) directing all DOE sites to reassess known chemical and radiological vulnerabilities and to evaluate for new vulnerabilities on a continuing basis. A subsequent Directive (U.S. Department of Energy, DOE Headquarters Memorandum, from Secretary Frederico Peña for Assistant Secretaries and Directors of Nuclear Energy and Energy Research, Subject: *Assessment of Hazards Associated with Chemical and Radioactive Waste Storage Tanks and Ancillary Equipment,* October 21, 1997) provided additional direction and guidance to focus assessment efforts on waste storage tanks and ancillary equipment.

In accordance with the Secretarial Directives, DOE-RL directed FH to conduct a systematic and comprehensive assessment of chemical and radiological vulnerabilities at the PHMC facilities. The FVA was conducted in response to this direction.

The FVA was initiated in 1998 and completed in 1999 (HNF-3262). The methodology used for the FVA (a technical paper providing an explanation of this methodology is available in Appendix A) is essentially the same methodology used for the RCHA.

The FVA required data information at the following two levels:

- Facility level
- Containment vessel level.

At the facility level, the data and information collected for the FVA related to asset ownership and identification; the adequacy of inspection, maintenance, and operation; configuration control; personnel training; and the lessons learned program.

At the containment vessel level, the following categories of data and information were collected:

- Containment vessel ownership and identification
- Characteristics of vessel (e.g., capacity, construction material, and application)
- Characteristics of contents (e.g., name, concentration, volume, and compatibility)
- Quality of characterization data for level of confidence and need for additional data

- Hazard characteristics of containment vessel contents
- Relative risk ranking factors for severity and likelihood of an occurrence
- Recommended additional controls
- Immediate and long-term corrective actions.

Certain categories of data and information collected, i.e., quality of data, reactivity hazard, and other risk ranking factors, each were defined further in such a way as to assign numerical values to the categories. A method for numerical evaluation of relative risk also was developed.

The hazard characteristics of chemicals were grouped and each of the four groups was assigned a hazard value (16, 9, 4, or 1) based most reactive (16) to least reactive (1). Quality of data was considered important from the standpoint that unknowns presented an unquantifiable risk and therefore were assigned to the highest hazard group.

The Facility Evaluation Board (FEB), an independent assessment organization of FH, conducted an assessment evaluating the overall performance of PFP with respect to chemical management and reduction of chemical vulnerabilities. The FEB identified three items of interest to the FVA process. Adding a nuclear criticality point-of-contact to the chemical vulnerability assessment team and approving a path forward plan to complete the chemical vulnerability assessment effort addressed two of the items. Corrective actions on these two items are complete. The remaining item is addressed through an ongoing status review of the chemical vulnerability assessment during the PFP Planning and Progress meetings. This action will be closed on 12/31/02 with the completion of the RCHA report and is currently tracked through the FH DTS. This FEB assessment established a basis for recommending closure of the Secretarial Directives. The FEB concluded that the efforts to date have met the criteria for closure of the directives.

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3.0 RESIDUAL CHEMICAL HAZARD ASSESSMENT

To ensure personnel safety and as a result of the commitment to meet TPA Milestone M-83-21, the RCHA was initiated. The RCHA was intended to assess process systems with residual chemicals that may pose a risk of injury to personnel and to identify items that require corrective actions or items with significant risk that could require mitigation to ensure risk reduction prior to the scheduled decommissioning of the system.

3.1 ASSESSMENT PROCESS

The RCHA includes two efforts that were combined to provide the material contained in this report. First, a vessel inventory was undertaken. This effort collected vessel information from various previously prepared databases and included a review of select engineering drawings and personnel interviews. Second, all items were inspected physically, records reviews were conducted, current conditions evaluated, and engineering personnel were interviewed. Items identified during the inventory effort that were not included previously in the FVA also were inspected. An action sequence flowchart is provided as Figure 2. Therefore, the general approach was as follows:

- Assess items using physical inspections, research, and interviews
- Assess the PFP vessel inventory for completeness ensuring complete coverage of items
- Identify any new vulnerabilities and evaluate associated hazards
- Identify any items with significant hazards
- Prescribe mitigation actions and schedules as necessary prior to final deactivation activities.

To accomplish the assessment, a dedicated mixed-discipline team was established. The members chosen for this RCHA team were a combination of scientists, engineers, and operational specialists from the PFP organization, including Process Engineering, Solid Waste Operations, Industrial Hygiene, Plutonium Process Support Engineering, Environmental Compliance, Nuclear Materials Stabilization Engineering, and Fluor Hanford Support, along with consultant specialists with numerous years of PFP and Hanford Site experience.

This assessment report provides the results of their efforts in the PFP RCHA data report (HNF-13940) where the process equipment item, building and room numbers, chemicals, status, and controls are identified.

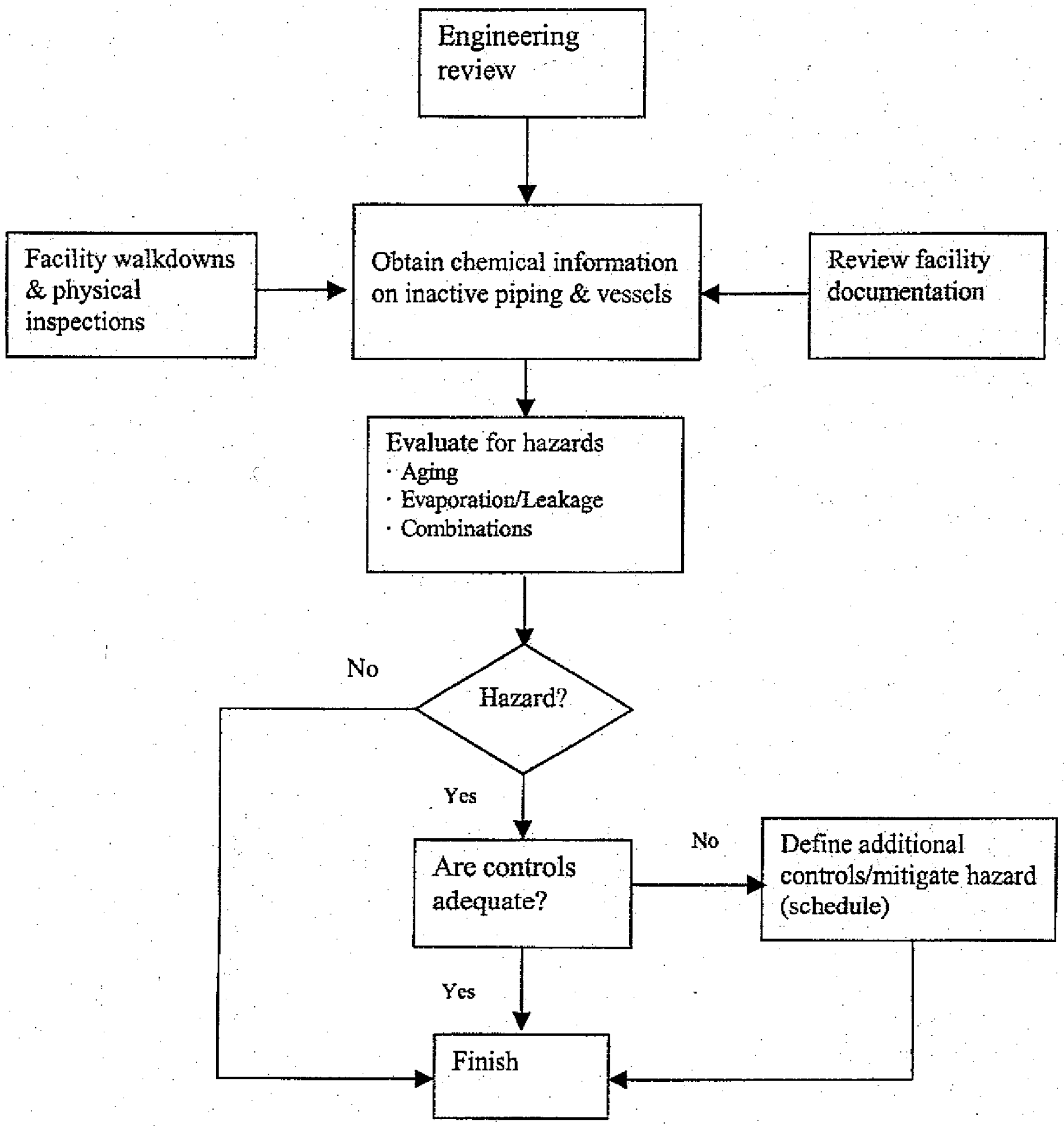

Figure 2. Assessment Process Flowchart.

3.2 ESTABLISHMENT OF EVALUATION CRITERIA

Risk scoring was performed using much the same method as the original FVA (Appendix A) Each item was evaluated based on a severity ranking factor and a likelihood ranking factor. It was noted that there was an improvement in the data quality knowledge as a result of physical inspections and records review and research; therefore, the quality of characterization data (safety characterization determination) was rated as '1' for all systems (the FVA had data quality numbers from 1 to 5). This value of '1' reflects the current high level of confidence in the information as a result of the physical inspection of all items and, for those items that were difficult to inspect, reflects the confidence in the information researched. Section 4.0 provides a discussion of the areas that were difficult to inspect. Severity and likelihood scores were determined as shown in Figure 3. The Hazard Group scores were evaluated using the original criteria, with current knowledge. A relative ranking score was obtained by multiplying severity by likelihood.

To determine the risk levels, each item was reviewed against the eight criteria (described in the following sections) drawn from the original FVA evaluation, where risk is based on severity and likelihood. Three types of severity factors were considered, including physical injury to humans, potential exposure to humans, and significance of secondary impact. Five types of likelihood factors were considered, including design, operation, containment vessel condition, emergency planning and safety basis, and maintenance and inspection. Table 3-1 provides a description of the severity and likelihood criteria.

The RCHA team, which has extensive experience with chemicals and their use at PFP, evaluated items based on the following concepts: (1) knowledge of the reactions that occurred in the processes, (2) information on reaction rates, (3) the conditions required for the reactions, and (4) the conditions that affect reaction rates.

3.2.1 Severity Ranking Factors

The following factors, in addition to data quality and hazard characteristics of material, were considered to influence the severity of consequences resulting from the loss of control of material, such as through an uncontrolled reaction or a leak release.

(1) Potential for human injury. Considerations included accessibility to personnel, number of persons potentially affected, and expected severity.

(2) Potential for human exposure. Considerations included vessel location relative to people, number of persons potentially affected, and likely exposure scenarios.

(3) Potential and significance of secondary impact. Considerations included other systems, structures, and components that could magnify consequences, e.g., fixed radioactive contamination, safety-critical systems, and ventilation systems; and considerations, such as distances or barriers between systems, and hazard characteristics of materials impacted.

3.2.2 Likelihood Ranking Factors

The following factors, in addition to data quality and hazard characteristics of material, were considered to influence the likelihood of occurrences involving the loss of control of a material.

(1) Design. Considerations included safety features, as applicable; e.g., pressure relief, secondary containment, air filtration, hydrogen mitigation, shielding, and seismic capacity.

(2) Operation. Considerations included whether the vessel and any ancillary equipment are operated as designed, per manufacturer's specifications (including design life), and within the documented safety envelope.

(3) Containment vessel condition. Considerations included integrity testing, protection from corrosion, modifications that potentially degrade integrity, and visual condition.

(4) Maintenance and inspection. Consideration included whether preventive maintenance and inspections are scheduled regularly and implemented.

(5) Safety authorization basis, emergency planning, and other programmatic controls. Considerations included whether the configuration of the containment vessel and ancillary equipment adequately is documented, reviewed, and approved; and whether it is subject to established programs, such as for inventory control, standards and requirements identification, authorization basis, fire protection, and emergency planning.

3.2.3 Risk-Based Relative Ranking

During the RCHA, material in a containment vessel once again was assigned to one or more of the four hazard groups based on the reactivity hazard, as identified during the FVA:

- Group (1): explosive, unstable reactive, unstable over time (e.g., because of aging in storage or contamination during use), and organic peroxides [29 Code of Federal Regulations (CFR) 1910.1200]
- Group (2): pyrophoric, water reactive, flammable gas, fissile materials (29 CFR 1910.1200)
- Group (3): *corrosive and highly toxic materials* (29 CFR 1910.1003, 1017, 1044-50)
- Group (4): all other materials (generally not very reactive), maybe flammable or toxic.

Each group was given a group score: Group (1) – 16, Group (2) – 9, Group (3) – 4, and Group (4) – 1.

The relative risk presented by a containment vessel was quantified by developing a vulnerability score, a numerical product of two quantities representing, respectively, the severity and the likelihood of an occurrence.

The data quality, the hazard group of material, and the severity and likelihood factors each were scored by assigning values, 1 through 5 (except for hazard group), where the value 1 represented the best condition and the value 5 represented the worst. As shown, the parameter representing the group of material was assigned the value 16, 9, 4, or 1, respectively, for the most reactive to the least reactive group.

The quantity representing the severity of an occurrence was the sum of values for data quality, hazard group of material, and for each of the three severity factors. The number for likelihood was developed in the same manner.

The value for confidence in data for all items is high and therefore given a value of 1. The final relative risk ranking is a product of appropriately normalized values for severity and likelihood (Figure 3). An example of the risk ranking process for item/identification number 1 is provided in Figure 4. A lower number is considered better, i.e., safer than a higher number. Both the RCHA and the FVA scoring criteria ranged from a minimum score of 2 through 100. This spread was established deliberately to provide good relative ranking of the data. To account for items that currently are removed from the system and shipped, or awaiting shipment (and thus cause zero risk), the score criteria were modified to provide a score of '0'.

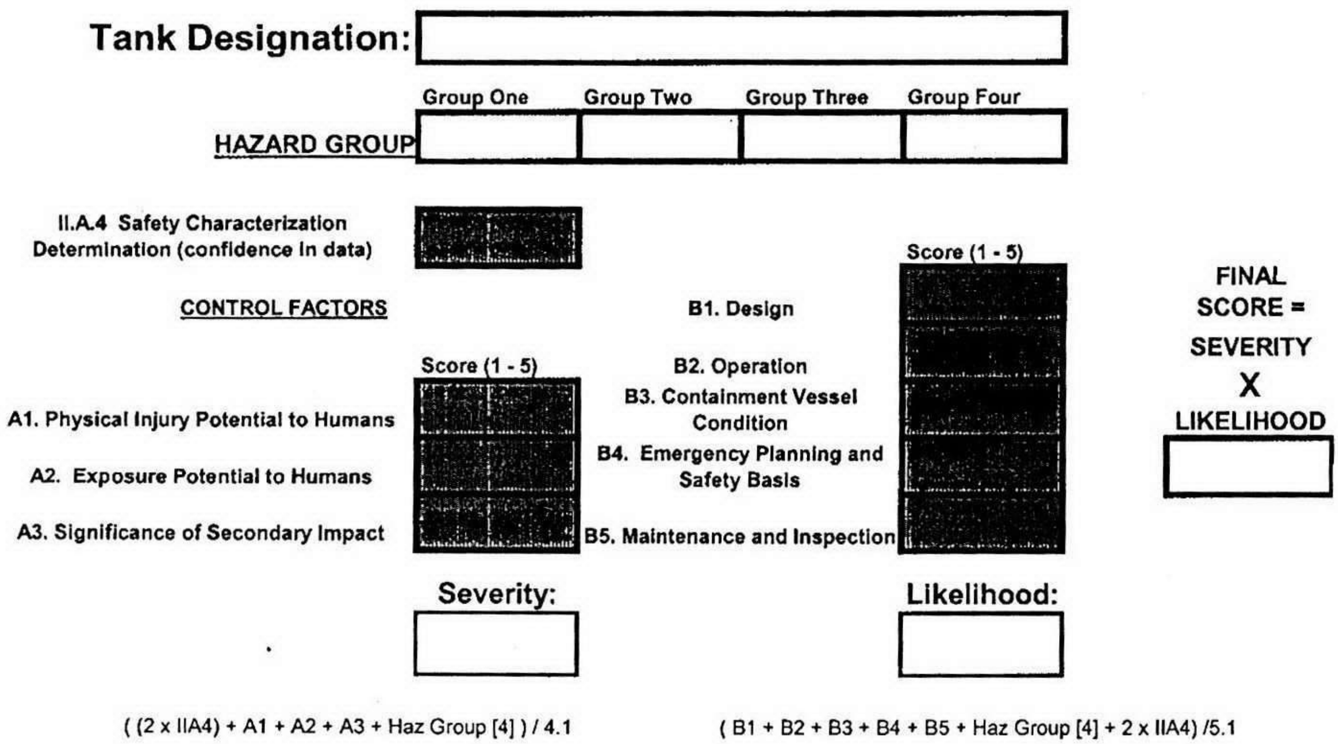

Figure 3. Scoring Worksheet.

Tank Designation: Identification No. 1, Nitric Acid Pipelines

	Group One	Group Two	Group Three	Group Four
HAZARD GROUP			X	

II.A.4 Safety Characterization Determination (confidence in data) — Score (1 - 5): [redacted]

CONTROL FACTORS

	Score (1 - 5)
A1. Physical Injury Potential to Humans	[redacted]
A2. Exposure Potential to Humans	
A3. Significance of Secondary Impact	

	Score (1 - 5)
B1. Design	[redacted]
B2. Operation	
B3. Containment Vessel Condition	
B4. Emergency Planning and Safety Basis	
B5. Maintenance and Inspection	

Severity: 5.1

((2 x IIA4) + A1 + A2 + A3 + Haz Group [4]) / 4.1

Likelihood: 2.9

(B1 + B2 + B3 + B4 + B5 + Haz Group [4] + 2 x IIA4) /5.1

FINAL SCORE = SEVERITY X LIKELIHOOD

15

Figure 4. Scoring Example.

Table 3-1. Severity and Likelihood Criteria.

Evaluation Factors	Value of Severity and Likelihood Factor		
	5	3	1
SEVERITY			
A1. Physical Injury Potential To Humans	Capable of damaging a limb, vision, or hearing. Capable of initiating a heart attack to a surprised person who is prone to heart attacks. Capable of second- or third-degree skin burns. Victim would need help getting to an eyewash or safety shower.	Victim would require nothing beyond first aid treatment. Victim could reach nearest eyewash or safety shower unassisted.	Essentially none.
A2. Exposure Potential To Humans	Could release gases, mist, or powder that threaten lives of those in same air space if inhaled. Also includes release of irritants.	Could release gases, mist, or powder that should not be inhaled, but are not irritants or life-threatening.	Essentially none.
A3. Significance of Secondary Impact	Capable of damaging safety systems or other equipment, not necessarily causing catastrophic failure of equipment. Cleanup is complicated.	Capable of releasing chemicals that corrode other systems slowly. Cleanup requires personnel protective equipment, but is not really difficult.	Any released chemical(s) do not corrode other vessels. Cleanup is routine.
LIKELIHOOD			
B1. Design	Bad material of construction. Unvented tank that could generate high pressures. Vented tanks where venting obviously is not adequate.	Vented tank that could generate gases and heat rapidly, but vent is expected to be adequate.	Heat and pressure generation very improbable in planned use.
B2. Operation	Space occupied frequently. Chemical(s) are more reactive and/or react more vigorously.	Space occupied infrequently. Chemical(s) not very reactive and/or not as vigorously reactive.	Vessel or space not used at all or very seldom. Chemical(s) cannot start any dangerous reaction.
B3. Containment Vessel Condition	Container integrity questionable. High pressure could be generated.	Container integrity adequate. High pressure cannot be generated.	Container integrity is good and expected to stay that way.
B4. Emergency Planning and Safety Basis	Difficult or slow to take countermeasures when abnormal conditions are noticed.	Countermeasures available and easy to implement.	Not expected to generate any kind of emergency response.
B5. Maintenance and Inspection	Inspections needed at least weekly. Repairs needed more often (months apart) because of the other factors. Violation of Washington (State) Industrial Safety and Health Administration/Occupational Safety and Health Administration.	Inspections needed monthly-quarterly. Repairs expected to be needed seldom (years apart).	Routine inspections will be done, but repairs not expected to be needed.

3.3 IDENTIFICATION OF VESSELS

As part of the RCHA, a PFP vessels inventory was conducted. Vessel information from this inventory was shared with the physical inspection team conducting the vessel inspections and evaluations to ensure all inventoried vessels were evaluated.

3.3.1 Existing Databases Review

As previous PFP vessel inventories existed, this effort began with a review and consolidation of several existing databases that included PFP vessels. The existing databases were obtained from:

- Facility Vulnerability Assessment
- Chemical Hazard Assessment
- Previous PFP vessel inventory
- PFP Chemical Management System.

Each of these databases was queried electronically, or if necessary, hand reviewed for mention of vessels. Once consolidated, the resultant vessel information comprised a more complete compilation of PFP vessels.

3.3.2 Document Review

Along with consolidating the existing databases, the vessel inventory included the review of engineering drawings, current and historical documents, and select personnel interviews.

Hundreds of engineering essential drawings were reviewed. A piping and vessel design specialist with 39 years of Hanford Site experience assisted in this review. Documents examined included the *Plutonium Finishing Plant Final Safety Analysis Report* (HNF-SD-CP-SAR-021, Rev. 2, and Rev. 3) and the *History & Stabilization of the Plutonium Finishing Plant (PFP) Complex, Hanford Site* (HNF-EP-0924, dated March 1997).

Information obtained from the engineering drawing and document search was reviewed by PFP plant cognizant engineers and by selected long-time PFP personnel with combined experience covering the years from 1960-1973, 1977, 1981, and 1984-1997.

Generally, vessels identified are not piping but some pipe segments known as 'pencil tanks' have vessel designations and therefore are included as vessels. Also, some engineering support drawings were reviewed. Inactive systems are most likely to appear on support drawings. To obtain greater inactive system information, such as might be found in support drawings, historical documents such as the *Z Plant Safety Analysis Report (Draft), Vol. III,* June 1977, and "*Plutonium Reclamation - Z Plant, Training Manual on Solvent Extraction, Z Plant, Production Operations, Rockwell Hanford Operations,*" January 1978, were reviewed for vessel references.

The vessel information was shared with the physical inspection team for incorporation in their process equipment inspections and evaluations.

3.4 PROCESS EQUIPMENT INSPECTIONS

The physical inspection team evaluated items using physical inspections, document research, engineering evaluations, and interviews.

3.4.1 Records Review and Data Packages

In addition to the physical inspections conducted for each RCHA item evaluated, an extensive records review was conducted for certain items using a graded approach and these records as well as current pictures were placed in data packages. These records were used to document existing conditions; record mitigation measures already taken to reduce risk, such as tank removals, tank emptying and flushing, line draining and flushing, and valve controls; and to identify planned future mitigation efforts. Records reviewed included, but are not limited to, the following:

- Facility Vulnerability Assessment
- Work packages
- PFP Facility Safety Analysis report
- Chemical Hazard Assessment
- Historical and recent photographs
- Process flow sheets
- Process documentation
- Maps and specification drawings
- Engineering and operations log books
- Letter books.

Pertinent records have been placed in a data package for most RCHA items. Also included in the data packages are pictures of current conditions where possible. Data represent a graded approach, i.e., there are less data for items with less relative risk than for those items with greater relative risk. Because of the graded approach, data packages do not exist for each RCHA item.

3.4.2 Facility Walkdowns

RCHA items were inspected physically for review to the practical extent afforded by access and visibility restrictions. The walkdowns involved looking at the equipment piece, vessel, or glovebox. Pipelines to and from the item also were inspected. Finally, the area around each item was inspected for secondary problems or mitigating barriers. Conditions offering possibilities for unfavorable interactions included overhead sprinkler lines, another vessel, or other nearby chemical transfer lines. Possible mitigating barriers could include a nearby safety shower, a dike for containing spills, blanked ports on a glovebox, or the glovebox itself as sealed containment. An important secondary problem to be addressed in several locations was the potential for a leak to occur, and for the leaked fluid to pick up or gather and transport radioactive material as the liquid would flow through the various floor or ceiling partitions to occupied compartments below.

As previously mentioned, all the RCHA items were visited during the walkdowns. Evaluation included the gloveboxes, vessels, and chemical transfer lines serving the RMA Line, RMC Line, the PRF, the 2736-ZB Building, the 243-Z Low-Level Waste Treatment Facility, and waste tanks in the 241-Z Building. All laboratories were reviewed. Two old processes located on gloveboxes HC-46F and HC-60 and analyzed in the FVA were not reviewed because these had been removed.

Two major areas and two smaller locations mentioned in the FVA were difficult to physically inspect because of their conditions, which involved high contamination levels, presence of chemicals, or lack of a practical access. The 242-Z Building and the PRF process canyon could not be accessed. Visibility into some equipment associated with the RMA line task III and radioactive acid digestion unit (RADTU) in the 234-5Z Building was limited. The evaluations for these areas are discussed in Section 4.0.

All of the accessible gloveboxes in the 236-Z Building were inspected during this review.

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4.0 AREAS DIFFICULT TO PHYSICALLY INSPECT

As previously discussed, some areas were difficult to physically inspect or had limited visibility into certain equipment. Equipment containing chemical hazards is all enclosed within gloveboxes or containment walls. These areas included the RADTU, 242-Z Building, RMA line task III, and the PRF canyon.

4.1 RADIOACTIVE ACID DIGESTION UNIT

RADTU was an extension and scale up of experimental acid digestion technology that began in the 1960s and was conducted at the Hanford Engineering Development Laboratory (HEDL) through the 1970s. Acid digestion is a chemical process developed to reduce the volume of combustible organic waste by converting the waste to gaseous effluents and stable solid residues for efficiently recovering plutonium from the waste. Up to 99 percent of the plutonium was removed from waste with this process.

RADTU was constructed in 1977 and began processing surrogate waste and potentially contaminated non-glovebox waste materials in November 1978. RADTU was shutdown in 1981.

Radioactive acid digestion, as demonstrated by RADTU, was a process that decomposed combustible radioactive waste solids in a medium of concentrated hot (230 to 260° centigrade) sulfuric acid. Sulfuric acid carbonized and partially oxidized the waste materials. Nitric acid was added to complete waste oxidation at a rate proportional to the feed of the waste. Offgasses varied according to the composition of the waste feed but consisted of CO_2, CO, H_2O, and HCL from waste oxidation, and SO_2, NO_2, NO, N_2, and H_2O from acid decomposition. Most of the RADTU processing equipment was located in gloveboxes (hoods). Liquid effluents were transferred to the chemical waste tank for pH adjustment and sampling before release.

Offgas treatment occurred in gloveboxes 300A, 300B, and in noncontained equipment adjacent to these gloveboxes. Glovebox 300A contained heat exchangers and glovebox 300B contained the primary scrubber. The demister and secondary scrubber were located adjacent to and outside of gloveboxes 300A and 300B. In process order, the offgas system consisted of a primary scrubber, a high-efficiency entrainment separator (demister), a secondary scrubber, a heater, two high-efficiency particulate air (HEPA) filters, an offgas blower, a third HEPA filter, and a dedicated RADTU stack. The demister vessel is the same vessel that housed the horizontal tray digester, the predecessor of the annular digester. Offgas from glovebox 200 was cooled and cycled through the scrubbers and demister. A dilute mixture of sulfuric, nitric, and hydrochloric acids was produced.

Glovebox 600 contained the acid fractionator. Dilute mixed acids from offgas treatment were concentrated in the fractionator and sent to gloveboxes 500A and 500B for storage before being recycled to the digester in glovebox 200. Incoming PFP waste was stored and assayed in rooms adjacent to the RADTU chemical processing equipment. Glovebox 100A was the waste airlock and received waste for processing. Waste boxes were loaded into the airlock on a conveyor belt. The waste was conveyed to glovebox 100B through a guillotine door that provided a gas tight seal.

In May 1981, HEDL was directed by the DOE to place RADTU in a safe shutdown status by the end of FY 1981 and transfer maintenance and custodial responsibilities to Rockwell Hanford Operations. Before the transfer, Rockwell Hanford required HEDL to perform the following:

- Remove all waste, solids, and liquids from the hoods and process system

- Flush, blank, and identify all acid, liquid, steam, and water lines, excluding the fire protection system and the steam lines for building heat
- Depressurize all pressurized systems
- Remove all chemicals from the premises
- Conduct a final radiological survey.

A status report, dated September 30, 1981, from J. E. Nolan (President, Westinghouse Hanford Company) to D. J. Cockeram (Vice President and General Manager, Rockwell Hanford Operations [HEDL No. 8153364]) stated, "HEDL has completed all essential activities to place RADTU in a safe standby status". Process vessels were reported to have been flushed with NH_3 (Jim Demitter, former RADTU Cognizant Engineer, personal communication, September 2002). However, it was not verified that the final aqueous rinse(s) occurred. An assay of the feed preparation, digester, residue drying, offgas, and storage transfer gloveboxes was accomplished after clean up.

The remaining RADTU facilities were inspected during the TPA Milestone M-83-21 vessel inventory walkdowns. Waste materials, chemical residuals, and glovebox conditions were observed. Visibility into certain gloveboxes was limited.

Nothing unusual was observed in the waste air lock and glovebox 100A. Glovebox 100B contains small amounts of residual waste feed at the sorting station, in the weighbox, and in the hopper for the pneumatic classifier. The pneumatic hopper is removed from its functional position under the shredder and is visible on the conveyor belt adjacent to the guillotine door. Although the shredder hatch is closed, it is estimated that some residual shredded waste feed is contained in the shredder.

A waste feed plug is visible in the ram cylinder. This plug was used during operations to help isolate the atmosphere in glovebox 200 from glovebox 100B. A batch of waste feed deliberately would be left in the ram cylinder when the process was shut down for the weekend and at other times. The plug appears to be partially acidified, presumably from acid fumes that came off the digester. Crystallization is apparent on piping and equipment throughout the glovebox. Some corrosion on glovebox contents is present as well. A white substance, possibly an oxide of nitrogen, is present inside of a funnel located below a slurry sampling point near the centrifuge.

Some of the windows on top of glovebox 200 are cracked. One is pushed downward and dislodged from its functional position. The opening has duct tape and plywood over it. It was reported that personnel stepped on these windows during D&D work in 1984.

Nothing unusual was observed in glovebox 300.

In glovebox 400, one of the residue pots remains in a clamshell furnace. Nothing was visible within the upper third of the pot, which appears to be clean. The lower two thirds of the residue pot were not visible. Some corrosion and crystallization were present on piping.

Because of the lack of credible potential for significant reactions, mitigation activities in the RADTU can safely await D&D.

4.2 242-Z WASTE TREATMENT FACILITY

The 242-Z facility was used at various times for several small-scale waste treatment processes and the recovery of americium, which was the last process run in the facility. The facility processes have been shutdown since an explosion that occurred in an ion exchange column in 1976. As a result of the explosion, there was extensive contamination of the process area with Pu, resin, and nitric acid. These contaminants were later fixed-in-place with an organic fixant.

The 242-Z Facility is separated into three sections: a tank room, an operations room, and an annex (provided for outside entry into the building). Entry into the 242-Z Facility is prohibited.

The 242-Z Facility structure, in conjunction with the ventilation systems, forms a confinement system designed to mitigate the release of hazardous material should a barrier fail. The ventilation systems complete the confinement system by providing a controlled, continuous flow of air from the environment into the various building areas, through HEPA filters, and back to the environment. Supply air is provided to the rooms through the 234-5Z Building supply plenum, while air is supplied to the gloveboxes and process cells through HEPA filters installed near the floor. Rooms, gloveboxes, and process cells normally are maintained at negative pressures relative to the atmosphere to prevent the movement of airborne material out of the facility. Exhaust ventilation air from the rooms pass through single-stage testable HEPA filters before reaching the 234-5Z Building E-3 HEPA filters (also single-stage). Glovebox and process cell exhaust air first is filtered by a single-stage testable HEPA filter in the 234-5Z Building, and is filtered through the two-stage, testable E-4 filters also located in 234-5Z. Both streams exhaust to the 234-5Z Building plenum and the 291-Z-1 stack. All electrical power to the facility has been disconnected.

All of the organic material in 242-Z Facility was stored in the W-4 tank from 1979 until removal and disposal in 1982 (HNF-SD-CP-HA-001 and *Technical Data: Plutonium Finishing Plant Chemical Hazards Assessment [HNF-SD-CP-TI-219]*). No documentation has been found to date to support flushing of lines/tanks. The 1982 conditions remain. The organic fixant used to coat many of the facility surfaces to fix contamination in place was 'Butvar'[1], which is an organic liquid that dries to hard film. A video taken in 1989 did not verify chemical inventories; the film showed that a layer of sludge was present on the tank room floor in a few localized areas.

While some residual chemicals remaining in the 242-Z Facility might be reactive, the small amount and segregation, along with the lack of external heating, makes a catastrophic reaction very unlikely.

4.3 REMOTE MECHANICAL A LINE TASK III

The complete RMA Line, located in the 234-5Z Building, converted plutonium from a liquid nitrate form into finished metal components for nuclear weapons assemblies. Task III was the reduction segment of the plutonium conversion process.

The Task III portion of the RMA Line is located in the 234-5Z Building. The processing steps that were performed in this segment of the RMA Line included the following:

- Insertion of a crucible into a pressure vessel (PV) and preparation of the PV
- Charging the crucible with a mixture of PuF_4, calcium metal, and iodine

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[1] 'Butvar' is manufactured by Solutia.

- Firing the charge by heating
- Cooling the PV.

The plutonium, slag, and crucible were removed from the PV and the slag and crucible separated from the plutonium metal. The plutonium metal button was pickled to remove residual slag and sampled. The plutonium metal button was weighed and canned for storage. The crucible and slag were saved for later recovery of residual plutonium.

The RMA Line operated for continuous intervals and intermittently from 1952 to 1976, when the line was placed in ready standby status. The RMA Line stabilization run occurred in 1979. A certain amount of cleanup was performed and metal plates were placed over many of the glovebox ports. In 1983, Rockwell Hanford Operations completed terminal cleanout of the RMA Line. Terminal cleanout consisted of removing some old equipment, loose or retrievable plutonium, and hydraulic fluids and placing the mechanical configuration into stable status. Although plans were made in the mid 1980's to restart the RMA Line, the line never operated again.

Extensive record searches completed for the RCHA reviewed the official cleanout documentation for Task III of the RMA Line. The cleanout was completed pursuant to the *A-Button Line Terminal Cleanout Process Control Plan* (RHO-SD-RE-PCP-003, Rev. A-0, July 1982). The objectives of the terminal cleanout campaign were to remove plutonium from the gloveboxes, reduce the sources for a contamination release, and reduce maintenance and surveillance. This included the removal of contaminated and potentially contaminated liquids.

The cleanout actions were itemized and initialed on completion. Cleanout actions included the following:

- Disassembly of equipment
- Scraping, sweeping, or vacuuming
- Wipedown
- Neutralization of surfaces (if required)
- Nondestructive assay
- Removal of combustibles
- Disconnection and plugging of chemical services
- Disconnection of electrical services
- Replacing bags and gloves with stubby bags
- Covering ports and sphincters with metal plates
- Inspection by a three-member team
- Sign-off for completion of cleanout actions
- Placing final postings.

Each cleanout record was reviewed for the RCHA. All of the required actions were completed and signed off by Production Operations, Research and Engineering, Health, Safety & Environment, and work supervision and therefore mitigation activities can be deferred safely until D&D.

4.4 PLUTONIUM RECLAMATION FACILITY CANYON

The PRF process was an improvement on the plutonium recovery technology of RECUPLEX in its use of a continuous organic treatment and recycle process, remote operation, use of geometrically favorable equipment (rather than administrative controls) to ensure nuclear safety, and its capability to partition plutonium and uranium. The main internal structural feature of the PRF was a process equipment cell known as the canyon. Process equipment hung on the canyon walls. PRF processes were conducted in stainless steel gloveboxes located on both sides of the canyon. The gloveboxes contained control valves, pumps, flow meters, interconnecting piping, and other equipment. The connections were serviced from the canyon equipment.

Operations began in 1964. In the years that followed, PRF underwent a series of modifications to improve performance, enhance safe operations, and to respond to mission changes. A third dissolver was added in 1966. In 1967, a step to remove solids by centrifugation was added, and in 1972 the process was expanded to include the extraction of uranium from aqueous solutions produced from dissolution of contaminated scraps. Concerted efforts were made to reduce effluents and to find better waste management practices. PRF shutdown in 1973, again in 1975, and in 1976 for maintenance upgrades, for review of criticality prevention specifications and procedures, in response to a strike by onsite union workers, and in response to an explosion in the 242-Z facility. Shutdown continued for 19 months during which all nitrated resin at the facility was disposed. A campaign to cleanup the process hoods and the canyon floor occurred in 1978 and 1979. D&D planning also began in 1978 followed by operability and viability assessments in 1979. A period of intensive upgrades and modifications ensued during 1982 to 1984. There were three process campaigns in the 1980's with maintenance and equipment upgrades occurring between each.

Supporting the change in the Hanford Site mission from production to waste cleanup in 1989, plans were made for the PRF to stabilize PFP process residuals. To support stabilization, the PRF tanks were drained and cleaned out according to PFP-94-PRF-010 (*Remove Aqueous/Organic Solutions From PRF Tankage*). Emptying and flushing of the tanks was confirmed (HNF-SD-CP-HA-001): "Drain valves for all tanks intended to be empty were opened to check for fluid". Agreements with Hanford Site regulators prevented restart for the stabilization campaign, and the PRF never operated again.

Walk downs, document reviews, subject matter expert interviews, and engineering evaluations have been ongoing for both completion of Milestone M-83-21 and for D&D. The PFP Technical Support organization provided the following summary of the current conditions at PRF, including the canyon.

The PRF contains no more than small amounts of chemicals trapped in various small lines (less than ½-inch diameter) or clinging to tank surfaces. Some of these chemicals might be capable of reacting with each other; however, their geometry and small amounts eliminate the possibility of a catastrophic reaction. Work plans are being created to locate any small amounts of chemicals in accessible areas and eliminate them.

Most of the bulk amounts of chemicals used in the PRF entered the system through large tanks. As mentioned previously, the PFP CHA (HNF-SD-CP-HA-001) confirmed these tanks are now empty. Chemicals that might not have been drained would have gone through piping down to other tanks in the PRF canyon or the access gloveboxes on the 1st and 2nd floors. Those lines will be opened, checked, drained, and flushed, if necessary, by a work package. Until those lines are emptied of potential chemical residuals, the chemicals are isolated from each other. The only way chemicals could combine for a reaction is via leakage. Leakage into a room would be detected during routine surveillances, and repaired via a reviewed and approved work package. Leakage into a tank would leave the chemical still contained.

The tanks within the PRF canyon are known to be drained, as stated in the FVA, except for the possibility of leakage from lines above (refer to preceding paragraph). Without leakage, residues might be present in these tanks, but in very small amounts. In addition, the steam has been disconnected to that building, removing the only source of heat beyond ambient temperature fluctuations. For these reasons, catastrophic reactions are not considered credible for tanks within the PRF canyon or access gloveboxes, and other reactions are unlikely. If these chemicals leak to the canyon floor or access glovebox floor, there is no chance for personnel exposure, and the geometry again makes a rapid reaction difficult. The access gloveboxes are vented to the PRF canyon, so personnel would not be exposed to fumes. The combined volumes of the chemicals are too little to flow out of the criticality drains.

These tanks and the canyon/glovebox floor areas are inaccessible to personnel. The access ports are covered by 'pie plates' that preclude access into the gloveboxes and seal anything in or out. The pie plates have been installed long enough that the bags or gloves underneath the plates should be considered breached and no longer a barrier. Removing these plates to replace the gloves and reactivate the ports prior to D&D would require extensive work to control radiological risks of airborne contamination and spread of surface contamination for work that can safely await D&D.

Removal of the PRF tanks and lines can wait safely until final D&D because of the lack of credible significant reactions in the PRF.

5.0 RESULTS OF ASSESSMENT

An important result of this assessment was that the RCHA team found no items that pose significant risk. Furthermore, RCHA items were found to have low relative risk values. None of the items require a response action prior to final deactivation.

The relative risk score distributions for all RCHA items are shown on Figure 5. No current relative risk ranking scores exceed 15 out of a possible 100 (FVA scores for PFP items reached 56).

Four bar charts (Figures 6 thru 9) show the severity and likelihood distributions of current RCHA items at PFP. The 1 to 10 scales of the original FVA were used to determine severity and likelihood scores. Given the high confidence in data, all data quality factors were assessed to be '1' and the current hazard group number was used in conjunction with the severity and likelihood scores of the new evaluation. All but 25 items have likelihood and severity scores of less than 3. Figure 6 describes all PFP items reviewed during the RCHA.

The RCHA items were classified into three categories: (1) 'high priority', (2) 'other/work scheduled', and (3) 'deferred'.

- High Priority: Because of the low relative risk values of all RCHA items, the high priority classification is not used to delineate items as having a significant risk or as requiring response actions prior to final deactivation. High priority items (Figure 7) have been determined through the relative risk values or engineering judgment to warrant completion in the near term. These items require passive controls to ensure personnel safety and mitigation of the condition was judged to be the most prudent action. Table 5-1 identifies the high priority items.

- Other/Work Scheduled: Other/Work scheduled items are those items scheduled for work as part of PFP's cost effective work practices. Other/Work scheduled items include items that have been removed or awaiting shipment (relative risk value of '0') or mitigated to a safe configuration until D&D. All other/work scheduled items (Figure 8) have been reduced to likelihood scores of less than 3 and severity scores of less than 6.

- Deferred: Deferred items include items with likelihood or severity scores of less than 6. These items are judged as items that pose minimal relative risk and the removal can be deferred safely until D&D. If these items are deferred for removal until later than fiscal year 2009, the items still do not pose sufficient threat for earlier mitigation efforts. Deferred items are shown in Figure 9. Only 12 items on the deferred list are of likelihood or severity scores of 3 up to, but not including, 6.

Table 5-1. RCHA High Priority Items.

Identification Number	Detail	RCHA Score
1	Nitric acid pipelines from RMC chemical preparation to process areas	15
2	Oxalic acid line	15
24	Potassium permanganate line	10*
29	Nitric acid lines	15
30	Oxalic acid lines	15
321	Chemical Lines	7*
*Indicates engineering judgment influenced high priority classification.		

Many RCHA were items initially were given higher relative rankings during the FVA because of uncertainties in chemical composition or volume and the determination to be conservative in assessing potential chemical hazards. In some cases, the recommended samples have been taken and analyzed, and the analytical data confirmed the contents were of lesser or no hazard. The additional information allowed the RCHA team to eliminate the uncertainties and place such items in a relatively lower hazard category. In other cases, the RCHA review by PFP personnel with extensive plant knowledge and experience has clarified and changed the perception for potential reactions. Reasons for such refinements include: (1) the chemicals present in the system now are known to have low potential for interaction, (2) the process condition that could cause a reaction is no longer present, or (3) a vessel within a glovebox is confirmed to be empty, and the chemical supply lines are blanked off at the glovebox, thereby preventing the chemical reactions postulated in the FVA.

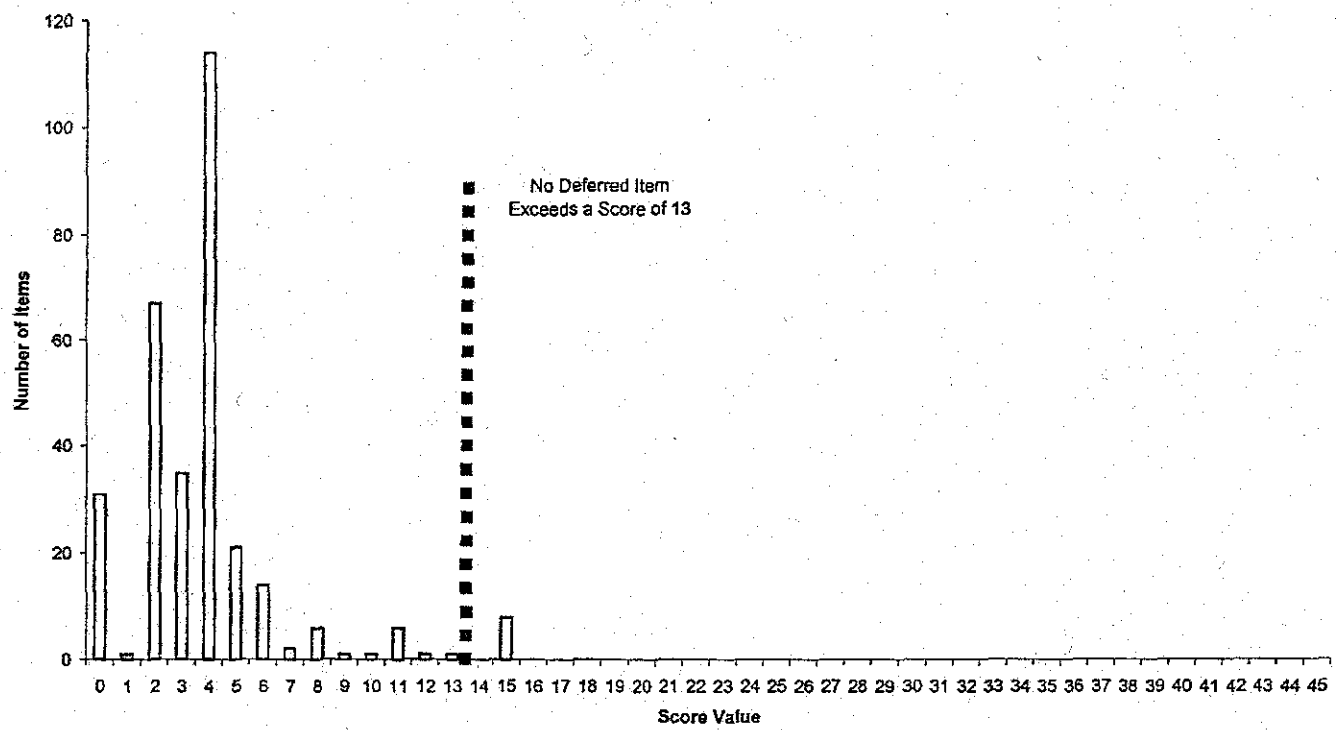

Figure 5. Score Distributions for RCHA Process Equipment.

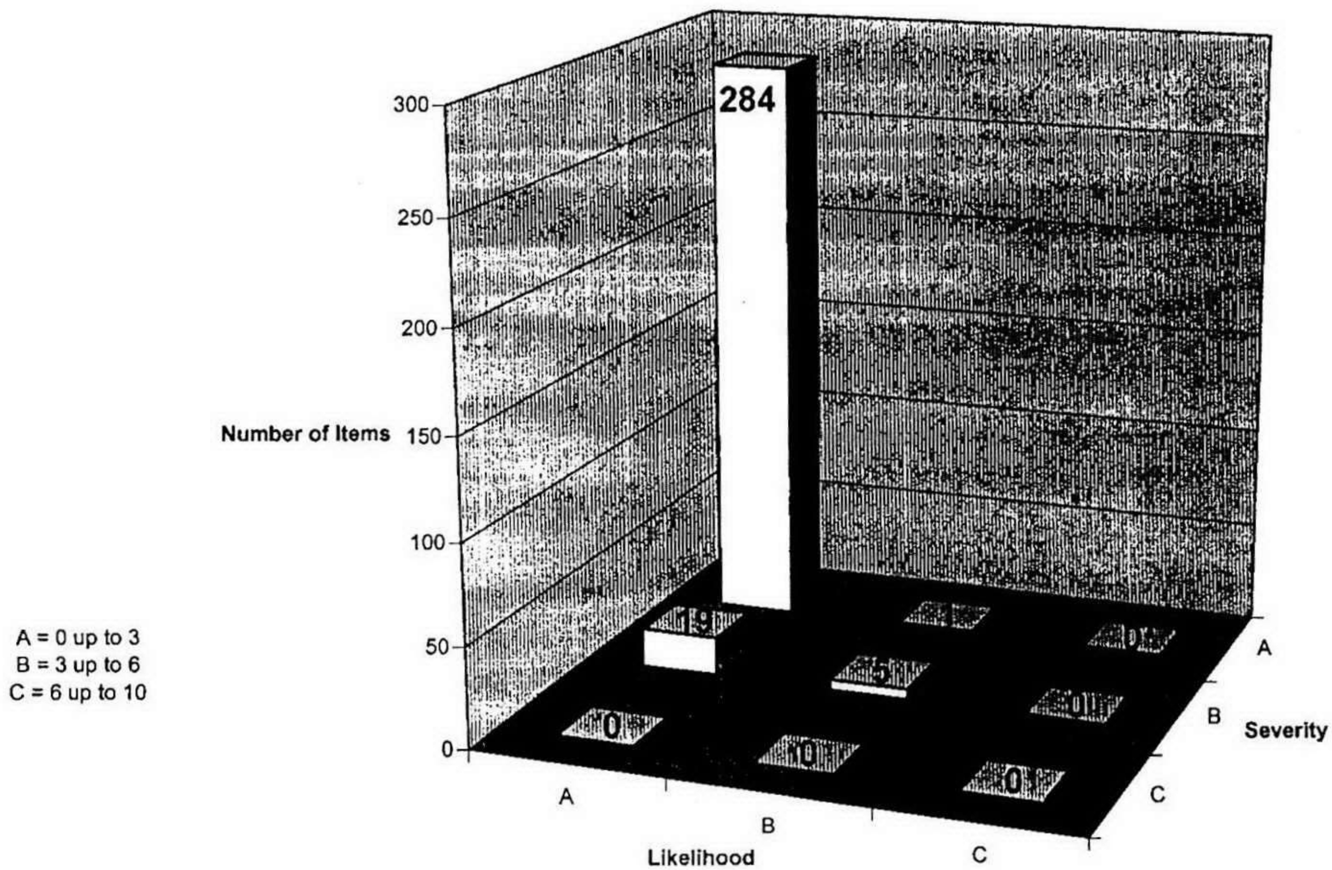

Figure 6. All PFP Items.

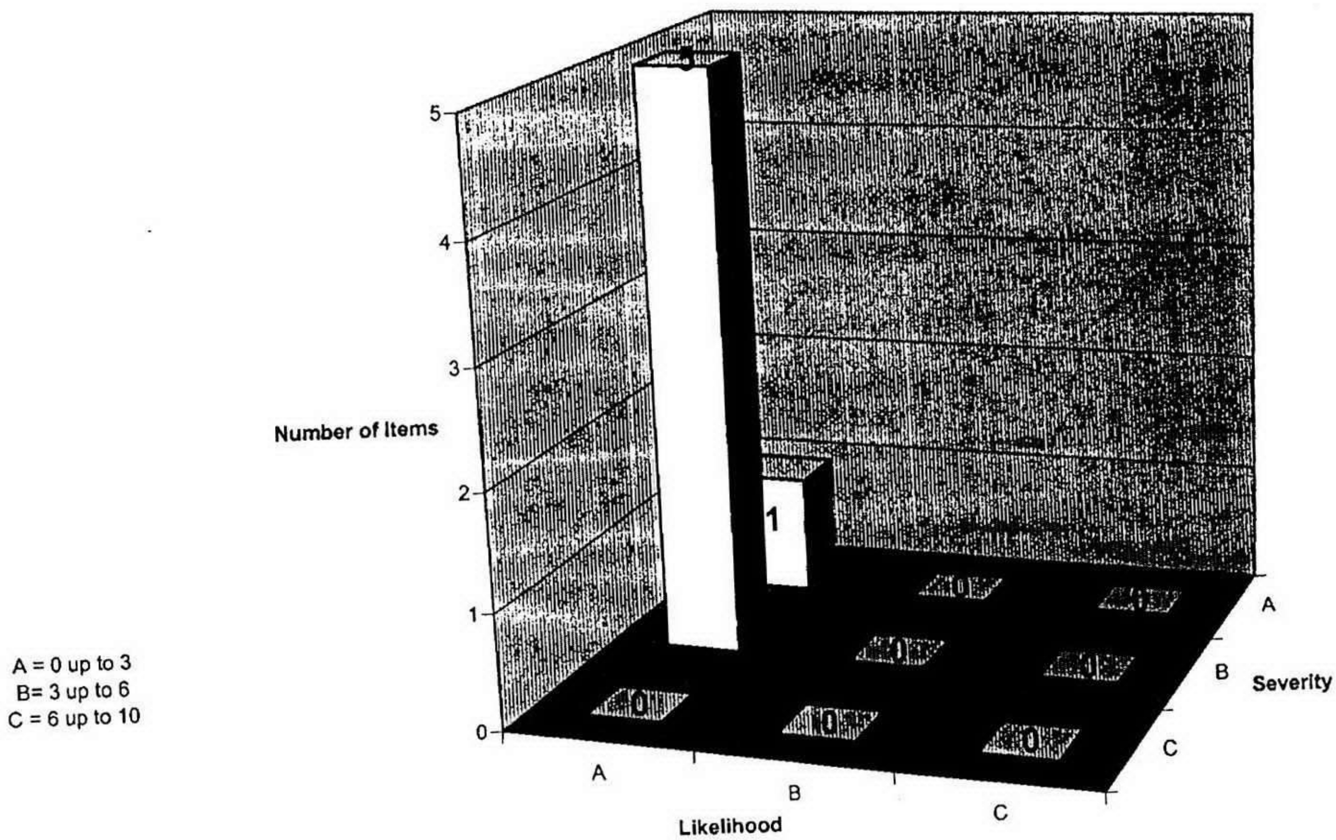

Figure 7. High Priority Items.

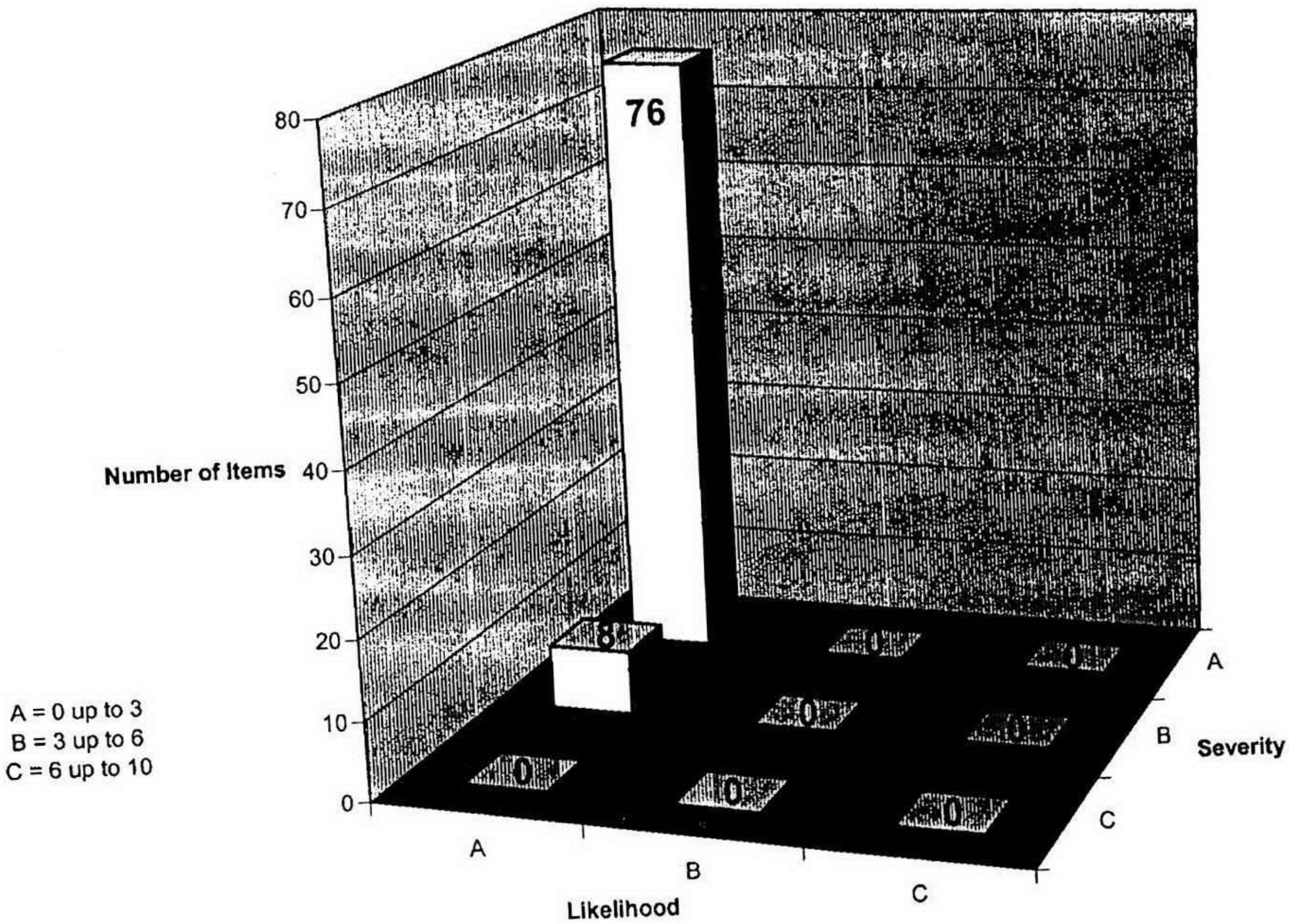

Figure 8. Other/Work Scheduled Items.

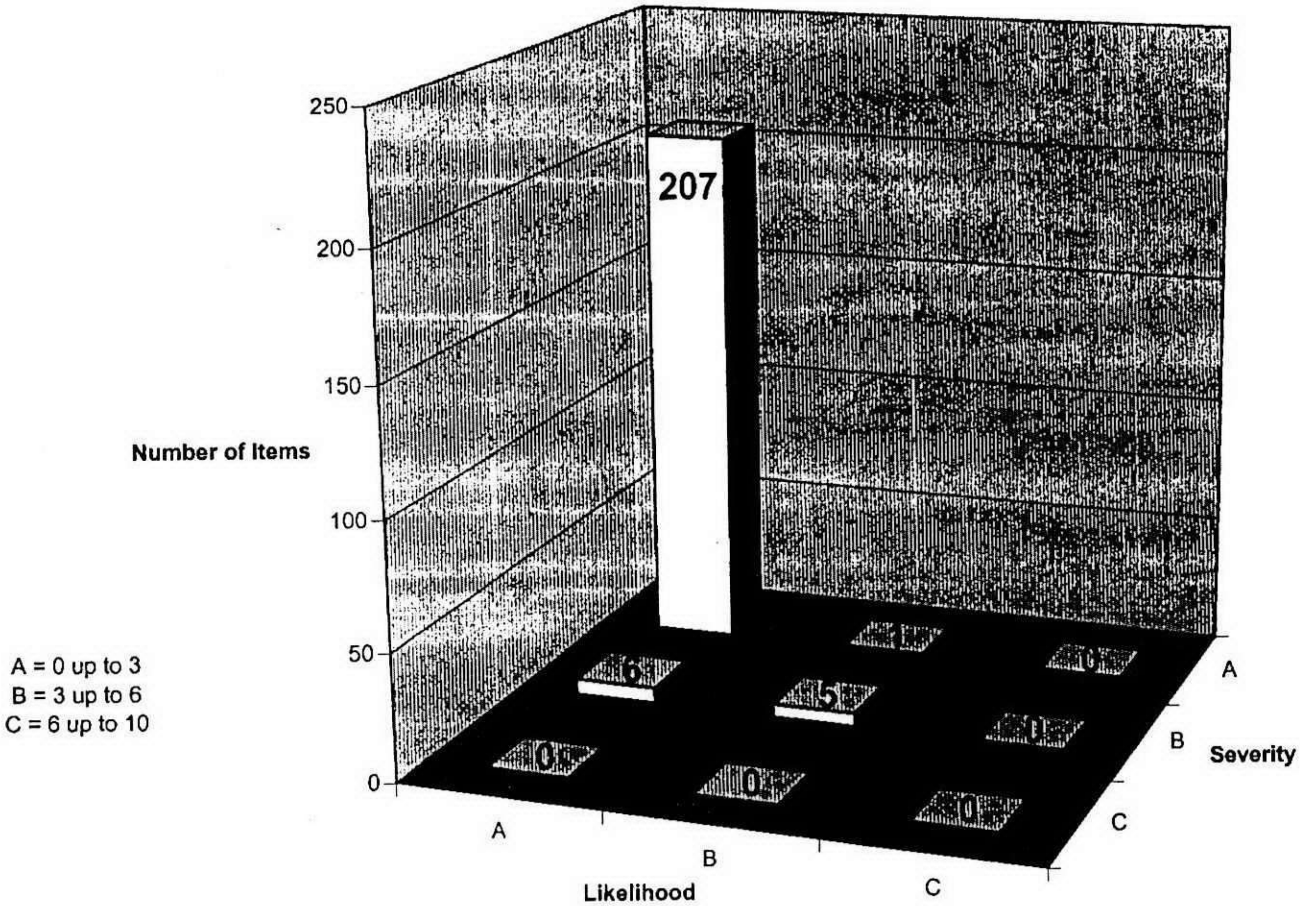

Figure 9. Deferred Items.

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6.0 CONCLUSIONS

The PFP RCHA has been completed. The assessment was performed to ensure that chemical hazards associated with inactive process equipment will not endanger the personnel, to facilitate the safe decommissioning of PFP, and to satisfy the requirements of TPA Milestone M-83-21. The RCHA meets the conditions of the milestone through the following:

- Listing inactive processing equipment that may contain residual chemicals (HNF-13940)
- Evaluating the associated hazards of equipment containing residual chemicals (HNF-13940)
- Documenting the evaluation criteria and process used (Sections 3.0)
- Categorizing items relative to risk to human health and the environment (Sections 3.0 and 5.0)
- Determining which items require response actions prior to final deactivation. None required
- Providing a schedule for any response actions required prior to final deactivation. None required.

The scope of the RCHA included all items identified in the FVA and additional items discovered during physical inspections of the buildings and records reviews. The total of 309 items were evaluated during the assessment using the criteria and methodology described in Section 3.0. No items posed a significant risk or required response actions prior to final deactivation. Relative risk values did not exceed 15.

A total of 6 PFP items were identified as high priority items because of the relative risk values or to engineering judgment.

The final disposition of all residual chemical residing in inactive process equipment will occur with the decommissioning of the PFP.

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APPENDIX A

ASSESSMENT OF CHEMICAL AND RADIOLOGICAL VULNERABILITIES

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DOE-0285-FP
Revision 0

Assessment of Chemical and Radiological Vulnerabilities

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

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ASSESSMENT OF CHEMICAL AND RADIOLOGICAL VULNERABILITIES

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ABSTRACT

Following the May 14, 1997 chemical explosion at Hanford's Plutonium Reclamation Facility, the Department of Energy Richland Operations Office and its prime contractor, Fluor Hanford, Inc., completed an extensive assessment to identify and address chemical and radiological safety vulnerabilities at all facilities under the Project Hanford Management Contract. This was a challenging undertaking because of the immense size of the problem, unique technical issues, and competing priorities. This paper focuses on the assessment process, including the criteria and methodology for data collection, evaluation, and risk-based scoring. It does not provide details on the facility-specific results and corrective actions, but discusses the approach taken to address the identified vulnerabilities.

1. INTRODUCTION

Various chemical occurrences, including the May 14, 1997 chemical explosion at the Hanford's Plutonium Reclamation Facility (PRF) and the December 8, 1999 accident at Oak Ridge's Y-12 Plant, indicate that significant chemical safety vulnerabilities may persist within the U.S. Department of Energy (DOE) defense nuclear complex. The Secretary of Energy's August 4, 1997 memorandum [DOE, 1997a] directed all DOE sites to reassess known chemical and radiological vulnerabilities and to evaluate for new vulnerabilities on a continuing basis. A subsequent memorandum [DOE, 1997b] provided additional direction and guidance to focus assessment efforts on waste storage tanks and ancillary equipment. The attainment of the goal to identify, characterize, and satisfactorily address all significant safety vulnerabilities is a challenging, ongoing process, especially at the larger DOE sites. The major roadblocks are the size of the problem (e.g., thousands of tanks and hundreds of miles of associated piping); technical issues (e.g., unique, complex, poorly known chemical mixtures stored in aging equipment); competing priorities; and limited resources.

Following the 1997 chemical explosion at PRF, all the DOE Richland Operations Office (DOE-RL) contractors urgently reviewed and evaluated their inventories to identify hazards associated with reactive chemicals and to ensure that appropriate hazard controls are in place. Extensive walk-down of facilities identified significant amounts of unneeded chemicals that were properly disposed, which resulted in a certain level of immediate risk reduction.

After the conclusion of the urgent effort mentioned above, DOE-RL and its prime contractor, Fluor Hanford, Inc. (previously, Fluor Daniel Hanford, Inc.), undertook a more systematic and comprehensive assessment of chemical and radiological vulnerabilities at the Project Hanford Management Contract (PHMC) facilities. The objectives and scope of the vulnerability assessment had to be carefully defined so that it did not unnecessarily duplicate the efforts that have gone into providing the basis for ongoing, well-defined risk elimination projects. For example, Hanford's cleanup mission is already addressing the interim and long-term hazards to the public and the environment through stabilization of diverse nuclear materials; deactivation and clean-out of reprocessing cells containing highly radioactive materials; and various other decommissioning, storage, and disposal projects. Also, it is noted that DOE-RL prime contractors responsible for the Environmental Restoration Contract and for the operation of the Pacific Northwest National Laboratory (work scope not encompassed by the PHMC) have ongoing risk characterization and cleanup efforts, which are commensurate with the nature of hazards associated with their facilities. Those efforts are separate from the vulnerability assessment discussed here.

The vulnerability assessment for PHMC facilities was specifically planned and designed to identify conditions not adequately understood and analyzed, or that do not have adequate controls, which could endanger the health and safety of workers and the public through injury or exposure to hazardous chemical or radiological material. The overall process was segregated into three phases. The first phase involved the development of a set of criteria and preliminary methodology for the assessment. The criteria and methodology explicitly took into account the generic complex-wide vulnerabilities that were identified in DOE's 1994 chemical vulnerability assessment [DOE, 1994]. The second phase consisted of a pilot test of the assessment criteria and methodology at five representative Hanford facilities. These two phases were instrumental in defining the scope and approach for a detailed, comprehensive assessment of all PHMC facilities. The third phase was that assessment, conducted according to the pre-defined objectives, scope, approach, and protocols.

The overall assessment, including all three phases, was performed over a period of about one year. It was a team effort, with Fluor Hanford taking the lead in terms of defining and directing the project, and PHMC subcontractors collecting data and evaluating vulnerabilities at their respective facilities.

This paper discusses the assessment with the objective of sharing the overall process and methodology. It does not present facility-specific results and corrective actions, except to characterize them in general terms so that the approach taken to address the identified vulnerabilities could be understood. Additional details are provided in [FDH, 1999].

2. OBJECTIVES AND SCOPE OF ASSESSMENT

The major objectives of the assessment were as follows:

- To identify and assess vulnerabilities, defined here as conditions that are not adequately understood, analyzed, or controlled, which could endanger the health and safety of workers or the public through injury or exposure to hazardous chemical or radiological material.
- To identify or develop appropriate corrective actions, applying a graded approach to addressing vulnerabilities.

The physical scope of the assessment basically included containment vessels of any kind and at any PHMC facility: containers, storage cabinets, tanks, piping, ancillary equipment, and miscellaneous structures, such as glove boxes, hot cells, and storage tunnels. However, the assessment scope and approach were developed to address credible vulnerability scenarios, so that available resources could be devoted to issues that may not have been adequately addressed through ongoing projects. In addition, the process allowed certain categorical exclusions.

Examples to illustrate these aspects are provided below.

Potential vulnerability scenarios:

- Explosion, ignition, or rapid over pressurization of the containment vessel (induced spontaneously, internally, or by external force, e.g., shock or heat)
- Release of materials due to containment vessel failure induced by contents or external source
- Release of materials due to incompatibility (reaction) between materials or between materials and the containment vessel

Storage vessels or containments that present a potential vulnerability:

- Portable storage vessels, ranging in size from small vials to large drums, including skid-mounted vessels (includes compressed inert, corrosive, poisonous, or toxic gases), rail cars, and tank trucks
- Above- and below-ground tank systems (including inactive miscellaneous underground storage tanks), ancillary piping, and equipment
- *Sumps and piping that indirectly lead to tanks (i.e., do not completely drain to the tank)*
- Distribution boxes leading to tanks or cribs, valve boxes, and pools
- Material/waste handling devices (e.g., glove boxes or other structures)
- Chemical Sewer Systems
- Storage tunnels

Chemicals and Containments that normally would not present a potential vulnerability:

- Any substance to the extent it is used also for personal, family, or household purposes or is present in the same form and concentration as a product packaged for distribution and use by the general public (e.g., bleach, motor oil, and gasoline) (DOE G 151.1-1, Volume II)
- Any commercial product in containers, without respect to volume, provided ALL of the following criteria are met —
  - Product must be stored in its original container, as packaged by the manufacturer. Bulk products, e.g., off-site owned and maintained containers such as rail cars, tank trucks, or compressed gas cylinders are considered to be original containers from the manufacturer or vendor.
  - Product must be stored in accordance with applicable recommendations or specifications (including shelf-life) set by the manufacturer.
  - Product must be stored in accordance with applicable site requirements, including DOE Orders and site procedures.
  - A Material Safety Data Sheet for the product must be available.
  - The product must be inventoried and tracked in a facility-based chemical management system.
  - The product container must be clearly labeled as to its contents.
- Ammunition and other munitions maintained for security operations provided they are stored, handled, and transported under approved Federal and State regulations, DOE Orders and site procedures
- Heating, ventilation, and air conditioning systems, including all materials contained within them, and their associated air distribution ductwork
- Fuel storage tanks (i.e., gasoline and diesel)
- Septic tanks, sanitary systems, Storm water drains, runoff tanks, and open storage pools
- Sumps and piping that directly lead to tanks (i.e., gravity drain completely to the tank)
- Ditches, ponds, trenches, soil drain fields, dry waste caissons, and burial grounds
- Fire water storage tanks and fire suppression systems
- *Steam systems or pressurized air systems*

Categorical exemptions:

Certain specific processes, facilities, or categories of containment vessels and materials were granted exemption from the vulnerability assessment. Exemptions were justified if substantial, documented information, which had been gathered through other efforts, was equivalent to information that would be gathered through the vulnerability assessment process. This information must have demonstrated that appropriate characterization and control of risk had been completed.

Exemptions were reviewed and approved by an Exemption Review Board through a formal process explicitly set up for this purpose. Facilities requesting exemptions were responsible for providing the supporting information and documentation. Insufficient knowledge about the material or containment vessel, nor the cost or timing of collecting the information, was allowed as basis for an exemption. Examples of facilities granted exemptions were the fully deactivated canyon processing facilities, PUREX and B-Plant, where achievement of appropriate pre-defined end-point criteria established by DOE and State regulatory authorities could be demonstrated.

3. ASSSESSMENT PROCESS

Besides the development of a proper scope and methodology, the key aspects of the overall assessment process included ensuring that adequate resources were devoted to the assessment through the formal request and approval of a change to the baseline work; training of the personnel involved in the assessment; and surveillance and verification by Fluor Hanford and DOE-RL.

The vulnerability assessment process involved the following major steps:

A. *Development of the assessment scope, methodology, and protocols*. Based on the results and information from Phases 1 and 2, a core team developed the detailed methodology, including the screening and scoping process for defining which items would be the subject of assessment (see illustration in Figure 1); lists of information and data to be gathered for facilities, containments, or vessels; requirements to be used in the assessment, electronic database format and content; data collection forms and checklists supporting the database; quality assurance requirements; qualification and training requirements; final deliverables; and the schedule. The core team had extensive qualifications and experience in safety, chemical management, radiological and environmental protection, conduct of operations, and performance assessment. The core team developed a management plan [FDH, 1998] and established protocols to implement the subsequent assessment process steps.

B. *Determination of impacts to current projects*. The subcontractors estimated the impact of conducting the facility assessments and developed formal Baseline Change Requests (BCRs). The impact of conducting the assessment took into consideration other priority work that would be either delayed or canceled, because additional funds for this assessment were not provided.

C. *Establishment of assessment of teams*. The subcontractors identified points of contact within their organizations and facilities, defined the roles and responsibilities, and established assessment teams comprised of qualified individuals to conduct the assessments at each facility.

D. *Training and performance of assessment*. Upon approval of the BCRs, subcontractors commenced assessments of their respective facilities. The assessment database format and instructions were transmitted to the teams, and training was provided to all personnel involved in the assessment. The teams were trained on the methodology for data collection, evaluation, and reporting to ensure thorough and consistent application at all facilities. The teams conducted the assessments, completed facility-level and containment vessel-level data collection forms, and entered the information into the assessment database. The nature of information required by the data collection forms is discussed later. The subcontractor organizations were responsible for verifying the accuracy of the information entered into the database. The database for each facility was then transmitted to the core team for consolidation and overall analysis.

E. *Surveillance of assessments.* A surveillance team comprising a few members drawn from the core team performed focused surveillance of the assessments to ensure that the information being gathered was acceptable and to allow for mid-course corrections. Surveillance was performed in at least one facility per subcontractor. Surveillance Report Summaries were prepared for each facility visited. Examples of inconsistencies that were found and corrected included incorrect classification of unknown contents, incorrect inclusion of out-of-scope items, and omission of items in scope. DOE-RL Facility Representatives performed surveillance and prepared independent reports.

F. *Overall analysis and results.* After the database was reviewed and verified, the core team identified appropriate groupings of vulnerabilities and expectations for management of the vulnerabilities.

G. *Follow-up and closure of corrective actions.* Actions that resulted from the assessment were managed within the framework of Fluor Hanford's Integrated Environment, Safety and Health Management System (ISMS).

4. ASSESSMENT METHODOLOGY

This section describes the data collected at the facility and containment vessel levels, the evaluations performed, and the manner in which this information was subsequently combined through an algorithm to score vulnerabilities based on the safety risk they present.

At the facility level, the data and information collected related to asset ownership and identification; and the adequacy of inspection, maintenance, and operation; configuration control; personnel training; and lessons learned program.

At the containment vessel level, the following categories of data and information were collected:

- Containment vessel ownership and identification
- Characteristics of vessel (e.g., capacity, construction material, and application)
- Characteristics of contents (e.g., name, concentration, volume, and compatibility)
- Quality of characterization data for level of confidence and need for additional data
- Hazard characteristics of containment vessel contents
- Relative risk ranking factors for consequence and likelihood of an occurrence
- Recommended additional controls
- Immediate and long-term corrective actions

Certain categories of data and information mentioned above; i.e., quality of data, reactivity hazard, and other risk ranking factors, were each defined further in terms of parameters that could be evaluated semi-quantitatively. These categories are further discussed next.

Quality of Characterization Data

The lack of adequate information about a material reflects increased risk because the requirements for its safe storage may not have been understood and implemented. The level of confidence in the available data to characterize the safety of the containment vessel and its contents was judged, based on the degree to which each of the following was available: (1) analytical data generated under an established quality assurance plan consistent with intended use; (2) process knowledge supported by controlled, peer-reviewed documentation; and (3) testimony from a person with primary knowledge.

Hazard Characteristics of Material

Material in a containment vessel was assigned to one or more of the following four groups, based on its reactivity hazard: (1) explosive, unstable reactive, unstable over time (e.g., due to aging in storage or contamination during use), and organic peroxides; (2) pyrophoric, water reactive, flammable gas, fissile materials; (3) corrosive and highly toxic materials; and (4) all other materials (generally not very reactive). Additional information helpful for classifying vessel contents into these groups, such as explanations of definitions and potentially adverse conditions, was provided to the assessment teams. Radioactive material was given an additional identifier. The contents, if unknown, were conservatively assigned to the first group.

Consequence Ranking Factors

The following factors, in addition to data quality and hazard characteristics of material, were considered to influence the severity of consequences resulting from the loss of control of material, such as through an uncontrolled reaction or a leak release:

(1) Potential for human injury. Considerations included accessibility to personnel, number of persons potentially affected, and expected severity.

(2) Potential for human exposure. Considerations included vessel location relative to people, number of persons potentially affected, and likely exposure scenarios.

(3) Potential and significance of secondary impact. Considerations included other systems, structures, and components that could magnify consequences, e.g., fixed radioactive contamination, safety-critical systems, and ventilation systems; and considerations, such as distances or barriers between systems, and hazard characteristics of materials impacted.

Likelihood Ranking Factors

The following factors, in addition to data quality and hazard characteristics of material, were considered to influence the likelihood of occurrences involving the loss of control of a material:

(1) Design. Considerations included safety features, as applicable; e.g., pressure relief, secondary containment, air filtration, hydrogen mitigation, shielding, and seismic capacity.

(2) Operation. Considerations included whether the vessel and any ancillary equipment are operated as designed, per manufacturer's specifications (including design life), and within the documented safety envelope.

(3) Containment vessel condition. Considerations included integrity testing, protection from corrosion, modifications that potentially degrade integrity, and visual condition.

(4) Maintenance and inspection. Consideration included whether preventive maintenance and inspections are regularly scheduled and implemented.

(5) Safety authorization basis, emergency planning, and other programmatic controls. Considerations included whether the configuration of the containment vessel and ancillary equipment is adequately documented, reviewed and approved; and whether it is subject to established programs, such as for inventory control, standards and requirements identification, authorization basis, fire protection, and emergency planning.

Risk-based Relative Ranking

The relative risk presented by a containment vessel was quantified by developing a vulnerability score, a numerical product of two quantities representing, respectively, the consequence and the likelihood of an occurrence. These two quantities, in turn, were obtained from the factors discussed above.

The data quality, the hazard group of material, and the consequence and likelihood factors were each parameterized and scored by assigning integer values, 1 through 5 (except for hazard group), where unity represented the best condition and the value five represented the worst. The parameter representing the hazard group of material was assigned the value 16, 9, 4, or 1, respectively, for the most reactive to the least reactive group. These values are each equal to the square of the hazard group in reverse order.

The quantity representing the consequence of an occurrence was the linear sum of parameter values for data quality (weighted twice), hazard group of material, and for each of the three consequence factors. The parameter value for data quality was doubly weighted so that the vulnerability score properly reflects conditions defined by poor quality data relative to those with good quality data. The quantity representing the likelihood of an occurrence was derived in the same manner, except that the linear sum of parameter values included each of the five likelihood factors instead of the three consequence factors.

The quantities representing the consequence and the likelihood were normalized so that their maximum value each was 10; and the maximum value of their product, the vulnerability score, was equal to 100. The algorithm for developing the vulnerability score was tested on selected containment vessels and materials, before its use by the assessment teams, to verify that it provides acceptable range of vulnerability scores for each hazard group.

5. OVERALL ANALYSIS AND RESULTS OF ASSESSMENT

There were a total of 1308 items for which data and information were collected. After the database of facility and containment vessel information, including the vulnerability scores, was reviewed and verified, the core team identified appropriate groupings of vulnerabilities and expectations for management of the vulnerabilities.

Ideally, the vulnerability scores would display a distribution centered near the bottom of the scale. This distribution would thin out as vulnerability scores increased because the number of items with relatively poor controls would be smaller. The scores generated by the assessment showed the expected pattern; however, it included an additional broad peak representing items that contain unknown materials. This is shown in Figure 2. A statistical analysis found that the data fit to a combination of two separate probability distributions: a gamma probability curve for the low-scoring group (i.e., a distribution that has only one tail), and a normal probability curve for the rest of the data. The division between the groups was identified as the point where the probability curve from one group was equal to the probability curve from the other group. This point, which occurred at a vulnerability score of 36, represented the boundary between the two groups.

The two groups of vulnerability scores were termed as the Activity-Level Group and the Facility-Level Group for the lower and the higher range of scores, respectively. These terms for the groups are based on how the identified vulnerabilities would be managed within the framework of ISMS. The characteristics and examples of the two groups are discussed below.

Activity-Level Group

This group is characterized by items whose properties and hazards were well understood and had adequate controls. Items in the Activity-Level Group could be addressed through existing processes, which include work planning and control, hazard identification and analysis, and conduct of operations. Work planning teams use the Automated Job Hazards Analysis process, applying a graded approach based on complexity and risk. Responsibility for resolving deficiencies at the activity level rests with the worker and the first-line supervisor.

Of the total number of items within the scope of the vulnerability assessment, 88% fell into this group. Fraction of the total identified as radioactive was 57%; and that identified as unknown was 0.2%. The group included waste containers, double-shell tanks, laboratory materials and waste streams, and receiving and shipping materials.

Facility-Level Group

This group is characterized by items whose properties and hazards were not sufficiently understood, and controls could be inadequate. Remediation and management of vulnerabilities at this level would require the consideration of facility workscope and project baselines, as well as the facility management's focused attention to ensure that adequate safety basis and proper hazard controls are in place. Safety basis changes could be required to resolve issues in this group. Actions taken to resolve deficiencies would include identifying the scope of work, ensuring adequate budgeting, recording actions through the Deficiency Tracking System, and tracking status through senior management meetings. Typically, these issues require significant resources to fix and need to be balanced against other facility priorities. Additionally, these issues should be specified as actions of remediation through the Multi-Year Work Planning process.

The Facility-Level Group accounted for 12% of the total number of items, with 87% identified as radioactive, and 85% of uncertain composition. These items include legacy waste or orphan containers, ion-exchange columns, single-shell tanks, inactive miscellaneous underground storage tanks, active and inactive radioactive waste transfer lines and associated valve pits and clean-out boxes.

6. CORRECTIVE ACTIONS AND FOLLOW-UP

A primary result of the vulnerability assessment was the identification of necessary corrective actions for the vulnerabilities identified. Identification of corrective actions was required for any material listed as unknown. The facility was also required to determine whether a corrective action should be implemented in the near-term or long-term. Many deficiencies and related corrective actions had been identified prior to the vulnerability assessment process.

The vulnerability grouping and nature of corrective actions were used to determine the priority and actions necessary to reduce the vulnerabilities to an acceptable risk. The corrective actions generally consisted of identifying the material through sampling and characterization, and determining the need for its continued storage. Examples of the identified corrective actions included the following:

- Sample and characterize material (one time or routinely).
- Review need for material and dispose or excess if not needed.

- Relocate or dispose of material.
- Implement a procedure for inspection.
- Reevaluate storage conditions/practices for material compatibility.
- Develop a surveillance procedure.
- Modify containment to add absorbent material.
- Label container.
- Isolate container from other systems.
- Properly vent containers to eliminate pressure buildup.
- Develop ways for detecting pressure buildups.
- Flush and clean containment.
- Determine potential for leakage.
- Verify status of container (e.g., whether it is empty).
- Install temperature controls.
- Perform an Unreviewed Safety Question (USQ) screening.
- Update the Authorization Basis.
- Close outstanding USQ.

During the course of the assessment, some situations were identified that required prompt corrective actions. For example, a few situations involved incompatible materials stored together, which were immediately corrected. In a couple of instances, more extensive actions were needed.

At the close of the assessment, the following recommendations were made:

- All open items in the Facility-Level Group should be entered into the Corrective Action Management System/Deficiency Tracking System for tracking completion of corrective actions. This process includes determining the priority of corrective actions. Items at the upper end of this group would generally receive priority in finalization of corrective actions.
- All items of unknown characteristics within the Facility-Level Group should be evaluated to determine the contents and to determine if the existing controls were adequate.
- Facility ownership should be clearly established for all items on the site.

7. SUMMARY AND CONCLUSION

The vulnerability assessment undertaken by DOE-RL and Fluor Hanford was an extensive effort that covered all PHMC facilities. The objectives, scope, and methodology for the assessment were carefully defined to focus on conditions that were not adequately understood or analyzed, or that did not have adequate controls, without duplicating previous and ongoing efforts. The assessment methodology incorporated the generic DOE complex-wide vulnerabilities previously identified, and went further in providing a semi-quantitative evaluation of the quality of data, hazard characteristics of material, and of several consequence and likelihood ranking factors. Based on this evaluation, each item subject to assessment received a relative vulnerability score to support the management of corrective actions. Vulnerabilities were split into two broad groups, the Facility-Level and Activity-Level Groups, so that the identified corrective actions could be readily managed within the framework of ISMS. The assessment provided a database of valuable information on facility and containment vessel conditions.

Overall, the vulnerability assessment showed that most of the items covered by the scope of the assessment were managed appropriately; and corrective actions, if necessary, could be addressed at the activity level through normal work planning and control processes. Some items required completion of existing programs to adequately identify their hazard characteristics and required controls. The assessment also identified opportunities for existing programs to reassess corrective actions and priorities.

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Figure 1. Vulnerability Assessment Process

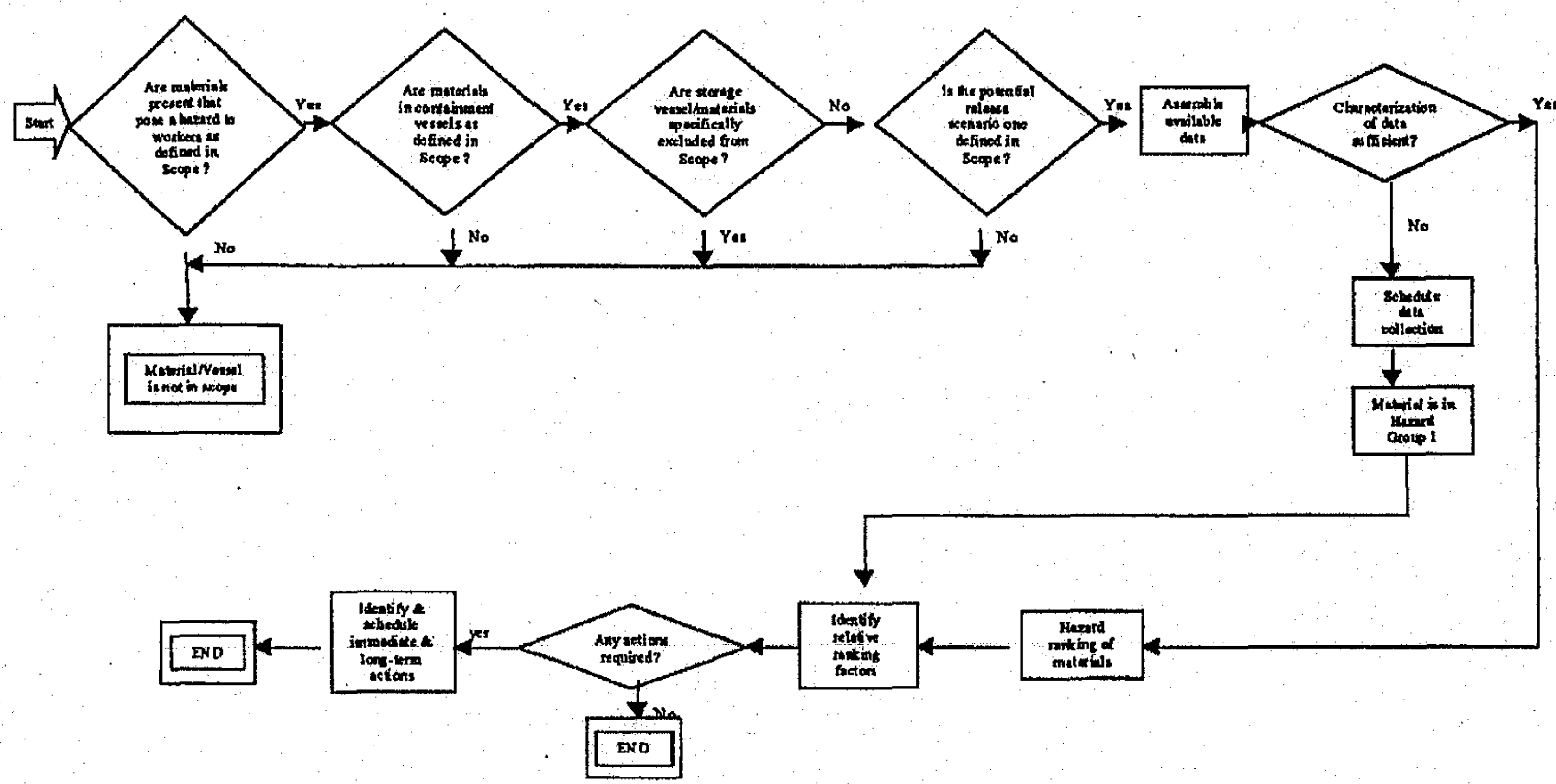

Figure 2. Results of Vulnerability Assessment