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Subcontractor Report

Integrity Assessment Plan for PNL 300 Area Radioactive Hazardous Waste Tank System

Final Report

March 1996

Prepared for Pacific Northwest National Laboratory
by Science Applications International Corporation
1845 Terminal Drive
Richland, Washington 99352
under Contract Number 143920-A-C7

Pacific Northwest National Laboratory
Operated for the U.S. Department of Energy
by Battelle

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EXECUTIVE SUMMARY

An Integrity Assessment Plan (IAP) is presented for the radioactive hazardous waste tank systems operated by the Pacific Northwest Laboratory in the 300 Area of the Hanford Site. The waste tank systems are located in the 324 and 325 Buildings. Liquid radioactive hazardous wastes generated in hot cells in these buildings are collected and then transferred into the 300 Area Radioactive Liquid Waste System (RLWS) operated by Westinghouse Hanford Company. Liquid wastes collected from the RLWS are transported to permitted storage and disposal in the 200 Areas.

This Integrity Assessment is required to comply with State of Washington Dangerous Waste Regulations (WAC 173-303-640) and federal requirements for owners and operators of facilities that treat or store hazardous materials under 40 CFR 264 and 265. This IAP, the first stage in the performance of the Integrity Assessment, describes the inspections, tests, and analyses required to assess the integrity of the 324 and 325 Building waste tank system (tanks, ancillary equipment, and secondary containment) and provides sufficient information for adequate budgeting and control of the Integrity Assessment program. It also provides necessary information to permit the Independent, Qualified, Registered Professional Engineer to approve the Integrity Assessment program.

Assessment of the waste tank system integrity for the 324 and 325 Buildings presents some engineering challenges because of the inaccessibility of the tanks, a result of high radioactivity content and consequent shielding requirements. The use and possibly further development of remote non-destructive examination (NDE) techniques may be required during the course of the integrity assessment project. To determine tank system configurations and tank contents (including information on radiation levels), an extensive survey of documents, records, drawings, and current and former users of the tanks was conducted. This survey generated a record of the waste tank system design and configuration and a summary of operating history to serve as a basis for identifying the potential tank conditions. The information gathered indicates that assessment of Tank TK-1 in the 325 Building should be performed first and the tanks in the 324 Building high-level vault should be performed last.

The Integrity Assessments will include a design assessment for each tank and ancillary equipment that addresses corrosion potential, operational loads, and external loads. Leak testing, visual inspection (using a remote video camera in high radiation areas), and limited NDE will be used to identify and characterize corrosion and cracks. Visual inspection will also be performed on tank and piping secondary containment. In a broad, but concise overview, a table identifying the major waste facility components, test regimes, and underlying regulations follows.

Component	Test/Evaluation	Regulation	Supporting Stds
Tanks	DE, ISI, LT, NDE, VT	Title 40 CFR Part 265 WAC 173-303-640 WAC 173-303-640-(2)(c) WAC 173-303-640(6)	ASME Sect. VIII ASME Sect. XI API
Secondary Containment	DE, ISI, VT	WAC 173-303-640(4)	UBC
Process Piping Drain Piping	DE, ISI, LT, NDE, VT	WAC 173-303-040 WAC 173-303-640-(2)(c)	ANSI B31.1
Ancillary Eqmt (Non-Piping)	DE, ISI, VT	WAC 173-303-040 WAC 173-303-640-(2)(c)	ANSI B31.1 ASME Sect. VIII ASME Sect. XI API

Table Legend and Notes:

DE = Design Evaluation:
Assessment of basic structural integrity, corrosion integrity, corrosion induced crack propagation mechanisms. Tanks evaluated under general guidance of ASME VIII while piping (and ancillary equipment) evaluations follow ANSI B31.1 design guidance. WAC 173-303-640-(2)(c) is the implementing regulation. The design evaluation and visual inspections may serve as a basis for wavier of leak testing (see WAC option). Detailed discussions provided by IAP Sections 4, 5 and 6.

ISI = In-Service Inspection:
Facility long term visual and NDE inspection program driven by requirement of WAC 173-303-640(6). Guidance (subset) of ASME XI suggested as the basis document to be used for development of waste facility ISI program requirements.

LT = Leak Test:
Hydrostatic or alternative vessel leak integrity test. American Petroleum Institute (API) inspection standards may also be considered as referenced by WAC 173-303-640, see also discussions of IAP Section 5 associated with Table 5.1.

NDE = Non-Destructive Examination:
Comprised primarily of ultra sonic and surface examination (e.g. dye penetrant) techniques. See IAP Appendix C for overview discussion.

VT = Visual Examination:
Actions of qualified weld inspectors, civil/structural engineers, process technicians. Encompasses remote examinations in satisfaction of WAC and in particular WAC 173-303-640(4) which deals with secondary containment qualification requirements.

CONTENTS

1.0 INTRODUCTION

The Pacific Northwest Laboratory (PNL), operated by Battelle Memorial Institute under contract to the U. S. Department of Energy, operates tank systems for the U.S. Department of Energy, Richland Operations Office (DOE-RL), that contain dangerous waste constituents as defined by Washington State Department of Ecology (WDOE) Dangerous Waste Regulations, Washington Administrative Code (WAC) 173-303-040(18). Chapter 173-303-640(2) of the WAC requires the performance of integrity assessments for each existing tank system that treats or stores dangerous waste, except those operating under interim status with compliant secondary containment.

This Integrity Assessment Plan (IAP) identifies all tasks that will be performed during the integrity assessment of the PNL-operated Radioactive Liquid Waste Systems (RLWS) associated with the 324 and 325 Buildings located in the 300 Area of the Hanford Site. It describes the inspections, tests, and analyses required to assess the integrity of the PNL RLWS (tanks, ancillary equipment, and secondary containment) and provides sufficient information for adequate budgeting and control of the assessment program. It also provides necessary information to permit the Independent, Qualified, Registered Professional Engineer (IQRPE) to approve the integrity assessment program.

The Waste Technology Engineering Laboratory (324 Building) provides office and laboratory space for PNL scientific and engineering staff conducting multidisciplinary research in the areas of waste characterization and immobilization, waste remediation and cleanup development, biomass research, spent fuel characterization, tritium development, and cesium chloride encapsulation. The 324 Building was designed with the necessary safety features and facilities to allow the use of radioactive and hazardous materials in support of these activities. The building is currently occupied by staff from the Waste Technology Center, Safeguards and Security Department, and the Office of National Security and Technology.

The Applied Chemistry Laboratory (325 Building) houses radiochemistry research, radioanalytical service, radiochemical process development, and hazardous and mixed waste treatment activities. The laboratories and specialized facilities accommodate work involving nonradioactive materials, picogram to kilogram quantities of fissionable materials, and up to megacurie quantities of other radioactive materials. The special facilities include 1) two shielded hot cell areas that provide for process development or analytical chemistry work with highly radioactive materials and 2) a waste treatment facility for processing hazardous, mixed, low-level, and transuranic wastes generated by PNL activities. The office, laboratory, and shop space house personnel from PNL's Analytical Chemistry Laboratory, Materials Sciences Department, Chemical Sciences Department, Chemical Technology Department, and support services.

The 324 and 325 Buildings have been maintained and upgraded continually to ensure that operations can be conducted safely, with minimal potential impact on the public, workers, and the environment, and to ensure continuity of programmatic activities.

1.1 SCOPE

The IAP includes the essential elements necessary to plan for conducting integrity assessment of the PNL RLWS associated with the 324 and 325 Buildings. The IAP provides a discussion of RLWS design, including system description, design criteria, process requirements, service history, and required lifetime. A waste characterization profile has been developed by gathering information from process records, published documents, sample data, and personnel interviews. An assessment of potential system failure mechanisms has been performed, and consideration has been given to aging affects, waste and material compatibility, design versus design loads and operating history. Based upon the information compiled, a plan for conducting the inspections, tests, and analyses required to assess the integrity of the system has been developed. The plan discusses non-destructive evaluation techniques and recommend those techniques that demonstrate the highest probability of acquiring the necessary data in a safe, efficient, and cost-effective manner. A review has been performed of secondary containment features and regulatory requirements to determine the inspections, tests, and analyses required to assess the adequacy of secondary containment.

Integrity Assessment Reports (IARs) for the 324 and 325 Building RLWS will be produced as a result of implementing this IAP. The IARs will document the results of the integrity assessments and will contain analyses of the following items:

- adequacy of tank system design
- waste characteristics with respect to materials compatibility and corrosion
- inspections and tests conducted to verify the integrity of the tanks and ancillary equipment.

Based on these analyses, a schedule for future assessments will be established as required by applicable regulations.

1.2 REGULATORY REQUIREMENTS

Tanks systems that contain dangerous waste are currently regulated under Washington State Dangerous Waste Regulations (WAC 173-303; Ecology 1980) and/or the U.S. Environmental Protection Agency's federal regulations. The wording and regulatory requirements of state and Federal regulations for tank systems are virtually identical. For interim status facilities, such as the 324 and 325, the applicable regulations are WAC 173-303-200, -400, and -640, and 40 CFR Part 265, Subpart J (EPA 1980). For final status facilities, the applicable regulations are WAC 173-303-200, -400, and -640 through -680; the requirements specified in WAC 173-303-640 through -680 are virtually identical to the requirements for final status facilities in 40 CFR Part 264, Subpart J (EPA 1980). The following presents a summary of the regulatory requirements applicable to the 324 and 325 Building RLWS tanks, ancillary equipment, and secondary containment.

Assessment of the integrity of existing tank systems is a WAC requirement. The basic requirement imposed on the owner or operator is to "determine that the tank system is not leaking or unfit for use" [WAC 173-303-640(2)(a)]. A written assessment reviewed and certified by an Independent, Qualified, Registered Professional Engineer that attests to the tank system's integrity must be obtained and kept on file at the facility [WAC 173-303-640(2)(a)]. Upon completion of an integrity assessment which concludes that the tank system is neither leaking nor unfit for use, "the owner or operator must develop a schedule for conducting integrity assessments over the life of the tank..." [WAC 173-303-640(2)(e)]. If the "tank system is found to be leaking or unfit for use, the owner or operator must immediately remove the tank system from service and take action to mitigate the leakage in accordance with the requirements of subsection (7) of this section" [WAC 173-303-640(2)(d)].

WAC 173-303-640(2)(c) requires that the integrity "assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated, to ensure that it will not collapse, rupture, or fail. At a minimum, consideration must be given to the following factors:"

- design standard(s) of construction (if available)
- dangerous characteristics of the waste(s) that have been and will be handled
- existing corrosion protection measures
- documented age (if available, otherwise an estimate)
- results of a tank system leak test, internal inspection or other tank system integrity examination.

For both tanks and ancillary equipment, the assessment must include either a leak test capable of taking into account the affects of temperature variations, tank end deflections, vapor pockets, and high water table effects or other integrity examination certified by an IQRPE that addresses cracks, leaks, corrosion, and erosion. WAC 173-303-640(2)(c)(B) notes that practices described in the American Petroleum Institute Guide for Inspection of Refinery Equipment, Chapter XIII, "Atmospheric and Low-Pressure Storage Tanks," (API 1981) may be used, where applicable, as guidelines in conducting tests other than leak tests.

The integrity assessment for secondary containment must be performed to ensure that containment complies with the requirements of WAC 173-303-640(4). At a minimum, the assessment must verify that secondary containment is

- Constructed of or lined with compatible materials capable of containing 100% of the capacity of the largest tank
- Placed on a foundation or base capable of providing appropriate support
- Provided with a leak detection system
- Sloped, designed, or operated to remove liquids resulting from leaks.

1.3 TERMINOLOGY

Several references are made in the document to "waste," "waste solutions," and "waste materials." These are typically used in reference to materials and solutions that are generated as a byproduct of the processes and activities. However, since the major processes conducted in the 324 and 325 Buildings were to demonstrate various solidification methods for radioactive wastes, the term "waste" can also be used in reference to the feed solutions for the solidification processes. An attempt has been made to provide some distinction between the two uses of the term "waste," by referring to the feed solutions as "waste feed," "waste feed materials," or "waste feed solutions." These distinctions are generally only required when the "waste" or "waste feed" is discussed in context with being discharged to a tank, transferred to or from a tank, and/or stored in a tank. It is not the intent of this distinction to be made for the purposes of regulatory interpretation, but rather as a clarification for assessing the past use of the tanks.

2.0 FACILITY AND TANK SYSTEM DESIGN CONSIDERATIONS

Included in this section are general descriptions of the 324 and 325 Buildings, a general description of the RLWS and its function, identification of portions of RLWS to be included in the integrity assessment, brief descriptions of system components requiring integrity assessment, and identification of system design criteria. Much of the information presented below has been obtained from the 324 and 325 Buildings Safety Analysis Reports (PNL 1991, 1992).

2.1 FACILITIES

The 324 and 325 Buildings are located in the 300 Area of the Hanford Site. The 300 Area is located on the southeast corner of the Hanford Site, approximately 6 miles north of downtown Richland. This area encompasses approximately 100 facilities that provide a variety of support functions for programs conducted at the Hanford Site and elsewhere. Construction and operation of the 300 Area began in the mid-1940s. Its current mission is primarily focused on research and development (R&D) programs. Some of the R&D activities conducted in the 300 Area yield dangerous waste, radioactive waste, and/or radioactive mixed waste (RMW).

2.1.1 324 Building

Major construction of the 324 Building, the Waste Technology Engineering Laboratory, was completed in 1965. The 324 Building contains facilities for conducting diverse studies on the chemical and physical processing of high-level radioactive materials, physical and chemical characteristics of irradiated materials, and nonradioactive process development. The building contains laboratories, hot cells, support facilities, and office space to pursue technical studies that range from laboratory to pilot-plant scale. These studies involve the use of materials having levels of radioactivity ranging from natural background to full process levels. In addition, laboratory research continues to be performed to develop basic and applied data in support of DOE programs.

The physical dimensions of the 324 Building are 62.5 m by 71.6 m (205 ft by 235 ft) in plan and 13.7 m (45 ft) in height above ground level. The 324 Building has a partial basement and first, second, and partial third floors for a total of approximately 9,450 m^2 (101,709 ft^2) of floor area. The foundation structure is poured-in-place reinforced concrete. The superstructure is constructed from insulated fluted steel industrial panels supported on a structural steel frame. The parapeted roof has a slightly sloped steel deck covered with concrete with gravel-finished, Class II, 20-year, built-up roofing. The 324 Building was designed to the requirements of the Uniform Building Code (UBC 1961) and Hanford Plant Standard (HPS) Standard Design Criteria (SDC) 4.1 Revision 2 (1959).

The original 324 Building is divided into five integrated but separate primary working areas:

- Area #1 - Engineering Development Laboratories (EDL), tank pit, service tunnel, office area, and storage. In 1974, a small addition was constructed (324C) adjoining the southwest corner of EDL. Immediately south of 324C and adjoining the addition is the lithium storage addition.

- Area #2 - first-floor offices, lobby, lunch room, conference room, men's restroom/change room, women's restroom/change room, decontamination room, janitor's closet, copy machine vestibule, telephone equipment, and second-floor offices.

- Area #3 - basement - RE cell service gallery, elevator equipment, storage, and elevator vestibule; first floor - offices, room, first-floor laboratory; second floor - laboratories, vestibule, restrooms; third-floor - offices, chemical makeup rooms, head tank room, Zone III exhaust fan and filter rooms, RE cells control room; and the first-, second-, and third-floor RE cells and operating galleries. The RE cell complex consists of A, B, C, D, and Airlock cells.

- Area #4 - storage vault and laboratory area, basement laboratories, mechanical spaces, Shielded Materials Facility (SMF) cells and operating galleries including offices, the manipulator repair shop, and the ventilation and equipment rooms. The SMF cell complex consists of East, South and Airlock cells.

- Area #5 - Zone I and Zone II exhaust fan and filter rooms, damper and filter pit, high-level vault, low-level vault, cask handling area, truck lock including the load-out stall, high- and low-level vault sample room, low-level canyon, and the manipulator shop.

Attached to the 324 Building are several gas bottle storage areas, an acid storage tank, a scrubber for EDL exhaust, the building stack (324B), and the sampling building (324A) for the stack.

Since the original 324 Building was constructed, three major building areas have been added to the facility:

- Area #6 - In 1979, the High Bay Engineering Laboratory (HBEL) was added. It serves as a full-scale engineering development laboratory. It has an open area from floor to roof and three mezzanine levels that cover portions of the ground floor.

- Area #7 - In 1980, a Support Facilities Addition (craft shop) was constructed. It serves as the craft maintenance shop for the entire facility and contains two offices.

- Area #8 - In 1989, an office addition was constructed to house research and development staff. There are 24 offices, a conference room, and a women's restroom on the first floor, and 24 offices, a lunchroom, and a conference room on the second floor.

Two shielded underground vaults are equipped for temporary segregation and storage of radioactive liquid wastes and other solutions generated within the facility. One of the vaults is used for low- to intermediate-activity-level wastes, while the other is used for wastes and waste feed of high activity level. These vaults are located under the floors of the regulated shop and the cask handling areas, respectively. Each contains four stainless steel tanks with capacities ranging from 450 to 5000 gal. Each vault is accessible from above through one set of concrete cover blocks covering about 40 percent of the vault floor area. Beneath the concrete cover blocks are removable steel plate ventilation barriers with integral manhole covers.

The high-level vault is 21 by 13 by 14.5 ft deep below 6 ft of normal concrete shielding. The low-level vault is 28.5 by 13 by 18.5 ft deep below 2 ft of normal concrete shielding. The samplers for these tanks are located in a room 6 by 8 by 10 ft high in the northwest corner of Room 146, which is part of the EDL.

2.1.2 325 Building

The 325 Building, the Applied Chemistry Laboratory, was constructed in 1953 as a general purpose, nuclear research and development laboratory. The building provides specially shielded, ventilated, and equipped laboratories for radiochemical analyses and nuclear process development studies.

The 325 Building was built to the requirements of the Uniform Building Code (UBC) and Hanford Plant Standards (HPS). Later additions and modifications were built to the UBC and HPS applicable at those times. The 325 Building consists of 1) a central portion (completed in 1953) containing general purpose laboratories modified for low-level radiochemical work by provision of special ventilation and work enclosures; 2) a south (front) wing containing office space, locker rooms, a lunch room, and maintenance shops; and 3) east and west wings provided with shielded enclosures with remote manipulators for high-level radiochemical work. The exhaust fans and final stages of the high-efficiency particulate air (HEPA) filters are housed in a detached structure along the west side of the building at the north end (filter addition area). A storage area for potentially contaminated liquids is located in three vaults below ground level along the east side of the building near the north end of the east wing.

The central portion of the building consists of three floors (basement, ground, and second) and contains over 100 laboratories and offices. The south wing is made up of two floors and contains offices, a conference room, a machine shop, a lunch room, and rest rooms. The east wing (325A, High-Level Radiochemistry Facility), houses the shielded process research hot cells, truck lock, and manipulator repair, with a service area/truck lock addition. The west wing (325B, Shielded Analytical Laboratory) houses additional shielded process research hot cells.

The building frame is welded steel. The parapeted roof has a slightly sloped steel deck with gravel-finished built-up roofing. Exterior walls are industrial-insulated panels of fluted steel. The basement floor is painted concrete; the first and second floors are steel decks topped with concrete and finished with vinyl sheet or tile. Most original laboratory partitions are of a metal, movable type that is decontaminable in that the joints present minimum-sized cracks. All new construction, replacements, and modification of partitions are metal stud, dry-wall-type installations. Some second-floor and basement partitions are concrete or concrete block.

Standard laboratories are multiples of 3.0- by 3.7-m (10- by 12-ft) bays. Many of the laboratories have downdraft hoods and stainless steel gloveboxes. Gloveboxes and hoods exhaust through testable, self-contained, primary HEPA filters before exhausting through the general ventilation exhaust system. The general exhaust system to the stack consists of banks of final testable HEPA filters located in the exhaust fan/filter addition.

The east wing (325A) has three cells, shielded with high-density-concrete walls. An adjacent underground vault is divided into three compartments containing storage tanks, which range in capacity from 1,041 to 68,130 L (275 to 18,000 gal). Remote operation of the cell equipment is performed in the front face operating gallery; movement of materials takes place in the rear support gallery. The rear support gallery also provides access to the cells. The cells are ventilated by air drawn from the rear face gallery and exhausted into the basement through primary testable HEPA filters to the general ventilation exhaust, which contains the final stage of testable HEPA filters. The cells are constructed on the first-floor level. The basement level contains exhaust ducting, HEPA filters, and other miscellaneous services to the cells.

The west wing (325B) hot cell has six compartments, each enclosed in shield walls. Hollow sheet-metal partitions divide the compartments into three groups of two. The compartments are served by the front and rear face galleries. The cells are ventilated by air drawn in from the rear face and exhausted through two primary testable HEPA filter stages in series, then via the final testable HEPA filter stage of the general ventilation system to the exhaust stack. The compartments are constructed on the first-floor level. The basement level contains exhaust ducting, HEPA filters, and other miscellaneous services to the compartments.

Since the original 325 Building was constructed, an addition was added to house filters. The filter addition area, completed in April 1978, provides a final testable HEPA filtration stage for ventilation exhaust air. The filter addition area is located on the northwest side of the 325 Building and has four separate filter rooms, each containing filter frames for 39 HEPA filters.

2.2 RADIOACTIVE LIQUID WASTE SYSTEM

Several of the 300 Area facilities were designed for conducting research and development and analyses of highly radioactive materials and processes, as well as handling the radioactive liquid effluents generated by those activities. These facilities, which include the 324, 325, 326, 327, 329, 340, 340A, and 340B Buildings, are linked by an underground piping system known as the Radioactive Liquid Waste System (see Figure 2.1).

The 324, 325, 326, 327 and 329 Buildings, which are managed by PNL, generate liquid radioactive and hazardous wastes that are accumulated and transferred to the 340 Building (Waste Management Facility) and the 340A and 340B Buildings for disposal. Westinghouse Hanford Company (WHC) manages the 340, 340A, and 340B Buildings and the underground RLWS. The 307 and 309 Buildings are not owned or managed by PNL.

Radioactive liquid wastes generated by PNL activities are accumulated in containers or tanks, or are directly discharged to the RLWS. The only PNL facilities containing waste tanks are the 324 and 325 Buildings. In some cases, before the waste is discharged it is neutralized or filtered to render the waste acceptable for handling in the RLWS.

The discharged waste is collected in two tanks in the 340 Building, where additional neutralization may also occur. Six tanks in the 340A Building provide backup accumulation capacity. The accumulated waste is transferred to railroad tank cars within the 340B Building. Filled tank cars are subsequently transported across the Hanford Site and unloaded into the 204AR Building. The waste is transferred to and stored in double-shell tanks (DSTs), which are permitted for use as a storage facility.

Although the facilities supported by the RLWS were built primarily in the 1940s and 1950s, they employ design features required or encouraged under the state and Federal regulations pertaining to the Resource Conservation and Recovery Act (RCRA). These design features, which provide protection against releases of waste to the environment, include corrosion resistant stainless steel tanks and ancillary equipment, predominant use of welded pipe connections, tanks with only top-entering penetrations to avoid leaky side fittings, sealless (and leak-proof) jet pumps, secondary containment around all tanks and piping, and the use of highly reliable instruments to control the fill level of tanks and to detect leaks. Tanks supported by the RLWS are enclosed by thick concrete walls and cover blocks, and pipes are buried several feet deep to shield workers from radiation.

2.2.1 Waste Tank System Components Leading to the RLWS

This IAP applies only to the tanks, ancillary equipment, and secondary containment features contained within the 324 and 325 Buildings for which PNL is considered to have ownership and/or primary operating responsibility. The boundaries of the system are considered to be from the point at which the waste or waste feed enters the system ancillary equipment to the point where the RLWS lines exit the buildings. As per the definition in

WAC 173-303-040, "ancillary equipment" means any device including, but not limited to, piping, fittings, flanges, valves, and pumps, that is used to distribute, meter, or control the flow of dangerous waste from its point of generation to a storage or treatment tank(s), between storage or treatment tanks to a point of onsite disposal, or to a point of shipment for offsite disposal.

Several system features are specifically excluded from consideration in this IAP. These are Retention Process Sewer (RPS) diverter stations, the interbuilding transfer pipeline between the 324 and 325 Buildings, radioactive liquid shipping casks (bowling-ball casks), and associated transfer equipment. The RPS diverter stations consist of a counting instrument, an automatic-operated three-way valve, and associated alarms for diverting liquid flow from the Retention Process Sewer (RPS) to the RLWS if radioactivity above a preset level is detected in the waste. These stations and the interbuilding transfer lines are maintained and operated by WHC and therefore will not be considered part of the PNL system. Between the 324 and 325 Buildings is an interbuilding pipeline for transferring solutions in either direction. This line was originally installed for use in the Waste Vitrification Project, but the line has now been capped on the 324 Building end and disconnected at the 325 Building. There is no intent to use this pipeline in the future, so it will not be addressed in this IAP (PNL-1992, Section 4.2.7 and PNL-1991, Section 4.2.6). Radioactive liquid waste feed solutions can be shipped in bowling ball casks from either the 324 or 325 Buildings to the 340 Building or a waste receiving facility in the 200 Area. Radioactive liquid wastes are pumped into the bowling-ball casks using a vacuum system. The bowling-ball cask does not meet the definition of a "tank" given in WAC 173-303-040(88) (i.e., . . . a stationary device designed to contain an accumulation of dangerous waste . . .) and is not considered to be subject to the integrity assessment requirement.

2.2.2 324 Building RLWS Description

The RLWS within the 324 Building is composed of tanks and piping that discharges to the 340 Building; it excludes the diverter stations monitoring the RPS. Figure 2.2 shows the tank layout. Table 2.1 (provided at the end of Section 2.0) contains a description of the tanks associated with the 324 Building that will be addressed by this IAP. Transfer is accomplished by jetting the waste via the RLWS line, a double containment pipe with a leakage alarm. The 324 Building tanks serve the B-Cell, the load-out station (LOS), cubicle drains, the Room 18 diverter system pressure relief, tanks in the Low-Level Vault (LLV), the LLV sump, tanks in the High-Level Vault (HLV), the HLV sump, the Room 4 sump, the Room 147 glovebox and hood sink drain, Room 146 hood sink drains and safety shower drains, the truck lock sump, the personnel decontamination sink and shower drains, sink drains from Room 3F, and Tank TK-177, located in the wall of the fissile materials storage vault.

Building 324 tank connections are as follows:

- Tank TK-101 (LLV) can receive solution from Tanks TK-103, TK-108 (also located in the LLV), TK-115 (located in B-Cell), the LOS, cubicle drains, and the Room 18 diverter system pressure relief. Tank TK-101 contents can be transferred to Tank TK-102 or the LOS in addition to the 340 Building.

- Tank TK-102 (LLV) can receive solution from Tanks TK-101, TK-103, TK-108 (also located in the LLV), and TK-116 (located in B-Cell); the LLV sump; the Room 18 diverter system pressure relief; Room 4 sump; Room 147 glove box; Room 147 hood sink drain; Room 146 hood sink drains; Room 146 safety shower drains; the truck lock sump; and the personnel decontamination sink and shower drains. The contents of Tank TK-102 can be transferred to Tank TK-104 (in the HLV), the LOS, or to the 340 Building.

- Tank TK-103 (LLV) can receive solution from the LOS. The contents of Tank TK-103 can be transferred to Tanks TK-101 or TK-102.

- Tank TK-104 (HLV) can receive solution from the LOS, the HLV Sump, the Pipe Trench and Tanks TK-104 and TK-107. The contents of Tank TK-104 can be transferred to the LOS and Tank TK-105.

- Tank TK-105 (HLV) can receive solution from Tanks TK-104 and TK-106 and A & B Cells. The contents of Tank TK-105 can be transferred to Tank TK-104 and the LOS.

- Tank TK-106 (HLV) can receive solution from the LOS, Tank TK-107 and B & C Cells. The contents of Tank TK-106 can be transferred to the LOS and Tanks TK-105 and TK-107.

- Tank TK-107 (HLV) can receive solution from Tank TK-106. The contents of Tank TK-107 can be transferred to the LOS and Tanks TK-104 and TK-106.

- Tank TK-108 (LLV) can receive solution from the Pipe Trench and Tank Process Sewer. The contents of Tank TK-108 can be transferred to Tanks TK-101 and TK-102.

- Tank TK-177, located in the wall of the Fissionable Materials Storage Vault, receives solution from drains in the SMF cells and the Airlock. This tank can be pumped directly to the inter-building transfer piping system which then gravity drains to the 340 Building. Tank TK-177 is not within the scope of this plan.

- Room 3F has six sink drains that collect in a tank located in Room 3F. The contents of this tank can be pumped to the 340 Building. Presently, this tank and pump are locked and tagged out-of-service. Water service to the sinks is also shut off. The tank in this room will not be considered as part of this assessment.

2.2.3 324 Building RLWS Design

The 324 Building contains eight waste and waste feed storage tanks, identified as Tanks TK-101 through TK-108. All of the solutions in these tanks discharges, directly or indirectly, to the 340 Building. However, only Tanks TK-101, TK-102, and TK-177 are connected to the RLWS and capable of directly transferring liquid waste to the 340 Building facility. The other tanks, drains, and sumps are connected to Tanks TK-101, TK-102, and TK-177.

Tanks TK-101 through TK-106 and TK-108 were originally built in the 1940s and were subsequently modified in 1963. All of the circumferential shell and long seam welds were completely radiographed following modification. In addition the tanks were leak tested by filling with water after the modifications were completed. Tank TK-107 was built in 1963. It was hydrostatically tested to a pressure of 3 psig.

Tanks TK-101, TK-103, and TK-108 are 6.5 ft in diameter by 13.86 ft high and have a storage capacity of 3,380 gal. Each tank's shell, top, and bottom plate consists of 0.5-in.-thick 25-12 CB stainless steel plate with a 1/8-in.-thick 18-8 CB stainless steel jacket, to enable circumferential heating and cooling of the tanks. The tank rests on 18 pads placed in two concentric circles about the longitudinal axis of the tank and one in the center. The roof of the tank is flat and the floor is sloped. The tank operates at a very slight negative pressure.

Tank TK-102 is 8.0 ft in diameter by 13.86 ft high and has a storage capacity of 5,000 gal. The roof of the tank is flat and the floor is sloped. The tank operates at a very slight negative pressure.

Tank TK-104 is 9.0 ft in diameter by 8.90 ft high and has a storage capacity of 4,000 gal. The tank rests on 18 pads placed in two concentric circles about the longitudinal axis of the tank and one in the center. The roof of the tank is flat and the floor is sloped. The tank operates at a very slight negative pressure.

Tank TK-105 is 9.5 ft in diameter by 8.88 ft high and has a storage capacity of 5,000 gal. The roof of the tank is flat and the floor is sloped. The tank operates at a very slight negative pressure.

Tank TK-106 is 4.0 ft in diameter by 5.00 ft high and has a storage capacity of 450 gal. The tank's walls and bottom consist of 1/4-in.-thick stainless steel plate with a 3/16-in.-thick stainless steel plate jacket. The tank roof consists of 3/8-in.-thick stainless steel plate. The roof of the tank is flat and the floor is sloped. The tank operates at a very slight negative pressure.

Tank TK-107 is 5.5 ft in diameter by 6.0 ft high and has a storage capacity of 974 gal. The tank's walls, top, and bottom consist of 1/4-in.-thick type 304L stainless steel plate. The tank's jacket extends 3.5 ft above the base of the tank. The tank is supported by three legs. The roof of the tank is flat and the floor is sloped. The tank operates at a very slight negative pressure.

The 324 Building tanks are fitted with bubbler tubes for measuring or observing liquid level, specific gravity, and tank pressure (vacuum). Instrument readings are logged daily. Thermocouples are also used for measuring temperature. The tanks are also equipped with high liquid level and high temperature alarms. Use of steam jets and top entering instrumentation precludes the need for penetrations into the tank walls, thereby avoiding leaky fittings below the liquid level. Tanks are vented through a common vessel vent system that discharges air and vapors to the atmosphere via HEPA filters (Bovay 1992; Ebasco 1990).

Building piping is 1-1/2-in. and 2-in. diameter stainless steel with welded joints. The pipes are typically hung by harness and strap from the joist system of the floor above. The piping within the building is not encased except where it passes through a concrete structure (floor or wall). At these points it is encased in a 4-in.-diameter epoxy pipe. The piping is not shielded. Engineering drawings indicate that the stainless steel piping was furnished, installed, and tested in accordance with the applicable Hanford standards of the time (Bovay 1992).

The stainless steel piping drains to the tanks by gravity flow. The gravity piping was designed to be installed with a fall of 1/16 in. per 1 ft of run. This slope yields a capacity of 8 gal/min for the 1-1/2-in.-diameter pipe and 16 gal/min for the 2-in.-diameter pipe. The 2-in.-diameter stainless steel piping is used to steam jet from the tanks to the interbuilding piping connecting to the 340 Building. At the steam jet pressure of 80 lb/in.^{2}, the 2-in.-diameter pipe has an equivalent capacity of 730 gal/min (Bovay 1992).

All 324 Building piping was pneumatic tested at 3 lb/in.^{2} and 250 lb/in.^{2} (gravity and steam, respectively) without any pressure loss in 24 h at the time of installation. The steam jets are approximately 40 years old and have an expected remaining life of 10 years (Bovay 1992).

2.2.4 325 Building RLWS Description

The 325 Building RLWS is composed of pipes and holding tanks within the 325 Building and the 325A High-Level Radiochemistry Facility (HLRF) and 325B Building additions. Waste from the pipes or holding tanks is jetted or pumped to the 340 Building via the RLWS line (a double containment pipe provided with a sump alarm if leakage occurred from the primary pipe) or to a cask in the liquid transfer hood, which is then transported by truck to the 200 Area tanks. The waste in holding tanks is sampled at the 325 Building before it is transferred to the 340 Building. However, one portion of the RLWS that includes a hood and floor drain (now plugged) in the central portion of the 325 Building is not connected to a holding tank. Waste through this portion flows directly through RLWS lines that are routed to the 340 Building. Table 2.2 contains a description of the tanks associated with the 325 Building that will be addressed by this IAP. Figure 2.3 shows the tank layout.

The 325 Building RLWS consists of three component sections: central, east wing, and west wing. The radioactive liquid waste from these sections exits the 325 Building at two locations to join the RLWS outside the building. The waste is then routed to the 340 Building.

In the central portion of the 325 Building, the RLWS is connected to one hood in Room 528 and one plugged floor drain in Room 529. There are no holding tanks in this part of the system, so the waste flows through one of the two RLWS lines leaving the 325 Building and is routed to the 340 Building.

The radioactive liquid waste from the cells and two sinks in the 325B Building addition (west wing) drain into a 760-L (200-gal) holding tank in Room 32. The radioactive liquid waste can be jetted to the 325 Building radioactive liquid waste line, and from there it goes directly to the 340 Building. In addition, the tank level instrumentation provides an alarm and automatically diverts the wastes to the 340 Building if the waste level reaches the high level setpoint.

The RLWS in the east wing of the 325A Building addition consists of four components: 1) three underground, shielded vaults that contain seven tanks ranging in size from 1,040 L (275 gal) to 68,000 L (18,000 gal) that serve as holding/transfer vessels; 2) three tanks in Room 40A, including three 340-L (90 gal) slab tanks and one 400-L (105 gal) cylindrical tank. The slab tanks serve as waste tanks for the cells and the cylindrical tank is a process tank; 3) a diversion box, liquid transfer station, and liquid transfer hood that are used as the central control for transferring radioactive liquid waste between several locations in the 325A Building addition; and 4) piping systems that connect the components.

Sources of the radioactive liquid waste and routing of the waste are as follows:

- The A, B, and C cells drain to the Room 40A tanks, and the contents can then be transferred to several other locations in the 325A Building.

- Several sinks and floor drains in the 325A HLRF are connected to the second radioactive liquid waste line exiting the building, physically located in the 325A Building. Lab 601 has an access point through a drain line from an Inductive Coupled Plasma (ICP) apparatus. Lab 603 contains six points of access: two floor drains, a sink drain in a hood, a drain from a liquid transfer hood, and a drain connected to the ultrasonic cleaner. None of these access points in Lab 603 are plugged.

- Cooling water from process tanks, a glovebox, and the cells, goes to a diverter station in Room 50. This diverter station serves a function similar to the description for the RPS system and is currently out of service (disconnected). The cooling water lines to the vault tanks are locked out of service. The DOVs are locked in place to divert any flow from the vault tanks back to WT-1. Currently, the DOV between the RLWS and the 340 Building line has been removed and the lines have been capped.

- The central collection point for radioactive liquid waste in the 325A Building is Tank WT-1. The transfer of the radioactive liquid waste from Tank WT-1 is done either by jetting to the RLWS line exiting the 325A Building or by vacuum transfer to a cask in the liquid transfer hood. Shielded casks can be used to transport radioactive liquid waste to the 200 Area for disposal.

2.2.5 325 Building RLWS Design

The 325 Building contains twelve storage tanks. All the tanks have a vertical longitudinal axis except Tanks WT-1 and WT-4, which are positioned horizontally. Tanks PT-1 through PT-5 transfer their contents into Tank WT-1, which in turn is jet pumped to the 340 Building. Currently, only two of the tanks, WT-l and TK-1, are directly connected to the RLWS and discharge directly to the 340 Building. The jet pump from WT-1 remains out of service despite repeated attempts by 325A personnel to repair it. (Tank WT-4 is not currently being considered by PNL to be part of the RLWS. It can only be used for conveying liquid waste to the 324 Building and as previously stated this connection is not in service.) The tanks were originally built in 1944 and modified in 1961. The shells for Tanks PT-1 through PT-5 were leak tested by filling with water at atmospheric pressure after all the modifications were completed in 1961. The tank modifications focus on making the old tank connections and transfer mechanisms compatible with the RLWS. The modifications are mostly updates of connections, instrumentation, and dip tubes. In addition the jackets were hydrostatically tested to a pressure of 20 psi for 1 h. Tank WT-1 was hydrostatically tested at a pressure 60 psi for 1 h (Ebasco 1990).

Tanks PT-1 and PT-2 are 9.00 ft in diameter by 8.72 ft high and have a storage capacity of 3,900 gal each. The tanks' walls, top, and bottom consist of 3/8-in.-thick stainless steel plate with a 3/16-in.-thick stainless steel jacket extending 7.00 ft up the side of the tank. The tank is supported by 12 legs located around the perimeter of the shell. The roof of the tank is flat and the floor is sloped. The tank operates at a very slight negative pressure.

Tanks PT-3 and PT-5 are 3.50 ft in diameter by 4.00 ft high and have a storage capacity of 270 gal. The tanks' walls consist of 3/16-in.-thick stainless steel plate. The top and bottom consist of 1/4-in.-thick stainless steel plate with a 1/8-in. thick stainless steel jacket extending 2.83 ft up the side of the tank. The roofs of the tanks are flat and the floor is sloped. Each tank is supported by four legs. The tank operates at a very slight negative pressure.

Tank PT-4 is 3.50 ft in diameter by 6.00 ft high and has a storage capacity of 404 gal. The tanks' walls, top, and bottom consist of 3/16-in.-thick stainless steel plate with a 3/16-in.-thick stainless steel jacket extending 5.00 ft up the side of the tank. The tank is supported by four legs. The roof of the tank is flat and the floor is sloped. The tank operates at a very slight negative pressure.

Although no drawings for Tank WT-1 were available, drawings for a reportedly similar tank were reviewed. The tank is 9.00 ft in diameter by 39.23 ft long and has a storage capacity of 17,500 gal. The tank's walls and head consist of 9/16-in.-thick ASTM A70 carbon steel plate (Specification ASTM A70 has been discontinued and replaced by ASTM A285). The tank operates at a very slight negative pressure.

The retention tank in the 325B Building (sometimes designated Tank TK-1) has a storage capacity of 200 gal. The tank collects radioactive liquid from the hot cells in the building.

Tank W-4 is a horizontal steel tank located in Vault A. The contents of Tank W-4 can be emptied by vacuum transfer through the pipeline to the 324 Building; however, the vacuum transfer system is no longer operational (Ebasco 1990).

Tank W-5 is located in Room 40-A and has a 400-gal capacity. This tank is connected to the 324 Building via a double-encased line. The tank was used for dissolver solution from the 324 Building.

Slab Tanks W-1, W-2, and W-3 are for the in-cell floor drains in A, B, and C, respectively. Slab tanks W-1 and W-3 are connected.

The tanks located in the 325 Building are fitted with bubbler tubes for measuring or observing liquid level, specific gravity, and tank pressure (vacuum). Instrument readings are logged daily. Thermocouples are also used for measuring temperature. The tanks are also equipped with high liquid level and high temperature alarms. Use of steam jets and top entering instrumentation precludes the need for penetrations into the tank walls, thereby avoiding leaky fittings below the liquid level. The tanks are vented through a common vessel vent system that discharges air and vapors to the atmosphere via HEPA filters (Ebasco 1990).

The 325 Building piping is 1-1/2-in. and 2-in. diameter stainless steel with welded joints. The pipes are typically hung by harness and strap from the joist system of the floor above. The piping within the building is not encased except where it passes through a concrete structure (floor or wall); at these points it is encased within a 4-in. diameter epoxy pipe. The piping is not shielded. Review of the 325 Building drawings indicates that the stainless steel piping was furnished, installed, and tested in accordance with the applicable Hanford standards in use at the time (Bovay 1992).

The 325 Building stainless steel piping drains to the tanks by gravity flow. The gravity piping was designed to be installed at a rate of fall of 1/4 in. per 1 ft of run. This slope and size of piping yields a capacity of 8 gal/min and 16 gal/min for the 1-1/2 in. and 2 in. diameter, respectively (Bovay 1992).

The stainless steel piping within the 325 Building that carries waste to the two building discharge points is steam jetted at 80 lb/in.^{2} with this pressure the 2-in.-diameter pipe has an equivalent capacity of 730 gal/min. All piping was pneumatic tested at 3 lb/ft^2 and 250 lb/ft^2 for the gravity and steam, respectively without any pressure loss in 24 h at the time of installation (Bovay 1992).

The function of the sumps and pumps in the 325A HLRF tank vaults is to collect and transfer liquid waste or waste feed materials to other tanks in the RLWS. These sumps are equipped with liquid sensing alarms and pumps. The sumps and floor drains drain directly to Tank WT-1. The drain from personnel decontamination also discharges to Tank WT-1.

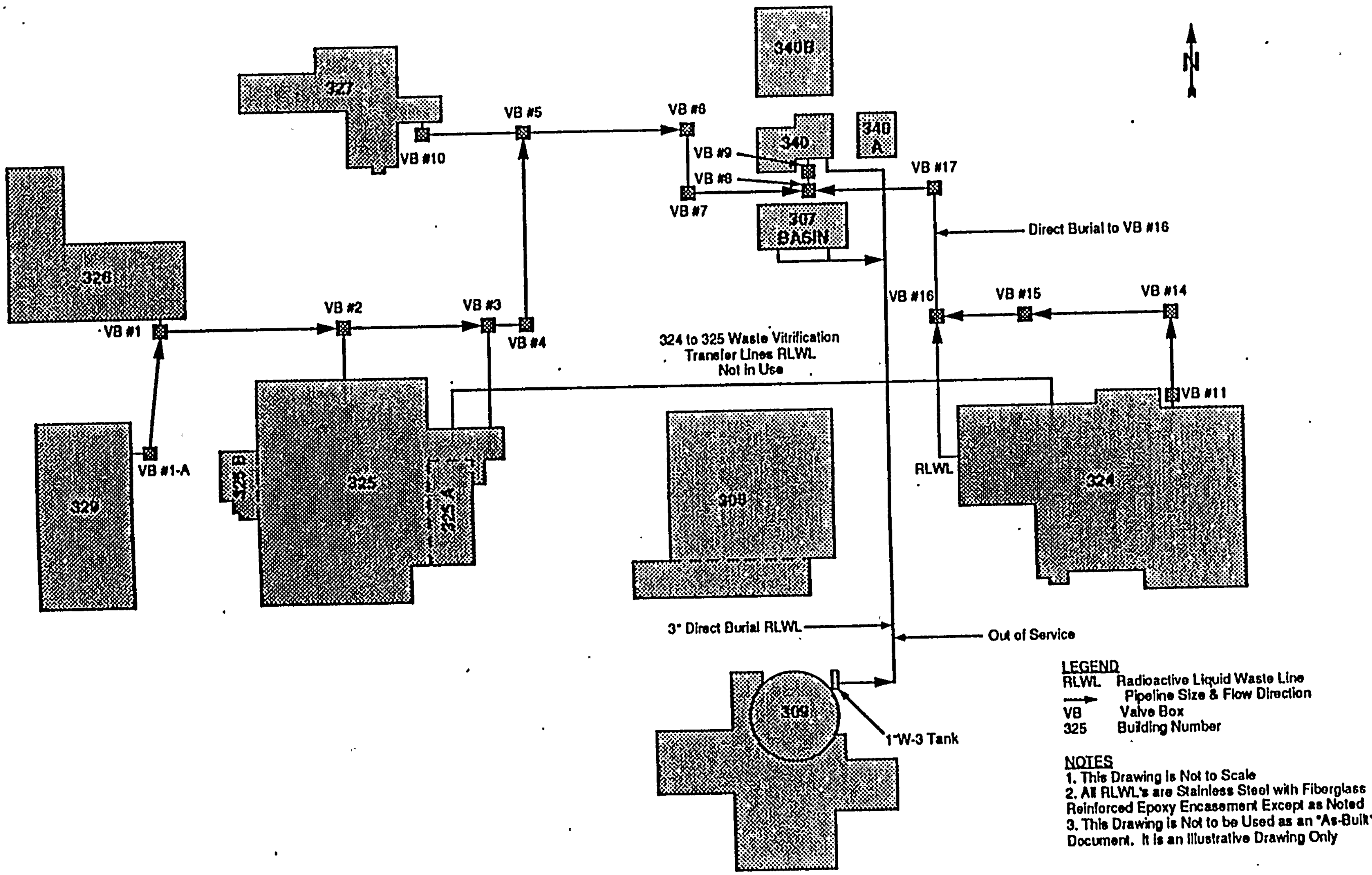

FIGURE 2.1. 300 Area Radioactive Liquid Waste System Schematic

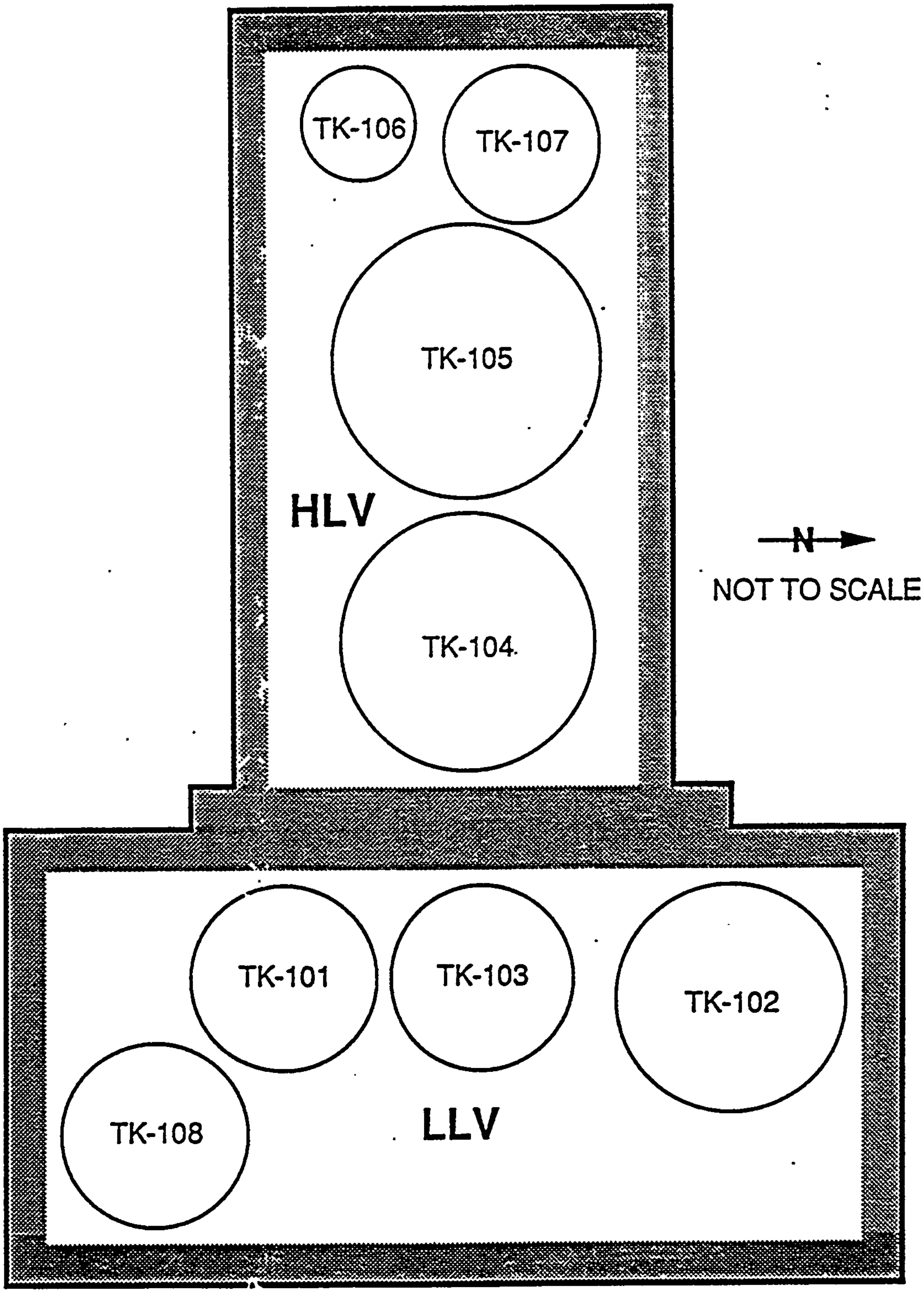

FIGURE 2.2. Tanks in the 324 Building

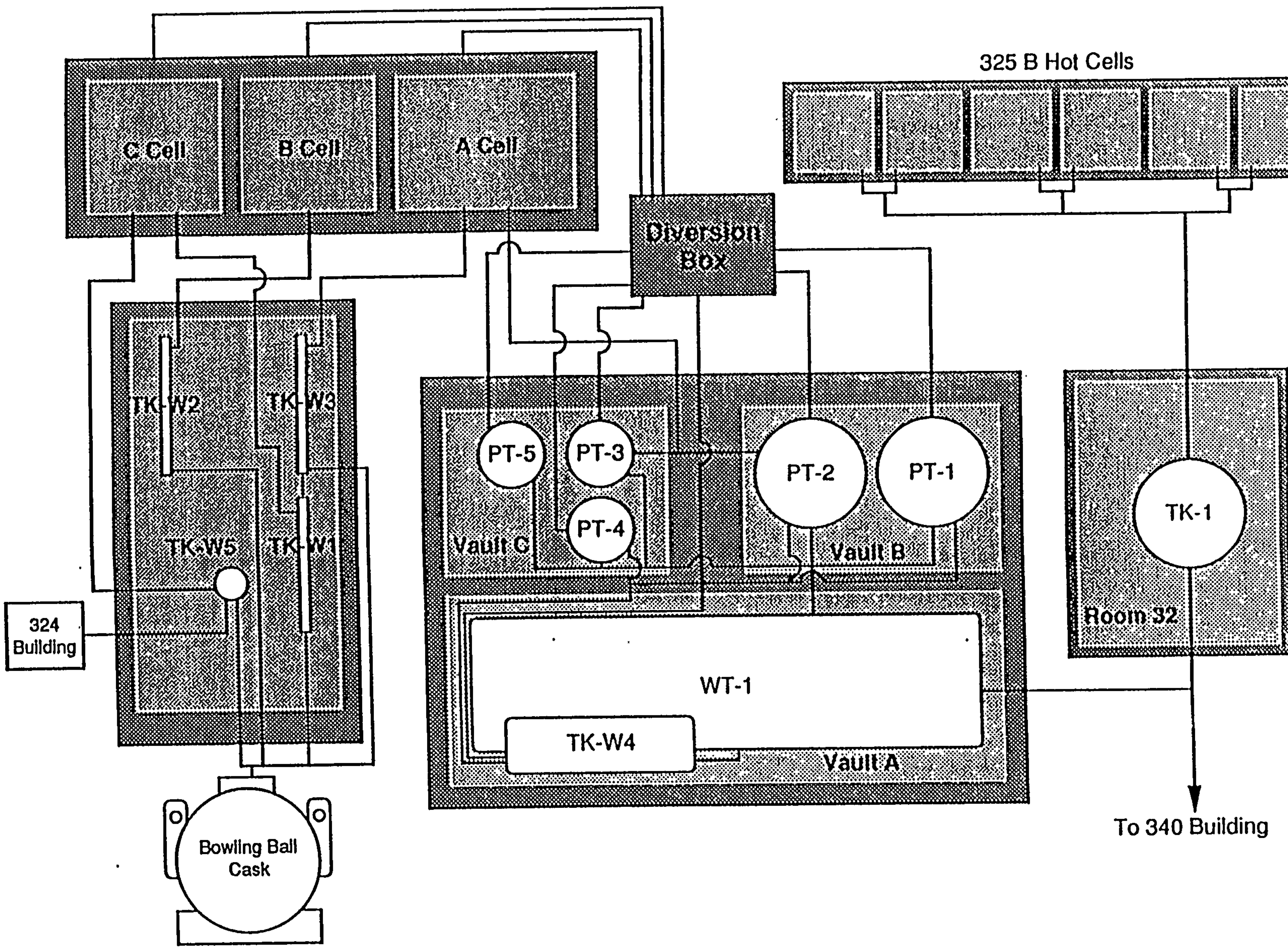

FIGURE 2.3. 325 Building Schematic Diagram

TABLE 2.1. 324 Building Tank Information

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
TK-101	324 Building Low Level Vault (LLV)	• The tank is 6.5 ft in diameter by 13.86 ft high and has a storage capacity of 3,380 gal.[1] • The tank shell, top, and bottom plate consists of 0.5-in.-thick 25-12 Cb stainless steel plate with a 1/8-in.-thick 18-8 Cb stainless steel jacket.[1] • The tank rests on 18 pads placed in two concentric circles about the longitudinal axis of the tank and one in the center.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank operates at a slight negative pressure.[1] • Any new replacement parts or materials used will be constructed of 304L stainless steel.[6] • Can receive solutions from Tanks TK-103, TK-108 (also located in LLV), and TK-116 (located in B-cell), the LOS, cubicle drains, and the Room 18 diverter system pressure relief.[4] • In addition to the 340 Building, Tank TK-101 contents can also be transferred to Tank TK-102 or the LOS.[4]	<u>Material Used</u> Dupont Spec. 820-R1 Grade 820B, 25-12 Cb sst Dupont Spec. 820-R1 Grade 820A, 18-8 Cb sst <u>Welds</u> ASME Code PAR U-69 <u>Heat Treating</u> Dupont Spec. 819-R1 Modifications made during move to 324 Building: <u>New Material</u> AISI Type 304L sst corrosion passed <u>Welding</u> Hanford Standard Spec HWS-4924-S <u>Radiograph</u> HWS-8227	HD-62068 H-3-20415

[1] Ebasco 1990, Pages G-1 - G-2, Section 1.1.1.
[2] PNL 1991b, Page 9, Section 4.1.2.
[3] PNL 1992, Page 4.17, Section 4.1.6.1.
[4] PNL 1992, Page 4.43, Section 4.2.6.1.
[5] PNL 1992, Page 4.54, Section 4.4.1.
[6] WHC blueprint # H030020415, # 101 Waste Tank.
[7] WHC blueprint # H030020416, # 102 Waste Tank.
[8] WHC blueprint # H030020417, # 103 Waste Tank.
[9] WHC blueprint # H030020418, # 104 Waste Tank.
[10] WHC blueprint # H030020419, # 105 Waste Tank.
[11] WHC blueprint # H030020420, # 106 Waste Tank.
[12] WHC blueprint # H030021015, # 107 Waste Tank.
[13] WHC blueprint # H030020421, # 108 Waste Tank.
[14] WHC blueprint # H030020440, # 177 Waste Tank.

TABLE 2.1. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
TK-102	324 Building Low Level Vault	• The waste storage tank is 8.0 ft in diameter by 13.86 ft high and has a storage capacity of 5,000 gal.[1] • The roof is flat and the floor is sloped.[1] • The tank operates at a slight negative pressure.[1] • The jacket is 18-8 Cb stainless steel and the tank is 25-12 Cb stainless steel.[7] • Can receive solution from Tanks TK-101, TK-103, TK-108 and TK-116 (located in B-cell), the LLV sump; Room 146 hood sink drains; Room 146 safety shower drains; the truck lock sump; and the personnel decontamination sink and shower drains.[4] • The contents of Tank TK-102 can be transferred to the LOS or to the 340 Building.[4] • Tank TK-102 can also be transferred to Tank TK-104.[7]	Material Used Dupont Spec. 820-R1 grade 820B, 25-12 Cb sst Dupont Spec. 820-R1 grade 820A, 18-8 Cb sst Welds ASME Code PAR U-69 Heat Treating Dupont Spec. 819-R1 Modifications made during move to 324 Building: New Material AISI Type 304L sst corrosion passed Welding Hanford Standard Spec HWS-4924-S	HD-62070 H-3-20416

1 Ebasco 1990, Pages G-1 - G-2, Section 1.1.1.
2 PNL 1991b, Page 9, Section 4.1.2.
3 PNL 1992, Page 4.17, Section 4.1.6.1.
4 PNL 1992, Page 4.43, Section 4.2.6.1.
5 PNL 1992, Page 4.54, Section 4.4.1.
6 WHC blueprint # H030020415, # 101 Waste Tank.
7 WHC blueprint # H030020416, # 102 Waste Tank.
8 WHC blueprint # H030020417, # 103 Waste Tank.
9 WHC blueprint # H030020418, # 104 Waste Tank.
10 WHC blueprint # H030020419, # 105 Waste Tank.
11 WHC blueprint # H030020420, # 106 Waste Tank.
12 WHC blueprint # H030021015, # 107 Waste Tank.
13 WHC blueprint # H030020421, # 108 Waste Tank.
14 WHC blueprint # H030020440, # 177 Waste Tank.

TABLE 2.1. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
TK-103	324 Building Low Level Vault	• The tank is 6.5 ft in diameter by 13.86 ft high and has a storage capacity of 3,380 gal.[1] • The tank shell, top, and bottom plate consists of 0.5-in.-thick 25-12 Cb stainless steel plate with a 1/8-in.-thick 18-8 Cb stainless steel jacket.[1] • The tank rests on 18 pads placed in two concentric circles about the longitudinal axis of the tank and one in the center.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank operates at a slight negative pressure.[1] • The contents can be transferred to Tanks TK-101 and TK-102.[4]	Material Used Dupont Spec. 820-R1 Grade 820B, 25-12 Cb sst Dupont Spec. 820-R1 Grade 820A, 18-8 Cb sst Welds ASME Code PAR U-69 Heat Treating Dupont Spec. 819-R1 Modifications made during move to 324 Building: New Material AISI Type 304L sst corrosion passed Welding Hanford Standard Spec HWS-4924-S	HD-62068 H-3-20417

1 Ebasco 1990, Pages G-1 - G-2, Section 1.1.1.
2 PNL 1991b, Page 9, Section 4.1.2.
3 PNL 1992, Page 4.17, Section 4.1.6.1.
4 PNL 1992, Page 4.43, Section 4.2.6.1.
5 PNL 1992, Page 4.54, Section 4.4.1.
6 WHC blueprint # H030020415, # 101 Waste Tank.
7 WHC blueprint # H030020416, # 102 Waste Tank.
8 WHC blueprint # H030020417, # 103 Waste Tank.
9 WHC blueprint # H030020418, # 104 Waste Tank.
10 WHC blueprint # H030020419, # 105 Waste Tank.
11 WHC blueprint # H030020420, # 106 Waste Tank.
12 WHC blueprint # H030021015, # 107 Waste Tank.
13 WHC blueprint # H030020421, # 108 Waste Tank.
14 WHC blueprint # H030020440, # 177 Waste Tank.

TABLE 2.1. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
TK-104	324 Building High Level Vault (HLV)	• The waste storage tank is 9.0 ft in diameter by 8.90 ft high and has a storage capacity of 4,000 gal.[1] • The tank rests on 18 pads placed in two concentric circles about the longitudinal axis of the tank and one in the center.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank operates at a very slight negative pressure.[1] • The tank and jacket are constructed of 304L stainless steel.[9] • The tank can receive waste from Tanks TK-107, TK-102, and TK-105.[9] • The contents of Tank TK-104 can be transferred to Tank TK-105.[9]	Material Used HW-5301, Type 304L sst HW-5302, Type 347 sst Welds HW-4924-S Fabrication & Materials HW-4987 Finishing HW-3791 Modifications made during move to 324 Building: New Material AISI Type 304L sst corrosion passed Welding Hanford Standard Spec HWS-4924-S Radiograph HWS-8227	H-2-2655 H-3-20418

1 Ebasco 1990, Pages G-1 - G-2, Section 1.1.1.
2 PNL 1991b, Page 9, Section 4.1.2.
3 PNL 1992, Page 4.17, Section 4.1.6.1.
4 PNL 1992, Page 4.43, Section 4.2.6.1.
5 PNL 1992, Page 4.54, Section 4.4.1.
6 WHC blueprint # H030020415, # 101 Waste Tank.
7 WHC blueprint # H030020416, # 102 Waste Tank.
8 WHC blueprint # H030020417, # 103 Waste Tank.
9 WHC blueprint # H030020418, # 104 Waste Tank.
10 WHC blueprint # H030020419, # 105 Waste Tank.
11 WHC blueprint # H030020420, # 106 Waste Tank.
12 WHC blueprint # H030021015, # 107 Waste Tank.
13 WHC blueprint # H030020421, # 108 Waste Tank.
14 WHC blueprint # H030020440, # 177 Waste Tank.

TABLE 2.1. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
TK-105	324 Building High Level Vault	• The waste storage tank is 9.5 ft in diameter by 8.88 ft high and has a storage capacity of 5,000 gal.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank operates at a very slight negative pressure.[1] • The jacket is constructed of 18-8 Cb stainless steel and the tank is 25-12 Cb stainless steel.[10] • Tank TK-105 can receive waste from Tanks TK-104 and TK-106.[10] • Tank TK-105 can transfer its contents to Tank TK-104.[10]	Material Used Dupont Spec. 820-R1 Grade 820B, 25-12 Cb sst Dupont Spec. 820-R1 Grade 820A, 18-8 Cb sst Welds ASME Code PAR U-69 Heat Treating Dupont Spec. 819-R1 Modifications made during move to 324 Building: New Material AISI Type 304L sst corrosion passed Welding Hanford Standard Spec HWS-4924-S Radiograph HWS-8227	HD-62069 H-3-20419

1 Ebasco 1990, Pages G-1 - G-2, Section 1.1.1.
2 PNL 1991b, Page 9, Section 4.1.2.
3 PNL 1992, Page 4.17, Section 4.1.6.1.
4 PNL 1992, Page 4.43, Section 4.2.6.1.
5 PNL 1992, Page 4.54, Section 4.4.1.
6 WHC blueprint # H030020415, # 101 Waste Tank.
7 WHC blueprint # H030020416, # 102 Waste Tank.
8 WHC blueprint # H030020417, # 103 Waste Tank.
9 WHC blueprint # H030020418, # 104 Waste Tank.
10 WHC blueprint # H030020419, # 105 Waste Tank.
11 WHC blueprint # H030020420, # 106 Waste Tank.
12 WHC blueprint # H030021015, # 107 Waste Tank.
13 WHC blueprint # H030020421, # 108 Waste Tank.
14 WHC blueprint # H030020440, # 177 Waste Tank.

TABLE 2.1. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
TK-106	324 Building High Level Vault	• The waste storage tank is 4.0 ft in diameter by 5.00 ft high and has a storage capacity of 450 gal.[1] • The tank's walls and bottom consist of 1/4-in.-thick stainless steel plate with a 3/16-in.-thick stainless steel plate jacket.[1] • The tank roof consists of 3/8-in.-thick stainless steel plate.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank operates at a very slight negative pressure.[1] • The jacket is 18-8 Cb stainless steel and the tank is 25-12 Cb stainless steel.[11] • Tank TK-106 can receive waste from Tank TK-107.[11] • The contents of this tank can be transferred to Tanks 105 and 107.[11]	Material Used HW-3075-SS-1 grade 820B, 25-12 Cb sst HW-3075-SS-1 grade 347, 18-8 Cb sst Welds ASME Code PAR U-69 Heat Treating HW-3075-SS-1 Modifications made during move to 324 Building: New Material AISI Type 304L sst corrosion passed Welding Hanford Standard Spec HWS-4924-S	HD-62494 H-3-20420

1 Ebasco 1990, Pages G-1 - G-2, Section 1.1.1.
2 PNL 1991b, Page 9, Section 4.1.2.
3 PNL 1992, Page 4.17, Section 4.1.6.1.
4 PNL 1992, Page 4.43, Section 4.2.6.1.
5 PNL 1992, Page 4.54, Section 4.4.1.
6 WHC blueprint # H030020415, # 101 Waste Tank.
7 WHC blueprint # H030020416, # 102 Waste Tank.
8 WHC blueprint # H030020417, # 103 Waste Tank.
9 WHC blueprint # H030020418, # 104 Waste Tank.
10 WHC blueprint # H030020419, # 105 Waste Tank.
11 WHC blueprint # H030020420, # 106 Waste Tank.
12 WHC blueprint # H030021015, # 107 Waste Tank.
13 WHC blueprint # H030020421, # 108 Waste Tank.
14 WHC blueprint # H030020440, # 177 Waste Tank.

TABLE 2.1. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
TK-107	324 Building High Level Vault	• The waste storage tank is 5.5 ft in diameter by 6.0 ft high and has a storage capacity of 974 gal.[1] • The tank's walls, top, and bottom consist of 1/4-in.-thick type 304L stainless steel plate.[1] • The tank's jacket extends 3.5 ft above the base of the tank.[1] • The tank is supported by three legs.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank operates at a slight negative pressure.[1] • Tank TK-107 can receive waste from Tank TK-106.[12] • Tank TK-107 can transfer to Tanks TK-104 and TK-106.[12]	Material Used HWS-8061-S, 304L sst HWS-8064-S, 304L sst HWS-8067-S, 308L sst Welding HW-4924-S HWS-8240 Pipe & Fittings HWS-8064-S HWS-8066-S Radiograph HWS-8227	H-3-21012

1 Ebasco 1990, Pages G-1 - G-2, Section 1.1.1.
2 PNL 1991b, Page 9, Section 4.1.2.
3 PNL 1992, Page 4.17, Section 4.1.6.1.
4 PNL 1992, Page 4.43, Section 4.2.6.1.
5 PNL 1992, Page 4.54, Section 4.4.1.
6 WHC blueprint # H030020415, # 101 Waste Tank.
7 WHC blueprint # H030020416, # 102 Waste Tank.
8 WHC blueprint # H030020417, # 103 Waste Tank.
9 WHC blueprint # H030020418, # 104 Waste Tank.
10 WHC blueprint # H030020419, # 105 Waste Tank.
11 WHC blueprint # H030020420, # 106 Waste Tank.
12 WHC blueprint # H030021015, # 107 Waste Tank.
13 WHC blueprint # H030020421, # 108 Waste Tank.
14 WHC blueprint # H030020440, # 177 Waste Tank.

TABLE 2.1. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
TK-108	324 Building Low Level Vault	• The tank is 6.5 ft in diameter by 13.86 ft high and has a storage capacity of 3,380 gal.[1] • The tank shell, top, and bottom plate consists of 0.5-in.-thick 25-12 Cb stainless steel plate with a 1/8-in.-thick 18-8 Cb stainless steel jacket.[1] • The tank rests on 18 pads placed in two concentric circles about the longitudinal axis of the tank and one in the center.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank operates at a slight negative pressure.[1] • The contents can be transferred to Tanks TK-101 and TK-102.[4]	Material Used Dupont Spec. 820-R1 Grade 820B, 25-12 Cb sst Dupont Spec. 820-R1 Grade 820A, 18-8 Cb sst Welds ASME Code PAR U-69 Heat Treating Dupont Spec. 819-R1 Modifications made during move to 324 Building: New Material AISI Type 304L sst corrosion passed Welding Hanford Standard Spec HWS-4924-S Radiograph HWS-8227	D-62068 H-3-20421

1 Ebasco 1990, Pages G-1 - G-2, Section 1.1.1.
2 PNL 1991b, Page 9, Section 4.1.2.
3 PNL 1992, Page 4.17, Section 4.1.6.1.
4 PNL 1992, Page 4.43, Section 4.2.6.1.
5 PNL 1992, Page 4.54, Section 4.4.1.
6 WHC blueprint # H030020415, # 101 Waste Tank.
7 WHC blueprint # H030020416, # 102 Waste Tank.
8 WHC blueprint # H030020417, # 103 Waste Tank.
9 WHC blueprint # H030020418, # 104 Waste Tank.
10 WHC blueprint # H030020419, # 105 Waste Tank.
11 WHC blueprint # H030020420, # 106 Waste Tank.
12 WHC blueprint # H030021015, # 107 Waste Tank.
13 WHC blueprint # H030020421, # 108 Waste Tank.
14 WHC blueprint # H030020440, # 177 Waste Tank.

TABLE 2.2. 325 Building Tank Information

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
W-1	325 Building Room 40A	• Slab tank for the floor drain in A Gallery Hot Cell A. • The walls, roof and floor of the slab tanks are 9.5 mm (3/8 in.) thick 304L stainless steel. The tanks are 2.5 m by 0.9 m by 2 m (8.17 ft by 3 in. by 6.5 ft) with a capacity of approximately 94 gal. The slab tanks have a stainless steel containment pan and a leak detection system.[6] • The three slab tanks (W-1, W-2, and W-3 in the north end of Room 40A) beneath the 325A Building addition hot cells are designed to store waste drained from the hot cells. • These tanks are critically safe for any combination of fissionable material in powder solution form that drains into them.[4]	Materials Used ASTM A-193 GR B8 ASTM A-194 GR 8 ASTM A-213 304L ASTM A-240 304L ASTM A-276 304L ASTM A-312 TP 304L ASTM A-479 304L Fabrication ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Welding Fabrication requirements ASME Section II ASME Section V ASME Section VIII ASME Section IX WPS-230-W WPS-235-W STAW (processes) Countersink butt weld connectors ASME Section VIII, Division I Material, cleaning and testing Construction specification A06440-C2	H-3-43311

1 Ebasco 1990, Pages G-2 - G-3, Section 1.1.2.
2 PNL 1991c, Page 4.9, Section 4.1.2.2.
3 PNL 1991c, Page 4.20, Section 4.2.5.1.
4 PNL 1991c, Page 4.45, Section 4.6.3.7.
5 Blueprint # H-3-43197, Vessel Assembly TK
6 Blueprint # H-3-43312, Vessel Assembly TK-W5
7 Blueprint # H-3-43311, Vessel Assembly Tanks TK-W1 TK-W2 & TK-W3.
8 Blueprint # H-3-9321, Mechanical Process Tanks Modifications Cerium Recovery Facility.

TABLE 2.2. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
W-2	325 Building Room 40A	• Slab tank for the floor drain is A Gallery Hot Cell B. • The walls, roof and floor of the slab tanks are 9.5 mm (3/8 in.) thick 304L stainless steel. The tanks are 2.5 m by 0.9 m by 2 m (8.17 ft by 3 in. by 6.5 ft) with a capacity of approximately 94 gal. The slab tanks have a stainless steel containment pan and a leak detection system.[6] • The three slab tanks (W-1, W-2, and W-3 in the north end of Room 40A) beneath the 325A Building addition hot cells are designed to store waste drained from the hot cells. • These tanks are critically safe for any combination of fissionable material in powder solution form that drains into them.[4]	Materials Used ASTM A-193 GR B8 ASTM A-194 GR 8 ASTM A-213 304L ASTM A-240 304L ASTM A-276 304L ASTM A-312 TP 304L ASTM A-479 304L Fabrication ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Welding Fabrication requirements ASME Section II ASME Section V ASME Section VIII ASME Section IX WPS-230-W WPS-235-W STAW (processes) Countersink butt weld connectors ASME Section VIII, Division I Material, cleaning and testing Construction specification A06440-C2	H-3-43311

[1] Ebasco 1990, Pages G-2 - G-3, Section 1.1.2.
[2] PNL 1991c, Page 4.9, Section 4.1.2.2.
[3] PNL 1991c, Page 4.20, Section 4.2.5.1.
[4] PNL 1991c, Page 4.45, Section 4.6.3.7.
[5] Blueprint # H-3-43197, Vessel Assembly TK
[6] Blueprint # H-3-43312, Vessel Assembly TK-W5
[7] Blueprint # H-3-43311, Vessel Assembly Tanks TK-W1 TK-W2 & TK-W3.
[8] Blueprint # H-3-9321, Mechanical Process Tanks Modifications Cerium Recovery Facility.

TABLE 2.2. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
W-3	325 Building Room 40A	• Slab tank for the floor drain in A Gallery Hot Cell C. • The walls, roof and floor of the slab tanks are 9.5 mm (3/8 in.) thick 304L stainless steel. The tanks are 2.5 m by 0.9 m by 2 m (8.17 ft by 3 in. by 6.5 ft) with a capacity of approximately 94 gal. The slab tanks have a stainless steel containment pan and a leak detection system.[6] • The three slab tanks (W-1, W-2, and W-3 in the north end of room 40A) beneath the 325A hot cells are designed to store waste drained from the hot cells. • These tanks are critically safe for any combination of fissionable material in powder solution form that drains into them.[4]	<u>Materials Used</u> ASTM A-193 GR B8 ASTM A-194 GR 8 ASTM A-213 304L ASTM A-240 304L ASTM A-276 304L ASTM A-312 TP 304L ASTM A-479 304L <u>Fabrication</u> ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. <u>Welding Fabrication requirements</u> ASME Section II ASME Section V ASME Section VIII ASME Section IX WPS-230-W WPS-235-W STAW (processes) <u>Countersink butt weld connectors</u> ASME Section VIII, Division I <u>Material, cleaning and testing</u> Construction specification A06440-C2	H-3-43311

[1] Ebasco 1990, Pages G-2 - G-3, Section 1.1.2.
[2] PNL 1991c, Page 4.9, Section 4.1.2.2.
[3] PNL 1991c, Page 4.20, Section 4.2.5.1.
[4] PNL 1991c, Page 4.45, Section 4.6.3.7.
[5] Blueprint # H-3-43197, Vessel Assembly TK
[6] Blueprint # H-3-43312, Vessel Assembly TK-W5
[7] Blueprint # H-3-43311, Vessel Assembly Tanks TK-W1 TK-W2 & TK-W3.
[8] Blueprint # H-3-9321, Mechanical Process Tanks Modifications Cerium Recovery Facility.

TABLE 2.2. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
W-4	325 Building Vault A	• Tank W-4 is a horizontal steel tank located in Vault A.[1] • A-vault contains one 68,000-L (18,000-gal) (WT-1) storage tank and one 1,514-L (400-gal) transfer tank.[2] • The tank is 1 m long with a 0.8 m diameter (3 ft by 2.6 ft).[5] • Tank W-4 is 304L[7] stainless steel. • Contents of Tank W-4 can be emptied by vacuum transfer through the pipeline to the 324 Building; however, the vacuum transfer system is no longer operational.[1]	Materials Used ASTM A-182 F 304L ASTM A-240 304L ASTM A-276 304L ASTM A-312 TP 304L ASTM A-403 WP 304L Fabrication ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Welding Fabrication requirements ASME Section II ASME Section V ASME Section VIII ASME Section IX WPS-235-W WPS-230-W STAW (processes) Material, cleaning and testing Construction specification A06440-C1	H-3-43197

[1] Ebasco 1990, Pages G-2 - G-3, Section 1.1.2.
[2] PNL 1991c, Page 4.9, Section 4.1.2.2.
[3] PNL 1991c, Page 4.20, Section 4.2.5.1.
[4] PNL 1991c, Page 4.45, Section 4.6.3.7.
[5] Blueprint # H-3-43197, Vessel Assembly TK
[6] Blueprint # H-3-43312, Vessel Assembly TK-W5
[7] Blueprint # H-3-43311, Vessel Assembly Tanks TK-W1 TK-W2 & TK-W3.
[8] Blueprint # H-3-9321, Mechanical Process Tanks Modifications Cerium Recovery Facility.

TABLE 2.2. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
W-5	325 Building Room 40A	• Tank W-5 is a vertical tank with a capacity of 100 gal. It is approximately 2.7 m by 0.5 m (8.75 ft by 1.5 ft).[7] • Tank W-5 is 304L stainless steel[6].	Materials Used ASTM A-194 GR 8 316 sst ASTM A-193 GR B8 304L ASTM A-240 304L ASTM A-276 304L ASTM A-312 TP 304L ASTM A-403 WP 304L ASTM A 479 304L. Fabrication ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Welding Fabrication requirements ASME Section II ASME Section V ASME Section VIII ASME Section IX WPS-235-W WPS-230-W STAW (processes) Material, cleaning and testing Construction specification A06440-C2	H-3-43312

[1] Ebasco 1990, Pages G-2 - G-3, Section 1.1.2.
[2] PNL 1991c, Page 4.9, Section 4.1.2.2.
[3] PNL 1991c, Page 4.20, Section 4.2.5.1.
[4] PNL 1991c, Page 4.45, Section 4.6.3.7.
[5] Blueprint # H-3-43197, Vessel Assembly TK
[6] Blueprint # H-3-43312, Vessel Assembly TK-W5
[7] Blueprint # H-3-43311, Vessel Assembly Tanks TK-W1 TK-W2 & TK-W3.
[8] Blueprint # H-3-9321, Mechanical Process Tanks Modifications Cerium Recovery Facility.

TABLE 2.2. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
WT-1	325 Building Vault A	• Tank WT-1 is positioned horizontally.[1] • Although no drawings for Tank WT-1 were available at the time of this plan was written, drawings for a reportedly similar tank were reviewed.[1] • The tank is 9.00 ft in diameter by 39.23 ft long and has a storage capacity of 17,500 gal.[1] • The tank's walls and head may consist of 9/16-in.-thick ASTM A70 carbon steel (Specification ASTM A70 has been discontinued and replace by ASTM A285).[1] (Materials of construction will be verified during the integrity assessment.) • The tank operates at a very slight negative pressure.[1] • Tank WT-1 can transfer its contents directly the 340 Building facility. • The central collection point for radioactive liquid waste in 325A is Tank WT-1. • The transfer of the radioactive liquid waste from WT-1 is done either by jetting to the RLWS line exiting 325A by way or vacuum transfer to a cask in the liquid transfer hood.[3]	Modifications during installation at 325 Building: Modifications HWS-7496 Tested HWS-7496 Notes from drawing H-3-9321	H-3-9321

[1] Ebasco 1990, Pages G-2 - G-3, Section 1.1.2.
[2] PNL 1991c, Page 4.9, Section 4.1.2.2.
[3] PNL 1991c, Page 4.20, Section 4.2.5.1.
[4] PNL 1991c, Page 4.45, Section 4.6.3.7.
[5] Blueprint # H-3-43197, Vessel Assembly TK
[6] Blueprint # H-3-43312, Vessel Assembly TK-W5
[7] Blueprint # H-3-43311, Vessel Assembly Tanks TK-W1 TK-W2 & TK-W3.
[8] Blueprint # H-3-9321, Mechanical Process Tanks Modifications Cerium Recovery Facility.

TABLE 2.2. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
PT-1	325 Building Vault B	• The waste tank is 9.00 ft in diameter by 8.72 ft high and has a storage capacity of 3,900 gal.[1] • The tanks walls, top, and bottom consist of 3/8-in.-thick stainless steel jacket extending 7.00 ft up the side of the tank.[1] • The tank is supported by 12 legs located around the perimeter of the shell.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank operates at a very slight negative pressure.[1] • Can transfer contents to Tank WT-1 which in turn is jet pumped to the 340 Building facility.[1] • The tanks in B- and C-Vaults can be emptied by transferring the liquid to a shielded cask via a vacuum transfer system or can be transferred to the waste-storage tank (WT-1) in A-Vault.[2]	<u>Material Used</u> HWS-3221 SST type 304L HWS-5902 SST type 347 ASTM A7-52T carbon steel ASTM A-53 or A-30 steel plate <u>Fabrication</u> Spec. HW-4997 Rev. 1 <u>Welding</u> Spec. HW-4924-S <u>Painting of steel</u> HW-5508 Rev. 3 Modifications during installation at 325 Building: <u>Modifications</u> HWS-7496 <u>Tested</u> HWS-7496 Notes from drawing H-3-9321	HD-62372 H-3-9321

[1] Ebasco 1990, Pages G-2 - G-3, Section 1.1.2.
[2] PNL 1991c, Page 4.9, Section 4.1.2.2.
[3] PNL 1991c, Page 4.20, Section 4.2.5.1.
[4] PNL 1991c, Page 4.45, Section 4.6.3.7.
[5] Blueprint # H-3-43197, Vessel Assembly TK
[6] Blueprint # H-3-43312, Vessel Assembly TK-W5
[7] Blueprint # H-3-43311, Vessel Assembly Tanks TK-W1 TK-W2 & TK-W3.
[8] Blueprint # H-3-9321, Mechanical Process Tanks Modifications Cerium Recovery Facility.

TABLE 2.2. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
PT-2	325 Building Vault B	• The waste tank is 9.00 ft in diameter by 8.72 ft high and has a storage capacity of 3,900 gal.[1] • The tanks walls, top, and bottom consist of 3/8-in.-thick stainless steel jacket extending 7.00 ft up the side of the tank.[1] • The tank is supported by 12 legs located around the perimeter of the shell.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank operates at a very slight negative pressure.[1] • Can transfer contents to Tank WT-1 which in turn is jet pumped to the 340 Building facility.[1] • The tanks in B- and C-Vaults can be emptied by transferring the liquid to a shielded cask via a vacuum transfer system or can be transferred to the waste-storage tank (WT-1) in A-Vault.[2]	Material Used HWS-3221 SST type 304L HWS-5902 SST type 347 ASTM A7-52T carbon steel ASTM A-53 or A-30 steel plate Fabrication Spec. HW-4997 Rev. 1 Welding Spec. HW-4924-S Painting of steel HW-5508 Rev. 3 Modifications during installation at 325 Building: Modifications HWS-7496 Tested HWS-7496 Notes from drawing H-3-9321	HD-62372 H-3-9321

[1] Ebasco 1990, Pages G-2 - G-3, Section 1.1.2.
[2] PNL 1991c, Page 4.9, Section 4.1.2.2.
[3] PNL 1991c, Page 4.20, Section 4.2.5.1.
[4] PNL 1991c, Page 4.45, Section 4.6.3.7.
[5] Blueprint # H-3-43197, Vessel Assembly TK
[6] Blueprint # H-3-43312, Vessel Assembly TK-W5
[7] Blueprint # H-3-43311, Vessel Assembly Tanks TK-W1 TK-W2 & TK-W3.
[8] Blueprint # H-3-9321, Mechanical Process Tanks Modifications Cerium Recovery Facility.

TABLE 2.2. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
PT-3	325 Building Vault C	• The waste tank is 3.50 ft in diameter by 4.00 ft high and have a storage capacity of 270 gal.[1] • The tanks walls consist of 3/16-in.-thick stainless steel plate with a 1/8-in.-thick stainless steel jacket extending 2.83 ft up the side of the tank.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank is supported by 4 legs.[1] • The tank operates at a very slight negative pressure.[1] • Can transfer contents to Tank WT-1 which in turn is jet pumped to the 340 Building facility.[1] • The tanks in B- and C-Vaults can be emptied by transferring the liquid to a shielded cask via a vacuum transfer system or can be transferred to the waste-storage tank (WT-1) in A-Vault.[2]	Material Used Dupont Spec. 2028 carbon steel Assembly & Testing Equip. Dupont Spec. 2026 Modifications during installation at 325 Building: Modifications HWS-7496 Tested HWS-7496 Notes from drawing H-3-9321	HW-74536 H-3-9321
PT-4	325 Building Vault C	• The waste tank is 3.50 ft in diameter by 6.00 ft high and has a storage capacity of 404 gal.[1] • The tanks walls, top, and bottom consist of 3/16-in.-thick stainless steel plate with a 3/16-in.-thick stainless steel jacket extending 5.00 ft up the side of the tank.[1] • The tank is supported by 4 legs.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank operates at a slight negative pressure.[1] • Can transfer contents to Tank WT-1 which in turn is jet pumped to the 340 Building facility.[1] • The tanks in B- and C-Vaults can be emptied by transferring the liquid to a shielded cask via a vacuum transfer system or can be transferred to the waste-storage tank (WT-1) in A-Vault.[2]	Material Used Spec. HW-3575-SS-1 SST 18-8 CB Welding ASME Code, Par U-69 Modifications during installation at 325 Building: Modifications HWS-7496 Tested HWS-7496 Notes from drawing H-3-9321	HD-62487 H-3-9321

[1] Ebasco 1990, Pages G-2 - G-3, Section 1.1.2.
[2] PNL 1991c, Page 4.9, Section 4.1.2.2.
[3] PNL 1991c, Page 4.20, Section 4.2.5.1.
[4] PNL 1991c, Page 4.45, Section 4.6.3.7.
[5] Blueprint # H-3-43197, Vessel Assembly TK
[6] Blueprint # H-3-43312, Vessel Assembly TK-W5
[7] Blueprint # H-3-43311, Vessel Assembly Tanks TK-W1 TK-W2 & TK-W3.
[8] Blueprint # H-3-9321, Mechanical Process Tanks Modifications Cerium Recovery Facility.

TABLE 2.2. (cont.)

TANK NO.	TANK LOCATION	TANK DESCRIPTION/FUNCTION	CONSTRUCTION/INSTALLATION SPECIFICATIONS FOR TANK SYSTEMS	REF. DWGS.
PT-5	325 Building Vault C	• The waste tank is 3.50 ft in diameter by 4.00 ft high and have a storage capacity of 270 gal.[1] • The tanks walls consist of 3/16-in.-thick stainless steel plate with a 1/8-in.-thick stainless steel jacket extending 2.83 ft up the side of the tank.[1] • The roof of the tank is flat and the floor is sloped.[1] • The tank is supported by 4 legs.[1] • The tank operates at a very slight negative pressure.[1] • Can transfer contents to Tank WT-1 which in turn is jet pumped to the 340 Building facility.[1] • The tanks in B- and C-Vaults can be emptied by transferring the liquid to a shielded cask via a vacuum transfer system or can be transferred to the waste-storage tank (WT-1) in A-Vault.[2]	Material Used Dupont Spec. 2028 carbon steel Assembly & Testing Equip. Dupont Spec. 2026 Modifications during installation at 325 Building: Modifications HWS-7496 Tested HWS-7496 Notes from drawing H-3-9321	HW-74536 H-3-9321
TK-1	325 Building Room 32	• The radioactive waste from the cells and two sinks in the 325B Building addition (west wing) drain into a 760-L (200-gal) holding tank in Room 32.[3] • Located in the 325B Building addition is the 200 gallon holding tank for the RLWS system, Tank TK-1. It is located along the east wall of Room 32. The tank has a stainless steel drip pan beneath it, however, this pan does not have sufficient capacity to hold the entire contents of the tank.[1] • Contents can be transferred directly to the 340 Building facility.[1] • The radioactive liquid waste can be jetted to the 325 Building radioactive liquid waste line, and from there it goes directly to the 340 Building.[3]		

[1] Ebasco 1990, Pages G-2 - G-3, Section 1.1.2.
[2] PNL 1991c, Page 4.9, Section 4.1.2.2.
[3] PNL 1991c, Page 4.20, Section 4.2.5.1.
[4] PNL 1991c, Page 4.45, Section 4.6.3.7.
[5] Blueprint # H-3-43197, Vessel Assembly TK
[6] Blueprint # H-3-43312, Vessel Assembly TK-W5
[7] Blueprint # H-3-43311, Vessel Assembly Tanks TK-W1 TK-W2 & TK-W3.
[8] Blueprint # H-3-9321, Mechanical Process Tanks Modifications Cerium Recovery Facility.

3.0 WASTE CHARACTERIZATION

The purpose of this section is to present a historical profile of the wastes and waste feed materials stored in the tanks and transfer piping. The information included in this section is based on 1) the review of numerous documents describing processes and the facilities in which the processes were performed, 2) information received during interviews of personnel who were involved with development of processes and operation of the facilities, 3) inventories of chemicals, 4) waste and waste feed materials characterization data for waste in tanks as available, and 5) information available in other documentation for the facility including safety analysis reports and facility effluent monitoring plans. Summaries of the personnel interviews are found in Appendix B, and specific reference to individual interviews is footnoted. The reader is referred to Section 1.3 for clarification on the terminology used in this section.

Section 3.1 includes information on the wastes and systems in the 324 Building. Section 3.2 includes information on the wastes and systems in the 325 Building.

3.1 DESCRIPTION OF WASTES AND SYSTEMS IN THE 324 BUILDING

Liquid wastes generated within the 324 Building hot cells have been discharged to the building vault tanks since 1968. Three programs have generated the majority of the liquid waste in the 324 Building vault tanks. These are the Waste Solidification Engineering Prototype Program (WSEP), the Nuclear Waste Vitrification Project (NWVP), and the Fabrication of Cesium and Strontium Heat and Radiation Sources, also known as the FRG Program. The Zeolite Vitrification Program was also conducted in the 324 Building, but the program handled only solid waste and thus did not use the RLWS. The RLWS in the 324 Building handles liquid wastes that have ranged from high-level waste feed material used in the waste treatment process demonstrations to process condensates from the decontamination equipment located downstream of the solidification systems. Presently, the RLWS is used to contain residue liquid waste from the above-mentioned programs in addition to decontamination solutions.

Although minimal information is available on the uses of the vault tanks prior to emplacement in the RLWS of Building 324, there is evidence that seven of the eight vault tanks were used in the 321 Building during 1950-1958 to contain solutions to support a PUREX prototype.

The following sections provide information on program and process histories related to the characterization of wastes and waste feed materials discharged to the tanks, the use and function of each vault tank during these programs, and identification of auxiliary process equipment connected to the vault tanks. The resulting characterization information will support assessments of the potential for corrosion and degradation of the tanks. A brief description of the methodology used to compile the characterization information is also provided.

3.1.1 Pre-324 Building Process History of Vault Tanks

Six of the 324 Building vault tanks (TK-101, TK-102, TK-103, TK-105, TK-106, and TK-108) were constructed in the early 1940s; they were reported to be procured for C Plant in the 200 Area. C Plant was never constructed and the tanks remained unused (residing in the 200 Area) until the late 1940s when they were transferred to the 300 Area.[1] In approximately 1950 these tanks were installed for use with 321 Building processes.[2,3] Tank TK-104 was constructed in 1954 and directly installed into 321 Building.[4]

From 1950-1958, the 321 Building was used for testing numerous PUREX flow sheet modifications. The tanks contained nitric acid, several non-radioactive chemical solutions, sodium nitrates and nitrites, sodium carbonates, and caustic solutions. Sanitary water was primarily used for aqueous feed make-up. A few of the tanks contained uranium solutions (although not fission products). No halides were reported to have been used in any of the processes discharging wastes to the tanks. The tank cooling and heating jackets were reported to be used routinely. Tank temperatures were typically maintained between 50-60°C; however, temperatures of 100°C were apparently not uncommon.[3]

After their removal from the 321 Building in approximately 1958, Tanks TK-101, TK-102, TK-103, TK-104, TK-105, TK-106, and TK-108 were subsequently modified at the J.A. Jones shop and installed in the 324 Building vaults in approximately 1964.[2] While the tanks were being modified, they were tested to detect leaks and radiographed to check welds and seams; the tank jackets (if present) were hydrostatically tested at 20 psig.[4] It is assumed that process or raw water was used for leak detection testing. Tank TK-107 was constructed in 1963 and was subject only to radiograph and dye penetration testing of the welds.[4]

3.1.2 Waste Solidification Engineering Prototypes (WSEP)

The WSEP program began in 1966 and continued through 1972. The program was designed to demonstrate three methods of solidifying highly radioactive waste. These methods were pot solidification, spray solidification, and phosphate glass formation.

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[1] Interview with Frank Haun, 1/25/93.

[2] Notes from Jeff Surma, 4/6/92.

[3] Interview with Gil Nicholson, 3/23/93.

[4] Tank 104-108 Blueprints.

High-level radioactive wastes from aqueous reprocessing plants are primarily mixtures of fission products and various nonradioactive constituents, in the nitrate form. The feed material compositions used in the WSEP program were prepared to represent a 1) PUREX waste solution containing a large amount of iron such as would result when an iron canister is used to transfer chopped fuel elements from the mechanical head-end to the dissolver, and the canister is co-dissolved with the fuel and 2) a PUREX waste solution from a process optimized to produce a waste containing a minimum quantity of nonfission product material. Chemicals were substituted for several of the fission products. Molybdenum was substituted for technetium, nickel for palladium, cobalt for rhodium, copper for silver and cadmium, potassium for cesium, and rubidium and iron for a significant portion of the ruthenium. A significant amount of aluminum was unavoidably introduced at PUREX and was present in the feed material for WSEP (Bond, et al. 1971).

The WSEP involved handling the largest quantities of radioactivity among the programs contributing to the RLWS. The tanks received approximately 52 MCi during the WSEP radioactive demonstrations; of the 52 MCi of total activity, 5 MCi was mixed fission products from the PUREX feed material, 0.1 MCi was strontium, 40 MCi was cesium/praseodymium, and the balance was not specifically identified.[5]

3.1.2.1 Pot Solidification

Two separate processes are considered pot solidification methods. These are pot calcination and rising level glass. In the pot calcination method, the waste is fed to a heated pot and is concentrated to a salt cake. This occurs by elevating the temperatures to exceed the boiling waste critical heat flux, which allows calcine to begin to grow radially inward from the pot wall. These calcine deposits then act as resistance to further heat transfer from the pot wall to the continuing feed solution. The feed solution slowly decreases and is soon cut off. The calcine is then denitrated by heating to 900°C to decompose the residual nitrates resulting in the final product which is a soluble calcine comprised primarily of oxides. Escaping vapors from the process are condensed and collected; non-condensibles are filtered and then released as airborne effluents.

The rising level glass method consists of feeding a liquid waste with the glass-forming materials into a stainless steel pot heated at 900°C. A melt takes place, creating three layers in the pot: fluid glass, calcine (sinter), and a waste liquid on the top. The feed rate of the liquid waste is varied such that the resulting liquid and calcine layers are at a minimum. Once the container is full with 100% fluid glass, the pot is cooled to allow solidification. Off gasses from this process are condensed and collected: non-condensibles are filtered and then released as airborne effluents (Bond, et al. 1971).

[5] Memo from Jack McElroy to W.D. Richmond/C.R. Richey, July 25, 1983.

3.1.2.2 Spray Solidification Process

The basic operations accomplished in spray solidification are 1) conversion of aqueous waste solution to finely divided oxide powder by spray calcination and 2) formation of a melt that solidifies to a coherent mass that is physically stable and chemically inert. The melt can be formed in a continuous melter and batch dumped into a receiver pot for final storage (standard spray solidification process) or the melt can be formed directly in the receiver pot (in-pot melting).

The first step is to feed the liquid through a pneumatic atomizing nozzle into the top of the spray calciner. As the spray travels down the heated portion of the calciner, it is dried into a powder. Most of this powder then falls directly into the melter; the remainder goes with the off-gas into the filter chamber. The powder that falls through the filter chamber is collected on porous metal filters and is periodically retrieved by blowing high-pressured jets of steam backward through the filters, causing the dislodged powder to fall into the melter. The fluxes for the spray solidification process can be added to the waste before drying or added directly to the melter. Depending on the types of waste used and the desired characteristics, the following different fluxes were used, either alone or mixed with another: P_2O_5, Li-Na-Al, CaB_2O_3 (Colemite), B_2O_3, and SO_2. The waste powder is melted at a temperature between 700-1200°C. The molten waste flows from the melter to the final storage vessel through an overflow weir or a freeze valve. Once the pot is full, it is cooled and finally sealed for storage (Bond, et al. 1971).

3.1.2.3 Phosphate Glass Process

The phosphate glass process is carried out in two continuous steps. These are 1) a low-temperature (120 to 140°C) concentration step in which aqueous waste, chemically adjusted by the addition of phosphoric acid together with certain metal salts (when required) is continuously concentrated and partially denitrated to a thick slurry and 2) a high-temperature (1000 to 1200°C) glass-forming step in which final removal of water, nitrates and other volatile constituents is accomplished. When the receiver is full, it is removed, sealed, and taken to storage (McElroy, et al. 1971).

3.1.2.4 WSEP Auxiliary System

Process auxiliaries necessary for the solidification system consist of equipment for 1) preparing aqueous waste solutions for feeding the solidifier, 2) decontaminating the solidifier off-gas, and 3) decontaminating the solidifier condensate and recovering nitric acid.

The wastes generated from solidification processes consisted of volatilized material from the feed, entrained liquid or solid aerosols, and process air. The volatilized materials consisted primarily of water, nitric acid, various oxides of nitrogen, and a small amount of ruthenium tetroxide (RuO_4). The small amount of noncondensible constituents in the solidifier off-gases was discharged to the atmosphere after treatment (McElroy, et al. 1972).

In the 324 Building auxiliary system, vapors from the solidification system that are not acceptable for discharge without further treatment are first routed through a condenser to the evaporator. The solidifier condensate is concentrated in the evaporator (along with incoming feed in some cases). The vapors from the evaporator are decontaminated from entrained aerosols in the evaporator tower by impingement plates, bubble caps, and a mist eliminator and then condensed. The evaporator condensate was further decontaminated and concentrated in the acid fractionater where the nitric acid was recovered. The vapors from the fractionater are again condensed and about 80% of the fractionater distillate is recycled to the evaporator as acid stripwater, while the remaining 20% is collected as waste. The remaining gases are treated by high efficiency filtration, scrubbing, and additional filtration before discharge to the atmosphere. Figure 3.1 illustrates the WSEP auxiliary system (McElroy, et al. 1972).

The WSEP auxiliary system includes Tanks TK-113 (evaporator), TK-115 (fractionater), TK-116 (fractionater distillate receiver), and TK-118 (scrubber) located in B-Cell of the 324 Building. The following description identifies process routes for liquid effluent discharges to the vault tanks. The information is not considered to be complete with respect all of the in-process routing capabilities of the auxiliary systems.

The major process route for Tank TK-113 is to transfer condensed waste to Tank TK-114 (feed tank) and the minor process route of discharge is to the high level vault Tank TK-104 (alkaline waste storage). The major process route of the fractionater bottoms (acid) from the fractionater (Tank TK-115) is to the high level vault Tank TK-105 (acid waste storage) with minor process routes of discharge to Tanks TK-116 and TK-117 (process condensate). Vapors off of the evaporator (Tank TK-113) are sent through two stages of condensing: 1) the evaporator condenser, and 2) combined with vapors off the fractionater (Tank TK-115) and condensed in the fractionater condenser for discharge to Tank TK-116. The major process route of effluent discharge for the fractionater distillate receiver (Tank TK-116) is to the low level vault Tank TK-101 (condensate storage) with minor process routes of discharge to low level vault Tank TK-102 (condensate sample and storage) and auxiliary Tanks TK-115 and TK-117. The liquid effluent discharges from Tank TK-118 (scrubber bottoms) are sent to the high level vault Tank TK-104 and auxiliary Tank TK-116 (Rey 1966).

The melter receives its wastes from the interconnected utility Tanks TK-112 (evaporator feed tank) and TK-114 (calcine feed tank) also located in B Cell. The major process routes for Tank TK-112 contents are to transfer feed material from high level vault Tank TK-107 and to the evaporator (Tank TK-113). Vault Tanks TK-104 and TK-105 can also send waste feed material to Tank TK-112. The major process routes for Tank TK-114 contents are transfers of feed material from high level vault Tank TK-107 and to the calcine. Tank TK-114 can also discharge to Tank TK-105 (Rey 1966).

3.1.3 Nuclear Waste Vitrification Project (NWVP)

The objective of the NWVP was to provide a demonstration of the vitrification of high level liquid waste (HLLW) from spent fuel discharged from an operating light water reactor (LWR). The NWVP encompassed two tasks of the Commercial High-Level Waste Immobilization Program: Waste Preparation and Radioactive Demonstration of Vitrification. The project was started in April 1976 and terminated in June 1979. Total activity of the radioactive material handled during the NWVP was approximately 0.6 MCi.[5]

The NWVP involved equipment in the 324 and 325 Buildings. The 324 Building was used for fuel-cask unloading; fuel disassembly, shearing, and dissolving; and waste calcination and vitrification. The 325A Building was used to perform feed adjustment and solvent-extraction for HLLW waste preparation. In the 325 Building, the plutonium by-product of the waste preparation was purified from uranium and fission products by ion exchange and the calcination of the plutonium-nitrate occurred. An underground pipeline between the two buildings served for transfer of off-gas, dissolver solution, and HLLW.

3.1.3.1 324 Building NWVP Processes

The fuel assemblies are received in the Truck Lock unloading area, located in the 324 Building near the rear face of the hot-cell complex. For disassembly and shearing, the fuel pins are withdrawn from the fuel assembly and fed to a hydraulic shear. The cut fuel pieces drop down a chute into a basket located inside the dissolver vessel Tank TK-127. Dissolver solution is then filtered and sent to holding Tank TK-126 after dissolution is complete. The dissolver solution is transferred from the holding tank to the 325A Building through the 3/8-in. interbuilding pipeline (Wheelwright, et al. 1979).

Solvent-extraction of the dissolver solution was performed in the 325A Building to separate the uranium and plutonium from the fission products. The resulting dilute HLLW feed was then transferred from Tank W4 in the 325A Building through the interbuilding pipeline to high level vault Tank TK-106 in the 324 Building. The HLLW was then transferred to Tank TK-107, where the chemical composition was adjusted to that of typical waste by the addition of uranium and non-radioactive chemicals. Inert chemicals added to the HLLW in Tank TK-107 were: $NaNO_3$, $Fe(NO_3) \cdot 9H_2O$, $Cr(NO_3) \cdot 9H_2O$, $Ni(NO_3) \cdot 6H_2O$ and H_3PO_4 (75%). The waste feed material was then transferred to the HLLW Feed Tank TK-114 and then to evaporator Tank TK-113, both in B Cell where the waste feed would be concentrated to the required volume and acid concentration for feed to the vitrification process. The feed preparation required nearly a 10-fold reduction in the volume and acid depletion before calcination to be representative of a reprocessing plant waste feed. This was accomplished by a concentration/acid-stripping operation using the evaporator Tank TK-113. Concentrated solutions from the waste feed preparation processes was used for the two batch operations of the spray calcine/in-can melter system (Wheelwright, et al. 1979).

3.1.3.2 324 Building NWVP Auxiliary Systems

The auxiliary systems were operated in a similar manner to the auxiliary systems of the WSEP. Therefore, it is expected that the liquid waste and waste feed discharges to the vault tanks from the auxiliary systems tanks were similar to those described in Section 3.1.3.4. The only exception may be that the fractionater bottoms (acid), which were reported to be recycled for reuse during the WSEP, were actually discharged to the vault Tank TK-105. During the NWVP, the acid fractionater was used primarily as a second stage evaporator. This produced a cleaner condensate in Tank TK-116.[6]

Tank TK-114 has a moderately large heel and all of the concentrated waste feed material from the NWVP reportedly could not be pumped to the spray calciner (Wheelwright et al. 1979). Based on information from engineering drawings, the only vault tank to which Tank TK-114 can discharge is Tank TK-105 (Rey 1966). It is possible that this waste feed material was eventually discharged to Tank TK-105. However, it has also been reported that approximately 0.5 liquid metric ton (approximately 0.2 MCi) of liquid waste feed material from the NWVP is stored in Tanks TK-106 or TK-107.[7]

3.1.4 Fabrication of Cesium and Strontium Heat and Radiation Sources Program (FRG Program)

From 1986-1987, the 324 Building facilities were used to produce 30 isotopic heat sources in canisters for the Federal Republic of Germany (FRG) to be used as part of a repository testing program. These activities, which are frequently referred to as the FRG Program, involved the filling, closure, and decontamination of the 30 canisters (Holton, et al. 1989). The canister filling and decontamination processes utilized the vault tanks to contain feed waste solution, process condensates, and decontamination solutions as described below.

3.1.4.1 FRG Canister Filling

During three separate processing campaigns (RLFCM-7, -8, -9), canisters were filled using the radioactive liquid-fed ceramic melter to produce a borosilicate glass. The average radiochemical characteristics of each of the campaigns are provided in Table 3.1 (Holton et al. 1989). Feed materials for these campaigns were ^{137}Cs- and ^{90}Sr-laden nitrate waste solutions from Hanford's B Plant (Holton, et al. 1989). The original feed stock, cesium chloride and strontium fluoride, was converted to nitrate solutions before being transferred from the 200 Area to the 324 Building. Residual halides (in small quantities) were expected in the feed waste solutions.[8] The feed solutions were stored in high level vault Tanks TK-

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[6] Interview with Bill Bjorklund, 2/3/93.

[7] Interview with Langdon Holton, 2/1/93.

[8] Interview with Bruce Katayama, 2/3/93.

104 and TK-105 (Holton et al. 1989). Waste feed solutions were batch transferred from the Tanks TK-104 and TK-105 to Tank TK-112, where the temperature was controlled and monitored and solution was agitated. The contents of Tank TK-112 were then transferred to the evaporator Tank TK-113, where denitrification (addition of formic acid) then volume reduction was performed. The concentrated product from Tank TK-113 was then transferred to feed makeup Tank TK-114 where nonradioactive glass-forming chemicals were added.[8] The resulting feed was sent to the RLFCM, where the liquid was calcined and melted to form a borosilicate glass.

3.1.4.2 FRG Canister Decontamination

Electropolishing was used to decontaminate the top, sides, and bottom of the FRG canisters. The electropolishing process was performed in A Cell. The electrolyte used was 85 wt% phosphoric acid. The electropolishing process removed ~1 kg of metal and oxide from each canister's surface. After decontaminating 30 canisters, the resulting electrolyte contained 6627 ppm Fe, 3568 ppm Ni, 2221 ppm of Cr and 1.36 by 10^{-5} Ci ^{137}Cs/L of phosphoric acid. Approximately 400-650 gal of electrolyte was transferred to Tanks TK-101 and/or TK-102 in the low-level vault (Wheelwright, et al. 1979).[9,10]

3.1.4.3 FRG Auxiliary Systems

The auxiliary systems involved in the FRG Program activities were operated in a manner similar to those of the WSEP and NWVP, with the exception that Tank TK-115 (acid fractionater) discharged acid to Tank TK-108. Review of earlier engineering flow diagrams indicates that the option to route the liquid waste from Tank TK-115 to Tank TK-108 did not exist during WSEP and NWVP (Rey 1966). A sketch of the liquid systems flow in the 324 Building, approved in 1983, depicts modifications that were apparently made to allow transfer of liquids from Tank TK-115 to Tank TK-108.[11] Because the cesium and strontium nitrate feed material was stored in Tanks TK-104 and TK-105, these tanks were used to a greater extent during the FRG Program than during any of the earlier programs. Figure 3.2 depicts the general routing options for the process liquids between the auxiliary tanks and vault tanks.

3.1.5 Post-FRG Program to Present

Since 1987, no major liquid waste solidification programs have involved the vault tanks. The primary use of the high level vault tanks since 1987 has been to contain solutions remaining from the NWVP and FRG Program. The low-level vault tanks have been used to

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[9] Interview with Jeff Surma, 2/1/93.

[10] 324 Building Vault Tanks, Solution History, Galen Buck, 9/3/92.

[11] Drawing SK-3-19733.

receive liquid wastes resulting from decontamination operations. These solutions were primarily water and TURCO® products. The analytical results of vault tank samples taken in June 1990 are presented in Table 3.2.[12] Limited information is available for the sampling and analytical methods used. A full discussion of the analytical results for each of the tanks is included in Section 3.1.6.

Table 3.3 provides the type of solution and volume level at the time of sampling and as of April 1993.[12,13] It is reported that no solutions (other than small amounts of water) have been added to the tanks since the analyses were performed. The only activity reported is the jetting of solutions from Tanks TK-102, TK-103, and TK-108 to Building 340 in June 1990 and May 1991.[8,14] The analytical results presented in Table 3.2 were used to determine necessary actions (i.e., neutralization) to comply with the disposal requirements of the RLWS.[14]

3.1.6 Summary of Building 324 Vault Tank Wastes

Table 3.4 provides a summary of the chemical and radionuclide compounds and species in the 324 Building tanks. The information presented in the table is a compilation from all available sources that have indicated or designated constituents as potentially present in any of the 324 Building vault tanks during the life of the tanks. These sources included interviews with technicians, engineers, and project managers; project and program reports and procedures; characterization of feed material and solidified products; analytical results for vault tank contents; facility effluent monitoring plans (FEMPs); and solution transfer logs and history sheets.

The analytical results presented in Table 3.2 are the only known analytical data for the waste in the vault tanks; references in Table 3.4 to "Lab Analysis" correspond to results presented in Table 3.2. The analytical results in Table 3.2 are most representative of wastes generated during and following the FRG Program, with the exception of Tank TK-107 which was not used during the FRG Program and contained waste from NWVP at the time of sampling.

The following sections provide tank specific information regarding the presence of halides, pH, and temperatures of the tank contents, as these conditions are generally expected to affect the integrity of the tanks. A full assessment of the corrosion potential of the tanks is presented in Section 4.0. It is important to note that the information presented below is based primarily on a compilation of information derived from knowledge of the solidification

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[12] Analytical Data and Attachments, 6/7/90.

[13] Personal Communication with Galen Buck, 4/93.

[14] RLWS Disposal Approval Request 7/16/90, from TK-102, TK-103, TK-108; and 5/10/91 from TK-108.

and auxiliary process systems; interviews with technicians, engineers, and project managers; and, correlation to the analytical results presented in Table 3.2. Tank-specific information of tank contents during the time the tanks were connected to the 321 Building processes was not available, therefore the following descriptions are limited to the 324 Building processes.

3.1.6.1 Tanks TK-101, TK-102 and TK-103

Tanks TK-101 and TK-102 are the only vault tanks with capabilities for direct jetting to the 340 Building. As a result these tanks were used most often and probably handled a larger volume of waste than any of the other vault tanks. The contents of Tank TK-103 can also be transferred to Tanks TK-101 and TK-102. These tanks have been designated low-level condensate storage. Tanks TK-101 and TK-102 typically receive process condensate from the fractionater distillate receiver (Tank TK-116). It is not apparent whether Tank TK-103 is connected to the auxiliary tanks; however, it appears to contain waste similar to that of Tanks TK-101 and TK-102.

Table 3.2 reported pH values for Tanks TK-101, TK-102, and TK-103 that ranged from 6.33 to 8.39. It is likely the wastes in the tanks at the time of sampling were process condensates from decontaminating operations. These solutions included trisodium phosphate, potassium dichromate, and oxalate solutions, which would be expected to range from caustic to slightly acidic, respectively. Process condensates generated from the FRG Program operations were continually jetted to the 340 Building during the time when the program was active (1986-1987), and it is unlikely that these solutions were present in substantive quantities at the time of sampling (tank heels for Tanks TK-101, TK-102, and TK-103 are 30 gal, 21 gal, and 20 gal, respectively[1]). It is expected that the process condensates received from Tank TK-116 during waste solidification operations were slightly acidic, with pH levels ranging from 5 to 6. Halide concentrations for process condensates generated during solidification operations would not be expected to differ greatly from the analytical results in Table 3.2. It is likely that most of the halides present in the solutions originated from contamination of the technical grade reagents used in the processes.[15]

Tanks TK-101 and TK-102 also received phosphoric acid electrolyte used in A Cell for decontaminating the canisters produced for the FRG Program.[16] Tank TK-102 is considered the catch tank, as it is connected to cell floor drains and sink drains.[21] Tank TK-101, TK-102, and TK-103 have heating/cooling jackets. Review of the design and modification drawings reveal that these tanks' jackets are not presently connected to any supply/drain lines. However, the contents of Tank TK-102 may have reached 80°C in 1991 when acid solution transferred from Tank TK-108 was neutralized (chemical additions were made through a sink drain to Tank TK-102) before being sent to the 340 Building. There

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[15] Interview with Bill Bjorklund, 2/3/93.

[16] Interview with Jeff Surma, 2/1/93.

were no other reports of tank temperatures ever exceeding 55°C (an alarm sets off if temperature exceeds this limit).

3.1.6.2 Tanks TK-104 and TK-105

During the operation of the WSEP and the NWVP, Tanks TK-104 and TK-105 were set up to receive the bottoms from the evaporator and acid fractionater, respectively. Apparently, the acid fractionater was utilized as a second-stage evaporator. Tank TK-105 could also receive feed materials from the feed make-up tank (TK-114). Reportedly neither of these tanks was used very often during the WSEP and NWVP due to their large size (Tank TK-104 is 4,000 gal, Tank TK-105 is 5,000 gal) and corresponding large heel. However, transfers of clean acid (10<u>M</u> HNO_3) from the acid fractionater to Tank TK-105 were reported in 1978. It is also reported that during May 1979, Tank TK-105 held very concentrated solutions that may have reached temperatures as high as 75°C for approximately one month.

During operation of the FRG Program, Tanks TK-104 and TK-105 (primarily Tank TK-105) were used to contain strontium and cesium nitrate feed material for the RLFCM. These feed materials contained residual fluorides and chlorides from the conversion of original feed material to nitrates (performed at the 200 Area). The analytical results in Table 3.2 indicate fairly high levels of chloride and fluoride concentrations for Tank TK-105. The samples from Tanks TK-104 and TK-105 were reportedly taken after the tanks had been flushed. It is, therefore, likely that the halide concentration could have been higher in the actual feed material. Tank TK-105 has a cooling jacket and, therefore, may have been used preferably to Tank TK-104 for containing high temperature solutions and feed material.

3.1.6.3 Tanks TK-106 and TK-107

Tank TK-107 was routinely used during the WSEP and NWVP to contain feed materials before they were sent to the melter feed make-up tank (TK-114). During the NWVP, non-radioactive feed additions, including phosphoric acid, were made directly to Tank TK-107. The FRG Program did not utilize Tank TK-107 and apparently no solutions were added to the tank before it was sampled. Therefore, the data presented in Table 3.2 are most likely representative of the feed materials used in the NWVP, although the tank was probably flushed prior to sampling. In 1968 and 1979, the contents of Tank TK-107 reportedly reached a temperature of 75°C. Tank TK-107 has a cooling jacket, which was frequently used to cool the feed materials during the WSEP and NWVP.

Tank TK-106 was used during the NMVP to accept HLW from the 325A Building. Very little information is available on the use of Tank TK-106 during the other programs. Tank TK-106 could receive solutions from Tank TK-107 and, therefore, most likely contained the same types of waste or waste feed materials. The analytical results in Table 3.2 indicate that, at the time of sampling, Tank TK-106 contents were more typical of the process condensates stored in the low level vault tanks.

3.1.6.4 Tank TK-108

During the WSEP and NWVP, Tank TK-108 was not reported to have been used extensively. However, during the FRG Program Tank TK-108 was routinely used to receive clean acids from the acid fractionater. Solution transfer logs during the FRG Program confirm transfers from Tank TK-115 to Tank TK-108.[24] Table 3.2 analytical results correlate well to that of acid fractionater bottoms. It is expected that the concentration of halides is higher in the acids than that of the process condensates (Tanks TK-101, TK-102, and TK-103) due to these constituents being concentrated in the fractionater bottoms. Solutions in Tank TK-108 were transferred to Tank TK-102 and neutralized before they were jetted to the 340 Building.[15]

3.1.7 Process of Compiling Waste Characterization Information

Information on the types of wastes and waste feed materials stored in the tanks was obtained through the following: project reports; engineering drawings and sketches; interview notes; available vault tank analytical data, disposal request sheets, and solution transfer logs; and miscellaneous information located in program and project files. Project reports were available for the WSEP, NWVP, and FRG Program. These reports provided information on the feed material used (analytical data in some cases), processes performed, the use of the auxiliary systems, and limited information on the use of the vault tanks. The engineering drawings and sketches were used to identify process routes for liquid effluents transfers between the auxiliary tanks and the vault tanks. Interviews were conducted with ten people whose responsibilities ranged from program manager to technician; these people had been affiliated with 321 or 324 Building processes that discharged waste or waste feed materials to the vault tanks. The interviews, along with the waste transfer records and miscellaneous project file data, were typically used to confirm information obtained from the reports and drawings and/or speculations made regarding waste and waste feed characteristics of the tanks and tank contents. The resulting interview notes are presented in Appendix B.

3.2 DESCRIPTION OF WASTES AND SYSTEMS IN THE 325 BUILDING

Included in this section are descriptions of the major processes that have used the 325 Building RLWS from the time of its initial use to the present, a listing of many of the specific chemicals and radionuclides that have been used in the system, and a summary discussion of the higher-use tanks. These descriptions represent a cross-section of the type of work performed in the 325 Building and the radionuclides and chemicals involved in the different experiments and processes.

3.2.1 Descriptions of Processes Used in the 325 Building Which Discharged to the RLWS

3.2.1.1 Purification of Americium by Ion Exchange

Sequential anion and cation exchange processes were used for the final purification of ^{241}Am recovered during the reprocessing of aged plutonium metallurgical scrap. Plutonium was removed by absorption on Dowex 1®[17], X-3.5 (30-50 mesh) anion exchange resin from 6.5-7.5M HNO_3 feed solution. Following a water dilution to 0.75-1.0M HNO_3, americium was absorbed on Dowex 50W®, X-8 (50-100 mesh) cation exchange resin. Final purification was accomplished by elution of the absorbed band through 3 to 4 successive beds of the same resin, preloaded with Zn^{2+}, with an NH_4OH buffered chelating agent.

The recovery of mixed ^{241}Am-^{243}Am from simulated waste was also demonstrated. Solvent extraction was used in the 200 Areas to recover an HNO_3 solution of mixed lanthanides and actinides from waste generated by the reprocessing of 13.5 tons of Shippingport Power Reactor blanket fuel. Sequential cation exchange band-displacement processes were then used in the 325 Building to separate americium and curium from the lanthanides and then to separate approximately 60 g of ^{244}Cm from 1000 g of mixed ^{241}Am-^{243}Am.

3.2.1.1.1 Anion-Exchange Separation from Plutonium. The nitric acid anion-exchange process used for the separation of americium from plutonium takes advantage of the near-specific absorption of Pu^{IV} from 6 to 8M HNO_3 by a selected group of anion exchange resins and the simultaneous nonabsorption of most other cations. The four-cycle process is illustrated in Figure 3.3.

3.2.1.1.2 Cation-Exchange Purification of Americium. A band-displacement chromatographic process was developed and used for large-scale purification of promethium (Wheelwright, et al. 1979; Wheelwright 1980). This process employs four sequential steps:

1. Absorption of the ions to be separated from a dilute nitric acid feed solution onto a bed of cation-exchange resin.

2. Removal of unabsorbed material from the feed-absorption bed with a scrub solution.

3. Displacement of the absorbed ions down successive resin beds, preloaded with Zn^{2+}, by an ammonium hydroxide buffered solution of a chelating agent to separate the absorbed ions into individual pure-component absorption bands, with binary mixing only at front and back interfaces.

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[17] Dow Chemical Company, Midland, Michigan.

4. Collection of specification product, recycle, and waste as the bands are displaced from the final resin bed.

Figure 3.4 shows the NTA flowsheet as applied to the purification of americium. The chelating agents diethylenetriaminepentaacetic acid (DTPA) and nitrilotriacetic acid (NTA) were used.

3.2.1.1.3 <u>Recovery of ^{241}Am from Once-Purified Plutonium</u>. During the period 1973 through 1976, four campaigns were conducted to purify ^{241}Am recovered at the Hanford Plutonium Reclamation Facility (PRF) from a wide variety of metallurgical scrap using a countercurrent solvent extraction process. The product from the solvent extraction process was concentrated at the PRF by absorption from dilute HNO_3 onto a bed of Dowex 50W® cation exchange resin followed by elution from the resin with 7-8<u>M</u> HNO_3. The concentrate was then transferred to the ion-exchange pilot-plant facility in the 325A Building. The Pu/Am ratio in the concentrate varied over a range of 0.01 to 2. Other impurities included Fe, Cr, Ni, Al, Si, Ca, Mg, and Na in a wide range of concentrations.

After transfer, the solution was filtered, analyzed, and, when necessary, the plutonium oxidation state was adjusted to Pu^{IV} and the nitric acid concentration was adjusted to 7<u>M</u>. The plutonium was then extracted using the flowsheet shown in Figure 3.3. Several anion-exchange runs were made during each campaign because nongeometrically safe equipment limited the amount of plutonium that could be in the cell at one time. Following removal of the plutonium, the americium product solution from the anion exchange runs was diluted to 0.75 to 1.0<u>M</u> HNO_3 with water and processed by the cation exchange flowsheet in Figure 3.4. Americium from the center of the elution band was precipitated with oxalic acid, filtered, and calcined to oxide form. The americium in the binary mixtures at each end of the elution band was recycled in the succeeding campaign.

3.2.1.1.4 <u>Recovery of Mixed ^{241}Am-^{243}Am from Power Reactor Fuel Reprocessing Waste</u>. In 1967, 13.5 tons of Shippingport Power Reactor blanket elements were processed at the Hanford Redox Plant for the recovery of uranium, plutonium, and neptunium. A batch extraction process employing 50% by volume tri-n-butylphosphate in an n-paraffin hydrocarbon diluent was used to recover the lanthanide-actinide elements from the normally discharged waste. Following cask transfer to the "Semiworks" facility, a countercurrent solvent extraction process employing 0.4<u>M</u> bis(2-ethylhexyl)phosphoric acid and 0.3<u>M</u> tri-n-butylphosphate in n-paraffin hydrocarbon was used to further decontaminate the lanthanide-actinide mix from the Al, Fe, U, Pu, Na, and other fission products. The solution was then transferred to the ion-exchange pilot-plant facility in the 325A Building for final purification in a cask.

3.2.1.2 Ion-Exchange Separation of Kilocurie Quantities of High Purity Promethium

The trivalent rare earth fission products can be removed from the concentrated fission product waste and separated from cerium by precipitations or by solvent extraction processes. Separation of the individual rare earths can be accomplished most easily by ion exchange. Research done on this method demonstrated the feasibility of producing highly purified promethium in kilogram quantities.

The objective of the research done at PNL was to provide critical experimental evaluation of the effects of changes in the various operating parameters on both the extent and the rate of separation, for the eluting agents ethylenediaminetetraacetic acid (EDTA), hydroxyethylethylenediaminetriacetic acid (HEDTA), diethylenetriaminepentaacetic acid (DTPA), and nitrilotriacetic acid (NTA).

A series of experiments was performed in identical three-column systems. The columns, in sequence, were:

- an eluant degasser column
- a feed absorption column
- an elution column.

The degasser column was 5.06 cm^2 by 25 cm long, and filled to a depth of 15 cm with NH_4^+-cycle Dowex 50W®, X-8 (50 to 100 mesh) resin. The column was water-jacketed and operated at 90°C and, except for an occasional venting of collected gas, required no special monitoring provision attention. The absorption column was 2.38 cm^2 by 60 cm long and contained 100 ml (in water) of H^+-cycle Dowex 50W® resin. The elution column was 1.31 cm^2 by 190 cm long with variable volumes of H^+-cycle Dowex 50W® resin. With 100 ml of resin in the absorption column and 200 ml in the elution column, an absorbed band moved 2.0 band lengths during the elution. Both absorption and elution columns were water-jacketed for elevated temperature operation, and the temperature was controlled to ± 0.5°C.

In the experiment, the resin in the absorption column was completely saturated with rare earth ions from a nitrate feed solution containing equi-molar amounts of samarium, neodymium, and praseodymium, adjusted to a pH level of 4. The resin was then water washed to remove unabsorbed ions, connected in a series between the degasser and elution columns, and eluted at a controlled flow rate under a variety of experimental conditions. The column effluent solution was fractionated as it drained from the elution column, and the concentration of each rare earth in each fraction was determined by the ratio of neodymium to samarium and praseodymium constant in the feed. In all of the experiments described, H^+ served as the barrier ion for elutions with HEDTA, Zn^{+2} as the barrier ion for EDTA and NTA elutions, and either H^+ or Zn^{+2} for DTPA elutions.

The desired pH level was achieved by adding NH_4OH to the acid form of the chelating agent.

3.2.1.2.1 Large-Scale Promethium Purification. To supply the Pm^{147} needed, an ion exchange facility was installed in one of the shielded cells of the High Level Radiochemistry Facility at PNL. The initial installation contained seven 9-ft-high ion exchange columns ranging from 8 in. to 1 in. ID. The 8-in. column was stainless steel and the others were glass. Each column was water-jacketed for controlled-temperature operation. Also in the cell are associated tanks, valves, and instrumentation. The process flowsheet is shown in Figure 3.5. In operation, feed solution is pumped down-flow through the 8-in. absorption column and to waste at a rate of 1 to 2 L/min until the in-line gamma spectrometer detector on the effluent line indicates an activity breakthrough. At this point, the effluent is diverted back to the feed tank, and the absorption cycle is continued until the detector indicates a 10 to 20% breakthrough. The feed cycle is then terminated, and the loaded resin is washed free of unabsorbed feed with distilled water. Promethium losses are eliminated by cycling the final portion of the feed effluent and the wash effluent back to the feed tank for subsequent use.

The elution cycle is initiated by connecting the loaded absorption column in series with the first 4-in.-diam elution column and pumping 0.05M DTPA solution, buffered to pH 6.5 with ammonium hydroxide down-flow through the two columns at 3.5 to 4.0 m/min-cm^2. As the absorption band moves down the system, fresh Zn^{+2} cycle resin beds are added ahead of the band, and the flow rate is adjusted to correspond to the smallest diameter column in service. Trailing columns are removed from the system and stripped free of remaining rare earths when the detection equipment indicates the promethium content in the effluent to be reduced to an acceptable level.

As the elution progresses and the promethium becomes progressively concentrated in a sub-band near the leading edge of the combined elution band, judicious elution to waste of the leading edge, combined with removal of loaded columns from the trailing edge, greatly reduces the quantity of material in process when the promethium moves onto progressively smaller columns. When the promethium band reaches the final column, it is 150 and 250 cm long, depending on batch size, with 20 to 40 cm on the leading edge contaminated with neodymium. As the promethium band is eluted from the column, the binary mixtures from each end are segregated for recycle and the pure center cut collected for product conversion.

Twelve production runs were completed between October 21, 1965 and January 16, 1967. They utilized feeds of compositions which differed primarily in the sodium, cerium, and promethium contents. During the course of the twelve production runs, 1.2 by 10^6 (1,293 g) of "product fraction" promethium were recovered. The chemical purity of the promethium product at the time of separation exceeded 99.9%. Production was halted in 1967 for equipment modification. The revised flowsheet is shown in Figure 3.6. The first five columns were stainless steel and the last two were glass. The complexant was changed to NTA to reduce the time cycle. An additional 38 runs were made through July 11, 1969.

A total of 11.4 by 10^6 Ci (12.3 kg) of high purity pM (measured at time of separation) was produced in the revised pilot plant.

3.2.1.3 Hot Cell Operating in the Calcination of Liquid Wastes (WSEP)

Pilot plant studies of the calcination of high-level radioactive wastes occurred at Hanford from 1963-1970. This work was part of a world-wide effort to fix radioactive wastes in stable solid media, both to minimize storage costs by reducing volume and containment requirements, and to provide a safe form for the storage of such wastes, and for the storage and shipment of mixed or separated fission products.

In the calcination process, high-level radiation liquid waste obtained in the processing of irradiated fuel was converted to a sinter, slag or glass of relatively high density (2 to 3 g/cm^2), having less than one-tenth the volume of the concentrated waste as stored, and less than 1% that of the raw waste. Calcination studies were achieved through two methods: pot calcination and spray calcination. The necessary operations for both pot and spray calcination were performed by remote control and manipulation within a 7 by 15-ft cell.

In spray calcination, the feed solution was atomized by a steam nozzle at the top of a heated (approximately 750°C) column, and dried and partially calcined by radiant heat. The residue fell into a heated (approximately 850°C) pot at the bottom of the column, wherein the calcination process (dehydration, denitration, desulfation, etc.) was completed and a sinter of melt was formed, depending upon the composition of the residue. The water vapor, evolved gases, and leakage air were drawn through a condenser which removed the water and most of the entrained or soluble radioactive material. Following the condenser were caustic and electrostatic scrubbers, a silica gel bed, and high-efficiency filters for final decontamination of the off-gas. In most cases, however, the scrubber and silica gel had been found to be unnecessary, the condenser filters alone yielding overall decontamination factors in excess of 10%.

In pot calcination, the feed solution was dribbled directly into the pot, which first served as a boil-down concentrator at 100-150°C. Because of the lesser heat transfer as compared to the spray column, and the critical level-control problem, the feed rate was limited to about 1/2 gal/h. On completion of feed addition the temperature was raised and dehydration, denitration, etc., occurred stepwise as the corresponding temperatures were attained, with melting or sintering taking place in the 600-750°C range. Consequently, in pot calcination the off-gas flow was characterized by bursts of the various non-stable constituents, as contrasted with the mere uniform flow and composition obtained during spray calcination. The same feed and off-gas equipment was employed for both types of calcination.

3.2.1.4. Nuclear Waste Vitrification Project

The Nuclear Waste Vitrification Project (NWVP) was initiated to provide a demonstration of the vitrification of high-level liquid waste (HLLW) from spent fuel discharged from an operating LWR, a key to closing the fuel cycle and maintaining reprocessing as a technically acceptable option. At its inception, the NWVP encompassed two tasks of the Commercial High-Level Waste Immobilization Program: Waste Preparation and Radioactive Demonstration of Vitrification. The project was started in April 1976 and terminated in June 1979. The objective of the NWVP was to demonstrate the solidification (vitrification) as a borosilicate glass, of actual high-level liquid waste from spent LWR fuel.

Six pressurized-water-reactor (PWR) fuel assemblies, containing 2.3 tU from an operating light-water reactor (Point Beach), were processed for the generation of HLLW. A conventional PUREX-type process was used for the first NWVP processing cycle so the HLLW simulant generated would be typical of the nitric-acid, fission-product waste stream from the first extraction cycle (HAW) of a commercial plant.

Uranium and non-radioactive chemicals, normally added to the HLLW by back-cycling of waste from second and third solvent extraction cycles, were added to the dilute HLLW to produce a waste composition typical of the HLLW from a commercial plant. The waste was then concentrated tenfold to provide feed for the PNL-developed spray calciner/in-can melting (SC/ICM) process. During vitrification, the liquid waste feed was pumped at a rate of 10 to 15 L/h to the calciner vessel, which was maintained at 1050°C; this canister was attached directly to the bottom of the calciner. Glass-forming chemicals were metered into the canister simultaneously with the calcine. After the materials melted, the canister was cooled to produce a stable vitreous glass. Two 20.3-cm- (8-in.-) diameter by 244-cm- (8-ft-) high canisters containing glass were produced.

Integration of the 325A Building into the NWVP is shown in Figure 3.7. Dissolved fuel from the 324 Building was vacuum-transferred through the interbuilding pipeline to the 325A Building, where it was sampled for Special Nuclear Materials (SNM) accountability and adjusted to 2.5M and 300 gU/L. The uranium and plutonium were then separated from the fission products by solvent extraction. The HLLW, containing most of the fission products, was vacuum-transferred back to the 324 Building for vitrification. The uranium and plutonium were then processed through a cycle of anion exchange, during which the plutonium was partitioned from the uranium and further decontaminated from fission products. Finally, if needed, the plutonium would be processed through a second cycle of ion exchange for additional decontamination; it was then calcined to oxide. The uranium and fission-product waste stream from the ion-exchange cycles was accumulated and disposed of as an intermediate level waste (ILW). A backup dissolver system was provided in the 325A Building for use in the event of a malfunction in the 324 Building dissolver or in the inter-building pipeline.

The major processing components of the 325A Building included a backup dissolver system, a solvent extraction system, two ion-exchange systems (IX1 and IX2), the plutonium calciner, and an off-gas treatment system. Two important supporting systems were the ILW system and the process control instrumentation. The processing equipment is contained in two hot cells (A and C Cells) and in two lightly-shielded glove boxes. Liquid storage tanks are located below the cells and in an auxiliary vault. Chemicals are added to the processing equipment from an aqueous make-up area (AMU) adjacent to the cells and above the change rooms.

3.2.1.4.1 Intermediate-Level Waste Systems. The uranium-bearing streams from the ion-exchange system, along with the streams from the off-gas scrubber, the solvent-wash contractor, and the calciner off-gas condenser, were accumulated continuously in Tank A-10, then batch-transferred to Tank A-11. The transferred solution was sampled for special nuclear material (SNM) accountability, then discarded as ILW by one of two routes: 1) direct vacuum transfer to a 1900-L (500-gal) shielded transfer cask positioned in the Cask Transfer Hood (CTH), or 2) jet transfer to vault Tank PT-2, followed by vacuum transfer at a later time to a 1900-L cask in the CTH. Two identical casks were used in rotation to transfer all ILW by truck from the 325A Building to the 200E Area for disposal.

3.2.1.4.2 Interbuilding Pipeline. During NWVP construction, two 304L stainless steel, all-welded lines, a 3/8-in. Schedule 40 pipe, and a 3/4-in. Schedule 40 pipe were assembled, tested, and drawn through a buried 2-in. Schedule 40, 304L stainless steel, welded pipe, encased within a 4-in. fiberglass-reinforced epoxy pipe. The system was then extended into each building. The pipeline runs at depths ranging from 1 to 4 m (3 to 12 ft) underground.

The 3/8-in. pipe connects the dissolver-solution transfer head pot in B Cell of 324 Building with a block valve in C Cell of 325A Building. A polyethylene jumper, in C Cell, is used to connect the block valve with a line extending to Tank W-5 located in a vault below C Cell. Tank W-5 serves as a vacuum tank for receipt of dissolver solution from the 324 Building. The transfer of dissolver solution through the 3/8-in. pipeline is initiated by: 1) turning on the air lift on the line from Tank TK-126 (the dissolver solution storage tank) to the dissolver solution transfer pot, 2) applying vacuum to Tank W-5, and 3) opening the block valves in C Cell. The vacuum applied to Tank W-5 is controlled by use of an air-bleed tank. Constant communication between the two buildings is maintained by telephone during any transfer. A 25-L flush of 2.5M nitric acid, approximately the volume of the 3/8-in. pipeline, is drawn through the pipe after each transfer of dissolver solution to free the pipe of suspended solids and concentrated uranyl nitrate.

The 3/4-in. pipe connects Tank W-4 in A-Vault of 325A Building with Tank TK-106 in the 324 Building High-Level Vault. The solution is transferred by a steam jet in the 324 Building Pipe Trench. For NWVP purposes, this line is used to transfer HLLW from the 325A Building to the 324 Building.

3.2.1.5 Recovery and Purification of Plutonium and Neptunium from Irradiated Targets

Two sets of irradiation of Neptunium targets were performed in 1969 and in 1970. These were performed in the Hanford K-Reactor. The purpose was to investigate the production of medical-grade ^{238}Pu through this process. Described below are the processes to identify the radionuclides, chemicals, methods, facilities, and waste transfer and storage tanks used.

3.2.1.5.1 1969 Irradiation. Thirty neptunium target elements were irradiated during the summer of 1969. Twelve of the elements were fabricated using aluminum as the matrix material, and 18 were fabricated in graphite pellets. All of the aluminum elements and six of the graphite elements were canned in aluminum, and the remaining graphite elements in Zircaloy-2.

3.2.1.5.2 NpO_2-Al Target Elements. Twelve aluminum target elements were received in B Cell of 325A Building and were cut into two equal-length sections with a mechanical powered saw. The center ballast rods were removed and the sectioned elements plus saw cuttings were then transferred into C Cell for dissolution.

The bisected elements were dissolved in 12 dissolver batches in the C Cell 35-L dissolver. Two bisected sections (equivalent to one full element) were dissolved in 5 to 6 h. Including time required for solution makeup and transfer, dissolution time was usually about 8 h. The processing steps are summarized as follows:

1. A measured 24 L of 8M HNO_3 plus 33.8 grams of $Hg(NO_3)_2 \cdot H_2O$ dissolved in 100 ml of 8M HNO_3 were transferred into the dissolver.

2. One fuel element section was placed in the dissolver basket, lowered into the dissolver, and the dissolver sealed.

3. The vacuum off-gas system was adjusted to continuously sparge the dissolver and draw a negative pressure of 1 to 2 in. Hg.

4. The dissolver was heated by electrical resistance elements on the external surface until the solution temperature, monitored by an internal thermocouple, indicated a mildly exothermic reaction. The initiation temperature ranged from 75 to 105°C. The temperature was controlled by reducing the power and circulating cold water through coils in the dissolver.

5. After the exothermic reaction was completed, the dissolver was cooled and opened, the basket was inspected, and a second section of fuel then dissolved in the same solution.

6. Following dissolution of two fuel element sections per batch of dissolver solution, each batch was vacuum transferred to A Cell. The dissolver solution was accumulated in two separate tanks in A Cell because no single tank was large enough to contain the total volume of solution.

The ion-exchange purification process included the following steps:

1. Feed adjustment of both batches to give Pu^{IV} and Np^{IV} at 7.5M HNO_3.

2. Co-absorption of Pu and Np on a 23-L bed of Dowex 1®, X-3 (30-50 mesh) resin.

3. Co-decontamination with 10.8 bed volumes of 8M HNO_3 containing 0.005M KF at 60°C.

4. Pu partition cycle with 8.3 bed volumes of 5.7M HNO_3, 0.05M hydrazine, 0.05M ferrous sulfamate at 30°C or less.

5. Np product elution from the resin with 0.35M HNO_3 at 60°C.

6. Pu feed adjustment to Pu^{IV} at 7.5M HNO_3.

7. Pu absorption on a 4-L bed of Permutit® SK (50-100 mesh) resin.

8. Pu decontamination at 60°C with 10 bed volumes of 8M HNO_3 containing 0.005M KF.

9. Pu product elution with 0.6M HNO_3 at 60°C.

A brief wash with 8M HNO_3 was interposed between Steps 3 and 4, 4 and 5, and 8 and 9 to prevent contamination with iron or fluoride.

A Cell contains three large tanks (Tank 1 has a 360-L capacity, Tank 2 has a 360-L capacity, and Tank 3 has a 650-L capacity), but only Tank 1 can be heated or cooled. Both the initial feed adjustment (Step 1) and the Pu feed adjustment (Step 6) require extended heating cycles to oxidize Pu^{III} to Pu^{IV}. The run plan specified that the first batch of dissolver solution be collected in Tank 1, the feed adjustment made (Step 1), and the prepared feed then transferred to Tank 2. The second batch of dissolver solution was then accumulated in Tank 1 and the feed adjustment performed. When the co-absorption step was initiated, the feed in Tank 1 was pumped through the resin bed and collected in Tank 3. Tank 1 was then used to accumulate the column effluent waste solution from the last 100 L of the co-absorption cycle and part of the co-decontamination cycle.

All of the ion-exchange columns in A Cell are jacketed and can be heated or cooled. The run plan designated that the resin be removed from the largest column (250 L capacity) and the column be used as a tank to accumulate the effluent solution from the Pu partition cycle (Step 4), and to prepare the Pu feed for the final Pu purification cycle (Step 6). This would permit containment of all liquid waste within the cell until the run was completed and analytical results could be obtained on the solution held in each tank. Unfortunately, 20 to 30 L of water were left in the column after the resin was removed, and this error was not detected until after the partition solution had been accumulated in the column and part of the acid added to adjust to 7.5M HNO_3 (Step 6). The Pu analysis of Tank 1 waste was known, but not the Np analysis. In order to continue with the run, the assumption was made that the Np value would not be greatly different from the Pu value and the waste solution was transferred to a large vault waste tank. Tank 1 was then decontaminated and used to continue the Step 6 feed adjustment.

3.2.1.5.3 NpO_2-Graphite Target Elements. Three batches of graphite elements were involved with this set of irradiations. The first shipment included a total of 18 elements. The second shipment of graphite elements was discharged at a later date. The cans were stripped off at Radiometallurgy and the graphite pellets, segregated in three containers, were transferred into C Cell of 325 Building. A small number of unirradiated Np-graphite pellets was transferred for Np recovery. During the burning and dissolution steps, the groups of pellets were kept separate to maintain their identity as a function of the irradiation history.

The burning was performed on a batch basis in a stainless steel pot approximately 6 in. ID by 10 in. high. The pot was lowered into a small open-top resistance furnace and the furnace temperature controlled manually. A thermocouple in a well on the side of the pot provided temperature information. The pot lid was sealed on carefully machined flat surfaces and was held in place by simple clamps. The off-gas from the pot was drawn through a water-cooled heat exchanger and then through the C Cell dissolver off-gas system. Pure oxygen was introduced into the pot through a ring near the bottom of the pot. Approximately 10 to 12 pellets could be placed in the pot and burned to metal oxide in each 8-h period. The burning temperature target was 800°C. The reaction time at temperature was about 6 h and could be detected by observing the temperature readout record. The burning process is exothermic and once started, the furnace power was decreased to maintain a constant temperature. No attempt was made to determine the oxygen consumption as a function of graphite burned.

The solid residues from the burning step were separately dissolved in a 4-L stainless steel beaker on a hot place with boiling concentrated HNO_3. It was necessary to add a small amount of HF to initiate the reaction. The process was continued for 8 h for each batch. Extra acid was added to maintain a volume of approximately 3 L. After cooling, each dissolver solution was filtered through paper and the paper plus residue washed with dilute acid. After each of the four segregated dissolver solutions had been filtered, the filter papers plus enclosed residues were placed in the burning pot, dried, and heated at 800°C for 8 h with a normal oxygen flow. The contents of the pot were then leached in the pot with concentrated HNO_3 plus a trace of HF for 8 h at near-boiling temperature. After cooling and filtering, this leachate was designated as "scrap recovery." The four dissolver solutions and the scrap recovery solution were then each diluted to 3.50 L in their separate containers and sampled in duplicate.

The four batches of dissolver solution and the scrap recovery solution were combined and adjusted to give Pu^{IV} and Np^{IV} at an acid concentration of 7.5<u>M</u> and a volume of 200 L. This feed solution was processed in two separate runs (100 L of feed for each run) by the ion-exchange process previously described.

3.2.1.5.4 <u>1970 Irradiation</u>. As part of a Douglas United Nuclear-Atlantic Richfield Hanford Company (DUN-ARHCO) project designed to investigate the production of medical-grade ^{238}Pu by irradiation of Np_2O_3 in the Hanford K Reactor, 20 target elements were irradiated during 1970.

The dissolution of the 20 target elements was complicated by a dark solid material which resisted dissolution in 8<u>M</u> HNO_3-0.0034<u>M</u> Hg $(NO_3)_2$ solution at near-boiling temperature. These solids were dissolved by prolonged heating in 12 to 16 <u>M</u> HNO_3 containing some HF. With the exception of the usual accuracy problems associated with the analysis of ^{237}Np in the presence of ^{238}Pu, the ion-exchange recovery, the separation and purification of neptunium and plutonium proceeded satisfactorily. One batch of neptunium exceeded the gamma impurity specifications but was shipped to PUREX and blended with other neptunium.

When transferred to 325A Building, the graphite core elements were segregated from the water core elements and kept separated during the dissolution and processing steps. Both ends of each target were removed with a circular saw to minimize the amount of aluminum dissolved and to facilitate removal of the graphite rods from the graphite core elements. The targets were then dissolved, one at a time, in 8<u>M</u> HNO_3-0.0034<u>M</u> $Hg(NO_3)_2$ in the C Cell dissolver. Up to three elements were dissolved in each 30-L batch and the dissolver solutions were accumulated in A Cell and C Cell tanks. The dissolver solution aluminum concentration must be kept below about 1<u>M</u> to avoid precipitation of aluminum nitrate from the nitric acid solution when it cools to ambient temperature.

When the heel was removed from the C Cell dissolver, following dissolution of the graphite core elements, a considerable amount of dark sludge was found on the bottom of the dissolver. Because of the possibility that some solids had been transferred to the A Cell feed tank with the dissolver solution, an in-line filter was installed between the feed tank and the co-absorption ion-exchange column before the dissolver solution was pumped through the column during the feed absorption cycle. Following the run, the sludge was removed from the filter and from the dissolver, transferred into a large stainless steel beaker, and dissolved by boiling for several hours in 16<u>M</u> HNO_3 containing some HF. Possible residual solids in the feed tank were dissolved by heating 150 L of 12<u>M</u> HNO_3 containing some HF for 30 h at 60-80°C in the tank. These dissolver solutions were then combined, the acid content was adjusted to 8<u>M</u>, and the solution was processed as a second run.

3.2.2 Chemical and Radionuclide Usage

Listed in Table 3.5 are chemical and radionuclide compounds reported to have been discharged to the 325 Building RLWS. Table 3.6 lists chemical and radionuclide species reported to have been used. Chemicals and radionuclides are listed and identified as being used for specific processes. References (i.e., documents, interviews, and laboratory analyses) are listed at the end of each table. These are not complete lists of all chemicals and radionuclides used in the 325 Building RLWS; however, they represent those radioisotopes and chemicals described in the documents reviewed, the interviews conducted, and the data reviewed.

3.2.3 Specific Tank Usage in the 325 Building

Some waste characterization data, internal memos, and RLWS Disposal Approval Requests were available for review. The summaries discussed below represent different waste volumes that were stored (for an unspecified amount of time) or transferred through the RLWS to the 340 Building or to casks. They do not represent all of the transfers that have occurred since the system has been in operation, but do give a glimpse of the types of storage volumes or transfers that have been associated with the system.

3.2.3.1 Tank in Room 32 (Tank TK-1)

Characterization data were reviewed for waste held in Tank TK-1 in Room 32 of the 325 Building. This waste was transferred to the 340 Building. In the data reviewed, the waste was characterized for F, Cl, NO_2, Br, NO_3, PO_4, and SO_4. The highest concentrations of significant levels observed in the data reviewed were 160, 32,500, 14,500, and 250,000 μg/ml for F, Cl, NO_3, and SO_4, respectively.

One set of data for a transfer of process water was reviewed. In a RLWS Disposal Approval Request for 250 gal of process water for two to three times per year, the following data were observed. Radioactive material in the water was at relatively low levels (e.g., total alpha - 10 μCi/ml, total beta - 200 μCi/ml, total gamma - 200 μCi/ml; dose rate - 100 mR/hr). Specific radionuclides included ^{137}Cs, ^{90}Sr, and ^{60}Co.

Another set of data were for cleaning solutions from B Cell that was a total of about 5 gal. The pH was adjusted to a level between 7 and 10 with H_2SO_4 or NaOH depending on the initial pH level. Radioactivity levels were approximately 25 pCi for total alpha, 35 nCi for total beta, and 500 μCi for total gamma. The solutions included ppm levels of Cl, F, SO_4, NO_3, and PO_4.

A third set of data was for double-shell tank and single-shell tank liquid with Cl, NO_3, SO_4, and Na with the balance of water. The pH was 7.0 with the Cl molarity less than 0.01M. Radionuclides present were ^{90}Sr-Y, ^{60}Co, ^{106}Ru, ^{134}Cs, ^{144}Ce, ^{154}Eu, and ^{241}Am. The dose rate was approximately 2 R/h. The volume for each transfer was about 250 gal with a monthly limit of 500 gal. Concentrations of Cl, NO_3, and SO_4 were 16,000, 13,000, and 9,500 μg/ml, respectively.

3.2.3.2 Tank PT-2

A RLWS Disposal Approval Request was completed and acted upon between March and May of 1990 that described a transfer from Tank PT-2 to a cask to the 340 Building drain. The volume transferred was approximately 450 gal. Relatively low levels of radioactivity were included in the transfer (e.g., less than 10 μCi/ml of total alpha, no beta, about 110 μCi/ml total gamma, about 31 grams of total fissile material with a dose rate of 280 mR/hr). Analyses showed levels for Cl, NO_3, PO_4, SO_4, and HNO_3 of 7.2, 64,200, 4, 570, and 2,610 μg/ml, respectively. The associated hydrogen ion concentration in solution was 2.6M.

3.2.3.3 A Cell to Tanks W-1, W-2, and W-3

A RLWS Disposal Approval Request was completed that described a transfer for A Cell to Tanks W-1, W-2, and W-3. The waste stream contained trace amounts of cleaning solution and SST/DST core sample cleaned from the samplers, liners, and in-cell equipment. Radioactivity levels for total alpha, beta, gamma and fissile material were all insignificant. The pH level of the transferred material was approximately 6 or 7 and the transfer was limited to 120 gal per quarter. The chloride level in the tank was less than 0.01M.

3.2.3.4 Tank PT-3

Analyses of contents in Tank PT-3 provided the following results: the waste volume was 210 gal; the pH level of the waste was 0.05; it contained 0.58M HNO_3, 0.5M oxalic Acid, cerium, iron, chromium, nickel, and 1.1 g of plutonium.

3.2.3.5 Tank WT-1

Tank WT-1 has been one of the most frequently used tanks in the 325 Building. During its usage, nitric acid and relatively high levels of radioactivity have been stored in it. Evaluation of the documentation of volume of waste transferred to the 340 Building during the time frame of September 20, 1988 to November 1, 1988 showed that 5 transfers took place. The volumes for the transfers were 1500, 2000, 1000, 1600, and 1650 gal for a total of 7750 gal. Another request for batch transfer included the following information: volume - 7000 gal, total uranium - 14.4 kg of depleted uranium (DU); total plutonium - 15.4 g, ^{237}Np - 0.1 g; pH - 1.2; dose rate at 1 ft from 2-oz. sample was 1.75 mR/h.

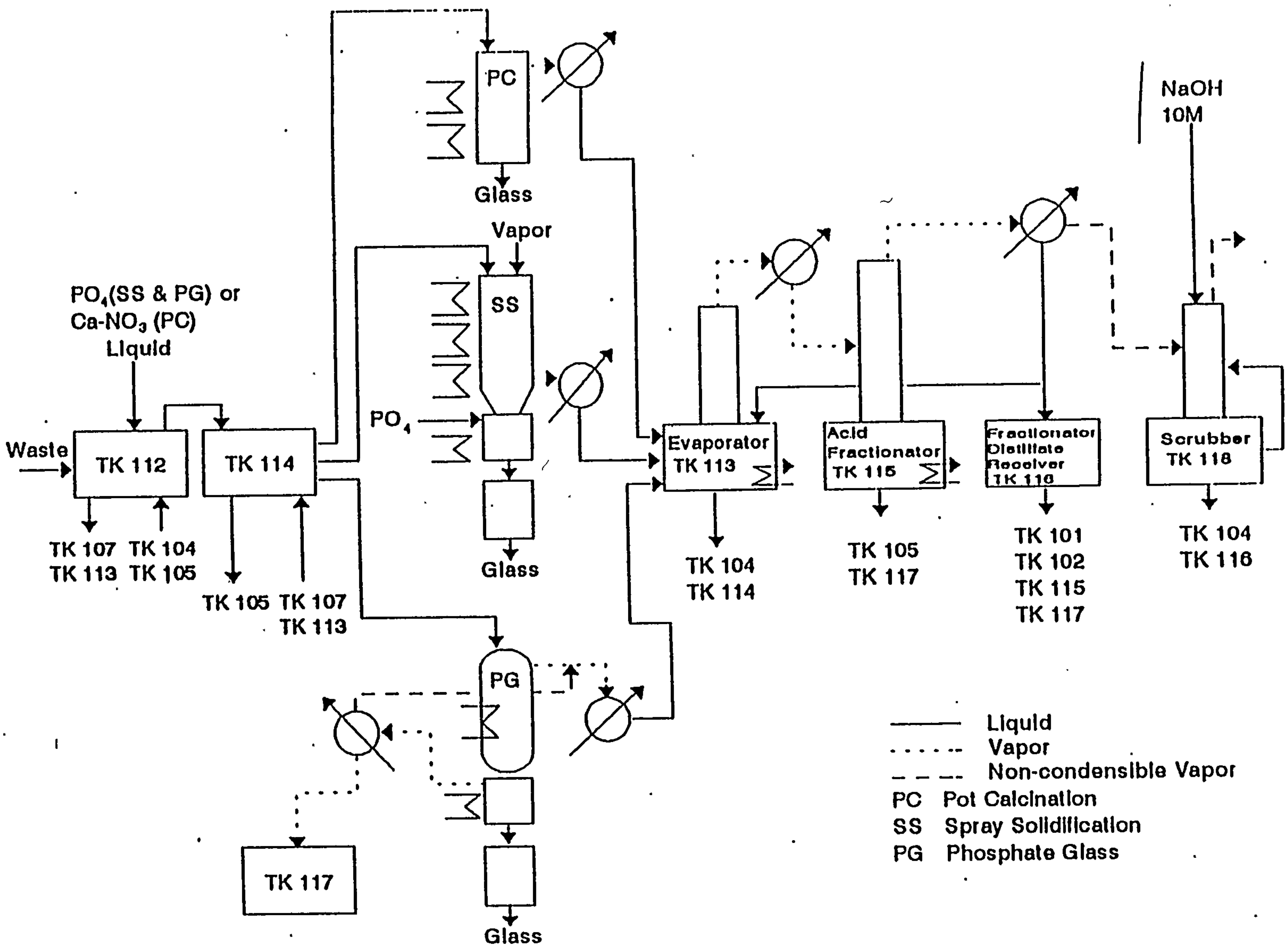


FIGURE 3.1. WSEP Auxiliary System

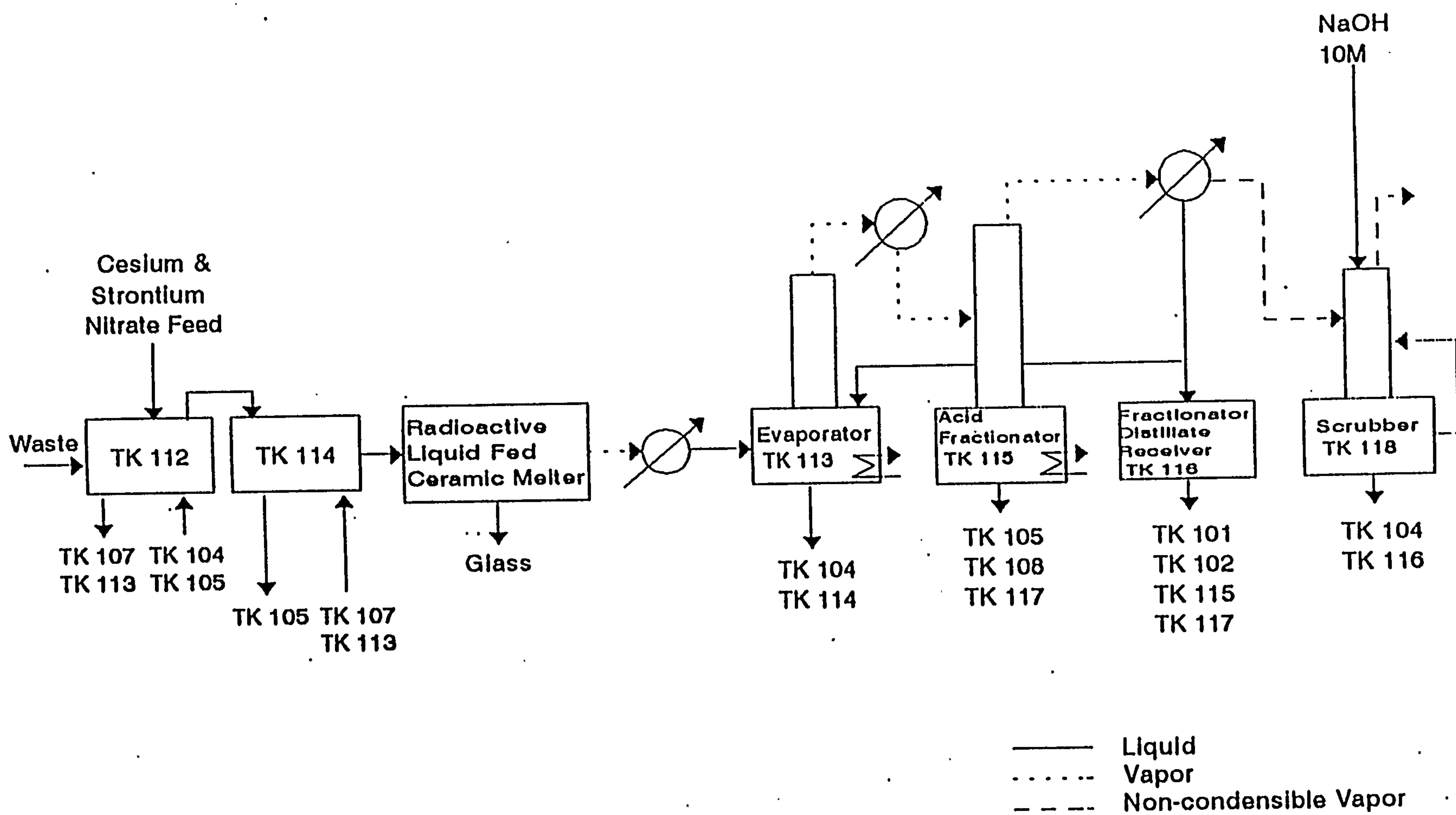


FIGURE 3.2. FRG Program Auxiliary Systems

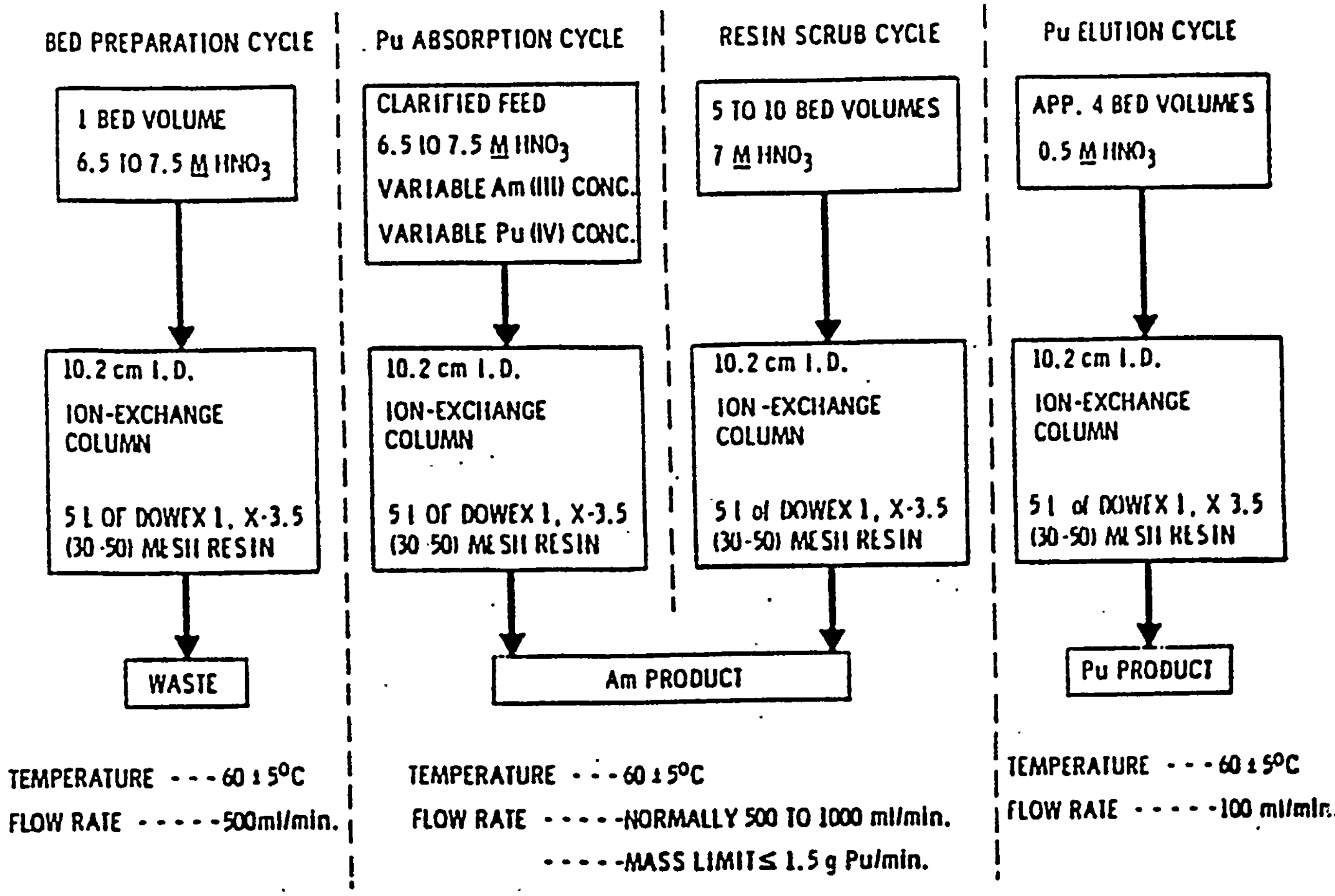
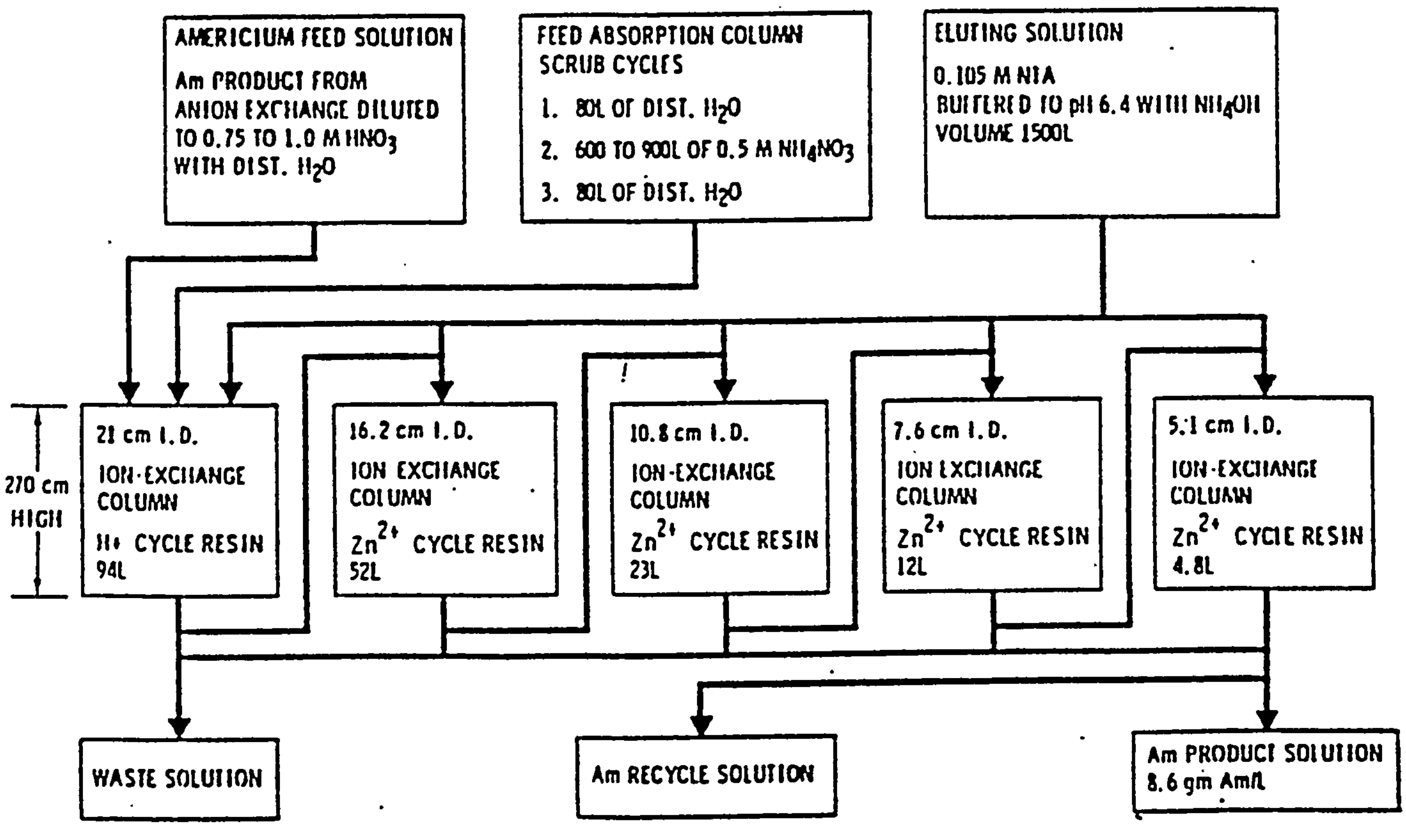


FIGURE 3.3. Flowsheet Used for the Anion-Exchange Separation of Americium from Plutonium



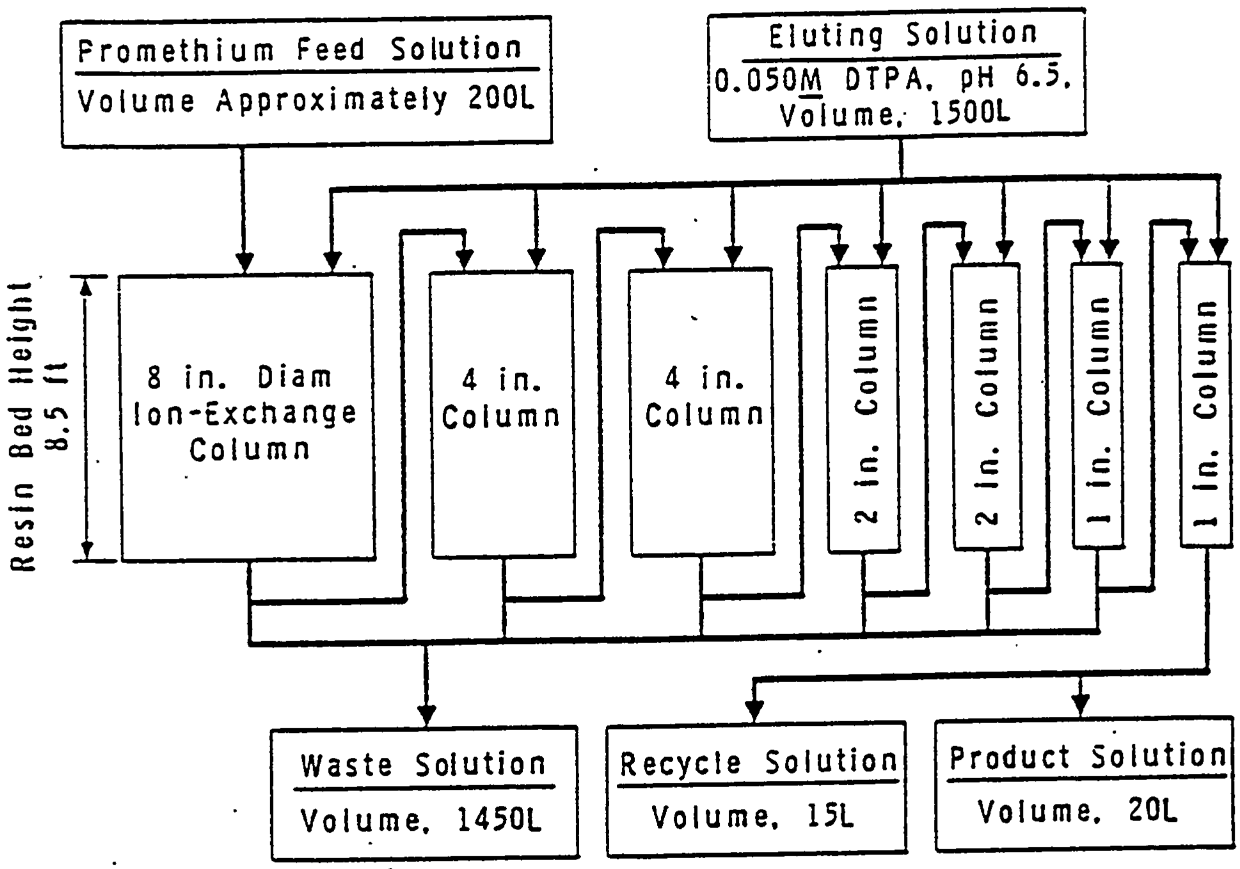
RUN CONDITIONS

RESIN - DOWEX 50W, X-8 (50-100 MESH)
FEED AND SCRUB CYCLE TEMPERATURE - - AMBIENT
ELUTION TEMPERATURE - - - - - - - - - - - - 60 ± 5°C
FEED AND SCRUB CYCLE FLOW RATES - - - - 1 TO 2 L/min
ELUTION CYCLE FLOW RATE - - - - - - - - - - 8ml/min - cm^2
RATE OF BAND ADVANCE - - - - - - - - - - - 43 ± 4 cm/hr

RUN CYCLE TIME

FEED CYCLE - - - - - - FEED DEPENDENT
SCRUB CYCLE - - - - 16 hrs
ELUTION CYCLE - - - 40 hrs

FIGURE 3.4. Flowsheet Used for the Cation-Exchange Purification of Americium



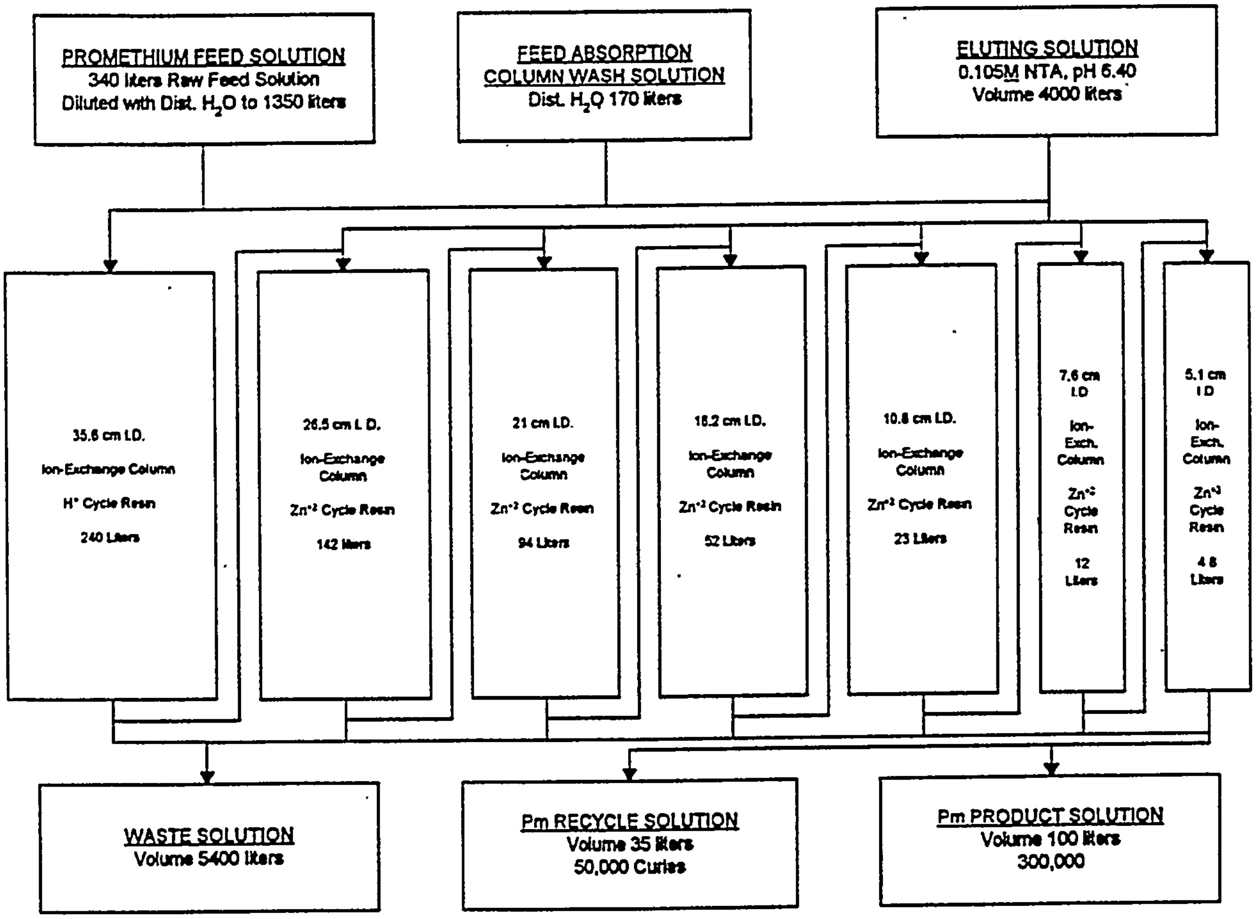
Run Conditions:

Elution Temperature	65 C
Elution Flow Rate	4 ml/min-cm^2
Rate of Band Advance	16-18 cm/hr

Run Cycle Time

Absorption Cycle	4 hr
Elution Cycle	160 hr
Turn Around Time	72 hr

FIGURE 3.5. Promethium Purification Flowsheet



RUN CONDITIONS

Elution Temperature	60 to 65°C
Feed and Wash Solution Flow Rates	3.8 ml/min-cm²
Elution Cycle Flow Rate	8 ml/min-cm²
Rate of Band Advance	35 cm/hr

RUN CYCLE TIME

Absorption & Wash Cycle	7.5 hours
Elution Cycle	60 hours
Turn Around Time	48 hours

FIGURE 3.6. Optimum Promethium Purification Flowsheet in Revised Equipment

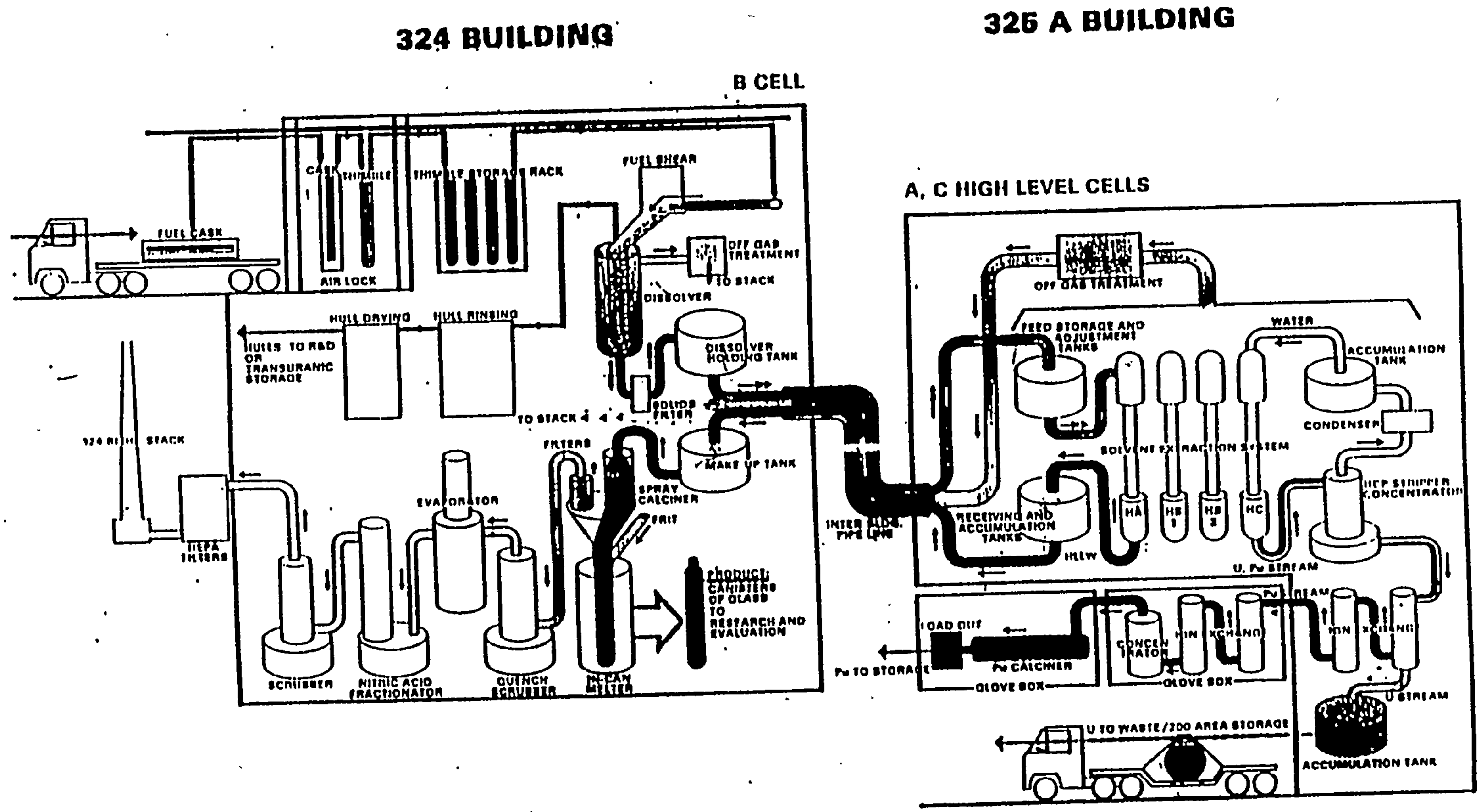


FIGURE 3.7. Nuclear Waste Vitrification Project

TABLE 3.1. Average Radiochemical Characteristics of the FRG Canisters

Campaign	Average ^{137}Cs Content/Canister kCi	Average ^{90}Sr Content/Canister kCi	Average Decay Heat/Canister, Watts	Average Surface Exposure Rate, R/hr
RLFCM-7	192	85	1490	272,000
RLFCM-8	78	143	1330	112,000
RLFCM-9	207	130	1860	310,000

TABLE 3.2. Analytical Status of 324 Building Vault Tank Samples as of June 7, 1990

Analyses	Vault Tank							
	TK-101	TK-102	TK-103	TK-104	TK-105	TK-106	TK-107	TK-108
pH	6.33	7.27	8.39	1.4(0.1N)	1.5	6.19	0.7(0.85N)	<1(4.28M)
Sr-90, d/m-ml	1.38E6	3.65E5	1.76E6	1.52E9	1.40E10	3.54E6	9.23E10	2.16E7
Total U, μg/ml	0.17	0.11	0.30	0.17	0.96	4E-2	4.9	<0.19
Fluoride, ppm	<20	1.5	7.6		648[a]	34		146
Chloride, ppm	143	65	166	<500[b]	3678[a]	152	<15[b]	218
Nitrate, ppm	<40	<0.8	<0.8		300[a]	89		1000
Nitrite, ppm	60	<0.8	0.8		38650[a]	NA[c]		27,900
Phosphate, ppm	1630	405	55		<40[a]	<40		<40
Sulfate, ppm	204	115	188		1976	<40		152
Cs-137, d/m-ml	6.54E6	1.81E6	6.80E6	1.09E9	2.64E10	5.22E6	1.42E11	5.25E8
Cs-134, d/m-ml	2.41E3	1.10E3	3.83E3	---	---	4.22E4	6.47E8	---
Sb-135, d/m-ml	4.71E3	---	3.71E3	---	---	---	---	3.09E5
Eu-154, d/m-ml	3.11E4	---	---	---	3.77E5	5.69E4	1.50E9	---
Am-241, d/m-ml	---	---	---	---	1.55E5	---	---	---
Total, d/m-ml	5.04E5	2.31E3	8.83E3			9.00E4	2.32E9	5.41E3
ICP (attached)	(3)	(3)	(3)	(3)		(3)	(3)	(3)
Total Carbon ppm	1782	297	2595			10.9		34.9
Total Organic Carbon ppm	1779	257	2272			10.4		34.7
Total Inorganic/ Carbon as C ppm	3	40	323			0.5		0.2

a - Samples were taken 7/17/90
b - Samples were taken 6/18/90

TABLE 3.2 (ATTACHMENTS). Inductively Coupled Plasma (ICP) Analytical Results

Constituent	Vault Tank						
	TK-101 µg/ml	TK-102 µg/ml	TK-103 µg/ml	TK-104 µg/ml	TK-106 µg/ml	TK-107 µg/ml	TK-108 µg/ml
Al	478	2000	379	3.0	367	175	23.5
As		(24)			(4.9)		
B	396.4	176	281	5.47	262	131	42
Ba	97.5	404	822	1.90	78.6	1074	7.0
Be						394	
Ca	204.3	734	172	12.6	165	44	25.0
Cd						800	
Co						405	
Cr	4.87	(1.1)	(.59)	.48	(.43)		27
Cu		1.7	.79	5.04	26.8		
Dy				2.84		12200	
Fe	40.4	237	24.9	7.88	144		100
K	79	99	79	2.1	22	820	
La				2.0			
Li						44	
Mg	10.3	25	11.2	2.84	13	220	
Mn	2.66	1.6	1.1	5.42	.51	1340	645
Na	1477	3950	1497	45.9	731	190	*
Ni	8.22	1.5		1.49	3.6	360	30
P	477	162	29	11.5			
Pb		7.4	(4.4)	15.6	2.10		
Rh						830	
Se						390	
Si	310	1650	429	19.6	190.8	660	28
Sr	2.0	7.93	1.8	15.4	1.6		2.5

Procedure and M&TE used: PNL-SP-7/WA 55672.
All tabulated values have been corrected for lab dilution. Values in ( ) are approaching or at detection limit.

TABLE 3.2 (ATTACHMENTS). (cont.)

Constituent	Vault Tank						
	TK-101 µg/ml	TK-102 µg/ml	TK-103 µg/ml	TK-104 µg/ml	TK-106 µg/ml	TK-107 µg/ml	TK-108 µg/ml
Te						120	
Ti	3.9	14.8	2.7	.19	2.80		25
V						93	
Zn	2.1	16.5	2.8	1.2	5.2	620	12
Zr	2.0	6.55	1.6	2.78	1.4		740

Procedure and M&TE used: PNL-SP-7/WA 55672.
All tabulated values have been corrected for lab dilution. Values in ( ) are approaching or at detection limit.

TABLE 3.3. Solution Types and Volumes in the 324 Building Vault Tanks

Vault Tank (Waste Type)	Solution Type[13]	Volume, Gallons June 1990[13]	Volume, Gallons April 1993[14]
TK-101 (LLV)	Low-Level Condensate	1472	940
TK-102 (LLV)	Low-Level Condensate	1872	Empty
TK-103 (LLV)	Low-Level Condensate	1488	Empty
TK-108 (LLV)	Contaminated Nitric Acid	1871	Empty
TK-104 (HLV)	Dilute Cesium Nitrate Solution	1440	400
TK-105 (HLV)	Dilute Strontium Nitrate Solution	543	16
TK-106 (HLV)	Low-Level Process Solution	270	Empty
TK-107 (HLV)	Process Solution from Fuel Reprocessing Operations	194	92

TABLE 3.4. Reference List of Chemical and Radionuclide Compounds Reported to Have Been Used in the 324 Building RLWS

Chemicals/ Radionuclides	Bldg. 321 Processes	WSEP	NWVP	FRG	Post FRG Program	Not Program Specific (Deconning, etc.)
Acetic Acid						14
$Al(NO_3)_3$						1
Carbon Tetrachloride						14,15
Chloriform						14
$Cr(NO_3)_3$			8			
$CsNO_3$				4		
CsCl				2, 4 (trace)		
$CuNO_3$						16
$Fe(NO_3)_3$		10	8			
H_2SO_4						14
H_3PO_4		6 (residual)	8	5	16	3,7,16
Hexone						15
HNO_3	12	9	8			1,14,15
Hydrogen Peroxide						15
$K_2Cr_2O_7$ (potassium dichromate)						1
$K_2C_2O_4$ (potassium oxalate)						1
Na_2CO_3	12					
$NaNO_3$	12		8			
NaOH		9				1,15
Na_3PO_4 (Trisodium Phosphate)						1

TABLE 3.4. (cont.)

Chemicals/ Radionuclides	Bldg. 321 Processes	WSEP	NWVP	FRG	Post FRG Program	Not Program Specific (Deconning, etc.)
$Ni(NO_3)_2$			8			
SiO_3		9,10,11				
$Sr(NO_3)_2$				4		
SrF_2				2, 4 (trace)		
Trichloroethylene						14
Tributyl Phosphate (TBP)			8			
Turco Agent						1
Uranyl Nitrate			8			

TABLE 3.4. Reference List of Chemical and Radiochemical Species Reported to Have Been Used in the 324 Building RLWS (continued)

Chemicals/ Radionuclides	Bldg. 321 Processes	WSEP	NWVP	FRG	Post FRG Program	Not Program Specific (Deconning, etc.)
Ag			8			
Al		9,10,11		17		
Am			8		13 (Lab Analysis)	
As			8			
Ba		9,10,11	8	17		
Ca				17		
Cd			8	17		
^{144}Ce			8	17		1
Cl					13 (Lab Analysis)	4 (trace)
Cm			8			
Co		9,10				
Cr		9,10,11		17		14
^{137}Cs			8		13 (Lab Analysis)	7,14,16
^{134}Cs					13 (Lab Analysis)	
Cs				17		
Cu		9,10				
Dy			8			
Eu			8		13 (Lab Analysis)	
F					13 (Lab Analysis)	4 (trace)
Fe		9,10,11		17		
Gd			8			
Ge			8			

TABLE 3.4. (cont.)

Chemicals/ Radionuclides	Bldg. 321 Processes	WSEP	NWVP	FRG	Post FRG Program	Not Program Specific (Deconning, etc.)
H^+		9,10,11		17		
In			8			
K		9,10,11				
La			8	17		
Mg				17		
Mn				17		
Mo		9,10,11	8			
Na		9,10,11		17		
Nd			8	17		
Ni		9,10,11				
Nitrates (NO_3^-)	12	1,9,10,11		17	13 (Lab Analysis)	14
Nitrites (NO_2^-)	12	11			13 (Lab Analysis)	
Np			8			
Pb				17		
Pd			8			
Phosphates (PO_4^-)		9,10,11			13 (Lab Analysis)	
Pm			8			
Pr			8			
Pu			8			
Rb			8			
Rh			8			
Ru		9,10,11	8			
Sb		9,10	8		13 (Lab Analysis)	
Se			8			

TABLE 3.4. (cont.)

Chemicals/ Radionuclides	Bldg. 321 Processes	WSEP	NWVP	FRG	Post FRG Program	Not Program Specific (Deconning, etc.)
Sm			8			
Sn		9,10	8			
^{90}Sr		9,10,11	8	17	13 (Lab Analysis)	14,16
Sr				17		
Sulfates (SO_4^-)		9,10,11			13 (Lab Analysis)	
Tb			8			
Tc			8			
Te		9,10	8			
U	12	9,10,11	8		13 (Lab Analysis)	1
Y+Rare Earths		9,10,11	8			
Zr		9,10,11	8			

References:

1. Interview with Frank Haun, 1/25/93.
2. Interview with Langdon Holton, 2/1/93.
3. Interview with Jeff Surma, 2/1/93.
4. Interview with Bruce Katayama, 2/3/93.
5. Interview with Bill Bjorklund, 2/3/93.
6. Interview with Rudy Alleman, 2/3/93.
7. Holton et al. 1989.
8. Wheelwright et al. 1979.
9. McElroy et al. 1972.
10. Mandel and McElroy 1972.
11. Rey 1966.
12. Interview with Gil Nicholson, 3/23/93.
13. Analysis of 324 Vault tanks, June 7, 1990.
14. PNL 1991b.
15. Ebasco 1990.
16. Transfer Logs and History Sheets.
17. Boil Down Run Plan, Strontium Waste Preparation in Support of RLFCM-8.

TABLE 3.5. Reference List of Chemical and Radionuclide Compounds Reported to Have Been Used in the 325 Building RLWS

Chemicals	Projects							
	Ion Exchange	WSEP	NWVP	A Cell Special Projects	B Cell Special Projects	C Cell Special Projects	Waste Characterization	Misc.
$AL(NO_3)_3$								
$C_2H_2O_4$	8							
$Cr(NO_3)$			7					
$CuNO_3$								
DTPA	4,8					3		
EDTA	4					3		
$Fe(CN)_6$								
$Fe(NO_3)$			7					
Ferrous Sulfamate				5		I-EW		
H_2SO_4								
H_3PO_4 (75%)			7					
$HCl\text{-}Cl_2$						2		
HEDTA	4							
HF				5,6				
$Hg(NO_3)_2$				5,6				
HNO_3		7	7	5,6		I-EW		
Hydrazine				5				
KCL								
KF				5				
$KMnO_4$								
KNO_3						2		
NaCl-KCl								
NaOH		1						
$NaNO_3$			7					
NH_4F								
NH_4NO_3	8							
NH_4OH	4,8							
$Ni(NO_3)$			7					

TABLE 3.5. (cont.)

Chemicals	Projects							
	Ion Exchange	WSEP	NWVP	A Cell Special Projects	B Cell Special Projects	C Cell Special Projects	Waste Characterization	Misc.
NO_3		1(LA)					LA	
NpO_2-Al				5				
NTA	8							
PO_4		1(LA)						
$PuCl_3$					2			
PuO_2					2, I-EW			
SiO_3		1(LA)						
SO_4		1(LA)					LA	
SrF_2					I-EW			
Steam								I-JG
Turco agent								I-JG
U_3O_8						2		
UCl_4						2		
UO_2						2, I-EW		
UO_2Cl_2						2		
$ZnNO_3$								

1. Mandel and McElroy 1972.
2. Swanson et al. 1961.
3. Swanson 1982.
4. Wheelwright et al. 1966.
5. Wheelwright 1970.
6. Wheelwright 1971.
7. Wheelwright et al. 1979.
8. Wheelwright 1980.
9. Allemann 1963.
10. 325 Building FEMP (PNL 1991c).
11. EBASCO 1990.
12. 325 Building SAR (PNL 1991a).
13. SARA List of Chemicals for the 214 and 325 Buildings.

NOTE: LA = Laboratory Analyses
I-EW = Interview, Earl Wheelwright
I-FR = Interview, Frank Roberts
I-JG = Interview, John Green
I-RS = Interview, Rick Steele

TABLE 3.6. Reference List of Chemical and Radiochemical Species Reported to Have Been Discharged to the 325 Building RLWS

Radionuclides	Projects							
	Ion Exchange	WSEP	NWVP	A Cell Special Projects	B Cell Special Projects	C Cell Special Projects	Waste Characterization	Misc.
Ag-111m		1(LA)	7(LA)					
Al	4,8	1(LA)		5,6		3		
Am-241	4,8, I-EW		7(LA)				LA	
Am-243	8							
As			7(LA)					
Ba		1(LA)	7(LA)					
C						2		
Ca	4					3		
Cd		1(LA)	7(LA)					
Ce-141			7(LA)	5				
Ce-144	4	1		5			LA	
CePr-144		1						
Cl						2	LA	
Cm-244	8,I-EW		7(LA)					
Co-60						3	LA	
Cr	4	1(LA)						
Cs-134		1		5			LA	
Cs-137		1(LA)	7(LA)	5			LA	I-RS
CsCl					I-EW			
Dy			7(LA)					
Eu-154	4,8	1	7(LA)				LA	
Eu-155		1					LA	
F		1(LA)					LA	
Fe	4	1(LA)				3		
Gd	4		7(LA)					
Ge			7(LA)					
H-3		1(LA)						
In			7(LA)					

TABLE 3.6. (cont.)

Radionuclides	Projects							
	Ion Exchange	WSEP	NWVP	A Cell Special Projects	B Cell Special Projects	C Cell Special Projects	Waste Characterization	Misc.
K						3		
La	4		7(LA)					
Mg	4					3		
Mo		1(LA)	7(LA)					
Na	4	1(LA)				3		
Nb-95			7(LA)	5				
Nd	4	1						
Ni	4	1(LA)				3		
Np-237			7(LA)	5,0		I-EW		
Pa-233				5				
Pb	4	1						
Pd		1(LA)	7(LA)					
Pm-147	4, I-EW, I-FR		7(LA)					
Pr	4		7(LA)					
Pu-238			7	5,6		I-EW		
Pu-239			7	5				
Rb		1(LA)	7(LA)					
Rh		1(LA)	7(LA)					
Ru-103		1	7(LA)	5				
Ru-106		1(LA)	7(LA)	5				
Sb-125		1(LA)	7(LA)					
Se		1(LA)						
Sn		1(LA)	7(LA)					
Si	4							
Sm-151	4	1	7(LA)					
Sr-89		1						
Sr-90	I-EW, I-FR	1(LA)	7(LA)					I-RS

TABLE 3.6. (cont.)

Radionuclides	Projects							
	Ion Exchange	WSEP	NWVP	A Cell Special Projects	B Cell Special Projects	C Cell Special Projects	Waste Characterization	Misc.
Tb			7(LA)					
Tc-99		1(LA)	7(LA)					
Te		1(LA)	7(LA)					
Uranium		1(LA)	7					
Y	4	1(LA)	7(LA)					
Zn	4							
Zr-95		1(LA)	7(LA)					

1. Mandel and McElroy 1972.
2. Swanson et al. 1961.
3. Swanson 1982.
4. Wheelwright et al. 1966.
5. Wheelwright 1970.
6. Wheelwright 1971.
7. Wheelwright et al. 1979.
8. Wheelwright 1980.
9. Allemann 1963.
10. 325 Building FEMP (PNL 1991c).
11. EBASCO 1990.
12. 325 Building SAR (PNL 1991a).
13. SARA List of Chemicals for the 214 and 325 Buildings.

NOTE: LA = Laboratory Analyses
I-EW = Interview, Earl Wheelwright
I-FR = Interview, Frank Roberts
I-JG = Interview, John Green
I-RS = Interview, Rick Steele

4.0 DESIGN ASSESSMENT PLAN

The Design Assessment Plan, or design assessment, completes two broad-based objectives. First, an engineering evaluation of the facilities and systems in their as-is condition is completed to demonstrate that sufficient structural strength, commensurate with code and regulatory requirements, is present for safe waste retention. The engineering evaluation also focuses on the materials of construction and their long term compatibility (e.g., corrosion integrity) with the contained waste forms.

A second objective of the design assessment effort is to provide a focal point for documenting (collating) all design affecting data obtained from both field inspections and archival sources. In overview, this effort collates and coordinates pertinent results of the facility/tank design consideration task (Section 2.0), waste characterization task (Section 3.0) and the field efforts of the integrity assessment (Section 5.0). It is expected that the integrity assessment effort will interact actively with the design assessment activity. For example, it is envisioned that the engineer will, in part, guide the field inspection scope from design assessment results of structures, materials or systems. Conversely, field results may alter the engineer's effort in completing the design assessment report and the associated documentation package. Additionally, the results/documentation developed under the design assessment will aid in defining Phase 2 responsibilities and tasks. For example, the engineer's study and compilation of field inspect experiences (results, equipment performance, etc.) will aid in defining the scope of tasks needed to complete inter-facility assessments of buried piping and the consequent logical division of responsibilities.

The design and integrity assessment efforts will thus likely combine to yield the following itemized program results:

1. Design Assessment: A design evaluation of each tank (or group of tanks) and associated ancillary equipment to address:

   - Design description/as-is condition
   - Waste form characterization/corrosion potential
   - Operational loads
   - External (e.g., seismic) loads
   - Structural evaluation/rationale for scope of analyses (e.g., application of field inspection inputs)

2. Integrity Assessment: Leak test for each tank and ancillary equipment which includes:

- Leak measurement instrumentation.

- Visual inspection of the exterior surface for leakage and/or evidence of previous leakage (discoloration). Visual inspection will likely require use of a remote video camera in high radiation areas.

3. Integrity Assessment: Visual inspection of each tank and ancillary equipment to confirm that the as-built configuration conforms to the design requirements.

4. Integrity Assessment: Limited NDE of selected tanks and piping, where tank selection is based on identifying that tank in a vault or room which has been subject to the most corrosive waste and/or waste feed solutions. Such NDE will have to be performed remotely for those tanks and piping located in high radiation areas. NDE will be used to identify and characterize corrosion and cracks.

5. Integrity Assessment: Visual inspection of secondary containment features associated with each tank and piping to confirm the as-built configuration conforms to the design requirements.

6. Design Assessment: Complete a design report to provide a record (permanent documentation) which demonstrates compliance with applicable hazardous/radioactive waste storage standards. In itemization the report shall:

   - Comply with IAP QA documentation requirements

   - Collate all pertinent design integrity affecting data gathered from field (integrity assessments), literature and archival sources

   - Demonstrate code (facility/pressure boundary) compliance

   - Demonstrate regulatory compliance

   - Certification by a registered Professional Engineer

Given that the salient objectives and products of the design and integrity assessment efforts (i.e., Sections 4.0 and 5.0) have been highlighted we examine in the following subsections the detailed elements of the design assessment effort. Principally, this includes a discussion of the structural evaluations to be performed (including potential ignorable concerns), a brief and preliminary discussion of the corrosion potential and aging, and finally a discussion of past facility operating occurrences.

4.1 DESIGN STANDARDS EVALUATION

Assessment of the design integrity of existing tank systems is a WAC requirement. WAC 173-303-640-(2)(c) requires that an ". . . assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated, to ensure that it will not collapse, rupture, or fail." Additionally, the contract statement of work requires assessment of the tank system secondary containment with the requirements of WAC 173-303-640(4), which will be addressed in Section 6.0.

Completion of these design assessment requirements may logically be modelled after the customary architect/engineer functions associated with a safety-related nuclear or hazardous waste facility. Normally, the design assessment functions are largely comprised of the routine application of the various engineering discipline skills. However, the assessment task for the 324/325 Building waste facilities is complicated by varying degrees of uncertainties involving, for example, the contained waste form, past operational experiences, as-built design descriptions, and materials of construction. Nevertheless, the design assessment functions needed to fulfill the WAC requirements, remains largely unchanged from the task outline that would be applied to a new facility design situation. Thus, the basic design assessment tasks that are deemed pertinent, and sequentially logical, are outlined as follows:

- Design Standards/Regulatory Requirements
- Facility Design Description
- Facility Loads (Operating) Definition/Service Life
- Design (Structural) Evaluation
- Design Code Compliance
- Certified Design Report (Permanent Documentation/QA).

Each of the above task areas are broken down into more detail and discussed in the following subsections. Issues and remedial steps needed to address uncertainties of the facility design, or past operation, are included in the discussions as appropriate.

4.1.1 Design Standards - Regulatory Requirements

Section 1.2 stipulates the regulatory requirements applicable to the design assessment of the Building 324/325 facilities containing mixed hazardous/radioactive wastes. The WAC and Title 40 CFR Part 265 are the pertinent regulations which shall be reviewed in detail to identify the design assessment requirements. The engineer shall document compliance to an itemization (summary) of the regulatory requirements in the final design assessment report. In accordance with good engineering practices the engineer may include requirements beyond the scope of the regulations, as necessary, to assure defensibility of the final design assessment report and ultimately safe operation of the facility.

The original facility design standards and related information, as can be retrieved (see Section 2.0), will be compared to a slate of modern design standards encompassing civil structure design and qualification of pressure boundary systems. Specifically, for comparison it is proposed to use the following design standards:

Civil Structures:	UCRL 15910, (UBC 1991)
Piping:	ANSI B31.1, 1992
Tanks:	ASME Section VIII, Division 2, 1992

The design standard comparison will identify significant differences in the physical requirements of the systems, for example, wall thickness, design practices, and/or material requirements. The engineer will apply engineering judgment in the consideration (identification) of "significant" deviations of modern design codes with respect to the as-constructed (and present condition) of the 324/325 waste facilities. The engineer shall then rationalize in the design assessment report the consequences of the code deviations, in terms of design margin, safety, or facility life. The comparison will specifically not identify inconsistences in non-physical requirements such as inspection practices and material certification requirements.

4.1.2 Design Description

Waste storage vessels and associated ancillary equipment require structural evaluation to demonstrate regulatory compliance. Ancillary equipment is defined in WAC 173-303-040 as:

> ". . . any device including, but not limited to, such devices as piping, fittings, flanges, valves and pumps that is used to distribute, meter, or control the flow of dangerous waste from its point of generation to a storage or treatment tank(s), between dangerous waste storage and treatment tanks to a point of disposal on-site, or to a point of shipment for disposal off-site."

Piping connected to the waste tanks provides a variety of functions, including liquid transfer, instrumentation access, tank venting, cooling/heating water supply and return, etc. Many of these functions involve piping whose failure would not result in hazardous waste leakage. Integrity assessment is only required for piping whose failure could result in leakage of hazardous waste. In making a determination as to whether failure of a specific piping system could result in leakage of hazardous waste, consideration must be given to elevation and pressurization of the tanks, slope of piping and potential for siphon, routing of pumped transfer piping and characteristics of pumping system.

Section 4.1.2.1 outlines design features and broad-based parameters which may prove critical in the design assessment of primary waste retaining tanks and ancillary equipment. Section 4.1.2.2 outlines facility features which from the outset are deemed to be excludable from the scope of the IAP, as well as identifying systems requiring critical design assessment efforts.

4.1.2.1 Design Attributes of Tanks and Ancillary Equipment

The facility design description (as it pertains to the design assessment effort) is focused on providing those physical characteristics required by the engineer to complete a comprehensive structural (or "code") evaluation. The facility design description will be gleaned from both archival documentation sources and complimentary data obtained from in-situ (or remote hot-cell) observations and tests (refer also to the integrity assessment of Section 5.0). Specifications, standards, drawings, material/weld records and data obtained from field assessments shall be organized and compiled (appended) as reference documents into the engineer's final design assessment report. The engineer shall also aid in guiding the field integrity assessment effort by identifying critical inspection locations and/or special tests (e.g., material samples) that may be critical to the completeness and cogency of the design evaluation effort (i.e., the final design assessment report). Critical inspection locations shall be as determined from the engineer's structural evaluation of the vessel/piping high stress points. Alternatively, critical inspection locations may be identified where design practices or presumed fabrication techniques have yielded sites for corrosion, erosion, or other identifiable degradation mechanisms recognizable to the engineer. Examination of the identified critical inspection locations may test the practical limits of NDE application, or general area access, or both. The engineer, if required, shall thus be responsible for selecting alternative inspection points and inspection methods such that a rationale for bounding the degradation at the limiting sites can be established.

A proposed pre-examination list (i.e., prior to having field integrity assessment results) of critical design feature data would include some or all of the following parameters.

- Facility layout and arrangement drawings. Detailed component design drawings. Piping fabrication drawings with pipe schedules, support locations and restraint type. Equipment anchorage details. Vault design details including penetration details (particularly critical where differential settlement or seismic displacements of buried piping is to be considered). In the absence of such information the engineer shall review the critical elements of the facility design and devise an inspection plan to obtain at least a minimum set of data to define the pertinent geometric characteristics. For example, assumptions on the support spacing of inaccessible piping in pipe chases may be based on the spans from observable portions of the facility. or pictorial records. Conversely, the need for some design inputs may warrant the engineer's recommendation for special field measures. For example, partial excavation of a buried structure/pipe.

- Original design/QA standards/specifications, Purchase orders. and fabrication records.

- Materials of construction, including material properties as follows:

  - material specifications tabulated by component (e.g., tank, piping service, etc.)/plate thicknesses (when used)
  - yield and ultimate strength (room temperature yield strength probably acceptable)
  - Young's modulus, Poisson's ratio, thermal coefficient of expansion
  - Fracture mechanics properties, K_{Ic}, K_{SCC}, ΔK_{th}, da/dN curves, Charpy V-notch energy, nil-ductility data
  - weld filler material specification
  - thermal conductivity, weight density
  - corrosion rate data.

The engineer may find that the full slate of material properties cited above is not essential to completion of the design assessment. It is expected that feedback between the integrity assessment (field inspections) and waste form characterization effort (Section 3.0) will fix the engineer's analysis scope and thereby dictate the material properties needed. Securing all of the required material property data will likely require utilization of data obtained during field measurements and from samples taken from in-situ components. Given the difficulty in obtaining field data, the engineer will limit requests for such material data and determine, to the extent which is defensible, material properties from the literature and existing documentation. It is recognized, pragmatically, that in-situ material sampling, if deemed essential, may only be feasible where personnel access is viable. Robotic material extraction is not proposed since the economics tend to be prohibitive, and secondly, it is presently judged that the facility service conditions (past and future) are not severe enough to warrant in-situ material extractions (i.e., combining analytic, material literature studies, NDE, and visual examination inputs will likely yield a satisfactory facility qualification basis).

4.1.2.2 Non-Critical (Unassessed) Facility Design Features

Figures 4.1 through 4.20 provide process schematics, and Table 4.1 provides a functional description for the piping connected to each tank within the scope of this IAP. Note that at the end of Table 4.1, a legend of abbreviations is provided. A review of these figures/tables reveal candidate design assessment areas as well as potentially excludable system features. Discussion of the primary piping services and their likely assessment status is provided below.

- Instrumentation piping - Instrumentation piping enters the top of the tank and, by specification HWS-7486 (and by drawing notes), is required to be continuously sloped upward to the instrument. Thus, there would be no siphon potential for such piping and leakage of hazardous waste as a direct result of such piping failures would be precluded.

- Vent piping - Vent piping enters the top of the tank and, by specification HWS-7486 or as noted on drawings, is required to be continuously sloped upward to the vent supply (e.g., tank). Thus, there would be no siphon potential for such piping and leakage of hazardous waste as a direct result of such piping failures would be precluded. Integrity assessment of vent piping is not required.

- Pumped liquid transfer piping - Liquid is transferred from the tanks via jet pumps using process steam or water as the driving fluid. The jet pumps are located at the top of the tanks. Suction piping enters at the top of the tanks and discharge piping routes to another tank or the RLWS.. Pumped transfer piping is continuously sloped from the pump to the receiving tank or RLWS entry point. Integrity assessment of pumped liquid transfer piping is required.

- Process steam/water piping - Process steam or water is used as the driving fluid for the jet pumps. During pumping operations, the driving fluid and tank liquid wastes are mixed in the venturi. Thus, only very limited contamination of driving fluid piping immediately adjacent to the venturi would be possible as the pumping operation is started and stopped. Integrity assessment of driving fluid piping immediately adjacent to the pump will be assessed in conjunction with the associated pumped liquid transfer piping.

- Liquid drain piping into tank - In service drains that discharge to a tank enter the tank at the top and are continuously sloped from the source to the tank. Integrity assessment is required for such drain piping if it is used to transfer hazardous waste. Drains which have been removed from service and plugged do not require integrity assessment provided instructions have been issued which preclude future use.

- Sparger piping - Sparger piping provides compressed air to mixing spargers located near the bottom of the tanks. Such piping enters at the top of the tanks and provides no potential for siphoning tank waste upon piping failure. Thus, integrity assessment of sparger piping is not required.

- Sample piping - Sample piping enters the top of the tank and, by specification HWS-7486 or as note on drawings, is required to be continuously sloped upward to the sample chamber. Thus, there would be no siphon potential for such piping and leakage of hazardous waste as a direct result of such piping failures would be precluded. Integrity assessment of sample piping is not required.

- Jacket water piping - This piping provides cooling or heating water to the jackets surrounding the central portion of certain tanks. These jackets are welded to the outside of the tanks. The only way that jacket water could become contaminated with tank waste would be as a result of tank wall failure in the jacket area. Thus, integrity assessment of jacket water piping is not required.

- Other RLWS piping - Such piping routes liquids from the various tank systems and building drains to building 340 for disposal. Building 340 and much of the transfer piping is under the custody of WHC and not subject to integrity assessment under this contract.

4.1.3 Load Definition/Service Life

The facility, or process, loadings are generally benign for the waste storage systems under consideration. Normal operation (storage) is generally conducted at atmospheric pressure and ambient temperature conditions. Process systems (steam transfers or chemical flushing) may create slight vacuums in portions of the system while at other locations modestly elevated temperatures and pressures may result. Initial assumptions for the range of operating conditions shall be as follows:

Ambient Temperature Range:	-15 to 115°F
Vacuum (external pressure):	0.15 psi
Maximum Process Temperature:	175°F
Maximum Process Pressure:	2.0 x tank static head

The engineer shall review the above loadings for applicability to the portion of the facility under design assessment. Operational data revealed by the facility characterization effort may also be used as a basis in the final design assessment report.

It is assumed that the waste form requires little cooling other than natural convection heat transport. Thus the only off normal loading to be considered in the facility design assessment is seismicity. Significant wind or tornado loads are deemed not credible for the construction (or location) of the storage areas under consideration. Flooding, or the potential for flooding, shall be considered under conditions of the maximum predicted 25-yr 24-h rain fall. Additionally, the flooding potential (threat, if any) from ruptured building services shall be considered. Seismic load inputs shall be as specified by the UBC Code (see citation Section 4.1.1). However, pending final determination of the facility Safety Classification the design standard for seismic loading may require reevaluation.

Definition of service life will be established by the engineer from consideration of degradation due to corrosion, fatigue, or other time-dependent mechanisms. Conversely the facility owner may request a qualification assessment for a specified (desired) service period. The engineer may stipulate facility inspection requirements to support the assessment of service life.

4.1.4 Design (Structural) Evaluation

Information collected as part of the design description effort (Section 4.1.2), waste characterization (Section 3.0), and field integrity assessments (Section 5.0) will be combined to complete the design assessment. The design evaluation scope will encompass the tanks and ancillary equipment. The scope of the evaluation shall be limited to the critical features of the facility, or features that are representative of significant portions of the facility. In other terms, the engineer shall review, select and document the bases for determining the limiting components for evaluation. The intention is to infuse a sense of economy in completing the assessment while maintaining a focus on the technical credibility of the final design assessment report. It is also recognized that the evaluation boundaries, or scope, may of necessity be set by factors of limited access or incomplete design information. In these instances the engineer shall develop a rationale and statistical basis (if appropriate) for enveloping these "missing" inputs (or design features).

The design assessment evaluation will consider temperature, pressures, dead weight, flooding, and seismic loads primarily for the tank, piping and pipe support restraint systems. Calculations for the tanks will be performed to determine hydrostatic and hydrodynamic loads on the bottom of the tanks, shell stresses, required shell and head thicknesses, and nozzle reinforcements. Fracture mechanics techniques shall be applied to assess flaw stability, leak-before-break integrity and stress corrosion cracking potential (tank and piping components). Fabrication stresses (e.g., pipe bends, formed heads, welding, etc.) shall be considered in the assessments of corrosion material loss and fracture safety, or flaw propagation. Thermal stress (thermal fatigue) resulting from observed constraints, if any, (e.g., tank anchorage systems) shall be considered. The seismic integrity of tank anchorage features connecting to the secondary containment structure shall be completed.

Structural evaluation calculations may be performed by computer based finite element techniques or manual closed-form solutions. Given the nature of the generally modest load definition it is expected that the majority of the structural evaluation will rely on rudimentary manual calculations, including minimum flaw size determination for calibration of NDE inspection activities. Conversely, it may be expedient to utilize computer based fracture mechanics codes to assess, for example, situations of potential stress corrosion crack propagation at sites of residual weld stresses. Again, the engineer shall strive for economy in setting the scope of the evaluation while assuring defensibility of the final design assessment report conclusions.

Based upon the analyses detailed above, an attempt will be made to demonstrate that the 324/325 Building tank systems either have not experienced general corrosion, stress corrosion cracking damage, or radioactive damage from the wastes and waste feed solutions (compatibility), or have experienced damage at a slow rate (system components have defined finite lives). Additional testing, such as ultrasonic testing, will be evaluated and recommended if determined necessary during the course of the design assessment effort. The design assessment will permit conclusions to be made about current facility integrity and life expectancy as determined by inputs from past operating experiences, waste characterization, facility inspections and testing, from perhaps both NDE and destructive sampling measures.

4.1.5 Design Code Compliance

The design assessment shall be conducted to demonstrate compliance with the design codes of Section 4.1.1. Technical (design code) inconsistencies will be dispositioned item by item in the design assessment report. In this fashion areas of facility design, if any, not conforming to modern code design practices will be identified. The engineer shall infuse conservatisms into the facility design assessment where deficiencies between the as-constructed facility (or in-situ condition) and modern code requirements are identified. The objective is simply to establish a parity between the safety margins for the facility as it exists, and the allowable loads (or design safety margins) that would be realized under a new design utilizing the selected design standards.

4.1.6 Certified Design Report

The design assessment task shall be completed in conformance with quality assurance program requirements as stipulated by Section 7.0. A documentation package consisting of the engineer's detailed calculations, collected reference materials (including characterization results), and field inspection and test reports. The design assessment report shall be sufficiently detailed in scope (problem statement, assumptions, methods, and conclusions) such that a third party peer level reviewer may audit the work without recourse to the preparing engineer for clarification. The design assessment report shall be certified by a registered Professional Engineering with respect to issues of pressure boundary qualification. Additionally, corrosion assessments documented in the design report shall be reviewed by a National Association of Corrosion Engineers (NACE) Certified Corrosion Specialist.

4.2 WASTE COMPATIBILITY AND AGING CONSIDERATIONS

Section 4.2.1 discusses the basic corrosion mechanisms which are deemed applicable to the design assessment effort. The discussion concludes with a preliminary ranking (best estimate) of the corrosion potential for each of the tanks within the 324/325 facilities. Section 4.2.2 highlights application of corrosion and aging related degradation mechanisms as they may apply to the design assessment of structural integrity.

4.2.1 Corrosion Assessment

Subsections 4.2.1.1 through 4.2.1.5 provide an assessment of the potential corrosion mechanisms which may affect the integrity of the tanks. A description of corrosion properties of austenitic stainless steels and the corrosion based limits for the RLWS are included to provide baseline references for performing the assessment. Since most of the waste characterization information is based on process knowledge, the assessment is considered to be speculative. The value of the assessment is to provide a qualitative comparison of the potential for each of the tanks which may be susceptible to corrosion. This information can then be utilized to support decisions regarding priorities for implementing examination of the tanks. In addition the corrosion evaluation will be useful in supporting design assessment actions following examination of the tanks.

4.2.1.1 Materials of Construction

With the exception of two tanks, WT-1, and Tank TK-1 (Room 32) in the 325 Building, the piping and tanks were reported to be constructed from austenitic stainless steels. The specific alloy used for constructing Tank TK-1 is unknown (there were no drawings located on this tank). One reference reported WT-1 to be a carbon steel tank (Ebasco 1990); however, there were no drawings located for this tank and the materials of construction could not be verified. Based on pictures of the tanks during construction of Building 325 vaults WT-1 does not appear to be constructed of carbon steel. Table 4.2 identifies the specific stainless steels used for each of the tanks, tank top/side/bottom thickness, and approximate date of construction. Most of the tanks constructed in the 1940's utilized columbium (niobium) stabilized stainless steels, however after the early 1950's low carbon austenitic stainless steels were also used. Type 302Cb stainless steel was used as the material of construction for Tank PT-4, and also reported to have been used in most of the tank cooling/heating jackets and some modifications to the tanks. Type 302Cb stainless steel is a previous version of Type 347 stainless steels. Table 4.3 provides the approximate chemical composition of the various tank materials used.

4.2.1.2 Corrosion Properties of Austenitic Stainless Steels

Austenitic stainless steels are considered to have the best overall corrosion resistance of all the stainless steels and to be the most resistant to industrial atmospheres and acid media. These alloys have excellent resistance to nitric acid at practically all concentrations and temperatures. Austenitic stainless steels perform best under oxidizing conditions since their resistance is dependent on an oxide film that forms on the surface of the alloy (also referred to as passivity). However, reducing conditions and chloride ions destroy this film and cause rapid attack (Schweitzer 1983). The three principal localized corrosion mechanisms for austenitic stainless steels are pitting, crevice corrosion, and stress corrosion cracking. Parameters that affect the severity of localized corrosion include chloride ion concentration, solution pH, temperature, dissolved oxygen content, certain anions or cations, and flow rate of the solution (Johnson 1992).

Types 304L and the columbium stabilized austenitic stainless steels are specifically alloyed to resist intergranular corrosion and stress corrosion cracking (SCC). Intergranular corrosion and SCC can occur if the stainless steel becomes "sensitized". Sensitizing occurs in austenitic stainless steels because the solubility of carbon in these alloys decreases so rapidly with decreasing temperature, that chromium carbides can precipitate if these alloys are slowly cooled. During slow cooling through the critical range of 850 to 400°C, chromium atoms are removed from the grain boundary region due to the precipitated chromium carbides. Consequently, the regions adjacent to the grain boundaries have their chromium contents lowered to less than the critical 12% needed for corrosion resistance, and the alloy becomes susceptible to intergranular corrosion. In-field welding and improper annealing can cause sensitizing by slow cooling through the critical temperature ranges. Resistance to sensitizing in type 304L stainless steels is obtained by limiting the carbon content to 0.03%, which is below the solid-solution levels. Types 309Cb and 347 are stabilized by alloying columbium to form columbium carbides in preference to the chromium carbides (Uhlig 1985; Fontana 1986).

4.2.1.2.1 Pitting. Types 304L, 347 and 309Cb may be susceptible to pitting corrosion if subjected to an aggressive pitting media such as high chloride and fluoride contents, and low pH. Pitting may not initiate for an extended time after exposure to the solution, but once started, it can produce rapid attack. Molybdenum which is generally added to austenitic stainless steels (i.e., type 316) to increase resistance to pitting, is not alloyed in types 304L, 347 and 309Cb. Other conditions which are considered to accelerate pitting corrosion include (Uhlig 1985):

- High oxygen concentration in chloride environments (e.g., NaCl solutions).
- Operating temperatures above 60-80°C. (To avoid stress corrosion cracking and to minimize pitting, operating temperatures in NaCl solutions should be kept below 60-80°C).
- The presence of ferric ions and cupric ions, which are reported to greatly increase localized attack if present in chloride solutions (Johnson 1992).

4.2.1.2.2 Crevice Corrosion. Localized corrosion may occur within crevices or other shielded areas on steel surfaces exposed to chloride solutions. The small volumes of stagnant solutions in crevices can achieve localized concentrations of chloride that are much higher than that of the bulk solution. Crevice corrosion is primarily of concern in the piping systems which may have crevice-like features where solutions may accumulate (Johnson 1992). Observations in laboratory tests (pH 7, temperature 24-60°C) which demonstrate the effect of Cl^- concentration on crevice corrosion to be negligible at 250 ppm but significant above 750 is apparently consistent with industrial experience (Johnson 1992).

4.2.1.2.3 Stress Corrosion Cracking. Austenitic stainless steels can be susceptible to stress corrosion cracking (SCC) in certain chloride environments. SCC is a term used to describe service failures in engineering materials that occur by slow, environmentally induced crack propagation. The observed crack propagation is the result of the combined and synergistic interaction of mechanical stress and corrosion reactions. The stresses required to cause SCC are small, usually below the yield stress, and are tensile in nature. The stresses can be externally applied, but residual stresses (such as those from welding) often cause SCC failures (Jones 1992).

A critical feature for producing SCC of austenitic stainless steels in chloride solutions is the operating temperature. The effect of solution pH is complex, but generally solutions of high alkalinity are less likely to induce SCC. The traditional engineering viewpoint, based on practical experience, has been that chloride SCC does not occur in nonsensitized austenitic stainless steels at temperatures below 60°C, in near-neutral chloride solutions (Jones 1992). However, other sources report that stress corrosion cracking generally occurs at temperatures above 50°C (Dillon 1990). Cracking at ambient temperature has occurred (albeit very rarely), in solutions with very high chloride ion concentrations in highly acidic solutions, or in the presence of additional chemical species such as hydrogen sulfide, hypochlorites, or ferric ions (Dillon 1990). Under specific strongly acid conditions SCC has occurred at even lower temperatures than 60°C. However, failure at temperatures below 80°C are rare when solution pH is between 7 and 12 (Truman 1977).

A broadly accepted chloride level below which pitting and/or SCC is eliminated does not exist. This is due to 1) undetected active species in solutions which can aggravate cracking, and 2) localized high chloride concentration independent of the bulk solution causing pitting. Evaporation and occlusion of chloride ions in surface films are one example of localized chloride concentrating mechanisms (Dillon 1990). A review of the chloride ion concentration limits for the 204-AR Waste Unloading Facility was performed to evaluate the potential for detrimental effects on the facility from solution transfers exceeding 0.01M Cl^-. Table 4.4 shows the results of a literature search from the review (Johnson 1992). An additional reference states that there is no lower threshold concentration of chloride for chloride0induced SCC of 300 series stainless steels, and the temperature threshold for SCC has no lower bound (McIntyre 1987).

The presence of detrimental impurities such as ferric ions or hydrogen sulfide in the chloride solutions or chloride ion concentrating mechanisms (i.e., evaporation processes occurring in piping) could alter the corrosion behavior from that expected for straight chloride solutions. In these cases, even the limit of 0.01M chloride ions may be too high to provide the intended degree of protection against localized corrosion.

The review concluded that waste solutions containing 0.01 to 0.03M chloride ions most likely would not cause damage to an austenitic stainless steel system, provided the following limits were adhered to:

- Short duration and low frequency of these solutions in contact with the system.
- Solution pH in the range of 7 to 14.
- Solution temperatures below 50°C.
- Low levels of solution impurities known to aggravate localized corrosion (Johnson 1992).

4.2.1.3 RLWS Limits

In 1990, WHC established operating limits for the RLWS to protect the austenitic stainless steel from potentially corroding (Table 4.5) (McCarthy 1984; Schwartz 1991). The justification for these limits is provided below. A comparison of the Table 4.5 limits to the data obtained during the tank waste characterization effort is included in Section 4.2.1.5 as part of the corrosion assessment to the tanks.

The range for the pH is selected to keep standing solutions at low points in the system in reducing conditions that would not aggravate existing active corrosion sites and below reducing conditions strong enough to raise caustic cracking concerns. Maintaining the pH in this range also minimizes the formation of hydrofluoric acid for any F^- in the system.

The Cl^- limit of $<0.01\underline{M}$ (355 ppm), is consistent with other Hanford corrosion based technical specifications for austenitic stainless steels components that have shown no significant deterioration and is considered to be within the generally accepted level for corrosive service of austenitic stainless steels (Godfrey 1991).

Although, Cl^- ions are the primary concern for breakdown of the protective film on the stainless steels, other halogen ions (i.e., F^-, Br^-, I^-) may also attack this film. For the RLWS, low volumes of these constituents are expected due to their limited use in the 300 Area laboratories. Limiting the pH to a reducing condition is considered sufficient to minimize localized attack from F^-, Br^-, I^- (Ohl 1990).

4.2.1.4 Corrosion Assessment of RLWS Tanks and Piping

Data presented in the waste characterization sections (3.1 and 3.2) suggest that most of the tanks and piping may have been subjected to one or more of the conditions which could potentially cause corrosion: solutions with halides and low pH, and temperatures exceeding 50-60°C. In addition, although the tanks are not pressurized and are not routinely stressed, residual stresses at welded areas are most likely present, potentially contributing to stress corrosion cracking. Without knowing the length of time and frequency a tank was subjected to detrimental conditions, it is difficult to assess the potential for corrosion and/or stress corrosion cracking. However, based on process knowledge information it is unlikely that any of these tanks were subjected to the above mentioned detrimental conditions for any length of time, thereby greatly minimizing the potential for pitting corrosion and/or stress corrosion cracking to occur. The piping may well be susceptible to crevice corrosion if these features are present in the system.

Based on available process knowledge of the tanks contents, Table 4.6 presents a ranking of the 324 Building tanks in decreasing order, as to the potential for corrosion. Since this ranking is based on information that is not necessarily complete (Section 3.1 provides data on what types of waste that could have been in the tanks, but not necessarily <u>everything</u> that was in the tanks), the ranking in Table 4.6 should be reviewed with discretion. It should be noted that several of the tanks have the same ranking are considered to be relatively equivalent with respect to corrosion potential. Table 4.6 also includes the primary reason for corrosion potential and referenced section which identifies the section within this document that provides more detail on the waste characterization.

For the 325 Building, it was more difficult to make a preliminary assessment of each tanks corrosion potential. Lack of specific information on the tanks and their functions makes it difficult to assess their corrosion potential. However, Tanks WT-1 and TK-1 (Room 32) may have been subjected to more use and the most severe conditions, respectively. Based on available analytical data TK-1 in Room 32 has received waste that contained Cl^- concentrations significantly greater than 0.01M (355 ppm), and in some cases as high as 32,500 μg/ml (0.93M) (see section 3.2.3.1 for more detail). Solutions from tanks W1, W2, W3, PT-1, PT-2, and PT-3, are all transferred to WT-1 prior to transfer to Building 340. Because of this, Tank WT-1 is reported to have been used most frequently and is also the largest of the tanks. The limited analytical data available for the tanks contents, is insufficient to provide a correlation to their historical functions (Section 3.2.3.2 through 3.2.3.5).

4.2.1.5 Other Corrosion Mechanisms

Biological corrosion from sanitary water in contact with the tank cooling jackets may also be a concern. If the water was allowed to be stagnant in jacket (i.e., if they are not able to drain completely) for lengths of time bacterial-assisted corrosion may occur. Biological corrosion is not a type of corrosion; it is the deterioration of a metal by corrosion processes that occur directly or indirectly as a result of the activity of living organisms. Bacteria grows on sulfur or carbon sites and may affect the protective film of austenitic stainless steels[18] (Fontana 1986).

4.2.2 Corrosion/Aging Assessments in Design

Waste compatibility and aging assessments falling within the scope of the facility design assessment effort encompass consideration of a broad range of basic environmental parameters and affects. These general aging parameters may be grouped, for design assessment purposes, as:

- Corrosion
- Erosion, fretting, fretting fatigue, fretting corrosion
- Temperature, thermal fatigue

[18] Interview with Dick Westerman and Mike Danielson, 2/9/93.

- Irradiation.

Section 4.2.1 outlined various corrosion mechanisms for the presumed materials of construction and contained waste forms. Of fundamental interest is evaluation of tank and piping pressure boundary integrity assuming minimum wall thickness conditions resulting from the predicted (limiting) material loss due to the corrosion aging mechanism. Additionally, erosion estimates and fretting observations (e.g., fretting locations at pipe supports) shall be included in the assessment of pressure boundary minimal wall thickness. Portions of these inputs are likely to be empirically derived from field observation (including NDE), and are speculated to hold little consequence. For example, the systems are essentially operated statically with little or no dynamic loading or movement, thus fretting locations are judged unlikely. Similarly, erosion phenomena is presumed virtually nil due to assumed low process flow velocities and temperatures.

The design assessment, for thoroughness, shall document the pressure boundary material loss mechanisms which were postulated and rationalize (provide basis) for those aging phenomena which may be considered as having no consequence to the facility integrity. Additionally, the design assessment activity shall provide a focus to the integrity assessment effort (Section 5.0) to assure that field observations/tests needed to complete the design evaluation are obtained. The engineer responsible for completing the overall design assessment may develop inspection checklists to facilitate the thoroughness of the field surveys and thereby substantiate the conclusions of the design assessment.

Potential pressure boundary degradation mechanisms such as stress corrosion cracking or crevice corrosion (refer to Section 4.2.1) shall be considered in the design evaluation. These phenomena shall be considered in the design assessment utilizing fundamental principles of fracture mechanics in conjunction with the pertinent material characteristics deemed appropriate by the corrosion/materials engineer (e.g., da/dN curves, K_{SCC}, ΔK_{th}, etc.). The design assessment shall also review the facility design to identify physical locations of potential corrosion cracking (e.g., weld residual stress areas, partial penetration welds at nozzles, cold formed heads and pipe fittings, thermal constraints, known areas of lack of weld fusion, cooling water jacket stay features, etc.). Again, field inspections completed under the integrity assessment activity shall support the P.E.'s recommendations for developing (documenting) inputs needed for the design assessment. For the facility service conditions established by the engineer and stabilized materials of construction (i.e., SCC resistance), it may be likely that threshold crack propagation levels (ΔK_{th}) may not be achieved. Nevertheless documentation of such favorable results shall be completed.

Given the nature of the facility with its generally benign ambient and process temperature environment it is expected that relatively little in the way of thermal aging effects need be considered. No high temperature phenomena such as creep, creep rupture, or creep-fatigue interaction are expected to be present and active mechanisms. However, the design assessment shall consider potential areas of mechanical constraint (e.g., vessel anchorage) which even at relatively low differential temperatures may develop modest thermal stress states and potential cyclic loads (low temperature fatigue). Additionally, upon on final determination of the materials of construction, a review of the potential for nil-ductility transition temperature affects (brittle failure) shall be completed (e.g., some martensitic structures in stainless steels tend to have elevated NTD temperatures).

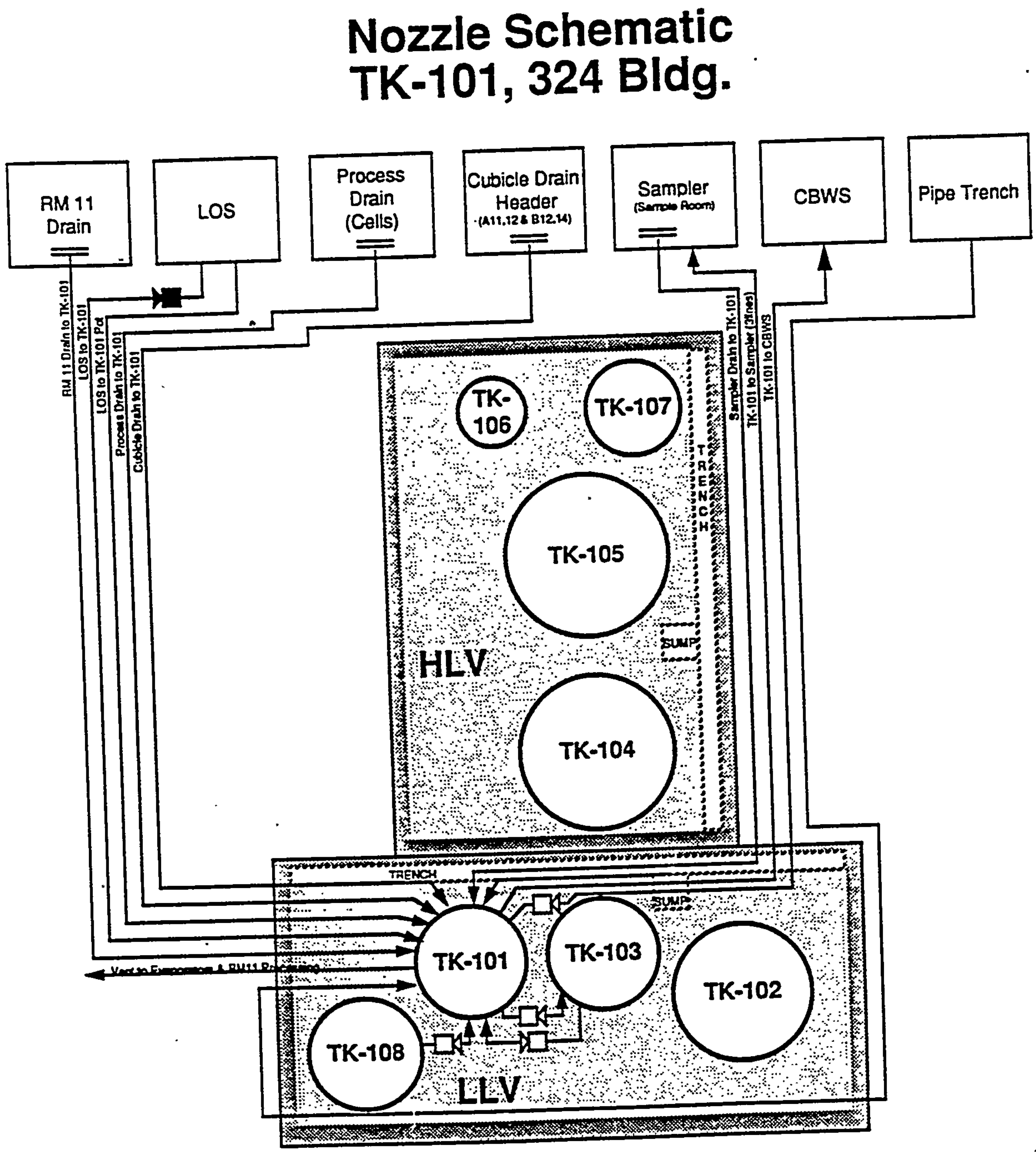
In general it is presumed that neutron flux with energies in excess of 0.1 MeV are not present or the exposure is low such that the total neutron fluence is limited. Thus, consideration of potential neutron embrittlement effects will not be required.

4.3 CONSIDERATION OF PAST OPERATING OCCURRENCES

A total of three spills have been observed for the buildings and the RLWS piping that is included in the assessment scope.

- The 325 building had a spill due to the overflow of a tank. An improperly installed level detector resulted in the tank overflow situation.
- Because the 325 building vaults are not under a roof as they are in 324 building, approximately 8,000 gal of rainwater drained between cover block joints and collected in one inadequately sealed vault (Ebasco 1990).
- A section of RLWS line that connects Building 329 and the first downstream valve box suffered corrosion that eroded through the line. The condition may be attributed to a low point in the line. The leak was detected in the pipe annulus. That 150-ft section was subsequently taken out of service and replaced with a plastic-in-plastic encased pipe (Ebasco 1990).

Figure 4.1



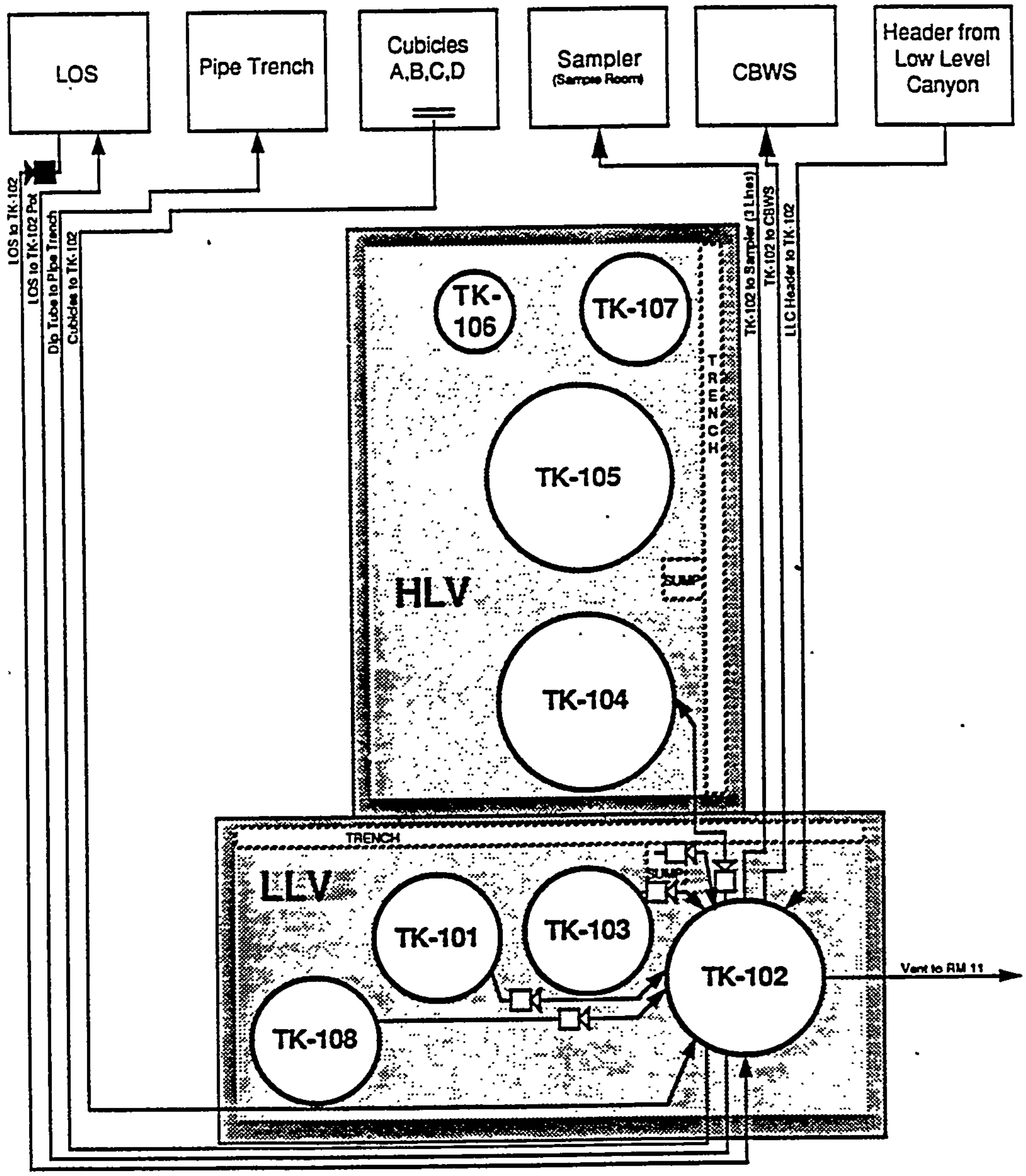
- Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted

Jet Pump inside Vault (Regardless of Location on Graphic)

Jet Pump outside Vault (Regardless of Location on Graphic)

Figure 4.2

Nozzle Schematic
TK-102, 324 Bldg.



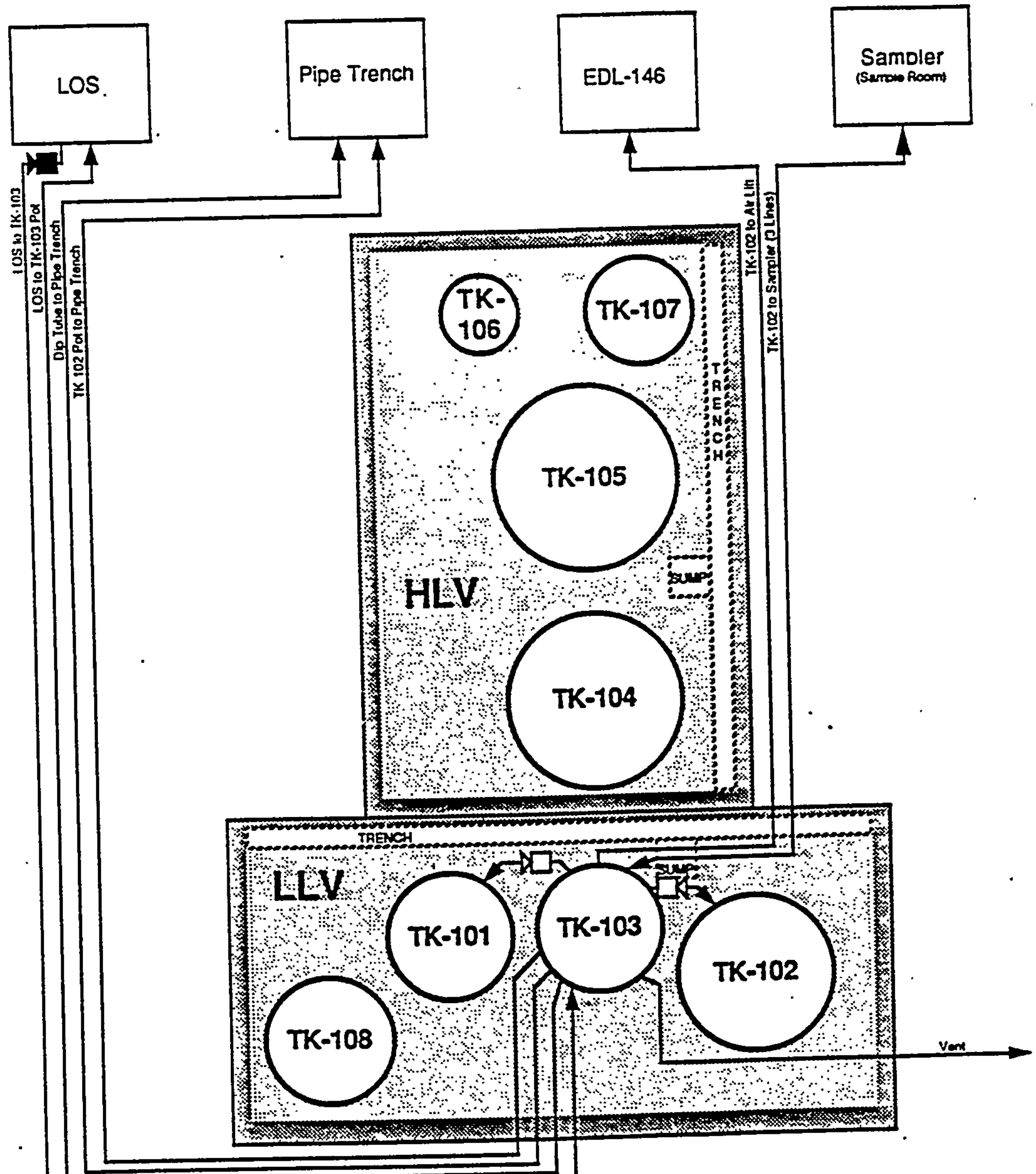
- Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted

Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.3

Nozzle Schematic
TK-103, 324 Bldg.



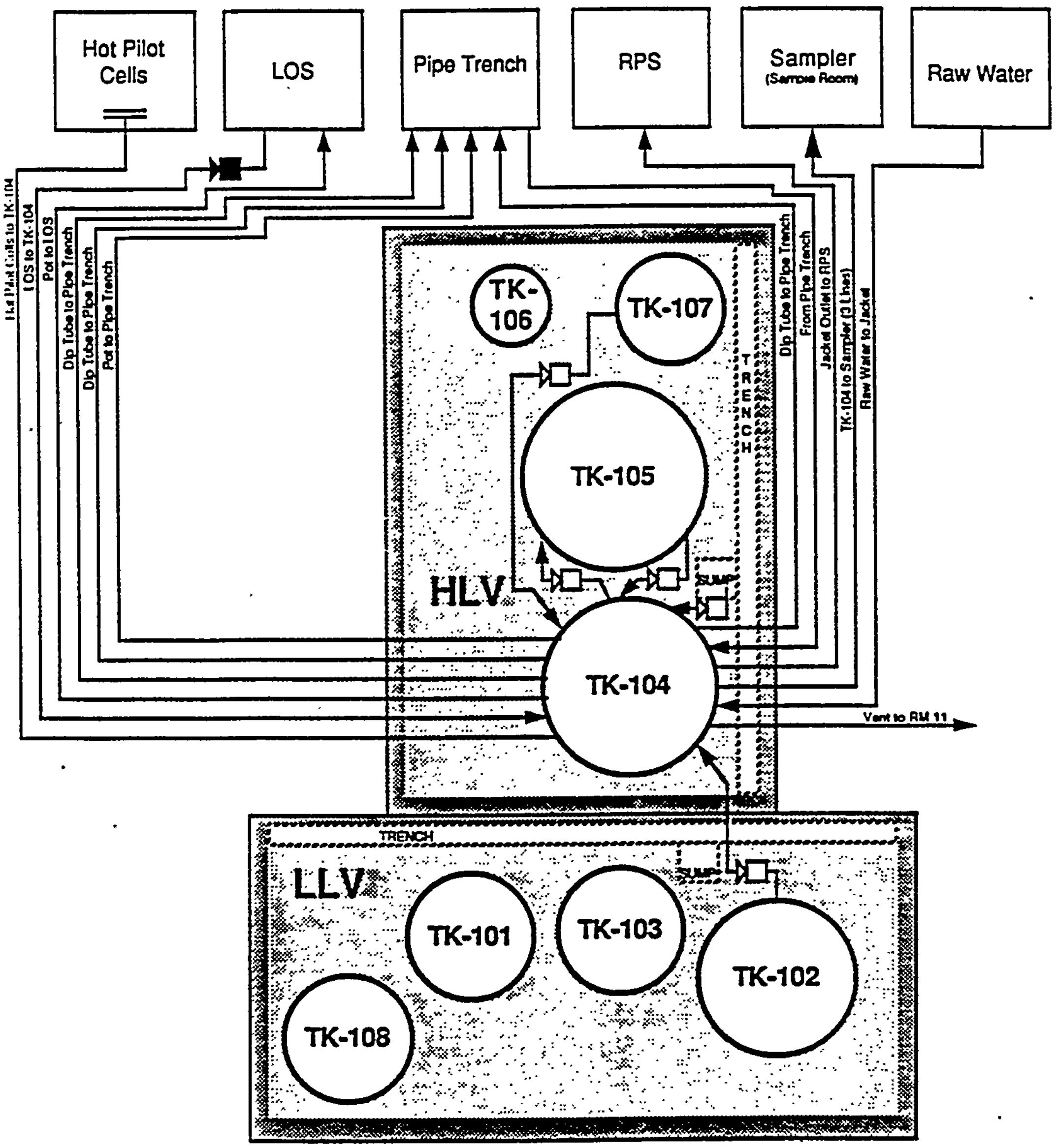
- Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted

Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.4

Nozzle Schematic TK-104, 324 Bldg.



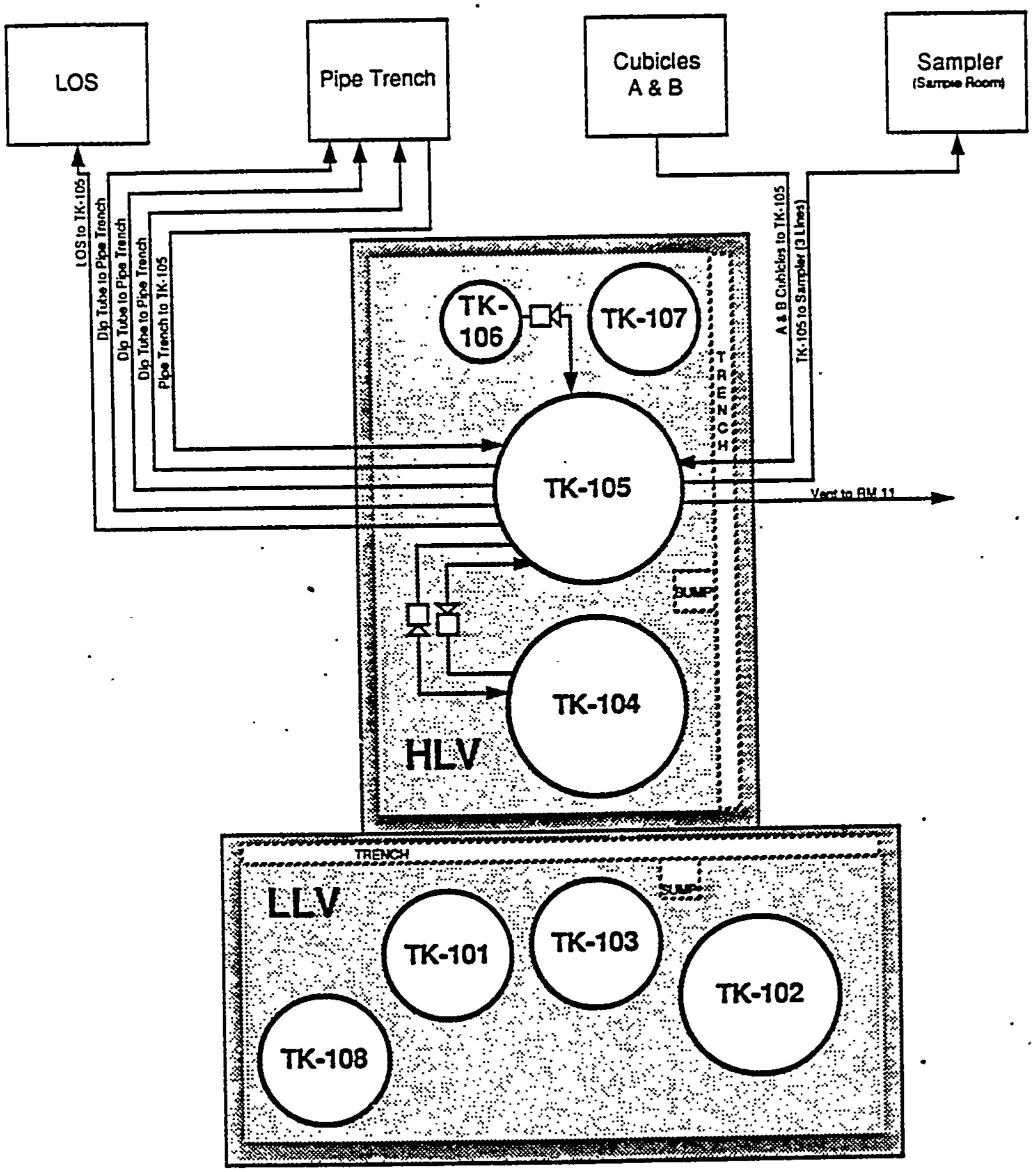
* Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted

Jet Pump inside Vault (Regardless of Location on Graphic)

Jet Pump outside Vault (Regardless of Location on Graphic)

Figure 4.5

Nozzle Schematic
TK-105, 324 Bldg.



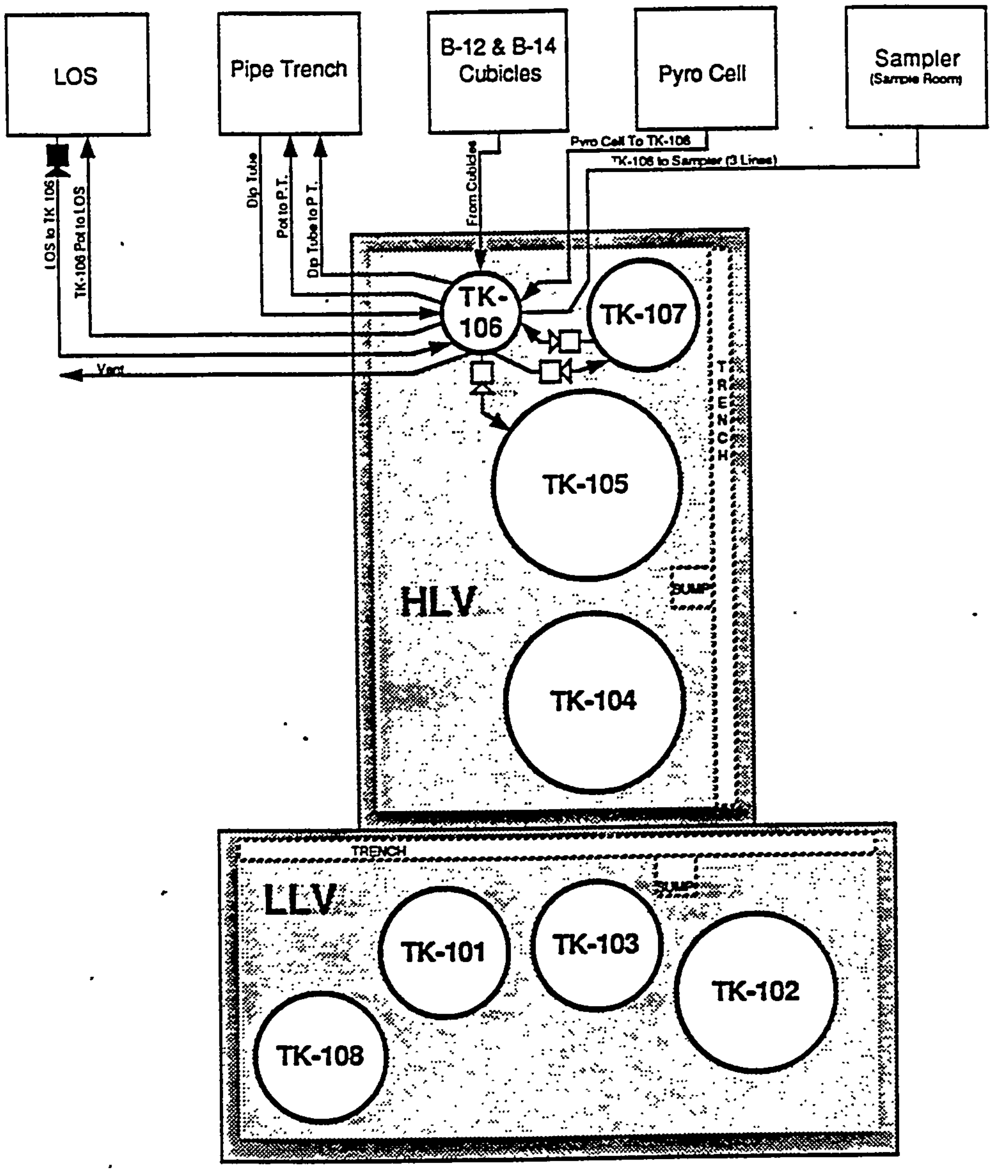
- Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted

Jet Pump inside Vault (Regardless of Location on Graphic)

Jet Pump outside Vault (Regardless of Location on Graphic)

Figure 4.6

Nozzle Schematic TK-106, 324 Bldg.



- Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted

Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.7

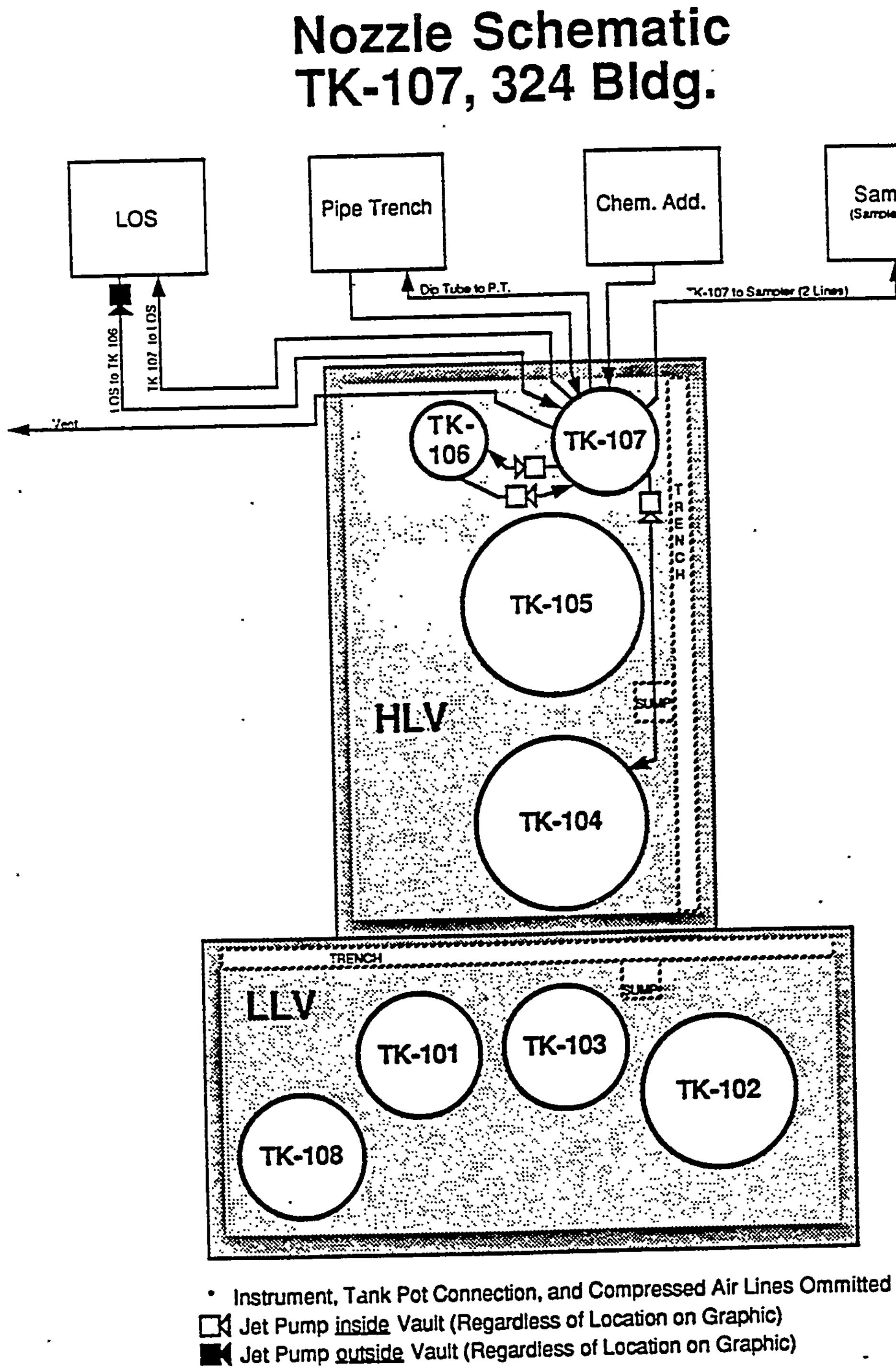
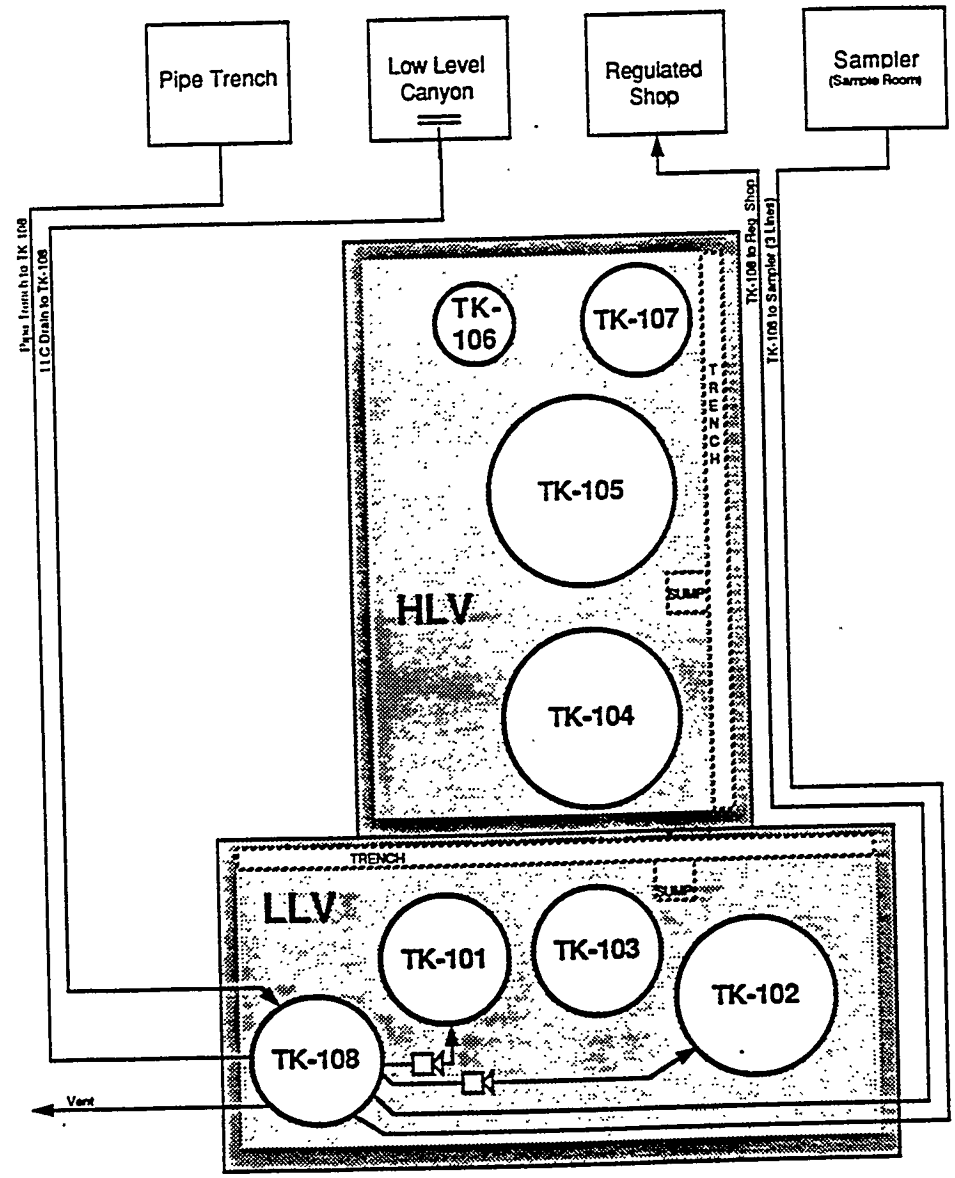

Nozzle Schematic
TK-107, 324 Bldg.
LOS
Pipe Trench
Chem. Add.
Sampler
(Sample Room)
Dip Tube to P.T.
TK-107 to Sampler (2 Lines)
LOS to TK 106
TK 107 to LOS
Vent
TK-106
TK-107
TRENCH
TK-105
SUMP
HLV
TK-104
TRENCH
SUMP
LLV
TK-101
TK-103
TK-102
TK-108
• Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted
Jet Pump inside Vault (Regardless of Location on Graphic)
Jet Pump outside Vault (Regardless of Location on Graphic)

Figure 4.8

Nozzle Schematic
TK-108, 324 Bldg.



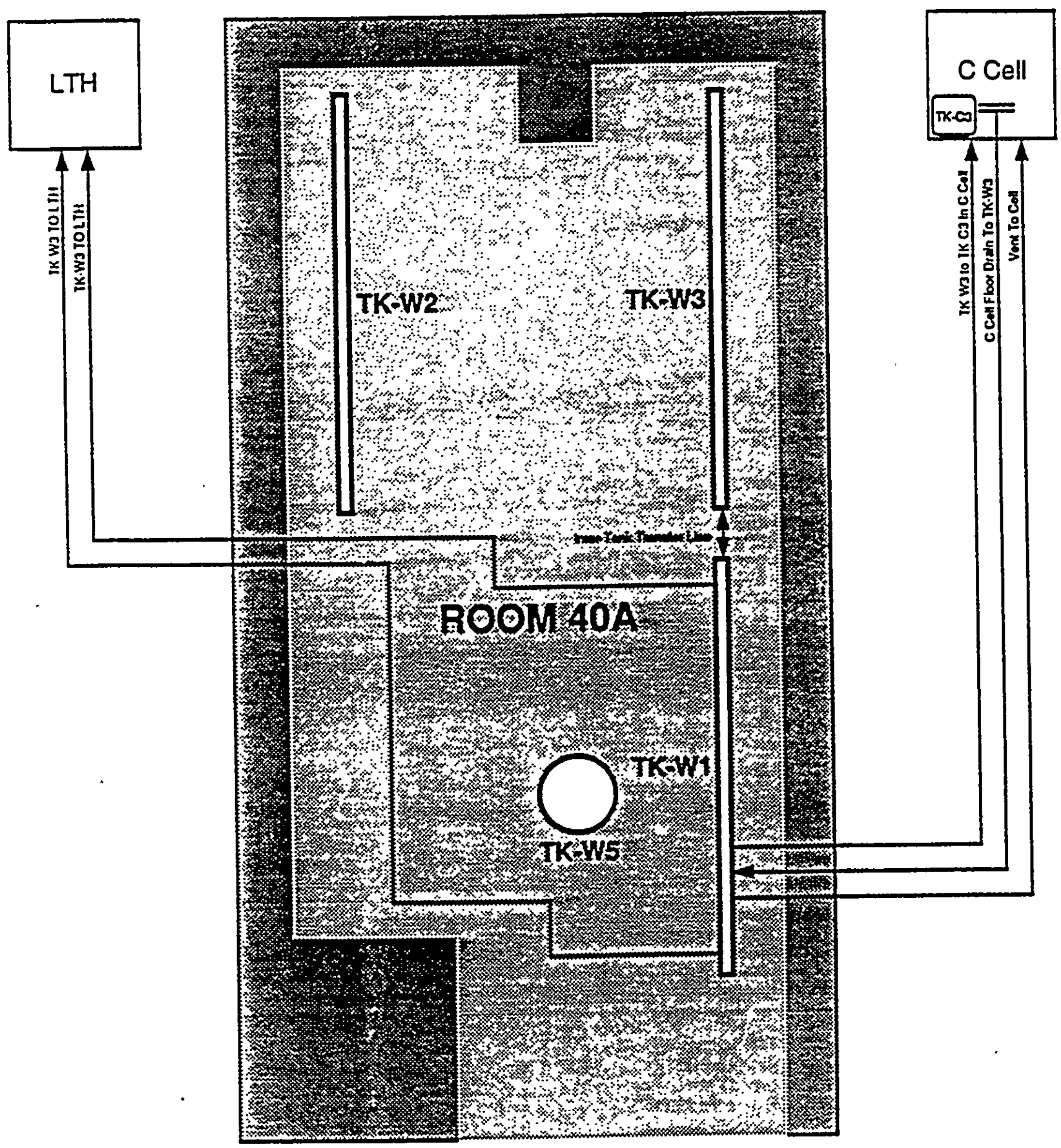
- Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted

Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.9

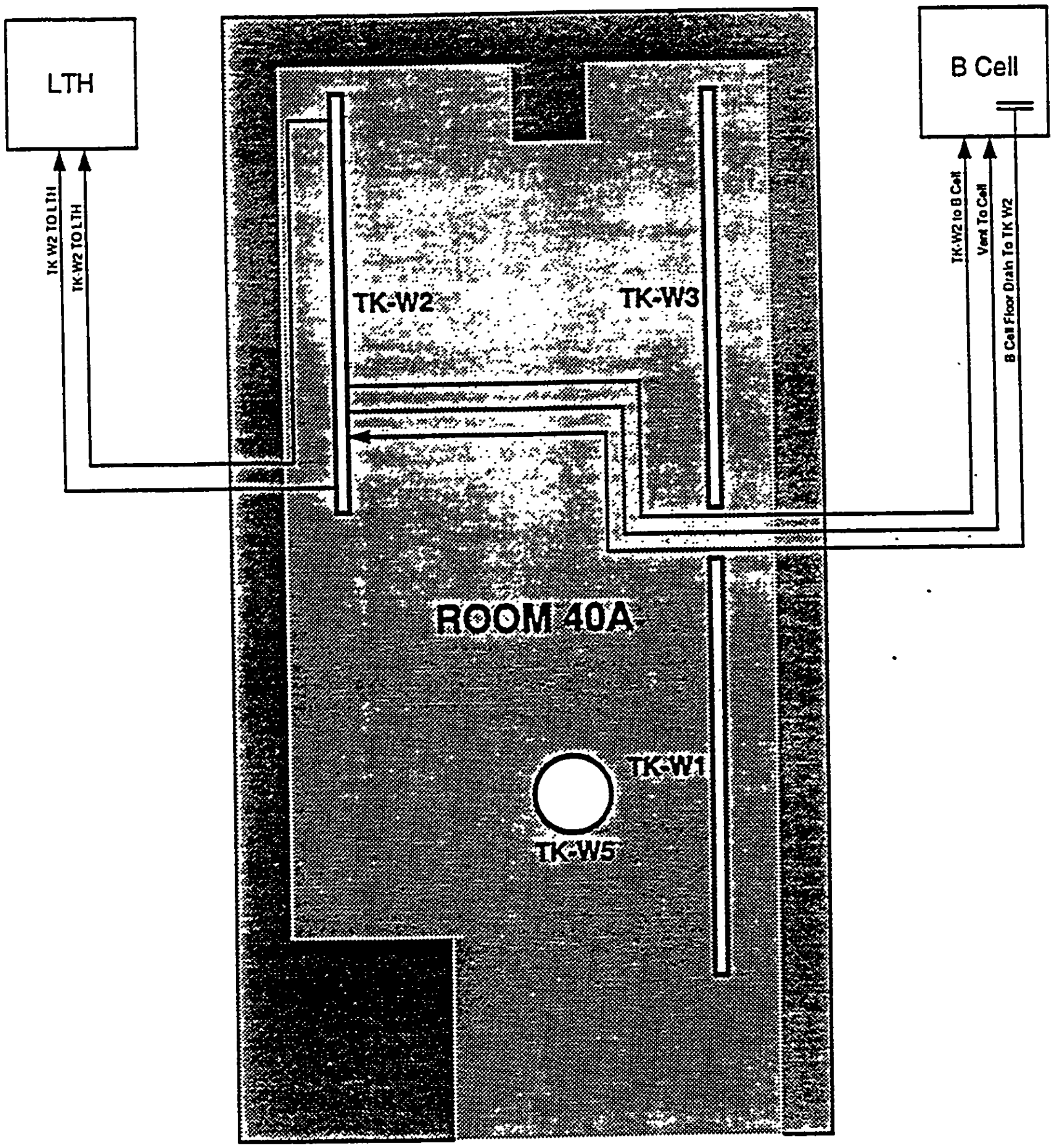
Nozzle Schematic
TK-W1, 325 Bldg.



- Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted
- Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)
- Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.10

Nozzle Schematic
TK-W2, 325 Bldg.



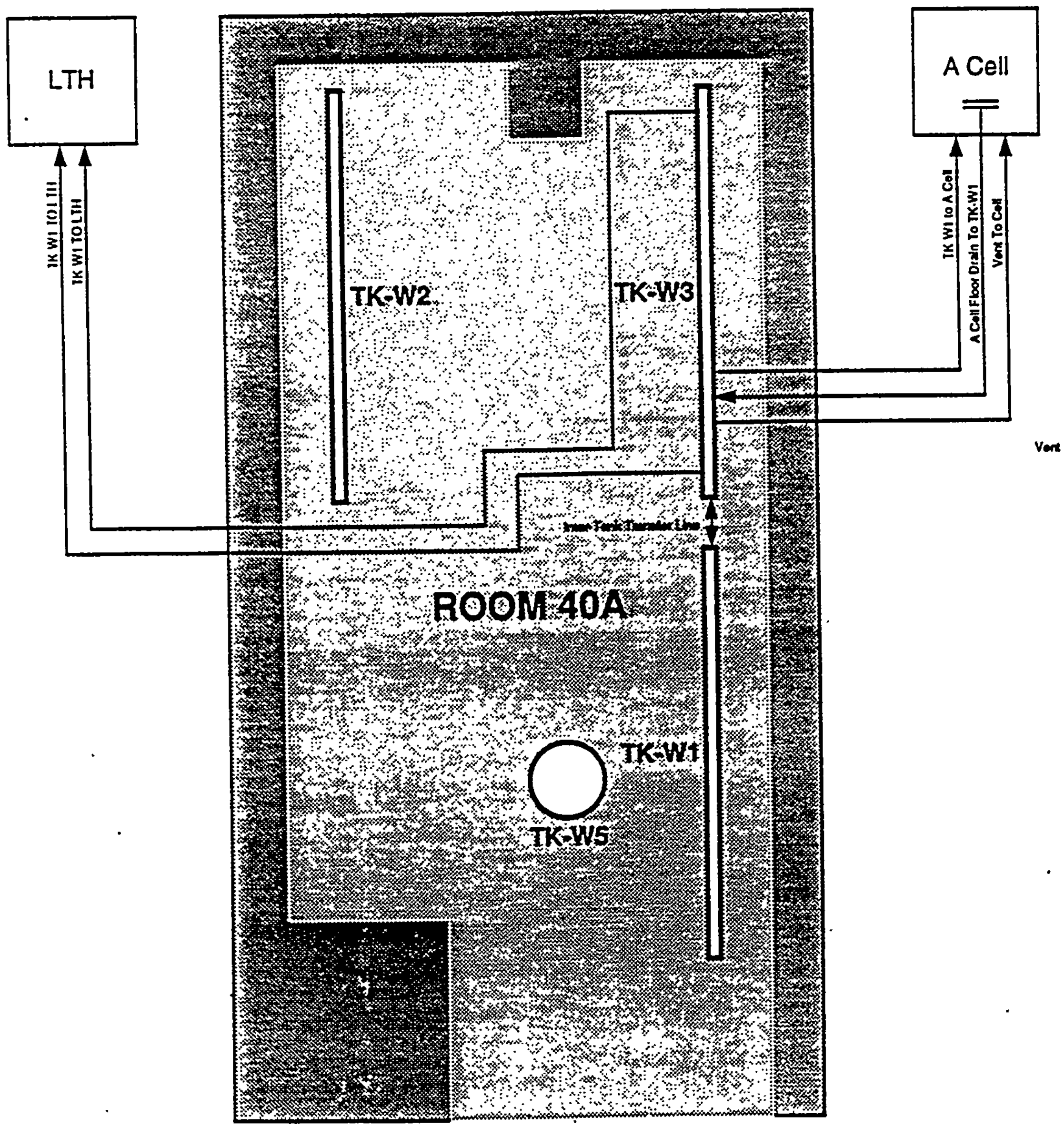
- Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted

☐ Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

■ Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.11

Nozzle Schematic
TK-W3, 325 Bldg.



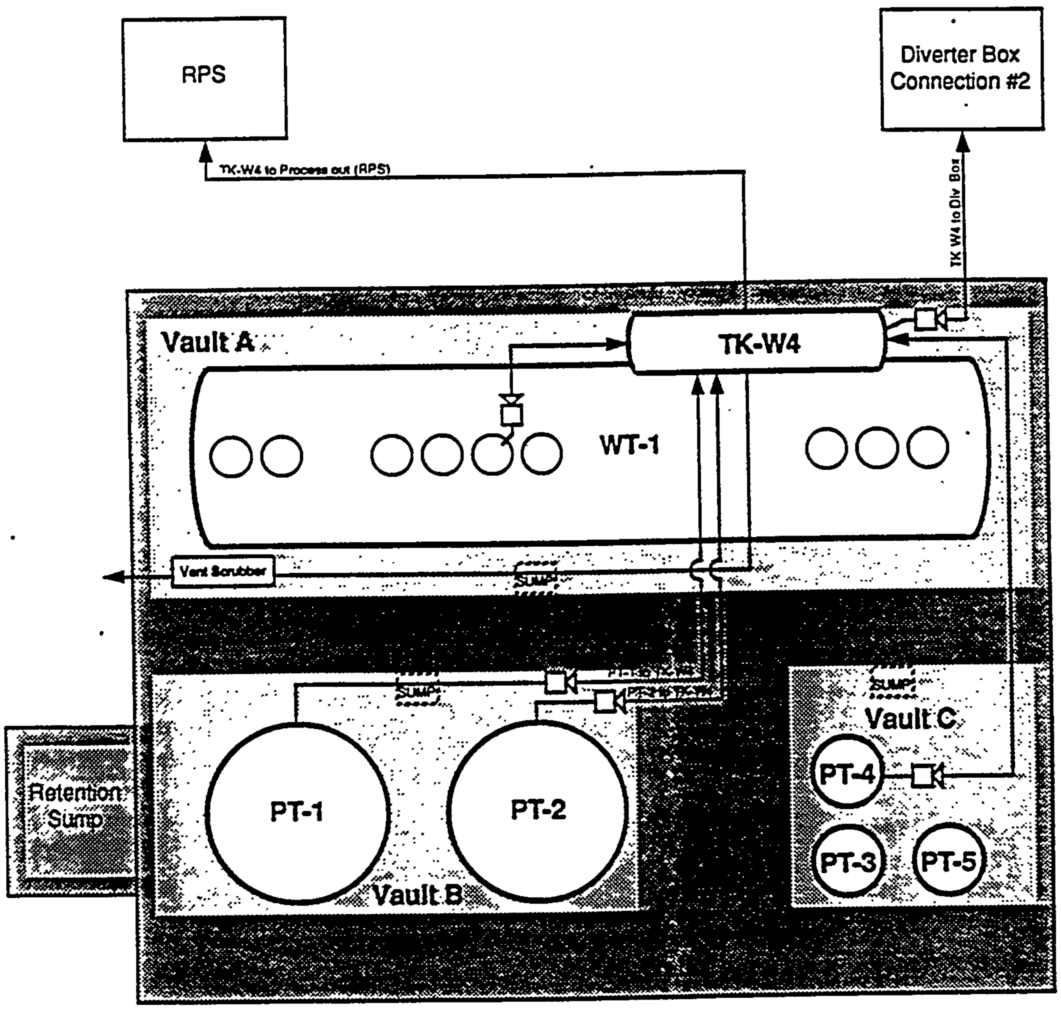
- Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted

Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.12

Nozzle Schematic
TK-W4, 325 Bldg.



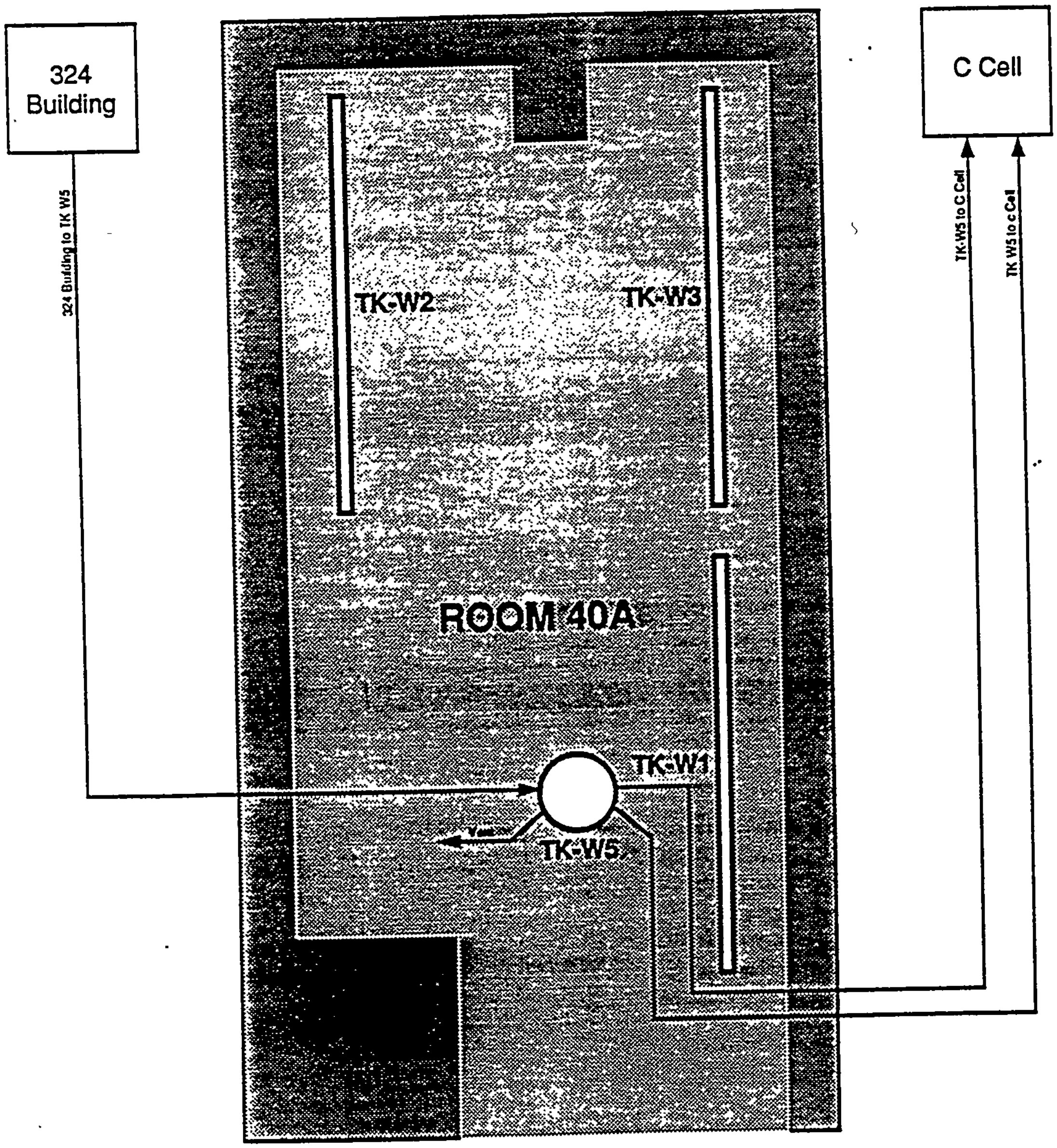
* Instrument, Tank Pot Connection, and Compressed Air Lines Omitted

Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.13

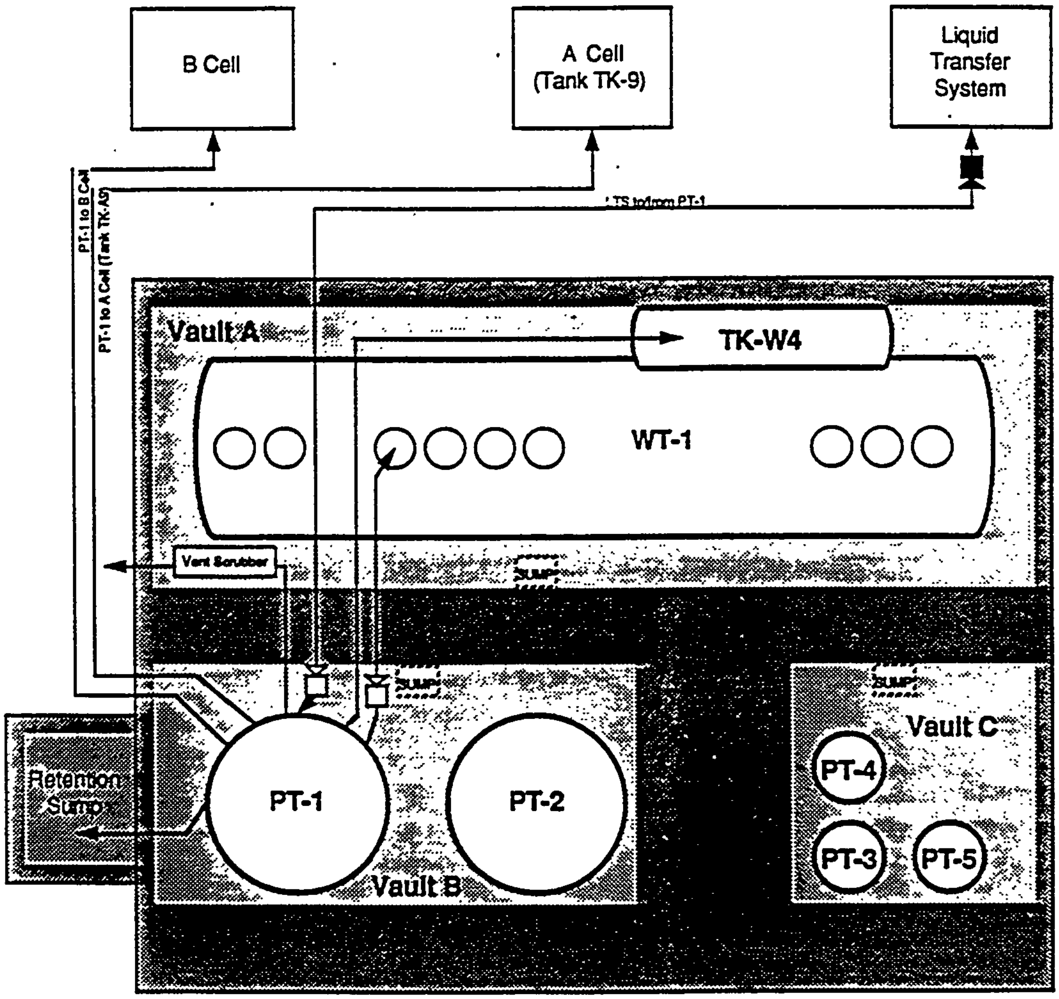
Nozzle Schematic
TK-W5, 325 Bldg.



- Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted
- Jet Pump inside Vault (Regardless of Location on Graphic)
- Jet Pump outside Vault (Regardless of Location on Graphic)

Figure 4.14

Nozzle Schematic
PT-1, 325 Bldg.



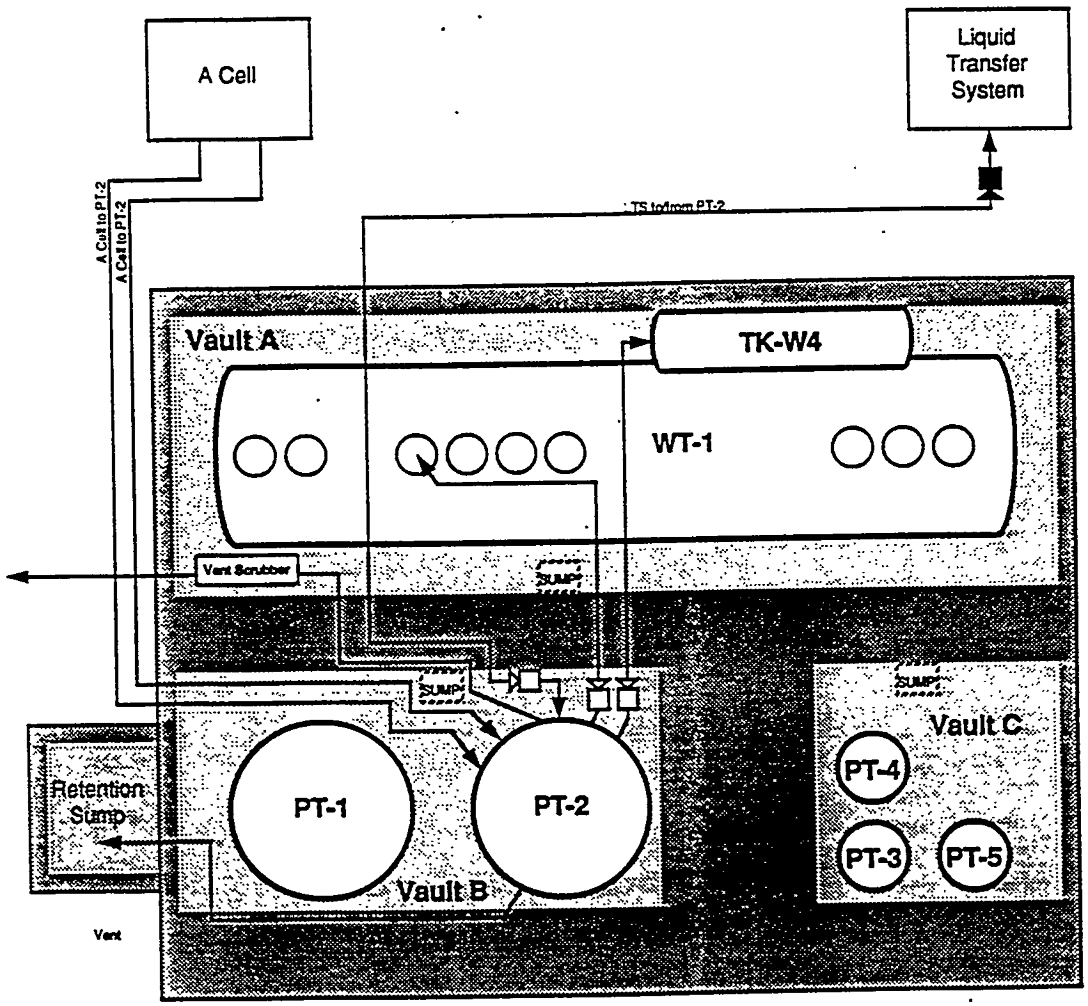
* Instrument, Tank Pot Connection, and Compressed Air Lines Omitted

Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.15

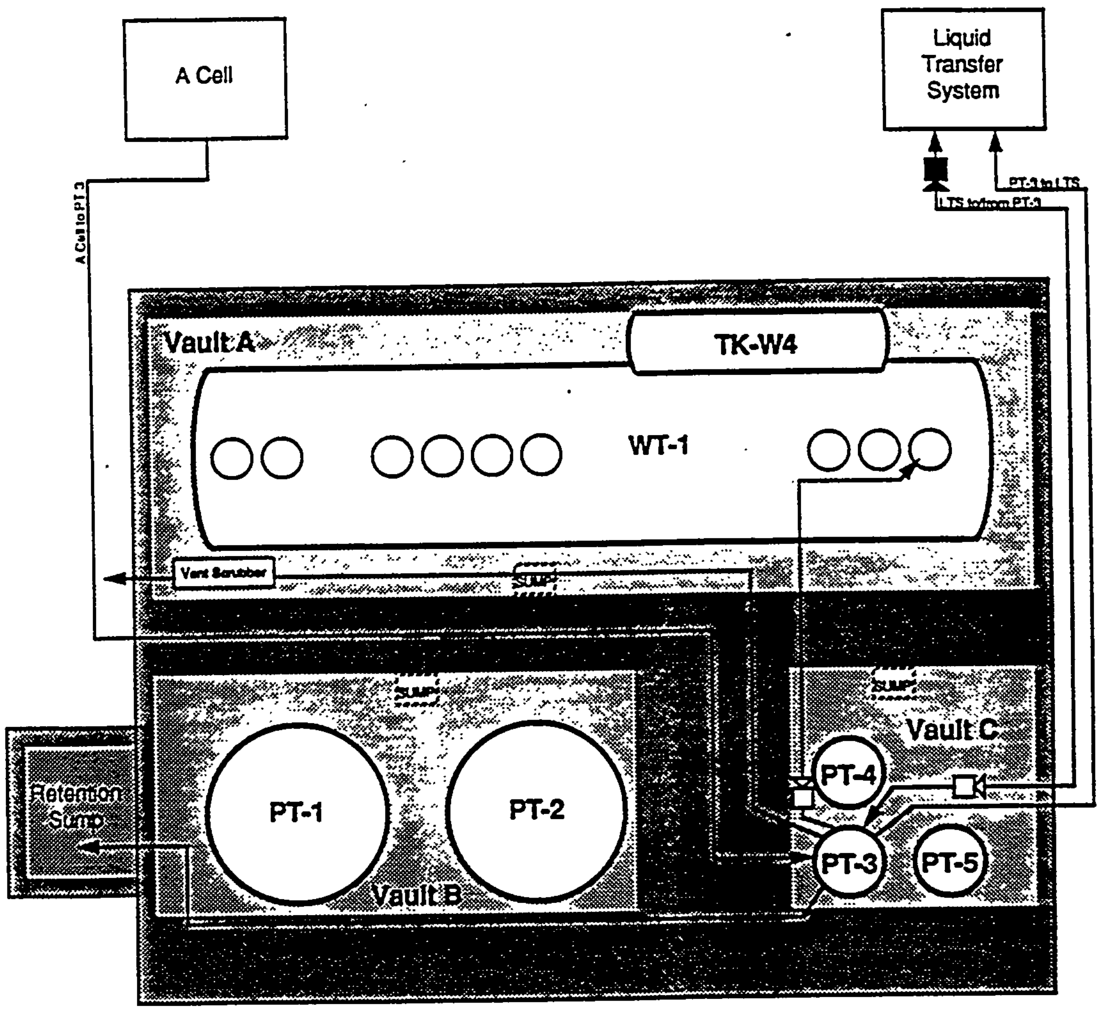
Nozzle Schematic
PT-2, 325 Bldg.



- Instrument, Tank Pot Connection, and Compressed Air Lines Omitted
- Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)
- Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.16

Nozzle Schematic
PT-3, 325 Bldg.



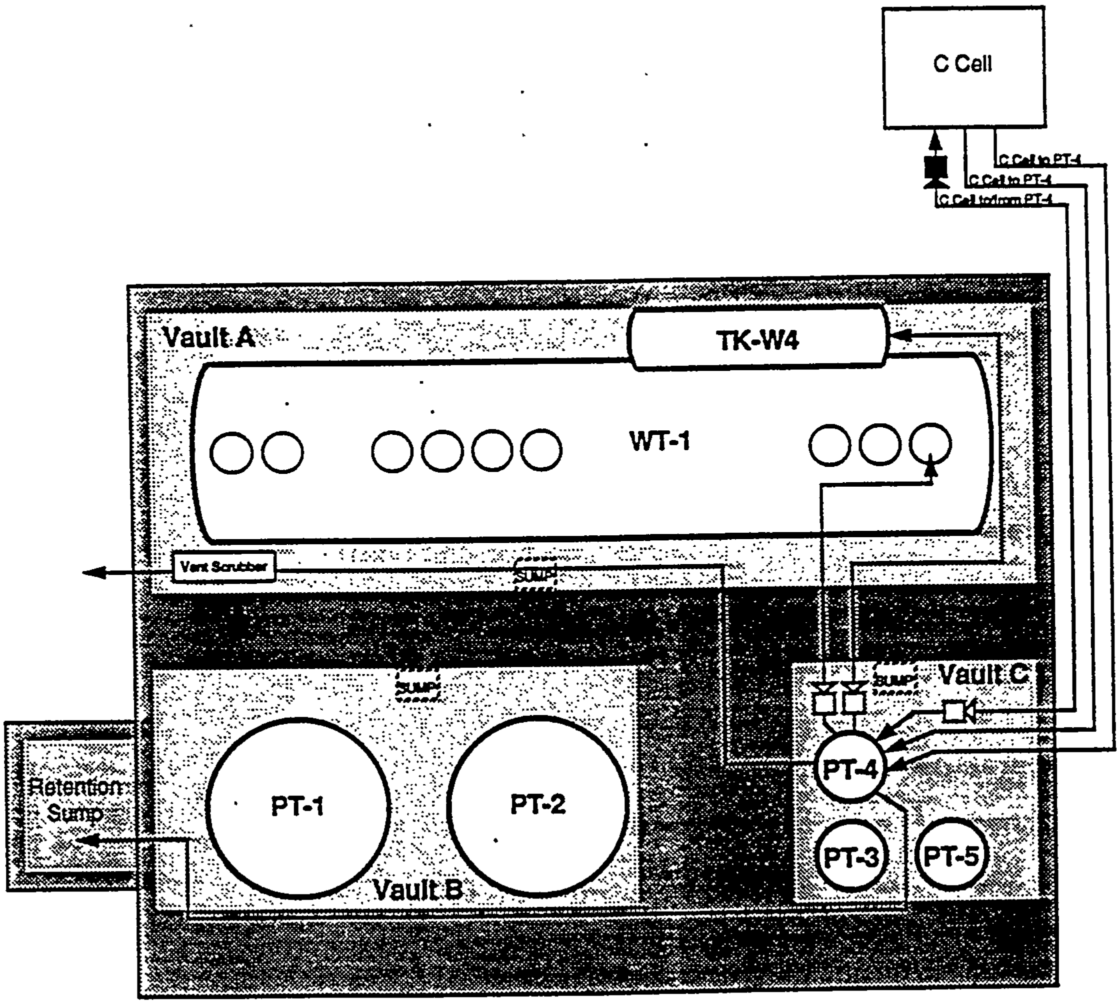
- Instrument, Tank Pot Connection, and Compressed Air Lines Omitted

☐◁ Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

■◀ Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.17

Nozzle Schematic
PT-4, 325 Bldg.



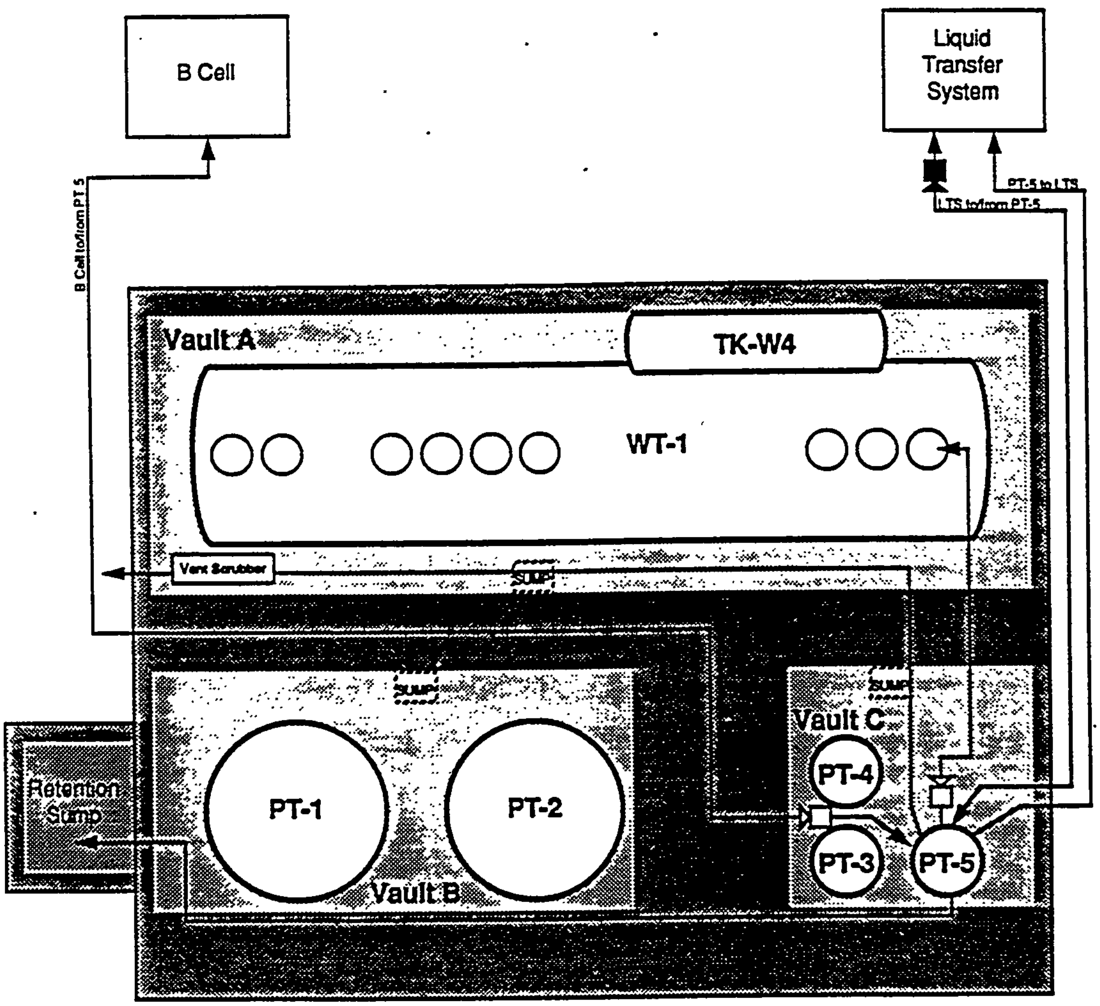
- Instrument, Tank Pot Connection, and Compressed Air Lines Omitted

Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.18

Nozzle Schematic
PT-5, 325 Bldg.



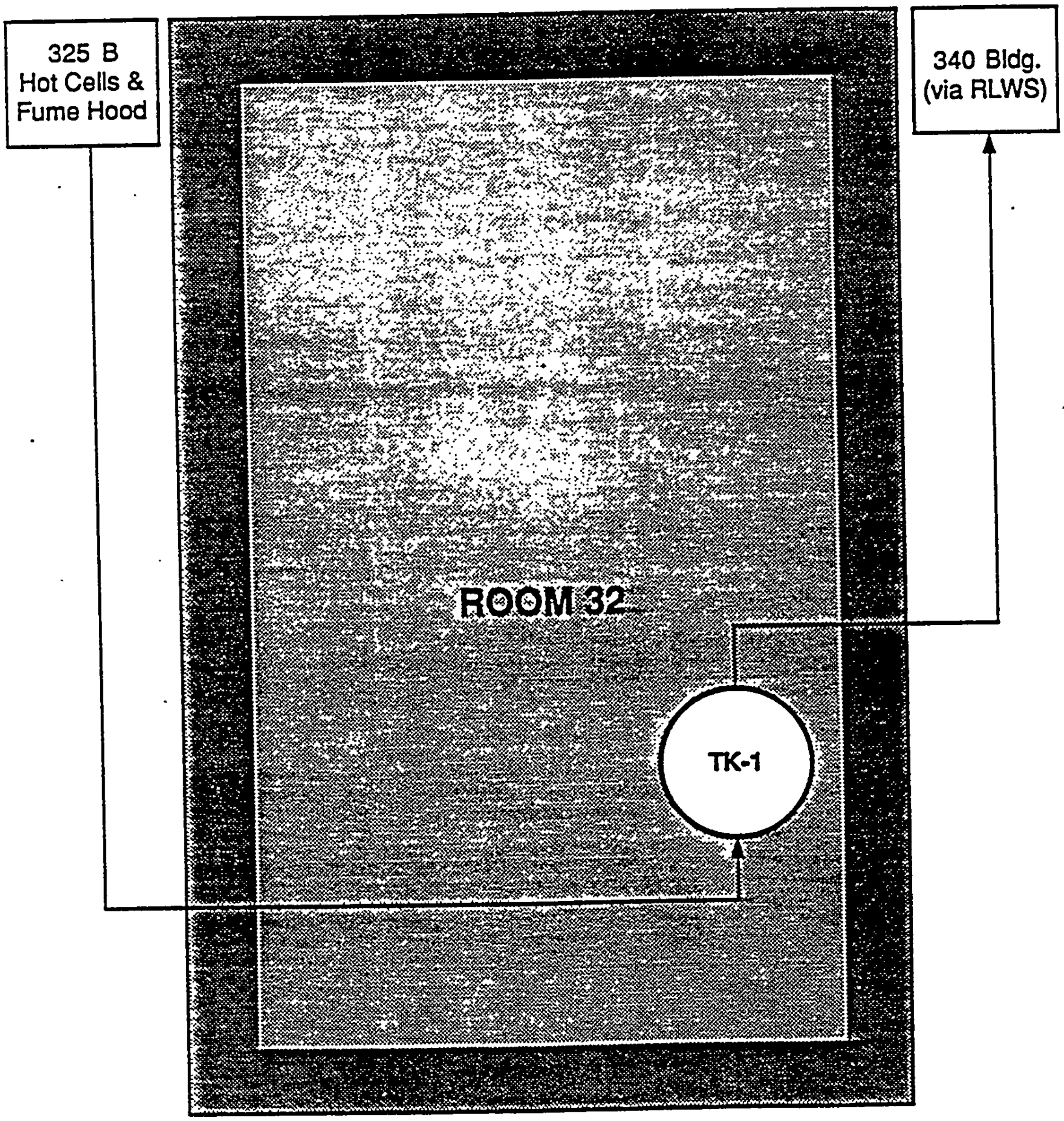
• Instrument, Tank Pot Connection, and Compressed Air Lines Omitted

☐ Jet Pump <u>inside</u> Vault (Regardless of Location on Graphic)

■ Jet Pump <u>outside</u> Vault (Regardless of Location on Graphic)

Figure 4.19

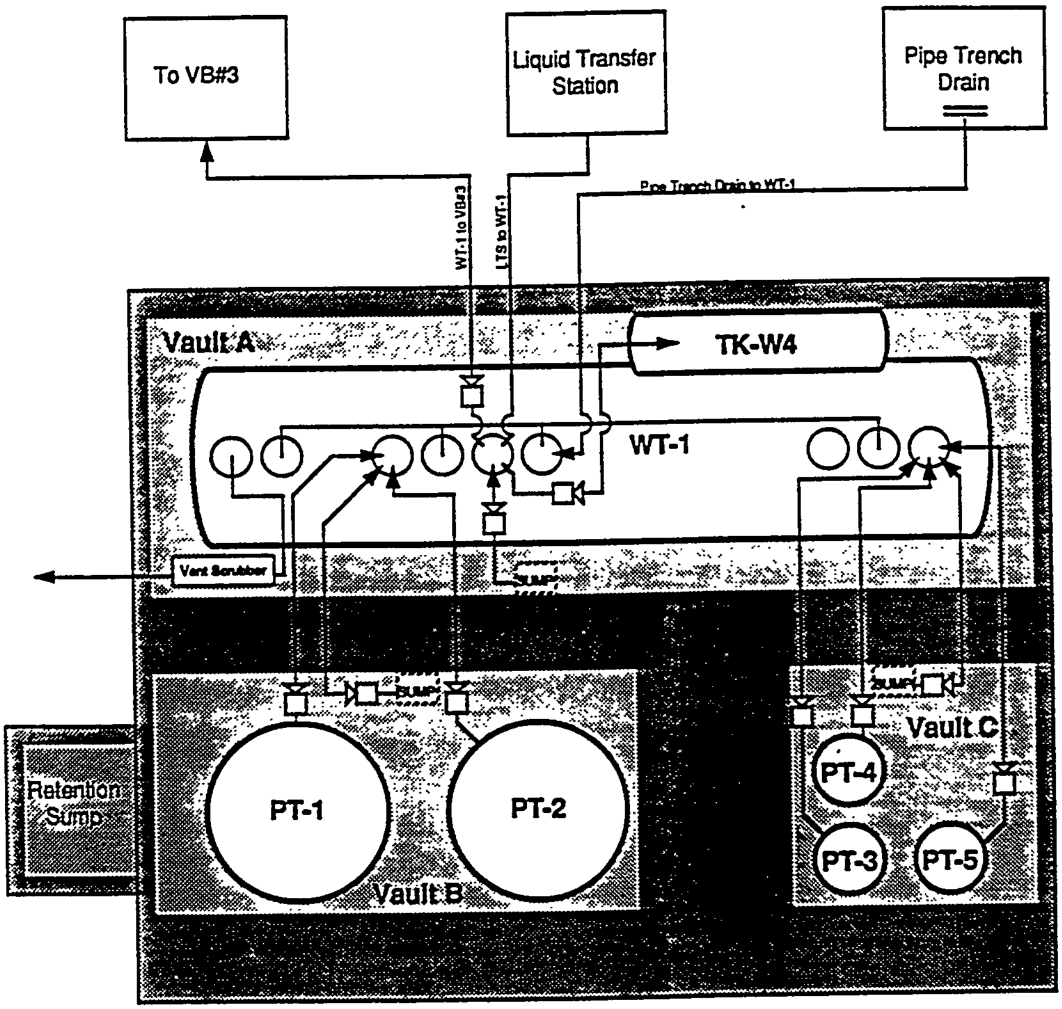
Nozzle Schematic
TK-1, 325 Bldg.



* Instrument, Tank Pot Connection, and Compressed Air Lines Ommitted
Jet Pump inside Vault (Regardless of Location on Graphic)
Jet Pump outside Vault (Regardless of Location on Graphic)

Figure 4.20

Nozzle Schematic
WT-1, 325 Bldg.



- Instrument, Tank Pot Connection, and Compressed Air Lines Omitted
- Jet Pump inside Vault (Regardless of Location on Graphic)
- Jet Pump outside Vault (Regardless of Location on Graphic)

TABLE 4.1. 324 and 325 Building RLWS Tank Summary Table

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
TK-101 324/LLV	H-3-20415 -Tank Detail	A:1"-TPS-1-63	TANK PROCESS SEWER	LOS JET J-41 TO TK-41
		A:1"		SPARE DIP TUBE
		B:2"-TPS-1-62	TANK PROCESS SEWER	PROCESS DRAIN
		C:.5"-TE-101	TEMPERATURE ELEMENT	TEMPERATURE
		D:1"-J-02-02	JET	TK-101 JET J-02 TO POT
		E:2"-TPS-1-54	TANK PROCESS SEWER	CUBICLE DRAIN
		H:T-26		WFI & SGI
		H:T-32		WFI & SGI
		H:T-67		WFI & SGI
		J:1"-CA-1-23	COMPRESSED AIR	AIR TO SPARGER
		K:1"-J-35-35	JET	TK-101 JET TO TK-102
		L:1"-J-33-33	JET	TK-103 JET TO TK-101
		L:1"-J-16-16	JET	TK-101 JET TO CBWS
		M:1"-TPS-1-42	TANK PROCESS SEWER	PIPE TR. TO TK-101
		M:1"-TPS-1-119	TANK PROCESS SEWER	RM.11 TO TK-101
		N:3"-VV-109	VESSEL VENT	TK-101 VENT & OVERFLOW
		P:1"-J-62-62	JET	TK-108 JET TO TK-101
		Q:1"-TPS-1-146	TANK PROCESS SEWER	SAMPLER DR. TO TK-101
		R:.5"-S1A		SAMPLER
		R:.5"-S1B		SAMPLER
		R:.5"-S1C		SAMPLER
		S:1"-TPS-1-34	TANK PROCESS SEWER	LOS TO TK-101 POT

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
TK-102 324/LLV	H-3-20416 -Tank Detail	A:1"-J-03-03	JET	TK-102 TO POT
		B:2"-TPS-2-68	TANK PROCESS SEWER	FROM CUBICLES A,B,C,D
		C:1"-J-35-35	JET	TK-101 TO TK-102
		D:1"-J-56	JET	TK-108 TO TK-102
		E:2"-TPS-2-69		HDR FROM LLC
		F:.5"-S2A-2A		SAMPLER
		F:.25"-S2B-2B		SAMPLER
		F:.25"-S2C-2C		SAMPLER
		G:1"-CA-24	COMPRESSED AIR	SPARGER
		H:1"-J-32	JET	TK-103 TO TK-102
		J:1"-TPS-2-44	TANK PROCESS SEWER	DIP TUBE TO PIPE TRENCH
		K:3"-VV-108	VESSEL VENT	VENT
		L:.5"-T-27		LLI & SGI
		L:.5"-T-33		LLI & SGI
		L:.5"-T-68		LLI & SGI
		M:1"-TE-102-102	TEMPERATURE ELEMENT	TEMPERATURE
		N:1"-J-34-324	JET	TK-102 TO TK-104
		P:1"-J-17	JET	TK-102 TO CBWS
		Q:1"-TPS-2-35	TANK PROCESS SEWER	TK-102 POT TO LOS
		R:1"-J-37	JET	LLV SUMP TO 102
		S:1"-TPS-2-45	TANK PROCESS SEWER	DIP TUBE TO PIPE TRENCH

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
TK-103 324/LLV	H-3-20417 -Tank Detail	A:1"-J-33	JET	TK-103 TO TK-101
		B:.5"-TE-103-103	TEMPERATURE ELEMENT	TEMPERATURE
		C:1"-J-04	JET	TK-103 TO POT
		D:1"-J-05	JET	TK-103 TO POT
		E:1"-TPS-3-46	TANK PROCESS SEWER	DIP TUBE TO PIPE TRENCH
		H:.5"-T-28 (HP)		LLI & SGI
		H:.5"-T-34 (LP)		LLI & SGI
		H:.5"-T-69 (REF)		LLI & SGI
		J:1"-CA-25	COMPRESSED AIR	SPARGER
		K:1"-J-32	JET	TK-103 TO TK-102
		L:		
		M:3"-VV-107	VESSEL VENT	VENT
		N:		
		P:.5"-S3A		SAMPLER
		P:.25"-S3B		SAMPLER
		P:.25"-S3C		SAMPLER
		Q:1"-TPS-3-37	TANK PROCESS SEWER	FROM LOS TO TK-103
		R:.5"-TPS-3-117	TANK PROCESS SEWER	AIR LIFT
		R:.25"-CA-21	COMPRESSED AIR	TO LLC
		S:1"-TPS-3-47	TANK PROCESS SEWER	POT TO PIPE TRENCH
		T:1"-TPS-3-36	TANK PROCESS SEWER	POT TO LOS

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
TK-108 324/LLV	H-3-20421 - Tank Detail	A:1"		SPARE DIP TUBE
		B:1"-J-62	JET	TK-108 TO TK-101
		C:.5"-S8A		SAMPLER
		C:.25"-S8B		SAMPLER
		C:.5"-S8C		SAMPLER
		D:1"-TPS-1-43	TANK PROCESS SEWER	PT TO TK-108
		E:.5"-TE-108	TEMPERATURE ELEMENT	TEMPERATURE
		H:3"-VV-109	VESSEL VENT	VESSEL VENT OVERFLOW
		J:1"-RS-LLV-314	REG. SHOP-LOW LEVEL VAULT	SPARGER
		K:1"-RS-LLV-315	REG. SHOP-LOW LEVEL VAULT	TK-108 TO REG. SHOP
		L:.5"-VIA-316	VENTILATION INSTRUMENT AIR	WFI & SGI
		L:.5"-VIA-404	VENTILATION INSTRUMENT AIR	WFI & SGI
		L:.5"-VIA-405	VENTILATION INSTRUMENT AIR	WFI & SGI
		.5"-VIA-406	VENTILATION INSTRUMENT AIR	WFI & SGI
		M:1"-J-56	JET	TK-108 TO TK-102
		N:2"-TPS-1-56	TANK PROCESS SEWER	LLC DRAIN
		P:		SPARE
		Q:		SPARE
		R:1"		SPARE DIP TUBE

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
TK-104 324/HLV	H-3-20418 -Tank Detail	A:2"-TPS-4-76	TANK PROCESS SEWER	FROM LOS AND HOT PILOT CELLS
		B:1"-MP-4-18	MED. PRESSURE STEAM	SPRAY JET
		C:.5"-T-29		LLI & SGI
		C:.5"-T-35		LLI & SGI
		C:.5"-T-70		LLI & SGI
		D:1"-MP-4-J-06	MED. PRESSURE STEAM	JET TO POT
		E:1"-MP-4-J-07	MED. PRESSURE STEAM	JET TO POT
		F:1"-CA-4-26	COMPRESSED AIR	SPARGER
		G:1"-104		FROM HLV SUMP - J-36
		H:1"-J-28	JET	TK-107 TO TK-104
		J:		DIP TUBE TO PIPE TRENCH
		K:1"-TPS-4-337	TANK PROCESS SEWER	FROM PIPE TRENCH
		K:1"-TPS-4-338	TANK PROCESS SEWER	SAMPLER
		L:.5"-S4A-4A		SAMPLER
		L:.25"-S4B-4B		SAMPLER
		L:.25"-S4C-4C		TEMPERATURE
		M:.5"-TE-104	TEMPERATURE ELEMENT	VENT
		N:3"-VV-104	VESSEL VENT	DIP TUBE TO PIPE TRENCH
		P:1"-TPS-4-331	TANK PROCESS SEWER	TK-104 TO TK-105
		Q:1"-J-54	JET	LOS TO TK-104
		R:1"-TPS-4-77	TANK PROCESS SEWER	105 TO TK-104
		R:1"-J-31	JET	POT TO PIPE TRENCH
		S:1"-TPS-4-336	TANK PROCESS SEWER	POT TO LOS
		T:1"-TPS-4-38	TANK PROCESS SEWER	JACKET OUTLET TO RPS
		U:1"		RAW WATER TO JACKET
		V:1"-283		DIP TUBE TO PIPE TRENCH
		W:1"-156		

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
TK-105 324/HLV	H-3-20419 -Tank Detail	A:2"-TPS-5-82	TANK PROCESS SEWER	A & B CELL CUBICLES
		B:1"-MP-5-19	MED. PRESSURE STEAM (125 PSI)	SPRAY JET
		C:.5"-TE-105	TEMPERATURE ELEMENT	TEMPERATURE
		D:1"-J-08	JET	TK-105 TO POT
		E:1"-J-09	JET	TK-105 TO POT
		F:.5"-T-30		LLI & SGI
		F:.5"-T-36		LLI & SGI
		F:.5"-T-71		LLI & SGI
		G:1"		J-54 TO TK-105
		H:1"-J-31	JET	TK-105 TO TK-104
		J:.5"-S5A-5A		SAMPLER
		J:.25"-S5B-5B		SAMPLER
		J:AIRLIFT .25"-S5C-5C		SAMPLER
		K:3"-VV-105	VESSEL VENT	VENT
		L:1"-CA-5-27	COMPRESSED AIR	SPARGER
		M:1"-TPS-5-339	TANK PROCESS SEWER	DIP TUBE TO PIPE TRENCH
		N:1"-TPS-5-340	TANK PROCESS SEWER	FROM PIPE TRENCH
		P:1"-TPS-5-330	TANK PROCESS SEWER	DIP TUBE TO PIPE TRENCH
		Q:1"-TPS-5-155	TANK PROCESS SEWER	DIP TUBE TO PIPE TRENCH
		R:1"		FROM TK-106 TO TK-105
		S:1"-TPS-5-335	TANK PROCESS SEWER	POT TO PIPE TRENCH
		T:1"-TPS-5-39	TANK PROCESS SEWER	POT TO LOS
		U:1"		JACKET WATER INLET
		V:1"-RW-5-147	RAW WATER	JACKET WATER OUTLET

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
TK-106 324/HLV	H-3-20420 -Tank Detail	A:1"-TPS-6-86	TANK PROCESS SEWER	FROM PYRO CELL
		B:1"		TK-107 JET TK-106
		B:1"-MP-6-J-20	MED. PRESSURE STEAM	SPRAY JET
		C:1"-TPS-6-40	TANK PROCESS SEWER	FROM LOS
		D:.5"-TE-106	TEMPERATURE ELEMENT	TEMPERATURE
		E:.5"-T-31		LLI & SGI
		E:.5"-T-37		LLI & SGI
		E:.5"-T-72		LLI & SGI
		F:1"-J-10	JET	JET TO POT
		G:1"-TPS-6-341	TANK PROCESS SEWER	DIP TUBE TO PT
		G:1"-J-49	JET	TK-106 TO TK-105
		H:.5"-S6A-6A		SAMPLER
		H:.25"-S6B-6B		SAMPLER
		H:.5"-S6C-6C		SAMPLER
		J:1"-J-11	JET	JET TO POT
		K:.5"-TPS-6-333	TANK PROCESS SEWER	DIP TUBE TO PIPE TRENCH
		L:3"-VV-106	VESSEL VENT	VENT
		M:1"-TPS-6-87	TANK PROCESS SEWER	FROM B-12 & B-14 CUBICLES
		N:1"-TPS-6-332	TANK PROCESS SEWER	POT TO PT
		P:1"-TPS-6-41	TANK PROCESS SEWER	POT TO LOS
		Q:1"-CA-6-28	COMPRESSED AIR	SPARGER
		R:1"-148		JACKET IN
		S:1"-RPS	RETENTION PROCESS SEWER	JACKET OUT
		T:1"-J-30	JET	TK-106 TO TK-107

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
TK-107 324/HLV	H-3-21015 -Tank Detail	A:1"-J-39	JET	JET TO POT
		B:1"-TPS-7-157	TANK PROCESS SEWER	DIP TUBE
		B:1"-J-28	JET	TK-107 TO TK-104
		C:		AGITATOR
		D:		SPARE
		E:1"		SPARE DIP TUBE
		E:.5"-S7A-7A		SAMPLER
		E:.25"-S7B-7B		SAMPLER
		F:1"-CBWS	CRIB WASTE SEWER	COIL OUT
		G:1"-286		COIL IN
		H:3"-VV-217	VESSEL VENT	VESSEL VENT
		J:1"-J-29	JET	TK-107 TO TK-106
		J:1"		TK-106 TO TK-107
		K:1"-J-40	JET	JET TO POT
		L:1"-J-40	JET	SPRAY JET
		M:1"-285		JACKET WATER IN
		N:.5"-MP-270	MED. PRESSURE STEAM	LLI & SGI
		N:.5"-REF-271		LLI & SGI
		N:.5"-HP-273	HIGH PRESSURE STEAM	LLI & SGI
		N:.5"-TE-107-1-272	TEMPERATURE ELEMENT	TEMPERATURE
		P:1"-RPS	RETENTION PROCESS SEWER	JACKET OUT
		R:1"-TPS-7-209	TANK PROCESS SEWER	LOS JET
		R:1"-TPS-7-334	TANK PROCESS SEWER	PIPE TRENCH
		S:1"-CH-HLV-287	CASK HANDLING HLV	AIR SPARGER
		U:1"-TPS-7-207	TANK PROCESS SEWER	POT SUCTION
		V:1"-TPS-7-329	TANK PROCESS SEWER	POT SUCTION
		W:.5"-CH-HLV-288	CASK HANDLING HLV	CHEM. ADD.
		W:.5"-TE-107-2-295	TEMPERATURE ELEMENT	RESISTANCE BULB

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
W1	H-3-70460/2,4	A:.25"		WF/SGI (LO)
325/40A	-Piping Detail	B:.25"		WF/SGI (HI)
	H-3-43311	C:25"		WF/SGI (MED)
	-Tank Detail	D:.5"-1160		TANK W1 TO LTH
		E:.5"-1142/139		TANK W1 TO A CELL
		F:.5"-1143		TANK W1 TO LTH
		G:2"-D-8533	DRAIN	FROM A CELL FLOOR DRAIN
		64-1"-M-CW	????	FROM A CELL FLOOR DRAIN
		64-2"-M-CW	????	FROM A CELL FLOOR DRAIN
		H:1"		INTER-TANK CONNECT (W1,W3)
		J:.25"-2546/234		TANK W1 VENT TO CELL
W2	H-3-70460/2,4	A:.25"		WF/SGI (LO)
325/40A	-Piping Detail	B:.25"		WF/SGI (HI)
	H-3-43311	C:.25"		WF/SGI (MED)
	-Tank Detail	D:.5"-1160		TANK W2 TO LTH
		E:.5"-1145/339		TANK W2 TO B CELL
		F:.5"-1146		TANK W2 TO LTH
		G:1"-D-8534	DRAIN	FROM B CELL FLOOR DRAIN
		65-1"-M-CW	????	FROM B CELL FLOOR DRAIN
		H:NOT CONNECTED		NOT CONNECTED
		J:2545/340		TANK W2 VENT TO CELL
W3	H-3-70460/2,4	A:.25"		WF/SGI (LO)
325/40A	-Piping Detail	B:.25"		WF/SGI (HI)
	H-3-43311	C:.25"		WF/SGI (MED)
	-Tank Detail	D:.5"-1140/440		TANK W3 TO C CELL
		E:.5"-1139/456/1130		TANK W3 TO TK-C3 C CELL
		F:.5"-1141		TANK W3 TO LTH
		G:1"-D-8535	DRAIN	FROM C CELL FLOOR DRAIN
		66-1"-M-CW	????	FROM C CELL FLOOR DRAIN
		H:1"		INTER TANK CONNECT (W1,W3)
		J:.25"-2547/439		TANK W3 VENT TO CELL

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
W5 325/40A	H-3-70460/2,4 -Piping Detail H-3-43312 -Tank Detail	A:.375"-P-1127 (SPARE) B:.375"-P-1128 C:.375"-P-1138 .5"-P-1000 D:.375" E:.5" F:.5"-D-8538	PROCESS DRAIN PROCESS DRAIN PROCESS DRAJN PROCESS DRAIN DRAIN	TANK W5 TO C CELL TANK W5 TO C CELL 324 BLDG TO TANK W5(VIA 4"VG-2000) 324 BLDG TO TANK W5(VIA 4"VG-2000) VACUUM/AIR/VENT COOLING COIL IN TANK W5 TO 2"-D-8500(COIL OUT)
PT-1 325/VAULT B	H-3-70460/2,4 -Piping Detail H-3-9321 -Tank Detail	9-.5"/1136 10-.5" 25-.5"/350-.5" 27-.5"/258-.5" .5"-P-1192/ .5"-P-1151 29-.5" 161-2" 178-1-.5"	PROCESS DRAIN	PT-1 TO W4 (VIA J-PT-1-1) PT-1 TO/FROM LTS PT-1 TO B CELL PT-1 TO A CELL TK-A9 (VIA J-A9-1) PT-1 TO WT-1 (VIA G-7) PT-1 TO VENT SCRUB. (VIA 160-2") PT-1 TO RETENTION SUMP
PT-2 325/VAULT B	H-3-70460/2,4 -Piping Detail H-3-9321 -Tank Detail	11-.5"/P-1135 12-.5" 21-.5"/148-.5" 23-.5"/250-.5" 30-.5" 162-2" 178-1-.5"	PROCESS DRAIN	PT-2 TO W4 (VIA J-PT-2-1) PT-2 TO/FROM LTS A CELL TO PT-2 A CELL TO PT-2 PT-2 TO WT-1 (VIA G-8) PT-2 TO VENT SCRUB (VIA 161/160) PT-2 TO RETENTION SUMP
PT-3 325/VAULT C	H-3-70460/2,4 -Piping Detail H-3-9321 -Tank Detail	15-.5" 16-.5" 31-.5" 164-2" 10/2-.5" 177-1"		PT-3 TO LTS (VIA J-PT-4) PT-3 TO/FROM LTS PT-3 TO WT-1 (VIA G-10) PT-3 TO VENT SCRB(VIA 166/165/160) A CELL TO PT-3 PT-3 TO RETENTION SUMP

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
PT-4 325/VAULT C	H-3-70460/2,4 -Piping Detail H-3-9321 -Tank Detail	17-.5"/1134 18-.5"/P-1193 4-.5"/448-.5" .5"-P-1126 24-.5"/27-.5" .5"-P-1194 .5"-449/.5"-1092 28-.5"/-450/-1091 32-.5" 165-2" 176-1"	PROCESS DRAIN PROCESS DRAIN	PT-4 TO W4 (VIA J-PT-4-1) C CELL TO PT-4 (VIA J-C3-3) C CELL TO PT-4 (VIA J-C3-3) PT-4 TO/FROM C CELL PT-4 TO WT-1 (VIA G-11) PT-4 TO VENT SCRUB (VIA 160) PT-4 TO RETENTION SUMP
PT-5 325/VAULT C	H-3-70460/2,4 -Piping Detail H-3-9321 -Tank Detail	18-.5" 20-.5" 26-.5"/349-.5" 33-.5" 166-2" 175-1"		PT-5 TO LTS (VIA G-6) PT-5 TO/FROM LTS PT-5 TO/FROM B CELL PT-5 TO WT-1 (VIA G-12) PT-5 TO VENT SCRUB (VIA 160/165) PT-5 TO RETENTION SUMP

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
W4 325/VAULT A	H-3-70460/2,4 -Piping Detail H-3-43197 -Tank Detail	A:.5"-W-6040-PL	WATER	COIL INLET
		B:.5"-D-8537-PL	DRAIN	COIL OUTLET(TO DIV. SYSTEM)
		C:.25"-I-9809-PL	INSTRUMENTATION	LIQ LEVEL(LO)
		D:.25"-I-9908-PL	INSTRUMENTATION	LIQ LEVEL(HI)
		E:.5"		TEMPERATURE
		F:.5"-P-1137-PI	PROCESS DRAIN	PROCESS IN FROM WT-1
		G:.5"-P-1137-PI	PROCESS DRAIN	PROCESS IN FROM PT-2
		H:.5"-A-5097-PI	COMPRESSED AIR	AIR SPARGE
		J:.5"-P-1158-PI	PROCESS DRAIN	WASHDOWN
		K:.5"-P-1136-PI	PROCESS DRAIN	PROCESS IN FROM PT-1
		L:.5"-P-1134-PI	PROCESS DRAIN	PROCESS IN FROM PT-4
		M:.5"		TEMPERATURE
		N:.25"-I-9810-PI	INSTRUMENTATION	LIQ LEVEL (HI)
		P:.25"-I-9811-PI	INSTRUMENTATION	SG (MED)
		R:.75"-P-1001-PI	PROCESS DRAIN	PROCESS OUT
		S:.5"-P-1159-PI	PROCESS DRAIN	PROCESS OUT TO DIV BOX CON.#2
		T:2"-VG-2093-PI	VESSEL VENT	VENT
		U:.5"-P-1158-PI	PROCESS DRAIN	JET OUT FOR VESSEL WASHDOWN
TK-1 325/RM 32	H-3-70460/2,3,4 -Piping Detail	_:_	(TO BE PROVIDED LATER)	FROM 325B HOT CELL, HOOD, DRAIN
		_:_	(TO BE PROVIDED LATER)	TO 340 BLDG

TABLE 4.1. (cont.)

Tank/Building	Ref. Drawings	Tank Nozzle and/or Line Number	Stream Category	Service
WT-1 325/VAULT A	H-3- 70460/2,3,4 -Piping Detail H-3-9321 -Tank Detail	1:2"-G-VP-163	CORROSIVE/VENT	VENT
		2:		
		3:29-.5"-H-PS	PROCESS	PT-1 TO WT-1
		3:189-1 .5"	PROCESS	FROM B VAULT SUMP
		3:30-.5"-H-PS	CORROSIVE CONTAMINATED	PT-2 TO WT-1
		4:		
		5:13-.5"-H-PS/1137		WT-1 TO W4
		5:.5"-34-PS	CORROSIVE CONTAMINATED	TO 63-3"-M-CW (OUT TO VB#3)
		5:188-1 .5"-G-SC	CORROSIVE CONTAMINATED	FROM SUMP
		5:185-1 .5"-G-SC	CORROSIVE CONTAMINATED	FROM LIQUID TRANSFER STATION
		6:191-1 .5"-G-SC	PROCESS	FROM TRENCH DRAIN
		7:	PROCESS	
		8:	PROCESS	
		9:190-1 .5"-G-SC		FROM C VAULT SUMP
		9:33-.5"-H-PS		PT-5 TO WT-1
		9:31-.5"-H-PS		PT-3 TO WT-1
		9:32-.5"-H-PS		PT-4 TO WT-1

Key to table abbreviations (NOTE: This is not a complete list; only those abbreviations that are known are included)

A	Air
CA	Compressed Air
CBWS	Crib Waste Sewer
CW	Chilled Water
G	Corrosive Contaminated
HLV	High Level Vault
HLVS	High Level Vault Sump
IA	Instrument Air
LLC	Low Level Canyon
LLI	Liquid Level Indicator Line
LLIA	Liquid Level Alarm Line
LLV	Low Level Vault
LLVS	Low Level Vault Sump
LOS	Load Out Station
LP	Low Pressure Steam (15 psi)
LTH	Liquid Transfer Hood

TABLE 4.1. (cont.)

M	????
MP	Medium Pressure Steam (125 psi)
P	Process Drain
PT	Pipe Trench
REF	Reference
REG	Regulated
RPS	Retention Process Sewer
RS	Retention Sump
RW	Raw Water
SC	Contaminated Sewer
SGI	Specific Gravity Indicator
TE	Temperature Element Tube
TK	Tank
TPS	Tank Process Sewer
VP	Vacuum Process
VIA	Ventilation Instrumentation Air
VG	Vent Gas
VV	Vessel Vent
WFI	Weight Factor Indicator

References:

1. Chemical and Materials Engineering Laboratory Operating Manual, PNL, Richland, WA
2. WHC Blueprint # H-3-20415 No. 101 Waste Tank
3. WHC Blueprint # H-3-20416 No. 102 Waste Tank
4. WHC Blueprint # H-3-20417 No. 103 Waste Tank
5. WHC Blueprint # H-3-20421 No. 108 Waste Tank
6. WHC Blueprint # H-3-20418 No. 104 Waste Tank
7. WHC Blueprint # H-3-20419 No. 105 Waste Tank
8. WHC Blueprint # H-3-20420 No. 106 Waste Tank
9. WHC Blueprint # H-3-21015 Waste Vault Storage Tank - TK-107
10. WHC Blueprint # H-3-70460 (1) 325,325B RLWS Under First Floor Iso.
11. WHC Blueprint # H-3-70460 (2) RLWS 325A & Vault Below 1st Flr. Iso.
12. WHC Blueprint # H-3-70460 (3) 325A Tank Piping Sections and Details
13. WHC Blueprint # H-3-70460 (4) 325A Tank Drain Piping Schedule
14. WHC Blueprint # H-3-43311 Vessel Assembly Tanks Tank W1, Tank W2, Tank W3
15. WHC Blueprint # H-3-43312 Vessel Assembly Tank W5
16. WHC Blueprint # H-3-9321 Mechanical Process Tanks Modification Cerium Recovery Facility
17. WHC Blueprint # H-3-43197 Vessel Assembly Tank W4
18. WHC Blueprint # H-3-43196 Piping Interbuilding Transfer Line Modifications
19. Pete Lowry, 5/20/93

TABLE 4.2. Tank Construction Summary

Tank	Material of Construction	Side/Top/Bottom Thickness	Age/Approximate Date Constructed
W-1	304 L S.S.	0.375"/0.375"/0.375"	1977
W-2	304 L S.S.	0.375"/0.375"/0.375"	1977
W-3	304 L S.S.	0.375"/0.375"/0.375"	1977
W-4	304 L S.S	0.25"/0.25"/0.25"	1977
W-5	304 L S.S.	0.25"/0.5"/0.25"	1977
WT-1	NA	NA	NA
PT-1	304 L S.S.	Drawing not Legible	1944
PT-2	304 L S.S.	Drawing not Legible	1944
PT-3	309 Cb S.S.	0.1875"/0.25"/0.25"	1944
PT-4	302 Cb S.S.	0.1875"/0.375"/0.1875"	1944
PT-5	309 Cb S.S.	0.1875"/0.375"/0.1875"	1944
TK-1 (Rm 32)	NA	NA	NA
101	309 Cb S.S.	0.5"/0.5"/0.5"	1943
102	309 Cb S.S.	0.5"/0.5"/0.5"	1943
103	309 Cb S.S.	0.5"/0.5"/0.5"	1943
104	304 L S.S.	0.5"/0.5"/0.5"	1954
105	309 Cb S.S.	0.5"/0.5"/0.5"	1943
106	309 Cb S.S.	0.25"/0.375"/0.25"	1944
107	304 L S.S.	0.25"/0.5"/0.25"	1963
108	309 Cb S.S.	0.5"/0.5"/0.5"	1943

References:

WHC Blueprint #H-3-20415 No.101 Waste Tank.
WHC Blueprint #H-3-20416 No.102 Waste Tank.
WHC Blueprint #H-3-20417 No.103 Waste Tank.
WHC Blueprint #H-3-20418 No.104 Waste Tank.
WHC Blueprint #H-3-20419 No.105 Waste Tank.
WHC Blueprint #H-3-20420 No.106 Waste Tank.
WHC Blueprint #H-3-20421 No.108 Waste Tank.
WHC Blueprint #H-3-21015 Waste Vault Storage TK-107.
WHC Blueprint #H-3-43312 Vessel Assembly TK-5.

TABLE 4.2. (cont.)

WHC Blueprint #HW-74536 Plan & Sections (PT-3,P T-5).
WHC Blueprint #HD-62372 Tank D-1 (PT-1, PT-2).
WHC Blueprint #HD-62487 Weigh Tank (PT-4).
WHC Blueprint #D-62068 T-3, T-4, T-5 (TK-101, TK-103, TK-108).
WHC Blueprint #D-62069 T-6 (TK-105).
WHC Blueprint #H-3-9321 Mech. Process Tanks Mods. Cerium Fac.
WHC Blueprint #H-3-43311 Vessel Assembly Tank W1, Tank W2, Tank W3.
WHC Blueprint #DET-62803 Tank 3'-6" DIA. x 4'-0".

TABLE 4.3. Approximate Composition (%) of the Various Tank Materials

Tank Material	309Cb Stainless Steel	304L Stainless Steel	347 Stainless Steel
C	0.07 Max	0.03	0.10 Max
Cb (Nb)	10 x C Min 1% Max	---	10 x C Min 1% Max
Cr	22.0 Min	18-20	18.0 Min
Cu	---	---	---
Fe	Remainder	Remainder	Remainder
Mn	1.25-2.5	2.0	2.5 Max
Ni	12.0 Min	8-12	12.0 Min
P	0.035	0.045	0.04 Max
Si	0.75 Max	1.0	0.75 Max
S	0.030	0.03	0.04 Max

TABLE 4.4. Pitting Corrosion of 304 Stainless Steels in Chloride Containing Water

Chloride Ion Content (ppm)	Temperature (°C)	pH	Time (months)	Pitting Corrosion	Reference
1000	40	7	0.44	Initiated	Wang et al 1988
250 - 5000	24 - 60	7	6	None	Redmerski et al 1983
5000 - 10000	Ambient	4	15.9	Mild	Auld 1965
330	80	1.5	7.3	Severe	Auld 1965
50	50	1.4	17.6	None	Auld 1965
110 + organic liquid	70	7.5	6.7	Mild	Auld 1965

TABLE 4.5. Corrosion Based Limits for the RLWS

Variable	Limit
pH	$7<pH<13$
Cl^- limit	<0.01 M
F^-, Br^-, I^-	No restriction, provided $pH>7$,

TABLE 4.6. . Potential Corrosion Ranking of the 324 Building Tanks

Ranking	Tank Designation	Primary reason for ranking	Referenced Section
1.	TK-105	Presence of Cl^- in feed materials stored in the tank. Cl^- concentration reported to be approximately 0.10M.	Analytical results presented in Table 3.2.
2.	TK-104	Contained feed materials similar to that of Tk-105.	Section 3.1.6.2.
3.	TK-107	Contained highly acidic feed material during the NMVP. Solutions reported to have reached temperatures exceeding 75°C.	Section 3.2.6.3
3.	TK-106	Contained solutions similar to that Tk-107.	Section 3.2.6.3
3.	TK-108	Received acids from the acid fractionater. Acids may have contained residual halides concentrated from the acid fractionater.	Section 3.2.6.4
	TK-102	These tanks most likely handled the largest volume of waste, however they typically contained process condensates with pH values that ranged from 6-8, and generally low halide concentration. These tanks were also connected to cell floor drains and sink drains. Although the solution volume discharged from these sources is probably small compared to process condensate, it is difficult to characterize.	Section 3.2.6.1.
4.	TK-101	These tanks most likely handled the largest volume of waste, however they typically contained process condensates with pH values that ranged from 6-8, and generally low halide concentration. These tanks were also connected to cell floor drains and sink drains. Although the solution volume discharged from these sources is probably small compared to process condensate, it is difficult to characterize.	Section 3.2.6.1.
4.	TK-103	These tanks most likely handled the largest volume of waste, however they typically contained process condensates with pH values that ranged from 6-8, and generally low halide concentration. These tanks were also connected to cell floor drains and sink drains. Although the solution volume discharged from these sources is probably small compared to process condensate, it is difficult to characterize.	Section 3.2.6.1.

5.0 INTEGRITY ASSESSMENT PLAN

WAC 173-303-640(2)(c) specifies that the assessment must include, for other than nonenterable underground tanks, either a leak test or other integrity examination, certified by an IQRPE (See Appendix A), that addresses cracks, leaks, corrosion, and erosion. The following subsections describe the overall assessment methodology that will be used to meet this requirement for the PNL tank systems in the 324 and 325 Buildings. Until the initial phases of the assessment are complete, there will not be enough data to determine the best assessment methods for each system component. As assessment activities progress, detailed work packages will be developed for each phase of activity that will contain the specific details of how each system component will contain the specific details of how each system component will be assessed. This plan sets forth the general criteria that will be used in preparing the detailed work packages. The scope of this effort will not include the disposition of a leaking or unfit for use tank system or component. After the initial integrity assessment is completed, requirements and schedule for future integrity assessments will be developed. The tank systems and ancillary equipment covered in this IAP are listed in Section 2.2.

It is anticipated that much of the integrity assessment work will actually be performed by PNL personnel working with SAIC design and NDE personnel. Thus, PNL will require qualification, inspection, and quality assurance procedures that integrate with those of SAIC and assure that only qualified and trained personnel and qualified processes are utilized.

5.1 ASSESSMENT APPROACH

Based upon the information on the tank systems presented in Sections 2.0, 3.0 and 4.0, and information obtained during design assessment activities, one tank from each building, room, and/or vault (and similarly, ancillary components) will be identified whose design and history indicates it as the most probable candidate for loss of integrity. Specific locations on tanks and ancillary equipment where damage is most likely to be found will be identified. Information presented in Sections 3.0 and 4.0 indicates that possible candidate tanks include either Tank TK-101 or TK-102 in the 324 Building, and Tank WT-1 in the 325 Building. The purpose of identifying candidate tanks and components in this manner is to limit the degree of intrusive assessments of other tanks and ancillary equipment. Limitation of work on other tanks and components (and thereby dose) may be technically defensible if limited damage is found in the candidate tanks. At a minimum, each system tank will be subjected to a leak test, probably hydrostatic, and external visual inspection.

For each of the candidate tanks and components, it will be necessary to determine which and the extent to which possible damage locations can be evaluated. The ability to evaluate these locations will be limited by the accessibility of humans and equipment to those locations. Accessibility problems include high dose rates in many areas, the presence of piping in the vicinity of tanks, lack of space between tanks and vault walls, the absence of acceptable tank ports for internal viewing purposes, and the presence of heating/cooling jackets on many tanks. It will not be possible to completely evaluate every weld and component without significant disassembly of equipment and the accrual of significant personnel dose. Therefore practical judgments must be made on the extent of physical tests (such as ultrasonic testing) and visual inspections required. These practical judgments will be based on factors such as the degree of reduction-of-integrity (if any) found at accessible, highest-potential-for-failure locations and the radiation doses received in evaluating those locations.

It is possible that sufficient damage may be discovered after conducting a limited number of tests or inspections to conclude that a tank or system component is no longer suitable for service. If this is the case, the requirements of WAC 173-303-640(7) will be addressed. Alternatively, some signs of deterioration may be found that lead to the conclusion that certain inaccessible locations should be evaluated as well. Such a decision may require significant equipment disassembly and may involve high dose rates. Because most of the tanks and ancillary equipment are constructed of corrosion-resistant stainless steel, it is possible and, perhaps likely, that inspection results will indicate that tanks (or components) are acceptable for intended service after conducting a limited number of tests and inspections.

An early step in the assessment process will be the evaluation of system drawings to determine the space available for conducting the various manual and remote inspections and tests that might be employed. Examples of candidate inspections and tests include hydrostatic leak tests, nondestructive examinations (NDE), such as ultrasonic testing, dye penetrant testing, and viewing with the aid of remote video cameras and periscopes. After this step is completed the inspection and testing strategy will be developed.

Another important step will be to evaluate the potential radiation exposures that may be accrued at locations where assessment activities will be conducted. Currently there is no dose rate information available for inaccessible tank system areas. Accurate dose rate information will have to be obtained for each area where assessment activities are to be conducted before making the final selection of testing and inspection methods. Personnel exposure will be evaluated as a function of distance (with and without shielding) and in relation to various dose rates resulting from different levels of decontamination effectiveness. It is likely that the RLWS tanks and ancillary piping are too radioactive to conduct the evaluations safely without decontaminating the system, unless only remote inspection and testing methods are used. The degree of decontamination achievable will be a function of the ability to gain access to locations where radioactivity is concentrated, the effectiveness and amounts of the decontamination fluid(s) used, and the procedures for their use.

The types and amounts of decontamination fluids will be limited by waste acceptance criteria and by available storage capacity. The volumes of fluids required to achieve decontamination to the point that would allow manned entry to the tank system location may exceed available capacity. It may also jeopardize other compliance activities that generate wastes that must be stored. If decontamination is not feasible, then remote methods must be used to conduct the integrity assessment.

Development of instruments and techniques will be required to conduct inspections remotely. The time required to develop this equipment and techniques must be factored into the overall assessment schedule. Because of the expected difficulties in achieving the levels of decontamination acceptable for manual inspection and testing, it is likely that some remote inspection and testing methods will require development. These remote methods may include a means of conducting and recording external and internal visual inspections of tank system surface materials. Also required may be remote methods for conducting ultrasonic or dye penetrant testing. The specific remote methods requiring development will depend on which failure mechanisms are considered most credible and the best methods of evaluating the mechanisms, considering accessibility constraints.

To achieve compliance while minimizing dose, it will be important to utilize information gained during evaluations of the first tanks and components when conducting subsequent evaluations (see design assessment considerations of Section 4.0). As recommended earlier, the first evaluations should be conducted on tanks and components likely to have been exposed to the most damaging conditions. If such evaluations show insignificant deterioration, it will be possible to assess other system tanks and ancillary equipment with methods requiring less hands-on activity.

Based upon the analysis detailed above, an attempt will be made to demonstrate that the PNL RLWS components either have not experienced general corrosion, stress corrosion cracking damage, or radiation damage from the wastes (compatibility) or have experienced damage at a slow rate (system components have a finite life). The assessment results will permit conclusions to be made about current conditions and life expectancy of the tank systems, including ancillary equipment, and piping.

5.2 FAILURE MECHANISMS AND ASSESSMENT

Evidence of corrosion, leaks, cracks, buckles, and bulges will be sought in accessible tanks, valves, and auxiliary equipment.

5.2.1 Tanks

Corrosion is the prime cause of deterioration of steel storage tanks and accessories; therefore, finding and measuring the extent of corrosion is the major reason for inspecting tanks. Internal corrosion in the vapor space above the liquid surface may be caused by water vapor, oxygen, or acidic vapors. For the area of the tank below the liquid level, corrosion is caused by the presence of acid salts, hydrogen sulfide, or other sulphur compounds. Because of the quality of the water used for tank cooling, corrosion of the tank outer surface in the area of the cooling water jacket is also a possibility. Ultrasonic testing methods are most useful for measuring a tank's thickness and determining the location, size, and nature of defects caused by internal corrosion.

External corrosion of tank bottoms can be a serious problem. Atmospheric corrosion can occur on all external parts of a tank. This type of corrosion may range from negligible to severe, depending on the atmospheric conditions of the locality. An acidic atmosphere can destroy protective coatings and increase the rate of corrosion. The external conditions surrounding the PNL RLWS tanks are benign, therefore this form of corrosion is not expected to have caused significant deterioration. External visual inspections will be the most suitable method for determining the extent of external corrosion. If visual inspection suggests the presence of surface corrosion and the need for more detailed investigation, simple hand tools will be used (e.g., scrapers, wire brushes, hammers, mirrors, magnifiers, etc.) to aid further visual inspection. If the results indicate the need for more sophisticated equipment, ultrasonic testing equipment will be employed.

Leaks are most often marked by discoloration in the area below the leaks and are generally caused by corrosion (discussed above), seal failure or cracks. Very few seal failures are expected since all tank penetrations are made at the top, most penetrations are welded, the tanks are operated at atmospheric pressure and piping runs are welded rather then flanged; therefore, very few seals are used in the PNL RLWS system. Any indication that a tank or component is leaking due to a seal failure will result in removal from service as soon as possible. Visual external inspection will provide the first indication of potential tank leaks. Leak tests for the types of tanks used in the PNL RLWS are normally conducted by filling the tanks with water and either using the installed tank instrumentation or supplemental instrumentation to detect leaks.

The nature of any cracks found by visual inspection will be carefully determined. Any indications that a tank or component is leaking due to a crack will result in its removal from service as soon as possible accompanied by a complete inspection with subsequent repairs. Cracks may be triggered by many causes: faulty welding, unrelieved stress concentrations around fittings, insufficient reinforcement at openings, stresses caused by settlement or earth movement, vibration, and/or poorly designed repairs. With austenitic stainless steel, as used for most RLWS tanks and piping, stress corrosion cracking is a potential cause of cracking. Cracks are most likely to be found at the connection of the bottom plate and shell of a welded tank, around nozzle connections and manholes, and at welded brackets and seams. An external visual inspection will be performed at such locations. If any signs of cracking are identified the suspected area will be cleaned and the dye penetrant or ultrasonic testing method used.

Buckles and bulges will normally be evident by visual inspection, even from a distance. It will be important to determine the cause of any identified distortion. Distortion can be caused by settlement of the tank, earthquake, internal pressure in the tank caused by defective vents or relief valves, excessive negative pressure in the tank, severe corrosion of the shell, movement of the connected piping, or other mechanical damage. When a tank is of welded construction and has serious distortions, the welded seams may be severely overstressed at some points and may tend to crack. If this type of cracking is suspected the same investigation methods mentioned above will be employed.

5.2.2 Valves

System ancillary equipment consists of transfer piping, jet pumps, and liquid sensing equipment. Materials of construction for these components are similar to those for the system tanks and are subject to the same failure mechanism described above. The most likely failure mechanisms are mechanical failure (e.g., induced by vibration, settlement, improper support) and possible corrosion at low points in piping runs. As previously mentioned, the potential for system failure has been minimized by using welded piping runs and tank penetrations, top entering tank penetrations, and sealless jet pumps for liquid transfer. As with the tanks' visual inspection, external inspection of accessible surfaces will provide the first indication of potential failure. Any areas showing signs of failure or degradation will be examined closely using more extensive examination methods such as ultrasonics. Due to the methods of construction, failure of jet pumps or liquid sensing equipment does not directly threaten the integrity of the system. However, proper operation of these components may be essential to detecting system failure and mitigating the results. Therefore, jet pumps and liquid sensing equipment will be functionally tested to ensure proper operation.

5.3 LEAK TESTS

WAC 173-303-640 (2)(c)(v)(B) requires that the assessment for other than nonenterable underground tanks and ancillary equipment include a leak test or other integrity examination. If limited damage is found in the tank system components identified as the most probable candidates for loss of integrity then leak testing will be the preferred method of assessment for the remaining system components. Leak tests limit the need for hands-on work and will reduce the personnel dose required to perform the assessment. Tank leak tests have to be capable of taking into account the following:

- effects of temperature variation
- tank end deflection
- vapor pockets
- high water table effects.

Because all of the system tanks are either enclosed in cells, vaults or buildings, the evaluation of water table effects is not appropriate. To the extent practical the tanks will be cleaned and decontaminated before testing. The other effects listed above can be reduced to acceptable levels by choosing an appropriate leak testing method. At the time the leak test procedure is developed, it will be determined if existing instrumentation can be used for the test and whether it is capable of taking into account the effects listed above. If the installed instrumentation cannot be used, a leak testing device that meets EPA guidance (EPA 1986) will be selected. Table 5.1 lists leak testing devices for volumetric measurement which EPA recognizes as being adequate to address all areas of concern.

An approved leak test procedure will be developed for conducting system leak tests. The test procedures developed for conducting the leak tests will take into consideration maximum operating tank levels. If radiologically practical the tanks and piping will be hydrostatically tested in conformance with recognized engineering standards such as ASME Section XI, Article IWD-5000, Paragraph IWD 5223, "System Hydrostatic Test" or the API Guide for Inspection of Refinery Equipment, Chapter XIII (API 1981). The ancillary equipment will be tested by flowing water through each portion of the system while visually observing the accessible portions for leaks. For portions of the system which are not accessible for visual observation, a known amount of water will be flowed through the system and measured against that collected at the other end. Tests of ancillary equipment will also be conducted in a manner consistent with accepted engineering standards, such as ASME Section XI, Article IWD-5000, Paragraph 5223(d) or the API guide mentioned above.

5.4 NON-DESTRUCTIVE EXAMINATIONS

Several types of non-destructive examination (NDE) techniques will be necessary to accomplish the intended assessment activities. Ultrasonic testing will be employed on the tanks and ancillary equipment identified as "worst-case." If these examinations reveal minimal deterioration, then visual examination of external surfaces coupled with leak tests will be used for the remaining system components. If significant damage is detected in the "worst-case" components, more extensive use of ultrasonic examination will be necessary. When the visual inspection indicates that more sophisticated equipment is needed to assess a suspected problem, other appropriate NDE methods will be employed. Techniques that could be used to supplement visual examination are dye penetrant (for suspected surface cracks) and ultrasonic testing (deep cracks, corrosion, and physical damage).

Visual Inspection. Inspection of the tank system will be focused on direct visual examination of the external surfaces of tanks and exposed ancillary equipment. Inspection of the system components will be performed remotely using video and/or photographic equipment. Photographs and video tapes will be retained for later analysis by qualified experts and to provide documentation of the inspections. System welds, seams, joints, flanges, gaskets, tank surface, surrounding floor, jumpers, supports/restraints, etc., will be examined for signs of degradation including potential for damage from falling objects. The visual inspection will also be used to confirm that the as-built configuration conforms to the design drawings and specifications.

A visual inspection will be performed on the accessible external portions of the remaining ancillary equipment such as in-cell or vault piping, internal building transfer piping, piping joints, flanges, and gaskets. Visual inspection will also be used as a means of compliance assessment for secondary containment components.

The inspections will look for evidence of cracks, leaks, corrosion, erosion, and any other defects or conditions affecting system integrity. The inspections will be conducted in accordance with an approved procedure. Visual inspections will conform to recognized engineering standards such as ASME Section XI, Article IWD 3000, Paragraph IWD 3140, "Inservice Visual Examinations." Additional inspections and nondestructive examination (NDE) will be performed if examinations suggest indications of tank system damage or corrosion.

Dye Penetrant. The suspected region on tank or ancillary equipment is sprayed (or painted) with a special dye penetrant, the dye concentrates in the surface defect. Once the dye dries a chemical developer or special light source is used to reveal the extent of the defect. Once the extent of the defect is known ultrasonic testing will be performed to determine the depth of the defect and resulting impact on component integrity.

Ultrasonic Testing. This technique can be used to measure a components thickness and determine the location, size and nature of defects. An ultrasonic impulse is generated within the material being tested and a transducer in contact with the material used to detect discontinuities in the signal. The nature of the discontinuities is directly related to the type and extent of the defect. Only the outside of the component has to be accessed to use these techniques. Results are permanently recorded and can be displayed in 2-D or #-D real-time for easy comparison, periodic monitoring or future analysis.

5.5 ANCILLARY EQUIPMENT ASSESSMENT

For assessing the integrity of ancillary equipment practices such as those described in API, "Guide for Inspection of Refinery Equipment, Chapter XI - Pipe, Valves and Fittings," Second Edition, 1974 may be used. Inspections on ancillary equipment will be conducted concurrently with the tank and secondary containment inspections. External visual inspection of piping, flanges, valves, welds, and joints will be conducted for signs of corrosion, erosion, fouling, cracks, misalignment, vibration and leaks. Thickness measurements and pressure tests to determine tightness may also be performed to determine structural integrity. Those portions of the ancillary equipment identified as having a high potential for failure, based on usage history and design analysis, will be subjected to closer examination using ultrasonic techniques to identify signs of internal corrosion, erosion or cracking. The results of the external visual inspections and the selective ultrasonic examinations will be used to determine the need for more further assessment.

5.6 PERIODIC INTEGRITY INSPECTIONS

Environmental protection strategy for waste storage tanks is based upon period integrity inspections that reflect the status of the system at a point in time, coupled with system monitoring and secondary containment to serve as real-time protection. As a result, regulations require that tank systems must be inspected on a routine basis to minimize the probability of accidental releases of hazardous wastes to the environment. The frequency of the inspections depends on the likelihood of the tank system failure and on the severity of the threat to human health and the environment. The results of the integrity assessment activities will be used to determine the appropriate type and frequency for integrity inspections.

WAC 173-303-640(6) requires that the owner or operator of a waste tank system having a compliant secondary containment system must provide for the following inspection activities:

- Develop a schedule and procedure for inspecting overfill controls.
- Inspect the following at least once each operating day:
  - above-ground portions of the tank system, if any, to detect corrosion or releases of waste
  - data gathered from monitoring any leak detection equipment to ensure that the tank system is being operated according to its design
  - the construction materials and the area immediately surrounding the externally accessible portions of the tank system, including the secondary containment system, to detect erosion or signs of releases of dangerous wastes.
- Inspect cathodic protection systems, if present, according to a schedule designed to ensure that they are functioning properly.
- Document in the operating record of the facility an inspection of all items covered by the periodic assessment program.

Overfill controls and instruments include flow-rate controls, level controls, temperature gauges, pressure gages, control valves, analyzers, alarms,and emergency shutoff devices. The type of components that should be inspected include transmission systems, power supplies, seals, purges, panels and enclosures, electrical equipment, insulation, operating mechanisms, insulating and lubricating oils, bearings, and batteries. If these instruments and controls are an integral part of the daily operation of a facility they may already be visually inspected on a frequent basis. At a minimum, all instrumentation and control equipment should be thoroughly inspected according to the manufacturer's recommended frequency and methodology.

Many of the tanks, associated ancillary equipment and secondary containment features in both the 324 and 325 Buildings are inaccessible to daily inspection because they are contained in vaults covered with large concrete blocks or in highly radioactive areas. Since daily visual inspection of these tanks is currently impractical, a feasible alternative would be to perform a daily check of leak detection instruments, tank level indicators, and temperature and pressure indicators for evidence of problems. If a failure were to occur in a component of the tank system resulting in a leak, the secondary containment would ensure that no waste would be released into the environment.

If, based upon the results of the integrity assessment, visual inspection of a tank(s), ancillary equipment or secondary containment in a vault or cell is needed, then remote television cameras, periscopes or other remotely operated non-destructive examination equipment may be required. This will limit the exposure of personnel to the radioactive environment and provide for the necessary inspection frequency.

During the performance of the integrity assessment all portions of the system will be assessed. The following will be identified in the Integrity Assessment Report and used to shape the routine inspection program:

- Those portions of the system which are accessible to routine daily visual inspection
- Those portions of the system which are inaccessible to daily visual inspection
- Any portions of the tank system or secondary containment requiring increased inspection frequency due to deterioration
- An assessment of deterioration rates of the tank system equipment
- Suggested inspection frequencies for each portion of the system (based on deterioration rates)
- Suggested methods and techniques for use in performing routine inspections on each portion of the system (accessible and inaccessible).

Methods and techniques utilized during the integrity assessment may prove useful for routine periodic inspection. Because of the preparations necessary to perform the integrity assessment it may be most cost effective to design, test and install the necessary equipment to perform routine periodic inspections at this time.

It may be possible to minimize the number and frequency of routine integrity inspections by first examining the tank(s) and ancillary equipment with the most corrosive service history. If no serious deterioration is found during the integrity assessment, each group of tanks or ancillary equipment with the same metal composition and design type may then require only one inspection on an infrequent basis (e.g., it could be inferred that corrosion, being insignificant in 35 years of operating service, is unlikely to be an issue during the next several years). Permission to use this approach would require a sound technical basis which offers convincing evidence that the approach would ensure an equivalent level of environmental protection to daily inspections of above-ground tanks and piping.

Following completion of the integrity assessment and any necessary system modifications, formal procedures for implementing and documenting the routine inspection program will be developed.

TABLE 5.1. Leak Testing Devices

Method	Principle	Claimed Accuracy (gal/hr)	Tank Preparation
	Volumetric Measures		
Ainlay Tank Integrity Testing	• Pressure measurement by a coil-type manometer, determine product level change in a propane bubbling system	0.02	Fill the tank the evening before a test
ARCO HTC Underground Tank Leak Detector	• Level change measurement by float and light sensing system	0.05	Adjust the level at 66-76 percent
Certi-Tec Testing	• Monitors pressure changes resulting from product level changes	0.05	None
"Ethyl" Tank Sentry	• Level change magnification by a "J" tube manometer	Sensitive to 0.02 in. level change	No deliveries 24 h prior to a test
EZY-CHEK Leak Detector	• Pressure measurement, determine product level change in an air bubbling system	Less than 0.01	Fill up 4 h prior to a test, usually test at night
Fluid-Static (Standpipe) Testing	• Pressurize a system by a standpipe • Keep the level constant by product addition or removal • Measure rate of volume change	Gross	Fill the tank prior to a test
Heath Petro Tite Tank and Line Testing (Kent-Moore)	• Pressurize a system by a standpipe • Keep the level constant by product addition or removal • Measure volume change • Product circulation by pump	Less than 0.05	Fill the tank prior to a test
Leak Lokator Test Hunter - Formerly Sunmark Leak Detection	• "Principle of Buoyancy" - The apparent loss in weight of any object submerged in weight of the displaced volume of liquid	0.05 even at product level at the center of a tank	Typically fill the tank before testing (if it is possible to fill a tank by the product)
Mooney Tank Test Detector	• Level change measurement with a dip	0.02	Fill the tank 12 to 14 h prior to a test
Tank Auditor	• "Principle of Buoyancy"	0.00001 in the fill pipe. 0.03 at the center off 10.5-ft diameter tank	None
Two-Tube Laser Interferometer System	• Level change measurement by laser beam and its reflection	Less than 0.05	None

6.0 SECONDARY CONTAINMENT COMPLIANCE ASSESSMENT

Although the requirements of WAC 173-303-640(2), which address the need for an integrity assessment for existing tank systems, do not require an integrity assessment for secondary containment, it is necessary to determine whether existing secondary containment features are in compliance with WAC requirements and if these features are intact and fully functional. This section will present a discussion of the WAC requirements for secondary containment, a description of existing secondary containment features, an assessment of compliance, and a plan for determining functionality.

6.1 WAC REQUIREMENTS FOR CONTAINMENT AND DETECTION OF RELEASES

The requirement for containment and detection of releases from dangerous waste tanks is contained in WAC 173-303-640(4). In general the requirement states that secondary containment shall be designed, installed, and operated to prevent any migration of wastes or accumulated liquid out of the system to the soil, ground water, or surface water at any time during the use of the tank system. Secondary containment shall also be capable of detecting and collecting releases and accumulated liquids until the collected material is removed. Specific minimum requirements for secondary containment include these features:

- Constructed of or lined with materials that are compatible with the wastes and must have sufficient strength and thickness to prevent failure owing to pressure gradients, physical contact with the waste, climatic conditions, and the stress of daily operations

- Placed on a foundation or base capable of providing support to the secondary containment system, resistant to pressure gradients from above and below the system, and capable of preventing failure due to settlement, compression, or uplift

- Provided with a leak-detection system that is designed and operated so that it will detect the failure of either the primary or secondary containment structure or the presence of any release of dangerous waste or accumulated liquid in the secondary containment system within 24 h

- Sloped or otherwise designed or operated to drain and remove liquids resulting from leaks, spills or precipitation. Spilled or leaked waste and accumulated precipitation must be removed from the secondary containment system within 24 h.

Secondary containment for tanks must include one or more of the following devices:

- An external liner

- A vault

- A double-walled tank
- An approved equivalent device.

Within the 324 and 325 Buildings, the primary means of providing secondary containment for tanks is with a lined vault. The requirements specify that vaults must be

- Designed or operated to contain 100% percent of the capacity of the largest tank within its boundary
- Designed or operated to prevent run-on or infiltration of precipitation into the secondary containment system unless the collection system has sufficient excess capacity. Such additional capacity must be sufficient to contain precipitation from a 25-year, 24-h rainfall event
- Constructed with chemical-resistant water stops in place at all joints (if any)
- Provided with an impermeable interior coating or lining that is compatible with the stored waste and that will prevent migration of waste into the concrete
- Provided with a means to prevent the formation of ignitable vapors within the vault (if the waste being stored meets the meets the definitions of ignitable or reactive)
- Provided with an exterior moisture barrier or be otherwise designed or operated to prevent migration of moisture into the vault if it is subject to hydraulic pressure.

The requirements also specify that ancillary equipment must be provided with secondary containment (e.g., trench, jacketing, double-walled piping) that meets the general requirements listed above except for

- Aboveground piping (exclusive of flanges, joints, valves, and other connections) that is visually inspected for leaks on a daily basis
- Welded flanges, welded joints, and welded connections that are visually inspected for leaks on a daily basis
- Sealless or magnetic coupling pumps and sealless valves that are visually inspected for leaks on a daily basis
- Pressurized aboveground piping systems with automatic shut-off devices that are visually inspected for leaks on a daily basis.

6.2 DESCRIPTION OF SECONDARY CONTAINMENT SYSTEMS

6.2.1 324 Building Secondary Containment Systems

There are two vaults in the 324 Building: the low level vault (LLV) and the high level vault (HLV).

The LLV is located in Room 17 under the floors of Room 147. It is used for storage of low- to intermediate-activity wastes. The vault contains four stainless steel tanks: TK-101, TK-102, TK-103, and TK-108.

The LLV is 8.7 m wide by 4.0 m long by 5.6 m deep (28.5 ft by 13 ft by 18.5 ft). The vault is concrete with the walls and floor lined with #11 gage stainless steel sheet or plate, extending 4 ft up from the highest point of the floor.

The vault is covered by a set of concrete shielding blocks 0.6 m (2 ft) thick. Several of the blocks are removable and can cover approximately 40% of the vault floor area. Beneath the cover blocks there are removable steel plate ventilation barriers with integral manhole covers.

The floor of the vault is sloped in the vault's shortest direction toward a trench located along one wall. The trench in turn slopes from both ends of the vault toward its middle where a sump is located. The sumps are equipped with liquid sensing alarms and pumps to transfer liquid to other tanks in the system.

The HLV is located in Room 16 under the floors of the cask handling area. It is used for storage of high-activity wastes. The vault contains four stainless steel tanks: TK-104, TK-105, TK-106, and TK-107.

The HLV is 6.4 m wide by 4.0 m long by 4.4 m deep (21 ft by 13 ft by 14.5 ft). The vault is concrete with the walls and floor lined with stainless steel sheet or plate, extending 3.5 ft from the highest point of the floor.

The vault is covered by a set of concrete shielding blocks 1.8 m (6 ft) thick. Several of the blocks are removable and can cover approximately 40% of the vault floor area. Beneath the cover blocks there are removable steel plate ventilation barriers with integral manhole covers.

The floor is sloped in the vaults shortest direction toward a trench located along one wall. The trench in turn slopes from both ends of the vault toward its middle where a sump is located. The sumps are equipped with liquid sensing alarms and pumps to transfer liquid to other tanks in the system.

6.2.2 325 Building Secondary Containment Systems

There are three vaults associated with the 325 Building: Vault A, Vault B and Vault C, all located adjacent and external to the east side of the 325A Building. Vault A shares a wall with Room 50 in the 325A Building. The vault cover blocks are accessible from the outside of the 325 Building.

Vault A is the easternmost vault. It is 13.4 m (44 ft) long by 4.3 m (14 ft) wide. Tanks WT-1 and W-4 are located in Vault A.

The vault has concrete walls and floor with the walls a minimum of 30.5 cm (1.0 ft) thick. It has a 1/8-in.-thick, 304L stainless steel liner that is 0.9 m (3 ft) above the high point for the floor. This liner is of sufficient size to hold the entire contents of the tanks. The cover block over Vault A is 0.9 m (3 ft) normal concrete.

The floor of the vault is sloping in the vaults shortest direction toward a trench located along one wall. The trench in turn slopes from both ends of the vault toward its middle where the sump is located. The sumps are equipped with liquid sensing alarms and pumps to transfer the liquid to other tanks in the system.

The vault and tanks are vented through the building ventilation system, including two levels of HEPA filtration.

Vault B is the northwesternmost vault. It is 7.9 m (26 ft) long by 4.3 m (14 ft) wide. Tanks PT-1 and PT-2 are located in Vault B.

The vault has concrete walls and floor with the walls a minimum of 30.5 cm (1.0 ft) thick. It has a 1/8-in.-thick, 304L stainless steel liner that is 30.5 cm (1 ft) above the high point of the floor, which is adequate to hold the contents of the two tanks. The cover block over vault B is 1.2 m (4 ft) normal concrete.

The floor of the vault is sloping in the vaults shortest direction toward a trench located along one wall. The trench in turn slopes from both ends of the vault toward its middle where the sump is located. The sumps are equipped with liquid sensing alarms and pumps to transfer the liquid to other tanks in the system.

The vault and tanks are vented through the building ventilation system, including two levels of HEPA filtration.

Vault C is the southwesternmost vault. It is 4.3 m (14 ft) square. Tanks PT-3, PT-4, and PT-5 are located in Vault C.

The vault has concrete walls and floor with the walls a minimum of 30.5 cm (1.0 ft) thick. It has a 1/8-in.-thick, 304L stainless steel liner that is 30.5 cm (1 ft) above the high point for the floor. It is adequate to hold the contents of the tanks. The cover block over Vault C is 1.2 m (4 ft) normal concrete.

The floor of the vault is sloping in the vaults shortest direction toward a trench located along one wall. The trench in turn slopes from both ends of the vault toward its middle where the sump is located. The sumps are equipped with liquid sensing alarms and pumps to transfer the liquid to other tanks in the system.

The vault and tanks are vented through the building ventilation system, including two levels of HEPA filtration.

The 325A Building also contains Tank W-5 and three slab tanks: W-1, W-2, and W-3. These are located at the north end of Room 40A, beneath the 325A hot cells.

The walls, roof and floor of the slab tanks are 3/8 in. thick 304L stainless steel. The tanks are 8 ft 2 in. by 3 in. by 6 ft 6 in. with a capacity of approximately 94 gal.

The slab tanks have a stainless steel containment pan and a leak detection system. The floor liner is designed to spread any leaking solution into safe slab geometry.

Located in 325B is the 200 gal holding tank for the RLWS system, TK-1. It is located along the east wall of Room 32. The tank has a stainless steel drip pan beneath it. However, this pan does not have sufficient capacity to hold the entire contents of the tank.

6.3 COMPLIANCE ASSESSMENT PLAN

Compliance assessment will consist of two activities: a design assessment to determine if the system secondary containment features meet the WAC requirements listed in Section 6.1 above and a functional assessment to verify that the installed features have not failed and will function as required.

6.3.1 Design Compliance

A design assessment for secondary containment will be performed to ensure that containment complies with the requirements of WAC 173-303-640(4). At a minimum, consideration must be given to the following design features:

- Constructed or lined with compatible materials
- Placed on a foundation or base capable of providing appropriate support
- Provided with a leak detection system
- Sloped, designed, or operated to remove liquids resulting from leaks.

6.3.1.1 Compatibility and Strength

Depending on the chemical characteristics of the tank solutions, a compatible material must be used as the material of construction or liner for the secondary containment. A detailed characterization of wastes and waste feed materials stored in the PNL RLWS tanks has been performed and the results presented in Section 3.0. This data, along with information from the Chemical Engineers' Handbook, the National Association of Corrosion Engineers (NACE), construction design standards, coating specifications, on-site tests, and any other relevant source will be used to establish the compatibility of the stored waste with its secondary containment. The characterization of waste and waste feed materials is valuable in the assessment of any existing damage to the system.

Secondary containment strength is generally a function of thickness for a given material. The strength must be sufficient to prevent failure and ensure the continued operation of the leak-detection device. Information extracted from engineering drawings will be used to perform engineering calculations to prove that secondary containment has the strength to support the weight of all tanks when full and that the additional pressure of released waste will have only a minimal impact on support capabilities.

6.3.1.2 Foundation Integrity

Secondary containment should be properly supported to prevent structural failure due to settlement, compression of uplift. An examination of engineering drawings will be performed to determine that proper backfill specifications were used during construction of secondary containment structures.

6.3.1.3 Leak-Detection Capability

The leak-detection portion of a secondary containment system is one of the most important components. Early warning leak-detection systems provide continuous surveillance for the presence of a leak or spill. A review of engineering information will be performed to determine if leak detection instrumentation is present and that it is appropriate for its intended function. A review of operational data will be conducted to identify any reliability problems with the installed instrumentation.

6.3.1.4 Adequate Drainage

Engineering drawings will be reviewed to assure secondary containment systems have been provided with adequate means to drain and remove any leakage or spill. The system should be designed to drain liquid to the leak-detection system and provided with the means to remove any waste within 24 h or as soon as practical.

6.3.2 Functional Assessment

The functional assessment will demonstrate the adequacy of secondary containment (vaults and valve boxes) by performing a visual inspection to identify any potential failures and by conducting simple water holding tests, if warranted. It will also be important to demonstrate the reliability of liquid sensing instrumentation in vault and valve box sumps. In the case of vaults, it will be important to demonstrate that sump pumps can be activated to expeditiously remove the entire volume of a worst-case leak to a reserved tank or facility that has been demonstrated to be capable of containing the volume of the leak.

All inspection methods will be performed in accordance with the same standards, QA requirements and acceptance criteria as those applied for assessments on the primary system components.

TABLE 6.1. Secondary Containment for the 324 Building

Contained Systems/Components	Usage and Physical Description	Containment Design Features	Leak Detection and Removal	Inspection and Removal
LOW LEVEL VAULT				
• TK-101 • TK-102 • TK-103 • TK-108 • Inter-tank and system piping	The vault is used for storage of low- to intermediate-activity wastes. The LLV is 8.7 m wide by 4.0 m long by 5.6 m deep (28.5 ft by 13 ft by 18.5 ft).	The vault is concrete with the walls and floor lined with #11 gage stainless steel sheet or plate, extending 1.2 m (4 ft) up from the highest point of the floor.	The floor of the vault is sloped in the vaults shortest direction toward a trench located along one wall. The trench in turn slopes from both ends of the vault toward its middle where a sump is located. The sumps are equipped with liquid sensing alarms and pumps to transfer liquid to other tanks in the system.	The vault is covered by concrete shielding blocks 1.2 m (4 ft thick) but is accessible from above through a set of concrete cover blocks, 0.6 m (2 ft) thick, covering about 40% of the vault floor area. Beneath the concrete cover blocks are removable steel plate ventilation barriers with integral manhole covers.
HIGH LEVEL VAULT				
• TK-104 • TK-105 • TK-106 • TK-107 • Inter-tank and system piping	The high level vault is located in Room 16 under the floors of cask handling area (CHA). It is used for storage of high-activity wastes. The HLV is 6.4 m wide by 4.0 m long by 4.4 m deep (21 ft by 13 ft by 14.5 ft).	The vault is concrete with the walls and floor lined with stainless steel sheet or plate, extending 1 m (3.5 ft) from the highest point of the floor.	The floor is sloped in the vaults shortest direction toward a trench located along one wall. The trench in turn slopes from both ends of the vault toward its middle where a sump is located. The sumps are equipped with liquid sensing alarms and pumps to transfer liquid to other tanks in the system.	The vault is covered by concrete shielding blocks (4 ft thick) but is accessible from above through a set of 0.6 m (2 ft) thick concrete cover blocks covering about 40% of the vault floor area. Beneath the concrete cover blocks are removable steel plate ventilation barriers with integral manhole covers.

REFERENCES

Safety Analysis Report for the 324 Building, Section 4.0.
Safety Analysis Report for the 325 Building, Sections 4.0 and 6.0.
300 Area Radioactive Liquid Waste Management Engineering Study, Section 4.3.4.

TABLE 6.1. (cont.)

300 Area Dangerous Waste Tank Management System: Compliance Plan Approach, Sections 3.1.1 and 3.1.2.

Hanford Drawings:

H-3-9308 (1&2)	Structural Vault and Trench Liners
H-3-20276	SST Liner Details Tank Vault Area 5
H-3-22633	Radioactive Liquid Waste (RLW) Piping Plan & Elevation
H-3-43311	Vessel Assembly Tanks W1, W2, and W3
H-3-43312	Vessel Assembly Tank W5
H-3-43450	Structural Room 40-A Floor Liner Plan, Sections & Details
H-3-46871 (1&2)	Radioactive Liquid Waste Line - Basement Overhead Plan

TABLE 6.2. Secondary Containment for the 325 Building

Contained Systems/Components	Usage and Physical Description	Containment Design Features	Leak Detection and Removal	Inspection Considerations
VAULT A				
• WT-1 • W-4 • Inter-tank/system piping	Vault A is the eastern most vault in the vault area. It is 13.4 m by 4.3 m (44 ft by 14 ft) wide.	The walls and floor of the vault are concrete which are lined with a 3.2 mm (1/8-in.) thick, 304 L stainless steel liner that is 0.9 m (3 ft) above the high point of the floor. This liner is adequate to hold the entire contents of the tanks. The vault walls are a minimum of 30.5 cm (1.0 ft) thick. The vault and tanks are vented through the building ventilation system, including two levels of HEPA filtration.	The floor of the vault is sloping in the vaults shortest direction toward a trench located along one wall. The trench in turn slopes from both ends of the vault toward its middle where the sump is located. The sumps are equipped with liquid sensing alarms and pumps to transfer the liquid to other tanks in the system.	The vault has a cover block overhead that is 0.9 m (3 ft) normal concrete.

TABLE 6.2. (cont.)

Contained Systems/Components	Usage and Physical Description	Containment Design Features	Leak Detection and Removal	Inspection Considerations
VAULT B				
• PT-1 • PT-2 • Inter-tank/system piping	Vault B is the northwestern most vault in the vault area. It is 7.9 m by 4.3 m (26 ft by 14 ft) wide.	The vault has concrete walls and floor with the walls a minimum of 30.5 cm (1.0 ft) thick. The walls and floor of the vault are lined with a 3.2 mm (1/8-in.) thick, 304 L stainless steel liner that is 30.5 cm (1 ft) above the high point of the floor, which is adequate to hold the contents of the two tanks. The vault and tanks are vented through the building ventilation system, including two levels of HEPA filtration.	The floor of the vault is sloping in the vaults shortest direction toward a trench located along one wall. The trench in turn slopes from both ends of the vault toward its middle where the sump is located. The sumps are equipped with liquid sensing alarms and pumps to transfer the liquid to other tanks in the system.	There is a cover block over vault B that is 1.2 m (4 ft) normal concrete.

TABLE 6.2. (cont.)

Contained Systems/Components	Usage and Physical Description	Containment Design Features	Leak Detection and Removal	Inspection Considerations
VAULT C				
• PT-3 • PT-4 • PT-5 • Inter-tank/system piping	Vault C is 4.3 m (14 ft) square and is the southwestern most vault.	The vault has concrete walls and floor with the walls a minimum of 30.5 cm (1.0 ft) thick. The vault walls and floor have a 3.2 mm (1/8-in.) thick, 304 L stainless steel liner that is 30.5 cm (1 ft) above the high point for the floor. It is adequate to hold the entire contents of the tanks. The vault and tanks are vented through the building ventilation system, including two levels of HEPA filtration.	The floor of the vault is sloping in the vaults shortest direction toward a trench located along one wall. The trench in turn slopes from both ends of the vault toward its middle where the sump is located. The sumps are equipped with liquid sensing alarms and pumps to transfer the liquid to other tanks in the system.	The vault has a cover block that is 1.2 m (4 ft) normal concrete.

TABLE 6.2. (cont.)

Contained Systems/Components	Usage and Physical Description	Containment Design Features	Leak Detection and Removal	Inspection Considerations
ROOM 40A				
• W-1 • W-2 • W-3 • W-5 • Inter-tank/system piping	Room 40A is located beneath the 325A hot cells. The tanks are located in the north end.	Room 40A is constructed of 3000 psi, 28 day strength concrete with an 11 Gage 304L stainless steel plate liner. The liner extends 1.8 m (6 ft) up the sides of the room and is designed to spread any leaking solution into safe slab geometry. Beneath the slab tanks is also a stainless steel containment pan.	Beneath the slab tanks is a stainless steel containment pan equipped with a leak detection system. The floor of the room is sloped to a sump located on the western side of the room and there is a curb at the western most edge of the room where the exit is located.	
ROOM 32				
• TK-1 • Inter-tank/system piping	Located in 325B is the 200 gal holding tank for the RLWS system, TK-1. It is located along the east wall of Room 32.	The tank has a stainless steel drip pan beneath it; however, this pan does not have sufficient capacity to hold the entire contents of the tank.		There are no drawings available for the design of this tank.

7.0 QUALITY ASSURANCE

The tank integrity assessment program will be planned, performed and monitored in accordance with the administrative controls established in the SAIC Richland Operations Quality Assurance Program Plan. The following section describes the special controls that will be applied to inspection, test and analysis activities required to support the tank integrity assessment.

7.1 ORGANIZATION

The organizational structure, functional responsibilities, levels of authority, and lines of communication for personnel performing inspection, test, and analysis activities will be defined in detailed work plans established for the specific test or inspection task. For activities performed by PNL staff who provide input to SAIC activities, oversight will be coordinated through both PNL and SAIC QA organizations, ensuring that each critical sequence in the performance of critical inspections and tests is identified and appropriate verification activities are scheduled.

7.2 QUALITY ASSURANCE PROGRAM

The Quality Assurance Program consists of the Quality Assurance Program Plan plus appropriate detailed work plans and implementing procedures. The QA Program defines the requirements for independent verification of inspection and test activities to ensure they are performed under suitably controlled conditions including the use of appropriate equipment and that prerequisites for a given activity have been satisfied before the activity begins.

In addition, the Quality Assurance Program will ensure that personnel performing inspection and testing activities and engineering analyses are qualified to perform their assigned tasks. Work plans will define the required actions and responsibilities for assuring that appropriate skills are available and utilized.

7.3 DEVIATIONS FROM PLAN

This IAP is intended to provide the basic guidance and criteria for performing the integrity assessment activities required for that portion of the RLWS within the 324 and 325 Buildings. As the assessment activities progress, it may become necessary to implement minor planned deviations from this plan. Deviations which clearly do not impact quality assurance, safety, or personnel will be permissible provided they are reviewed by the PNL project manager. These deviations will be noted in the working copy of this IAP and initialed and dated by the PNL and SAIC project managers. Situations requiring significant deviations from this plan will require a revision of the IAP, or approval of the PNL Program Manager, PNL Quality Assurance, and the SAIC Project Manager. Other approvals may also be required and will be obtained as necessary.

7.4 INSTRUCTIONS, PROCEDURES, AND DRAWINGS

The quality assurance program is organized in such a way that adequate and continuous control is exercised over all activities affecting quality. Inspection and test activities and engineering analyses will be prescribed by and performed in accordance with documented instructions, procedures, Radiation Work Permits (RWPs), or plans of a type appropriate to the circumstances. Technical documents will be prepared under the direction of the Project Manager or his designee. These documents will include or reference the following as appropriate:

- a detailed description of the activity including the intended final result
- qualitative and quantitative acceptance criteria
- methods for documenting or recording data obtained
- handling, storage, cleaning, preservation or shipping requirements, if any
- methods for qualification of procedures, equipment and personnel
- equipment and instrumentation to be used
- controlled conditions under which the activity is to be performed
- environmental, radiological, and safety controls or precautions
- identification of mandatory "hold" or "witness" points.

7.5 DOCUMENT CONTROL

The quality assurance program will ensure that sufficient documentation be developed to demonstrate the adequacy and completeness of inspection and test activities and engineering analyses. All such documentation will be maintained in an orderly manner and will be legible, traceable, and readily identifiable. Provisions will be established for independent technical review of inspection and test plans and reports and engineering analyses. Such reviews will be carried out by competent independent personnel as established by company management.

7.6 ENGINEERING ANALYSIS

Engineering analyses will be performed in a planned, controlled, and documented manner. Engineering calculations will be legible and in a form suitable for reproduction, filing, and retrieval. They will be sufficiently detailed as to purpose, method, assumptions, design input, references, and units such that a person technically qualified in the subject can review and understand the analyses and verify the adequacy of the results without recourse to the originator. Calculations will be identifiable by subject (including structure, system, or component to which the calculation applies), originator, reviewer, and date; or by other data such that the calculations are retrievable. The analysis process will provide for periodic evaluation of the analysis activities.

7.7 IDENTIFICATION AND CONTROL OF MATERIALS AND DATA

All materials and equipment will conform to appropriate specifications and quality standards before being utilized for inspection and test activities. Materials will be appropriately stored, segregated, handled and protected during the assessment activities to maintain their suitability. Special consideration will be given to shelf-life and deterioration control, including potential for radiation damage.

In addition, controls will be established to ensure that data developed and/or used are identified in a manner which provides traceability necessary to allow the determination of its' correct use. Data generated as the result of activities will include a reference to the origin of the data. Where data are the result of the efforts of more than one organization (e.g., PNL, SAIC, etc.), the documentation will be annotated to show which organization produced what portion of the data.

7.8 CONTROL OF PROCESSES

Planning of special processes will ensure that examination processes and methods are developed and performed under controlled conditions in a specified manner and sequence. Controlled conditions include appropriate controls for materials, equipment, personnel safety, processes and procedures, computer software, and personnel. Special process procedures will include or reference:

- applicable codes and standards for the processes
- equipment qualification and calibration requirements
- personnel qualification and level of qualification requirements
- environmental conditions and monitoring requirements
- safety precautions and requirements
- ALARA analysis and radiological controls
- process parameter limits and monitoring requirement
- required inspections, examinations, or tests

- acceptance or rejection criteria.

For special processes not covered by existing codes and standards, or where quality requirements exceed the requirements of existing codes and standards, the above requirements will be clearly and completely described in the procedure.

Non-destructive examinations (NDE) will be performed in accordance with procedures which have proven to be capable of detecting and locating discontinuities described in the applicable requirements as unacceptable (borderline) or as required to be reported. Non-Destructive Examination Levels of qualification and examination will be in accordance with the American Society of Nondestructive Testing Recommended Practice SNT-TC-1A.

7.9 INSPECTION

All inspections required to verify conformance of an item or activity to specified requirements will be planned and executed. Characteristics to be inspected and inspection methods to be employed will be specified in procedures, plans and instructions, and results of those inspections will be documented.

Planning for inspection of tank systems and ancillary equipment will be documented in detailed work plans which identify or reference the following information as applicable:

- system concerned
- characteristics concerned
- method to be used
- drawings, specifications, or procedures and revision level to be used
- ALARA analysis and radiological controls
- acceptance or rejection criteria
- personnel qualifications - discipline and level
- calibration measuring and test equipment required
- records requirements
- hold points and notification times.

The results of inspection activities will be documented and will identify, as a minimum:

- date of inspection
- item(s) or activity(ies) inspected
- name of inspector (or unique identifier)
- type of observation
- acceptance/rejection criteria used
- equipment used (serial number of control number and calibration date)
- results of inspection activity.

7.10 TEST CONTROL

Tests required to demonstrate that tank systems and ancillary equipment will meet state regulations will be planned and executed. Planning for test activities will be accomplished and documented by the responsible Engineer or Scientist as directed by the Project Manager. Test requirements and acceptance criteria will be based upon specified requirements contained in applicable contract, design or other pertinent documents. Planning documentation will identify or reference the following information:

- requirements and objectives
- prerequisites
- suitable environmental conditions
- equipment and calibrated instruments requirements
- condition of equipment and the items under consideration, as appropriate
- personnel qualifications (discipline and level)
- method of conducting the activity (including monitoring and data acquisition requirements,and the evaluation and verification of results)
- acceptance or rejection criteria
- discussion of expected uncertainties in data
- documentation requirements for results

- references, including applicable codes and standards.

Personnel performing test activities will be appropriately selected based on education and experience and documented in appropriate personnel records. Appropriate training on procedures, methods, and safety will be performed and documented prior to performance of test activities.

Detailed test requirements will be documented in plans and procedures which will be reviewed and approved prior to use. The procedures will contain step-by-step instructions for the conduct of activities and will identify or reference the above information.

Test reports will document the results of test activities and will include, as a minimum:

- test identifications
- system or item tested
- date of test
- name of tester or data recorder
- equipment used (serial or control number, calibration status)
- results of test (including appropriate data sheets, charts, graphs, etc.)
- reference to data uncertainties and resolutions
- evaluation of test results and name of the evaluators.

7.11 CONTROL OF MEASURING AND TEST EQUIPMENT

Instrumentation and other measuring and test equipment (M&TE) used for performance of inspection and test activities will be controlled and, at specified periods, calibrated and adjusted to maintain accuracy within necessary limits.

M&TE will be selected based on documented requirements for instrument type, range, accuracy, and tolerance. Each piece of M&TE will be uniquely identified in a manner that ensures the correct identity of the device. M&TE will be calibrated, adjusted, and maintained in accordance with written procedures or instructions at intervals determined by frequency of usage or as prescribed by codes, standards and manufacturer's recommendations. Calibration intervals will be defined in the applicable procedures.

Items used as calibration standards will be certified to standards traceable to the National Bureau of Standards or other accepted standards. If no known nationally recognized standard exists, the basis for calibration will be documented.

M&TE found or suspected to be out of calibration or malfunctioning will be replaced, and an evaluation made to determine the validity of previous results. This includes the acceptability of inspection and test activities since the last acceptable calibration. M&TE requiring repair will be removed from service, repaired, and recalibrated before being returned to service.

When not in use, each M&TE item will be stored in an access controlled area that will be environmentally controlled and free from any environmental hazards. When in use, precautions will be taken to minimize environmental hazards to instruments. Personnel using such M&TE will be qualified in the use of the M&TE.

7.12 CORRECTIVE ACTION

Conditions adverse to quality are conditions which fail to comply with technical or quality requirements. Such conditions will be identified promptly and corrected as soon as practical. In the case of a significant conditions adverse to quality, the cause of the condition will be determined and corrective action taken to preclude recurrence of the identified condition. The identification, cause and corrective action for significant conditions adverse to quality will be documented and reported to responsible management so that follow-up action can be taken to verify implementation of corrective actions.

7.13 RECORDS

Records that furnish documentary evidence of quality will be specified, prepared and maintained. Sufficient records will be generated to demonstrate achievement of the required technical work objectives and verify effective implementation of the quality program.

Specific records to be generated for an inspection and test activity or engineering analysis will be identified in the detailed work plans. Such records will be retained, for a specified period, in such a manner as to be retrievable for analysis in order to identify quality trends and the need for, and effectiveness of, corrective action. While in storage, quality records will be protected from damage, loss, and deterioration due to environmental conditions.

7.14 AUDIT PROGRAM

All elements, aspects and services pertaining to the tank integrity program will be audited and assessed on a regular basis. Audits will be carried out in order to determine whether the various elements within the quality assurance program are effective in achieving stated quality objectives. Audits will be performed in accordance with written procedures or plans.

Personnel carrying out audits of quality system elements will be independent of the specific activities or areas being audited. Audit findings, conclusions, and recommendations will be submitted in documentary form for consideration by the program manager and senior line management.

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APPENDIXES

APPENDIX A

IQRPE CERTIFICATION

APPENDIX A

IQRPE CERTIFICATION

The IQRPE will certify the Integrity Assessment Report as follows:

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my assessment of the plans and procedures utilized for obtaining this information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

APPENDIX B

PERSONNEL INTERVIEW RESULTS

APPENDIX B

PERSONNEL INTERVIEW RESULTS

Name: Frank Haun
Galen Buck

Date/Time of Interview: 1/12/93, 1:30 pm

Other people present at interview: Lee Fetrow (PNL), Mike McCoy (PNL), Judson Kenoyer

Duties/responsibilities/title: Lead technicians, operators, in Bldg. 324.

Time period worked in Building 324: Galen Buck: 1968-71, and 1976 - present, Frank Haun: 1966- present (except 71-73, majority of work in Bldg. 324 was shut down during this time)

Projects or processes worked: WSEP, NWVP, and FRG program.

Information provided:

The vault tanks have temperature alarms that will activate at temperatures exceeding 55°C. These alarms have been in place since the construction of the vault tanks.

Feed material was not sent to the LL Vault tanks. Tanks 116 & 118 in B-Cell fed tanks 101 and 102. In the early days 116 and 118 held caustic solutions.

The following chronological list identifies processes performed in Bldg. 324, that would have used the tanks in the vaults:

Program	Processes	Time Period Conducted
WSEP	Spray Calcination	1967 - 1970
	Pot Calcination	1967 - 1970
	Rising Glass	one run in 1970
	Phosphate Glass	1967 - 1968

Program	Processes	Time Period Conducted
NWVP	Spray Calcination In-Can Melting	1978 - June 1979
FRG		1986 - 1987

The first load of radioactive material into TK-107 occurred 10/26/66 - based on information from Frank Haun's logbook.

Based on calibration reports for the tanks the heels for each of the tanks are as follows:

Tank	Size of Heel
101	30 gal.
102	21 gal.
103	20 gal.
104	1.3 gal.
105	Could not measure.
106	Was not available.
107	7 liters
108	4 gal.

The 324 Bldg. Manager may have the transfer logs for the tanks.

Tanks 101 and 102 have the only connections to the RLWS pipeline to Bldg. 340. These were the tanks most often used. Pipelines to Bldg. 340 have concentric leak detectors.

According to their information: Tanks TK-101 and TK-103 hold 3300 gal
TK-102 - 4900 gal
TK-108 - holds 3200 gal

TK-102 is a "catch tank" - is connected to floor drains, etc.

The sample analyses performed in 1990 was taken after the HL vault tanks were flushed. The LL vault tanks were not flushed prior to sampling (typically these tanks were not flushed).

Name: Frank Haun

Date/Time of Interview: 1/25/93, pm

Other people present at interview: Jody Cruse

Duties/responsibilities/title: Lead technician in Bldg. 324.

Time period worked in Building 324: Frank Haun: 1966- present (except 71-73, majority of work in Bldg. 324 was shut down during this time)

Projects or processes worked: WSEP, NWVP, and FRG program.

Information provided:

Frank was able to locate the following information and data from his search in the "warehouse" and his own logbooks:

Waste Solidification Engineering Prototypes - Technical Manual, BNWL-MA-19

Data sheets from characterization of the feed material from BNWL-1667

The following information on temperatures, records of acids, halides, radionuclides present in the tanks:

- Ce^{144}. HNO_3(6M) sodium hydroxide and ANN (Aluminum Nitrates) were reported to have been in the vault tanks.
- 10-8-68 The solution in TK-107 got to 75°C.
- Most all of the spray calciner runs were spiked with ruthenium.
- Tri sodium phosphate solutions were used for deconning.
- 1WW feed was a PUREX waste stream - special run was sulfate free.
- Potassium dichromate and oxalate solutions were used for deconning (probably part of TURCO products).
- During May 1979 time frame (for approximately 1 month), Tanks 105 & 107 held very concentrated solutions which may have reached temperatures as high 75°C.
- Information from log book - Transfer from TK-115 to TK-105 occurred on 10/21/78, solution was 10M HNO_3.

Frank recalled the following information on the NWVP: 1st cold run - 10/26078, 2nd cold run - 11/78, 1st hot run - 2/21/79, 2nd hot run 3/22.

Frank said he was not able to locate any of the run books or any other information on sampling prior to solution transfers to Bldg. 340.

Frank recalled that some of the vault tanks in Bldg. 324 were constructed in the early 1940's and were originally intended for use in what was to be C-Plant in the 200 Area. C-Plant was never constructed and the tanks remained unused (residing in the 200 Area) until the mid 1940's, when the tanks were transferred to the 300 Area. They were used for about 10 years (until approximately 1958) to contain uranium solution in Bldg. 321. In 1958 they were pulled out for modifications and testing prior to being placed in the Bldg. 324 vaults.

In conversations with Mike McCoy on 1/27/93, he described that Bldg. 321 housed a cold pilot version of PUREX. Basically the same types of PUREX materials were used, except that there were no fission products.

Name: Earl Wheelwright

Date/Time of Interview: 1/28/93
Other people present at interview: Lee Fetrow (PNL), Judson Kenoyer (SAIC - lead on interview)

Duties/responsibilities/title: Project Manager

Time period worked in Building 325: 1960 to present.

Projects or processes worked: Most except for Waste Solidification.

Information provided:

The following information was obtained from Earl describing the program history of the building utilizing a "poster board" which presented the dates and processes. Notes from Earls verbal descriptions are presented in italics.

325A Hot Cells - Construction Completed - 1960

325 A-Cell Special Projects

1. Ion-Exchange Pilot Plant (1960-1962)
   - Purified 1st 75,000 Ci ^{90}Sr for RTGs
   - 1st Macro-scale ^{147}Pm Purification

2. Waste Solidification (1962-1964)
   - 1st Spray Calcination (200 g) of Purex 1WW
   - Demonstration of Phosphate Glass Melter

   Earl W. did not work on this project. Rudy Alleman was project manager. This feed material was also used in Bldg. 324 approximately 4 years later. The chemical make-up of the feed should be very similar for the two processes.

3. Ion-Exchange Pilot Plant (1964-1977)
   - Recovered and Purified 14 million curies of ^{147}Pm
   - Purified 1 kg ^{90}Sr
   - Purified 65 g ^{244}Cm from Shippingport Waste
   - Purified 3 kg ^{241}Am

4. NWVP (1977-1980)

   Processed 3 metric tons of processed fuel. Dilute nitric acid solution was sent as the feed material - no chlorides were added. They processed 2 runs through spray calciner and in-can melter. All liquids were made into glass. The only by-products *from the process that could have been disposed in the tanks were water vapor and cooling water.*

325 B-Cell General Purpose Lab Work

1. B-Plant Flowsheet Development
   - Cs Precipitation
   - Cs Ion Exchange
   - Sr Recovery by Pb Sulfate Carrier Precipitation

2. High Level Waste Behavior During Thermal Concentration

3. SrF_2 Capsule Development

4. CsCl Capsule Development

325 A-Cell, Special Projects

1. Demonstrated Molten Salt Electrodeposition of UO_2-PUO_2 (1960-63)
   This was the only project that Earl recalled using chloride salts.

2. Recovery of ^{237}Np and ^{238}Pu from Special Target Material (1964-1966)
   This process used nitric acid solutions

3. Solvent Degradation Tests for LMFBR Processing (1966-70)

4. Recovery of Medical-Grade ^{238}Pu from Special Targets (1972-1973)
   This process used essentially the same chemicals as #2 (C-Cell).

5. Preparation of Capsules for SrF_2 Compatibility Testing (1973-1977).
   This was a continuation of #4 in B-Cell.

6. NWVP (1977-1980)

NWVP equipment placed on standby by DOE Order in 1980. The limited available space has been used since that date for the following programs: *(Between all of the following projects, a total of 50 gal or less of liquid waste was probably generated).*

1. MCC Leach Tests of Waste Glass
2. MCC Leach Tests of Spent Fuel
3. Post Irradiation Examination of N-Reactor Boron Thermal Shield.
4. Tests on RHO Flowsheet for Converting NCRW to Non-TRU
5. Characterization of NCRW
6. Characterization of Tank-Farm Double-Shell Slurry

7. N-Reactor Fuel Iodine Control Tests
8. N-Reactor Fuel Uranium Dissolution Tests
9. Recovery of Sr Using Antimonic Acids

In response to a question regarding written guidelines for the disposal of liquid wastes into the tanks Earl W. stated that the people involved in these projects were scientists that recognized that they were using a stainless steel system. They therefore were not intentionally disposing of any halides or acids in any concentration that would degrade the stainless steel.

#2 from A-Cell used Purex 1WW - this waste probably had the highest levels of radiation. However, all of the feed product was calcined to a solid waste and none of the liquid feed went into the tanks.

For #4 NWVP, Tanks PT-4 and W-4 stored feed material for transfer to 324. The transfers were made by steam jet and/or vacuum. These feed materials may also be considered on to have very high radiation levels in comparison to other materials handled in Bldg. 325. However, no liquid feed material was ever generated as waste in Bldg. 325.

Name: Langdon Holton

Date/Time of Interview: 2/1/93, am

Interview Conducted By: Jody Cruse (SAIC)

Other personnel present at interview: Mike McCoy (PNL)

Duties/responsibilities/title: Project manager/research scientist

Time period worked in Building 324: 1977 - present

Projects or processes worked: NWVP (1977) and FRG Program (after 1986)

Information provided:

The largest volume of curies handled in the cells and vault tanks was during the WSEP - Radioactive Demonstrations, 1968-1972; approximately 50 MCi was received during this time. The PUREX Tech. Manual should characterize the 1WW feed used in these demonstrations.

There was no work conducted in the building between 1972 - 1976.

In 1977 the NWVP was established, and spray calcining/in-can melting was performed until 1980. Approximately 6 metric tons of U-equivalent solution was processed (concentration not provided). There is approximately ½ metric ton (liquid) (approximately 200 kilocuries) remaining from this program is stored in TK-106 or -107.

In 1981 work was performed on the Zeolite Vitrification Program. This program handled only solid waste, the vault tanks were not used for this program.

From 1982-1987 , The RLFCM (Radioactive Liquid-Fed Ceramic Melter) was used to produce cesium and strontium heat and radiation sources (canisters). This is also referred to as the FRG program. This program processed approximately 20MCi. The Cs and Sr feed may have had some halides. Bruce Katayama should have this information.

Sampling and analysis of vault tank liquids prior to transferring to Bldg. 340 was limited to gamma counting. Langdon H. did not recall that any other analyses were performed.

The pH for TK-108 tends to be low because the process condensate from the acid fractionater drains to TK-108.

There may be some additional information the safety assessments for the tanks performed throughout the years. Some of these assessments evaluated the potential and consequences of leaks, explosions, and other accident scenarios. Langdon was going try and locate some of these reports.

Name: Jeff Surma

Date/Time of Interview: 2/1/93

Interview Conducted By: Jody Cruse (SAIC)

Other personnel present at interview: Mike McCoy (PNL)

Duties/responsibilities/title:

Time period worked in Building 324: Approximately 10 years.

Projects or processes worked:

Information provided:

Floor drains from Room 146 (Sodium Experiments) and 147 (Manipulator Shop) used to drain to the Low Level Vault Tanks. These drains were plugged and/or shut off in 1991. Jeff S. was not able to provide specific tank.

Galen Buck jetted some solution to Bldg. 340 in the summer of 1992.

Talk to Bruce Katayama about the TURCO products used for deconning. He should also have information on the volumes of water used for deconning. These data were compiled in a report written by Katayama.

During the FRG program, they were continuously jetting process condensate solution to Bldg. 340.

In the summer of 1987, phosphoric acid waste was generated from the electropolisher (approximately 1000 gal) as part of the FRG program. Jeff S. recalls that this solution may have gone into TK-101. Approximately 650 gal of the waste was jetted to Bldg. 340 (no date provided), the remaining 350 gal is reported to be in one of the low level tanks.

Jeff S. guessed that we may expect to see 3000 - 4000 R/hr at the surface of the vault tanks.

Name: Bruce Katayama

Date/Time of Interview: 2/3/93

Interview Conducted By: Jody Cruse, SAIC

Other people present at interview: Lee Fetrow, Mike McCoy - PNL

Duties/responsibilities/title: Chemical Engineering. Worked on C-Cell, corrosion testing of canisters and German Program

Time period worked in Building 324: 1974 - present

Projects or processes worked: FRG Program

Information provided:

A large amount of tech. grade reagents were used in the processes. These reagents could have contaminants such as chlorides and fluorides.

Tanks 104 and 105 have left over heels of the FRG operation. The tank heel is from a flushing and rinsing cycle. Water used to perform flushing operation is from steam condensate (distilled water) tank in Bldg. 324.

The LL Vault tanks usually contained steam condensate or process condensate.

<u>Data</u>

The data from vault tank samples taken June 7, 1990 probably represents a high-end bounding case for the concentrations of halides in the waste, compared to liquids stored in the tanks in previous years. These samples are representative of liquid wastes used during the FRG campaign. The feed material was cesium and strontium nitrate solution from the 200 Area. The original feed stock, cesium chloride and strontium fluoride was converted to nitrate solutions prior to transferring from the 200 Area to the 300 Area in order to preserve the stainless steel system in Bldg. 324. The halides present in the vault tank samples are most likely residual from converting the solution to nitrates.

The pH of TK-108 is low because it receives condensate from the cell concentrator tanks. In addition it also receives process condensate from the acid fractionater tanks.

No solution has been added to the tanks since the analysis in June 1990. The only activity is that solutions in Tanks 102, 103, and 108 were jetted to building 340.

The only tanks that have heels are 104 and 105.

Non-radioactive feed additions were added in B-cell. The feed make-up was done in the cells and not the tanks. The only exception is Tank 107, where feed material from the NWVP was returned to the vault tank. Typical non-radioactive feed additions were glass composition, pH adjustments. The feed material was sometimes concentrated in B-cell.

Contact Galen Buck for specific information on the tank temperatures. The temperature of tank 102 when neutralized may have reach 80°C in 1991. This information should be in the log.

The LL vault tanks are never flushed, the liquid is directly jetted to the 340 building.

C-Cell is not connected to the vault tanks. The vault tanks normally served B-cell and some of A-cell.

Randy Thornhill is pulling out some of the process tanks and piping (used for jetting solutions to and from the tanks) in B-cell. They are sectioning them in order to remove them. It may be possible to ask for pictures.

There may be some old GE reports documenting corrosion testing of SS w/ Cb that was done in the late 1950's.

Name: Bill Bjorklund

Date/Time of Interview: 2/3/93

Interview Conducted By: Jody Cruse, SAIC; Lee Fetrow, Mike McCoy - PNL

Duties/responsibilities/title: Program Manager for NWVP and FRG Program up to equipment installation. Designed equipment, coordinated installation of equipment.

Time period worked in Building 324: 1973 - 1986

Projects or processes worked: NWVP and FRG Program

Information provided:

For the NWVP, the spent fuel (from the TWR commercial facility) came into Bldg. 324. It was chopped up and dissolved in boiling nitric acid. In Bldg. 325 the Pu was extracted. The HLW from the extraction was returned to the vault tanks. From the vault tanks the waste was transferred to the cells to be concentrated and then returned to TK-107. The run books had all of the pertinent information w.r.t the transfers. Not much waste was generated as a by-product of the NWVP - the end product was 2 canisters of glass - 12" x 8'.

The piping between Bldg. 324 and 325 was very closely monitored. The transfers from Bldg. 325 were made in ~50 liter lots.

Most of the acids used were commercial grade. There may be specifications somewhere - Earl Wheelwright may know where they are.

Jim Miner may know where the run books are. They may be in the official record storage - Rose _______ is the records person. May want to ask for the Quarterly Reports.

Bill Bjorklund's involvement in the projects was to write up instructions on the how the processes were to be performed. The technicians took care of the transfers.

Tanks TK-131 and TK-132 were built much later. They were used to contain feed material for the FRG Program. These tanks were installed in approximately 1986. They may have had feed material in them for only 2-3 months. There probably would not be any relevant information or data obtained from metallographic samples of these tanks. (We had briefly discussed the option of getting samples during the decommissioning of these tanks with Randy Thornhill).

Tanks TK-112 and TK-114 would be the most representative of the condition of the vault tanks. Tanks TK-112 and TK-114 have been in Bldg. 324 since the building was initially constructed. The jumpers from the off-gas system would be a worse-case representation. These were operated at high-temperature with concentrated acid solutions.

Tanks 106 and 107 probably contained the most severe waste in regards to degradation to the materials. Waste transferred from the bowling ball cask or underground pipeline (from Bldg. 325) usually went to Tanks TK-106 and TK-107. From Tank TK-107 the waste would typically be steam jetted into Tanks TK-112 and TK-114. These cell tanks were used for feed preparation and makeup.

Tanks 104 and 105 are very large and were not used very much. Cleaner acids may have come from the acid fractionater and were transferred into Tanks TK-104 and TK-105. Tanks TK-104 and TK-105 were typically not used because of their large size and the corresponding tank heels and dilution considerations.

Chemicals were not added in the vault tanks. This was usually done in Tanks TK-112 and TK-114.

Last Monday 2/1/93 all of the effluent in Tank TK-112 was transferred to Tank TK-107.

Process condensate, steam condensate, cooling liquids, sumps, sample tray drains, cubicle drains, typically went to the LL vault tanks. The LL vault tanks were used to contain contaminated water - to be jetted to Bldg. 340.

Steam condensate from the concentration of solutions went to Tank TK-116 and then to TK-101.

If the specific gravity of the tank heel for Tank TK-115 got too high, they would jet it to TK-105. This solution was typically high dose and low pH. However, the heel from TK-115 is very small - approximately 100-200 L.

There have been situations when a pipe in the cell broke (i.e., cooling tubes), these solution would probably have ended up in one of the vault tanks.

There should be thermocouples on TK-107.

Bill was not aware of operating temperatures of the vault tanks ever exceeding 80°C. Halides were typically only present as contaminants. To the best of his recollection, no thiosulfates or sulphur dioxides were used in the processes. Phosphoric acid may have been used in A-Cell for deconning the FRG canisters by electropolishing.

Name: Don Knowlton

Date/Time of Interview: 2/3, a.m.

Interview Conducted By: Jody Cruse, Robin Slagle, SAIC; Lee Fetrow, Mike McCoy, PNL

Duties/responsibilities/title:

Time period worked in Building 324: 1977 - present

Projects or processes worked: Vitrification Project

Information provided:

The 324 Bldg. was completed in 1965. NMVP started in 1976. It was shut down Sep. 30, 1979. Actual operations stopped in June 30, 1979. Flushing of tanks and clean up was performed between June and Sep. Most of the activities occurred in FY 1977.

There were monthly reports for the NMWP. The operations manager Pat Schutty may have them as well as letter books.

The vitrification program used fuel out of the reactors. The FRG program had approximately 20 MCi over 2-3 years. The WSEP had 50 MCi over 10 years.

Name: Larry Maples

Date/Time of Interview: 2/3

Interview Conducted By: Jody Cruse, Robin Slagle, SAIC; Lee Fetrow, Mike McCoy, PNL

Duties/responsibilities/title: Building Manager

Time period worked in Building 324: 1990 - 93

Projects or processes worked:

Information provided:

Steve Kostorowski, PNL Bldg. Mgr of 337 prior to consolidation, may know where the records are.

Tatsuya Hikido may know about Tank TK-177. The only future use for TK-177 is to be the collection point for water in response to fires. The water would be routed to TK-102 after TK-177.

Harold Van Tuyl has the old SARS. Langdon Holden and Bill Bjorkland mentioned that they thought there were some corrosion analyses done for the tanks in these SARS.

Name: Rudy Alleman

Date/Time of Interview: 2/3/93, p.m.

Interview Conducted By: Jody Cruse, Robin Slagle, SAIC; Lee Fetrow, Mike McCoy, PNL

Duties/responsibilities/title: Scientist

Time period worked in Building 325: 1957 - 1963

Projects or processes worked:

Information provided:

Rudy A. designed some equipment for the ion-exchange pilot plant. He worked in the waste solidification program, did not know about the waste management activities.

Process condensate was generated from the waste solidification processes. The only other liquid wastes were from clean-up of the cells.

The feed materials for the processes were neutralized prior to getting it from the 200 area.

The only potential for corrosion was from the phosphate glasses, excess phosphoric acids may have ended up in the tank.

The solidification project was basically a pilot plant for the Bldg. 324 work performed later.

Name: Dick Westerman, Mike Danielson

Date/Time of Interview: 2/9/93

Interview Conducted By: Jody Cruse, SAIC; Lee Fetrow, Mike McCoy, PNL

Duties/responsibilities/title: PNL Material Scientists, specializing in corrosion of stainless steels and underground storage tanks.

Time period worked in Building 324: not applicable

Projects or processes worked: not applicable

Information provided:

Any repairs or modifications to the Bldg 324 tanks after removal from Bldg. 321, should show up in a visual inspection with remote camera. However, if the tanks have jackets, it may be difficult to see repairs or modifications - they may have been done from the inside.

Dick Westerman commented that the concentration of halides is very low based on the 1991 analytical data from the Bldg. 324 tanks.

Building 321 contained cold PUREX operations without the fission products. (Mike M.)

There could be a concern with bacterial corrosion from water through the cooling jacket. There could also be attack from the chlorides in the water. Failure caused by corrosion of the water passed through the cooling jackets is fairly prevalent. Would need to know if they completely drain the water out of the jackets.

Bacterial corrosion can also occur from dirty water used in the hydrotests.

Bacterial-assisted corrosion is where the bacteria has carbon and sulfur sites to grow on - not expected from condensate, but would expect them from process water.

Stress corrosion cracking can occur at any temperatures.

First step would be to look at the jacket visually, if there are no visually apparent defects, it would be a good start.

If the tank is going to fail it will probably be from a crack or pit. Most likely it will not occur from general corrosion. Cracks typically come in clusters. A repaired crack may be more susceptible to future cracking. Through cracks would be of big concern.

309Cb was used in T-Plant. Many of these pipes are still functional and intact.

There is nothing wrong with the Cb added stainless steel, as long as the welders really know what they are doing.

Keith Scott - Process Engineering - WHC. Earl Schwenk (works for Keith) may be aware of how the 309Cb SS have performed in service at the Hanford site.

Nitric acid is usually good in stainless steels because its a strong oxidizer and passivates the SS. Nitrates may also act as a passivator (Danielson and Westerman are presently investigating this).

Radiation does not necessarily kill the bacteria. Cannot rely on radiation to kill bacteria.

Name: Frank Roberts

Date/Time of Interview: 3/4/93

Interview Conducted By: Judson Kenoyer, Jody Cruse, SAIC; Lee Fetrow, Mike McCoy, PNL.

Duties/responsibilities/title: Process Engineer

Time period worked in Building 325: 1959 (just as the hot cells were completed)

Projects or processes worked:

Information provided:

Fission product strontium recovery, was an ion exchange process used a large amount of chelating agents - EDTA in those radiation environments would presumably break down to N, O, C, and water. They used nitric acid. Based on his recollection, there were no halides used.

Mike McCormick - professor at CWU - worked in Bldg. 325.
Robert Lee Moore (967-3773) - retired - may have been involved with the installation of the tanks. Involved from the beginning up until 1968 - wrote a book about it.

Lane Bray - also worked in Bldg. 325.

Often transferred solutions from tanks by vacuum. Tried not to use pumps or valves in the hot cells.

The piping system between Bldg. 324 and 325 was put in specifically for the NMVP.

He could not remember there ever being any criteria for transfers to Bldg. 340.

Name: Gil Nicholson

Date/Time of Interview: 3/23/93

Interview Conducted By: Jody Cruse, Robin Slagle (SAIC), Mike McCoy, Lee Fetrow (PNL)

Duties/responsibilities/title: Worked as Development Engineer in Bldg. 321

Time period worked in Building 321: 1954-61

Projects or processes worked:

Information provided:

From his recollection, most of the tanks presently in the 324 vaults were from Tank Farm #2, which was located on the south side of Bldg. 321. The tanks were in a concrete lined pit, approximately 2-4 ft below grade and open to the environment. During 1950 - 1958, Bldg. 321 was used for testing various PUREX flow sheet modifications. The tanks were used to contain nitric acid, various non-radioactive chemical solutions, sodium nitrates and nitrites, sodium carbonates, and caustic solutions. Only 1 or 2 of the tanks in that farm were used to contain uranium solutions (no fission products). There were no halides involved in the processes discharging to the tank. In most cases sanitary water was used for feed make-up.

Tank F-8 did not come from Tank Farm #2, but from F Cell.

The cooling and heating jackets were used. Typically temperatures in the 50-60°C were maintained; however, temperatures at 100°C were not uncommon.

Dan Siemans may have some knowledge of the tanks used in Bldg. 321.

The tanks in Tank Farm #2 had wall thicknesses of 3/8". They were fabricated to be used remotely. Tanks in Tank Farm #1 had wall thicknesses of 1/4".

Name: John Green

Date/Time of Interview: January 15, 1993/9 - 10:30 a.m.

Interviewer: Judson Kenoyer, SAIC

Other people present at interview: Lee Fetrow, Mike McCoy (PNL)

Duties/responsibilities/title:

Time period worked in Building 325: Since 1958 till the present. He "retired" 3 years ago May, 1993.

Projects or processes worked: Vitrification projects

Information provided:

Discussion was on the use of the tanks in the 325 Building that were used for the major processes studied over approximately the past 30 years. The tank in Room 32 is not included in this discussion. Others had the responsibility for that tank.

The 325A Tank Farm includes the following tanks: PT-1, -2, -3, -4, -5 and WT-1.

The waste vitrification process used tanks PT-4 and WT-1; the work was done in A Cell. Fuel elements were dissolved in the 324 Building; the solution was brought to the 325 Building. From the W-5 tank, it was transferred into C Cell to run through columns. Separation of Uranium and Plutonium was performed in 1977. The uranium work was performed using PT-1 and PT-2. The plutonium work was performed in glove boxes. It was calcined down - set out as oxides. The condensate went into WT-1 (approximately 6 gal per run). Waste from the vitrification went back to the 324 Building and was feed for the glassification process. The material went from the cells to PT-4, to W-4, to the pipeline. They geared up for the work in 1977, the work was performed in about 6 months; by 1980, the work was done.

The Tank Farm was built in about 1963.

For specific chemicals, look at the PUREX flow sheets.

PT-4, W-4, W-5 were used for the Feed Solution and Dissolver Solution. W-5 hasn't been used since about 1980. WT-1 has probably been used the most for waste.

Mr. Green stated that his logbooks dated Pre-1991 have been cleared out.

Encapsulation work - PT-1 and PT-2 were used. It involved the Cs feed from PUREX. Strontium work was performed in 1961 and 1962. The 1-WW solutions from PUREX were also used. The major waste volumes went to WT-1. All other tanks were process tanks. Volumes involved were the following: 9,000-15,000 gal were stored over 2-3 years - until they were ready to receive. About 500 gal/day were transferred until the tanks were empty - or until they wouldn't take any more.

The slab tanks (40-A) were not used for products. They were connected to the drains in the cells. Flushes from the cells went to them. They have secondary containment.

When the cells were decontaminated (i.e., sprayed down), a 0.5<u>M</u> Nitric acid solution was used.

In about 1987, there were water leaks in one of the cells (W-1 and W-3) and on the floor. This involved about 1500 gal of water.

Personnel in the 324 Building have used a jet cleaner in the past in their decontamination work. Mr. Green found that this cleaner will foam up and clogs the piping.

Contents of WT-1 can be sent to the 340 Building. Some of the contents have been "real hot" and put into the 500-gal casks, then transferred. Readings of 1-2 R/h were not uncommon; in the early days, these readings were considered normal.

In the time frame of 1962-1967, the work involved Sr, Am, Np, Cs, Cm, Pr, and Pu. WT-1 was the major waste tank. PT-1, PT-2, and PT-4 were the main process tanks. PT-3 and PT-5 were not used that much.

Of all the chemicals used in the tanks, nitric acid was the most corrosive material.

Promethium, Yttrium, Americium, other radionuclides in the feed material - into PT-1 and PT-2, then through the resin columns. Bands of radionuclides with 5 or 6 columns. Products were obtained from each column and the condensate (just water) went to WT-1.

Other persons involved in the work included:

Glen Benedict (1963) - Pu-Extraction process.
Earl Wheelwright
Harold Van Tuyl
Larry Epson
Rudy Almon
Ben Johnson - Calciner (1958); phosphate glass process (1963)
Gary Brian - head of vitrification project
Don Knowlton - had these hot cells and those in the 320 Building.
Lane Bray

George Jensen
Glen Benedict
Jerry Richardson

WT-1 dose rates were not as high as for the PT tanks.

All of the uranium waste was put into PT-1 and PT-2 and shipped out to PUREX.

There have been pipes changed in the system. Designs have been changed - but not due to corrosion. Some new instrument lines have been added.

If there were chlorides in the system, they had to be in very small amounts - the levels were minimized. There were essentially no fluorides.

There are leak detectors in the vault areas. Stainless steel floors

When WT-1 was full, it couldn't overflow.

Sump pumps are in each vault. Sump alarms are also present.

He could not remember any problems with instrumentation or leakage that occurred during the last 10 years.

During the busiest times, 500 gal/day of waste went into WT-1.

The material that went into PT-1 and PT-2 was hot enough to require cooling water so that it wouldn't boil.

Between projects the tanks were decontaminated. A permanganate product has been used from Turcel (Product number 45-18?). It is a caustic. Water used mostly to decontaminate.

It was known that chlorides were to be minimized. The vapors that come off of chlorides would dull the finish of the stainless steel. Perhaps there was some Strontium Chloride and some Cesium Chloride -- but in small amounts.

Plutonium work that included some hydrozene was performed in 1963 and 1964 by Glen Benedict.

There was some sulfuric acid around but Mr. Green couldn't remember ever using it.

The data log books that are still available for review are under the custodianship of T. K. Andrews.

Name: Earl Schwenk and Keith Scott, WHC

Date/Time of Interview: February 25, 1993/1:30 - 2:15 p.m.

Interviewers: Bill Conn, Jody Cruse, Judson Kenoyer (SAIC)
Mike McCoy and Lee Fetrow (PNL)

Other people present at interview: None

Duties/responsibilities/title:

Projects or processes worked: WHC Engineering (including Tank Integrity Assessments)

Information provided:

Earl Schwenk and Keith Scott are part of the group that has performed the tank integrity assessments on the tanks in the 219-S Laboratories. This includes writing the plan to do the assessments, performing the assessments, re-evaluating outstanding items of non-compliance, and working off those items. Some of the assessment plans were reviewed by WDOE. The Assessments were sent to them.

Different "levels" of tanks were involved: low-activity, medium-activity, and high-activity. Photos were taken of the low- and mid-activity tanks. General walk-downs and other visual documentation was used when possible.

Some tanks were stainless steel but were sitting on carbon steel shims.

Exposure rates near the low- to mid-activity tanks were about 50-100 mR/h.

Remote cameras were used on the high-activity tanks; the lids were taken off of the vaults.

Other tanks were filled in a cascading fashion to see if there were any leaks.

In some tanks, it was possible to take out the dip tube and have the sample analyzed.

Video cameras - They stayed away from radiation-hardened ones; they were not worth the expense. The ones they used were color and cost about $1K each - just use them a few times and throw them away when they were done. Could use them in 100-200 R/h fields easily. Some of them were 3-4 lux cameras. Some were "lipstick" size. Dave Smet, WHC could be a contact. Other contacts include Jim Krogness for fiber optics. Also Mike Sumsion, WHC and Scott Werry, WHC.

Ultrasonic testing was performed for the determination of wall thickness.

Pitting could be seen with the remote cameras and photographs.

A 30-ft fiber optic cable can cost $20K.

Photos can be taken in about 20 minutes of a tank where the videos may take 2-3 h to document the same situation.

Periscopes have also been used. They used one that was obtained from the equipment pool; it was 3" in diameter.

Byron Brenden (PNL) developed one of the optics system used in the past.

Corrosion and/or pitting can occur when pHs are neutral or less than neutral and chlorides are present. If the chloride concentration is not less than 1-2 ppm, there may be problems with pitting.

Earl Schwenk brought up the question of how the leak detectors operate and how are they calibrated and periodically checked for proper functioning.

They have done the tank integrity appraisal of tanks in 219-S and are now doing the work on the tanks associated with the 242-A Evaporator. They are done with the tank integrity study.

Materials information on 309-stainless steel (or Type 2512 - minor differences) could be obtained from Dick Westerman or Harry Smith (PNL).

Stainless steel type 304 - hydrofluoric nitrate eats it up.

Standards review - there needs to be a seismic analysis on the piping too.

Review of document - internal reviewers can be extensive.

Name: Rick Steele

Date/Time of Interview: February 8, 1993/9-10:30 a.m.

Other people present at interview: Lee Fetrow (PNL)

Duties/responsibilities/title:

Time period worked in Building 325: Since 1976

Projects or processes worked: Analytical overchecks of fuel (308 Bldg.) for FFTF (1976-1981); Environmental monitoring (groundwater) with Bob Stromatt and the Safeline Project (1981 - for about 1-2 years); started Hot Cell work (about 1982); worked with Dale Archer (1982-1989); Spent Fuel (1982-1987); Waste Tank Characterization (After June, 1987).

Information provided:

Most of the discussion was spent on the tank in Room 32 of 325B. Its "unofficial" designated identification is "TK-1". Mr. Steel believes that it was put into the building during the mid-1970's during a renovation project - perhaps when the new drain system was installed.

Documentation of wastes that went into or through system? Mr. Steel had no knowledge about the time frame prior to 1982. Between 1982-1987, work on fuels was performed. Dissolutions were turned back into solids. Only contaminated rinses would have gone into and through the system. Two exceptions:

- Late 1980's - 325 Building provided process support for the 324 Building for the FRG Program. There were 3 campaigns. The feed concentrate was extremely hot - 1-1.5 Ci/ml of feed of ^{137}Cs; 0.5 Ci/ml of ^{90}Sr. Feed or glass into solution (1/4 gm of dried material into 250 ml - sent to the 340 Building. This was done 3 or 4 times. It was not stored but transferred from the cell to the tank in Room 32 and then to the 340 Building. Very high exposure rates were observed: a 10 R/hr meter was pegged during the transfer.

- Within the last few years - The tank waste characterization efforts. Acceptance criteria must be met: 1) No solids; 2) No flammables; 3) No fissile material; and 4) No corrosives. Acids are neutralized and solutions are heat-treated - no potential for organics. Chlorides are precipitated before transfer from the hot cell. Typical waste batch: 5 gal in 1 gal increments. Waste is segregated by matrix and several different analyses are performed on it (e.g., for carbon content, chloride, pH, metal content, and 3 radiochemical counts - total alpha, total beta, and gamma scan).

The waste tank in Room 32 is currently 40% full. Personnel in the 340 Building won't allow for a transfer until the batch is sampled and there is currently no way to sample the waste. The discussion has been elevated to the Center level.

Others that may know about the tank and system? Dave Cochran - perhaps knows about the work performed during the 1960's. Carl Saari may know about the work performed during the 1970's. Mr. Steele has a log of renovation for the Shielded Analytical Lab (SAL). Names of persons listed in that log include the following:

- RF Keough
- LS Kellog
- RE Brimson
- MR Weiller
- MC Burt
- CE Saari
- WD Greenhalgh
- MW Goheen
- RW Stromatt
- RL Miller
- JH Ennen

Photographs that may be useful include Battelle photos 752552-16 and 752552-17. They show the room prior to the time when the tank was located there (not a direct view, but at an angle). Some photographs show the work that had to be done to replace some of the piping beneath the cells because of corrosion. The original piping was not stainless steel; it was carbon steel.

Three or four years ago, they did have a problem with the tank - it overflowed and Room 32 was a mess. At that time, no liquid level was measured. They had received a high-level alarm but it was believed that the instrumentation was in error. However, it turned out that a piece of wood (splinter) had plugged a jet and the tank overflowed through the overflow hose. The jet was cleared and the system was OK. New conductivity probes were installed. A capacitance probe for level indication was installed. A secondary containment that will hold the total volume (i.e., 200 gal) was installed with a liquid sensor in the pan for the purpose of leak detection. The Cog Facility Engineer on the leak detection project was RR Hazelbaker; he is located in the 337 Building.

Another Engineering Request that may be useful to track down is ER 3986. This one may have to do with the Retention Tank Level Controls; Doug Larson was involved with this.

Mr. Steele believes that he has all of the notebooks, engineering diagrams, photographs, log books, and other paperwork that Carl Saari left when he retired.

Other information that may be useful that is accessible through Mr. Steele are data on the analyses of the waste prior to being transferred to the tank in Room 32 prior to the transfer to the 340 Building.

APPENDIX C

EVALUATION OF NDE METHODS

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C.1 GENERAL NDE TECHNOLOGY

This appendix presents a review of the state-of the-art in non-destructive examination (NDE) technology. For purposes of this review the integrity condition of the RLWS can be classified as either leaking or not leaking. NDE methods for the different cases are described as below.

C.1.1 Leaking System

A preliminary evaluation of leaking components is suggested using the following methods:

Vacuum Test. A vacuum condition is introduced into the system. Vacuum pressure is then monitored to detect leaks in the system. This test can be performed prior to other leak detection methods.

Acoustics. Air is introduced into the system to a certain pressure, which is monitored by a pressure gage. An acoustic transducer is placed on the piping system. If leaks exist, a gas leaking sound is detected by the transducer.

Bubble Detection. Soapy water is usually applied to the suspected area outside the tank or pipe. The tank or pipe is then pressurized with air to 5 psig, and the operator watches for bubbles, which indicate leaking areas.

Hydrostatic Test. Water is put into the tank and its connected pipe system. The system is pressurized to 5 psig, and the pressure is monitored. The presence of water on the external surface indicates the leaking area.

C.1.2 Non-Leaking System

NDE methods are widely used to routinely inspect for corrosion and cracking of tanks and pipes. In addition, new techniques are being developed for special applications. The following is a review of available technology:

Ultrasonic Imaging. Conventional ultrasonic testing (UT) with hand-held transducers has been used widely for corrosion or crack detection in a variety of different materials. This method uses an ultrasonic impulse, in a frequency band from 500 kHz to 20 MHz; a transducer, in contact with the tested material, detects indications of discontinuity. Liquid couplant is usually applied between the transducer and the material surface. This method can detect flaws deep within the material, including corrosion/erosion, pitting in tanks and pipes, and cracks in welds. Inspection can proceed from either side or through the material being tested. Ultrasonic testing is a nonvasive form of inspection. The hand-held UT, while simple and inexpensive, has operator-dependent accuracy. Results are limited to the actual site of the test. Although flaws may be present in the immediate area, they would not be detected without direct tests. The method is used in many fields including inspecting tanks, valves in ship's seawater piping, piping systems for nuclear power plants and the petroleum industry, and aircraft fuselages.

Methodology includes selection of areas to be inspected. Following set-up, scanning time is approximately 10-20 minutes for each area, depending on area selected. Results are permanently recorded and can be displayed in 2-D or 3-D real-time for easy comparison, or for periodic monitoring in future engineering analysis. Transducer accessibility to the component is a necessary condition for this technique. A scanner track, for guiding the transducer as it maintains contact with the subject material, must be accessible to the tested surface.

Laser Ultrasonic. This technique uses a laser beam to generate thermal shock (i.e., a pulse on the surface of the material being tested). The pulse signal propagates through the material, reflecting from the cracks or flaws; it is then reflected to the surface, where the signals are detected by second laser beam. The technique does not need direct transducer contact or couplant. This method can inspect material surfaces not suitable for direct contact due to high temperature or high levels of radioactivity, such as some RLWS components. This technique first developed 10 years age, is still in the laboratory testing stage. Further evaluation will determine the exact pulse power level, data resolution, accuracy and reliability of different applications.

Transmission X-ray and Neutron Radiography. X-ray and neutron radiography methods have been widely used to detect cracks in metal and welds, as well as in fiber composite materials. These methods send X-ray or neutron beams from one side of the material and are detected across the material, and are suitable for identifying defects in pipe welds. For tank welds, the X-ray and neutron sources must be in the tank, receiving signals from the outside wall. Conventional transmission X-ray or neutron techniques cannot be adapted for corrosion inspection inside the tank or pipe walls. Since X-ray and neutron sources transmit from one side to the other, the beam must have access to the test material. X-ray and neutron radiography is radioactively hazardous. Appropriate safety procedures must be observed.

Auto Radioactive Method. A gamma ray detector can be placed around the weld seam to detect flaws. The probe may need to be insulated to eliminate irrelevant signals from ambient radiation. As noted earlier, this method requires access to the immediate vicinity of the tested component.

Fluorescent Dye Penetrant. The welded region on both the tank and pipe outer surface are sprayed with special dye penetrants; surface cracks may be inspected visually, using a light source. A borescope or telephoto lens may be used to closely examine those areas not adjacent to the operator. Results can be video recorded for further analysis.

Laser Optics. A laser-scattering technique was developed to measure surface conditions. This technique can inspect corrosion inside tank or pipe walls qualitatively. The laser would emanate from an optical fiber to the inside of the tank or pipe. More laboratory tests are needed to adapt this method to tank or pipe inspection.

Robotic Inspection. Robots are used in environments unsuitable for human contact. A variety of robots can be adapted for use in ultrasonic imaging tests or remote visual inspections. Specific design and implementation of a robot to perform required tasks, motions, and functions would be required to apply this technique.

C.2 CANDIDATE NDE METHOD

For system components with no leaks, NDE methods will be used to examine for corrosion or cracks. This section discusses the candidate NDE methods. Accessibility of components being inspected is a prerequisite condition for NDE methods, since the signal must pass through or reflect off the actual material. Another requirement is knowledge of the level of radiation in the environment surrounding the component to be examined. The level of radioactivity will affect whether a human operator can be used and the length of time the operator would be permitted in the environment. It will also determine what instruments can be used. Factors to consider include accuracy of results, reliability, scanning speed, equipment cost, and cost of operations.

C.2.1 Ultrasonic Imaging

Ultrasonic imaging is considered the most suitable NDE method for tank and piping systems inspection. Ultrasonic signals are capable of the deepest metal penetration. This method is non-hazardous, has been widely used to measure and monitor corrosion/erosion of submarine seawater systems, surface ships, nuclear power plant cooling systems, aircraft fuselage, and petroleum storage tanks. Using the straight-beam pulse-echo technique, it can inspect wall thickness variations resulting from corrosion. Using angle-beam techniques, it can detect and size cracks in welds. The microprocessor records ultrasonic data and locations, which can be displayed in real-time and can be analyzed later to monitor corrosion increase or crack growth. Basic requirements for ultrasonic imaging include component accessibility and a smooth surface (to provide uniform contact with the transducer). The accuracy and data clarity of the imaging results are described below.

C.2.2 Remote Controlled Inspection

Ultrasonic or visual scanning can be automatically performed to inspect a tank in high radiation fields, using remotely operated equipment. The scanner and its track can be placed and operated by a robot. The robot for this application should be equipped with a camera or fiber optic lens to provide visual inspection of the outer surface condition of the tank. Remote visual inspection can be used as a leak detection technique on the tank or pipe surface. It is also helpful in determining surface conditions or interference from adjacent structures, guiding the transducer to the precise inspection location on the tank surface. Robots already existing in the market that can be adapted for remotely controlled inspections. Figure C.1 presents a sketch of a robot with a camera and sensor head for remote inspection. Figure C.2 shows a robotic arm inside a tank, performing tasks in an environment unsuitable for human operators. The robot functions will be designed and tested in the laboratory before field use.

C.2.3 Future Technology

Laser pulsing can also be used to generate an ultrasonic signal on the surface to be tested. This method, conducted under laboratory conditions for more than ten years, has shown promising features, including non-contact with the test surface and increased speed in scanning. The range of operation is 5 to 10 ft, from the laser beam output to the test surface. Actual data accuracy, resolution, signal penetration power, signal-to-noise ratio, and reliability in a radioactive environment are currently being studied in this developing technology. While not fully tested, it appears to be a potential inspection technique for this application.

C.2.4 Selected Components

The following types of components will have to be evaluated during the assessment of the RLWS: single wall tank; double wall tank; single wall pipe and; double wall pipe.

Single Wall Tank. Tanks will be measured from the bottom and side by the straight-beam pulse/echo method to determine the level of radioactive liquid waste remaining. The amount of area to be inspected will be determined by the severity of the corrosion pattern: Angle beam tests will be conducted along horizontal and vertical weld seams. Emphasis will be on welds in areas where liquid waste is in contact with the inner tank wall. At least one scan will be performed on areas above the liquid level.

Double Wall Tank. The straight beam pulse/echo method will measure the liquid waste level from the tank bottom on tanks with double side wall. Size and locations will be determined by the results of inspections of the tank bottom.

Single Wall Piping. The RLWS piping system was constructed in a steady gradient elevation level. Liquid waste accumulates in the pipes at the lowest bends only, these areas will have a high priority for evaluation. Both pulse/echo methods will be used to measure wall corrosion patterns on the lowest bends. The angle-beam method will be used to detect cracks in the piping system welds. Three sections of pipe will be inspected, in addition to the localized lowest bends inside Building 325. Two of these sections are at the piping entrance and exit to the building; the third is in the middle of the piping system in the building.

Double Enclosure Piping. The outside enclosure on the piping will be cut open for inspection. Pipe buried underground is insulated by a fiberglass enclosure. That piping will be excavated for inspection. The outer pipe surface must be smooth to allow sufficient transducer contact with the outer pipe wall, for accurate results in ultrasonic imaging. The number of areas to be inspected depends on results of the first series of tests in the piping system inside Building 325.

C.3 RLWS ASSESSMENT LOGISTICS

As described above, ultrasonic imaging is the best NDE method for examining corrosions or corrosion cracking inside a material. But it is not practical to inspect the entire surface of the RLWS components with the method. In fact, only strategic areas on the components needed to be inspected. These strategic areas for the tank are on the tank bottom and the tank wall where liquid waste may still remain, the tank wall where the liquid surface line and the weld seams in the lower part of the tank. For the piping, the areas to be inspected are the local bends and the welded seams.

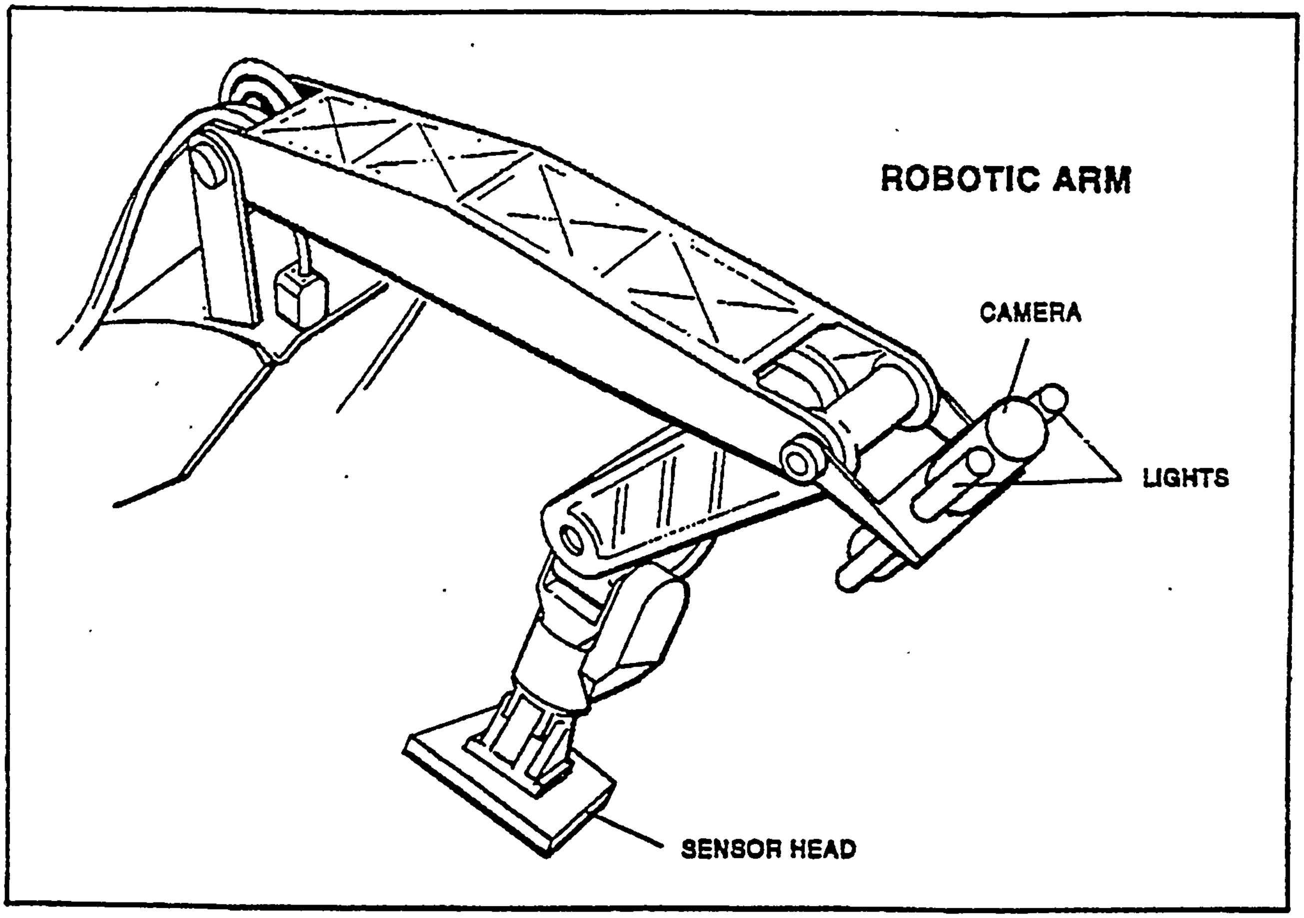

FIGURE C.1. Schematic Robotic Arm with Camera and Sensor Head

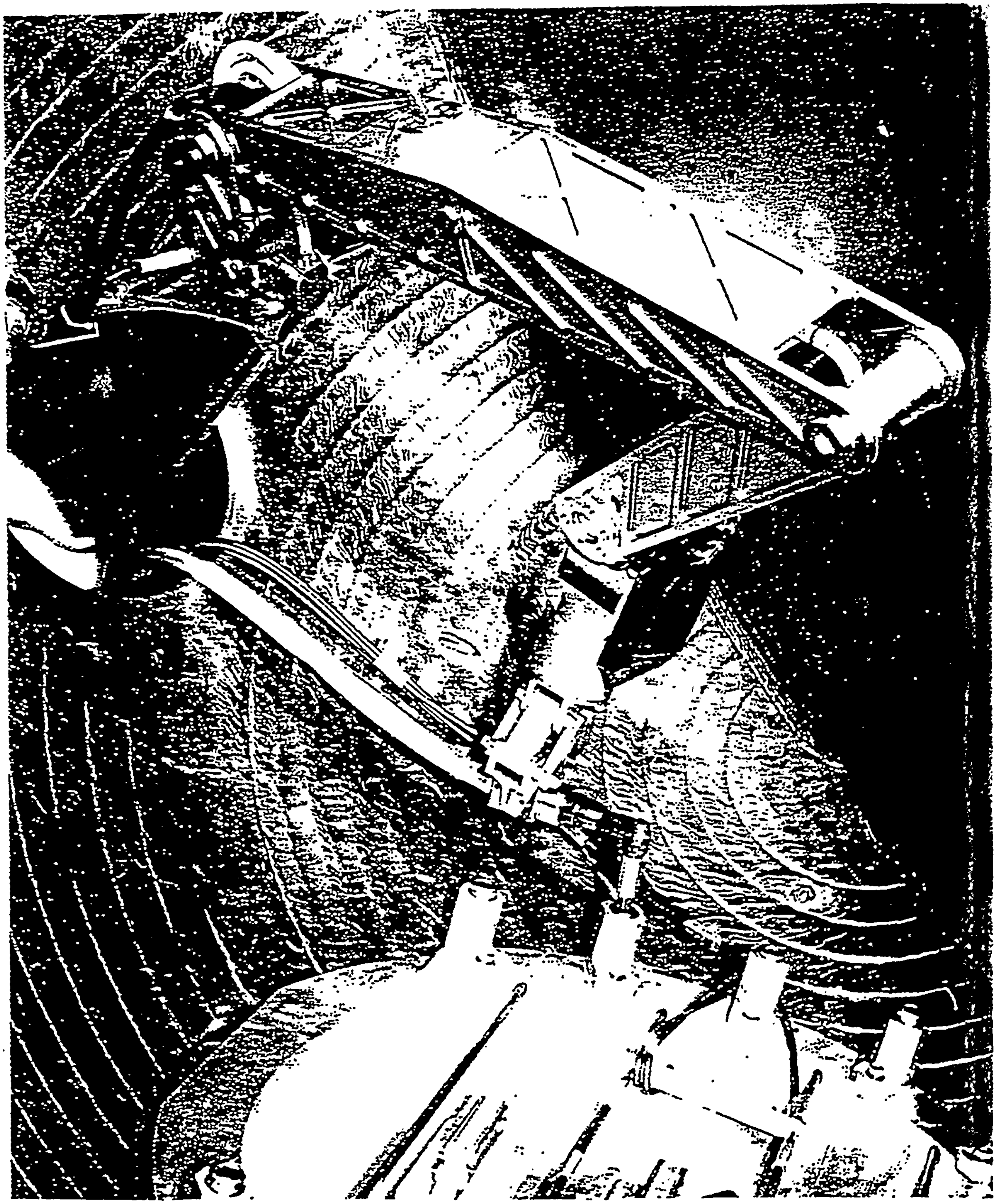

FIGURE C.2. Robotic Arm Inside Tank

APPENDIX D

TANK COMPLIANCE VERSUS RADIATION PROTECTION CONSIDERATIONS

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TANK COMPLIANCE VERSUS RADIATION PROTECTION CONSIDERATIONS

The tanks in the 324 and 325 Buildings will be subject to tank standards of WAC 173-303-640. These standards include requirements for integrity assessments, secondary containment, leak detection, operating controls, inspections, and other actions. Several of these requirements will involve the potentially hazardous action of opening vaults and valve boxes. Activities associated with integrity assessments and inspections will result in the highest potential radiation exposures. Exposure potential may also exist for other tank system compliance activities (e.g., retrofitting of equipment). Such actions are likely to result in radiation exposures to workers.

On occasion it may become difficult to comply with WAC requirements while maintaining compliance with DOE radiation protection requirements. Potential compliance difficulties stem directly from the fact that WAC regulations were developed for situations that did not involve occupational exposure to ionizing radiation. It is expected that for the majority of WAC requirements, compliance can be achieved with little or no incremental increase in radiation risks to workers. However, for those instances where there will be a significant increase in either collective or individual radiation doses to bring about compliance with the WAC, further evaluation of alternative methods and application of additional protective equipment will be required. If alternative compliance approaches become necessary, to avoid unnecessary radiation doses, they will be submitted to Ecology for negotiation.

The guidance developed by EPA, "Radiation Protection Guidance to Federal Agencies for Occupational Exposure," (52 FR 2822) can be utilized to help determine how much radiation risk is too much. This guidance sets forth three fundamental radiation protection criteria. A situation involving a violation of any one of these three fundamental criteria would represent unacceptably high risks from radiation exposure. Therefore, unacceptably high risks from radiation exist when:

- Performing the WAC task results in increased radiation hazards without sufficient off-setting overall benefit, in spite of reasonable efforts to control the radiation exposure.

- Performing the WAC task requires unnecessary radiation exposure since alternative methods are available that can provide substantive or equivalent compliance with the RCRA requirement while keeping radiation doses as low as reasonably achievable (ALARA).

- Performing the WAC task results in radiation doses that exceed numerical radiation protection standards, in spite of efforts to maintain radiation exposures to levels that are as low as reasonable achievable (ALARA).

Performance of WAC activities will be planned in accordance with DOE policy of optimization of radiation protection (commonly designated by the acronym ALARA). ALARA is based on the assumption that no dose, regardless of how small, is entirely without risk. The concept recognizes the goal of managing risk at an acceptable level, but not eliminating risk. DOE has chosen to define the ALARA dose as "the dose that is as low as social, technical, economic, practical, and public policy permit" (DOE 5480.11).

It is expected that PNL will employ existing procedures set forth in, "Health Physics Manual of Good Practices for Reducing Radiation Exposure to Levels that are As Low As Reasonably Achievable (ALARA)" (PNL-6577), to assess whether proposed compliance activities meet ALARA principles. The ALARA analysis involves determining the net benefit derived from applying radiation protection measures in terms of monetary gains and losses. The costs of the protective measure (including materials, manpower, and a dollar equivalent of radiation exposure incurred) are subtracted from the gross benefit expressed as the dollar equivalent of exposure saved, societal benefit, improved public relations, and other factors. Usually several alternatives are assessed to determine the optimum exposure reduction. It is this optimum balance between detriment and cost that is judged to be ALARA.

The following activities and assessments will be conducted during the integrity assessment to provide the necessary information to determine level of risk, to provide a basis for ALARA analyses, and to justify alternative compliance approaches:

- Identify which tanks, ancillary equipment, and secondary containment systems are needed for ongoing accumulation of RMW. Remove remaining tank systems from service or dedicate them to non-dangerous radioactive waste or backup secondary containment uses only.

- Using tank system design and service information, identify components most likely to have been exposed to conditions that could compromise their integrities and locations on tanks and ancillary equipment where loss of integrity is most likely to have occurred and/or may occur in the future. Determine the minimum number of locations and types of assessments necessary to establish system integrity.

- Evaluate the ability to gain access to and evaluate those locations that are most likely to experience loss of integrity. Include in this assessment accessibility for both remotely operated equipment and man-held equipment.

- Assess dose rate levels expected as functions of distance from and shielding of the tank system components. Also, assess dose rate levels as functions of the amount of decontamination needed to allow access to tank system components, the amount of decontamination solutions required, and the amount of decontamination wastes that would be generated. Finally, assess the amounts of decontamination solutions that the RLWS can accommodate.

Using the information and results obtained through the efforts described above, criteria and parameters will be developed for safely conducting integrity assessment work as well as any other necessary regulatory compliance actions. These criteria and parameters will also help to develop alternative compliance approaches where strict compliance cannot be achieved safely (i.e., within the constraints of the ALARA principle).

An example of an alternative compliance approach might address the requirement for daily visual inspection. In place of the daily inspection frequency, visual inspections of tanks enclosed in vaults could be conducted on a decreased frequency that would provide better worker protection under ALARA. The alternative inspection frequency could be determined on the basis of assessments of deterioration rates of the tank system equipment, and on daily verification that leak detection and tank level measuring equipment are functioning properly. Another example might be the placement of labels directly on tanks containing highly radioactive materials. Depending on the external and internal radiation hazards present, an equivalent method may be to label the entrance to the tank area, showing by a map or drawing the exact locations of the tanks and describing the chemically hazardous materials.

In the unlikely event that the use of protective equipment or alternative measures is not ALARA and doses are in excess of acceptable limits, then a potential for inconsistency exists. PNL will then need to re-evaluate the alternative measures and the ALARA analysis. Programmatic alternatives may need to be explored including major capital improvements. If alternative measures continue to fail ALARA analyses and/or if doses continue to be in excess of acceptable limits, DOE-RL should be notified.

The most likely area for significant difficulties between the WAC and DOE requirements stems from the absence of cost considerations in complying with the WAC and the presence of cost-benefit considerations in determining what is ALARA. Given sufficient time and money, most, if not all the WAC requirements should be able to be accommodated. The cost in both time and money of those accommodations can be balanced against the benefit and risk under ALARA; there is no mechanism for balancing cost and benefit under the WAC. However, the most likely scenario is that alternative approaches will be devised that are fully compliant with DOE requirements and retain the purpose of the original WAC requirement.

In conclusion, the intent of the integrity assessment is to comply fully with any WAC requirements that can be conducted safely and within ALARA guidelines. If conflicts between safety and ALARA guidelines and the requirements of the WAC are identified, alternative compliance approaches will be proposed for negotiation. It is recognized that it will be difficult to safely comply with certain requirements without employing alternative compliance approaches.

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