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SAFETY ANALYSIS REPORT FOR THE UNH NEUTRALIZATION PROJECT - FEBRUARY 1995

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REPORT

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FEMP-2385
Revision 1

Safety Analysis Report for the UNH Neutralization Project

Prepared By

The Fernald Environmental Restoration Management Company
With The U. S. Department of Energy
Under Contract No. DE-AC05-92OR21972

February 1995

Fernald Environmental
FERMCO
Restoration Management Corporation

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United States Government

memorandum

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DATE: DOE-0715-95

REPLY TO
ATTN OF: FN:Simak

SUBJECT: **URANYL NITRATE HEXAHYDRATE PROJECT SAFETY ANALYSIS REPORT AND TECHNICAL SAFETY REQUIREMENTS APPROVAL**

TO: Phil Hamric, DOE-OH

THRU: Nat Brown, DOE-OH

Attached for your approval is the revised Safety Analysis Report (SAR) and Technical Safety Requirements (TSR) for the Uranyl Nitrate Hexahydrate (UNH) Project. Also provided is a "redline/strikeout" version of the SAR indicating only those revisions reflecting the U.S. Department of Energy (U.S. DOE) Safety Evaluation Report (SER).

The Department of Energy, Fernald Area Office (DOE-FN) SAR Review Team reviewed the subject revisions without any additional comment. Therefore, the DOE-FN is recommending full approval of the SAR and TSR which was previously approved by the Department of Energy, Ohio Field Office (DOE-OH) on a conditional basis in conjunction with the SER.

If you have any questions, please contact John Simak at (513) 648-3150.

Glenn Griffiths
for Jack R. Craig
Director

Attachment: As Stated

cc w/o att:

J. Zimmerman, DOE-OH
W. Quaider, DOE-FN
C. White, DOE-FN

CONCURRENCE: [signature] DATE: 4/13/95
J. Phil Hamric, Manager
Ohio Field Office

APR 1 4 1995

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FEMP-2385
REVISION NO. 1

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FINAL SAFETY ANALYSIS REPORT for the UNH NEUTRALIZATION PROJECT

FEMP-2385

REVISION 1

FEBRUARY 1995

AUTHORIZED BY: [signature] 4-26-95
D. Otte, President — Date

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

The Fernald Environmental Restoration Management Company
P. O. Box 538704
Cincinnati, OH 45239-8704

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ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
AEDO	Assistant Emergency Duty Officer
AIHA	American Industrial Hygiene Association
ALARA	As Low As Reasonably Achievable
ALI	Annual Limit on Intake
ANSI	American National Standards Institute
ARF	Airborne Respirable Fraction
BDN	Biodenitrification (facility)
BEBA	Beyond Evaluation Basis Accident
CAM	Continuous Air Monitor
CEDE	Committed Effective Dose Equivalent
CEGL	Continuous Exposure Guideline Limits
CEOSHP	Comprehensive Environmental Occupational Safety and Health Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DAC	Derived Air Concentration
DBA	Design Basis Accident
DCF	Dose Conversion Factor
D&D	Decontamination and Decommissioning
d/m/g	disintegrations per minute per gram
DNFSB	Defense Nuclear Facility Safety Board
DOE	Department of Energy
DOE-HQ	DOE Headquarters
DOE-FN	DOE Fernald Field Office
EBA	Evaluation Basis Accident
EDO	Emergency Duty Officer
EEGL	Emergency Exposure Guideline Limits
EG	Evaluation Guidelines
EMS	Emergency Message System
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
ERPG	Emergency Response Preparedness Guidelines
ERT	Emergency Response Team
ES&H	Environmental Safety & Health
FEMA	Federal Emergency Management Agency
FEMP	Fernald Environmental Management Project
(FN)	Fernald Field Office
HARM	Hazardous Atmospheric Release Model
HEPA	high-efficiency particulate air (filter)
HVSW	High Velocity Straight Wind
I&C	Instrumentation and Control
ICR	Incremental Cancer Risk
ICRP	International Commission on Radiological Protection

IDLH	Immediately Dangerous to Life and Health
IH	Industrial Hygiene
ISP	In-service Surveillance Program
ISRC	Independent Safety Review Committee
JPM	Job Performance Measurements
JSA	Job Safety Analysis
LCO	limiting conditions for operation
LCS	limited control setting
LEL	Lower Explosive Limit
LOC	Level of Concern
MMICS	Maintenance Management Information Control Systems
MSDS	Material Safety Data Sheets
MDU	Magnesium Diuranate
MTU	metric tons of uranium
NAS	National Academy of Sciences
NCRP	National Council on Radiation Protection
NFPA	National Fire Protection Association
NFS	Nuclear Fuel Service
NIOSH	National Institute of Occupational Health and Safety
NLO	National Lead of Ohio
NPDES	National Pollutant Discharge Elimination System
NPH	Natural Phenomena Hazard
NTS	Nevada Test Site
OAC	Ohio Administrative Code
OK	within specification liquor product
ORR	Operational Readiness Review
OSHA	Occupational Safety and Health Administration
OSR	Operational Safety Requirement
PAG	Protective Action Guideline
PEL	Permissible Exposure Limits
PEL-C	Permissible Exposure Limits Ceiling
PFD	Process Flow Diagram
pH	powers of Hydrolysis
PHA	Preliminary Hazard Assessment
P&ID	Piping and Instrumentation Diagram
ppb	parts per billion
PPE	Personnel Protective Equipment
ppm	parts per million
QA	Quality Assurance
QAPjP	Quality Assurance Project Plan
QC	Quality Control
RAC	Risk Acceptance Curve
RC	Radiological Control
RCRA	Resource Conservation and Recovery Act
RPR	Radiological Performance Requirement
RSO	Remediation Support Operations

RWP	Radiation Work Permit
SAR	Safety Analysis Report
SARA	Superfund Amendment and Reauthorization Act
SCSSC	Safety Class System Structure or Component
SIH	Standard Industrial Hazard
SL	Safety Limit
SME	Subject Matter Expert
S/RID	Standards/Requirements Identification Document
SSSSC	Safety Significant System Structure or Component
STD	Standard (DOE)
STEL	Short Term Exposure Limit
SWRB	Storm Water Retention Basin
TARE	weight of container and packaged material
TCLP	Toxicity Characteristic Leaching Procedure
TLD	Thermoluminescent Dosimeter
TLV	Threshold Limit Value
TSR	Technical Safety Requirement
TWA	Time-Weighted Average
UNH	Uranium Nitrate Hexahyrdate
UPRSG	UNH Procedure Review Standing Group
USDOT	U.S. Department of Transportation
USQ	Unreviewed Safety Question
USQD	Unreviewed Safety Question Determination
WCC	Work Coordination Center

EXECUTIVE SUMMARY

ES.1 Facility Background and Mission

This Safety Analysis Report (SAR) was prepared for the Uranyl Nitrate Hexahydrate (UNH) Neutralization Project. The UNH Neutralization Project mission is to safely neutralize and dispose of approximately 200,000 gallons of UNH solution currently in storage as waste at the Fernald Environmental Management Project (FEMP). The UNH Neutralization Project Facilities include Plant 2/3 and Plant 8, specifically:

Plant 2/3, Building 2A, Digestion and Denitration
Plant 2/3, Building 3E, Hot Raffinate
Plant 2/3, C.D. Blend Tanks
Plant 2/3, O.K. Liquor Tanks
Plant 2/3, NFS Tanks
Plant 8, Waste Water Treatment Facility

The Plant 2/3 facilities storing the UNH solutions have been shutdown since 1991 and will be decontaminated and decommissioned (D&D). The UNH solution must be removed to facilitate the D&D of these facilities. The Plant 8 Waste Water Treatment facility is an established operation that will continue operation after completion of the UNH Neutralization Project. The UNH Neutralization Project's scope of work for which approval is being sought includes:

- Removal of UNH Solutions from 18 Storage Tanks
- Neutralization of the acid and precipitation of uranium
- Filtration of resulting slurry
- Disposition and transfer of filtrate
- Drumming and staging of filtered solids
- Maintenance of Processing System

The short project duration and current D&D mission were considered when preparing the SAR, determining the level of analysis, and applying the graded approach.

ES.2 Overview of the Facility

The Fernald Environmental Management Project (FEMP) is located in rural southwestern Ohio near the unincorporated village of Fernald. The uranium processing facility was designed and constructed in the early 1950s. In 1991, the DOE announced that the facility would be shutdown, decontaminated, and decommissioned. The site has 18 tanks which contain UNH solutions that were left in storage tanks as a result of the shutdown. Tank D1-7 is not included as a UNH solution storage tank, as discussed in Section ES.2.1.

The stored UNH solutions are located in five areas within the Plant 2/3 Refinery boundaries. A new dedicated pipeline has been installed from the individual UNH Storage Tanks to Building 2A Digestion Tanks F1-25 and F1-26 where the UNH solution dilution, neutralization, and precipitation will occur. A new transfer line from these processing tanks to the Plant 8 East and West EIMCO filters feed tanks has been installed to transfer the high nitrate slurry (magnesium diuranate, water, magnesium oxide) for filtration.

ES.2.1 General Processing Plan

The UNH solutions will be transferred from their storage tanks to either Tank F1-25 or F1-26 in Building 2A and diluted with water to reduce uranium and acid concentration controlling heat of neutralization and the generation of NO_x. The diluted solution will be neutralized with magnesium oxide slurry to precipitate the metals as their respective hydroxides. The neutralized solutions will then be transferred to Building 8 and the precipitated metals will then be removed from the neutralized solution via filtration. The filtered solids will be drummed and staged on-site pending disposal at the Nevada Test Site (NTS). The resulting water will be recycled to Building 2A for use as tank and equipment rinse water, dilution water for the next batch, or processed through Biodenitrification Facility (BDN) into an effluent suitable for release under existing site NPDES permit. Reference Appendix A for the Process Flow Diagram (PFD).

Tank D1-7, located in the Digestion area of Building 2A will not be processed under the UNH Neutralization Project. Laboratory analysis indicated that the contents require treatment by another process because it is a water/organic mixture and not UNH. Process requirements have been implemented that maintain Tank D1-7 in a safe configuration until processing. The Process Requirements identify the requirements to isolate Tank D1-7 inlets and discharges. The isolation will ensure that no reagents or energy sources will enter Tank D1-7 and the contents of D1-7 will not be transferred. Isolation is accomplished by the installation of blanks, blind flanges, and lock and tags as described in the Process Requirements. The FEMP report, *Safety of Uranyl Nitrate Hexahydrate (UNH) Solutions with Respect to "Red Oil" Formation and Consequent Events* (Ref. 1), provides the analysis and basis for the controls implemented by the Process Requirements. The Process Requirements for Tank D1-7 were reviewed by the Independent Safety Review Committee (ISRC). The UNH Neutralization Project Manager shall ensure that the Process Requirements are not violated by UNH Neutralization activities.

ES.2.2 UNH Neutralization Background

Neutralization of uranyl nitrate solutions and precipitation of the uranium from the solution was previously accomplished using magnesium hydroxide. This procedure is well established, and has been used intermittently in Plant 2/3. Previous testing indicated that all the metals of concern, uranium, chromium, and barium, will precipitate from solution and can be removed by filtration. That testing also showed that the resulting filter cake is not a hazardous waste per the Toxicity Characteristic Leaching Procedure (TCLP) test specified by the EPA, and that the filtrate is suitable for processing through the existing biodenitrification process and subsequent discharge.

In 1992, approximately 20,000 gallons of UNH solution were processed as described in plant test, PTA-90-2/3-003-0. During that plant test, UNH solution from three storage tanks was blended together to reduce the overall isotopic concentration of U-235 in the resulting blend below 1.00% and improve the homogeneity and filterability of the solution. The blended solution was then diluted with process water to reduce the uranium concentration below 50 grams U per liter. The dilute solution was then heated to between 110 and 130 degrees F, and neutralized with magnesium hydroxide. Upon neutralization, uranium, barium, and chromium precipitated from the solution. The precipitated solids were filtered from the solution and drummed, and the filtrate quarantined pending laboratory analysis. Subsequent laboratory analysis demonstrated that the filter cake passed the TCLP, and the filtrate contained no contaminants at concentrations which would prevent its processing in the plant biodenitrification unit.

Upon completion of the plant test, operations were suspended pending conversion of the plant test procedure into formal operating procedures to complete processing of the UNH Solutions. Shortly after processing resumed, a spill of approximately 30 gallons of dilute UNH solution occurred which resulted in DOE placing a hold on any further processing of UNH solutions. The resulting Type B investigation (Ref. Type B Investigation) required further study and assurances of system integrity and control before processing could restart.

ES.2.3 Previous Spill Summary

The UNH spill resulted from an accidental transfer of diluted UNH to Plant 8 prior to neutralization. The former UNH process used a Plant 2/3 sump water collection tank to dilute and heat the UNH. While the UNH process was on standby, a back shift operator from the waste water filtering operation, not informed that the UNH process had resumed, transferred the dilute UNH to Plant 8. Additional areas of concern were that the tank placard indicated that the tank contained sump water and the discharge valve on the tank was not locked and tagged as required by the project for process control.

After the material was transferred, a waste water filter operator noticed an odor at the filter basin and that the filtrate was a lime green. A field sample was taken of the filtrate and was found to have a very low pH. The supervisor then realized that UNH had been transferred to Plant 8. The supervisor contacted the UNH process manager, who instructed the supervisor to neutralize the UNH in the waste water tanks.

The following morning the decision was made to return the unneutralized UNH that had passed through the filter back to the dilution tank in Plant 2/3. The line used to transfer this material back to the tank was the same line used to transfer the many Plant 2/3 floor sumps to the waste water hold tank. To avoid mixing of the liquid, all floor sumps were turned off leaving the check valves on the floor sump as a boundary to the transfer.

After the transfer was initiated several check valves failed allowing the liquid to enter several floor sumps. One floor sump overflowed outside the secondary containment (floor) in the Denitration Area of Plant 2/3. An estimated 30 gallons exited the plant to the ground outside the main Plant 2/3 building."

ES.2.4 Type B Investigation Findings and Recommendations

The Type B Investigation team determined that the event was caused by a lack of process control on the part of the UNH Neutralization Plant Test and made recommendations that have been implemented as indicated in the SAR (see Sections 2 & 3 of the SAR).

ES.3 Facility Hazard Classification

The UNH Neutralization Project has been determined to be a Hazard Category 3 activity, based on the verified inventory of radiological materials, in accordance with DOE-STD-1027-92. See Appendix E for the hazard classification. There is no potential for criticality.

ES.4 Safety Analysis Overview

The UNH Neutralization Project is a chemical process where an acidic solution of varying strengths is neutralized by a basic solution producing a filterable slurry. Because the operation is a chemical process, the safety analysis utilized process safety management principles.

The primary hazards are the: 1) spilling UNH which is mitigated by process control features and transfer system upgrades, and 2) Tank D1-7 fire hazard (see subsection ES.2.1). which is mitigated by its isolation from the UNH project and Process Requirements. The project organization and interfaces with support organizations is described in Section 17.

Hazards and release mechanisms associated with the UNH Neutralization Project were initially identified in a Preliminary Hazard Analysis (PHA). Subsequent analyses, including a What-If/Checklist Analysis and a Hazard and Operability Analysis (HAZOP), were performed to supplement the PHA. Additional hazard analyses were performed to identify the OSHA-regulated industrial safety issues. The "OSHA Assessment for the UNH Project: Plant 8, 2/3, and Hot Raffinate," summarizes the OSHA Occupational, Industrial Hygiene, and Fire Safety hazards/compliance issues. The final hazard analysis is included in Appendix C and represents the summary of all hazard analyses performed for the UNH Project. The results of the Hazard Analysis demonstrate that all hazards are acceptable.

The hazards identified were primarily related to worker safety. These hazards include the potential for contact with a strong acid, exposure to NO_x, radiation exposure, and common industrial hazards. Controls are in place to prevent or mitigate the hazards to the worker. The primary hazard to the environment is a spill. This hazard is mitigated by the secondary containment, new transfer equipment, and collection of run-off at the Storm Water Retention Basin. There were no hazards identified affecting the off-site population.

Though no quantitative accident analysis is required for the UNH Project, a set of bounding accidents was modeled assuming the most conservative meteorology. These accidents modeled included natural phenomena events, explosion, fire, and spills. As determined qualitatively in hazard analysis, none of the other accidents quantitatively exceeded on-site or off-site evaluation guidelines. Reference Appendix E for the consequence calculations and detailed results.

ES.5 Organizations

The Fernald Environmental Restoration Management Company is the prime contractor responsible for the facility design, construction, maintenance, and operation. The Ralph M. Parsons Company prepared the final design and maintenance, operations, and safety analysis support. Wise Construction Company provided construction support. Safety Management, Inc., provided safety analysis support by conducting the HAZOP and What-if analyses.

ES.6 Safety Analysis Conclusions

The safety basis is adequate and appropriate because there are no significant hazards to the environment, on-site, or off-site populations. The hazards are primarily related to worker safety. These hazards are controlled by established industry standards and other regulations. A TSR has been prepared containing the administrative controls important to safe operation and worker protection.

ES.7 SAR Organization

The SAR contents and organization follow draft versions of DOE-STD-3009-94, *Preparation Guide for U. S. Department of Energy Non Reactor Nuclear Facility Safety Analysis Reports*. DOE-STD-3009-94 was finalized during the review of this SAR and it was not feasible to rewrite the SAR to follow the final format and content guidance of DOE-STD-3009-94. Sections are organized as recommended in 3009-94 with only minor differences in the content of each section. Table 1, UNH Neutralization Project SAR Organization, indicates where 5480.23 requirements will be addressed in the SAR.

TABLE 1: UNH Neutralization Project SAR Organization

Topic	SAR Chapter	5480.23 Topic
Executive Summary	unnumbered	8.b.(3)(a)
Site Characteristics	1	8.b.(3)(c)
Facility Description	2	8.b.(3)(d)
Hazard and Accident Analysis	3	8.b.(3)(e),(k)
Safety Structures, Systems, & Components	4	8.b.(3)(d)
Derivation of Technical Safety Requirements	5	8.b.(3)(p)
Prevention of Inadvertent Criticality	6	8.b.(3)(h)
Radiation Protection	7	8.b.(3)(i),(k)
Hazardous Materials Protection	8	8.b.(3)(j),(k)
Radioactive and Hazardous Waste Management	9	8.b.(3)(g),(k)
Initial Testing, In-service Surveillance, and Maintenance	10	8.b.(3)(o)
Operational Safety	11	8.b.(3)(q)
Procedures and Training	12	8.b.(3)(m)
Human Factors	13	8.b.(3)(n)
Quality Assurance	14	8.b.(3)(r)
Emergency Preparedness	15	8.b.(3)(s)
Provisions for D&D	16	8.b.(3)(t)
Management, Organization, and Institutional Safety	17	8.b.(3)(l)

Note: Topics (b), (f), and (u) are incorporated into all applicable chapters

SECTION 1
SITE CHARACTERISTICS

1.1 Introduction

This section provides a description of the FEMP site characteristics relevant to the UNH Neutralization Project. The UNH Neutralization Project has been determined to be a Hazard Category 3 activity, based on the verified inventory of radiological materials, in accordance with DOE-STD-1027-92. Following the graded approach recommended in DOE-STD-3009-94, the site characteristics information is limited to locating the site, facilities utilized, and boundaries. A limited discussion of the geography, demography, meteorology, hydrology, and geology are included to support the accident analysis assumptions and scenario development in Section 3 and Appendix E of this SAR.

1.2 Requirements

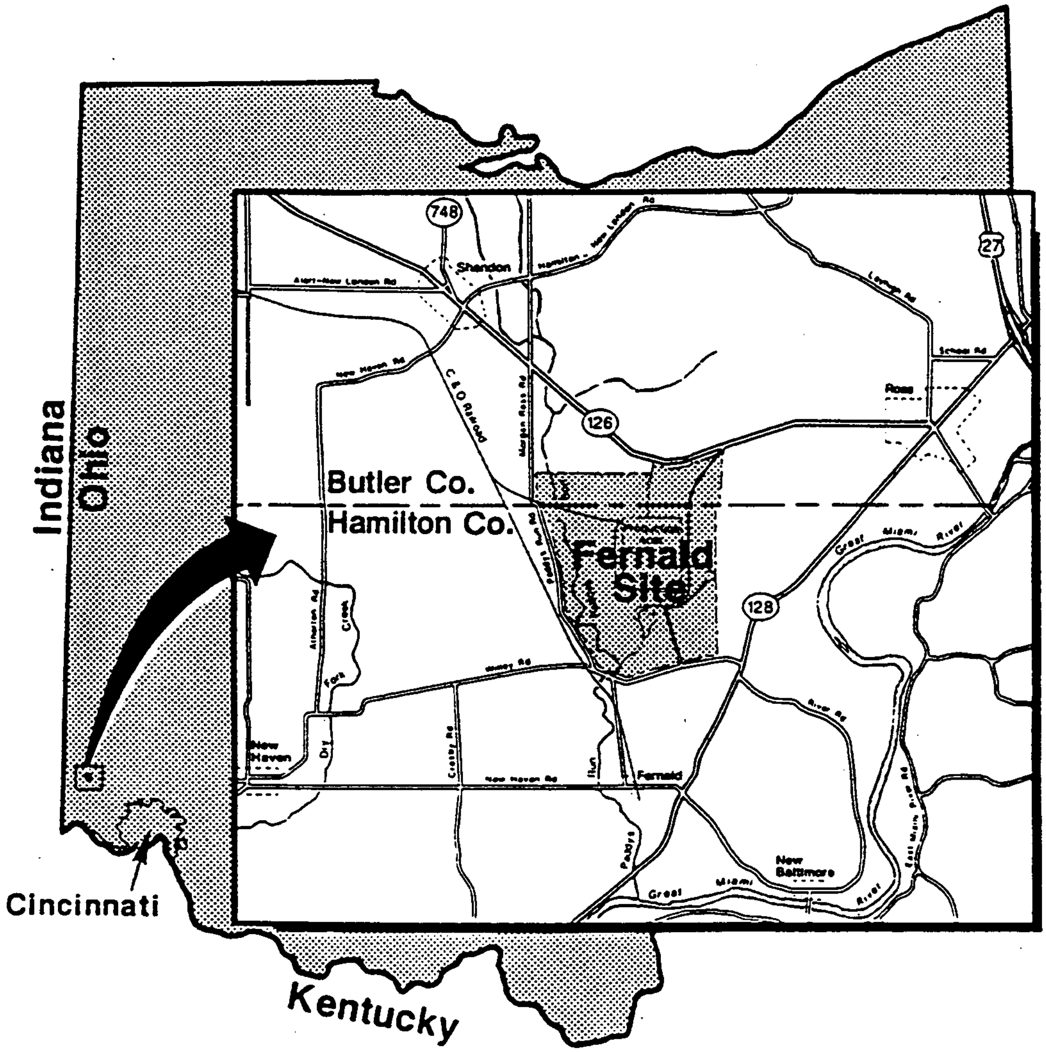
The UNH Neutralization Project utilizes existing facilities constructed from 1953 to the present. Criteria for facility siting and natural phenomena protection are undetermined. The facilities utilized for the UNH Neutralization Project were evaluated in, *Safe Configuration Assessment of the UNH Tank System*, December, 1993 (Ref. 1). The report determined that there was no immediate structural danger and that secondary containment provides adequate capacity. Modifications were made to the piping and instrumentation of the tanks to facilitate safe transfer of materials. The modifications were in accordance with DOE Order 6430.1A. Since the UNH Neutralization Project is removing the UNH in a safe, expedient manner to eliminate the hazards associated with continued storage of UNH, no further criteria were developed.

1.3 Site Description

The Fernald Environmental Management Project is located in rural southwestern Ohio near the unincorporated village of Fernald in Hamilton County. The FEMP is located about 17 miles northwest of downtown Cincinnati, Ohio.

Figure 1-1, General Site Map, identifies the major surrounding roads and site boundaries. The site is generally bounded on the north by State Route 126, on the south by Willey Road, on the west by Paddy's Run Road, and on the east by Knollman's Dairy Farm. State Route 128 runs along the southeast side of the FEMP site. The former production area of the FEMP covers approximately 136 acres in the central portion of the site. Surrounding the production area is a buffer consisting of leased grazing land, reforested land, and unused areas. Paddy's Run flows south-southeast along the western edge of the site.

Figure 1-1 General Site Map



Public access is controlled through the North and South access points. Reference Figure 1-2, Public Exclusion Areas, for the Public Exclusion Areas and Access Control Points.

1.3.1 Geography

The center of the FEMP site is located at approximately 39 degrees, 18 minutes north latitude and 84 degrees, 41 minutes, 15 seconds west longitude. The FEMP site is situated on a relatively level plain, about 580 feet above sea level. The land rises to 698 feet at the northern boundary and slopes downward to 551 feet at Paddy's Run, a small creek, on the western boundary.

1.3.2 Demography (Off-Site)

The FEMP is located in the eight-county Cincinnati-Hamilton (Ohio-Kentucky-Indiana) Consolidated Metropolitan Statistical Area, which had a 1988 population of approximately 1.7 million. The Consolidated Metropolitan Statistical Area consists of Hamilton, Butler, Clermont, and Warren Counties in southwestern Ohio; Boone, Campbell, and Kenton Counties in northern Kentucky; and Dearborn County in southeastern Indiana. The residential population within a 5-mile radius of the FEMP is approximately 23,000. The population density within 5 miles is fairly uniform. Significant localized centers of population within this 5-mile radius of the FEMP are the towns of Ross (east by northeast), Fernald (south), and New Baltimore (south by southeast). The regional population distribution is dominated by the City of Cincinnati and its suburbs to the southeast of the FEMP, beginning about 5 miles away. The urban complex of Hamilton and Fairfield, about 10 to 20 miles to the northeast, and the urban growth along U.S. Highways 27 and 127 greatly influence the population density; however, the population density within 5 miles of the plant is half the state average and is much less than the average of Hamilton and Butler Counties. Therefore, the immediate FEMP area can be characterized as rural. The population growth within a 5-mile radius of the plant is projected to be negligible for the duration of the project.

1.3.3 Demography (On-Site)

FERMCO employs approximately 2,500 workers. Most of which access the site in both administrative and radiologically controlled areas. No more than 300 employees are working, either outside or in near-by buildings, within a 100 meter radius of a UNH Neutralization activity (UNH workers excluded). Out of the 300 workers, the largest concentration of approximately 125 workers is in the Plant 1 area with the remaining workers evenly distributed around the UNH Neutralization Project. All personnel on-site are subject to site emergency procedures.

1.4 Environmental Description

A brief discussion of the meteorology, hydrology, geology are included to support the accident analysis assumptions. The following subsections are summarized from the detailed FEMP site environmental description in the *FEMP Site-Wide Characterization Report (SWCR)*(Ref. 2). The SWCR describes the history and physical characteristics of the FEMP and surrounding areas and presents a summary of all site data available as of December 1, 1991.

1.4.1 Meteorology

Meteorological conditions at the FEMP site are typical of conditions throughout southwestern Ohio, but wind direction may be influenced by local topography. The facility is situated in a valley oriented from west-southwest to east-northeast, through which the Great Miami River flows to the west-southwest. Gently rolling hills surround the site and larger hills form the boundaries of the aforementioned valley.

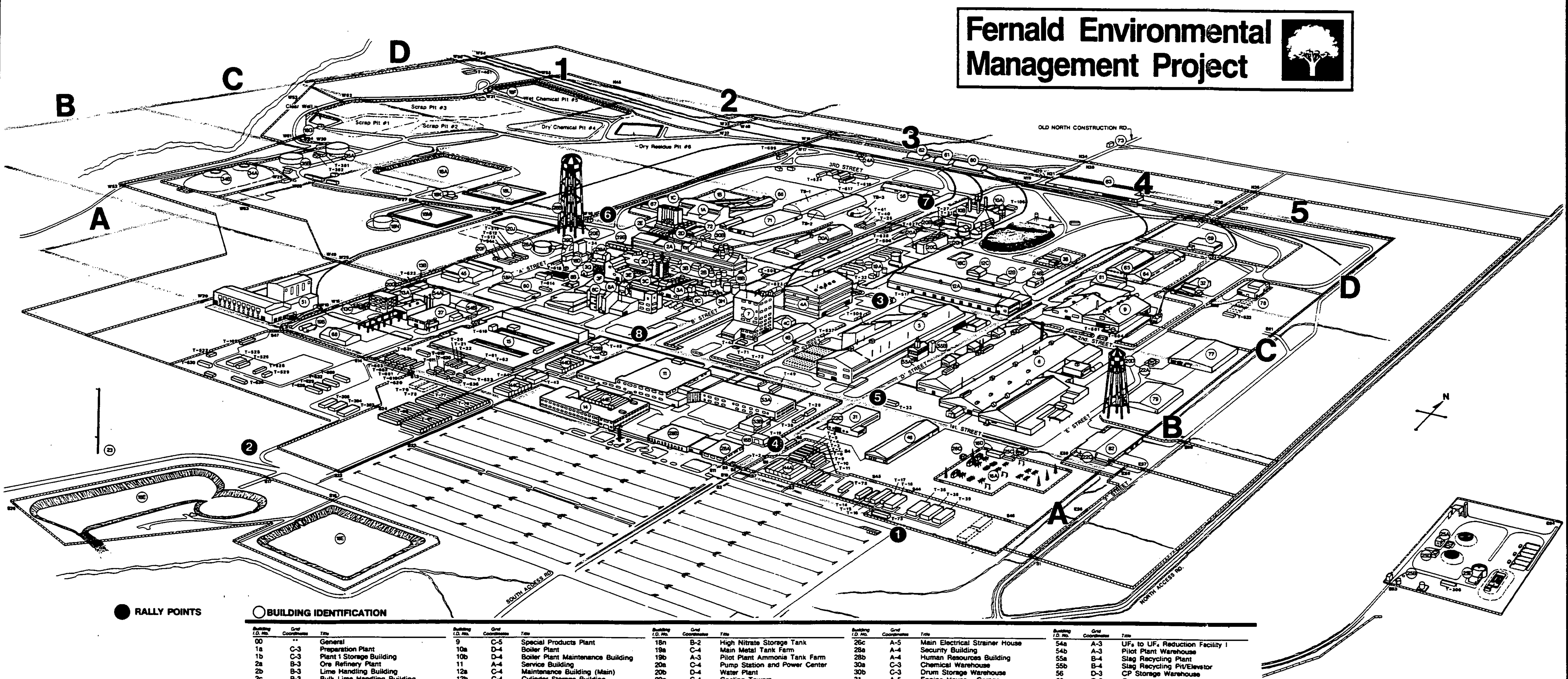
The Greater Cincinnati and Northern Kentucky International Airport and an on-site meteorology tower collect meteorological data for the FEMP area. Meteorological data from the Greater Cincinnati and Northern Kentucky International Airport, approximately 17 miles south of the FEMP site, are comparable to data collected from the FEMP meteorological tower. Short-term and local variations in the data are largely due to differences in local topography.

The Cincinnati, Ohio area, with a nominal elevation of 761 feet above sea level and an approximate latitude of 39 degrees north, has a 99 percent low winter temperature of 8 degrees F and a 99 percent high summer temperature of 94 degrees F (dry bulb). The area average annual wind speed is 7.1 mph, and the normal precipitation is 39.91 inches. The average relative humidity at 7:00 a.m. is 80 percent and at 1:00 p.m. is 57 percent. The average annual number of precipitation days is 132, the average annual number of days below 32 degrees F is 99, and the average annual amount of snowfall is 19.0 inches. Stability Class G with a wind speed of 0.5 meters per second has been determined, based on FEMP meteorological tower data, as the 95% meteorology conditions.

1.4.2 Hydrology

The site is located within the Great Miami River drainage basin. Stormwater from most of the FEMP to the Great Miami River is primarily via Paddy's Run, a small creek which begins north of the FEMP and flows southward slightly east of the site's western boundary. The intermittent stream begins to flow to the underlying sand and the gravel aquifer south of the waste pit area. About 1.5 miles south of the site, Paddy's Run empties into the Great Miami River.

Paddy's Run drains the FEMP to the Great Miami River. About 20 percent of the FEMP's stormwater



BUILDING IDENTIFICATION

Building I.D. No.	Grid Coordinates	Title
00	**	General
1a	C-3	Preparation Plant
1b	C-3	Plant 1 Storage Building
2a	B-3	Ore Refinery Plant
2b	B-3	Lime Handling Building
2c	B-3	Bulk Lime Handling Building
2d	B-3	Metal Dissolver Building
2e	C-3	NFS Storage and Pump House
3a	B-3	Maintenance Building
3b	B-3	Ozone Building
3c	B-3	Control House
3d	B-3	NAR Towers
3e	B-3	Hot Raffinate Building
3f	B-3	Digestion Fume Recovery
3g	B-3	Refrigeration Building
3h	B-3	Refinery Sump
4a	B-4	Green Salt Plant
4b	B-4	Plant 4 Warehouse
4c	B-4	Plant 4 Maintenance Building
5	B-4	Metals Production Plant
6	B-5	Metals Fabricating Plant
7	B-4	Plant 7
8a	B-3	Recovery Plant
8b	B-3	Maintenance Building
8c	B-3	Rotary Kiln/Drum Reconditioning Building
9	C-5	Special Products Plant
10a	D-4	Boiler Plant
10b	D-4	Boiler Plant Maintenance Building
11	A-4	Service Building
12a	C-4	Maintenance Building (Main)
12b	C-4	Cylinder Storage Building
12c	C-4	Lumber Storage Building
13a	A-3	Pilot Plant Wet Side
13b	A-3	Pilot Plant Maintenance Building
13c	A-3	Sump Pump House
14	A-4	Administration Building
15	A-3	Laboratories
16a	A-5	Main Electrical Station
16b	A-4	Electrical Substation
18a	C-2	Surge Lagoon
18b	B-3	General Sump
18c	C-4	Coal Pile Runoff Basin
18d	B-3	Biodenitrification Towers
18e	*	Storm Water Retention Basin
18f	D-1	Pit 5 Sluice Gate
18g	C-1	Clearwell Pump House
18h	B-3	BDN Effluent Treatment Facility
18k	B-2	Methanol Tank
18l	C-2	Low Nitrate Tank
18m	B-2	High Nitrate Tank
18n	B-2	High Nitrate Storage Tank
19a	C-4	Main Metal Tank Farm
19b	A-3	Pilot Plant Ammonia Tank Farm
20a	C-4	Pump Station and Power Center
20b	D-4	Water Plant
20c	C-4	Cooling Towers
20d	B-5	Elevated Storage Tank (Potable H_2O)
20e	B-3	Well House #1
20f	B-3	Well House #2
20g	A-3	Well House #3
20h	D-4	Process Water Storage Tank
20j	B-2	Lime Slurry Pits
22a	B-5	Gas Meter Building
22b	A-3	Stormsewer Lift Station
22c	A-5	Truck Scale
23	*	Meteorological Tower
24a	D-3	Railroad Scale House
24b	C-4	Railroad Engine Building
25a	*	Chlorination Building
25b	*	MH #175
25c	A-5	Sewage Lift Station Building
25d	*	U.V. Disinfection Building
25e	*	Digester Control Building
26a	B-3	Pump House - H.P. Fire Protection
26b	B-3	Elevated Water Storage Tank
26c	A-5	Main Electrical Strainer House
28a	A-4	Security Building
28b	A-4	Human Resources Building
30a	C-3	Chemical Warehouse
30b	C-3	Drum Storage Warehouse
31	A-5	Engine House - Garage
32	D-5	Magnesium Storage
34a	B-1	K-65 Storage Tank - North
34b	B-1	K-65 Storage Tank - South
35a	C-1	Metal Oxide Storage Tank - North
35b	B-1	Metal Oxide Storage Tank - South
37	A-3	Pilot Plant Annex
38	D-4	Propane Storage
39a	B-3	Incinerator Building
39b	B-3	Shelter Storage Building
39c	B-3	Incinerator Building Sprinkler Riser House
44a	A-5	Trailer Complex - 6-Plex - East
44c	A-3	Trailer Complex - 7-Plex - South
44d	A-3	Trailer Complex - 7-Plex - North
44e	A-4	Trailer Complex - 10-Plex
45	B-3	Rust Engineering Building
46	A-5	Heavy Equipment Garage
51	A-2	UF_6 to UF_4 Reduction Facility II
53a	A-4	Occupational Safety & Health Building
53b	A-4	In-Vivo Building
54a	A-3	UF_6 to UF_4 Reduction Facility I
54b	A-3	Pilot Plant Warehouse
55a	B-4	Slag Recycling Plant
55b	B-4	Slag Recycling Pit/Elevator
56	D-3	CP Storage Warehouse
60	D-3	Quonset #1
61	D-3	Quonset #2
62	D-3	Quonset #3
63	D-4	KC-2 Warehouse
64	D-5	Thorium Warehouse
65	D-5	(Old) Plant 5 Warehouse
66	C-3	Drum Reconditioning Building
67	C-3	Plant 1 Thorium Warehouse
68	A-3	Pilot Plant Warehouse
69	D-5	Decontamination Building
71	C-3	General In-Process Storage Warehouse
72	C-3	Drum Storage Building
73	*	Fire Brigade Training Center Building
77	C-5	Finished Products Warehouse
78	D-5	New D&D Facility
79	B-5	Plant 6 Warehouse
80	B-3	Plant 8 Warehouse
81	C-5	Plant 9 Warehouse
82	B-5	Receiving & Incoming Materials Inspection Area

May 1992 WEMCO Graphics #1583 Note: Trailer Identification Subject to Change. This information taken from Engineering Dwg. #44-5500-X-00018 Rev.15 and FEMP Aerial Photo 10/16/91.

** NOTE: Any Unidentified Area is Referred to as 00 General * Outside of Perimeter Security Fence

Figure 1-2 Public Exclusion Areas

runoff is collected and treated prior to discharge to the Great Miami River.

The average flowrate of the Great Miami river at Paddy's Run is 3,400 cubic feet per second. In 1991, the monthly flow varied from 46,000 cubic feet per second in January to 330 cubic feet per second in November.

1.4.3 Seismology

The FEMP facility is located in a seismically quiet region that has experienced ground motion principally because of events in adjacent regions. Potential earthquake activity having direct effect on the Fernald reservation has been identified to be a result of the seismic activity in three zones; Anna, Ohio; the New Madrid Fault; and the Appalachian Zone. Throughout the nineteenth and twentieth centuries, no damaging earthquakes have been recorded within 71 miles of the FEMP (Ref. 2).

1.4.4 Geology

The FEMP is located in the ancestral valley of the Great Miami River. This valley is about 2 miles wide at the FEMP with the floor about 200 feet below the present topography. During the initial glaciation of southwestern Ohio, the valley was filled with sand and gravel deposited by the meltwater of the receding glaciers. Subsequent glacier advances deposited glacial till on the subsurface of sand and gravel. Postglacial erosion by the Great Miami River and its tributaries removed significant portions of the glacial overburden and left terrace remnants which stand topographically higher than surrounding bottom lands.

The geology of the FEMP and its surrounding areas can be divided into three primary stratigraphic units: the bedrock, the sands and gravels of the Great Miami Aquifer, and the unconsolidated glacial overburden deposits. All of these geologic units occur within the FEMP boundaries to some degree.

1.5 Natural Phenomena Threats

The natural phenomena threats are from potential earthquakes, tornadoes, high winds and floods. Each of these threats are described below. Natural phenomena accidents affecting the UNH Neutralization Project do not have the potential for affecting off-site individuals, as defined in DOE-STD-1027-93 for a Hazard Category 3 Facility. For each Natural Phenomena event the only preventive action that can be taken is to remove the UNH from the storage tanks and place the UNH in a more safe configuration, which is the intent of the UNH Neutralization Project. The natural phenomena discussion therefore contains only the relevant information for the Hazard and Accident Analysis Section of this SAR.

1.5.1 Earthquakes

Earthquakes above 0.13g_a are beyond the Evaluation Criteria as defined in DOE-STD-1020-94. The frequency of an earthquake in this acceleration range is 1.0E-3 events/year (Ref. 3).

1.5.2 High Wind

High winds above 70 miles per hour (mph) are beyond the Evaluation Criteria as defined in DOE-STD-1020-94. The frequency of high wind exceeding this level 2.0E-2 events/year (Ref. 3). Note that DOE-STD-1020-94 does not require an evaluation of tornados for HC-3 facilities.

1.5.3 Floods

100- and 500-Year Floodplain Determination Sitewide (Ref. 5) states that some parts of the site are located below the 100-year floodplain. The location of a facility above the floodplain does not imply that the facility is not subject to flooding by deluge. A facility may be susceptible to flooding by the inability of drainage to accommodate intense short-term rainfall.

In the production area, local flooding in the form of pools in undeveloped areas is possible. Surface water from the production area drains into the Stormwater Retention Basins (SWRBs) located in the south portion of OU-3. Natural drainage from the waste pit area is primarily directed and collected by the Waste Pit Stormwater Management System.

1.6 External Man-Made Threats

External man-made threats include potential events such as aircraft or vehicle impact and railway/transportation explosion. Additionally, other events such as those generated in the facilities near UNH tanks in activities other than UNH neutralization may occur. These facility events include explosions due to propane or explosive welding gas leaks and forklift impacts. These events were considered in the development of the Hazard Analysis in Appendix C.

1.7 Nearby Facilities

The facilities surrounding the UNH Neutralization Project facilities are former production facilities currently functioning as uranium storage facilities. The *Plant Hazards Survey* (Ref.4) involved a detailed survey to identify the hazards associated with the activities in the facilities at the FEMP, and perform a preliminary hazard categorization. The survey results indicate that the majority of the accident initiators and postulated consequences related to the handling and storage the drum inventory and the removal of the material holdup. Basis for Interim Operations (BIOs) reports are being prepared to describe the safety basis for these facilities and the controls of the inventory of hazardous materials.

Review of the survey indicates that there are no credible accidents in a nearby facility that could cause an accident in the UNH Neutralization Project. With the exception of accidents resulting from major common cause initiators or a nuclear criticality, the consequences of accidents in other site facilities affect only the immediate facility. A common cause event or nuclear criticality can impact the UNH Project by causing an evacuation. Advance warning is usually provided for most major common cause events, such as natural phenomena events, and precautions are taken as discussed in Section 15.4.5, Protective Actions. A criticality event in a nearby facilities would require that the occupants of surrounding unalarmed facilities remain in the facility until evacuation is permitted. The UNH Neutralization Project has written procedures for placing the system in a safe stand-by mode in the event the facility must be evacuated and major common cause and criticality events would not initiate an accident in the UNH Neutralization Project.

None of the nearby facilities have the potential to impact the safety of operations in the UNH Neutralization facilities. Several site programs and procedures address the safety and control of hazardous and nuclear materials in the FEMP facilities. To verify that the conditions of the nearby facilities continue to have no impact on the UNH Project and that the site programs and procedures are effective, Plants 1 and 4 will be walked down monthly to confirm that plant conditions are consistent with the *Plant Hazards Survey* for the duration of the UNH Neutralization Project.

1.7.1 Traffic

Traffic will be controlled in and around the UNH Neutralization Project during operations by denying access to any traffic that is not UNH Neutralization Project related. The UNH Project facility owners control the access to the facilities and work that can be performed in the facilities during operations. All activities not defined in the scope of the UNH Neutralization Project and Final Safety Analysis Report (FSAR) will be reviewed through the USQ process. Only work related to the UNH Neutralization Project and to correct facility safety defeciencies will be permitted in Plant 2/3 during the UNH Neutralization Project.

1.7.2 Plant 8 Waste Water Treatment

The Plant 8 will continue waste water treatment operations utilizing the Large EIMCO filter. The UNH Neutralization Project utilizes the East and West EIMCOs. The East and West EIMCO filtering system is physically separated from the Large EIMCO filtering system. The waste water treatment operations have no impact on the safety of the UNH Neutralization Project. The workers are trained and qualified to operate both systems and there are written procedures that address placing either system in a safe stand-by mode. Because both operations utilize the same work force it is unlikely that both systems will be operating at the same time.

There is no accident scenario for either process with the potential for initiating an accident in the other. UNH neutralization and precipitation takes place in Plant 2/3. Plant 8 will only perform the filtering operation to remove the solids. This operation is essentially the same as the current operations with only minor adjustments to account for a thicker slurry. The filtering system for the UNH Project is physically isolated from the waste water system eliminating the potential for inadvertent transfers between the two.

1.7.3 Inventory Control

The UNH Neutralization Project will control the inventory of radiological and hazardous materials in Plant 2/3 and Plant 8. No radiological or hazardous materials, other than those required to support the UNH Project and continuing waste water processing will be introduced in the facilities.

1.8 References

1) FERMCO, December 1993. *Safe Configuration Assessment of the UNH Tank System.*

2) DOE 1993. *FEMP Site-Wide Characterization Report (SWCR),* Fernald Environmental Management Project, Fernald, Ohio. DOE, Fernald Field Office: FEMP-SWCR-3.

3) DOE-STD-1020-94, "Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities," April, 1994.

4) FERMCO, September, 1994. *Plant Hazards Survey and Preliminary Hazard Categorization,* FEMP-2352, Rev. 0.

SECTION 2
FACILITY DESCRIPTION

2.1 Introduction

This section provides facility and process descriptions and previous processing history. The UNH dilution, neutralization, and precipitation process is located in Building 2A of the Refinery Area. The filtration process is located in Plant 8. Filtration operations in Plant 8 are well established. The UNH Storage Tanks are located in various areas located within the Refinery. New transfer piping, pumps, and instrumentation have been installed to ensure safe transfer. Most of the modifications were implemented as a result of the Type B Investigation of the UNH spill. The most significant Type B Investigation Findings were administrative and programmatic issues and are addressed in other sections of this SAR. The system modifications support configuration and process control that was not achievable with the system as it was prior to this project.

2.2 Requirements

The UNH facilities are existing structures and processing systems that have been upgraded with new piping, pumps, and instrumentation. The facilities will eventually be decontaminated and dismantled, therefore, it was only economically feasible to upgrade structure characteristics that serve a safety purpose or an operability concern. Applicable DOE 6430.1A, General Design Criteria, criteria were applied to modifications and upgrades. The design criteria and codes applicable at the time of original construction were not developed.

2.3 Scope of Work

The purpose of the Uranyl Nitrate Hexahydrate (UNH) Project is to safely neutralize and dispose of approximately 200,000 gallons of uranium dissolved in nitric acid (UNH). The UNH was "Material in Process" until June 1991 when DOE reclassified it as a waste material. This reclassification caused the material to be characterized as a mixed hazardous waste under the Resource Conservation and Recovery Act (RCRA) due to its corrosive properties and hazardous constituents. These UNH solutions are presently stored in eighteen tanks at the Fernald Environmental Management Project (FEMP). Reference Appendix E for the contents of each tank and Appendix A for the location of each tank. The solutions will be diluted, neutralized and filtered. The solid filter cake is expected to be non-RCRA hazardous and meet acceptance criteria for shipment to the Nevada Test Site (NTS) for burial as low-level radioactive waste. The liquid filtrate will be tested to confirm its acceptability for discharge under the present National Pollutant Discharge Elimination System (NPDES) permit.

2.3.1 UNH Neutralization Background

Neutralization of uranyl nitrate solutions and precipitation of the uranium from the solution was previously accomplished using magnesium hydroxide. This procedure is well established and has been used intermittently at the Refinery Sump. Previous testing showed that the resulting filter cake is not a hazardous waste per the Toxicity Characteristic Leaching Procedure (TCLP) test and that the filtrate is suitable for processing through the existing biodenitrification process and subsequent discharge.

In 1992, approximately 20,000 gallons of UNH solution were processed during a plant test. During the plant test, UNH solution from three storage tanks was blended to reduce the overall isotopic concentration of U-235 in the resulting blend below 1.00% and improve the homogeneity and filterability of the solution. The blended solution was then diluted with process water to reduce the uranium (U) concentration below 50 grams U per liter. The dilute solution was then heated to between 110 and 130 degrees F and neutralized with magnesium hydroxide. The neutralization process was a two stage, continuous process. The UNH solution was pumped to a tank where it was mixed with magnesium hydroxide and allowed to overflow to a second tank. The solution had a total residence time of approximately two hours, during which the acid was neutralized and the heavy metals precipitated. The resulting slurry containing the heavy metals including uranium, barium, chromium, and a significant excess of magnesium oxide, was transferred to the Plant 8 Waste Water Treatment Facility for filtration. The precipitated solids were filtered from the solution and drummed, and the filtrate was transferred to the high nitrate filtrate storage tank for further processing through the existing biodenitrification process before discharge. The process generated approximately 500,000 gallons of filtrate and 620 drums of filter cake. Subsequent laboratory analysis demonstrated that the filter cake passed the TCLP, met the Nevada Test Site NTS waste acceptance criteria, and was shipped to NTS. The filtrate was later discharged through the system under the NPDES permit.

In April 1993, the inadvertent transfer of approximately 20,000 gallons of dilute UNH solution to Plant 8 and the resulting release of an estimated 30 gallons of UNH solution to the environment resulted in a Type B Investigation of the circumstances leading to the release. The conclusions of the Type B Investigation required further study of the operations and assurances of system integrity and configuration control before any processing could restart. Lessons learned from the investigation and from the February 1993 Plant Test Report (Ref. 1), which documented the results of the 1992 plant test, have influenced the selection of the processing methodology, operating procedures and management discipline, and equipment to be utilized in the present UNH Neutralization Project. Reference the Corrective Action Implementation Plan Final Status Report for the Type B Investigation on the Uranyl Nitrate Solution Incident (Ref. 2) for the implementation of the Type B Investigation Findings into the UNH Neutralization Project.

2.3.2 General Process Description

The previous plant test, though successful in neutralizing the UNH solution and precipitating the heavy metals, was not an efficient use of reagent and generated an excessive quantity of high nitrate filtrate for the BDN facility. A batch process was determined to be more appropriate for several reasons. A batch process allows greater control over the process, whole tanks to be emptied at a time (some will require several batches), processing of UNH solutions of higher uranium concentrations, and more efficient use of reagents. In the continuous process, because batches are prepared by blending different tanks, the number of UNH solution transfers required is greater than a batch process and it would take longer to completely empty a storage tank. Another result of the continuous process was the excessive use of magnesium hydroxide. The reactant, magnesium hydroxide, has a low solubility and is essentially a suspension of magnesium oxide in water before mixing with the UNH solution. Because of the short residence time in the continuous process, an excess of the reactant was added to attain the proper pH. The resulting filter cake had a large constituent of MgO, unnecessarily increasing the waste volume and disposal costs.

The bench scale testing was performed to support the UNH Neutralization Project. Its purposes were threefold: 1) to characterize the contents of the individual UNH tanks, 2) to investigate possible treatment conditions and verify that the treated material would meet existing discharge/disposal criteria, and 3) to recommend treatment conditions for the UNH inventory.

Characterization of the UNH inventory indicated that: 1) the acid normality ranges from 0.19 to 4.65, 2) uranium concentration varies from 13 to 341 grams/liter, 3) uranium enrichment varies from 0.79 to 1.29% U235, and 4) significant concentrations of barium, chromium, lead, and mercury are present in most of the UNH solutions.

Samples from each UNH storage tank were first titrated (ie. measured addition to a known sample quantity) with concentrated sodium hydroxide to determine total caustic consumption. Samples were then titrated using powdered magnesium oxide in a manner to simulate the proposed batch treatment process. Those tests indicated that magnesium hydroxide was the preferred reagent for neutralization/precipitation due to the better filterability of the precipitated solids and the rates of neutralization/precipitation are sufficient to support processing at ambient temperatures.

Based on the test results, the batch recipes for each tank were developed to obtain optimum results and most efficiently utilize reagents within the process parameters. The process parameters are:

1) neutralization of no greater than a 1N UNH solution to control the temperature rise due to neutralization.

2) no diluted UNH solution temperatures greater than 130 degrees F to control NO_x

generation.

3) neutralization of solution with uranium concentrations of no greater than 100 grams/liter.

Processing the UNH solutions in the manner recommended in the bench test report will result in dilute UNH solution batches estimated to range in size from 15,000 to 18,000 gallons, with uranium concentrations ranging from 32.8 g/l to 98.7 g/l and normalities ranging from 0.46N to 0.98N. The neutralization/precipitation of all of the UNH solutions will require approximately 23,000 gallons of magnesium hydroxide and generate approximately 275,000 gallons of high nitrate filtrate. The actual process performance, batch numbers & sizes, and quantity of reagent may vary from the bench test results and be slightly adjusted once full scale processing begins.

To achieve the project's objectives, it is planned to neutralize the existing inventory of UNH solution with magnesium hydroxide. This will cause the uranium and other heavy metals in solution to precipitate out of solution. The precipitate will be separated from the resulting slurry using a vacuum filter. The filtrate will be processed into an effluent suitable for transfer to the BDN Facility and eventual release under the existing site NPDES permit. Figure 2.3-1 is a simplified process flow diagram of the UNH process. Figure 2.3-2 is a simplified process flow diagram of the Plant 8 Filtration Operation.

Figure 2.3-1 Simplified UNH Process Flow Diagram

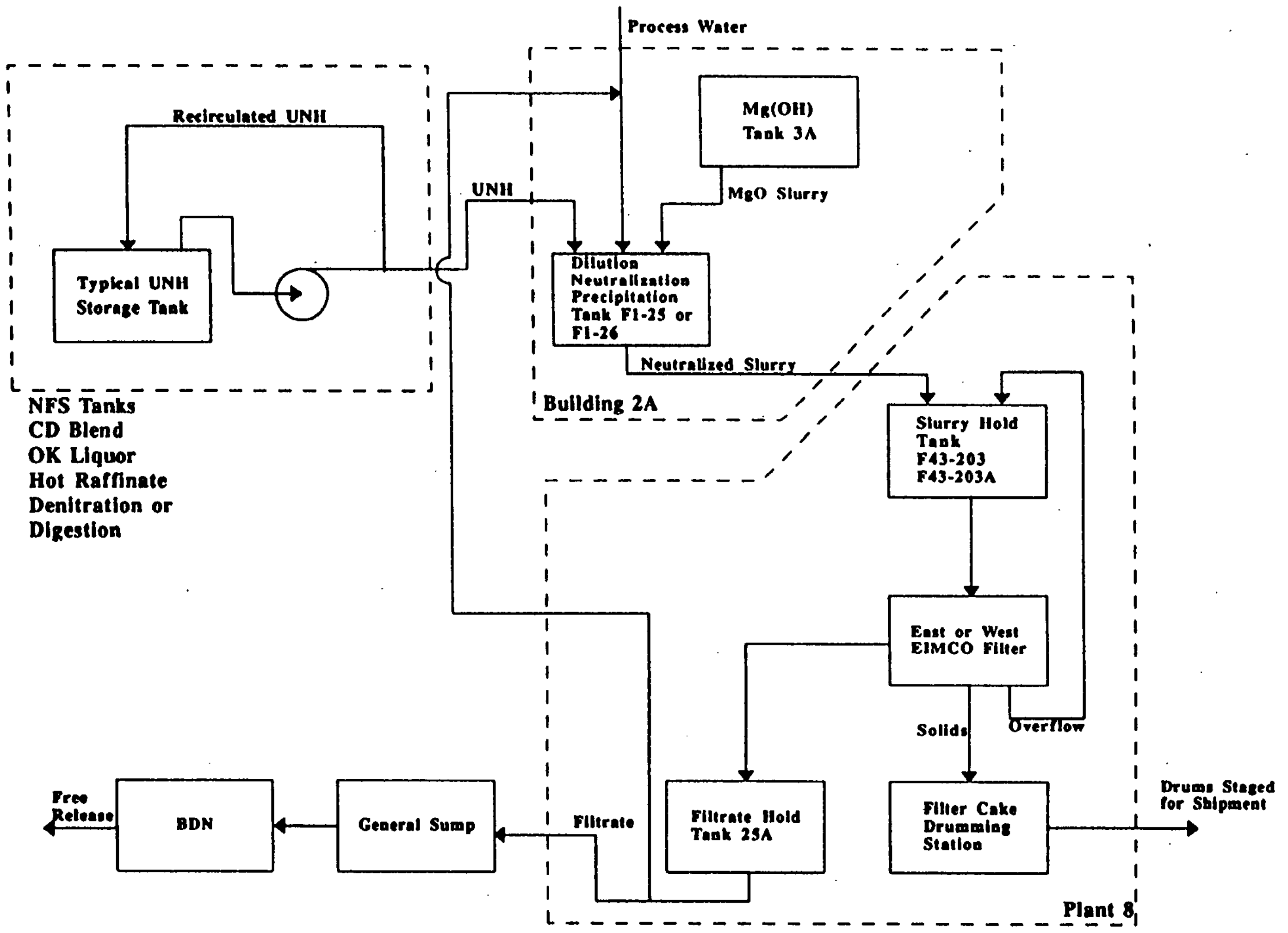
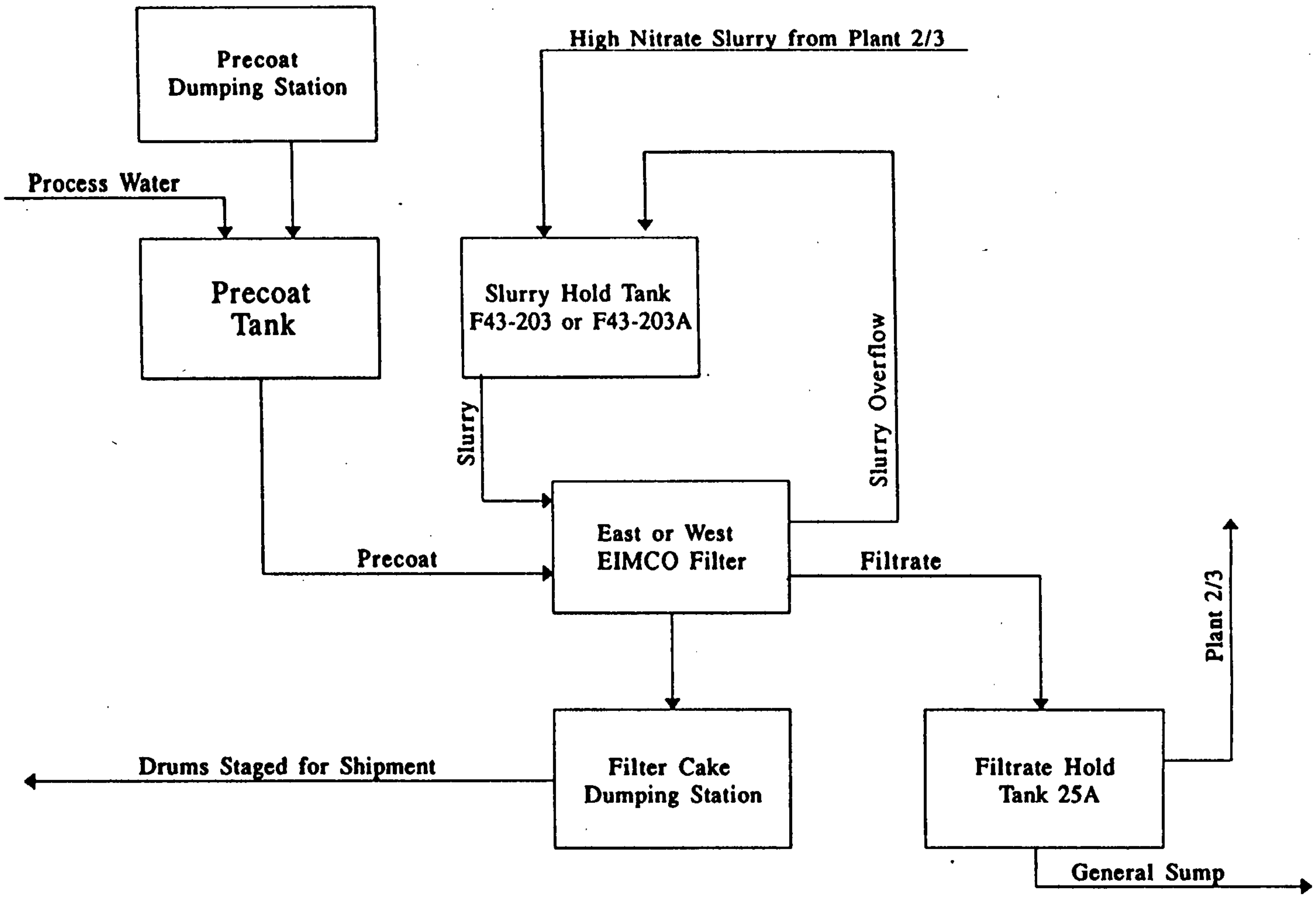


Figure 2.3-2 Simplified Plant 8 Filtration Process Flow Diagram



The FEMP has approximately 200,000 gallons of UNH that is stored in 18 tanks. The UNH solution is pumped in batches to a dilution/neutralization tank in Plant 2A where it is mixed with warm water to make a solution containing less than 1 N free acid and less than 100 grams per liter of uranium. Each dilute batch is then neutralized in the same tank with magnesium hydroxide slurry. The excess nitric acid is neutralized to form soluble magnesium nitrate, and the UNH solution reacts to form a magnesium diuranate precipitate. Other heavy metal contaminants, such as chromium and barium, are also precipitated in the process. The resulting high nitrate slurry is transferred to existing filter feed tanks and filtered on existing rotary drum vacuum filters (East and West Eimco filters) in Plant 8. The filter cake is collected in drums, sampled, and staged for shipment to NTS. The high-nitrate filtrate is either discharged for treatment in the Biodenitrification (BDN) facility or returned to Plant 2/3 for dilution or rinse water.

2.3.3 Process Chemistry

The chemistry involved in this process is principally the removal of uranium dissolved in nitric acid, having a valence state of +6, by the addition of magnesium hydroxide [$Mg(OH)_2$] to the solution. It is probable that both of the following reactions occur :

$$2\ UO_2(NO_3)_2 + 3\ Mg(OH)_2 \rightarrow MgU_2O_7 \downarrow + 2\ Mg(NO_3)_2 + 3\ H_2O$$

$$UO_2(NO_3)_2 + Mg(OH)_2 \rightarrow UO_2(OH)_2 \downarrow + Mg(NO_3)_2$$

The resulting solids which are precipitated would then be a mixture of magnesium diuranate (MgU_2O_7) and uranyl hydroxide ($UO_2(OH)_2$), as well as other dissolved species (Al, Fe, Cu, etc.) which are precipitated in their hydroxide forms. It has been noted during the laboratory demonstration work that the iron and aluminum precipitation begins first, in the range of 2-3 pH, and that the uranium precipitation extends over the range of ~4-6.5 pH. The Plant 8 process specification of $\geq$ 7 pH prior to filtration of any solution/slurry is appropriate for the slurry which will be generated by this precipitation process. The nitric acid content of each storage tank initiates the first reaction brought about as the initial flow of magnesium hydroxide is added to the precipitator, the acid and base neutralizing each other.

The resulting magnesium nitrate, as well as that produced from the precipitation indicated in the reaction equations above, produce a "high nitrate filtrate" which is handled separately from other waste water streams. This filtrate is stored in the high nitrate tank, located in the waste pit area, from which it is metered into the waste water stream entering the biodenitrification (BDN) facility where the nitrates are biologically decomposed. By this route, the waste water complies with the NPDES specification for nitrates prior to discharge to the Great Miami river.

2.3.4 UNH Dilution

Existing Tanks F1-25 and F1-26 are used to dilute the UNH solutions with water to an acid normality of less than 1 and a uranium concentration of less than 100 grams per liter. The dilution water is be put into the tank prior to the addition of UNH. The water to be used for dilution will come from one of the following sources:

1) Clear water left in the tank after a neutralized batch of UNH is transferred to Plant 8
2) Filtrate water from the filtering of slurry in Plant 8
3) Filtrate water from the filtering of Waste Water in Plant 8, or
4) Process water.

Options one through three have been added to the project to minimize the amount of water generated during the UNH project. If options two through four are used, the water may be heated using a new direct steam injection heater.

2.3.5 UNH Neutralization

After the UNH solution has been diluted, magnesium hydroxide is added to neutralize the free acid and precipitate the metals present. Magnesium hydroxide is provided to the project either by direct transfer from a vendor's tanker truck or by mixing magnesium oxide and water in Tank 3A, which is located near Tanks F1-25 and F1-26. The magnesium hydroxide is added via a progressive cavity pump hooked up to a supply tanker truck or Tank 3A. Magnesium hydroxide flow is controlled by means of a batch controller incorporated into the transfer pump skid. The quantity of magnesium hydroxide to be added to each batch of UNH is determined based on analytical laboratory data previously obtained. The pH in the neutralization tank is monitored during magnesium hydroxide addition to ensure the pH reaches 7. Laboratory work has demonstrated that the UNH solution constituents are thoroughly removed, meeting every requirement for the resulting filtrate, by bringing the solution to a pH of 7 or greater by magnesium hydroxide addition prior to filtration. The liquid temperature is monitored during neutralization so that the temperature of the dilute UNH liquid is controlled to less than 130 degrees Fahrenheit (F) to minimize formation and emissions of NO_x. Tanks F1-25 and F1-26 are vented to a scrubber to ensure NO_x emissions are minimized. Reference Section 2.8.1 for the scrubber description and Section 8.14 for monitoring requirements.

Temperature control is achieved by controlling the temperature of the incoming dilution water. The addition of UNH will not occur unless the temperature of the dilution water is within the temperature range specified for that batch. The temperature considers the calculated heat of dilution and neutralization. Temperature control during neutralization is achieved by shutting down the $Mg(OH)_2$ feed. With no reagent entering the system, the temperature rise will slow. The $Mg(OH)_2$ is injected into the tank at a low nominal rate so as to have an effective response time to the high temperature abnormal condition. The UNH Transfer and Neutralization Procedure, 2-C-308, addresses the actions to take in the event of a high temperature alarm.

2.3.6 High Nitrate Slurry Filtration

After neutralization, the resulting slurry is no longer UNH. The material is a high nitrate slurry that contains magnesium diuranate and the RCRA characteristic hazards no longer exist. The slurry is transferred to Plant 8 for filtering. The high nitrate slurry is received in Tanks F43-203 and F43-203A. Using a new progressive cavity pump, the high nitrate slurry is transferred to the East and/or West EIMCO Filters. Filtrate that meets the Plant 8 discharge criteria will either be recycled to Plant 2/3 for use as dilution/rinse water or pumped to the BDN High Nitrate Tank for processing through the BDN Facility prior to discharge. Filtrate not meeting the Plant 8 discharge criteria is returned to Plant 2/3 for reprocessing.

2.4 Facility Overview and History

The Facilities associated with the UNH Project are Plant 2/3 and Plant 8. The stored UNH solution is located in Plant 2/3, which is composed of several buildings as described in the following subsections. Filtering of the neutralized UNH will take place in Plant 8.

2.4.1 Plant 2/3 (Refinery) History

Plant 2/3 converted natural uranium ore concentrates and enriched recycled materials to uranium trioxide (UO_3). The primary functions of the Refinery included the following:

- digesting recycled materials in nitric acid
- recovering uranium from internal process wastes, including uranium contaminated slag
- performing liquid-liquid countercurrent solvent extraction
- recovering nitric acid from nitrogen oxide (NO_x) discharges from the digestion and denitration operations
- calcining the concentrated uranium liquor to UO_3.

The three steps in the process of converting recycled materials to UO_3 were digestion, extraction, and denitration. In the digestion step, the recycled materials were conveyed into agitating tanks for digestion in nitric acid. The resulting slurry consisted of acid insolubles and a digest liquor of impure uranyl nitrate and excess nitric acid. Depending on the amount of undissolved solids, the slurry was either filtered and concentrated, or sent directly to a storage tank for future makeup of extraction batches. Extraction batches were made up of UNH from several storage tanks to meet the selected U-235 enrichment.

In the primary extraction step, the aqueous feed slurry and an organic solvent (a mixture of tributyl phosphate and kerosene) entered a column from opposite ends. They were pumped countercurrent to one another in a pulsating manner through a column containing a large number of perforated plates. In the presence of nitric acid, the uranyl nitrate in the feed slurry was preferentially attracted to the organic solvent. Most of the nitric acid and impurities are left behind in what is called the aqueous raffinate. A raffinate mixer-settler was used in series with the primary extraction columns to further reduce the uranium content of the aqueous waste stream leaving these columns.

Purified uranyl nitrate was recovered from the organic solvent stream by re-extraction with heated deionized water in a parallel column. In the absence of nitric acid, the uranyl nitrate contained in the solvent is preferentially attracted to the water phase. After the solvent was treated with sodium carbonate solution to remove degradation products, the stripped solvent stream was reacidified and recycled to the primary extraction columns. The aqueous uranyl nitrate was sampled to ensure that it conformed to strict chemical specifications and then concentrated by boiling and evaporation. Concentrated product was calcined in denitration pots to yield UO_3, the end product of the Refinery.

The Nitric Acid Recovery Plant operated in conjunction with the Refinery to recover nitric acid from the fumes generated in digestion and denitration. The acid was returned to the digestion area for reuse.

Production at the FEMP was stopped in 1989 and since mid-1991, the site mission has been focused on waste management and environmental restoration. Approximately 200,000 gallons of acidic uranyl nitrate hexahydrate (UNH) solution is stored in eighteen stainless steel storage tanks. The uranium content of these tanks ranges from 13.2 to 341.0 grams U/liter. The total quantity of uranium amounts to a nominal 100 metric tons of uranium (MTU). The uranium in six tanks has an enrichment of ≥ 1% U-235. The solutions have free nitric acid ranging from 0.19 to 4.65 Normal (N). One additional Tank, D1-7, contains a uranium/water/organic mixture that will not be processed within the scope of the UNH Neutralization Project. All other organic mixtures have been removed form the UNH Project facilities. Tank D1-7 has FEMP Process Requirements in place that must be observed when performing work in the area (Ref. 3).

This material is classified as a Resource Conservation and Recovery Act (RCRA) characteristic hazardous waste under 40 CFR 261.22 due to its corrosivity and as a toxic hazardous waste under 40 CFR 261.24 due to its content of two heavy metals (chromium and barium).

2.4.2 Plant 8 History

Plant 8 (the Recovery Plant) was constructed at the FEMP site in 1952 to reclaim uranium from process wastes and by-products for recycle. A variety of milling, drying, oxidation, precipitation, dissolution, and filtration processes were used to recover uranium (or thorium) from such waste streams. Besides its recycle functions, the plant equipment was used to achieve waste management objectives and on occasion, to treat enriched uranium residues. Most uranium recovery operations in Plant 8 were discontinued in 1989. Thorium recovery operations ended several years earlier. The primary operations of the former Scrap Recovery Plant were:

- screening recycled materials
- drying and heating uranium-contaminated residues to oxidize impurities
- drying and heating waste materials for off-site disposal
- drum washing
- filtering contaminated water for recovery and waste operations

The present operations in Plant 8 involve the processing and treatment of waste water from site operations and storm water to remove uranium, regulated metals, and volatile organics. Bulk materials which are used in the water treatment process which may be stored in the vicinity of the project area are hydrated lime (calcium hydroxide), sodium hydroxide, and calcined diatomaceous earth (dicalite).

2.5 Processing Facilities and Equipment

Processing of the UNH solutions is accomplished using a combination of new and existing equipment. In general, existing storage and processing tanks are used, while some of the interconnecting piping, transfer pumps, and hardware are new construction. New instrumentation and engineered controls have been installed to improve process safety and control. The new construction design, fabrication, testing, and inspection requirements are included in the *Design Specifications for the UNH Project* (Ref. 8).

2.5.1 Plant 2/3 Processing Systems

2.5.1.1 UNH Piping Transfer System

A new dedicated transfer system constructed of 3" diameter, schedule 40, 304L Stainless Steel piping, is utilized to transfer UNH solutions from the individual storage tanks to the dilution/neutralization tanks F1-25 and F1-26. Valves and pumps in the UNH transfer system are 316 Stainless Steel. The piping to transfer the neutralized UNH slurry to Plant 8 is 3" diameter carbon steel piping. The valves are full-port ball valves. All piping, valves, and pumps are arranged so that all flanged connections are located within diked areas for spill control, either permanent or temporary. The new piping system is designed for slurry transfer and will ensure configuration control and positive control of tank transfers as it will connect to only one storage tank at a time. Carbon steel piping is utilized to transfer high nitrate slurry to, and within Plant 8.

The UNH Piping Plan, located in Appendix A, is drawing number 92X-5900-P-0058. Three separate piping and instrumentation diagrams are provided in Appendix A for the transfer system (92X-5900-N-0074), dilution and neutralization system (92X-5900-N-0075), and filtration system (92X-5900-N-0076). All piping is installed above ground with flanged connections inside secondary containment and inspected for leaks on a daily basis when being used for UNH transfer operations. Drain valves are installed on either side of each block valve. These drain valves also may be used for flushing should the header become plugged. The UNH Neutralization operating procedures address the steps to take in the event of a plug. Appropriate measures to clear a plug will be determined on a case by case basis and any additional permits and safety reviews will be obtained. The new piping is compatible with the material to be transferred.

2.5.1.2 UNH Flexible Hose Connection

The connection between the progressive cavity pump and the new UNH Piping and the UNH Storage Tanks is made utilizing braided stainless steel flex hoses for final fit-ups. The pump discharge is connected to the main transfer header at each of the valved points in turn through temporarily installed hard piping using braided stainless steel flex hoses for final fit-ups. A recirculation line from the pump back to the source tank is used to allow for greater tank agitation than that provided by the existing tank agitators.

2.5.1.3 Progressive Cavity Pumps

Progressive cavity pumps are used to transfer UNH solutions, high nitrate slurries, and magnesium hydroxide slurries. All pumps are equipped with a flow totalizer, reversing capability, and high and low pressure shut-offs.

2.5.1.3.1 UNH Solution Transfer Pumps

A progressive cavity pump is used to pump the UNH solutions from the individual storage tanks to the dilution/neutralization Tanks F1-25 and F1-26. These pumps are skid mounted for portability and are connected in turn to each tank for processing. Two pump skids have been purchased to allow for optimum hook-up. One pump is hooked up to a tank and operating while the second pump is in the process of being hooked up to the next tank. This will allow for a "leap-frog" type of arrangement that should reduce the overall processing time.

The pump skids will be located within or overflow to the existing secondary containment area of each tank or group of tanks. To allow for this, the pump skids have a 12-inch tall stainless steel pan built around the skid. This pan has a 2-inch line that will drain any leakage into the secondary containment area of each group of tanks.

2.5.1.3.2 High Nitrate Slurry Transfer Pumps

Two progressive cavity pumps have been installed to transfer the high nitrate slurry from Tanks F1-25 or F1-26 to the Plant 8 Filter Feed Tanks, F43-203 and F43-203A, via new carbon steel piping. A recirculation line has been installed from the pump discharge back to Tanks F1-25 or F1-26 for extracting a sample and to promote better tank agitation. A third progressive cavity has been installed to transfer the neutralized slurry from Tanks F43-203 and F43-203A to the East and West EIMCO Filter.

2.5.1.3.3 Magnesium Hydroxide Transfer Pump

One progressive cavity pump has been installed to transfer magnesium hydroxide to the dilution/neutralization Tanks F1-25 or F1-26. Magnesium hydroxide is supplied either from a vendor tanker truck or Tank 3A. A flexible chemical hose is used to connect the tanker truck or Tank 3A to the pump.

2.5.1.4 Dilution/Neutralization Tanks (F1-25 and F1-26)

New instrumentation for Tanks F1-25 and F1-26 includes a level indicator/alarm/recorder and a temperature indicator/alarm/recorder. Both tanks have high level and high-high level alarms and switches which shut off the UNH and water inlet valves to prevent overfilling of the dilution/neutralization tanks. The tank temperature indicator will indicate the temperature of the liquid at three levels (top, middle, and bottom) in the tank. All new instrumentation will use existing tank nozzles. A flow meter has been installed to meter the quantity of dilution water transferred into the tank. Temperature instrumentation has been installed on the dilution water line to indicate water temperature prior to entering the tanks. Flow out of the tanks is controlled by adjusting the pump speed, and both instantaneous and total flow readouts are provided. All meter indicators are mounted on new control panels located near the dilution/neutralization tanks.

Each dilution/neutralization tank is equipped with a pH probe that monitors the addition of magnesium hydroxide and to assure that the UNH is neutralized prior to transfer to Plant 8. The pH probe is also equipped with a low pH alarm.

The flow of neutralized UNH solution from the dilution/neutralization tanks is positively controlled by an interlock system. This system requires that the UNH inlet valves on the dilution/neutralization tank be closed prior to activating the discharge pump. This will prevent the entry of additional liquids into the tanks while pumping a completed batch to Plant 8.

2.5.1.5 UNH Storage Tanks

All UNH storage tanks are constructed of 304L stainless steel, except Tank F1-308 which is made of 347 stainless steel. The *Safe Configuration Assessment of the UNH Tank System* (Ref. 4) reported the results of ultrasonic testing on the UNH storage tanks. The thickness of the tanks was measured in several areas around weld sites to check for excessive corrosion. None of the tanks exhibited excessive corrosion or other inherent failure mechanisms which would cause them to fail in the near future.

Instrumentation for each storage tank is monitored at the control panel of the UNH solution transfer pump skid. A level transmitter is used to measure the level in the storage tank. Also, a thermowell is installed to measure the temperature at three (3) levels (top, middle, and bottom) within the tank. Installation of these instruments utilizes existing nozzles on the tanks. The instrumentation is moved from tank to tank with the pump. Readouts from the instrumentation are installed on the pump skid panel.

2.5.2 Plant 8 Processing Systems

Plant 8 systems perform the filtering and drumming operations of the filtered slurry from Building 2A. The Plant 8 Waste Water Facility is an established operation and the equipment is in place. Plant 8 operators have established procedures and experience for filtering the type of material that will be transferred from Building 2A dilution, precipitation, and neutralization activities.

2.5.2.1 Plant 8 East and West EIMCO Filters

The Plant 8 EIMCO Filters are rotary drum vacuum filters. Both filters are identical and have the same processing capacity. Preventative maintenance has been performed on the two filters to ensure operability.

2.5.2.2 Filter Feed Tank F43-203

Filter Feed Tank F43-203 receives slurry from Building 2A Tanks F1-25 and F1-26. The tank discharges only to the East and West EIMCO Filters and is equipped with an overflow line from the filter to a nozzle oriented on the top of the tank. Tank F43-203 has a nominal capacity of 10,000 gallons.

2.5.2.3 Filter Feed Tank F43-203A

Filter Feed Tank F43-203A receives slurry from Building 2A Tanks F1-25 and F1-26. The tank discharges only to the East and West EIMCO Filters and is equipped with an overflow line from the filter to a nozzle oriented on the top of the tank. Tank F43-203A has a nominal capacity of 5,000 gallons.

2.5.2.4 Filtrate Hold Tank 25A

Tank 25A receives filtrate and vacuum pump seal water from the East and West EIMCO filters and discharges through an existing pump to either the General Sump or returns the Filtrate to Building 2A for reprocessing or use as dilution water. Tank 25A has a nominal capacity of 25,000 gallons.

2.5.2.5 Precoat Tank

The Precoat Tank supplies the Dicalite slurry required to precoat the East and West EIMCO Filter drums. Dicalite is dumped into a dumping station equipped with exhaust ventilation minimizing dust generation in the breathing zone of the worker. Process water is introduced through an existing nozzle. The tank has a nominal capacity of 6,000 gallons.

2.5.2.6 Drumming Station

The drumming station consists of three components: the discharge chute from the filters, the drum enclosure, and exhaust system. No significant modifications were made to the system and preventative maintenance has been performed on the system to ensure proper operation.

2.6 UNH Neutralization Processing Parameters

A pre-operational bench scale testing program (Ref. 5) was conducted to provide information for the development of the procedures and parameters needed to safely and efficiently dilute, neutralize, and filter the UNH. This program involved sampling of the contents of each UNH tank after agitation and chemical analysis of each sample to determine its uranium, free acid and heavy metal concentrations. The test program also included laboratory dilution, neutralization, and filtering of the UNH samples to determine the optimum amount of neutralizing agent required, evaluate the filterability of the resulting slurry, and identify the kinds and concentrations of contaminants remaining in the filtrate.

2.6.1 Storage Tank Connection

UNH Solution is removed from each storage tank from the top. A dip leg has been inserted into an existing nozzle or manway. A work plan has been prepared for the connection to each UNH Solution storage tank by UNH Neutralization Project Management. The plan was reviewed by Safety Analysis to determine compliance with the Safety Analysis Report. The portable skid mounted pump will be moved to a location next to the tank to be emptied, anchored, and connected to the new header utilizing prefabricated spool pieces. The new assembly will be hydrostatically tested prior to connection to the UNH storage tank. Once the assembly is certified, the pump suction will be connected to the storage tank dip leg utilizing prefabricated spool pieces. When connected the system is considered ready to transfer UNH Solution.

2.6.2 Neutralization/Precipitation Tank Preparation (F1-25 or F1-26)

Prior to transferring UNH Solution to Tank F1-26, dilution water from the process water supply or recycled filtrate is added to a level calculated to result in a uranium concentration < 100 grams per liter, an acid concentration less than or equal to 1 Normal, and a temperature in the range of 60 to 80 degrees Fahrenheit. Bench scale testing of the samples from the UNH Storage tanks have been performed to determine the optimum temperature and quantity of water needed to meet the above specifications. Dilution water is heated by a steam injection heater. The steam control valve is a "failed closed" design. Prior to the addition of UNH solution to the warm water, the water inlet valve must be closed by procedure. The exact setting of the heater is dependent on the temperature of the UNH Solution to be transferred, may vary with seasonal ambient air temperatures, and is dependent on whether the solution is stored inside or outside. When the appropriate amount of dilution water is in the tank and at the correct temperature, the tank is considered ready to receive UNH Solution from the Storage Tank.

2.6.3 Transferring UNH Solution to Tank F1-25 or F1-26

To transfer UNH Solution from the Storage Tank, the UNH Transfer Pump is set to transfer a specified quantity of UNH Solution. The process water line is opened to the pump suction, and the line is filled with water to prime the pump, if required. Once the suction line is full, the two isolation valves in the hose connections are closed as directed in the operating procedure. The pump is started, and the metering valve automatically shuts the pump off after the specified quantity is transferred. UNH Solution is transferred to Tank F1-25 or F1-26 at approximately 100 gallons per minute.

2.6.4 Rinsing UNH Solution Storage Tanks

Once the UNH Solution is removed from a storage tank, the tank is rinsed with filtrate or process water, depending on the specific tank. The objective is to remove all UNH Solution, sludge, and solids. The sludges or solids contained in the tank are composed of insoluble compounds of silica and metals including iron, aluminum, and magnesium flouride residues. These solids are present in a silt-like layer in some of the tanks, most of which will be suspended in the solution by agitation and eventually removed by the filtering operations in Plant 8. There are no adverse reactions associated with the solids/sludges.

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A residual heel of rinse water may be left in a tank depending on the tank geometry. If a heel cannot be removed by pumping through the top, a connection may be made to the tank's bottom discharge to complete the emptying of the tank. For tanks that share a common header, this connection is made after all tanks containing UNH solutions are emptied and contain only a heel of rinse water.

2.6.5 Neutralization/Precipitation

After the solution is diluted and the agitator is running, the magnesium hydroxide is added from its metering pump. The pump controller for the magnesium hydroxide transfer pump provides control of the total quantity transferred and the flow rate. The flow rate is adjusted to allow the neutralization/precipitation reaction to occur at the optimum rate and varies for the solutions in each storage tank. The quantity transferred is set to optimize the quantity of magnesium hydroxide required to reach a pH of approximately 7. The quantity to be transferred is a direct result of bench scale modelling and has a accuracy of +or- 5%. The operator monitors the pH indicators, and an automatic recorder monitors the pH as it rises. The recorder results are utilized to further refine the neutralization process by indicating how the pH rises over time and the effects of the magnesium hydroxide feed rate and time.

2.6.6 Transfer of High Nitrate Slurry to Plant 8

After the magnesium hydroxide feed pump transfers the set amount of material to Tank F1-26, the pH is monitored for a set period of time until a plateau is reached. If the desired pH is reached, a sample is pulled from the tank and analyzed for pH. If the sample results verify the pH is correct, the valve line-up is made to transfer the material to Plant 8. If the material has not reached the desired pH, small amounts of magnesium hydroxide are added until the desired pH is reached, and then the process will continue as described above. The magnesium hydroxide cannot achieve a pH greater than 9 because of its solubility. The acceptance criteria for Plant 8 is a pH of $6 < pH < 9$, therefore there is no concern. The magnesium hydroxide pump will shut down when the pH reaches 7.1.

2.6.7 Receiving High Nitrate Slurry at Plant 8

Slurry can be transferred to either Tank F43-203 or F43-203A. The target transfer quantity is 13,000 gallons, and the total capacity of the Tanks is 15,000 gallons. Each tank is equipped with a level indicator, alarm, and switch that is interlocked to the input valve. Upon high level in either tank, the switch will close the input valve leading to high pressure in the transfer header. A pressure sensing switch at each transfer pump (either F1-25 or F1-26) will shut down the pump.

2.6.8 Filtering High Nitrate Slurry at the East and West EIMCO Filters

Slurry is transferred to the EIMCO filter basin. The drum rotates in the basin similar to a paddle wheel in water. A vacuum pump maintains a pressure differential across the drum which has a cloth cover and diatomaceous earth coating. Water is drawn through the filter, and the solids are deposited on top of the precoat. The EIMCO filters are designed with an overflow line that returns excess slurry to the source tank. The overflow valves are interlocked to ensure that only the valve on the source tank is open during pump operation, ensuring that the excess material is returned to only the source tank. This method allows for the maximum drum contact with the slurry. Slightly above the overflow line is a level switch interlocked to the slurry transfer pump that will shut down the pump in the event the overflow becomes blocked or restricted. The overflow line is a 4 inch gravity flow. As the drum rotates, the filtered solids build up and increase the operational diameter of the drum. A scraper knife is mounted along the axis of the drum. It removes the solids as they build up, leaving a layer of dicalite on the drum to capture solids from the slurry. The removed solids fall through a chute to the drumming station located on the floor below. The resulting filtrate is transferred to the Filtrate Receiver Tank 25A.

2.6.9 Drumming Filtered Solids

A 55 gallon drum with a plastic liner is placed in the drumming station enclosure to contain the solids falling down the chute from the filter. Prior to beginning filtration at the EIMCO filter, the HEPA exhaust system is turned on and verified to be operating within its parameters. The HEPA operational parameters, alarms, and operator actions are defined in the drumming station operating procedure. Once the filtering operation begins, the operator monitors the HEPA performance to ensure operation with material in the chute. When a drum is full, as determined by a visual inspection through a glass window, the drum is removed by a roller conveyor as an empty drum enters. Verification sampling may occur prior to adding sorbent material, as required by NTS waste acceptance criteria. The drum access door is closed, and the station is returned to operational status. The UNH Neutralization Project's scope ends when the drummed material is moved from Building 8 to its staging area. The material at this point in the process is suitable for long term storage or immediate disposal and will not re-enter the UNH Neutralization process.

2.6.10 Receiving Slurry Filtrate

Filtrate is received from the filter vacuum pumps at filtrate receiver Tank 25A. The filtrate is drawn through the filter by the vacuum pumps into a separator tank and pumped to Tank 25A via the filtrate transfer pump.

2.6.11 Transferring Slurry Filtrate

Once the filtrate receiver tank is full, verification samples are taken and analyzed for uranium and pH. Filtrate that does not meet specifications for uranium, as determined by FEMP General Sump acceptance criteria, is returned to Building 2A Tanks F1-25 or F1-26 for use as dilution water. The UNH Neutralization Project recycles as much water as needed for dilution of the next batch of UNH Solution. The remaining water is processed through the FEMP's General Sump, Plant 8 Waste Water Treatment System, and Biodenitrification facility, as required, before free release to the Great Miami River. UNH Neutralization Project scope ends when filtrate water is pumped to FEMP's General Sump. Filtrate at this point in the process is not considered hazardous material and will not re-enter the UNH Neutralization process, though contaminant concentrations may induce further processing to meet the FEMP's annual discharge limits.

2.7 Operations Sampling

Three types of samples are taken during processing: operation/process, in-process, and analytical laboratory samples.

2.7.1 Operations/Process Sampling

pH probes are installed in the dilution/neutralization tanks, F1-25 and F1-26, to provide operators with a continuous recorded reading on the liquid pH during the neutralization of the UNH. The pH indications also are used to control the rate and quantity of magnesium hydroxide addition to the process.

Thermocouples are installed in process Tanks F1-25 and F1-26 to provide a continuous, recorded temperature during dilution and neutralization. Temperature is monitored to control the liquid temperature and control NO_x generation.

2.7.2 In-Process Sampling

In-Process samples are taken and field analyzed using portable equipment to monitor for the presence of Uranium and measure for pH.

The pH sample is analyzed using a portable pH analyzer that has been calibrated using a buffer solution.

The presence of Uranium is determined by using a dimple plate, potassium ferrocyanide, and glacial acetic acid. If Uranium is present in a drop of the sample, the dimple will turn color. This analysis is qualitative and will detect uranium present in concentrations well below the discharge limits of 0.048 g-U/l for Plant 8 filtrate. If there is an indication that uranium is present, laboratory analysis is required to determine the quantitative uranium concentration and whether it exceeds the discharge limit.

These in-process samples are used in the following applications:

Table 2.7-1 In-Process Sampling

Source	Liquid Sampled	Description
Neutralization/ Dilution Tank	Neutralized UNH Slurry	After settling or lab scale vacuum filtering, the clear liquid phase is checked for Uranium and pH. This will provide an indication that the uranium was precipitated and acid neutralized, prior to transfer to Plant 8.
Rinsed UNH Tank	UNH Tank Heel	The UNH Tank is rinsed until the pH is greater than 2.0. This will need to be achieved prior to bottom discharge.
Filter Effluent	Filtrate	Periodic checking of filtrate as produced from filter to check filter performance.

2.7.3 Analytical Laboratory Sampling

Samples are periodically extracted from in-process fluid, filter cake, and filtrate and transported to the Analytical Laboratory for chemical analysis. Sampling will routinely be performed on the diluted UNH for uranium inventory accountability, on the filtrate prior to its discharge to the General Sump and on the filter cake to confirm its suitability for shipment to the Nevada Test Site.

2.8 Confinement Systems

2.8.1 NO_x Scrubber/ Process Tank Ventilation

A NO_x fume scrubber is installed on the UNH process tanks F1-25 and F1-26 to enhance the current exhaust ventilation. Bench scale lab tests have indicated that the generation of excessive NO_x is not anticipated. Operation of the fume scrubber is limited to the process steps with the potential of generating NO_x. The scrubber is operated when receiving UNH or rinse water from a UNH storage tank, the liquid temperature is > 120 degrees F, and magnesium hydroxide is being added. Inlet fume conditions will be a flow rate of 100 acfm and a temperature of 100 degrees F. See subsection 8.14 for NO_x monitoring requirements.

Fumes may be generated due to a temperature increase during the dilution and neutralization of UNH solutions containing up to 10 percent nitric acid. The NO_x concentration (assume 200 ppm, maximum) and nitric acid concentration (assume 200 ppm, maximum) are removed by the system. The scrubber will remove 90 percent of the inlet vapor contaminants. Scrubber exhaust fan is capable of pulling 100 acfm through the scrubber packing with 2-inch water gauge (w.g.) external static pressure.

2.8.2 Plant 8 Drumming Station Ventilation

The East and West Rotary Drum Filter Drumming Station are provided with portable HEPA filter units as exhaust ventilation. Because the materials are damp, dispersible material is minimal. The dust collection system has been designed with two prefilters. The first prefilter has the capability of self cleaning. Self cleaning is initiated by a high differential pressure across the prefilter or by a preset time. The second prefilter has alarm capability for both high and low differential pressure. Both of these systems are engineered capture moist particles and protect the HEPA and alarm in case of failure.

2.8.3 Plant 2/3 Secondary Containment/Spill Control

All UNH Solution Storage and Processing tanks are located within diked areas that provided spill control. All flanged connections are within the diked areas. Flanged connections to the pump skids that are located outdoors have spill control basins installed that drain into the diked areas. There are three dikes around the eight outdoor UNH tanks to provide spill control. The three dikes will contain the contents of the largest tank and the precipitation resulting from a 25-year, 24-hour rainfall, which is 4.9 inches for the Cincinnati area.

For tanks located indoors, the building floors provide spill control. There is a six inch curb at the base of the exterior walls that will provide containment and direct spills towards floor sumps (Ref. 4). In the Digestion area of Building 2A, the neutralization/precipitation area, the containment overflows to the adjacent C.D. Blend dike in the event of the sump system fails. All dikes in the Plant 2/3 area are configured to pump to Tank 25A located outside, north of Building 2A, with the exception of the O.K. Liquor dike and the Hot Raffinate Building which pump to Tank F2E-601 located in the O.K. Liquor diked area. The UNH Storage tanks have been declared Hazardous Waste Management Units (HWMUs) and the secondary containment and sumps are visually inspected daily and leak tested monthly in accordance with established Plant 2/3 dike and sump inspection procedure, 2-C-910.

The sumps are configured to pump directly to the receiving tank and are physically isolated from the UNH system. The only route of entry of UNH into the sump system is through a spill. There are no alignments for the sump system to pump into a UNH storage or Process Tank. Prior to processing UNH the sump holding Tank 25A must be verified empty so that it can contain a spill if it occurs during processing. Prior to processing a Hot Raffinate and O.K. Liquor Tank, the sump holding Tank F2E-601 must be verified empty.

2.8.4 Plant 8 Secondary Containment/Spill Control

Plant 8 tanks are indoors and the building provides spill control. There is a six inch curb around the base of the exterior walls that will provide containment and direct spills towards one main floor sump. The floor sump can be configured to transfer to any of the Plant 8 Process Tanks. The Plant 8 dike and sump inspection procedure is 2-C-913.

2.9 Safety Support Systems

2.9.1 Fire Protection System

None of the process chemicals or resulting residues of the UNH Neutralization Project are flammable or combustible. Potential sources of fires include motor control centers (electrical) and hot work. Excess materials and combustibles will be moved from the work area prior to operations. Tank D1-7 contains organic material that is controlled by the Tank D1-7 Process Requirements (Ref. 3).

2.9.1.1 Fire Detection

A Honeywell 1000 multiplex alarm system serves the fire detection system, including smoke, heat, and fire protection system water flow alarms. Alarms are continuously monitored from the communication center located in Building 53, the Health and Safety Building. Manual alarm pull stations are located throughout the plant and are alarmed in the communication center. The communication center may activate the EMS or Building Evacuation System to warn site personnel of a fire.

2.9.1.2 Fire Extinguishers

Fire extinguishers are located throughout the site to extinguish small fires and to minimize the possibility of large fires. All facility fire extinguishers meet NFPA-10 requirements (Ref. NFPA 10 fire extinguisher requirements). All extinguishers are periodically inspected and serviced.

2.9.1.3 Sprinkler Systems

Plant 8 is the only UNH Neutralization facility equipped with a sprinkler system. The sprinkler system is maintained and inspected as required by FERMCO procedures. The Plant 2/3 sprinkler system has been removed from service.

2.9.2 Radiological and Chemical Air Monitoring

Radiological and chemical air monitoring is provided by portable equipment as determined by

Radiological Control and Industrial Hygiene at the time of operation to ensure that current work area conditions are addressed. Air monitoring will consist of portable area monitors for airborne radiation located in the immediate work area, area NO_2 monitoring in the work area, and personnel alarming NO_2 monitors during transfer, dilution, and neutralization of UNH solution. Reference the Sections 7 and 8 of this SAR and the Task Specific Health and Safety Plan (Ref. 6) for specific requirements.

2.9.3 Radiation Detection Alarms

Radiation Detection Alarms (RDAs) are located in Plant 2/3 and Plant 8. The RDAs consist of a sensor that detects a radiation release from a criticality, audible horns, and visible lights. The alarms are in place and will remain operational during the UNH Neutralization Project though there is no potential for criticality.

2.10 Utility Distribution Systems

2.10.1 Electrical

The portable pump skids, instrumentation, and controls will receive power from existing plant electrical supplies. Reference the Design Criteria for the UNH Neutralization Project for a detailed description of the equipment electrical requirements, design codes, and power source utilized.

2.10.2 Process Water

Water is supplied by existing site systems.

2.10.3 Instrument and Breathing Air

Instrument air is supplied by existing site systems. Breathing air is supplied by a dedicated breathing air compressor or high pressure breathing air cylinders.

2.11 Auxiliary Systems and Support Facilities

No auxiliary systems are in place specifically for UNH Neutralization activities. Failure of power supply, water, and air will result in placing the activity in a safe stand-by mode until problems are resolved. All automatic valves fail closed with loss of power. UNH Transfer and Neutralization Procedure, 2-C-308, addresses the actions to take if electrical power, process water, or the air supply is lost.

2.12 Comparison to Design Criteria

2.12.1 New Installations

All new construction complies with DOE Order 6430.1A, General Design Criteria. Reference the UNH Neutralization 100% Design Criteria Document (Ref. 7) with the exception of portions of the transfer piping. DOE Order 6430.1A requires either double walled pipes or pipes within secondary confinement where pipes leave a facility. Portions of the transfer piping is not within secondary confinement. The piping design is considered adequate for the following reasons:

- The secondary containment approach meets the requirements of Ohio RCRA requirements for Hazardous Waste (OAC 3745-66-93).
- During operations FERMCO personnel will visually observe the pipe to verify that there is no leakage.
- All runoff from surface area under the UNH transfer piping drain to the storm sewer equipped to alarm at low pH. The flow is captured by the 10.5 million gallon Storm Water Retention Basin and treated in the site's Interim Advanced Wastewater Treatment Facility.
- The piping is used to transfer hazardous material for a short duration, then rinsed out.
- The design provides significant cost savings.

2.12.2 Existing Equipment

The existing facilities are exempted from the requirements of DOE Order 6430.1A. FERMCO document, Safe Configuration Assessment of the UNH Tank System, found that there was no indication of immediate structural hazards and that secondary containment was adequate. No comparison to current criteria was made.

2.13 References

1) WEMCO. *Proof of Process Plant Test Report for the Disposition of Uranyl Nitrate Solutions*, February, 1993.

2) FERMCO, December, 1994. *Corrective Action Implementation Plan Final Status Report for the Type B Investigation on the Uranyl Nitrate Solution Incident*.

3) FEMP. *Process Requirements for the Maintenance of Tank D1-7 in a Safe Configuration until Processing*, effective August 26, 1994.

4) FERMCO, December 1993. *Safe Configuration Assessment of the UNH Tank System.*

5) FERMCO, June, 1994. *UNH Bench Test Report.*

6) FERMCO, August, 1994. *Project Specific Health & Safety Plan for the Neutralization and Stabilization of UNH Solutions at Plants 2/3 and 8 (Operations).*

7) PARSONS. *UNH Neutralization 100% Design Criteria Document.*

8) PARSONS. *Design Specifications for the UNH Neutralization Project.*

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SECTION 3
HAZARD AND ACCIDENT ANALYSIS

3.1 Introduction

The UNH Neutralization Project has been determined to be a Hazard Category 3 activity, based on the verified inventory of radiological materials, in accordance with DOE-STD-1027-92. The Hazard and Accident Analysis Section addresses the requirements of 5480.23, Topic 8, paragraphs 8.b.(3)(e) and 8.b.(3)(k), in accordance with DOE-STD-1027-92, draft DOE-STD-3009, and draft DOE-STD-3005 as appropriate for a Hazard Category 3 activity. There is a potential for only significant localized consequences, and the hazards associated with processing the UNH are primarily limited to project workers. To ensure that a wide range of nuclear, chemical, operational, and industrial hazards were identified, several hazard analysis methods were employed utilizing the team approach. Team members included operations, management, and safety. Industrial hazards or hazards addressed by other programs and regulations are identified in the hazard analysis to facilitate the development of procedures, training, and emergency preparedness plans. Because the neutralization is a chemical process, Process Safety Management Principles were followed in the hazard and accident analysis. Though no quantitative accident analysis is required, limited quantitative consequence analysis was performed to verify the hazard category and assess chemical consequences.

3.2 Applicable Rules, Regulations and DOE Orders

DOE Order 5480.23, "Nuclear Safety Analysis Reports," is the primary Hazard and Accident Analysis driver. DOE-STD-1027-92, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports," draft standard DOE-STD-3009-YR, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports," and draft DOE-STD-3005-93, "Definitions and Criteria for Accident Analysis", are utilized for the format, content, and evaluation criteria. Other guidance utilized in the hazard and accident analysis is noted in the specific section where it is applied.

3.3 Hazard Analysis

Hazards and release mechanisms associated with the UNH Neutralization Project were initially identified in a Preliminary Hazard Analysis (PHA). Subsequent analyses, including a What-If/Checklist Analysis and a Hazard and Operability Analysis (HAZOP), were performed to supplement the PHA. The PHA identified the radiological inventory forming the basis for the Hazard Classification in accordance with DOE-STD-1027-92. The UNH Project is a Hazard Category 3 based on the verified inventory of radiological materials, and the remaining hazard and accident analyses requirements are implemented in accordance with DOE-STD-1027-92. Additional hazard analyses were performed to identify the OSHA-regulated industrial safety issues. The "OSHA Assessment for the UNH Project: Plant 8, 2/3, and Hot Raffinate"(Ref. 1), summarizes the OSHA Occupational, Industrial Hygiene, and Fire Safety hazards/compliance issues. The hazard analyses were consolidated in the SAR final Hazard Analysis, Appendix C. The PHA and OSHA Assessment were reviewed by other project team members to develop procedures, training, and emergency preparedness plans.

3.3.1 Hazard Analysis Methodology

The hazard analysis identified the hazardous material quantity, form, and location, along with energy sources and potential initiating events. Preventive and mitigative features were also identified. Hazards were evaluated to determine safety significance to the on-site and UNH Project worker populations. There are no hazards with the potential to affect the off-site population. Several methods were utilized to identify and evaluate hazards as described below.

3.3.1.1 Hazard Identification Methodology

The inventory of hazardous material to be treated was identified and the quantity and composition verified by outage measurements and laboratory analysis, respectively. The inventory of process-related chemicals necessary for the neutralization, precipitation, and filtration were calculated based on the bench scale testing of the process in the laboratory and process capacities. Hazards associated with the facilities being utilized were identified by reviewing previous air monitoring records, facility history, and walk down inspections. The radionuclide inventory used for hazard classification is included in Appendix E, Hazard Classification, and other identified hazards are found in Appendix B, Hazard Descriptions.

3.3.1.2 Hazard Evaluation Methodology

Hazards were evaluated utilizing the PHA, What-If/Checklist, and Hazard and Operability Analysis (HAZOP) methods. The PHA evaluated the hazards associated with the facility, utilities, and inventory. The What-if Checklist evaluated the hazards associated with the 50 % design and was a precursor to the more detailed HAZOP. The HAZOP evaluated the hazards associated with the operation of the system and potential deviations from the intended operation. The hazards identified in each of these methods were assembled in one Hazard Analysis table (Appendix C). The table includes the hazard/event, cause, mitigators, preventive features, qualitative consequence and frequency classifications, and actions/comments. Hazards that are standard to industry, addressed by consensus standards, and are currently controlled by implemented site procedures and training are considered controlled and not further evaluated. The hazard evaluation criteria utilized is presented Table 3.3-1, Consequence Classification Criteria; Table 3.3-2, Frequency Classification; and Table 3.3-3, Criteria for Safety Significance.

Table 3.3-1 includes the criteria for determining the severity of the accident sequence formed by the hazard/event and cause columns of the Hazard Analysis in Appendix C. Criteria were not developed for the general public because a Hazard Category 3 activity has the potential for only significant localized affects. The numbers indicated in the Hazard Table Designation column of the Table 3.3-1 correspond to the consequence column of the Hazard Analysis tables in Appendix C, with the exception of industrial hazards already addressed by consensus standards and site programs, training, and Health and Safety Plans.

Table 3.3-1 Consequence Classification Criteria

Severity	Hazard Table Designation	Worker Safety	Worker Radiation Exposure	Worker Chemical Exposure
High	4	> 1 fatality	≥ 25 Rem	ERPG-3
Moderate	3	1 fatality or ≥ 5 serious injuries	≥ 5 but < 25 Rem	ERPG-2
Low	2	≥ 1 but < 5 serious injuries	≥ 0.1 but < 5 Rem	ERPG-1
Below Concern	1	Minor Injuries	< 0.1 Rem	PEL-TWA

Table 3.3-2 includes the qualitative frequency estimates applied to the scenarios formed by the hazard and consequence columns of the Hazard Analysis table. The short project duration was considered when applying the frequency estimates. The number in the Hazard Table Designation column of Table 3.3-2 corresponds to the Frequency Class column of the Hazard Analysis.

Table 3.3-2 Frequency Classification

Descriptive word	Hazard Table Designation	Description	Description
Anticipated	4	$10^{-1} \geq p > 10^{-2}$	Incidents that may occur several times during the lifetime of the facility.
Unlikely	3	$10^{-2} \geq p > 10^{-4}$	Accidents that are not anticipated to occur during the lifetime of the facility.
Extremely Unlikely	2	$10^{-4} \geq p > 10^{-6}$	Accidents that will probably not occur during the life cycle of the facility.
Incredible	1	$10^{-6} \geq p$	Accidents that are not credible.

Table 3.3-3 is the matrix of the Frequency Classification and the Consequence Classification values included in Tables 3.1-1 and 3.3-2, and is used to determine safety-significance. For each scenario in the Hazard Analysis table in Appendix C, the first number in the Accident Bin column of the table corresponds to the cause, and the second to the Table 3.3-3 designation. If an event in the hazard analysis has a accident bin number greater than 5 (designated with SS), the listed preventive/mitigative feature is designated safety-significant. None were identified for the UNH Project. There were no safety-class items because the UNH Project is a category 3 activity and has no potential for off-site consequences.

Table 3.3-3 Criteria for Safety Significance

	Hazard Consequence		
Frequency	**Low**	**Moderate**	**High**
Anticipated	3	6 SS	9 SS
Unlikely	2	5 SS	8 SS
Extremely Unlikely	1	4	7 SS
Incredible	n/a	n/a	n/a

3.3.1.2.1 Preliminary Hazard Analysis (PHA)

The PHA was a collaborative effort of safety, design, operations, and management representatives performing the following steps:

1) Identification of radiological, chemical, industrial, and unique hazards.
2) Review of new and previous analyses and lessons learned.
3) Qualitative evaluation of the identified hazards listing the hazard/event, cause, consequence, and corrective action/mitigators.

The technical approach outlined in "Guidelines for Hazard Evaluation Procedures," 2nd Edition, AIChE (Ref. 2) was followed with one modification. Qualitative Hazard Categories were not included in the PHA tables. They were determined after the completion and incorporation of other analysis results. The PHA also included a description of the process and the Hazard Categorization. The PHA was distributed to all UNH Project team members, independent reviewers, and the DOE to provide an introduction to the UNH Project scope and associated hazards.

3.3.1.2.2 Hazard and Operability Analysis (HAZOP)

The HAZOP of the 90% Design was performed to identify process-related hazards. Though the system is not complex, a HAZOP was considered an appropriate technique to better identify specific process related hazards, evaluate operability, and aid in procedure development. Prior to performing the HAZOP, a "What-if" Analysis was performed to identify any "fatal flaws" that could be fixed prior to the HAZOP and introduce the HAZOP team members to the UNH Neutralization process. Safety Management, Inc., an independent contractor, led the What-if and HAZOP analyses. The technical approach outlined in "Guidelines for Hazard Evaluation Procedures" was followed. A team representing safety, design, operations, and management was assembled. The team and leader reviewed the 50% design drawings and work plan. The leader developed a list of What-If questions, using a checklist to cover any gaps, and the team evaluated each question. No "fatal flaws" were identified and the team continued with the HAZOP analysis when the 90% design was submitted.

Following Process Safety Management principles and techniques was also a recommendation of the Type B Investigation (Ref. 3) of the spill from the UNH spill in April 1993. The team leader systematically led the team through the processing system sections identifying the consequences of deviations from normal operations. No serious issues were identified, and the results of the HAZOP were incorporated into the Hazard Analysis. The HAZOP analysis is included in Appendix D.

3.3.2 Hazard Analysis Results

3.3.2.1 Hazard Identification

The results of the hazard identification and evaluation are presented together in Table form in Attachment C, Hazard Analysis for the UNH Neutralization Project. Appendix E, Hazard Categorization, includes the UNH Storage Tanks inventory, summarizes the composition of the UNH solution, and includes the Hazard Classification comparison to DOE-STD-1027-92. No hazards were identified affecting the off-site population. There are no significant hazards to the on-site population. Hazards identified affect the UNH Project workers.

3.3.2.2 Hazard Classification

Hazard Classification was performed in accordance with DOE-STD-1027-92. The total inventory of radionuclides within the scope of the UNH Project was identified in the PHA and compared with the Threshold quantities for radionuclides in Table A.1 of Attachment 1 to DOE-STD-1027-92. A criticality Safety Analysis (CSA) was performed that determined that there was no potential for criticality for the UNH Neutralization Project (See Section 6). Reference Appx-E, "Radiological Hazard Classification" table for the comparison to the Category 2 and Category 3 Threshold Quantities, and "Uranium Inventory" for the inventroy in each tank. The comparison resulted in the UNH Project being classified as a Hazard Category 3. The hazard categorization is conservative because no segmentation was utilized, though only a fraction of the inventory will be at risk during processing. The tanks will be emptied one at a time, and tank groupings are separated by distance and physical barriers (reference Appendix A for tank locations).

The UNH Project has sampled all of the UNH tanks to verify the quantity and characterization of the inventory. In several of the tanks, the concentrations of transuranic elements were not quantitatively determined. However, based on process knowledge, the presence of such material is expected to be negligible. For the purpose of a conservative hazard analysis, the concentrations of transuranic elements in these tanks were assumed to be equal to those measured for the "worst case tank."

3.3.2.3 Hazard Evaluation

The hazards and their associated preventive and mitigative features were evaluated against the criteria presented in Section 3.3.1.2 and no Safety-Class or Safety-Significant Systems, Structures, or Components were identified (SCSSCs or SSSSCs). Hazards were evaluated against the worker safety-significant criteria to determine if any of the identified mitigators and preventive features should be designated safety-significant. None of the preventive or mitigative features were determined as significant to worker safety. Hazards that are standard to industry, addressed by consensus standards, and are currently controlled by implemented site procedures and training are considered controlled and not further evaluated. The hazard analysis combined with the Health and Safety Plan and Conduct of Operations principles, and other controls identified in the following paragraphs are considered adequate to ensure the safety of the worker.

3.3.2.3.1 Safety Enhancements

The safety enhancements were implemented as a result of lessons learned from previous processing, the Type B Investigation (Ref. 3) prior to the preparation of this SAR, and as a result of the Hazard Analysis.

DOE Order 5480.19, "Conduct of Operations", has been implemented to ensure a formality of operations and define a clear chain of command, as recommended in the Type B Investigation. All UNH Project equipment will be clearly labeled and easily identified.

The UNH Neutralization processing system in Plant 2/3 and Plant 8 has been physically separated from all other operations.

FERMCO Energy Isolation and Control has been implemented. Process and energy isolation will ensure that workers will be protected from shock, high pressure, and other energy sources while performing work.

"As-Built" drawings of the existing equipment have been prepared. Drawings of the processing facilities and equipment had not been kept up-to-date. Project Management prepared the "as-built" drawings to verify the equipment is in a safe configuration, maintenance activities are performed properly, and components called out on drawings can be identified in the field.

Workers will be trained and qualified to perform the tasks required for the UNH Neutralization Project. Formal task/project-specific training is performed and qualification cards developed for all operators. Only workers with appropriate qualifications will be permitted to work on the UNH Neutralization Project.

The composition and quantity of UNH has been verified by analyzing new samples, reviewing historical data, and implementing verified outage measurement procedures.

Floor sump curbing has been installed in the buildings where deficient to ensure containment capability in the event of a spill.

Batch processing was selected over continuous neutralization because more system control is provided. The batch process optimizes the quantity of reagents, puts less inventory at risk, and provides an opportunity to ensure process goals are met prior to transferring material to the filtering facilities.

Because of the hazards associated with using old equipment, new piping, valves, pumps, and instrumentation have been installed to ensure accurate operation and indication. The previous processing project Test Run Report and Type B Investigation identified several problems associated with the use of the existing facilities, all of which were corrected by the new installations.

No direct heating of UNH will occur. Warm dilution water and the heat of dilution and neutralization will be utilized to reach the desired temperatures. Generation of NO_x and the potential for overheating are greatly reduced.

The use of compressed air to clear lines has been eliminated reducing the potential of over-pressurizing process components.

Dry runs will be performed with water as a substitute for UNH to facilitate on-the-job training, verify system operation, and verify procedures.

3.3.2.3.2 Defense-in-Depth

Process piping utilized to transfer UNH is schedule 40, 304L stainless steel, which is appropriate for the type of material and operating pressures.

Pumps are designed with no-leak seals and a high pressure switch to shut off the pump to ensure the piping is not overpressured in the event of a plug or leak. A line has been installed connecting the discharge and suction of the pumps which contains a pressure relief valve that will actuate in the event the high pressure switch does not shut off the pump. Pressure indication is also provided at the pump controls, where a worker will be stationed at all times during a transfer.

Processing tanks are provided with level sensors that will close inlet valves upon high level. The resulting high pressure will shut down the pumps. Prior to adding UNH to Tank F1-25 or F1-26, dilution water is added to a certain specified level for a batch. If too much water is introduced, it can be pumped out prior to adding the hazardous material. UNH transfer pumps are self-metering, a specified amount of material to be transferred is programmed and pumped. When the diluted UNH is in the processing tank, enough "free-board" remains to accept the total contents of the magnesium hydroxide tank or tanker. It was determined in the HAZOP that the potential for overflow of a processing tank was low.

3.3.2.3.3 Worker-Safety Features

The following features were not determined to be safety significant, but provide an additional level of assurance that the facilities can operate safely.

The Project Specific Health and Safety Plan has been completed which instructs workers on the potential hazards and provides specific guidance on PPE and other actions to be taken to assure worker safety. General industrial safety, access and egress, training, hazardous material handling and control, PPE, emergency/contingency plans, and monitoring requirements are included in the Health and Safety Plan. Workers are briefed on the potential hazards in the work area and the requirements of the Health and Safety Plan.

Worker safety features consist of administrative controls and structure, systems, and components. The primary administrative control is "Conduct of Operations." The Conduct of Operations Order has been implemented in the form of Standing Orders and Conduct of Operations Principles are reflected in the UNH Project procedures, training, staffing, qualifications, and management. Reference Section 11, Operational Safety, for a the application of Conduct of Operations requirements for the UNH Project.

Process controls, indicators, and alarms have been installed to ensure workers are aware of the conditions of the process system. Controls and indicators are located together at central control panels, permitting immediate response to an alarm indication. The Uranyl Nitrate Neutralization Project Control Philosophy (Ref. 7) contains a detailed description and location of the controls, indication, and alarms provided for the UNH Neutralization Project.

3.4 Accident Analysis

Though no accidents requiring quantitative analysis were identified in Section 3.3, quantitative accident analysis was performed for selected accident scenarios. Scenarios selected were based on the accidents that would bound facility consequences and provide a worst case estimate of toxicological and radiological consequences. The quantitative analysis assumed the most conservative meteorology. These included natural phenomena events, explosion, fire, and spills. As determined qualitatively in hazard analysis, none of the other accidents quantitatively exceeded on-site or off-site evaluation guidelines. Reference Appendix E for the consequence calculations and detailed results.

3.5 References

1) FERMCO. *OSHA Assessment for the UNH Project: Plant 8, 2/3, and Hot Raffinate*

2) American Institute of Chemical Engineers, September 1992, *Guidelines for Hazard Evaluation Procedures, Second Edition.*

3) DOE, June, 1993. *Type B Investigation, Uranyl Nitrate Solution Incidents at the Fernald Environmental Management Project, April 27 & 28, 1993*, DOE-FN-93:0001.

4) DOE-STD-3009-YR, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, U.S. DOE, Washington D.C., April, 1994 draft.

5) DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, U.S. DOE, Washington, D.C., December, 1992.

6) DOE-STD-3005-YR, Evaluation Guidelines for Accident Analysis and Safety Structures, Systems, and Components. U.S. DOE, Washington D.C., February, 1993 draft.

7) FERMCO, September, 1994. *The Uranyl Nitrate Neutralization Project Control Philosophy.*

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SECTION 4
SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

4.1 Introduction

This section identifies and describes those facility structures, systems, and components (SSCs) that are necessary for the facility to satisfy the Evaluation Guidelines (onsite and offsite) or SSCs that are significant to worker safety. There were no Safety Class or Safety Significant SSCs identified for the UNH Neutralization Project.

4.2 Requirements

The designation of a System, Structure, or Component (SSC) as Safety-Class or Safety-Significant is performed in accordance with:

DOE Order 5480.22, "Technical Safety Requirements"

DOE Order 5480.23, "Nuclear Safety Analysis Reports"

DOE-STD-3005 draft, "Evaluation Guidelines for Accident Analysis and Safety Structures, Systems, and Components"

DOE-STD-3009 draft, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports"

Design codes, standards, and criteria for SSCs are not included because none of the SSCs are designated as Safety-Class or Safety-Significant. SSC design criteria is located in the *UNH Project 100% Design Criteria Document* (Ref. 4), which is based on DOE Order 6430.1A.

4.3 Safety-Class Systems, Structures, and Components

Safety-Class SSCs are systems, structures, or components whose preventive/mitigative function is necessary, within the constraints of an accident model, to keep hazardous material exposure to the public below the off-site evaluation guidelines (Ref. 1). There were no SSCs relied upon in the accident analyses to meet off-site evaluation guidelines (Ref. Section 3.4 of this SAR).

4.4 Safety-Significant Structures, Systems, and Components

Safety-Significant SSCs are systems, structures, or components whose preventive/mitigative function is necessary, within the constraints of an accident model, to keep hazardous material exposure to on-site workers below the on-site evaluation guidelines. In addition, based on judgement of the results of the hazard analysis, those SSCs that could have significant impact on meeting the safety of the facility worker, exclusive of standard industrial hazards, are also safety-significant SSCs (Ref. 1).

No SSCs are designated as safety significant. No SSCs were relied upon in an accident scenario to prevent or mitigate accident consequences below on-site evaluation guidelines (Ref. Section 3.4 of this SAR).

No SSCs were judged to have a significant impact on meeting the safety of the facility worker (Ref. Section 3.4 of this SAR).

4.5 References

1) DOE Standard 3009-YR, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Safety Analysis Reports," April, 1994 draft.

2) DOE Standard 3005-YR, "Evaluation Guidelines for Accident Analysis and Safety, Structures, Systems, and Components," February, 1994 draft.

3) DOE Standard 1027-92, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports.

4) Parsons, August, 1994. *UNH Neutralization 100% Design Criteria Document*.

SECTION 5
DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

5.1 Introduction

This section provides information addressing the requirements of DOE 5480.23, Topic 16, paragraph 8.b.(3)(p) relating to the derivation of Technical Safety Requirements (TSRs).

The UNH Neutralization Project has been determined to be a Hazard Category 3 activity, based on the verified inventory of radiological materials, in accordance with DOE-STD-1027-92. The safety envelope for this activity meets the following definition:

- No project related accident scenarios result in an on-site or off-site dose that exceeds the evaluation criteria.
- Non-standard worker safety events which could result in 5+ severe injuries or prompt death are controlled by administrative controls.
- Operational and process safety is based on "defense in depth" in design and operation.

5.2 Requirements

DOE 5480.22, "Technical Safety Requirements."

5.3 TSR Derivation

Only a TSR with Administrative Controls is required for this activity. No systems, structures, or components (SSCs) are relied upon to reduce exposures below Evaluation Guidelines. None of the SSCs perform significant worker-safety functions. The evaluation criteria for determining worker-safety significance is presented in Section 3. None of the identified SSCs identified in the Hazard Analysis, if omitted or misused would exceed this criteria and are not Safety Significant. Because there are no SSSSCs or SCSSCs there are no Safety Limits (SL), Limiting Control Settings (LCSs), Limiting Conditions for Operation (LCOs), and Surveillance Requirements in the TSR.

5.4 Administrative Controls

The following administrative controls shall be included in a TSR for the UNH Neutralization Project. The administrative controls apply at all times once project authorization has been obtained to commence processing, unless otherwise noted.

5.4.1 FERMCO Responsibility

The project organization shall include, at a minimum, the following personnel with the identified responsibilities:

- Project Manager with overall responsibility for safety and regulatory compliance and interface between the project and technical support organizations and subcontractors
- Operations Manager with responsibility and authority to direct all field operations, day to day supervisory authority, and responsibility for compliance with established control procedures
- Support personnel for Fire Protection, Emergency Preparedness, Radiation Control Technicians, Industrial Hygiene, Quality Assurance, Maintenance, and Occupational Safety
- Project personnel with responsibility for performing tasks safely and empowered to stop any activity that endangers workers or the environment

5.4.2 FERMCO Organization

The FERMCO RSO organization has overall responsibility for assuring that activities are performed safely. The relationship of the RSO organization, project organization and technical support shall be defined in the UNH Project Technical Implementation Plan (TIP). The RSO organization shall develop, implement, and maintain the following documentation:

- Project Specific Health and Safety Plan
- Safety Analysis Report

FERMCO is responsible for the development and enforcement of a Safety & Health Program. The Safety and Health Program shall follow the requirements of DOE Directives and the regulations of other Federal agencies and the State of Ohio. The RSO organization is responsible for ensuring the project is performed in compliance with Safety and Health Program requirements. (See Section 5.4.4.1 for specific Safety and Health Program requirements.)

5.4.3 Procedural Controls

Written procedures shall cover the conduct of activities during normal, abnormal, and emergency conditions and surveillance, testing, and maintenance. The procedures shall be revised as necessary based on use in the field until the UNH project is completed. Failure to follow any of the following six requirements shall result in a TSR Violation since such failure would be a clear violation of the safety basis documented in the SAR. Qualified operators and operations supervisors are permitted to deviate from written procedures to take immediate actions during emergency conditions to place the facility in a safe condition, and to protect equipment, personnel and public safety.

1. Enriched filter cake shall be packaged, handled, staged, and stored in accordance with written nuclear safety procedures or analyses in accordance with DOE Order 5480.24, *Nuclear Criticality Safety*.

2. The written operating procedures shall contain controls that reduce the generation of NO_x.

3. Tank D1-7 will not be processed as part of this project and all other projects and activities in the area of Tank D1-7 shall be in accordance with the Process Requirements for Tank D1-7.

4. Process sampling shall be performed to verify that the pH of high nitrate slurry is greater than 7.0 prior to transferring to the rotary drum filters.

5. Sampling and analysis shall be performed that verifies that the uranium concentration and enrichment of the filter cake is within the specifications of Criticality Safety Analysis (CSA) 94-010; and the filter cake meets the Nevada Test Site (NTS) waste acceptance criteria prior to shipping the filter cake to NTS.

6. Sampling and analysis of the filtrate shall be performed to verify that the filtrate is acceptable for discharge from the UNH Processing System for further treatment prior to discharging the filtrate from the Filtrate Hold Tank.

7. Sampling and assay analysis of UNH crystals left in UNH tanks shall be performed prior to turning the tanks over to the Safe Shutdown Program.

5.4.4 Programmatic Administrative Controls

For the following programmatic Administrative Controls, a TSR Violation would occur if the intent of the Administrative Control requirements are not met and there is a direct threat to the safety of the facility, personnel or the environment. The programmatic administratice controls listed below shall be included a TSR for the UNH Neutralization Project. The TSR shall identify the requirements applicable to the program and the committment to implement and maintain the program in accordance with the specified requirements.

a) Safety and Health Program

b) Radiation Protection Program
c) Industrial Hygiene Program
d) Industrial Safety Program
e) Fire Protection Program
f) Emergency Preparedness Program
g) Document Control Program
h) Quality Assurance Program
i) Conduct of Operations Program
j) Review and Audit Program
k) Unreviewed Safety Question Program
l) TSR Violation and Occurrence Reporting Program
m) Nuclear and System Safety Program
n) Training and Qualification Program
o) Minimum Operations Shift Complement

5.5 Interface with TSRs from Other Facilities

There are no existing TSRs for other interfacing facilities which are applicable to this activity. Process Requirements have been established for Tank D1-7 (Ref. 1). These requirements are addressed in Section 11, Operational Safety.

5.6 References

1) FERMCO, August, 1994. *Process Requirements for the Maintenance of Tank D1-7 in a Safe Configuration Until Processing.*

2) FERMCO, 1995. *Technical Safety Requirements for the UNH Neutralization Project*, FEMP-2400.

SECTION 6
PREVENTION OF INADVERTENT CRITICALITY

6.1 Introduction

This section provides information related to inadvertent criticality protection addressing the requirements of DOE 5480.23, Topic 8, paragraph 8.b.(3)(h).

6.2 Requirements

Compliance with DOE 5480.24, "Nuclear Criticality Safety," is required. Site requirement, SR-2117, "Nuclear Criticality Safety Requirements," identifies the specific requirements from DOE 5480.24 that are applicable to this site.

6.3 Criticality Evaluation

Two of the UNH Storage Tanks contain material above the minimum enrichment for criticality (1.034 ± 0.010 wt % U-235) identified in ARH-600, table III.B-2. Tank D1-10 is located in the Digestion Area of Building 2A and contains 2587 gallons of uranyl nitrate enriched to 1.29 ± 0.001 wt % U-235. Tank F2-607 is located in the NFS Tank area and contains 23,975 gallons of uranyl nitrate enriched to 1.09 ± 0.001 wt % U-235. All other UNH material is critically safe by enrichment during all neutralization processing stages and poses no criticality safety concerns. The highest enrichment of the remaining material is in Tank F2E-5, which contains approximately 23,625 gallons of uranyl nitrate enriched to 1.018 ± .001 wt % U-235 (Ref. Appendix E).

Criticality safety control for UNH neutralization of tanks D1-10 and F2-607 is ensured by safe uranium concentration. Minimum critical concentration of 1.3% enriched uranium is 1.7 g U/cc per ARH-600, table III.B.2-7 (Ref. 1). Laboratory bench scale testing of uranyl nitrate precipitation, as documented in FEMP Criticality Safety Analysis (CSA) 94-010 (Ref. 2), resulted in a maximum uranium concentration of 0.2 g U/cc and it is not credible for the uranium concentration to exceed the safe value of 1.7 g U/cc. Field precipitation is anticipated to achieve less than the maximum uranium concentration achieved in the lab. Enrichment values for all UNH storage tank material have been independently verified. The nature of the process precludes potential for criticality and no credible contingencies have been identified with respect to the UNH neutralization project that will lead to a criticality event.

6.4 Nuclear Safety Procedures

The UNH Neutralization Project will generate enriched filter cake that must be packaged and stored in accordance with the appropriate FEMP Nuclear Safety Requirements. A Criticality Safety Analysis shall be prepared for the staging of these drums. To ensure that the materials generated are properly characterized, staged, and meet disposal criteria, two samples per batch will be analyzed to determine the uranium concentration and enrichment of the dry compound prior to final characterization, packaging, and shipment.

6.5 References

1) R. D. Carter, G. R. Kiel, and K. R. Ridgeway, "Criticality Handbook, Vols. I, II, III," Atlantic Richfield Hanford Co. report ARH-600, 1968.

2) FERMCO, July, 1994. Criticality Safety Analysis, CSA 94-010, *UNH Neutralization Project*.

3) FERMCO, June, 1993. *Nuclear Criticality Safety Requirements*, SR-2117, Rev. 0.

SECTION 7
RADIATION PROTECTION

7.1 Introduction

This section provides information on the FEMP Radiation Protection Program as it relates to the UNH Neutralization Project facilities and activities.

7.2 Requirements

Programmatic requirements are identified in the DOE *Radiological Control Manual* (Ref. 1), which provides the basis for the FEMP radiological protection program. DOE Radiological Control Manual requirements are codified in 10 CFR 835, "Occupational Radiation Protection". The FERMCO *Comprehensive Environmental, Occupational Safety and Health Program (CEOSHP)* (Ref. 2), contains the site-specific Radiological Control Manual for FEMP activities and is identified as Radiological Protection Requirements (RPRs).

7.3 Radiation Protection Organization

The Radiological Control (RC) Department of Environmental Safety and Health Division (ES&H) has the responsibilities for the Radiation Protection/ALARA Program. Radiological assessment, engineering, compliance, and dosimetry are essential elements of the RC Department. Detailed responsibilities are given in Radiological Performance Requirement (RPR) 5-3 of the FERMCO *CEOSH Program* and the FEMP *ALARA Program Manual* (Ref. 3).

7.4 Radiological Protection Training

All UNH work areas are within posted Contamination Areas. All UNH Project workers requiring access to the work areas must have Radworker II training and General Employee Training (GET). Annual GET and bi-annual Rad Worker II refresher training is required. Respiratory protection training and a Respirator fit test are required for most activities in the work areas. Access to the controlled areas is controlled by a radiation technician that will deny access to any worker out of compliance with GET and Rad Worker training. The UNH Operations Manager monitors the training requirements for the UNH Project workers and will not permit any worker out of compliance with site and project-specific training to work on the UNH Project.

7.5 ALARA Policy and Program

The joint Radiological and ALARA Committee has established policies to ensure occupational exposures and environmental releases are as low as practicable. Radiological Engineering will ensure the process of reasonably reducing radiation exposure is employed in the radiological control program. Specific Committee requirements are presented in Section 1, Article 138 of the *DOE Radiological Control Manual*. FEMP management has the following policy:

1) No practice involving radiation exposure shall be adopted unless its introduction produces a positive net benefit.

2) All exposures shall be kept ALARA with economic and social factors taken into account.

3) The dose limits identified in Section 2 of the DOE *Radiological Control Manual* will not be exceeded, and challenging administrative limits have been set to ensure ALARA.

The ALARA program is only as effective as each individual's performance. All individuals at the FEMP are instructed in the rules for radiation protection and in the use of ALARA principles to minimize exposure.

An ALARA/Design review (Ref. 4) has been completed in accordance with the DOE Radiological Controls Manual and FEMP ALARA Program Manual. The average dose-rate that an individual will receive, while at their designated work stations, will be limited to less than 0.5 mrem/hour and there is no need for work area stay-time limits or shielding. Previous operations resulted in exposures well below established regulatory limits.

7.6 External Radiation Exposure Control

External radiation exposure control requirements are addressed in the *DOE Radiological Control Manual*. These requirements are integrated into the design of new operations, facility modifications, and radiological work planning documents, and are fully implemented work begins. Radiation Work Permits (RWPs) control entrance into radiologically controlled areas. External dose is minimized and controlled by the following measures:

1) RWPs specify radiological precautions, stay times, PPE, and personnel monitors.

2) Decontamination is performed to the extent practical.

3) Routine radiation surveys are performed to evaluate potential sources of radiation dose and to trend area radiological conditions.

4) Adherence to good ALARA work practices is emphasized and discussed with the workers.

7.6.1 UNH Neutralization Project Control Measures

Decontamination and the removal of unnecessary sources of external radiation exposure will be the primary control measures for this project. Work area modifications will be implemented to increase distance from sources of radiation exposure which cannot be removed. Stay-times will be specified when all other options have been exhausted. All reasonable measures are taken to prevent direct contact of personnel (on the skin) with UNH solutions or other forms of radioactive materials. Specific PPE requirements are determined and included on the FERMCO work permit at the time of the activity to ensure that the work area conditions at the time of the activity are reflected.

7.6.2 Occupational Radiation Dose Limits

Radiation dose limits and administrative dose controls are used for controlling personnel occupational radiation exposure. The limits and controls for exposure to ionizing radiation are described in the *DOE Radiological Control Manual*. While 10 CFR 835 limits occupational exposure limit to 5 rem/year (CEDE), the DOE *Radiological Control Manual* specifies an administrative limit of 2 rem/yr. The FEMP administrative limit is 1 rem/yr for both external and internal radiation dose. Radiation received from medical or dental exams or radiotherapy is not included in occupational radiation exposure.

7.6.3 General Public Radiation Dose Limit

The radiation dose limit for members of the general public and visitors to the FEMP is 100 mrem per year as specified in the DOE Radiological Control Manual.

7.7 External Dosimetry

All personnel entering the radiological Controlled Area of the FEMP are required to wear personal dosimeters (TLDs), in accordance with site access procedures. In addition to their own personal TLD (Thermolumiscent Dosimeter), individuals may be required to wear additional dosimetry devices as required by the task specific RWP.

Requirements for issuing, processing (including frequency of processing), and storing dosimeters, as well as reporting of dosimetry results, are established by the RC Department. All personnel who enter the FEMP are responsible for individual compliance.

The RC Department provides dosimeters for all personnel requiring them at the FEMP, operates and maintains dosimetry processing equipment, and records and reports dosimetry results. In addition, the RC Department identifies personnel for whom dosimetry is required.

As required by DOE Order 5480.15, "DOE Laboratory Accreditation Program for Personnel Dosimetry," the FEMP's external dosimetry program is certified by the DOE Laboratory Accreditation Program.

7.7.1 Extremity Dosimetry

As stated in the *DOE Radiological Control Manual*, extremity dosimetry is required to assess exposure in a non-uniform radiation field. The RC Department evaluates the need for extremity dosimetry based on the task and the location of work, identifies personnel required to wear extremity dosimetry, and establishes requirements for issuing, processing (including frequency of processing), storing dosimeters, and reporting results. All personnel issued extremity dosimeters are responsible for compliance with the requirements. The need for and the type of dosimetry are specified by the RC Department in an RWP.

The FEMP extremity monitoring program uses single-element TLDs mounted in ring badges. Extremity dosimeters are processed and calibrated to determine the radiation dose to the skin of the extremity.

7.7.2 Personal Accident Dosimeters

Inside of each assigned personnel dosimeter badge is a packet containing the personal accident dosimeter. These dosimeters contain a sulfur pellet and three different types of metal foils which are activated by the neutron flux associated with a criticality accident. Analysis of the radioactivity in the pellet and foils will provide indication of an individual's absorbed neutron dose.

7.8 Internal Radiation Exposure Control

Internal radiation exposure is minimized with engineering and administrative controls and by radiological worker training programs, which emphasize good radiological work practices and principles of ALARA. The primary exposure pathway for internal exposure is respiratory. The following measures are employed to minimize the generation of and exposure to airborne radiation:

1) Work surfaces and transition areas are kept clean of removable contamination.

2) Work areas are posted and controlled by Radiological Work Permits (RWPs) which specify appropriate anti-contamination measures and personnel monitoring requirements.

3) Control points, barriers, and instruments for personnel/equipment monitoring are in place to ensure adequate contamination control.

4) Containments and HEPA filtration devices are used to control airborne radioactive material releases to the ambient work environment for those activities which have the potential to create airborne hazards.

7.9 Internal Dosimetry

Internal radiation monitoring at the FEMP is routinely accomplished by performing in vitro and in vivo bioassay measurements and by evaluating worker exposures to airborne radioactive materials. The RC Department defines the internal radiation monitoring program for all personnel at the FEMP.

Internal radiation monitoring is required for all radiation workers exposed to surface or airborne radioactive contamination of 100 mrem annual effective dose equivalent from intakes of all radionuclides from occupational sources or if any organ or tissue dose equivalent could exceed 5 rem annual dose equivalent.

All personnel are responsible for reporting for in vivo examinations when scheduled and for leaving excreta samples for in vitro analysis when requested. Failure to comply is considered a serious offense and may result in disciplinary action. The schedule for collecting routine samples and the criteria for collecting non-routine samples (i.e., incident or special samples) is established by the RC Department.

In addition, baseline, annual, and termination urine samples are required of all employees. Any visitor who intends to be on site for more than 5 working days is required to provide an initial, weekly, and end-of-visit urine sample.

In vivo monitoring is the detection and quantification of radioactive materials in the lungs by means of measuring the photons emitted. The In Vivo Examination Center utilizes intrinsic germanium detectors inside a shielded counting chamber to provide sensitive, high-resolution measurements of radioactive materials that emit low-energy photons.

Internal dose assessments are performed to determine intakes of radioactive material that are significant. Dose assessments are generally performed according to International Commission on Radiological Protection Publication No. 30 (ICRP-30) methodology. The RC Department may modify the approach if recent publications or actual bioassay data indicate that this would be appropriate. Methods of estimating the dose equivalent from internal sources of radiation are to be appropriate to the workplace conditions and consistent with National Council on Radiation Protection (NCRP), ICRP, and the US EPA.

7.10 Radiological Protection Instrumentation

Radiological instruments are periodically checked and calibrated to ensure their reliability and accuracy. Instruments have tags or labels with their calibration dates. Calibration sources meet the National Institute of Standards and Technology requirements. Each of the following instruments has a record which specifies its use, calibration frequency, and calibration procedure:

1) Portable survey instruments
2) Bioassay measurement equipment
3) Laboratory, counting room, and fixed radiation measuring equipment
4) Process and effluent monitors and sampling equipment
5) Radiation area monitors
6) Portal monitors and other personnel contamination monitors
7) Pocket and electronic dosimeters
8) Air sampling equipment
9) Tool and waste monitoring equipment
10) Protective clothing and equipment monitors

In addition, the records of maintenance and special calibrations are maintained. The above requirements are based on *DOE Radiological Control Manual*, and the *CEOSHP Manual*.

7.11 Respiratory Protection Program

The Respiratory Protection Program has been established at the FEMP to coordinate the selection, issuance, use, maintenance, and inspection of respirators. The program complies with DOE orders which incorporate the substantive provisions of OSHA and meets the recommendations of ANSI/Z-88 Standards.

Respiratory protection is required for FEMP employees whenever potential respiratory hazards are present at concentrations that could present a health concern or as dictated by good health physics practices. Assurance that personnel are not exposed to occupationally derived airborne radioactivity is provided through the implementation of RPR 4-4, "Respiratory Protection-Radiological Control Requirements," of the *CEOSHP Manual*.

The appropriate level of respiratory protection is required for all situations where there is a potential to exceed applicable occupational limits (PELs, STELs, TLVs, or DACs), to include emergency response and fire fighting activities, and to encounter oxygen deficient atmospheres.

The Respiratory Protection Program specifies the types of respirators approved for use at the FEMP and describes procedures for conducting respirator storage audits and the performance of medical evaluation for respirator use. All respirator users at the FEMP must be fitted and trained as part of this program. An ample supply of respirators shall be readily available for a qualified user.

Respirators requirements for the UNH Project activities are determined at the time the work is to be performed. Respirator requirements are subject to change as preventive actions are taken to remove respiratory hazards and protect from both radiological and non-radiological respiratory hazards. Reference the RWPs and Chemical/Hazardous Work Permits posted at the Plant 2/3 and 8 Radiological Control Points for respiratory protection requirements for specific activities.

7.12 Air Monitoring

Air monitoring is conducted in occupied work areas where an individual could receive an annual intake of 2 percent or more of the appropriate annual limit on intake (ALI), or where an individual could be continuously exposed to airborne concentrations of 10 percent or more of the appropriate derived air concentration (DAC). The types of air monitoring employed are:

1) Personal Air Sampling (PAS), utilizing a low volume pump and lapel mounted sample filter.

2) General Area (GA) sampling, to monitor ambient airborne radioactive material concentrations and to trend and detect changing radiological conditions.

3) Working Level Monitors (WLMs), track etch cups, scintillation detectors, and special grab sampling techniques are used to assess exposures to radon and radon progeny, in affected areas of the facility.

4) Continuous Air Monitors (CAMs) are used in areas where airborne radioactive material concentrations could routinely exceed 1 DAC, with alarm set points established and based on the appropriate DAC and respiratory protection factors.

RPR 2-2, "Airborne Radioactivity Monitoring," of the FERMCO CEOSHP Manual can be referenced for more detailed information.

7.13 Radiological Monitoring and Contamination Control Programs

Radiation and surface contamination levels are monitored by the Radiological Control Department and the required protective equipment (e.g., respirators and clothing), TLDs, and any other special radiological precautions are determined. These requirements are implemented for each task via an RWP.

Routine surveys are performed to assess contamination levels in the process areas. The need for surface contamination surveys is addressed in the RWP and work activities.

Radiation surveys are performed by RC personnel to preclude the possibility of exceeding established radiation dose limits, and minimizing dose. Surveys are used to define the boundaries for posting radiation and high radiation areas. Area radiation surveys are performed routinely, as determined by the activity.

As discussed above, controls are maintained for areas with known contamination. Posted areas advise the individual worker of clothing and respiratory requirements which minimize the contamination. Prior to exiting a contamination or airborne radioactivity area, the individual is required to perform a frisk to prevent the spread of contamination. Possible contamination areas are monitored to evaluate the need for control requirements (e.g., clothing and respirators) and decontamination. Contamination control requirements are discussed in Section 2 of the *DOE Radiological Control Manual*.

7.14 Radiological Protection Recordkeeping

Radiation Protection Program records are retained by two ES&H Division organizations, RC and Dosimetry and Instrumentation. The records retained include radiological monitoring, work place monitoring, and personnel exposure.

7.14.1 Radiological Monitoring Records

All original radiological sampling data including maps, surveys, and original sample worksheets are retained and filed by the RC Department to ensure retrievability for a prescribed retention period.

7.14.2 Work Place Monitoring

Records of surveys, data sheets, maps, RWPs, health physics calculations, investigations, air sample results, worksheets, and any other documentation directly related to work-place monitoring are filed by the RC Department and maintained indefinitely.

Documentation of work conditions affecting the results of work area monitoring are listed on the appropriate record with sufficient detail to allow understanding at an undefined future date.

7.14.3 Personnel Exposure

All supervisors receive copies of their personnel's quarterly dose. A summary of annual, cumulative, and Committed Effective Dose Equivalent (CEDE) is provided to each employee and subcontractor radiation worker on an annual basis. Dose records are kept indefinitely by Dosimetry. All raw data, corrected data, and employee external radiation reports are filed quarterly.

7.15 Radiological Area Boundaries, Posting, and Controls

Radiologically controlled areas are classified in accordance with their radiation, contamination, and airborne radioactive material levels. The areas are delineated by permanent structures (e.g., doors and walls) or temporary provisions (e.g., cords and chains). The physical barriers are placed so that they are visible from all directions and various elevations. The boundary signs indicate the condition (e.g., contamination or radiation) and special entry requirements. The posting requirements, definitions, and methods presented per the *DOE Radiological Control Manual*, are followed by the RC Department and implemented in accordance with RPR 4-0, "Radiological Protection Procedure," of the *CEOSHP Manual* for posting. Specific DOE requirements are given in Articles 233 through 237 of the *DOE Radiological Control Manual*. All UNH Neutralization Project work areas are currently posted as Contamination Areas with boundaries clearly marked with access requirements and posted RWPs. Area classification, boundaries, and postings are subject to change as the hazards are removed and will not constitute an Unreviewed Safety Question (USQ).

7.16 Entry and Exit Control Program

Access to the FEMP radiologically controlled area is controlled at the rear of the Service Building and vehicle access gate. Access to Building 2A, NFS Tanks, O.K. Liquor Tank, Hot Raffinate, and C.D. Blend is controlled through the radiological control point in the Extraction area of Building 2A. Access to Plant 8 is controlled through the control point on the south side of Plant 8. Prior to access training requirements are verified and the person is briefed on the applicable, posted RWP. If the person is requesting access for a task not specified on an RWP, access will be denied until an RWP is generated specific for the activity. No stay times restrictions are required for the UNH Neutralization operations.

7.17 Occupational Radiation Exposures

The average dose-rate that an individual will receive, while at their designated work stations, will be less than 0.5 mrem/hour. Conservatively assuming 8 hours of exposure each day, 5 days per week, for a project duration of 10 months, the exposure is 0.9 rem/yr. including internal and external dose. The dose is less than the FERMCO administrative limit of 1 rem/yr, DOE's limit of 2 rem/yr, and the 10 CFR 835 limit of 5 rem/yr. Exposures are anticipated to be lower than those estimated because of the modifications made by the UNH Project and workers will not be in the work area 8 hours each day.

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7.18 References

1) DOE, *Radiological Control Manual*

2) FERMCO, February, 1993. *Comprehensive Environmental, Occupational Safety and Health Program (CEOSHP)*, ESH-1-1000.

3) FEMP, January, 1994. *FEMP ALARA Program Manual*, RM-0015.

4) FEMP, August, 1994. *Final ALARA/Design Review for the UNH Neutralization Project.*

5) DOE Order 5480.15, "DOE Laboratory Accreditation Program for Personnel Dosimetry"

SECTION 8
HAZARDOUS MATERIAL PROTECTION

8.1 Introduction

This section describes the hazardous material protection provisions. The section summarizes the hazardous material concerns from the hazard analysis in Section 3. It also describes the relationship to other SAR Sections, where these sections contain the requested information. The information in this section addresses the requirements of DOE Order 5480.23, Topic 10 paragraph 8.b.(3)(j), relating to nonradioactive hazardous material protection. The SAR is not intended to be the vehicle for review and approval of the site program.

8.2 Requirements

The requirements are listed in Table 8.2-1 below.

Table 8.2-1 - Hazardous Material Protection Requirements

Requirements	Law	Regulation or DOE Order
Hazardous Waste Management	Resource Conservation and Recovery Act	40 CFR 262, 264, 265, 268
Hazardous Waste Management	Ohio Solid and Hazardous Waste Act	OAC 3745-52 et. seq.
Asbestos Abatement	Ohio Asbestos Abatement Law	OAC 3701-34 et. seq. and OAC 3745-20 et. seq.
Packaging of Materials	Department of Transportation	49 CFR 172, 173
Hazardous and Radioactive Mixed Waste Program		5400.3
Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes		5480.3
Hazardous Waste Operations and Emergency Response		29 CFR 1910.120

8.3 Industrial Hygiene Organization

The Industrial Hygiene section is organized under the Occupational Safety, Health, and Medical Services Department of the Environmental Safety and Health Division (ES&H). The industrial hygiene section works to prevent occupational illnesses and injuries through the anticipation, identification, and control of airborne chemical hazards in the workplace. Industrial Hygiene is responsible for the selection, the analysis, and the interpretation of air monitoring methods for non-radiological chemical contaminants. General air monitoring and personnel monitoring (i.e., worker breathing zone monitoring) are performed as necessary to assure contamination control.

8.4 The ALARA Policy and Program

FEMP management has the responsibilities for the Chemical Protection/ALARA Program. The FEMP management is aware of conditions and potential problems. Employees are trained, monitored for exposure, notified periodically of occupational history, and provided the necessary equipment and procedures to safely control conditions. More specific responsibilities are given in the FERMCO *CEOSH Program* (Ref. 1) and the FEMP *ALARA Program Manual* (Ref. 2).

FEMP management has the following policy:

1) No practice involving chemical exposure shall be adopted unless its introduction produces a positive net benefit.

2) All exposures shall be kept ALARA with economic and social factors taken into account.

Generally, if sample results exceed half of an applicable exposure limit, engineering and/or administrative controls and the use of Personal Protective Equipment are implemented as soon as possible to reduce employee exposure.

8.5 Hazardous Material Identification Program

Hazards are identified by conducting walk-through of the facilities, air sampling, and research into the history of the facility. The *FEMP Plant Hazards Survey and Preliminary Hazard Categorization* (Ref. 3) involved a systematic inspection of all FEMP Facilities to determine physical, chemical, and radiological hazards. Section SPR 5-0, "Industrial Hygiene," of the *CEOSHP* Manual states that FERMCO recognizes the importance of reducing chemical hazards and states how the hazards are minimized.

8.5.1 UNH Project Hazardous Materials

The chemical hazards associated with the UNH project are shown in Table 8.5-1 below. Hazardous materials and mitigators are addressed in the Hazard Analysis, Appendix C. UNH is the most hazardous material with the potential to seriously burn skin and mucous membranes upon contact. Workers will be required to wear chemical resistant PPE and respiratory protection when operating transfer equipment and components, inspecting & sampling activities, monitoring transfers, cleaning up spills or leaks, and other tasks with the potential for exposure to UNH contact or inhalation of UNH aerosols or NO_x. Specific PPE requirements are determined and included on the FERMCO work permit at the time of the activity to ensure that the work area conditions at the time of the activity are reflected.

Table 8.5-1 Hazardous Materials

Chemical	Location and Use	Hazard
$Mg(OH)_2$	Neutralization of UNH	Not Hazardous
MgO	Neutralization of UNH (mixed with water to form $Mg(OH)_2$)	Inhalation hazard (irritant)
UNH	To be processed	Acidic and Radiological Inhalation and skin contact Heavy metal toxic to kidneys
NO_x	May be generated from agitation, transfer, rinsing tanks, and addition of UNH to warm water	Inhalation
Heavy Metals (Pb, Hg, Ba, Cr, & etc.)	Throughout process	Environmental hazard Toxic to internal organs
Diatomaceous Earth	Plant 8 East and West EIMCO filters & Precoat makeup tank	Inhalation Hazard (silicosis)
Filter Cake	Plant 8 East and West EIMCO filters Drumming Station	Inhalation hazard Internal radiation and toxic Silicosis from dicalite
Nitrates	Neutralized UNH filtrate	Environmental hazard
Uranium	Contamination - potentially all areas	Inhalation and ingestion
Asbestos	Plant 2/3 deteriorating insulation and transite panels.	Inhalation hazard Lung cancer

8.6 Hazardous Materials Training

All workers receive the site minimum training for access as required by RCRA, OSHA, and DOE addressing the chemical, radiological, and physical hazards associated with the FEMP facilities. Reference Section 12 for the site training requirements. Workers are briefed on the task specific Health and Safety Plan and the combined Radiological and Chemical/Hazardous Work Permit, which address the specific hazards in the work area.

8.7 Hazardous Material Protection Instrumentation Program

Instruments are periodically checked and calibrated to ensure their reliability and accuracy. Instruments have tags or labels with their calibration dates. Each of the following instruments has a record which specifies its use, calibration frequency, and calibration procedure:

1) Portable Air Monitoring Equipment
2) Air sampling equipment

In addition, the records of maintenance and special calibrations are maintained. The above requirements are based on the *CEOSHP Manual*.

8.8 Respiratory Protection Program

The Respiratory Protection Program has been established at the FEMP to coordinate the selection, use, maintenance, and inspection of respirators. The program complies with DOE orders which incorporate the substantive provisions of OSHA and meets the recommendations of ANSI Z-88.2-1992 Standards. The UNH Neutralization Project Health and Safety Plan (HASP) discusses the details of the use of the portable supplied-air, air-filtering, and other respirators that may be required for the UNH Neutralization Project activities.

Respiratory protection is required for FEMP employees whenever potential respiratory hazards are present at concentrations that could present a health concern or as dictated by good health practices. Respiratory protection is required during emergencies such as fires or spills when the employee may be exposed to oxygen deficient atmospheres, high airborne contaminant levels, or smoke. Respirators are also required during either routine or unscheduled maintenance where action levels (8-hour exposure limits; ceiling exposure limits; or 15-minute, short-term exposure limits) may occur.

The Respiratory Protection Program specifies the types of respirators approved for use at the FEMP and describes procedures for conducting respirator storage audits and the performance of medical evaluation for respirator use. All respirator users at the FEMP must be fitted and trained as part of this program.

An ample supply of respirators shall be readily available for qualified users.

Respirator requirements for the UNH Project activities are determined at the time the work is to be performed. Respirator requirements are subject to change as preventive actions are taken to remove respiratory hazards and protect from both radiological and non-radiological respiratory hazards. Reference the RWPs and Chemical/Hazardous Work Permits posted at the Plant 2/3 and 8 Radiological Control Points for respiratory protection requirements for specific activities.

8.9 Air Monitoring

The air monitoring program is conducted to maintain compliance with DOE orders which invoke Occupational Safety and Health Administration (OSHA) requirements for personnel exposure limits. For airborne chemical contaminants, the most restrictive of the current values for either the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values or the OSHA permissible exposure limits establish maximum acceptable worker exposure. Selection of a specific air monitoring method will be based upon accuracy, reliability, and other considerations (e.g., reuse/disposable, analysis requirements, cost, etc.) to assure worker safety.

Results are reported and a copy maintained and made available to the worker or former worker upon request in compliance with 29 CFR 1910.20. The UNH project will control asbestos hazards by placing barriers between operators and asbestos-contaminated areas and monitor to ensure barriers are effective. Where it is not possible to control asbestos by engineered controls, respiratory protection is required. Respiratory protection will be worn only when specified in the FEMP Work Permit.

8.10 Hazardous Material Monitoring and Control

Industrial Hygiene monitors for various hazardous airborne chemicals using different real-time instruments and compares results to OSHA or ACGIH occupational exposure limit standards. Combination flammable gas, oxygen, carbon monoxide, and hydrogen sulfide monitors are used for confined space monitoring. Mineral acids and nitrogen dioxide are measured by a paper tape monitor. Personal monitoring instruments are utilized to measure nitrogen dioxide in the breathing zone. All monitors are calibrated prior to use and have regular maintenance performed. In addition to real-time monitors, IH also collects air contaminants on various media such as filters, charcoal tubes, or silica gel tubes for laboratory analysis.

8.11 Hazardous Material Protection Record Keeping

A series of records are maintained on an employee by the Medical Department and the Safety Engineering Department as specified in Emergency and Medical Services Execution, EMPR 3-0 and 3-8, of the

FERMCO CEOSHP Manual. A Supervisor's Report of Injury Form and a copy of the Notification of Visit to Medical Services are used to document that an occupational illness or injury may have occurred and that medical aid was administered. These two forms provide the record keeping basis for exposure to hazardous materials while used for all occupational injuries and illnesses reports.

8.12 Hazard Communication Program

DOE and OSHA standards [DOE Order 5480.10 and OSHA 29 CFR 1910.1200, Hazard Communication] require that health hazards be identified and that affected employees and others be notified of hazards. The methods used for compliance with these requirements are contained in the FEMP *Chemical Hazard Communication Program*, RM-2086 (Ref. 4). The purpose of hazard communication is to ensure that the hazards of all chemical materials on site are evaluated so that proper controls can be maintained and to ensure that information concerning the hazards is transmitted to affected employees and others as appropriate.

SPR 5-6, "Hazard Communication," of the *CEOSH* Program implements the requirements of OSHA 29 CFR 1910.1200, establishes responsibilities for hazard communication at the FEMP, and applies to all FERMCO personnel. Requirements are included to cover the following HAZCOM or Right-to-Know aspects: communicating hazard information, controlling the purchase of chemicals, determining potential health hazards, material safety data sheets, container labels, training and information on non-routine work.

8.13 Occupational Medical Programs

The FEMP Occupational Health Program conforms to DOE Order 5480.8A, "Contractor Occupational Medical Program," and the FERMCO *CEOSH* Program conforms to 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," as required by DOE policy. The purpose of these programs is to protect employees against health hazards in the work environment.

Occupational medical exams establish a baseline for an employee's health and are part of the medical records. Medical examinations are classified in two categories. The annual Class I examination is required for any employee who spends more than approximately 10 percent of work time in areas where the potential for exposure to substances exists. For hourly workers, emergency response team members, and security personnel, a yearly physical is mandatory. This examination includes an evaluation of medical history, blood and urine assays, pulmonary function tests, hearing test, electrocardiography, a physical exam, and physician evaluation. Medical certification is required to use respiratory protection.

The physician's examination under 29 CFR 1910.120 is initiated by either a significant employee exposure or the potential for such exposure (i.e., a potential employee exposure that is either at or near the action level or at or near the permissible exposure limit). The Medical Services Section generally notifies Industrial Hygiene (IH) to provide monitoring assessments of any exposures. The need for bioassays is evaluated on a case-by-case basis by the Medical Director.

8.14 Occupational Chemical Exposure

The IH monitoring database indicates that NO_x can approach FERMCO action levels when UNH is heated, the tanks are rinsed, or UNH solutions are transferred. In order to eliminate worker exposure to NO_x, several process controls were implemented. There will no direct heating of UNH, reducing the generation of NO_x. Tanks are equipped with exhaust ventilation, reducing the migration of NO_x, to the breathing zone, that may occur during transfers or mixing. In addition to the controls, air monitoring will be in place to indicate if action levels are exceeded. Supplied-air respirators are available for work that has the potential for generating NO_x above action levels in the breathing zone. Such work can include maintenance on the tank components and rinsing of the tanks, as determined by the IH technician on the Chemical/Hazardous Work Permit. When monitoring equipment alarms and indicates that action levels are exceeded, workers are instructed to, place the system in a safe configuration, exit the area, and notify the supervisor. The supervisor notifies Industrial Hygiene for resolution and further guidance.

Friable asbestos has been detected in Building 2A, Digestion, resulting primarily from the deterioration of transite panels. Monitoring has historically indicated that action levels can be exceeded when work disturbs settled asbestos. Worker exposure will be controlled by erecting temporary barriers, monitoring for airborne levels, housekeeping to remove settled asbestos, and air-purifying respirators.

8.15 References

1) FERMCO, February, 1993. *Comprehensive Environmental, Occupational Safety and Health Program (CEOSHP)*, ESH-1-1000

2) FEMP, January, 199. *FEMP ALARA Program Manual*, RM-0015

3) FEMP, April, 1994. *FEMP Hazard Survey and Preliminary Hazard Categorization*, Rev. C.

4) FEMP, July, 1992. *Chemical Hazard Communication Program*, RM-2086.

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SECTION 9
RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

9.1 Introduction

This section summarizes the plans for management of the Radioactive and Hazardous Waste present and generated during operations, as required by DOE 5480.23, Topic 7 paragraph 8.b.(3)(g) relating to radioactive and hazardous waste management for the facility. A source of approximately 200,000 gallons of Uranyl Nitrate, classified as a RCRA mixed hazardous waste, will be processed to produce magnesium diuranate and aqueous filtrate. The aqueous filtrate will be treated and tested to confirm its acceptability for discharge under the present National Pollutant Discharge Elimination System (NPDES) permit and released to the Great Miami River. The solid filter cake of magnesium diuranate and precipitated regulated metals will be drummed, sampled to verify it is not RCRA Hazardous Waste and meets Nevada Test Site (NTS) acceptance criteria, and staged for shipment to NTS. The Uranyl Nitrate Hexahydrate Neutralization Project Removal Action Work Plan provides a complete, coherent discussion of the treatment processes and disposal/discharge criteria to be utilized in managing the process waste products.

9.2 Requirements

1) 40 CFR 261, Identification and Listing of Hazardous Waste

2) NVO-325 (Rev. 1), Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements.

3) Ohio EPA Authorization to Discharge Under the National Pollutant Discharge Elimination System (NPDES): OEPA Permit #1I000004*BD effective 2/12/90; *CD effective 7/15/91; and *DD effective 5/20/93.

9.2.1 Applicable or Relevant and Appropriate Requirements (ARARs)

Although the UNH Neutralization Removal Action is exempted from the procedural requirements to obtain Federal, State or local permits, Section XIII.B of the Amended Consent Agreement requires DOE to provide specific information regarding the permits that would be required in the absence of the CERCLA permit exemption for on-site response actions. This permit information is required to include:

- Identification of each permit that would otherwise be required;

- Identification of the standards, requirements, criteria or limitations that would have had to have been met to obtain each permit; and,

- Explanation of how the response action will meet the standards, requirements, criteria, or limitations identified in the above Item.

The Permit Information Summary was prepared and included in the UNH Neutralization Project Removal Action Work Plan (Ref. 1) to fulfill the requirements of Section XIII.B of the Amended Consent Agreement. The summary provides a description of how this removal action will comply with the standards, requirements, criteria, or limitations that would be imposed by permits required absent the CERCLA permit exemption for on-site response actions.

9.3 FEMP Waste Management Organization

The management of radioactive and hazardous waste at the FEMP is integrated across several Divisions which include; Waste Programs Management, Remediation Support Operation, Materials Control & Accountability, and Regulatory Programs. Waste Programs Management is responsible for the planning efforts (budgeting, procuring resources, procedures, etc.) involving all waste management projects and activities. Remediation Support Operation is responsible for providing the properly trained personnel (laborers, chemical operators, motor vehicle operators, etc.) to perform the work outlined by Waste Programs Management. Materials Control & Accountability is responsible for the coordination of waste container tracking which includes; documenting container contents, properly labeling containers, storage and movement of containers, and entering container information into the waste tracking computer database. Materials Control & Accountability is also responsible for accounting for all nuclear materials. Regulatory Programs is responsible for ensuring all waste management activities are in compliance with all DOE Orders and regulatory drivers.

9.4 Radioactive and Hazardous Waste Stream Sources, Handling and Treatment Systems

The materials to be processed by the UNH Neutralization Project includes solutions presently stored in eighteen stainless steel storage tanks. The contents of these tanks vary in uranium content from 13 to 341 grams of uranium per liter. Another tank, D1-7, contains a uranium/organic/water mixture which will require additional treatment not within the scope of the UNH Project. Six of the tanks contain uranium with an isotopic enrichment of 1% or greater of U-235. The solutions have a free acid content of up to 4.7N. The material stored in the nineteen tanks is classified as a RCRA hazardous waste under 40 CFR 261.22 due to its corrosivity characteristic and under 40 CFR 261.24 due to toxicity characteristic resulting from the presence of two heavy metals (chromium and barium).

The only gaseous waste stream identified for this process will consist of NO_x gases generated during the neutralization steps. A scrubber system is included at the dilution/neutralization tank to mitigate any NO_x emissions though exceeding regulatory limits is not likely (Ref. 2).

As a result of the dilution and neutralization processes included in this project, the excess nitric acid will be neutralized to form soluble magnesium nitrate, and the UNH will react to form a magnesium diuranate precipitate.

The precipitate, which also will contain other metal contaminants such as chromium and barium, will be separated from the filtrate by rotary drum vacuum filters, collected in drums, and sampled. Dust collection systems are provided at the drumming stations to control the release of airborne particulate. Air monitoring instrumentation is installed at the stations to assure safe levels of particulate matter are maintained.

The filtrate will be transferred to the FEMP Waste Water Treatment System, where it will be processed to convert the nitrate ions to nitrogen gas, tested to confirm its acceptability for discharge under the present NPDES permit, and released to the Great Miami River as part of the normal FEMP waste water discharge stream.

The drummed filter cake (precipitate) will be analyzed by the Toxicity Characteristic Leaching Procedure (TCLP) of 40 CFR 261, in accordance with the FEMP RCRA Part B Permit Application, to confirm that no hazardous waste is present. The drums will then be staged for shipment to the Nevada Test Site (NTS). A Project Specific Sampling and Analysis Plan, 94-795 (Ref. 3), has been prepared specifying sampling and analysis requirements for acceptance at the Nevada Test Site (NTS).

Enriched materials may require further analysis and processing prior to shipment.

9.5 Waste-Handling or Treatment System Functions

The UNH Neutralization Project as described in this SAR is a waste treatment system. The UNH solution inventory has been declared a waste, and the project mission is to convert the waste into a safe form for disposal.

9.6 Quantity and Forms

As discussed above, neutralization and precipitation of the uranyl nitrate will generate two waste streams, solid magnesium diuranate filter cake and aqueous filtrate. Barium, chromium, lead, and mercury will also be removed and present in the filter cake. The bench scale testing results show that approximately 5,000 55-gallon drums of magnesium diuranate filter cake and 275,000 gallons of high nitrate filtrate will be produced. Contaminated trash, analytical samples, used Personal Protective Equipment, and other process related trash will be generated. The following waste streams were identified on the Project Waste Identification Form (PWID) for the UNH Neutralization Project and are not RCRA Hazardous Wastes. None would meet any of the hazardous waste listings under OAC 3745-51-31 (in lieu of 40 CFR 261, Subpart D), or exhibit any of the hazardous waste characteristics under OAC 3745-51-21 to 24 (in lieu of 40 CFR 261.21 to 24)

9.6.1 Magnesium Diuranate Filter Cake

Magnesium diuranate filter cake will be generated and drummed in Plant 8. The drummed filter cake will be staged in Plant 1 for off-site disposal. The Uranyl Nitrate Bench Test Report and previous test results indicate that the waste stream will meet the requirements for disposal at the Nevada Test Site (NTS). Sampling and Analysis Plan Number 94-795 specifies the sampling and analysis requirements that, if followed, will generate results in agreement with sampling and analysis requirements of NVO-325, Rev. 1, *Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements*; and the FEMP *Sitewide CERCLA Quality Assurance Project Plan (SCQ)*.

9.6.2 Aqueous Filtrate

Filtrate that will not be recycled through the processing system will be transferred to the General Sump. Treatment of the filtrate after acceptance at the General Sump is not within the scope of the UNH Neutralization Project. The UNH Neutralization Project considered NPDES requirements to ensure treatability of the filtrate at the FEMP Biodenitrification Facility and release under the FEMP NPDES Permit.

9.6.3 Miscellaneous Waste

It is anticipated that six additional waste streams will be generated throughout the course of the project. The waste streams include:

- scrap wood
- scrap metal
- plastic, rubber, paper, fiberglass, rope
- non-regulated asbestos containing material (non-friable)
- electrical equipment (wire, conduit, lights, switches, etc.)
- personal protective equipment (PPE).

Each of these waste streams has either been characterized or will be characterized through the use of process knowledge checklists as it is generated using existing site procedures.

9.7 References

1) DOE-FN, Removal Action No. 20, Uranyl Nitrate Neutralization Project Removal Action Work Plan, June 1994.

2) IRS&T(NFS):91-1022, Rev. 2, "Plant 2/3 Uranyl Nitrate Disposal Safety Assessment."

3) FERMCO. 94-745, UNH Sampling and Analysis Plan.

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SECTION 10
INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

10.1 Introduction

The initial testing, in-service surveillance, and maintenance requirements for this facility that are important to the operability and safety of this facility are presented in this section.

10.2 Requirements

DOE Order 5480.31, "Start-up and Restart of Nuclear Facilities"
DOE Order 6430.1A, "General Design Criteria"
DOE Order 4330.4A, "Maintenance Management Program"
DOE Order 5700.6C, "Quality Assurance"

10.3 Initial Testing Program

Start-up testing demonstrates that a system or facility which has been newly installed, significantly modified, or shut down for a prolonged period is capable of fulfilling its intended design function. FEMP Engineering Procedure, "Start-up and System Operability Test Procedure," ENG-12-6003 (Ref. 1), establishes the guidelines for determining when a test is to be performed, its preparation, execution, and closeout. Construction and acceptance tests, instrumentation calibrations, individual systems tests, pre-operational integrated systems tests, and system operational tests certify that a new facility or system meets its design criteria. This test program contains both notification points and an evaluation of the process by the operating contractor's safety organization, quality assurance, and independent laboratory. The start-up test results are compared to both the design criteria and construction specifications to verify compliance with the design and designated standards. The results of the test program provide the documentation needed to validate the design, facility, construction, and safety analysis. The specific start-up testing requirements for the UNH Neutralization Project are presented and in Table 10.3-1, Start-up testing for the UNH Neutralization Project. These features were identified in the Hazard Analysis in Section 3 as having a direct bearing on the safety and operability of the process. The UNH Neutralization Project Manager is responsible for ensuring the completion of initial testing as required in ENG-12-6003 prior to operations.

Table 10.3-1 Start-up testing for the UNH Neutralization Project

System	Start-up Testing
System vessels, piping, and valves	Hydrostatic testing, operability (valves)
Pumps	Test for operability, flow rate
NO_x Air Monitoring	Test for operability, setpoint, and calibration
Required Air Monitoring Equipment	Test for operability, setpoint, and calibration
NO_x Scrubber	Test for operability and effectiveness
Level Indication & Control	Test for operability, setpoint, and calibration
Temperature Indication	Test for operability, setpoint, and calibration
pH Indication & Control	Test for operability, setpoint, and calibration
Limit switches on valves	Test for operability, setpoint, and calibration
Flow Indication & Control	Test for operability, setpoint, and calibration
Scales	Test for operability, setpoint, and calibration
Diked area and curbing	Test for leak tight condition
Local exhaust ventilation for diatomaceous earth	Test for operability and design flow rate
Ground Fault Circuit Interrupters	Test for operability

10.3.1 Simulation

Verification of the UNH process equipment, procedures, and training readiness prior to start-up will be obtained by an operability or simulation test. The simulation procedure will involve a demonstration of system operability using water as the process fluid. The following list of the equipment to be utilized during UNH processing will be included in this test.

Simulated "UNH" Tank - A tanker truck filled with water will be positioned near each of the five different UNH tank locations.

Dilution/ Neutralization Tank - Tank F1-26 will be used to received the water from the tanker truck. While the water is in tank F1-26, some quantity of magnesium hydroxide will be transferred to simulate neutralization.

Magnesium Hydroxide Supply Tank - Tank 3A, located by Tank F1-26, will be used to make-up a quantity of magnesium hydroxide by mixing $Mg(OH)_2$ with water.

Slurry Hold Tank - Tank F 43-203A will be used to receive the water from Tank F1-26. This tank will also be used to provide water to the East or West EIMCO

	Filter to simulate filtering of the UNH.
East and West EIMCO Filter -	Each filter will be operated separately during the simulation procedure.
Filtrate Hold Tank -	Tank 25A will be used to receive filtrate water from the East and West EIMCO Filter

The transfer of water from each processing vessel will be performed using the new pumps and piping systems. A training and qualification program incorporating Conduct of Operations and hazard analysis results will ensure that personnel have the ability to operate and understand the process. These programs will enable the simulation operation and a detailed review of the procedures and provide on-the-job type qualification prior to the actual processing of UNH solution.

The Operational Readiness Review Team reviews testing procedures and test results to ensure that a new system or process will be tested and its design function verified.

10.4 In-Service Surveillance Program (ISP)

When a component, system, or facility has been installed and its capability proven, this capability is periodically demonstrated and maintained by surveillance testing, in-service inspection, and/or maintenance. Test results will be documented and evaluated relative to acceptance criteria that satisfy specified objectives. Surveillance testing proves that the design function of a system or component be fulfilled when required. In-service inspection confirms that an aspect of a system or component continues to be satisfactory (e.g., pressure integrity). Test results will be documented and evaluated relative to acceptance criteria that satisfy specified objectives. System-by system in-service surveillance is presented in Table 10.4-1. Any indication of a leak is reported to the UNH supervisor. Corrective actions will be taken based on the severity and location of the leak. Reporting requirements will be followed as stated in Section 15. DOP testing of HEPA exhaust is required after opening the unit, replacing the filters, or every 6 months.

Table 10.4-1 Surveillance Requirements for the UNH Neutralization Project

System	Surveillance	Frequency
System vessels, piping, valves	Visual Leak Inspection	Transfer*
NOx Air Monitoring	Test for operability, setpoint, and calibration	Monthly
Airborne Radiation Monitoring	Test for operability, setpoint, and calibration	Monthly
PPE	Inspection for integrity	Each use
Asbestos Air Monitoring	Test for operability	Monthly
NOx Scrubber	Test for operability	Monthly
Level Indication & Control	Test for operability, setpoint, and calibration	Each Batch
Temperature Indication	Test for operability, setpoint, and calibration	Monthly
pH I&C	Test for operability, setpoint, and calibration	Monthly
Limit switches	Test for operability, setpoint, and calibration	Monthly
Flow Indication & Control	Test for operability, setpoint, and calibration	Monthly
Scales	Test for operability, setpoint, and calibration	Monthly
Drumming Station HEPA Exhaust	Test for operability DOP test	Each use Bi-annual; after opening unit; after filter change
Local exhaust ventilation for Dicalite	Test for operability	Each Use
NOTE: *Done during and after each Transfer		

10.5 Maintenance Program

The Maintenance Program for the UNH Neutralization Project supports and enhances the safe operation of the UNH systems and facilities. The UNH Project has an anticipated operating duration of 9 months and contains no safety-significant or safety-class systems structures, or components. Maintenance requirements are graded to focus on maintaining the operability and safety of the UNH processing systems and work environment.

10.5.1 Maintenance Philosophy

Maintenance has a major role in preserving DOE property and ensuring safe and reliable operation of facilities and equipment. The maintenance program for the UNH Neutralization Project utilizes the

FEMP Site Maintenance Program. Maintenance requirements are implemented utilizing an approach tailored to the UNH Neutralization Project. This approach provides for maintenance of equipment commensurate with the relative importance to safety, environmental protection and compliance, programmatic mission, and facility specific requirements. If equipment is important to safety, important to environmental protection, is costly to replace, or failure would seriously impact the Project, the maintenance requirements are more stringent than maintenance requirements applied to equipment or systems that do not have safety, environmental, or programmatic consequences. This philosophy is consistent with DOE Order 4330.4B.

10.5.2 Maintenance Program Management Systems

The Site Maintenance Program is controlled by two elements, the Maintenance Operating System and the Computerized Maintenance Management System (CMMS). The Maintenance Operating System consists of the documentation and procedures which ensures that structures, systems, and components are maintained in accordance with DOE Order 4330.4B. The CMMS is a computerized automated maintenance management system used to integrate and control work order generation, preventive maintenance (PM) scheduling, and machinery history. The maintenance work order system is the vehicle for requesting and completing maintenance activities.

UNH Neutralization Operations personnel coordinate PMs for both new and existing UNH Project equipment with the Maintenance Department to ensure that a PM does not become due at a time that will impact operations schedules.

Deficiencies noted on completed PM work packages or by deficiencies submitted to the RSO Commitment Tracking System initiate corrective maintenance activities for the UNH facilities. Work orders to correct deficient maintenance items are processed and scheduled using the CMMS system. Maintenance deficiencies are tracked from initiation through resolution.

10.5.3 Maintenance Work Order System

The FEMP Work Request/Order System provides the instructions for requesting, approving, and controlling service activities performed by Maintenance and Support Services at the FEMP. The procedure establishes a system that ensures that maintenance and related activities are performed in an auditable and safe manner consistent with DOE, other governmental, and FEMP policies. All requests for Custodial Maintenance, Trouble Calls, Preventive Maintenance, Corrective Maintenance, and Support Services are initiated and processed in accordance with this system. Quality, safety, maintenance, and operations personnel review work order prior to approval and release. To ensure configuration control the facility owners for the UNH Neutralization must approve work orders for the UNH facilities.

10.5.4 Maintenance Program Responsibilities

The Maintenance Department is organized under the Remediation Support Operations (RSO) Division and consists of a Maintenance Manager and designated personnel who perform planning scheduling, preventive and corrective maintenance coordination, machinery history recording, and materials management functions. The organization also consists of several specialty crafts.

10.5.5 Maintenance Program Equipment

All UNH equipment under configuration control is identified in the UNH Project Master Equipment List (MEL), which is a listing of UNH Project Facilities, systems, and equipment requiring tracking for maintenance purposes. UNH Project and maintenance engineering personnel evaluate facilities, systems, and equipment to identify required PMs. Under their guidance and in accordance with manufacturer's recommendations, PM procedures are written and subjected to review and approval by the site safety and quality organizations. The PM procedure, PM schedule, and component information is entered into the CMMS system.

Other items included in the maintenance program requiring safety inspection are power tools and special tools and equipment used in maintenance activities. Periodic assessment and appropriate calibration checks of maintenance tools and equipment ensure they are safe to use and are in current calibration, where applicable.

10.5.6 Maintenance Program Interfaces

The maintenance organization interfaces with the UNH Neutralization Project as follows:

- UNH Neutralization Operation administratively controls access to, and work in, the UNH Neutralization Facilities. Maintenance work order review and approval by the facility owner is required for work in the facility.

- UNH Neutralization maintenance work orders and procedures require review by quality and engineering personnel. Quality inspection support is required as specified in individual work orders.

- UNH Neutralization maintenance work orders and procedures are reviewed by safety personnel to ensure the adequate protection of the worker and by USQ TR trained personnel to determine if the specified maintenance involves an USQ.

- Cognizant Systems engineering personnel review PM procedures and recommend systems spare parts inventories.

10.6 References

1) FEMP Engineering Procedure, *Start-up and System Operability Test Procedure*, ENG-12-6003.

2) FERMCO, December, 1993. *FERMCO Operational Readiness Review Manual*, SM-0005.

3) DOE Order 4330.4B, "Maintenance Management Program"

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SECTION 11
OPERATIONAL SAFETY

11.1 Introduction

This section provides information that satisfies the requirements of DOE 5480.23, paragraph 8.b.(3)(q), relating to operational safety. The section describes the basis for programs, plans, and procedures used to assure that operation of the facility is managed, organized, and controlled in a safe manner in accordance with the requirements of DOE 5480.19 and other applicable DOE directives. The SAR is not intended to be the vehicle for review and approval of these programs. It is intended to describe the salient features of the program as it relates to this facility. The detailed programs and procedures are referenced facility documents and may be changed without further DOE approval if the changes do not constitute a Unreviewed Safety Question (USQ).

11.2 Requirements

DOE Order 5480.19, "Conduct of Operations Requirements for DOE Facilities"
DOE Order 5480.23, "Nuclear Safety Analysis Reports"

11.3 Conduct of Operations

DOE Order 5480.23, Attachment 1, Item 17, "Nuclear Safety Analysis Reports," states that the conduct of operations should demonstrate compliance with DOE Order 5480.19, "Conduct of Operations Requirements for DOE Facilities," and that the considerations in the following subsections should be addressed. The Remediation Support Operations Division's *Conduct of Operations Manual* (Ref. 1) establishes a policy for implementation of Conduct of Operations (CONOPS) requirements and guidelines in all functional areas within RSO Division facilities and activities. *Facility Owner's Standing Orders for Plant 2/3 Uranyl Nitrate Hexahydrate (UNH) Neutralization Project* (Ref.2) and *Facility Owner's Standing Orders for Plant 8 Filtration and Volatile Organic Compound (VOC) Treatment Systems* (Ref. 3) have been prepared for the UNH Neutralization Project.

11.3.1 Operations Organization and Administration

The UNH Neutralization Project is organized within the Remediation Support Operations (RSO) Division. An organization chart including the individuals assigned as interfaces for safety, training, procedures, and other key responsibilities is included in the UNH Neutralization Project Technical Information Plan (TIP) (Ref. 4).

11.3.2 Shift Routines and Operating Practices

All UNH personnel are expected to maintain high standards of performance in the conduct of their duties. They are required to be alert and aware of all conditions affecting their work site at all times. The UNH Supervisor, as the first-line supervisor, is responsible for maintaining expected performance standards for himself as well as his assigned task group.

11.3.2.1 Safety Practices

Safety is the number one priority for all UNH tasks and is a part of proper Conduct of Operations. All safety precautions required by the site Health and Safety Plan, the UNH Health and Safety Plan, the Safety Analysis Report, and the safety precautions listed as part of all applicable Standard Operating Procedures will be followed. In any given situation good engineering practice and common sense shall also dictate the actions of all personnel. When it appears that work cannot proceed safely, all UNH personnel are directed to stop, place the system or component in a safe configuration, and notify the UNH Supervisor. The supervisor must notify appropriate organizations, resolve the issue, and record the situation in the UNH Supervisor's Daily Log.

11.3.2.2 Operator Inspection Tours

Operator tours shall be documented and of sufficient detail to ensure that the status of equipment is known. Each operator will conduct a thorough tour of all areas within his/her responsibility, making appropriate equipment inspections at least once per shift. During the tour, equipment shall be inspected to ensure that it is operating properly or, in the case of standby equipment, that it is fully operable. In addition, the following activities shall be conducted in conjunction with the tour:

a. The status of equipment (i.e., operating, standby, work in progress, or out-of-service) shall be determined so that the operator will be best able to respond to problems he/she may face during his/her shift.

b. Components, such as electrical panels, alarm panels, autostart standby equipment, and breakers shall be inspected for abnormal or unusual conditions. Unexpected conditions such as equipment vibrations, unusual noises or smells, or excessive temperatures should be reported to the control room so that supervisors will be aware of the conditions and be able to direct repairs, troubleshooting, or additional operator action, as necessary.

c. Equipment panel alarm light bulbs and annunciators shall be periodically checked to ensure satisfactory operation of visual and audible abnormal condition indicators.

d. Each Operator shall inspect all areas for which he/she is responsible and note any deficiencies that may be present. These deficiencies may include steam, oil, or water leaks; fire and safety hazards or radiological problems; seismic concerns such as open electrical panels and mobile objects; clogged floor drains; housekeeping or cleanliness problems; and building deficiencies such as inoperative lighting, roof leaks, or doors that do not close properly.

Operators shall take appropriate action to correct or report deficiencies noted during tours. Equipment deficiencies are documented in accordance with the facility maintenance work request system.

11.3.2.3 Personnel Protection

Appropriate Personnel Protective Equipment (PPE) shall be worn while performing UNH tasks. Company issued safety shoes and safety glasses shall be worn at all work sites unless specifically exempted. Other PPE, as required by FERMCO Work Permits, shall be worn as required.

11.3.2.4 Response to Indications

Operators are instructed to believe that all instrument readings are accurate until proven otherwise. Any instrument that shows an abnormal or out-of-specification reading is to be considered correct until proven otherwise and the following action taken:

- Notify the UNH Supervisor immediately.
- Attempt to verify the abnormal / out-of-specification reading by checking other instruments that read the same parameters. When available, at least two other means of indication should be used.
- If there is any doubt about which instrument is correct, always believe the out-of-specification / abnormal instrument and as necessary, to protect against equipment damage and personnel injury, the equipment, system, or facility shall be placed in a safe condition.
- Promptly investigate the cause of the abnormal or out-of-specification reading.
- Malfunctioning or inaccurate instrumentation shall be reported to the UNH Supervisor and noted in the narrative section of the log/round/tour sheet and in the UNH Operators Log.

11.3.2.5 Resetting Protection Devices

Alarms or actuation of protection devices are to be considered real until proven otherwise. Take immediate action to place the affected equipment/system/facility in a safe condition to prevent damage or personnel injury. The following supplementary action shall be taken:

- Silence the alarm if an auditory signal is part of the alarm, but do not reset the alarm. After initial response to the alarm, silencing the auditory portion of the alarm will reduce stress and confusion in the affected area.

- Investigate the cause of the alarm or actuation of a protective device.

- Only reset an alarm or protective device after the cause has been determined, understood, and corrected or the actuation of the alarm or protection device has been found to be false. Authorization to reset a protective device or alarm shall be obtained from the UNH Supervisor.

- All alarms or actuation of protection devices shall be logged in the comment section of the log/round/tour sheet and the UNH Operator's Log with investigative and corrective action information.

11.3.2.6 Authority to Operate Equipment

All UNH field activities are performed under the supervision of the UNH Supervisor. The degree of supervision will be dictated by the complexity of the task and the risks involved. Each member of the task group must have a clear understanding of the supervisor's expectations as delineated in the daily pre-shift briefing. All non-routine or unusual operations must be under the direct supervision of the UNH Supervisor.

11.3.2.7 Potentially Distractive Written Material and Devices

Use of written material such as magazines and newspapers and entertainment devices such as radios, "walkmans", and televisions that do not relate to the field activity operations being conducted is prohibited.

11.3.3 Communications Within the Facility

UNH personnel will use formal communications techniques for audible communications. By using formal communications techniques an individual can accurately transmit and receive work instructions, feedback or results of work, results of data, emergency or safety warnings, and instructions. Both written and verbal communications must be clear, concise, and correct. Before trying to convey information or instructions, orally or in writing, a sender should plan what to say and then say it to him/herself to ensure that its clarity is what the sender intends. Only then should the sender convey the information or instructions to the intended receiver.

11.3.3.1 Emergency Communications

Reliable and accurate communications are essential for the safe and efficient operation of facilities supporting the UNH Neutralization Project. Use and control of communications systems for both normal plant operations and emergency operations are governed by the FEMP Emergency Plan which is addressed in Section 15. The FEMP communications center is the central control point for the use and monitoring of all radio communications, public address, and alarm systems.

11.3.3.2 Clear Communications

Communications that contain words with multiple meanings or similar sounds may be confusing (e.g., use "raise" and "lower" instead of "increase" and "decrease"). Use only proper noun names and numbers for equipment (e.g., "main power distribution circuit breaker number one"). When verbally communicating information combining both numbers and letters, both sender and receiver should use a phonetic alphabet to ensure clarity. One exception to the practice of using phonetic characters is the use of approved standard abbreviations such as "ID fan" for induced draft fan.

11.3.3.3 Concise Communications

Both oral and written communications that convey information or instructions must be as brief as possible while still effectively communicating the intended message.

11.3.3.4 Correct Communications

Messages intended to convey technical nomenclature should be specific to ensure that the correct unit or component is identified. Noun names and equipment or document numbers should be used together (e.g., "The Safe Shutdown Program Planning and Implementation Manual, IM-6001") to ensure that the message transmitted is properly understood by the receiver.

11.3.3.5 Telephone/Radio/Face-To-Face Communications Format

To ensure that an intended receiver understands exactly what a sender intends, telephone, radio, and face-to-face communications should all use the same well-proven formal radio communications format outlined below:

- Establish communications
- Sender convey the message
- Receiver repeat-back the message
- Sender confirm the correctness of the repeat-back

If a repeat-back is incorrect the sender should reconvey the message as many times as necessary to obtain a correct repeat-back and confirm the message is understood. If a message is long and/or complex, breaking it into segments with a repeat-back between each segment will help the receiver comprehend it sooner.

11.3.4 Control of Onshift Training

UNH field activities are conducted by personnel who are qualified for their on-shift duties, unless these activities are being conducted in accordance with an approved on-the-job training program. No unqualified personnel will be involved in field activities.

11.3.4.1 Training and Qualification Program Participation

Training and qualification will be conducted as an integral part of the UNH implementation process. A systematic approach to training, applied using a graded approach, is used to define the level of training required to proceed with the execution of a specific task.

- The UNH Supervisor assigned the responsibility for completing a specific field activity will conduct a task specific briefing and walk through for personnel who are assigned to perform the work to ensure that they have a though understanding about how to perform the work safely and correctly. Any uncertainties about how to proceed will be clarified prior to commencing the work. The supervisor has the right to re-assign personnel who do not understand or are unwilling to comply with safety and procedural requirements.

- A briefing and a task walk-through will generally suffice for task specific training; however, for more complex or higher risk tasks, a more detailed formal qualification may be required, as determined by the UNH Operations Manager.

11.3.5 Control of Equipment and Systems Status

Good engineering practice dictates that configuration of equipment and systems be controlled in such a way that facility owners, supervisors, and operators can readily determine the status of their facilities.

11.3.5.1 Status Change Authorization and Reporting

The process leader is responsible for maintaining proper configuration and shall authorize status changes to major equipment and systems. Since the process leader is typically the senior operating person on shift, he/she is tasked with maintaining a broad overview of facility operations. His/her perspective of status must necessarily be the focal point of shift operations.

Since the operators must be aware of equipment and system status, the process supervisor shall ensure that all changes in status are communicated to these persons. Typically, the control area operator is in the line-of-information flow to and from the process supervisor.

Changes in the status of facility equipment and systems should be reported to the governing stations (e.g., control area) or to the individual (or his relief) who authorized the change. Typically, changes in status of safety-related equipment and systems should be authorized by the process leader and reported to the control area.

11.3.5.2 Equipment and System Alignment

Prior to first placing the equipment or system into operation, individual components for facility equipment and systems should be properly aligned or checked for proper alignment. An initial alignment of valves, switches, and breakers establishes a baseline configuration against which further operations may be measured. Once the equipment or system is properly aligned and is operating in accordance with operating procedures, frequent complete alignments of all individual components may not be necessary. Alignment checklists should be used to guide the operator in establishing the correct component positions. The alignment checklists should include provisions for equipment nomenclature that matches the nomenclature placed on the component, a location for individual documentation of the check of each component, the required alignment position for each component, and a location for annotating deviations from the required alignment. The supervisor should review and approve completed alignment checklists.

The need for a complete alignment of equipment and systems should be based on the level of control that has been maintained over the status of the components. Typical situations that may require equipment and systems to be aligned include startup from cold shutdown, major outages, and mode changes. In addition, safety-related equipment and systems should be functionally tested in accordance with surveillance requirements in the technical specifications/operational safety requirements following maintenance and before the equipment or system is considered capable of performing its design function.

11.3.5.3 Equipment and Material Deficiencies

All equipment and material deficiencies shall be identified to the Process Leader through the Process Supervisor. The Process Leader will direct the appropriate action. If immediate corrective action is necessary the Process Leader will notify the Project Manager through the Operations Manager.

All deficiencies will be entered in the Equipment Status and Deficiency Log maintained at the Process Leader's Operating Base. The entry will remain in the log until the material deficiency is corrected.

11.3.5.4 Work Authorization

The Facility Owner is responsible for controlling all work on the systems related to the UNH Neutralization Project. Documentation of the status of all work in progress on the UNH Neutralization Project related systems will be maintained by the Facility Owner. Work requests will be processed in accordance with the FEMP Work Request/Order System SSOP-0061 (Ref. 5).

11.3.5.5 Equipment and Systems Return to Service

Equipment and systems removed from service shall be designated "Out of Service" and not returned to service until maintenance or modification has been conducted and retesting or special testing has been satisfactorily completed. The Facility Owner or his designee will authorize returning equipment and systems to operable condition.

11.3.5.6 Temporary Modification Control

Temporary modification of systems will be administratively controlled using the maintenance work order system to provide technical oversight and impact evaluation prior to approval. The Operations Manager will ensure compliance with the work procedure and provide required update of operating procedures and training.

11.3.5.7 Distribution and Control of Equipment and System Documents

The Operations Manager will ensure the latest revisions of engineering drawings are verified and will be available for operations. Operating procedures will be controlled and distributed per the Remediation Support Operations (RSO) Division Document System.

11.3.5.8 Equipment Locking and Tagging

Locks and tags will be used on those components that require special administrative control for safety or other reasons. Locks and tags provide some security that a component will be operated only by authorized facility personnel performing required evolutions in a controlled fashion. Additionally, locks and tags should alert the operator of the importance of the component and remind him/her that special controls over repositioning are to be maintained. Tags and locks are controlled by the *FERMCO Lockout/Tagout (Hazardous Energy and Material Control) Procedure*, SSOP-0719 (Ref. 6).

To perform any maintenance on any system in the UNH Project, the following steps will be taken to isolate that system from the environment and worker:

1) All systems to be worked on will be physically isolated by closing two valves in series, where possible, on all piping entering or leaving the tanks.

2) The valves will be locked, where possible, and tagged with a Danger-Do Not Operate tag, in accordance with the references listed below.

3) The locked and tagged valves will be recorded in the Lockout/Tagout log, in accordance with the references listed below.

4) When a line does not contain two valves in series, specific approval from the UNH Operations Manager will be obtained in order to proceed with only a single locked valve.

5) Exceptions to the two valve isolation requirements will be documented in the Lockout/Tagout log, in accordance with the references listed below.

6) When a valve can not be locked, specific approval from the UNH Operations Manager will be obtained in order to tag the valve with a Danger-Do Not Operate tag without a lock.

7) When a valve is secured only with the placement of a Danger-Do Not Operate tag, the location of the valve and the fact that a lock is not present will be recorded in the Lockout/Tagout Log.

11.3.6 Independent Verification Practice

The independent verification program is established to provide a system for independent verification of components which are considered critical to the safety of operation of the process, system, or facility. Independent verification shall be performed in those cases where a reasonable potential exists for component mispositioning. The Operations Manager will determine the method of independent verification for each component and procedures for documentation, and will ensure that all personnel performing the verifications are trained.

Those components in systems having safety related functions are considered for independent verification. Occasions for independent verification are established when components must be available and a reasonable probability exists that the component may be mispositioned. Independent verification of components will be performed when appropriate for situations including post maintenance, returning equipment to service, system lineups after extended shutdown, and periodic checks.

11.3.7 Notifications and Reporting Practices

The FEMP maintains the necessary emergency plans and procedures for notification and reporting of abnormal events meeting DOE requirements. Refer to Section 15.

11.3.8 Investigation of Abnormal Events

The FEMP maintains the program for the investigation of abnormal events to ensure that all significant aspects of an abnormal event are identified, investigated, and resolved in accordance with DOE requirements. Refer to Section 15.

11.3.9 Control of Hazardous Materials

The FEMP maintains plans and procedures for control of hazardous materials including radiation protection, hazardous material protection, and radioactive and hazardous waste management. Refer to Sections 7,8, and 9.

The FEMP maintains the fire protection plan and program. The fire protection system for the UNH Neutralization Program is addressed in Section 2.9.1.

11.3.10 Operations Turnover Practices

Oncoming operator/supervisors conduct a discussion of plant conditions with offgoing operator/supervisors prior to assuming responsibility for a shift position. Shift turnovers provide oncoming operators with an accurate picture of the overall facility status. Turnover consists of pre-shift briefing by the UNH Supervisor for the task work group. Reassignment or temporary absence of personnel may also require a turnover of responsibilities, which must be conducted in a formal manner.

11.3.10.1 Document Review

The oncoming UNH Supervisor must review all applicable documents, including the UNH Supervisor's Daily Log sheets since the beginning of the current task. For more complex or long-term tasks, further guidance will be provided by the UNH Operations Manager.

11.3.10.2 Shift Crew Briefing

A crew briefing will be conducted by the UNH Supervisor before work begins for that shift. The briefing will include a review of the status of the task, problems experienced since the task has begun and/or current problems, and evolutions in progress planned for the shift. The briefing must provide all shift personnel with the shift priorities and the objectives for that shift.

11.3.11 Logkeeping

The UNH Supervisor's Daily Log is a narrative log used to record fully the data necessary to provide an accurate history of the UNH Project. Events are recorded in a timely fashion to ensure the accuracy of the entry. The UNH Supervisor and the UNH Operations Manager will review the log to ensure that its status is current with the particular field activity to which it applies.

11.3.11.1 Logkeeping Instructions

The UNH Supervisor's Daily Log will contain the following information:

- Listing of personnel assigned.
- Documentation of satisfactory completion of the pre-shift briefing including safety issues discussed, work assignments, and work status.
- Any abnormal configurations.
- Status changes to safety-related and other major equipment.
- Occurrence of any reportable events.
- Out-of-specification process results.
- Shift reliefs if applicable.

Log entries will be made in a manner such that they can be easily read and understood. Additionally, the log entries will be made in black, waterproof ink, which is easily reproducible with standard photocopy machines. Corrections to erroneous entries will be made by placing a single line through the incorrect entry in such a way that it is not obscured. The correct information is then entered and the correction is initialed and dated.

11.3.11.2 Log Disposition

Completed and reviewed UNH Supervisor's Daily Log sheets will be filed with the completed UNH Neutralization Project Work Package.

11.3.11.3 Standing Orders for UNH Personnel

The RSO Division Conduct of Operations Manual (Ref. 1) and the Facility Owner's Standing Orders for Plant 2/3 Uranyl Nitrate Hexahydrate (UNH) Neutralization Project (Ref. 2), and the Facility Owner's Standing Orders for Plant 8 Filtration and Volatile Organic Compound (VOC) Treatment Systems (Ref. 3) are the policy documents for implementation of Conduct of Operations. The standing Orders shall be read and acknowledged by signature and date within two weeks of their original promulgation, every six months thereafter, and when directed by the UNH Operations Manager. Newly reporting UNH personnel shall initially read and acknowledge the Standing Orders within two weeks of being assigned to the UNH Neutralization Project and will be on restricted duty until the requirement is complete.

11.3.11.4 Orders to Operators

Timely Orders to Operators is a method for the Operations Manager and/or Facility Owner to communicate daily, job duration, time dependent, or other perishable written instructions to UNH operators. Compliance with Timely Orders to Operators is mandatory for all operators to whom they are addressed. Only the Operations Manager/Facility Owner, or a designated stand-in, shall issue these orders. Timely Orders to Operators, consisting of Long-Term and Daily Orders shall be:

- Issued directly to the applicable UNH Supervisor who shall ensure that they are reviewed and contents acknowledged by addressees initialling them during each applicable pre-job and subsequent pre-shift job briefing.
- Complied with explicitly without deviation. If it appears that a Daily or Long Term Order cannot be followed as written, if they are incomplete, or compromise safety or good engineering practices, the operator shall stop the action directed by the orders, place the work place in a safe condition, notify his/her immediate supervisor, and await resolution of the problem.

11.3.12 <u>Operator Aid Postings</u>

Operator aid postings are an important function in the safe operation of systems and components utilized in the UNH Neutralization Project. The Operations Manager is responsible for the administration of this program to ensure that the authorization, documentation, and review of operator aid postings are current, complete, and necessary. Remediation Support Operation's Division Operator Aid Postings (Ref 7) establishes policy for operator aid postings in compliance with DOE requirements.

11.3.13 Equipment and Piping Labeling

The labeling program for equipment and piping for systems associated with the UNH Neutralization Project is set forth in Remediation Support Operation's (RSO) Division Policy *Equipment and Piping Labeling* (Ref. 8). Labeling requirements for valves, piping, and products under the responsibility of the FERMCO Construction Manager are defined in the Project Performance Specification. Quality Assurance will verify that the equipment and pipe labeling is consistent with the UNH Neutralization Project drawings, design requirements, and procedures.

11.4 Site Policies and Procedures

Company Policy Documents and Facility Implementing Procedures are developed and implemented as appropriate. The *Management Plan: FERMCO Policies and Requirements Manual* (Ref. 9) includes the Standards/Requirements Identification Document (S/RID) for Operations. This S/RID identifies the operational requirements for the FEMP per the FERMCO contract with the DOE; Federal, State, and local laws; DOE Orders; and DOE Guidance documents. The UNH Neutralization Project has prepared a Technical Information Plan (TIP) (Ref. 4) identifying the S/RIDs specifically applicable to the UNH Neutralization Project.

11.5 Operation Requirements

This section specifies the requirements for operation of the UNH Neutralization System. Prior to the processing each batch of UNH solution, the following conditions or controls must be met or provided. The determination of operability is an ongoing function of the operations organization. This determination is based on activities such as performance of pre-operational equipment checks, verification of current calibrations, and up-to-date preventive maintenance tasks, review of open corrective maintenance items and defeciencies, and performance/review of post-maintenance and periodic tests. The operability of the system components is verified prior to the start of operations and checked on an on-going basis by means of checks included in the operating procedures, preventive and corrective maintenance, and calibration.

11.5.1 Staffing

A. The minimum staffing identified in Section 17.2 must be in place.
B. Training must be current.
C. Qualification cards must be complete for required workers.
D. Required FERMCO Work, Radiation, and Chemical/Hazardous Permits must be obtained and posted.

11.5.2 UNH Storage Tank

A. Level indication must be provided for the storage tanks being emptied.
B. High level alarm, and annunciator must be operational.

11.5.3 UNH Transfer System

A. Pump speed control and indicators must be operational.
B. Pressure sensors to shut down pump must be operational.
C. Pump discharge pressure indicator must be operational.
D. Flow indicator and totalizer must be operational.

11.5.4 Dilution Water Supply System

A. Flow totalizer must be operational.
B. Temperature control and indication must be operational.

11.5.5 Dilution/Neutralization Tank

A. Level indication, high level alarm, and automatic shut-off valve must be operational.
B. pH indication must be operational.
C. Temperature indication and high temperature alarm must be operational.
D. Agitator and controls must be operational.
F. Exhaust ventilation must be operational.

11.5.6 Magnesium Hydroxide System

A. Pump speed control and indicators must be operational.
B. Flow totalizer and indicator must be operational.
C. Pump interlocks must be operational.

11.5.7 Slurry Transfer Pumps

A. Pump speed controller and indicators must be operational.
B. Pressure sensors to shut down pump must be operational.
C. Pump discharge pressure indication must be operational.
D. Flow indicator and totalizer must be operational.
E. Valve interlocks must be operational.

11.5.8 Plant 8 Filter Feed Tanks (F43-203 and F43-203A)

A. Level indication must be operational.
B. Agitator and controls must be operational.
C. Valve interlocks must be operational.
D. High level switch, alarm, and automatic shut-off valve must be operational.

11.5.9 Plant 8 Filter Feed Pump

A. Pump controls and indicators must be operational.
B. Discharge pressure indication must be operational.
C. Pressure sensors that shut down pump must be operational.
D. Valve interlocks must be operational.

11.5.10 East and West Rotary Vacuum Filters

A. High level switch in filter basin must be operational during filtration.
B. High level alarm and pump shut-off interlock must be operational during filtration.

11.5.11 Plant 8 EIMCO Drumming Stations

A. Exhaust ventilation must be operational during filtration.

11.5.12 Plant 8 EIMCO Filter Precoat Tank

A. Exhaust ventilation must be operational while preparing precoat slurry.

11.5.13 Filtrate Tank 25A

A. Level indication must be operational.

11.6 Interface with Process Requirements from Other Facilities

Process Requirements for Maintenance of Tank D1-7 in a Safe Configuration Until Processing (Ref. 10) must be followed for any operations in Building 2A. Any modifications to Building 2A must be in concurrence with the Process Requirements for Tank D1-7. Process Requirements preparation is the responsibility of the Safety Analysis Department. Activities involving Tank D1-7 are the responsibility of the UNH Neutralization Project Manager. The UNH Neutralization Project has implemented the Process Requirements and the UNH Operations Manager is responsible for the surveillance of the system to ensure the system configuration is maintained.

11.7 References

1) FEMP RSO Division, December, 1994. *Conduct of Operations Manual*, M-100, Rev. 1.

2) FEMP RSO Division, December, 1994. *Facility Owner's Standing Orders for Plant 2/3 Uranyl Nitrate Hexahydrate UNH Neutralization Project*, M-115, Rev. 0.

3) FEMP RSO Division, December, 1994. *Facility Owner's Standing Orders for Plant 8 Filtration and Volatile Organic Compound (VOC) Treatment Systems*, M-116, Rev. 0.

4) FEMP, November 1994. UNH Neutralization Project Technical Information Plan, UNH-TIP-1000-0, Rev. 0.

5) FEMP, September, 1992, *Work Request/Order Procedure*, SSOP-0061, Rev. 0.

6) FEMP, February, 1994. *FERMCO Lockout/Tagout (Hazardous Energy and Material Control) Procedure*, SSOP-0719, Rev. 1.

7) FEMP RSO Division, December, 1994, *Operator Aid Postings*, D1O-20-017, Rev. 0.

8) FEMP RSO Division, December, 1994, *Equipment and Piping Labeling*, D10-20-018, Rev. 0.

9) FERMCO, December, 1993. *Management Plan: FERMCO Policies and Requirements Manual*, RM-0016, Rev. 0.

10) FERMCO, August, 1994. *Process Requirements for the Maintenance of Tank D1-7 in a Safe Configuration Until Processing*.

SECTION 12
PROCEDURES AND TRAINING

12.1 Introduction

This section provides information addressing the requirements of DOE 5480.23, paragraph 8.b.(3)(m), relating to procedures and training. The SAR is not intended to be the vehicle for review and approval of UNH Neutralization Procedures and Training. It describes the procedure development process and identifies procedures that are required for the safe normal and off-normal operation of the facility.

12.2 Requirements

DOE Order 5480.19, "Conduct of Operations Requirements," Chapters II, V, XVI.

DOE Order 5480.20, "Personnel Selection, Qualification, Training, and Staffing Requirements at DOE Reactor and Non Reactor Nuclear Facilities."

12.3 Procedures

Operating procedures are written to provide specific direction for operating systems and equipment during normal and postulated abnormal and emergency conditions. The procedures provide appropriate direction to ensure that the facility is operated within its design bases and used effectively to support safe operation of the facility.

The RSO Division Manual, *Conduct of Operations Manual* (Ref. 1), describes the policy, performance standards, and procedural guidance for the implementation of Conduct of Operations (CONOPS) in RSO facilities.

The RSO Division Procedure, D10-00-020, *Remediation Support Operations Division Document System* (Ref. 2), describes the system for controlling documents in the RSO Division Document System and applies to the UNH Neutralization procedures, material specifications, manuals, or methods. The procedure provides instructions to ensure that procedure development, content, changes and revisions, approval, review, availability, and use are appropriately addressed and support safe operation of the facility.

Procedure SSOP-0103, *FEMP Site Document System* (Ref. 3), describes the site-level system of documents which prescribes, processes, specifies requirements, and details the requirements for development, review, approval, distribution, and revision of these documents.

Procedure, SSOP-0716, *Control of Processes* (Ref. 4), describes the responsibilities and required actions for defining the control of processes and calls for controlling procedures to implement applicable codes, standards, and quality requirements. It also provides guidelines for qualifying special process/procedures and ensuring that personnel are qualified/certified as needed.

The Hazard Analysis in Section 3 identified procedure requirements that are needed to ensure safety. The procedural requirements are presented in Table 12.3-1 below.

Table 12.3-1 Task Specific Procedures

Procedure		Procedural Requirements
Process procedures	1.	A clear understanding of the scope of the project.
	2.	Step-by-step instructions for each operator and supervisor with built in cross-checking of parameters.
	3.	Address abnormal conditions and parameters, their implications, and appropriate responses.
Tank Emptying	1.	Step-by-step instructions for a worker safe operation.
Tank Filling	1.	Step-by-step instructions for a worker safe operation.
Leak Repair	1.	Step-by-step instructions for each operator and supervisor who will respond to leaks events.
	2.	Leak repair procedures specific to the nature of each materials: pressure, temperature, and corrosivity.

12.3.1 Development of Procedures

To ensure consistency among operating procedures developed for the UNH Project, the following guidelines based on DOE 5480.19, "Conduct of Operations Requirements" and associated DOE Standards "Guides to Good Practices" are followed for procedure development:

1) Administrative procedures and/or writers' guides shall direct the development and review process for procedures.

2) Procedures are developed for all anticipated operations, evolutions, tests, and abnormal or emergency situations.

3) Annunciator/alarm response procedures guide the operator in verifying abnormal conditions or changes in facility status and provide the appropriate corrective action are developed for all alarm panels.

4) All procedures should provide administrative and technical direction to conduct the intent of

the procedure effectively.

5) The extent of detail in procedure depends on the complexity of the task, the experience and training of the user(s), the frequency of performance, and the significance of the consequences of error.

6) Appropriate attention should be given to writing, reviewing, and monitoring operations procedures to ensure the content is technically correct and the wording and format are clear and concise. Although a complete description of a system or process is not needed, operations procedures should be sufficiently detailed to perform the required functions without direct supervision.

7) Procedure preparation, verification, and validation should receive high-level attention. Qualifications for procedure writers should be considered, including operating organization and experience. Review, verification, and validation should be formalized for written and software procedures.

12.3.1.1 Procedure Content

DOE Order 5480.19, "Conduct of Operations Requirements," provides requirements for the content of operating procedures being developed for the UNH Project. The guidelines listed below are followed for UNH Project procedure development:

1) The scope and applicability of individual procedures are to be readily apparent. Procedures with single-unit applicability should be distinctively identified to avoid confusion with sister-unit procedures. In addition, to enhance rapid retrieval, emergency procedures are to be distinguishable from other procedures. Color coding may be used for these purposes.

2) Procedures incorporate information from applicable source documents, such as the facility design documents, safety analysis documents, and vendor technical manuals.

3) Each step of a procedure that controls or references Operational Safety Requirements (OSR) or TSR identifies the OSR or TSR.

4) Prerequisites and initial conditions are detailed, with careful consideration given to the location of this information within the procedure, to ensure that the intent of the procedure is understood.

5) Definitions used in the procedure are to be explained.

6) Procedures are to be easily understood, and actions are to be clearly stated.

7) Procedures are to contain only one action per step.

8) Procedures are to contain sufficient but not excessive detail. The skill level, experience, and training of the users is considered.

9) Warnings, notes, and cautions are to be easily identifiable and contain no action statements.

10) Warnings, notes, and cautions are to precede the step to which they apply, and also appear on the same page as the step to which they apply.

11) Procedures are to be technically and administratively accurate.

12) Individual sign-offs are to be provided for critical steps. One sign-off is not to be applied to more than one action.

13) Limits and/or tolerances for operating parameters are to be specified and be consistent with the readable accuracy of instrumentation. Operators are not to be required to perform mental arithmetic to determine if a specified parameter is acceptable.

14) Acceptance criteria for surveillance or test procedures is to be easily discerned, including tolerances and units. If calculations are needed to compare data to acceptance criteria, the calculations are to be clearly explained.

15) Sequence of procedural steps is to conform to the normal or expected operational sequence. Training on this sequence, reinforced with procedures that show the same sequence, will serve to improve operator performance by development of patterns of action that are more easily remembered.

16) Procedures are to be developed with consideration for the human-factor aspects of their intended use. Charts and graphs are to be easily read and interpreted.

17) Emergency operating procedures are to provide guidance in responding to single and multiple incidents.

18) Portions or steps of other procedures that are used or referred to when performing a procedure are to be specifically identified within the procedure so that operators will not be confused when transferring between procedures.

19) Component or system shutdown, start-up, and restoration requirements, following shutdown or a surveillance or test activity, are to be specific and controlled by the procedure.

12.3.1.2 Procedure Approval

New and revised procedures will be approved prior to use. Operating procedures will be approved by the UNH Project Manager or his designee. Procedures that affect safety equipment and emergency procedures are reviewed by the facility safety review committee or by another appropriate review mechanism.

Changes that alter the intent of a procedure will receive the same approval as a new or revised procedure. Changes in operations procedures that do not affect the intent of the procedure may be approved by a qualified process engineer and a member of facility management.

12.3.2 Maintenance of Procedures

Procedure changes and revisions are necessary to ensure that procedures reflect current operating practices and requirements. The review and approval process for each procedure change or revision is documented using a Procedure Change Request Form.

The following requirements are applicable to UNH Project procedure changes and revisions:

1) Appropriate procedure changes and revisions are to be initiated when procedure inadequacies or errors are noted.

2) Procedure revisions are to be initiated when a significant change has been outstanding for greater than 6 months or when a procedure has been affected by more than five changes.

3) Procedure changes/revisions are to be implemented concurrently with modifications. Procedure updates required by temporary modifications should be handled as procedure "changes" and implemented concurrently with the temporary modification installation.

4) Important information regarding changes or revised procedures are to be communicated to appropriate operations personnel via the required reading system, pre-shift briefing, or a similar method.

5) Documentation of the reason for key procedure steps are to be maintained and reviewed when implementing changes or revisions that alter these steps. This practice is important to ensure that the reason for any step is not overlooked.

6) The review process is to involve verification and validation of the procedure using walk-through or similar methods.

12.3.2.1 Periodic Review

New and revised operations procedures are reviewed at least every 2 years to ensure that the information and instructions are technically accurate and that appropriate human-factor considerations are included.

Applicable procedures are reviewed after an unusual incident (such as an accident, an unexpected transient, significant operator error, or equipment malfunction). During reviews, procedures are compared to source documents to verify their accuracy.

12.3.2.2 Procedure Use and Availability

A controlled copy of all operations procedures is maintained in the control area and at specific work locations. Procedures are open and followed step-by-step when:

1) A trainee is conducting activities under the supervision of a qualified individual.

2) The operation being conducted is non-routine, complicated in nature, or infrequently performed.

3) There is evidence that a general weakness in procedural knowledge exists.

4) The procedure contains signoffs.

5) An error in performance could cause significant adverse impact.

6) The procedure contains an OSR/TSR.

UNH operators are required to be capable of performing the immediate action steps of emergency procedures without reference to the procedure. In addition, the emergency procedure is to be reviewed after the actions are performed, verifying that all required actions have been taken.

12.4 Training

This section addresses the specific training appropriate for the UNH Neutralization Project. All FEMP operations personnel are required to successfully complete and maintain current the General Employee Training requirements as stated in DOE Order 5480.20. The requirements of DOE Order 5480.11, "Radiological Protection for Occupational Workers (Ref. 5)," are satisfied by General Employee Training requirements and either Radworker I or Radworker II training. All UNH Operations personnel will have Radworker II training.

12.4.1 UNH Training and Qualification Requirements

Formal Qualification requirements as documented in Qualification Cards will be established for workers selected for the positions indicated in Table 12.4-1 below. These workers perform tasks that are associated with mitigators or controls. Radiation Control and Industrial Hygiene Technicians will be trained and qualified, in accordance with their respective programs, prior to working on the UNH Neutralization Project

Table 12.4-1 UNH Personnel Requiring Formal Qualification

Area	Position
Plant 8	Facility Owner
	Process Leader
	Process Supervisor
	Large EIMCO Filter Operator
	Small EIMCO (East and West) Filter Operator
	Valve Operator
	Chemistry Monitor
	Packaging Station Operator
	Packaging Station Scale Operator
	VOC Treatment System Operator
Plant 2/3	Facility Owner
	Process Leader
	Process Supervisor
	UNH System Monitor
	Pump Operator
	Valve Operator
	UNH Chemistry Monitor
	Sump Water Operator

12.4.2 Development of Training Programs

The content of the training program is determined by the Subject Matter Expert (SME), in that given topic, and a training coordinator. An SME is certified per SSOP-0014, *Documentation of a Subject Matter Expert* (Ref. 6). The SME incorporates operating feedback (from the FEMP and other facilities), operating procedures, training aids, and job analysis into the formulation of training course contents.

12.4.3 Maintenance of Training Programs

The Training Department is responsible for the development of training activities to comply with training requirements and to provide employees with training needed to qualify, re-qualify, or enhance job performance. Additionally, Training is responsible for the following:

1) Documenting and maintaining all training activities
2) Providing assistance in the development of all department/section training
3) Maintaining and administering the Training Records Management System
4) Maintaining original training records, including the maintenance of subcontractor training records supplied to Training by either Technical Instructors or the Manager of the contracting department

The Operations Manager is responsible for identifying the operations under his/her responsibility which comply with mandatory training requirements and which need trained, qualified, or certified employees. Additionally, the Project Manager is responsible for assuring that visitors, subcontractors, vendors, and temporary employees under their cognizance receive the training necessary for their protection and in accordance with DOE and FERMCO requirements. The Project Manager is ultimately responsible for the conduct and execution of training and for the documentation of SMEs.

All official training records are maintained by the Training Department as Training Master Records. Training Master Records are completed records documenting proof of an individual's training to perform his/her assignment in a safe and proficient manner. Records will be maintained in accordance with DOE Orders and FEMP procedures.

12.4.4 Modification of Training Requirements

The majority of the training requirements can be modified and implemented under existing site procedures. Where a training requirement has been specifically identified in the SAR, the change is subject to the Unreviewed Safety Question (USQ) process.

12.5 References

1) FEMP RSO Division, December, 1994. *Conduct of Operations Manual*, M-100, Rev. 1.

2) FEMP Remediation Support Operations Division, September, 1994. *Remediation Support Operations Division Document System*, D10-00-020.

3) FEMP, October, 1992. *FEMP Site Document System*, SSOP-0103, Rev. 0.

4) FEMP, March, 1993. *Control of Processes*, SSOP-0716, Rev. 0.

5) DOE Order 5480.11, "Radiological Protection for Occupational Workers"

6) FEMP, June, 1991. *Documentation of a Subject Matter Expert (SME)*, SSOP-0014, Rev. 0.

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SECTION 13
HUMAN FACTORS

13.1 Introduction

The UNH Project has been classified a Hazard Category 3 activity based on the criteria established in DOE-STD-1027-92 and following from the Hazard Category 3 definition, the activity has the potential for significant localized consequences. Therefore, human factors considerations were an integral part of the design decision making process. This Section presents the human factor features of the system design.

13.2 Requirements

DOE Order 6430.1A, Section 1300-12, "General Design Criteria"
DOE Order 5480.23, Section 8.b.(3)(n), "Nuclear Safety Analysis Reports"

13.3 Human Factors Program

Human factors issues were systematically evaluated during each of the hazard analyses described in Section 3.3 of this SAR. There was worker involvement in each step of the hazard analysis to ensure that the issues, based on worker experience, were identified. Because the UNH Project utilizes existing facilities not all issues can be corrected by feasible engineered solutions and administrative controls are required. The activities involved in the UNH Neutralization Project involve existing equipment and facilities that have been upgraded for worker and environmental safety as well as operability and are characterized by:

- Small number of simple operations
- Use of Personnel Protective Equipment
- Primarily automated process
- Process surveillance
- Several restrictive work environments

13.4 Identification of Human-Machine Interfaces

The UNH Processing system is relatively simple requiring workers to monitor and control a limited number of system variables. No Safety-Significant or Safety Class Systems, Structures, or Components were identified requiring human-machine interfaces. Human-machine interfaces include turning valves, reading indicators, controlling pumps, emptying bagged materials, and monitoring & recording process parameters. Exposures to hazardous materials are not anticipated during normal operations. Work in restrictive environments will generally be in preparation for processing and not while the process is operational.

In an emergency situation, workers are expected to be able to place the system in a safe configuration (shut down pumps and close valves). The controls are centrally located away from areas of significant risk.

Workers will always be wearing some level of PPE and breaks will be scheduled commensurate with the level of PPE and the environmental conditions during the activity.

13.5 Human-Machine Interface

The UNH Neutralization Project utilizes a mixture of new and old equipment and therefore human factors considerations were not built into the total system. Human factors deficiencies of the existing equipment and facilities were addressed where possible by the new installations as demonstrated in the following subsections.

13.5.1 Controls, Indicators, and Instrumentation

System controls and indicators are located on central control panels, providing opèrators immediate access to system controls in the same location of the indicators. The control panels are located in areas where respirators are not required so that workers are not required to be in potentially stressful and restrictive levels of PPE.

13.5.2 Labelling, Identification, and Marking.

All UNH system components are clearly marked to ensure that labels are clear and easily understandable by workers. The Quality Control Department will inspect the system prior to operations and verify that drawings, procedures, and equipment labelling are in concurrence. Clear identification of components and equipment reduces the possibility of operator error or delays.

13.5.3 Processing Components

New process components (e.g., valves, pumps, and instrumentation) are located in a manner that access is not inhibited, maintaining the workplace free of the need for sustained kneeling, stooping, holding, or lifting. Old equipment may not always be in the best configuration for human interaction. The Task Specific Health and Safety Plan will identify potential hazards for the workers. Those hazards are communicated to the worker in training and during pre-job briefings. The worker is instructed to rely upon good judgement as to his/her abilities and is instructed to report any activities that require sustained stress that can lead to an injury.

13.5.4 Staffing Levels

The minimum staffing levels determined for each activity will be in place for an activity to proceed. In the event that the minimum staffing level is not available, the activity will be delayed until the staff can be assembled. Minimum staffing levels are provided in Section 17, Tables 17.2-2 and 17.2-3.

13.5.5 Communications

The UNH Project policy on communications is located in the Facility Owner's Standing Orders and implements the communication requirements of DOE Order 5480.19, Conduct of Operations.

13.5.6 Job Safety Analysis (JSAs)

Job Safety Analyses (JSAs) are performed for operating procedures to identify and communicate to personnel hazards of the operation. Most procedures for the UNH Neutralization Project will have a JSA performed and the results implemented into the procedure and training prior to performing the task specified in the procedure. Draft procedures are presented to the workers for review in table-top sessions to ensure that the concerns and abilities of the workers are considered. JSAs may not be performed for procedures that are developed with safety and worker involvement and are considered to adequately address the hazards associated with an activity.

13.5.7 Personnel Protective Equipment

Personnel Protective Equipment (PPE) requirements have been minimized by design alternatives, equipment location, and facility repairs. Respirators will not be required in any of the UNH Neutralization areas except in parts of the Hot Raffinate Building. Respirators will not be required in the area of the control panels. The areas have been cleaned and respirator requirements have been reduced. Respiratory protection may be required for some off-normal and maintenance activities. The UNH Neutralization Project has focused on providing a non-restrictive work environment. Where possible, engineering solutions were implemented to reduce the PPE requirements or alternate locations were selected. Not all PPE requirements could be reduced to the minimum level, and workers will be required to wear restrictive PPE. For those activities the maximum stay times for workers will be determined at the time of the activity by a qualified Industrial Hygienist to ensure that the work conditions (temperature, work rate, PPE) at the time of the task are reflected. All UNH activities are clearly defined, and workers are qualified so that efficiency is maximized in these areas.

13.5.8 Emergency Response

Workers are instructed to place the system in a safe configuration in the event of an emergency. If the emergency is in the area of the controls, workers are instructed to leave the area. UNH Transfer and Neutralization Procedures and East and West Eimco Filter operating Procedures include the actions to place the systems in a safe configuration in the event of spill, leak, loss of power, loss of process air and water, and to respond to site warning and emergency notifications. Workers are trained on the requirements of these procedures and will practice safe shutdowns of the systems during simulated operations described in Section 10.3.1. Emergency response actions will be taken by the Site Emergency Response Team as discussed in Section 15. UNH Project worker training was developed considering the hazard described in the Hazard Analysis and HAZOP Analysis, Appendix C and D, respectively, and the Task Specific Health and Safety Plan.

SECTION 14
QUALITY ASSURANCE

14.1 Introduction

The UNH Neutralization Project is a Hazard Category 3 Activity. Because there are no Safety Class or Safety Significant Systems, Structures, or Components, the implementation of RM-0012, Quality Assurance Program Description (QAPD, Ref. 1), is adequate to ensure the safety of the facility. This site program will ensure that the components, systems, or services utilized in the UNH Project meet the specifications of the design criteria. The program has provisions for verifying installation, operability, and maintenance. DOE Order 5480.23 requires that sufficient information be provided to demonstrate appropriate commitment to a Quality Assurance Program, including descriptions of fourteen processes used at the facility. These fourteen processes are listed below along with the corresponding Criterion (QAPD, RM-0012) that address them:

i. Design control (Criterion 6 - Design)

ii. Procurement control (Criterion 7 - Procurement)

iii. Instructions, procedures, and drawings (Criterion 5 - Work Processes)

iv. Document control (Criterion 4 - Documents and Records)

v. Control of processes (Criterion 5 - Work Processes)

vi. Inspection, surveillance, and testing control (Criterion 8 - Inspection and Acceptance Testing, Criterion 10, Independent Assessment)

vii. Control of measuring and test equipment (Criterion 5 - Work Processes, Criterion 8 - Inspection and Acceptance Testing)

viii. Handling, storage, and shipping control (Criterion 5 - Work Processes)

ix. Control of nonconforming materials, components, and fabrication/construction features (Criterion 3 - Quality Improvement)

x. Corrective actions for identified conditions adverse to quality (Criterion 3 - Quality Improvement)

xi. Control of personnel training and qualification (Criterion 2 - Personnel Training and Qualification)

xii. Quality improvement (Criterion 3 - Quality Improvement)

xiii. Quality assurance documents and records (Criterion 4 - Documents and Records)

xiv. Independent quality audits (Criterion 10, Independent Assessment)

14.2 Requirements

10 CFR Part 830.120 "Quality Assurance Requirements"
G-830.120 "Implementation Guide for use with 10 CFR Part 830.120 'Quality Assurance'"

14.2.1 Program Standard

FERMCO's Quality Assurance Program Description (QAPD) uses 10 CFR Part 830.120 for its basic requirements. Other documents, such as NQA-1-1989, are used to enhance the QA Program and tailor it to meet the needs of the site. The site QA Program is administered by the QA Functional Area manager. Further information on the site QA Program is available in the preamble to the QAPD.

14.2.2 Description of Program

It is FERMCO policy to establish and implement a QA Program to ensure that risks and environmental impacts are minimized and that safety, reliability, and performance are maximized through the application of effective management systems commensurate with the risks posed by the facility and its work. It also incorporates requirements for effective planning, implementation, and assessment of environmental sampling and analysis activities. The QAPD, which is the model for the UNH Project Quality Assurance program, is organized into three functional categories: Management, Performance, and Assessment. These categories, and their subordinate criteria, describe the site QA Program. This document will describe how the site QA Program is applied to the UNH Project.

Within the three functional categories are the QA criteria that provide the basic requirements of a QA Program. Each criterion also identifies responsibilities.

14.3 Management: Functional Category A:

This category:

- contains the program elements that define the framework for management systems supporting the project QA Program;
- establishes the responsibility and authority of the functional units of the UNH project relative to assuring quality of processes and products involved in all activities for the project;
- describes the role of the project management in establishing and maintaining the project QA Program;
- defines required quality levels for work;
- outlines organizational responsibilities;
- provides for training of personnel, and
- describes the interfacing between organizations to ensure that the varied expertise of FERMCO is utilized for the benefit of the project;
- establishes a system for the prevention, early detection, correction, and reporting of deficiencies, including any breakdown in the management systems, to ensure the quality and improvement of removal, remediation, and remediation support; and
- describes the document control system and the system for the compilation of records which document how the work is to be done, and what was accomplished.

It is composed of the following criteria:

14.3.1 Program: Criterion 1

This criterion describes the requirements to develop, implement and maintain a documented Quality Assurance (QA) (or management) program. The organizational structure, functional responsibilities, levels of authority, and interfaces for the UNH project in managing, performing, and assessing the adequacy of work are described in Sections 7.3, 8.3, 9.3, 11.6, 15.4.1&2, 15.5, and 17.2 of this SAR, as well as in RM-0016 "FERMCO Management Plan".

14.3.2 Personnel Qualification and Training: Criterion 2

This criterion describes the requirements for personnel to be trained and qualified to ensure they are capable of performing their assigned work. Personnel shall be provided continuing training to ensure that job proficiency is maintained. Sections 7.4, 8.6, 11.3.4. 12.4, 15.4.10, and 17.2.3 of this SAR, and RM-0002 "Training Department Program Manual" address the requirements of this criterion.

14.3.3 Quality Improvement: Criterion 3

This criterion describes the requirements and responsibilities for establishing and implementing processes to detect, control, correct, and prevent quality problems and to promote quality improvement. Sections 2.9.2, 6 (all), 7.5-7.13, 8.5 and 8.8-10, 15.3, and 17.3.3 of this SAR address the requirements of Criterion 3.

14.3.4 Documents and Records: Criterion 4

This criterion describes the requirements and responsibilities for establishing and implementing a system for the control of documents and the handling, collection, storage, and control of quality assurance records generated by the project. This SAR meets the requirements of Criterion 4 in Sections 7.6&14, 8.11&12, and 17.3.2.

14.4 Performance: Functional Category B:

This category provides for:

- controlling activities associated with establishing and maintaining the technical requirements for our work, including design and procurement specifications and requirements for testing;

- the control of approved instructions, procedures, drawings, and other appropriate documents;

- the control of processes used in site restoration, environmentally related measurements, handling wastes, and in the construction and maintenance of facilities;

- the calibration of measuring and test equipment used in these processes, to maintain accuracy;

- the identification and control of items received or manufactured by FERMCO to verify they conform to established requirements.

- handling, storage, and shipping of materials to protect against loss of containment integrity and physical damage;

- using approved suppliers of purchased material, equipment, and services which satisfy company requirements;

- items (i.e., hazardous waste, environmental media, and product) to be monitored, measured, and tested;

- the monitoring and observation of associated processes during construction, operations (including environmental monitoring), and site restoration activities to determine conformance to procedural and technical requirements and to ensure continuous improvement in the quality of all products and services; and

- the acceptance status of items subject to inspection and testing.

It is composed of the following criteria:

14.4.1 Work Processes: Criterion 5

This criterion describes the requirements and responsibilities for the control of processes affecting work performance. The purpose of work process control is to ensure that standard processes and special processes are accomplished under controlled conditions. These standard processes and special processes include, but are not limited to: waste handling, packaging, certification and shipping; environmental data operations; welding; heat treating; core drilling; or nondestructive testing. This criterion's requirements are widely scattered throughout the SAR.

Work process control also includes the control of measuring and test equipment used by FERMCO for determining acceptability of characteristics, or which influence critical parameters of facility operations or standard and special processes.

14.4.2 Design: Criterion 6

This criterion describes the requirements and responsibilities for the implementation of a formal design control process. It is FERMCO policy to design items and processes using sound engineering/scientific principles and appropriate standards. The requirements of this criterion apply to all organizations that perform design or are responsible for design performed by contractors or subcontractors. Specific examples which meet the requirements of this criterion are found in Sections 2, 4, and 13.

14.4.3 Procurement: Criterion 7

This criterion describes the requirements and responsibilities for the preparation, review, and control of procurement documents. It also specifies the requirements and responsibilities for the control of purchased material, equipment, and services. This criterion is not covered in this SAR; RSO Divisional procedures and site procedures already established implement these requirements.

14.4.4 Inspection and Testing for Acceptance: Criterion 8

This criterion describes requirements and responsibilities for performing inspection and acceptance testing. It is FERMCO policy to perform inspection and acceptance testing of specified items and processes using established acceptance and performance criteria and to require calibration and maintenance of equipment used for inspections and tests. This criterion's requirements are addressed in Sections 2.7 and 10 (all).

14.5 Assessment: Functional Category C

This category provides for periodic assessment of the QA Program to determine its effectiveness and to promote quality improvement. It describes the organizational freedom and authority of the QA organization and its role in conducting audits and appraisals. Also covered is the role of project management in coordinating and facilitating management's conduct of performance assessments. Provisions are included for qualification of persons conducting assessments. It provides for the auditing of operations, systematic handling of nonconforming conditions, and learning through corrective actions, trending, and root cause analyses. It is composed of the following criteria:

14.5.1 Management Assessment: Criterion 9

This criterion describes the requirements and responsibilities for regularly assessing and documenting the adequacy and effectiveness of the QA (or management) program in providing the framework for the project to achieve its mission and objectives. It is FERMCO policy for management at all levels to periodically assess the integrated QA Program and its performance, and to identify and correct problems that hinder the organization from achieving its quality objectives. This criterion is addressed in Section 17.

14.5.2 Independent Assessment: Criterion 10

This criterion describes the requirements and responsibilities for the implementation of an independent assessment program. The FERMCO independent assessment program evaluates the adequacy and effectiveness of activities for compliance with applicable requirements. The requirements of this criterion are addressed here. The UNH Independent Assessment program will be coordinated between the FERMCO Quality Assurance Division and the UNH Neutralization Assistant Project Manager (APM). The APM will determine the areas to be assessed and their relative priorities within the project. The APM will then coordinate a schedule with the manager of Quality Systems and Audits for audits, and with the manager of Quality Engineering for surveillances.

14.6 References

1) FERMCO, April 1993. *Quality Assurance Program Description*, RM-0012, Rev. 2.

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SECTION 15
EMERGENCY PREPAREDNESS PROGRAM

15.1 Introduction

The FEMP maintains the necessary emergency plans and procedures to adequately define the emergency management program, provide guidance for all emergency responders (including employees), ensure adequate performance for critical systems, and meet all regulatory requirements. There are no accidents identified that would require emergency response measures in excess of the current FEMP abilities. However, upon review of the Hazard Analysis the Emergency Response Personnel must be aware of the system design and hazards associated with UNH. Effluent monitoring and material balance determination is the prime means of evaluating accident consequences to the environment and radiation monitors for radiation workers.

15.2 Requirements

The FEMP Emergency Plan implements and complies with the following:

1) DOE Orders 5000.3B, 5480.11, and the 5500 series

2) Title III of the Superfund Amendment and Reauthorization Act (SARA) of 1986, Emergency Planning and Community Right-To-Know Act, specifically section 303(c)

3) NRT 1-A, *Criteria of Review of Hazardous Material Emergency Plans*

4) CERCLA of 1980 as amended by Public Law 96-510, December 1980, specifically sections 120(c) and 103(a)

5) Ohio emergency planning laws and regulations

The above requirements are implemented by the following FEMP procedures:

1) SSOP-0089, "Personnel Accountability"

2) SSOP-0088, "Fernald Environmental Management Project Off-Site Emergency Warning System"

3) SSOP-1018, "Event Categorization/Classification"

4) ED-0001, "Event Notification and Occurrence Reporting"

5) PL-2194, "Fernald Environmental Restoration Management Corporation Spill Prevention Control, and Countermeasure Plan"

15.3 Identification and Categorization of Postulated Accidents

The FEMP has developed checklists to assist the Emergency Duty Officer (EDO) and the Assistant Emergency Duty Officer (AEDO) to ensure that predetermined critical factors are incorporated into the assessment process. ED-0001, *Event Notification and Occurrence Reporting* (Ref. 1), delineates the requirements for consistent and timely reporting of serious events. In accordance with DOE Orders 5500.2B, 5000.3B, and 5480.19 Chapters VI and VII, events and their responses are divided into the following categories:

1) Loggable Event: Non-routine event not significant enough to warrant reporting to any outside agency, but is documented for trend or other analysis.

2) Off-Normal Occurrence: Abnormal or unplanned events or conditions that adversely affect, potentially affect, or are indicative of degradation in the safety, security, environmental, or health protection performance or operation at a facility.

3) Unusual Occurrence: A non-emergency occurrence that has significant impact or potential for impact on safety, environment, health, security, or operations of a facility.

4) Emergency: The most serious occurrence which requires an increased alert status for on-site personnel and, in specified cases, for off-site authorities.

4a) Alert:

(1) Actual or potential substantial degradation of the level of safety of the facility.

(2) Any release is expected to be limited to small fractions of the appropriate Protective Action Guideline (PAG) or Emergency Response Planning Guide (ERPG).

4b) Site Area Emergency:

(1) Actual or likely major failures of facility functions needed for the protection of workers and the public.

(2) Any release is expected to exceed appropriate PAG/ERPG exposure levels on site but not off site.

4c) General Emergency:

(1) Actual or imminent catastrophic reduction of facility safety systems.

(2) Any release is expected to exceed appropriate PAG/ERPG exposure levels off site.

SSOP-1018, *Event Categorization/Classification* (Ref. 2) is the FEMP procedure utilized to characterize and categorize events. Other than severe natural phenomena events, there were no identified credible accidents associated with UNH processing that would elicit an alert, site area emergency, or general emergency categorization.

15.4 Facility Planning and Preparedness for Operational Emergencies

Facility planning is divided into the 12 subparts below. The primary hazards of the UNH Project are uranium and nitric acid. The initiating events and response are those that are similar to other facilities on-site. No unique actions are required for UNH related accidents except that personnel must be aware of the corrosive effects of nitric acid and compatible materials for containment of spills. The most significant accident identified for the UNH Project is a spill that would be contained in a dike. Preparedness for the removal and disposition of spills is required and governed by SSOP-0067, *Spill Incident Reporting and Cleanup* (Ref. 3). The only accident scenarios which could release a quantity capable of causing a significant dose (though within evaluation guidelines) are the severe natural phenomena events. In the event of severe phenomena, the total contribution of the UNH would be minimal in comparison with other materials stored on-site.

15.4.1 Emergency Response Organization

The following summarizes the responsibilities of key on-site emergency management personnel:

1) Emergency Director --the FERMCO President or designee has overall authority and responsibility for activities at the FEMP including emergency management.

2) Emergency Duty Officer (EDO)--the trained, senior management personnel responsible for the management and oversight of the FEMP emergency response activities until the FEMP Emergency Operations Center (EOC) is declared operational.

3) Assistant Emergency Duty Officer (AEDO)--the emergency management authority on site when the EOC is not operational. The AEDO is the incident Commander of the FEMP emergency response activities. The AEDO is the Facility Manager Designee.

4) Emergency Response Team (ERT)--on-site personnel available to respond to emergency events. A minimum manning level of five ERT members is required for all shifts. ERT personnel require special training.

The above personnel may be contacted by pagers, phone, or the Emergency Message System. Off-site personnel normally carry pagers.

15.4.2 Offsite Response Interfaces

FERMCO has formalized agreements with the following organizations to delineate their responsibilities during emergency conditions at the FEMP:

1) Fire Departments in Crosby, Ross, and Colerain townships

2) Medical facilities at Mercy Hospital, University of Cincinnati Hospital, and Providence Hospital

3) Emergency medical service from the Crosby Township Life Squad, Franciscan Ambulatory Care Unit, and the University Air Care Helicopter

4) Support as required from Butler and Hamilton Counties

5) Support as required from the State of Ohio, including the Emergency Management Agency, Ohio EPA, Department of Health, and State Highway Patrol

6) Support from the Federal Government, including the DOE Headquarters Emergency Operations Center and other Federal Facilities

15.4.3 Notification

ED-0001, *Event Notification and Occurrence Reporting*, outlines the initial notification requirements and details the actions required to prepare, track, and maintain the status for reportable events.

The AEDO and EDO initially analyze and categorize/classify events. The Fernald Field Office (FN) Duty Officer of the DOE makes the final determination of event classification. Events categorized as Off-Normal or higher are reported to a higher authority. The Environmental Compliance Release Evaluator is notified of spills and recommends the Emergency Classification Level. The FN Duty Officer makes the final determination of event classification. For all emergencies, the DOE-Headquarters EOC, the FN Duty Officer, Butler and Hamilton Counties, and the Sate of Ohio must be notified within 15 minutes of declaring an emergency. A 24-hour Notification, 10-day, and Final Occurrence Report are submitted to the DOE Program Manager and DOE Facility Representative for all events classified Off-Normal or greater.

15.4.4 Consequence Assessment

Initially the AEDO assesses the event impacts in the following manner:

1) Data Gathering--obtain information about the incident and its potential impact.
2) Evaluate Critical Factors--determine how and where initial efforts must be concentrated.
3) Tactical Attack Plan Development--formulate a structure plan to respond to the event.

Within 40 minutes of notification, the FEMP EOC is operational and the ERT, composed of senior advisory personnel, is assembled. Atmospheric dispersion conditions and other factors may be evaluated.

15.4.5 Protective Actions

Protective action recommendations are issued by the FEMP when an event will have off-site impact (by definition a GENERAL EMERGENCY). There are no specific events, as a result of the UNH neutralization project, which could result in a General Emergency. Some severe natural phenomena can occur in which the UNH tanks provide a contribution. However, the contribution is negligible compared to net dispersable hazards at the FEMP. Therefore, UNH is not specifically protected. In the event that protective actions are required, the FEMP may recommend either sheltering or evacuation according to the logic presented in PL-3020, *FEMP Emergency Plan* (Ref. 4) and EA-EMP-004, *Protective Action* (Ref. 5).

15.4.6 Medical Support

Medical vehicles for emergency use include two,fully-equipped ambulance vehicles designed to Federal standards and staffed by a minimum of two medical technicians whenever responding to a medical event. There are also various pieces of diagnostic equipment, two hospital wards with a total of four beds, an in vivo whole body counter, and other equipment. There are no unique medical requirements for the UNH neutralization project.

15.4.7 Recovery and Reentry

The primary responsibility for event termination and recovery planning rests with the Deputy Emergency Director with compliance from DOE-HQ, Butler and Hamilton Counties, and the State of Ohio. Upon termination of an emergency, the EOC is deactivated. The recovery plan should include a description of damage and those actions necessary to restore the facility and surrounding vicinity to a safe condition.

Reentry and Recovery Plans as designated in EA-EMP-003, *Reentry and Recovery* (Ref. 6), will be required for the UNH Project only in the event of severe natural phenomena.

15.4.8 Public Information

Protective actions are communicated to the population within the Immediate Notification Zone using the FMPC Off-site Emergency Warning System. Procedures governing this system are contained in SSOP-0088, *FMPC Off-Site Emergency Warning System* (Ref. 7). There were no accidents associated with the UNH Project affecting the off-site population. SSOP-1001, *Release of Information to the Public Concerning Nonemergency Events* (Ref. 8), governs the information provided to the public.

15.4.9 Emergency Facilities and Equipment

The following list summarizes the contents of PL-3020, *FEMP Emergency Plan*, Subsections 3.2.3, 3.2.4 and 3.3.8.

1) Emergency Communications

2) Site Phone System

3) Ring-down phone circuits between the FEMP and local government command centers

4) Cellular phone system

5) Plant Alarm System and plant Emergency Message System for on-site personnel

6) Long- and short-range radio backup to the phone system

7) Facilities for emergency response

8) The primary EOC, located on site, including references, communications, an air purification system, diesel generator, and audio-video equipment

9) Mobile Emergency Operation Center Alternate seat of the EOC which houses the necessary communication equipment

10) Joint Information Center disseminates information to the public via the news media

11) Equipment

(A) Fire truck tankers, ambulance squads, and other equipment to respond to hazardous material releases and fires

(B) Radiation monitoring and accident response equipment

(C) Construction equipment and mobile cranes

(D) Spill response vehicle and portable pumps

15.4.10 Training

Personnel involved in Emergency Preparedness are provided classroom training, practical training, and frequent drills and exercises. The training is defined, documented, and auditable.

15.4.11 Drills and Exercises

Various departments provide a formal training program for the instruction and qualification of all personnel involved in the emergency response organization. This program provides the initial and annual retraining of both primary and alternate response personnel. The program is composed of classroom and practical training, including frequent drills and exercises.

EOC staff qualification is documented on a fiscal year basis (October 1 - September 30) and tracked individually. Initially, an EOC Staff member is certified on satisfactory completion of training requirements within a fiscal year period. The date the last requirement is met becomes the individual's certification date.

FEMP employees participate in evacuation drills and personnel accountability drills to ensure preparedness in the event of an emergency. Personnel accountability ensures that all individuals are accounted for in the event of an emergency and is performed as described in SSOP-0089, *Personnel Accountability*, (Ref. 9).

15.4.12 Program Administration

The FEMP Emergency Preparedness Program is maintained and administered by Emergency Preparedness Department of the Environmental Safety and Health Division. The UNH Neutralization Project Management supports Emergency Preparedness by identifying the hazards associated with the project. The FEMP maintains the necessary emergency plans and procedures to adequately define the emergency management program, provide guidance for all emergency responders (including employees), ensure adequate performance for critical systems, and meet regulatory requirements.

15.5 Emergency Readiness Assurance Program

The emergency drill and exercise program provides members of the ERT at least one opportunity annually to practice their skills and be evaluated. The conduct of training, record keeping, and evaluation of training effectiveness are given in PL-3020, FEMP Emergency Plan.

15.6 Other Emergency Response Measures

None Identified.

15.7 References

1) FERMCO, June 1994, *Event Notification and Reporting*, ED-0001, Rev. 3.

2) FERMCO, June 1994, *Event Categorization/Classification*, SSOP-1018, Rev. 1.

3) FERMCO, March 1994. *Spill Incident Reporting and Cleanup*, SSOP-0067, Rev. 1.

4) FERMCO, June 1994. *FEMP Emergency Plan*, PL-3020, Rev. 1.

5) FERMCO. *Protective Action*, EA-EMP-004.

6) FERMCO. *Reentry and Recovery*, EA-EMP-003.

7) FERMCO, April 1994. *FEMP Off-site Emergency Warning System*, SSOP-0088, Rev. 2.

8) FERMCO, May 1994. *Release of Information to the Public Concerning Nonemergency Events*, SSOP-1001, Rev. 0.

9) FERMCO, February 1994. *Personnel Accountability*, SSOP-0089, Rev. 1.

10) DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information"

11) DOE Order 5480.19, "Conduct of Operations Requirements"

12) DOE Order 5500.2B, "Emergency Categories, Classes, and Notification and Reporting Requirements"

SECTION 16
PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

16.1 Introduction

The removal of the bulk UNH solution in Plant 2/3 will support the decontamination and decommissioning (D&D) of the Plant 2/3 facilities. The D&D of Plant 2/3 is not within the scope of the UNH Project, but the system modifications considered the future plans of the facilities.

16.2 Description of D&D Provisions

Several features of the system may make it useful for applications to support the D&D of other FEMP facilities. The system was designed to neutralize UNH solution, supporting the D&D of Plant 2/3, and utilizes components that can have other uses on-site. The only significant modifications to the system were the installation of new transfer piping, pumps, and instrumentation. The new piping is designed with drain valves at key locations to facilitate flushing. The new installations in Plant 2/3 do not significantly increase the D&D efforts required for Plant 2/3.

16.2.1 Processing other Wastes

The UNH processing system modifications considered the FEMP D&D mission. It essentially consists of two, well-instrumented process tanks with agitators, versatile pumps, controls, and a transfer line to the existing Plant 8 Waste Water Treatment Facility. After processing the UNH solution, the system may be used to treat other FEMP wastes (e.g., acid, caustic). UNH Project Management has begun investigating other uses for the system.

16.2.2 UNH Processing System

Many of the new installations can be removed and reused on other site projects. The pumps are skid mounted and portable with several potential uses. The new UNH piping system is sloped and provided with drain valves to aid in clean-out, flushing, and dismantling. UNH Project Management will maintain auditable records of equipment status so that future D&D efforts will have accurate information on the status of equipment and piping when the UNH project is complete.

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SECTION 17
MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

17.1 Introduction

The operating contractor for the FEMP is the Fernald Environmental Restoration Management Corporation (FERMCO), Cincinnati, OH. Management of the UNH Neutralization Project is under the Remediation Support Operations (RSO) Division, with day-to-day operations under the responsibility of the UNH Neutralization Project Manager. The management, organization, and institutional safety structures employed to ensure safe operation of the UNH Neutralization Project are described in the following sections. The safety programs that promote safety consciousness and morale, including safety culture, safety performance assessment, configuration and document control, occurrence reporting, and staffing and qualification are also discussed.

17.2 Organizational Structure, Responsibilities, and Interfaces

The UNH Neutralization Project is managed by the UNH Neutralization Project Manager, who reports to the Vice President of RSO.

17.2.1 UNH Project Manager

The UNH Project Manager is responsible for, and has full authority over, all aspects of the neutralization of the UNH stored at the FEMP. The UNH Project Manager is responsible for interfacing with the Environmental Safety & Health and Regulatory Programs Divisions to ensure that the UNH Neutralization activities are conducted in compliance with applicable environmental, safety, and quality requirements of the Department of Energy (DOE), federal, and state regulatory agencies. The organizational structure for the UNH Neutralization Project is found in the UNH Neutralization Project Technical Information Plan (TIP) (Ref. 1). The TIP contains the organization charts identifying the UNH Project staff and defines their responsibilities. This organization charts show the interface organizations that supply dedicated support to the UNH Neutralization Project.

17.2.2 Staffing and Qualifications

The development of the staffing and qualifications requirements for UNH processing are the responsibility of the UNH Operations Manager. Facility staffing levels for normal day-to day activities include a mix of management, administrative, maintenance, operations support, cognizant disciplines, and engineering personnel. While these people are necessary to perform activities in compliance with procedures, regulations, and orders, it is not necessary to have all staff functions present during operations. Minimum shift manning identifies the minimum personnel and qualifications required to be in attendance whenever an activity is being performed. Minimum shift staffing and qualifications are based on the ability to perform all required operational functions in accordance with written procedures and identify and respond to potential off-normal conditions, as derived from the hazard analysis.

17.2.2.1 Shift Staffing

The size of each shift and the qualifications of the personnel depend upon the specific activity being performed and are under the responsibility of the UNH Operations Manager. The UNH Operations Manger has determined the minimum staffing levels and staff qualification required to perform each activity associated with processing UNH in accordance with DOE 5480.19, "Conduct of Operations," and DOE Order 5480.20, "Personnel Selection, Qualification, Training, and Staffing Requirements at DOE Reactor and Non-Reactor Nuclear Facilities." Minimum shift staffing for Plant 8 and UNH Processing are included in Tables 17.2-1 through 17.2-5. Radiation Technician and Industrial Hygiene Technician support will be present or on-call at all times during operations.

Table 17.2-1 Plant 8 Filtering Minimum Staff

Position	Number / Shift
Process Supervisor	2
Filter Operator	1
Valve Operator	1
Chemistry Monitor	1
Packaging Station Operator	1
Scale Operator	1
Waste Shipment Loader (MVO)	1
TOTAL	**8**

Table 17.2-2 Dilution/Neutralization Tank Preparation Minimum Staff

Position	# / Shift
Process Supervisor	1
UNH System Monitor	1
Valve Operator	1
TOTAL	**3**

Table 17.2-3 Transfer of UNH from UNH Storage Tank Minimum Staff

Position	# / Shift
Process Supervisor	2
UNH System Monitor	1
Valve Operator	1
Pump Operator	1
Chemistry Monitor	1
TOTAL	**6**

Table 17.2-4 Magnesium Hydroxide Addition, Slurry Sampling, and Tank Rinsing Minimum Staff

Position	# / Shift
Process Supervisor	1
UNH System/Chemistry Monitor	1
Valve Operator	1
Pump Operator	1
TOTAL	**4**

Table 17.2-5 Transfer of Slurry to Plant 8 Minimum Staff

Position	Number / Shift
Process Supervisor (2 - Plt 8 and 2 - Plt 2/3)	4
Valve Operator (1 - Plt 8 and 1 - Plt 2/3)	2
Chemistry Monitor (1 - Plt 8 and 1 - Plt 2/3)	2
System Monitor (Plt 2/3)	1
Pump Operator (Plt 2/3)	1
TOTAL	**10**

17.2.2.2 Training and Qualification

The UNH Project personnel are categorized relative to their specific job function and receive training commensurate with this job function. The formal training requirements and program are designed to emphasize safety and are described in Section 12 of this SAR. Only trained, qualified workers will be permitted to work on the UNH Neutralization Project. The qualification process includes formal and informal training, demonstration of ability, and personnel interview. Operator briefings will be given at the beginning of each shift to keep worker knowledge level current and ensure the workers are aware of the system configuration prior to beginning the shift. Free forum discussions and a questioning attitude toward safety issues are encouraged.

17.2.2.3 Fitness for Duty Qualifications

FERMCO recognizes that employees can work to their capabilities only if a substance-free workplace is maintained. FMPC-0110, *Drug-Free Workplace/Substance Abuse* (Ref. 2), delineates the means of maintaining a drug-free workplace.

17.2.2.4 Personnel Allocation

A list of facility personnel by name, title, and work and home telephone numbers is readily available in the Communication Control Center and other applicable job-activity centers for use by on-shift or off-shift workers. The list includes management, radiation safety, and technical support personnel. Support personnel involved in the development of safety documentation will be made available, where possible, to provide guidance during the start-up and operation of the process.

17.2.2.5 Limitation for Overtime Worked

DOE Order 5480.20, "Personnel Selection, Qualification, Training, and Staffing at DOE Reactor and Non-Reactor Nuclear Facilities," working hour limitations for operating personnel are applied to the UNH Project operators.

17.3 Safety-Management Policies and Programs

The Safety management policies and programs include Safety Review and Performance Assessment, Configuration and Document Control, and Occurrence Reporting. These policies and programs are presented in the subsections below.

17.3.1 Unreviewed Safety Questions and Safety Evaluations

FEMP Unreviewed Safety Question and Safety Evaluation System, SSOP-1035, establishes the program for implementing the Unreviewed Safety Question Determination (USQD) process, as outlined in DOE Order 5480.21. The purpose of the USQD process is to determine if a change to a facility or activity can be made without prior safety review and approval by the original approving body. The FEMP USQD System training is divided into two levels of qualification, the Technically Responsible (TR) Individual and the Qualified Safety Evaluator (QSE). The TR qualification is a prerequisite to the QSE qualification. TR's screen changes/activities to limit the number of items put through the USQ process. QSE's perform all USQD/SEs in accordance with the provisions and requirements of SSOP-1035. The UNH Operations Manager and Plant Engineers are TR trained and will perform USQ Screenings.

17.3.2 Independent Safety Review Committee (ISRC)

The Independent Safety Review Committee (ISRC) evaluates safety basis documentation and ensures accuracy and consistency between safety analyses and their associated safety documentation. Independent safety reviews are conducted as required by SSOP-1080, *Establishing an Independent Safety Review Committee and Conducting Independent Safety Reviews* (Ref. 3), provides specifications for an ad hoc ISR Committee appointment, responsibilities, operational scope, membership, and reporting requirements.

17.3.3 Configuration, Design, and Document Control

In order to preserve the safety basis as defined in the SAR, drawings, records, documents, design, and the configuration of the UNH Neutralization Project Documentation must be maintained. UNH Project Management has the responsibility of maintaining project documentation and ensuring its integrity. All UNH Neutralization documents important to the safety basis will be controlled by the RSO Division's document control system, the issuing organization's document control system, or the site's document control system. UNH Project drawings are controlled by the UNH Project to ensure that only approved, up-to-date drawings are utilized by project personnel.

17.3.3.1 Design Change Management

Design changes are initiated by the UNH Neutralization Project and submitted for review by the engineering, safety, and quality organizations. Engineering reviews design changes to ensure that the change is a technically sound alternative to the existing configuration. Safety reviews design changes to ensure that the change does not affect the safety basis of the activity and ensures that the USQ process is implemented. Quality reviews design changes and the implementation of changes to ensure that a change is technically sound, affected subsystems and other documentation is addressed, and that the change is properly implemented. With concurrence from the requesting and reviewing organizations, the affected documents and drawings are updated by the issuing organization and reissued as a revision with a note explaining the revision.

17.3.4 Occurrence Reporting

FERMCO documents all occurrences at the FEMP. The categorization and reporting of the event is based on DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information." Guidance for initial event notification and reporting requirements is found in procedure ED-0001, *Event Notification and Occurrence Reporting* (Ref. 4). The Self-Assessment Group is responsible for conducting deficiency trend analyses, root cause analyses, incorporating lessons learned, and communicating results and trends throughout the FEMP.

17.3.4.1 Information Selection and Analysis

FERMCO provides for information selection and analysis by identification of root and contributory causes and by deficiency trend analyses. The causes, corrective actions, lessons learned, and impact are incorporated into the Occurrence Report. A DOE facility representative reviews and evaluates the Occurrence Report.

17.3.4.2 Root Cause Analysis of Experience

The information gained from an evaluation based on experience is dependent upon a complete description of the occurrence and identification of the root cause. FERMCO's determination of root cause provides insight on how to prevent or mitigate the effects of the event. An event is classified by its effect on the overall restoration program. Root cause analysis provides the identification of the primary cause and contributory causes.

17.3.4.3 Corrective Actions (Feedback)

Corrective Action is taken to prevent recurrence of an event at the FEMP. The impact of the event may be on the program or project, the environment, safety and health, or any combination.

17.3.5 Self-Assessment

The UNH Project performed a Self-Assessment to identify the level of compliance to the applicable S/RIDS, commitments, and other requirements on the UNH Neutralization Project. The non-compliance items were assembled into a master corrective action plan with a schedule for completion of each open item.

17.3.6 Safety Culture

The site has numerous policies and programs which promote an interest in and involvement of all associated workers in safety at the FEMP. These policies and programs facilitate a questioning attitude towards safety related activities and equipment and ensures that workers understand the potential risks and encourage personal safety. Some of the programs are discussed below. Reference the FEMP, *Voluntary Protection Program Strategic Safety and Health Implementation Plan* (Ref. 6), for a more comprehensive list.

17.3.6.1 Safety First Initiative

An effort is underway through the work of a mixed group of FERMCO representatives to improve the safety culture at the site focussing on the areas of: management commitment, employee involvement, rewards and recognition, communications, and training. The work group safety concept is part of this initiative.

17.3.6.2 Safety Standdown

Sessions are held with all employees and subcontractors at the FEMP and off-site locations to emphasize the importance of safety in all jobs. Employees are presented the Employee Bill of Rights, the FERMCO Safety Handbook, and surveyed on attitudes, perceptions, and awareness of safety.

17.3.6.3 Employee Bill of Rights

FERMCO management strongly supports the rights of all workers to work safely and in a safe environment. The Employee Bill of Rights provides workers the written commitment from management that they have the authority to exercise these rights. Included in these rights is the right to refuse work, without reprisal or loss of regular pay, which an individual feels is unsafe (Ref. 5).

17.3.6.4 Work Group Safety Concept

As part of the Safety First initiative, pilot work groups have been established to involve workers and supervisors in the identification and resolution of safety concerns. Concerns are addressed at this level or taken to management for resolution.

17.3.6.5 Walk your space

Each employee is trained and required to "walk their space" in each area where they work. "Walking their space" includes an inspection of the floor, equipment and general safety conditions of their immediate environment. The emphasis on such safety forming habits contributes to a safe working environment.

17.4 References

1) FEMP, November 1994. UNH Neutralization Project Technical Information Plan, UNH-TIP-1000-0, Rev. 0.

2) FEMP, August 1989. *Drug-Free Workplace/Substance Abuse*, FMPC-0110.

3) FEMP, August, 1994. *Establishing an Independent Safety Review Committee and Conducting Independent Safety Reviews*, SSOP-1080, Rev. 0.

4) FEMP, June, 1994. *Event Notification and Occurrence Reporting*, ED-0001, Rev. 3.

5) FEMP, February, 1990. *Open Communication of Employee Concerns*, FMPC-0122, Rev. 1.

6) FEMP, March, 1994. *Voluntary Protection Program Strategic Safety and Health Implementation Plan*, OS-VPP-PL02, Rev. 1.

APPENDIX A

PROJECT DRAWINGS

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Drawing Number	Title
92X-5900-X-00070, Rev. 0	Project Title Sheet
92X-5900-P-00058, Rev. 1	Piping Plan Uranyl Nitrate Processing System
92X-5900-P-00063, Rev. 2	Piping Plan and Sections Dilution-Neutralization Plant 2/3
92X-5900-F-00069, Rev. 0	Process Flow Diagram UNH Handling System
92X-5900-N-00074, Rev. 1	P&ID Transfer System
92X-5900-N-00075, Rev. 2	P&ID Dilution and Neutralization System
92X-5900-N-00076, Rev. 1	P&ID Filtration System

8966

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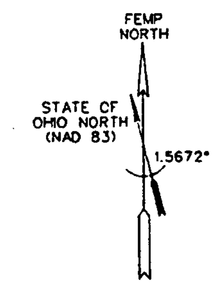
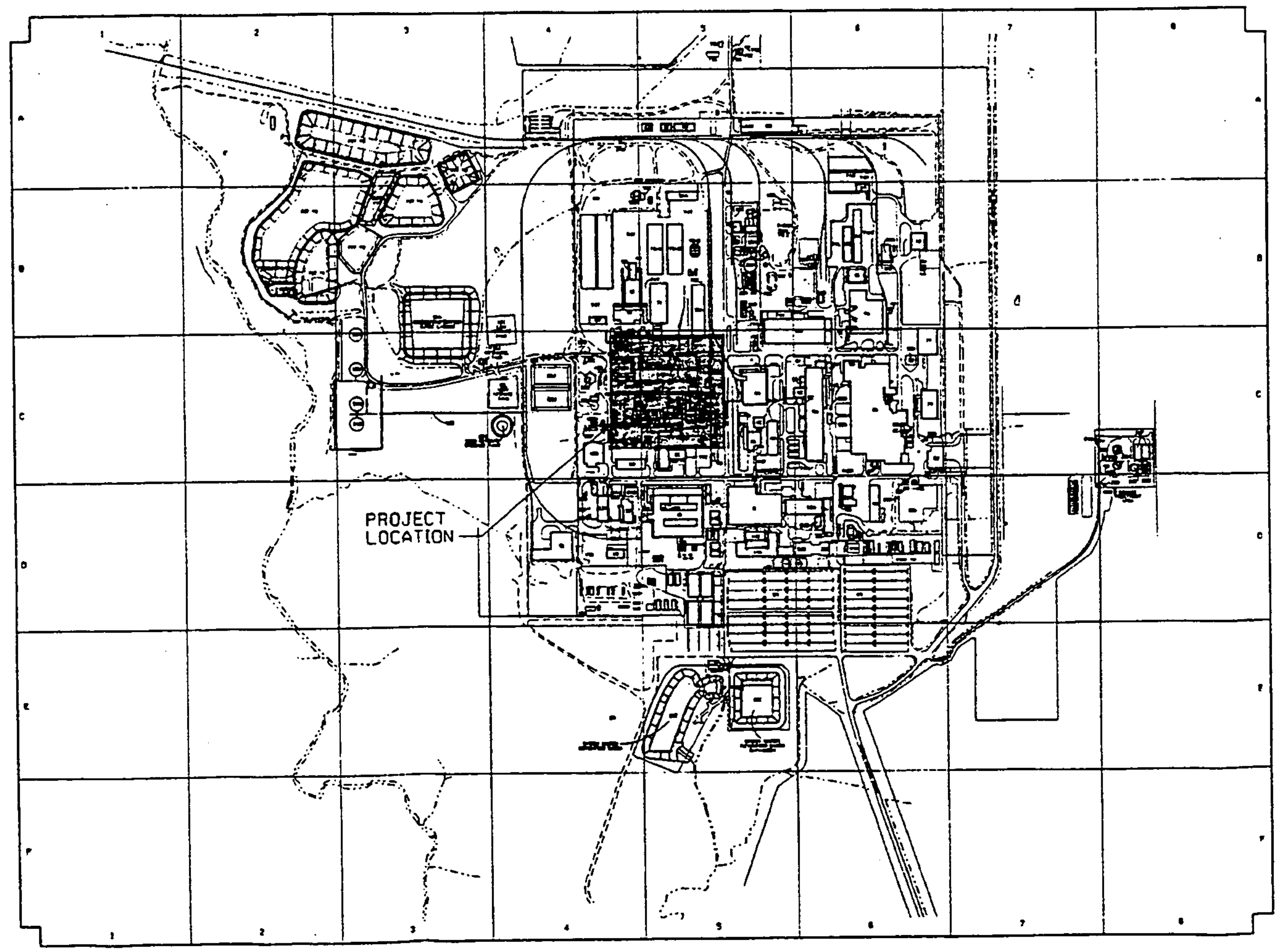
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

URANYL NITRATE NEUTRALIZATION PROJECT
OPERABLE UNIT 2





PARSONS

The Ralph M. Parsons Company * Parsons Main, Inc. * Engineering-Science, Inc.

ARCHITECTS - ENGINEERS
CINCINNATI, OHIO

NOTES

1. FOR DRAWING INDEX, SEE DRAWING 92X-5900-X-00071.

REF DWG NO.	DRAWING TITLE
92X-5900-X-00071	DRAWING INDEX

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	INITIALS AND DATE		
0	CERTIFIED FOR CONSTRUCTION	3-4-94	3-14-94	

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
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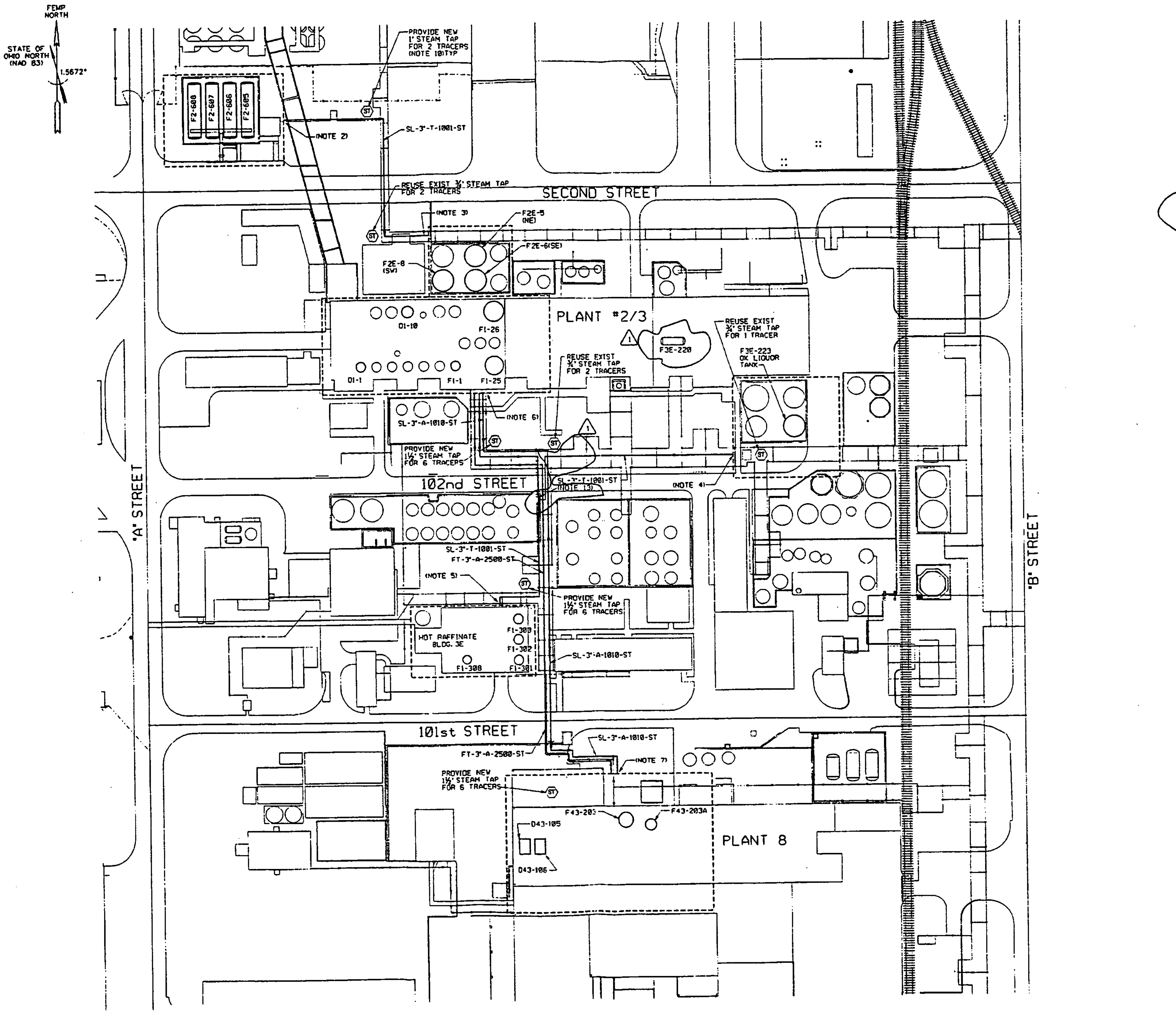
CINCINNATI, OHIO

PROJECT NAME: URANYL NITRATE NEUTRALIZATION PROJECT

DRAWING TITLE: PROJECT TITLE SHEET

DRAWN BY: L.J.GEORGE DATE: 03/09/94 LEAD ENGINEER: [signature] DATE: 3/26/94 CHECKED BY: A.W.SCHATZ DATE: 3/18/94
PLANT/BLDG NO. FLOOR SCALE: NONE CLASS
SUBMITTED FOR APPROVAL: [signature] DATE 3/25/94 FERMCO CRU APPROVAL: [signature] DATE 3/29/94

PREPARED UNDER PARSONS PROJECT ORDER NUMBER	DOE PROJECT NO.	FEMP PROJECT NO.	DRAWING INDEX CODE NO.	SHEET NO.	REV. NO.
CRU2/P0110		WBS L3 00-90701	92X-5900-X-00070	X0001	0



NOTES

1. FOR DRAWING INDEX SEE DRAWING 92X-5900-X-00071.
2. FOR PIPING IN THIS AREA SEE DRAWING 92X-5900-P-00059.
3. FOR PIPING IN THIS AREA SEE DRAWING 92X-5900-P-00060.
4. FOR PIPING IN THIS AREA SEE DRAWING 92X-5900-P-00061.
5. FOR PIPING IN THIS AREA SEE DRAWING 92X-5900-P-00062.
6. FOR PIPING IN THIS AREA SEE DRAWING 92X-5900-P-00063.
7. FOR PIPING IN THIS AREA SEE DRAWING 92X-5900-P-00065.
8. PIPING SHALL BE FIELD ROUTED AND FIELD SUPPORTED. GENERAL PIPE ROUTING IS SHOWN. DO NOT POCKET SLURRY LINES. ACTUAL FIELD CONDITIONS SHALL BE VERIFIED PRIOR TO FABRICATION AND NSTALLATION.
9. SUGGESTED PIPE SUPPORTS ARE SHOWN ON DRAWING 92X-5900-P-00066.
10. LOCATIONS FOR NEW AND EXISTING STEAM TRACING TAPS ARE SHOWN AS (ST). STEAM TRACING DETAILS ARE SHOWN ON DRAWING 92X-5900-P-00067.
11. FOR MECHANICAL PROCESS SYMBOLS AND LEGEND SHEET SEE DRAWING 92X-5900-N-00073.
12. FOR PIPING AND INSTRUMENTATION DIAGRAMS SEE DRAWINGS 92X-5900-N-00074, 92X-5900-N-00075, AND 92X-5900-N-00076.
13. LOCATE SPOOL TEE AND FLANGES FOR OK LIQUOR TANK SLURRY AND HOT RAFFINATE TANK SLURRY TRANSITION OVER EXISTING TANK CONTAINMENT (DIKED) AREA.

REF DWG NO.	DRAWING TITLE
92X-5900-X-00071	DRAWING INDEX
92X-5900-P-00059	PIPING PLAN AND SECTION - NFS TANKS
92X-5900-P-00060	PIPING PLAN AND SECTION - CD BLEND TANKS
92X-5900-P-00061	PIPING PLAN AND SECTION - OK LIQUOR TANK
92X-5900-P-00062	PIPING PLAN AND SECTION - HOT RAFFINATE TANKS
92X-5900-P-00063	PIPING PLAN AND SECTIONS DILUTION - NEUTRALIZATION
92X-5900-P-00065	PIPING PLAN AND SECTIONS - DEWATERING SYSTEM
92X-5900-P-00066	PIPING SUPPORT DETAILS
92X-5900-P-00067	STEAM TRACING DETAILS
92X-5900-N-00073	MECHANICAL PROCESS - P&ID SYMBOLS AND LEGEND SHEET
92X-5900-N-00074	MECHANICAL PROCESS - P&ID TRANSFER SYSTEM
92X-5900-N-00075	MECHANICAL PROCESS - P&ID DILUTION AND NEUTRALIZATION SYSTEM
92X-5900-N-00076	MECHANICAL PROCESS - P&ID FILTRATION SYSTEM

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FEMCO	DATE
1	MOVED SPOOL PIECE; ADDED TANK F3E-220	6/21/94	SF 6/29/94	
0	CERTIFIED FOR CONSTRUCTION	MB 3-25-94	JT 3-30-94	

INITIALS AND DATE

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

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CINCINNATI, OHIO

PROJECT NAME

URANYL NITRATE NEUTRALIZATION PROJECT

DRAWING TITLE

PIPING/PLANT DESIGN
PIPING PLAN
URANYL NITRATE PROCESSING SYSTEM

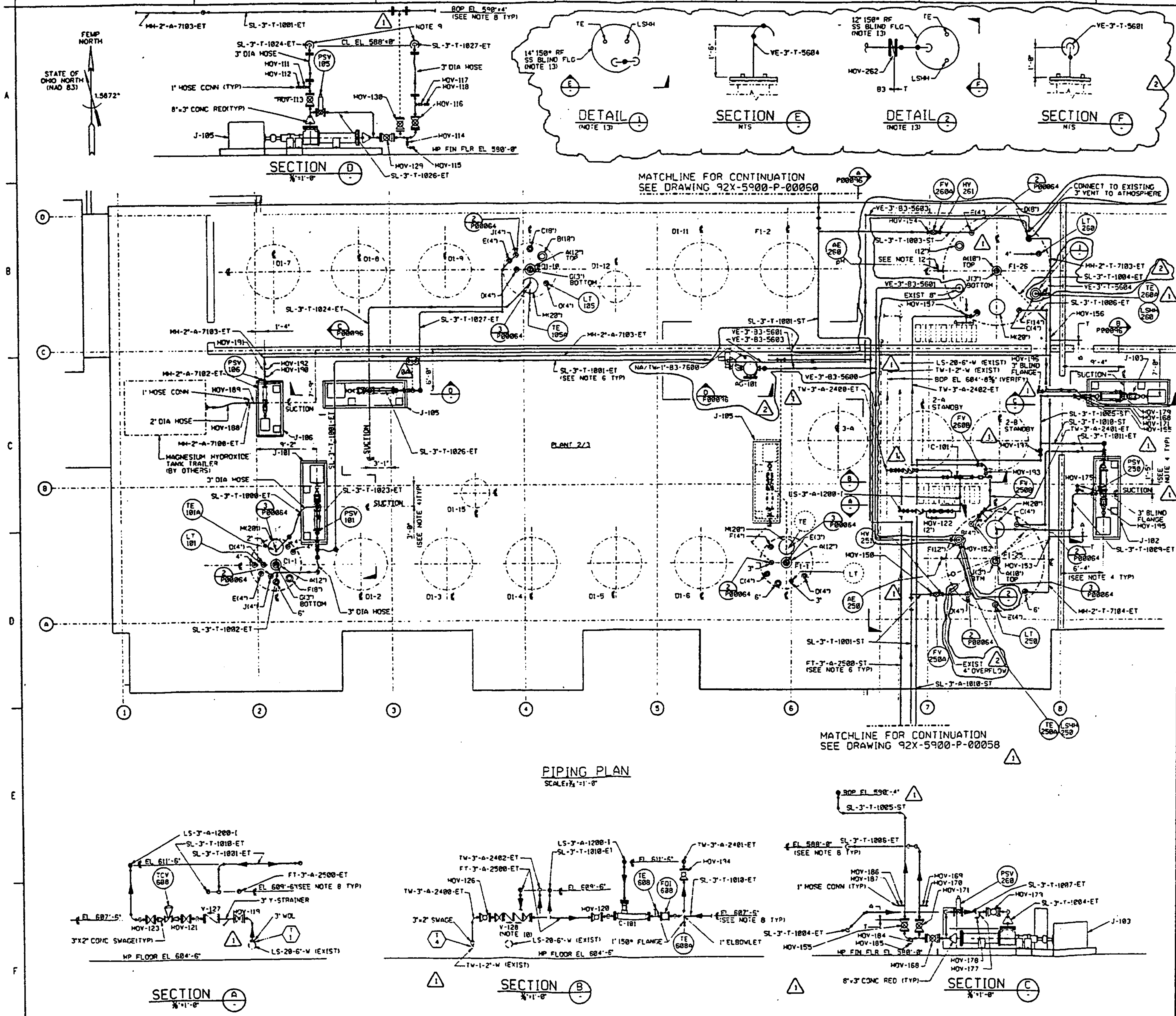
DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
D. ROSENE	1-10-94	JIM TABB	3-25-94	H. H. SWARTZ, JR	3-04-94

PLANT/BLDG. NO.	FLOOR	SCALE	CLASS
		1"=30'-0"	

SUBMITTED FOR APPROVAL	FERMCO CRU APPROVAL	CERTIFIED FOR CONSTRUCTION
MIKE BOLAND 3-25-94 (A-E, DATE)	JIM TISARANNI 3-30-94 (DATE)	CRU DIRECTOR, DATE

PREPARED UNDER PARSONS PROJECT ORDER NUMBER	DOE PROJECT NO.	FEMP PROJECT NO.	DRAWING INDEX CODE NO.	SHEET NO.	REV. NO.
CRU2/P0110		WBS 1.3 00-90701	92X-5900-P-00058	P0001	1

-6968



NOTES

1. FOR DRAWING INDEX SEE DRAWING 92X-5900-X-00071.
2. FOR GENERAL NOTES SEE DRAWING 92X-5900-P-00058.
3. FOR PIPING AND INSTRUMENTATION DIAGRAM IN THIS AREA SEE DRAWINGS 92X-5900-N-00074 AND 92X-5900-N-00075.
4. PUMP SKID AND TANK NOZZLE LOCATIONS SHOWN ARE APPROXIMATE AND SHALL BE FIELD VERIFIED PRIOR TO PIPE FABRICATION AND/OR INSTALLATION.
5. PUMP SKID CRIBBING OR SHIMMING REQUIRED FOR PUMP LEVELLING SHALL BE FURNISHED AND INSTALLED BY THE SUBCONTRACTOR.
6. PIPING SHALL BE FIELD ROUTED AND FIELD SUPPORTED. GENERAL PIPE ROUTING IS SHOWN. ACTUAL FIELD CONDITONS SHALL BE DETERMINED PRIOR TO INSTALLATION.
7. STEAM TRACING IS USED ON LINES SL-3"-T-1001-ST, SL-3"-T-1003-ST, SL-3"-A-1005-ST, SL-3"-A-1010-ST AND FT-3"-A-2500-ST. SEE DRAWING 92X-5900-P-00067 FOR STEAM TRACING DETAILS.
8. ELEVATIONS AND DIMENSIONS SHOWN ARE APPROXIMATE AND SHALL BE FIELD VERIFIED PRIOR TO FABRICATION AND INSTALLATION.
9. SAWCUT 8" DIAMETER HOLE (MINIMUM) IN EXISTING WALL.
10. FIELD ROUTE BACKFLOW PREVENTER DRAIN TO FLOOR SUMP AT ELEVATION 580'-0".
11. PIPING SHOWN IN DASHED LINE (-------) DEPICTS ALTERNATE PIPING LOCATION DURING OPERATIONS.
12. REMOVE EXISTING 1" FLANGE AND REPLACE WITH 1½" BEFORE INSTALLING pH PROBE.
13. SEE SPECIFICATION 13400, ATTACHMENT 2, SHT 10 OF 11, FOR TE AND LSHH CONNECTIONS. DRILL FLANGE FOR 3" DIAMETER STAINLESS STEEL VENT AND SCRUBBER SUCTION PIPES. FIELD VERIFY EXISTING NOZZLE FLANGE RATING AND SIZE PRIOR TO FABRICATION.

REF DWG NO.	DRAWING TITLE
92X-5900-X-00071	DRAWING INDEX
92X-5900-P-00058	PIPING PLAN - URANYL NITRATE PROCESSING SYSTEM
92X-5900-P-00060	PIPING PLAN AND SECTION CD BLEND TANK
92X-5900-P-00064	PIPING DETAILS
92X-5900-N-00074	MECHANICAL PROCESS - P&ID - TRANSFER SYSTEM
92X-5900-N-00075	MECHANICAL PROCESS P&ID DILUTION AND NEUTRALIZATION SYSTEM
92X-5900-P-00096	PIPING SECTIONS
92X-5900-P-00067	STEAM TRACING DETAILS

REV NO	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERMCO	DATE
2	ADDED SCRUBBER PACKAGE NUMBER AG-101 AND ASSOCIATED PIPING	WLL 9/15/94	SF 2/...	
1	REVISED PER FERMCO REQUEST	APP 6-21-94	SF 6-30-94	
0	CERTIFIED FOR CONSTRUCTION	MB 3-25-94	JT 3-30-94	

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
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CINCINNATI, OHIO

PROJECT NAME
URANYL NITRATE NEUTRALIZATION PROJECT

DRAWING TITLE
PIPING/PLANT DESIGN
PIPING PLAN AND SECTIONS
DILUTION-NEUTRALIZATION PLANT 2/3

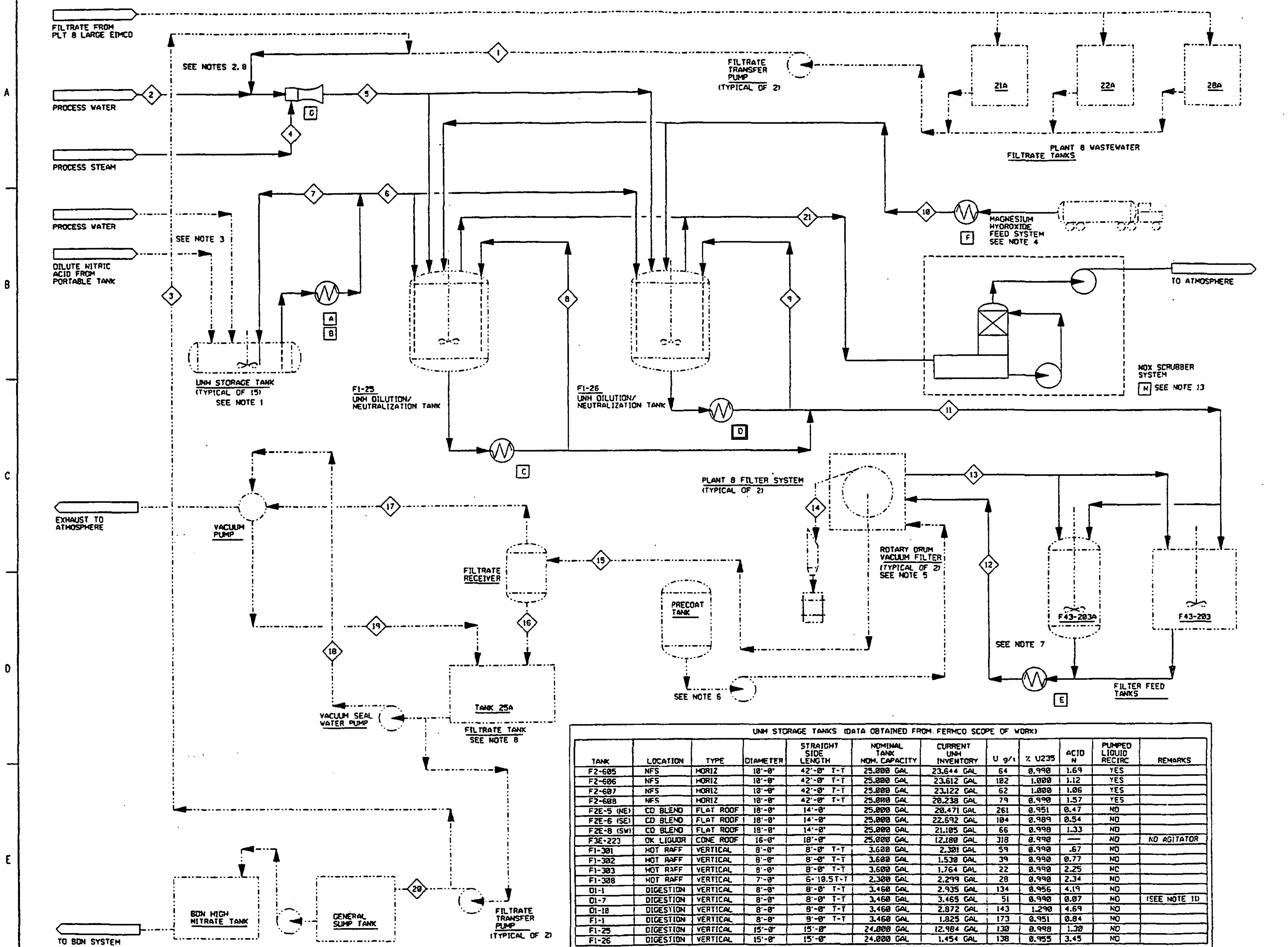
DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
D. ROSENE	1-10-94	JIM TABB	3-25-94	H.H.SVARTZ,JR	3-07-94

SCALE: AS NOTED

SUBMITTED FOR APPROVAL: MIKE BOLAND 3-25-94
FERMCO ORG APPROVAL: JIM TISARANNI 3-30-94

PREPARED UNDER PARSONS PROJECT ORDER NUMBER	COE PROJECT NO.	FERMCO PROJECT NO	DRAWING INDEX CODE NO	SHEET NO.	REV NO
CRU2/P0110		WBS 1.3 00-90701	92X-5900-P-00063	P0006	2

000169



UNH STORAGE TANKS (DATA OBTAINED FROM FERMCO SCOPE OF WORK)

TANK	LOCATION	TYPE	DIAMETER	STRAIGHT SIDE LENGTH	NOMINAL TANK NOM. CAPACITY	CURRENT UNH INVENTORY	U g/l	% U235	ACID N	PUMPED LIQUID RECIRC	REMARKS
F2-605	NFS	HORIZ	10'-0"	42'-0" T-T	25,000 GAL	23,644 GAL	64	0.990	1.69	YES	
F2-606	NFS	HORIZ	10'-0"	42'-0" T-T	25,000 GAL	23,612 GAL	102	1.000	1.12	YES	
F2-607	NFS	HORIZ	10'-0"	42'-0" T-T	25,000 GAL	23,122 GAL	62	1.000	1.06	YES	
F2-608	NFS	HORIZ	10'-0"	42'-0" T-T	25,000 GAL	20,238 GAL	79	0.990	1.57	YES	
F2E-5 (NE)	CD BLEND	FLAT ROOF	18'-0"	14'-0"	25,000 GAL	20,471 GAL	261	0.951	0.47	NO	
F2E-6 (SE)	CD BLEND	FLAT ROOF	18'-0"	14'-0"	25,000 GAL	22,692 GAL	104	0.989	0.54	NO	
F2E-8 (SW)	CD BLEND	FLAT ROOF	18'-0"	14'-0"	25,000 GAL	21,105 GAL	66	0.998	1.33	NO	
F3E-223	OK LIQUOR	CONE ROOF	16-0"	18'-0"	25,000 GAL	12,180 GAL	318	0.990	—	NO	NO AGITATOR
F1-301	HOT RAFF	VERTICAL	8'-0"	8'-0" T-T	3,600 GAL	2,301 GAL	59	0.990	.67	NO	
F1-302	HOT RAFF	VERTICAL	8'-0"	8'-0" T-T	3,600 GAL	1,530 GAL	39	0.990	0.77	NO	
F1-303	HOT RAFF	VERTICAL	8'-0"	8'-0" T-T	3,600 GAL	1,764 GAL	22	0.990	2.25	NO	
F1-308	HOT RAFF	VERTICAL	7'-0"	6-'10.5T-T	2,300 GAL	2,299 GAL	28	0.990	2.34	NO	
D1-1	DIGESTION	VERTICAL	8'-0"	8'-0" T-T	3,460 GAL	2,935 GAL	134	0.956	4.19	NO	
D1-7	DIGESTION	VERTICAL	8'-0"	8'-0" T-T	3,460 GAL	3,465 GAL	51	0.990	0.07	NO	(SEE NOTE 11)
D1-10	DIGESTION	VERTICAL	8'-0"	8'-0" T-T	3,460 GAL	2,872 GAL	143	1.290	4.69	NO	
F1-1	DIGESTION	VERTICAL	8'-0"	8'-0" T-T	3,460 GAL	1,825 GAL	173	0.951	0.84	NO	
F1-25	DIGESTION	VERTICAL	15'-0"	15'-0"	24,000 GAL	12,984 GAL	130	0.998	1.30	NO	
F1-26	DIGESTION	VERTICAL	15'-0"	15'-0"	24,000 GAL	1,454 GAL	138	0.955	3.45	NO	

STREAM NO.	1	2	3	4	5	6	7	8	9	10	11
COMPONENT	PLANT 8 WSTWATER FILTRATE	PROCESS WATER	OFF-SPEC FILTRATE RECYCLE	PROCESS STEAM	HEATED DILUTION WATER	UNH TO DILUTION TANK	UNH RECIRC	DILUTE UNH RECIRC	DILUTE UNH RECIRC	Mg(OH) TO NEUTRALI	NEUTRALI UNH TO PLANT 8
OPERATING MODE	INTERMIT	INTERMIT	INTERMIT	INTERMIT	INTERMIT	INTERMIT	INTERMIT	INTERMIT	INTERMIT	INTERMIT	INTERMIT
OPERATING (hr/day)											
LIQUID (lb/hr)	50040	50040	-	3703	53747						48975
SOLIDS (lb/hr)	0	0	0	0	0						13104
URANIUM (g/l)	0	0	0	0	0	22-318	22-318	~50	~50	0	-
FREE NITRIC ACID (N)	0	0	0	0	0	0-4.69	0-4.69	0-1.6	0-1.6	-	0
SPECIFIC GRAVITY (slurry)	-	-	-	-	-	1.1-1.5	1.1-1.5	~ 1.2	~ 1.2	1.5	1.24
SPECIFIC GRAVITY (liquid)	1.0	1.0	~ 1.1	-	1.0	-	-				~ 1.1
% SOLIDS	0	0	0	-	0	UP TO 30	UP TO 30	UP TO 10	UP TO 10	50	20
FLOW RATE (gpm)	100	100	100	-	109	100	100	100	100	50 MAX	100
TEMPERATURE °F	AMBIENT	60	60	324	140	AMBIENT	AMBIENT	120	120	AMBIENT	120
FLOW RATE (ACFM)											
NOTES			8		10, 12	1, 9, 10, 12	9			4	

STREAM NO.	12	13	14	15	16	17	18	19	20	21
COMPONENT	NEUTRALI UNH TO FILTERS	FILTER RECYCLE	FILTER CAKE	FILTRATE TO RECEIVER	FILTRATE TO STORAGE	SUCTION TO VAC PUMP	SEAL WATER SUPPLY	SEAL WATER RETURN	FILTRATE TO BDN	FUMES TO SCRUBBER
OPERATING MODE	CONTIN	INTERMIT	CONTIN	CONTIN	CONTIN	CONTIN	CONTIN	CONTIN	INTERMIT	CONTIN
OPERATING (hr/day)	24		24	24	24	24	24	24		24
LIQUID (lb/hr)	14693	-	1685	13008	13008		-	-		
SOLIDS (lb/hr)	3931	-	3931	0	0		0	0		
URANIUM (g/l)	-	-	0	0	0		0	0		
FREE NITRIC ACID (N)	0	0	0	0	0		0	0		
SPECIFIC GRAVITY (slurry)	1.24	1.24	0	-	-		-	-	1.0	
SPECIFIC GRAVITY (liquid)	~ 1.1	~ 1.1		~ 1.1	~ 1.1		~ 1.1	~ 1.1		
% SOLIDS	20	20	70	0	0		0	0		
FLOW RATE (gpm)	30	0	-	24	24		10	10	100	
TEMPERATURE °F	80		AMBIENT	AMBIENT	AMBIENT		AMBIENT	AMBIENT	AMBIENT	
FLOW RATE (ACFM)										100
NOTES	5, 7	5, 7	5							13

NOTES

1. THERE ARE 17 TYPICAL UNH STORAGE TANKS REQUIRING NEUTRALIZATION. INITIALLY, THE CONTENTS OF TANK F1-26 WILL BE NEUTRALIZED AND TRANSFERRED TO TANK F1-25. F1-26, NOW EMPTY, WILL BE CONVERTED TO A DILUTION/NEUTRALIZATION TANK TO PROCESS THE CONTENTS OF F1-25. WHEN F1-25 IS EMPTY, IT WILL ALSO BE CONVERTED TO A DILUTION/ NEUTRALIZATION TANK. BOTH F1-25 AND F1-26 WILL THEN BE USED TO PROCESS THE CONTENTS OF THE REMAINING 15 UNH STORAGE TANKS.
2. FILTRATE FROM THE PLANT 8 WASTEWATER FILTER WILL BE USED AS THE PRIMARY SOURCE OF UNH DILUTION WATER. PROCESS WATER WILL BE USED AS A BACK-UP SOURCE.
3. WHEN EMPTY, EACH UNH TANK WILL BE RINSED WITH DILUTE NITRIC ACID (1 NORMAL) FOLLOWED BY PROCESS WATER. THESE SOLUTIONS WILL BE USED TO DISSOLVE ANY CRYSTALS REMAINING IN THE TANKS. A HOSE CAN BE USED TO ADD THE DILUTE NITRIC ACID BELOW THE LIQUID LEVEL IN THE TANK.
4. MAGNESIUM HYDROXIDE WILL BE ADDED TO EACH DILUTION/NEUTRALIZATION TANK (F1-25 OR F1-26) TO REACH A FINAL pH OF 7. EACH DILUTION/NEUTRALIZATION TANK (F1-25 OR F1-26) WILL BE USED SEPARATELY FOR BATCH NEUTRALIZATION.
5. FLOWS SHOWN ARE TOTAL DESIGN RATES FOR BOTH THE EAST AND WEST EIMCO FILTERS OPERATING SIMUTANEOUSLY. FERMCO PROCEDURE "SOP 08-C-605 EIMCO FILTER OPERATION" WILL BE USED DURING FILTRATION.
6. FERMCO PROCEDURE SOP 8-C-104 MAKEUP OF PRECOAT SLURRY AND PRECOATING ROTARY VACUUM FILTERS" WILL BE USED FOR PRECOATING THE FILTERS.
7. ONE FILTER FEED TANK WILL FEED THE FILTER(S) WHILE THE OTHER TANK IS BEING FILLED FROM THE NEUTRALIZATION PROCESS. VALVES ON BOTH TANKS WILL BE CONTROLLED SO THAT THE INTERMITTENT SLURRY OVERFLOW FROM THE FILTER(S) CAN ONLY RETURN TO THE TANK THAT IS FEEDING THE FILTER(S).
8. ANY OUT-OF-SPECIFICATION FILTRATE COLLECTED IN TANK 25A FROM THE UNH PROCESS WILL BE TRANSFERRED BACK TO THE DILUTION/NEUTRALIZATION TANK (F1-25 OR F1-26) FOR REPROCESSING.
9. ONE PUMP WILL BE USED TO TRANSFER SLURRY. THE SAME PUMP CAN BE USED TO RECIRCULATE THE UNH WHEN NOT TRANSFERRING. THE SECOND PUMP WILL BE INSTALLED AT THE NEXT UNH STORAGE TANK TO BE PROCESSED. IT WILL BE USED TO RECIRCULATE THE UNH PRIOR TO TRANSFER.
10. TOTAL QUANTITIES FOR STREAM 5 AND STREAM 6 WILL BE DETERMINED SPECIFICALLY FOR EACH UNH STORAGE TANK TO BE PROCESSED.
11. THE CONTENTS OF TANK D1-7 WILL NOT BE PROCESSED UNDER THE SCOPE OF WORK OF THIS PROJECT.
12. DILUTION WATER, UNH, AND MAGNESIUM HYDROXIDE WILL BE ADDED TO ONE DILUTION/NEUTRALIZATION TANK AT A TIME.
13. SCRUBBER SYSTEM TO BE PROCURED AS A SKID MOUNTED UNIT. INSTALLATION AND ALL INTERCONNECTIONS SHALL BE PROVIDED BY FERMCO.

MAJOR EQUIPMENT LIST

MARK	QTY	EQUIPMENT NAME
A	1	UNH TRANSFER PUMP
B	1	UNH TRANSFER PUMP (SPARE)
C	1	NEUTRALIZED UNH TRANSFER PUMP
D	1	NEUTRALIZED UNH TRANSFER PUMP
E	1	FILTER FEED PUMP
F	2	MAGNESIUM HYDROXIDE FEED PUMP
		(ONE UNINSTALLED SPARE)
G	1	DILUTION WATER STEAM HEATER
H	1	NOX SCRUBBER SYSTEM

REF DWG NO.	DRAWING TITLE
92X-5900-X-00071	DRAWING INDEX
92X-5900-N-00073	SYMBOLS AND LEGEND SHEET

REV NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERMCO	DATE
0	CERTIFIED FOR CONSTRUCTION	3-4-94	3-3-94	

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

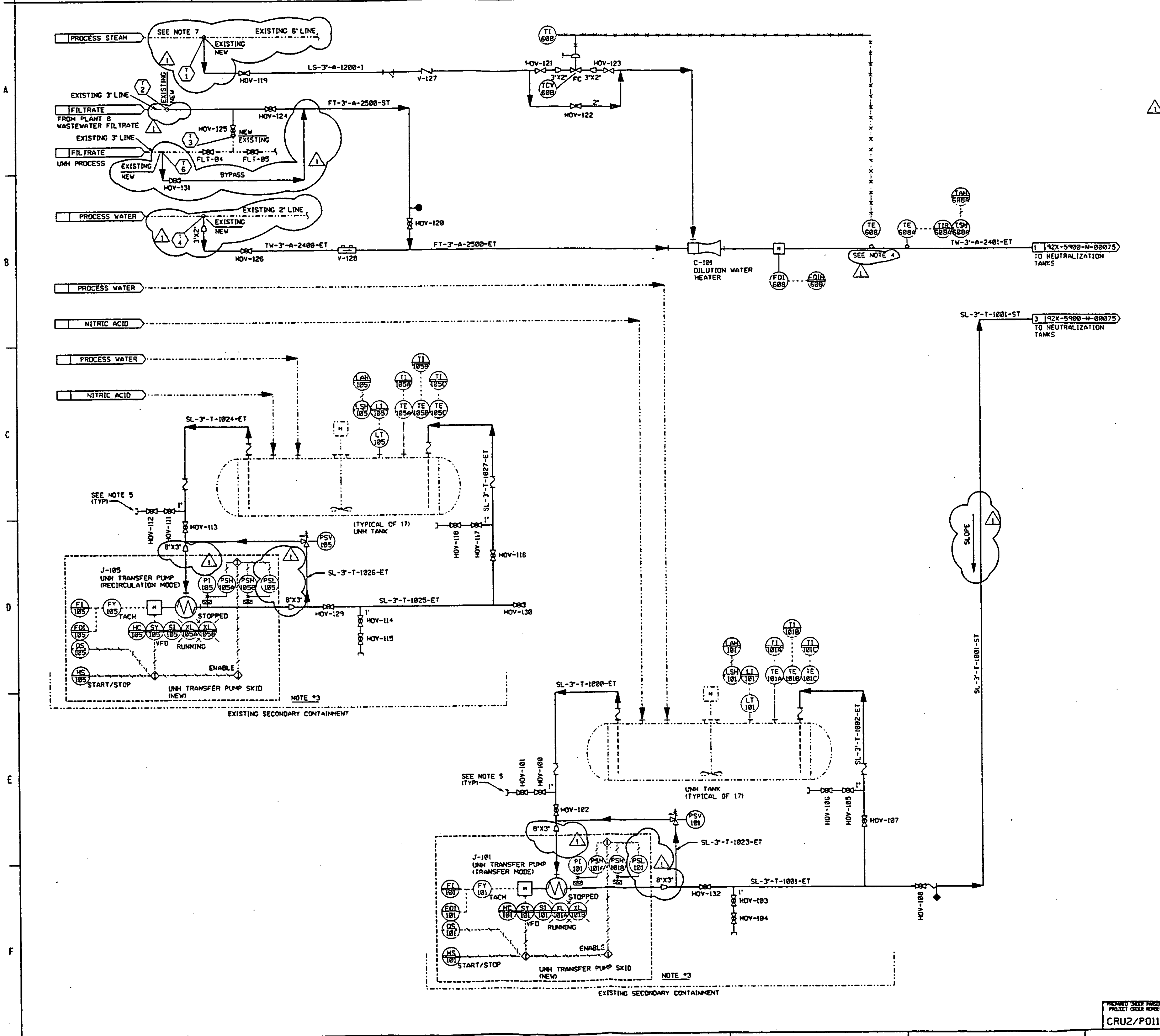
THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME: URANYL NITRATE NEUTRALIZATION PROJECT

DRAWING TITLE: PROCESS
PROCESS FLOW DIAGRAM
UNH HANDLING SYSTEM

DRAWN BY: JIM LAWSON DATE: 01-10-94 LEAD ENGINEER: SC Vader DATE: 3-25-94 CHECKED BY: K. STRADFORD DATE: 02-10-94
PLANT/BLDG. NO. FLOOR SCALE: NONE CLASS
SUBMITTED FOR APPROVAL DATE 3/25/94 FERMCO/CRU APPROVAL DATE 3-30-94

PREPARED UNDER PARSONS PROJECT ORDER NUMBER: CRU2/PO110 | DOE PROJECT NO. | FEMP PROJECT NO.: WBS 1.3 00-90701 | DRAWING INDEX CODE NO.: 92X-5900-F-00069 | SHEET NO.: F0001 | REV. NO.: 0



NOTES

1. FOR DRAWING INDEX SEE DRAWING 92X-5900-X-00071.
2. FOR SYMBOLS AND LEGEND SHEET SEE DRAWING 92X-5900-N-00073.
3. RELOCATE PUMP SKID, PIPING, AND VALVES TO NEXT TANK UPON COMPLETION OF PROCESSING AND RINSING OF A GIVEN TANK.
4. MINIMUM 3'-0" STRAIGHT LENGTH FOR TEMPERATURE SENSOR (1" NPT BULB).
5. 1" PROCESS WATER HOSE CONNECTION SHALL BE PROVIDED FOR FLUSHING AND PUMP PRIMING.
6. RELOCATE LEVEL AND TEMPERATURE INSTRUMENTS TO NEXT TANK UPON COMPLETION OF PROCESSING AND RINSING OF A GIVEN TANK.
7. TIE-IN LOCATION SHOWN ON DRAWING 92X-5900-P-00096.

LAST VALVE NUMBER | 132

REF DWG NO.	DRAWING TITLE
92X-5900-X-00071	DRAWING INDEX
92X-5900-N-00073	SYMBOLS AND LEGEND SHEET
92X-5900-N-00075	DILUTION AND NEUTRALIZATION SYSTEM

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERMCO	DATE
1	REVISED PER FERMCO REQUEST	[signature] 6/29/94	[signature] 6/30/94	
0	CERTIFIED FOR CONSTRUCTION	APP 3-25-94	JT 3-30-94	

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC
CINCINNATI, OHIO

PROJECT NAME
URANYL NITRATE NEUTRALIZATION PROJECT

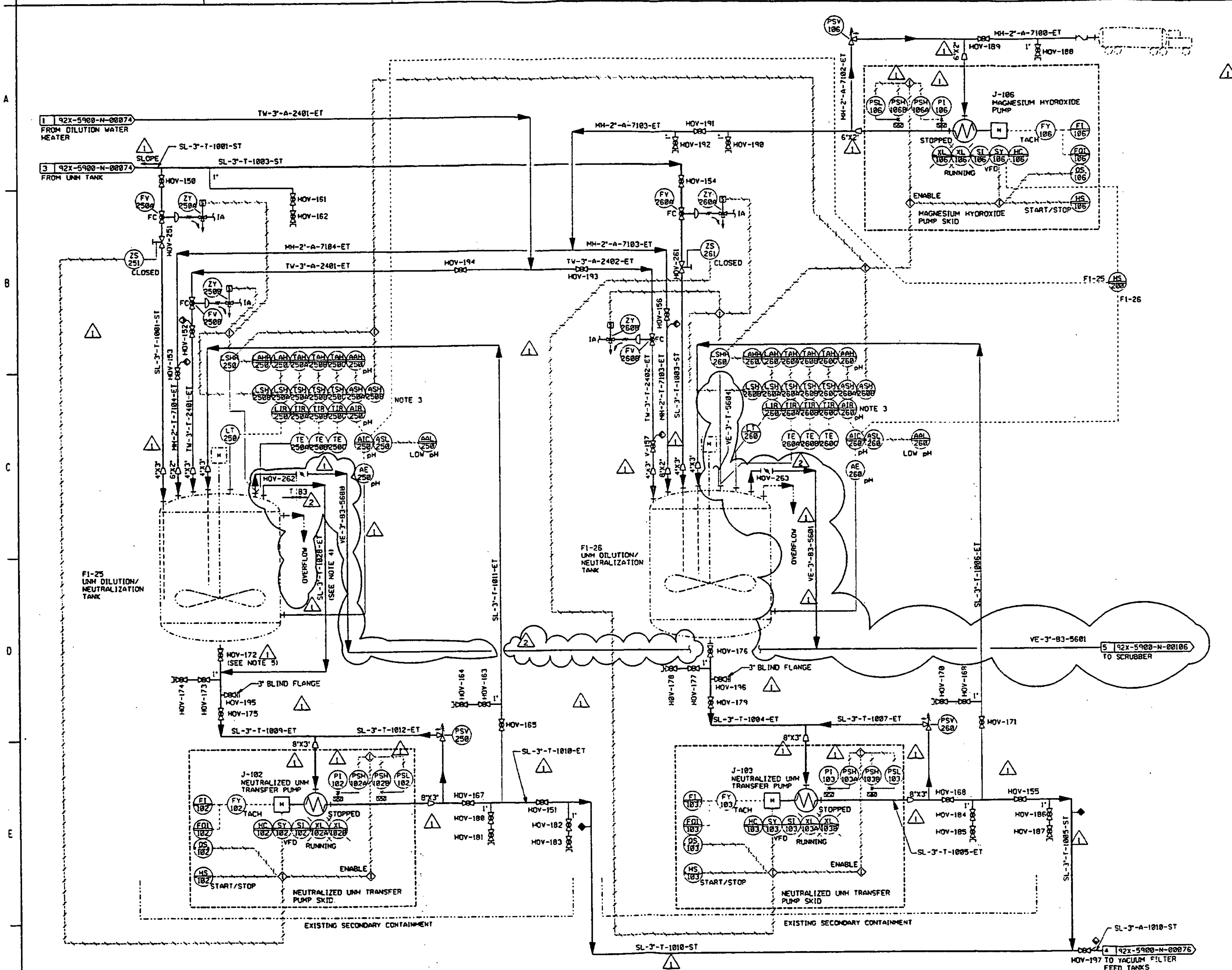
DRAWING TITLE
MECHANICAL PROCESS
PIPING AND INSTRUMENTATION DIAGRAM
TRANSFER SYSTEM

DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
JC BREWER	01-17-94	SALIM GHANTOUS	3-25-94	D. W. CARLSON	2-14-94

PLANT/BLDG NO. | FLOOR | SCALE | CLASS

SUBMITTED FOR APPROVAL	FERMCO CRU APPROVAL
A. P. PYRZ 3-25-94 (A-E, DATE)	J. TISARANNI 3-30-94 (DATE)

PREPARED UNDER PARSONS PROJECT ORDER NUMBER	DOE PROJECT NO.	FEMP PROJECT NO.	DRAWING BUILD CODE NO.	SHEET NO.	REV. NO.
CRU2/P0110		WBS 1.3 00-90701	92X-5900-N-00074	N0002	1



NOTES

1. FOR DRAWING INDEX SEE DRAWING 92X-5900-X-00071.
2. FOR SYMBOLS AND LEGEND SHEET SEE DRAWING 92X-5900-N-00073.
3. 6 PIN PROGRAMMABLE RECORDER/INDICATOR WITH ASSIGNABLE OUTPUT RELAYS.
4. ALTERNATE ROUTING FOR USE OF TOP SUCTION USING DIP LEG.
5. HOV-172 TO BE INSTALLED AFTER TANK F1-25 IS EMPTIED USING DIP TUBE.

LAST VALVE NUMBER HOV-263

REF DWG NO.	DRAWING TITLE
92X-5900-X-00071	DRAWING INDEX
92X-5900-N-00073	SYMBOLS AND LEGEND SHEET
92X-5900-N-00074	TRANSFER SYSTEM
92X-5900-N-00076	FILTRATION SYSTEM
92X-5900-N-00106	SCRUBBER SYSTEM

REV. NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERMCO	DATE
2	ADDED VENT LINES	9/19/94	8/19/94	
1	REVISED PER FERMCO REQUEST	APP 6-30-94	SF 6-30-94	
0	CERTIFIED FOR CONSTRUCTION	APP 3-25-94	JT 3-30-94	

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY

PARSONS

THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC
CINCINNATI, OHIO

PROJECT NAME
URANYL NITRATE NEUTRALIZATION PROJECT

DRAWING TITLE
MECHANICAL PROCESS
PIPING AND INSTRUMENTATION DIAGRAM
DILUTION AND NEUTRALIZATION SYSTEM

DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
JIM LAWSON	01-17-94	SALIM GHANTOUS	3-25-94	C. W. CARLSON	2-14-94

PLANT/BLDG NO. | FLOOR | SCALE | CLASS

SUBMITTED FOR APPROVAL: A. P. PYRZ 3-25-94 (A-E DATE)
FERMCO CRD APPROVAL: J. TISARANNI 3-30-94 (DATE)

PREPARED UNDER PARSONS PROJECT ORDER NUMBER	DOE PROJECT NO.	FEMP PROJECT NO.	DRAWING INDEX CODE NO.	SHEET NO.	REV. NO.
CRU2/P0110		WBS 1.3 00-90701	92X-5900-N-00075	N0003	2

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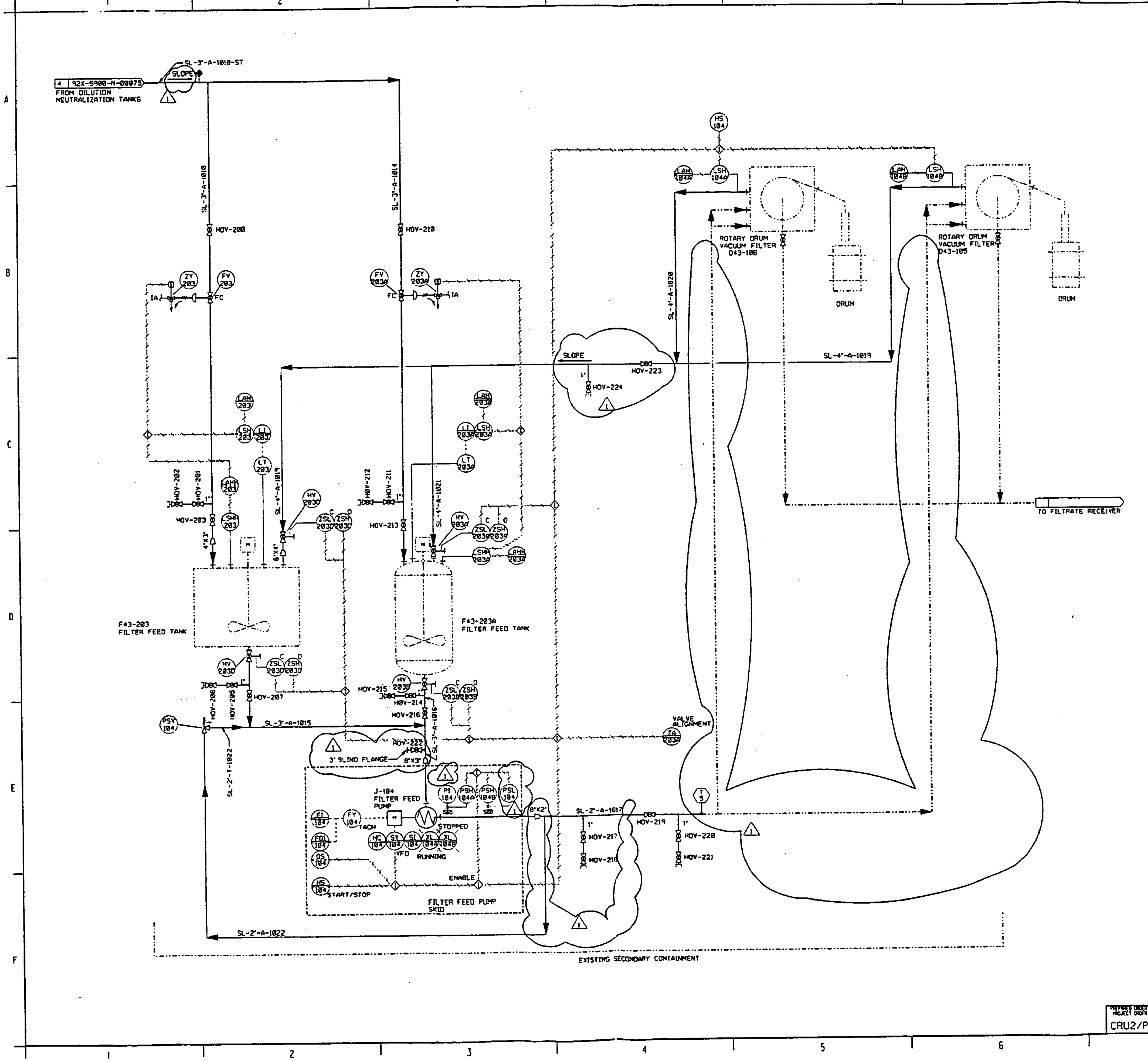

NOTES

1. FOR DRAWING INDEX SEE DRAWING 92X-5900-X-00071.
2. FOR SYMBOLS AND LEGEND SHEET SEE DRAWING 92X-5900-N-00073.

LAST VALVE NUMBER	224

REF DWG NO.	DRAWING TITLE
92X-5900-X-00071	DRAWING INDEX
92X-5900-N-00073	SYMBOLS AND LEGEND SHEET
92X-5900-N-00075	DILUTION AND NEUTRALIZATION SYSTEM

REV NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	APP	
1	REVISED PER FERMCO REQUEST		
0	CERTIFIED FOR CONSTRUCTION	APP 3-25-94	JT 3-30-94

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME
URANYL NITRATE NEUTRALIZATION PROJECT

DRAWING TITLE
MECHANICAL PROCESS
-PIPING AND INSTRUMENTATION DIAGRAM
FILTRATION SYSTEM

DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
JIM LAWSON	1-28-94	SALIM GHANTOUS	3-25-94	D. W. CARLSON	2-14-94

SUBMITTED FOR APPROVAL: A. P. PYRZ, 3-25-94
FERMCO CRU APPROVAL: J. TISARANNI, 3-30-94

PREPARED UNDER PARSONS PROJECT ORDER NUMBER	DOE PROJECT NO.	FERMCO PROJECT NO.	DRAWING NUMBER	SHEET NO.	REV. NO.
CRU2/PO110		WBS 1.3.1.1.1.1 00-90701	92X-5900-N-00076	N0004	1

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APPENDIX B

HAZARD DESCRIPTIONS

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B Hazard Identification

B.1 Chemical and Radiological Hazards and Location

B.1.1 Asbestos

Asbestos can be found in building materials and pipe insulation at several locations within the project boundary. Asbestos is a human carcinogen targeting the respiratory system. It is a respiratory hazard when friable.

B.1.2 Barium

Barium is a heavy metal that will be present in the UNH solutions and slurries throughout the system. It is a noted RCRA toxic heavy metal. Barium is an inhalation hazard and ingestion hazard.

B.1.3 Chromium

Chromium is a heavy metal that will be present in UNH solutions or sludges throughout the system. It is an inhalation and ingestion hazard.

B.1.4 Dicalite

Dicalite is a trade name for calcined diatomaceous earth. The material is used as the precoating agent on the EIMCO Filter drums. Dicalite is vacuumed onto the EIMCO filter screen and the precipitated compounds are deposited in it as the slurry is drawn through the filter. The Plant 8 EIMCO Filter drumming station will drum the filtered solids consisting of damp Dicalite, Barium Salts, Chromium hydroxide, and calcium or magnesium diuranate. Dicalite is an inhalation hazard.

B.1.5 Lead

Lead may be present in painted surfaces, flashing, and transite panel anchor bolt heads in and around the process buildings. Lead is a skin contact, inhalation, and respiratory hazard. Work that involves disturbance of these materials is at risk for suspension of lead particulates in the air.

B.1.6 Lime

Lime is used in the Plant 8 Waste Water Treatment system and may be stored in Plant 8. Lime is a respiratory, skin, and eye irritant.

B.1.6 Magnesium Hydroxide

Magnesium Hydroxide is a mild basic material that will be used in the Neutralization/Precipitation process conducted in Tanks F1-25 and F1-26. It is added to dilute UNH solution to facilitate the precipitation of uranium and other heavy metals. Magnesium hydroxide is not considered a significant hazard internal or skin contact hazard.

B.1.7 Mercury

Mercury is present in some test and monitoring equipment as well as florescent light tubes. It presents an ingestion, skin, and inhalation hazard.

B.1.8 Nitric Acid

Nitric acid is present in solution with UNH in the UNH Storage Tanks. It is an inhalation, ingestion, and skin contact hazard.

B.1.9 Nitrogen Dioxide

Nitrogen Dioxide can be generated during the processing of the Uranyl Nitrate solution. Generally it is not present in significant quantities until Uranyl Nitrate is heated above 130 degrees F. It is an inhalation hazard.

B.1.10 Uranium

Uranium will be present in several forms during the processing. Uranium Nitrate Hexahydrate (UNH) may be present in undissolved quantities in the tanks and associated piping and at previous leak locations. Uranyl Nitrate is the primary constituent in the UNH Storage Tanks. Magnesium diuranate will be present in Tanks F1-25 and F1-26 after neutralization/precipitation, the transfer lines from Digestion to Plant 8, and in the Plant 8 East-West EIMCO Filter System. Uranium contamination may be encountered in any of the areas where UNH processing is to be performed. Uranium is a hazard due to both its radiological and toxicological effects and is primarily an inhalation and ingestion hazard. Skin contact is a concern because of the potential for inadvertent ingestion or inhalation. Soluble uranium, such as Uranyl Nitrate, can pass through intact skin into the body upon skin contact.

B.2 Industrial Hazards

B.2.1 Noise

Excessive noise can occur during the operation of heavy machinery, pneumatic tools, generators, agitators, and other equipment.

B.2.2 Confined Spaces

A confined space is an area not designed for continuous human occupancy, is large enough for a person to bodily enter, and has limited means for entry and exit. Several of the Diked areas and most tanks are considered confined spaces.

B.2.3 Heat Stress

Heat stress can affect personnel performing activities with or without protective clothing when working in high ambient temperatures.

B.2.4 Cold Stress

Tasks may be conducted when the temperatures could be low enough to present a potential cold stress.

B.2.5 Personal Protective Equipment

Personal Protective Equipment while providing protection from hazards materials may hinder vision, reduce mobility and dexterity, and increase body temperature. This can impact the ability to perform required tasks and Job Safety and Task Analyses may be performed to address these and other safety issues. Pre-planning and engineering controls will help reduce the time required in PPE.

B.2.6 Lifting

Several operations will require lifting heavy objects. The dicalite bags are loaded into the precoat tank manually. A worker shall not lift more than 50 lbs without assistance from another person or mechanical aids.

B.2.7 Overhead Electrical Lines

While inspecting pipes, tanks, and other equipment personnel may encounter overhead electrical lines or temporarily installed overhead wiring and lighting.

B.2.8 Slips, Trips, and Falls

There will be many slip, trip, and fall hazards in the areas associated with the processing project. Many of the retrofitting and maintenance activities will take place at various elevations and surfaces.

B.2.9 Power Tools

Various power tools will be utilized in the field to connect the processing system to the UNH Storage Tanks and process material. A skid mounted pump will be utilized at each of the UNH Storage Tanks to transfer the material to the Blending Tanks F1-25 and F1-26.

B.2.10 Heavy Equipment

Heavy equipment such as fork lifts and aerials will be required for moving portable process equipment, drums, and other tasks.

B.2.11 Welding

Welding and cutting operations are referred to as "hot work". Prior to conducting "hot work", an Open Flame and Welding Permit shall be issued by FEMP site personnel. The purpose of the FERMCO Open Flame and Welding Permit is to establish guidelines by which the use of any flame or spark producing equipment, including gasoline and electric powered equipment, may be safely used in field project work. All welding and cutting shall be performed in accordance with Chapter 3 "Control of Open Flames and Welding" of the Fire Protection Requirements in *ESH-1-1000*, SPR 4-19.

B.3 Stored Energy Hazards

The stored energy hazards are addressed below.

B.3.1 Plant Air

The plant air supply will be active in the areas of processing, but is not currently utilized in the process and will be disconnected from process equipment. Airline respirators require connection to certified breathable air.

B.3.2 Plant Steam

Steam lines will be active in the areas of processing to provide building heat. Steam tracing will be installed on the new UNH piping runs. Steam will not be connected to tanks for heating of UNH solutions, however, a direct steam injection heater will be used to heat the incoming process water to the Neutralization tanks.

B.3.3 Electrical Current

Temporary cables and wiring will be run to the pump skid and control systems. Indicators and sensors installed in the tanks before processing will require installation or maintenance of the electrical supply to the equipment. As needed temporary lighting and heat tracing of piping may be installed.

B.3.4 Process Piping

During processing the transfer of material will generate an operating pressure differential to be determined. The development of blockage in any piping may lead to an increased pressure in the affected piping up to the controlled output pressure of the transfer pumps.

B.3.5 Compressed Gas Cylinders

Compressed gas cylinders that contain flammable or non-flammable gases will be required in various locations around the processing areas during the welding operations.

B.3.6 Hidden and Underground Utilities

If the project work scope involves penetrating/excavation into the surrounding earth, roof, floors, and walls of the facility a FERMCO permit is required. Due to serious injury potential from contacting or breaching existing utilities, a FERMCO Excavation/Penetration Permit with a complete mapping/drawings of all utilities and other potential hazards is required prior to start of excavation.

B.4 Unique Hazards

B.4.1 Transuranics

The tanks of uranium solution, in some cases, contain small quantities of the transuranic elements (TRU), Plutonium (Pu) and Neptunium (Np). Prior analysis has shown that both Pu and Np are only trace quantities and represent a low level of transuranic concentration which does not warrant additional controls beyond what is normally provided for uranium.

B.4.2 Incompatible Materials

When organics are present with nitric acid at high temperature ($>130°C$), there is a potential for the production of "Red Oil". Red Oil is a flammable volatile organic degradation product. In past boil-down and denitration operations, checks were made for the presence of an "organic layer". If present, the organic layer was removed before processing began. Inspections to date indicate that organics are present in only one tank, D1-7. This tank is being completely isolated so that inadvertent transfers to or from it are not possible. Project management will determine if the tank can be processed and how it will be accomplished.

B.4.3 Incompatible Materials

When the UNH solution is diluted, the temperature rise is less than 5 degrees F. The heat of neutralization will be less than 25 degrees F. The temperature rises are anticipated and are compensated for in the processing parameters.

APPENDIX C

HAZARD ANALYSIS

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Table C-1 Hazards Evaluation for Plant 2/3: Building 2A

I.D. NUMBER	HAZARD/EVENT	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
1.01	Friable asbestos	1. Asbestos disturbed and made airborne during area preparation/maintenance 2. Released by degraded asbestos containing transite ceiling panels	1. Unlikely 2. Unlikely	1. Brief exposure to Friable Asbestos fibers.	1. Low 2. Low	a. Remove or lockdown degrading asbestos containing material b. PPE- Respirators as interim measure c. Air monitoring	1. 2 2. 2
1.02	Kinetic - transite panels	1. Panels and supports degraded by exposure to nitric acid	1. Extremely Unlikely	1. Personnel injury as a result of impact	1. Low	a. Remove or lockdown degrading ceiling panels, or provide protective structure or equipment for work area.	1. 1
1.03	Kinetic - Deteriorating Catwalk	1. Decking dissolved in spots by past acid spills.	1. Unlikely	1. Personnel injury resulting from a fall, trip, cut.	1. Low	a. Structural evaluation of catwalks in Building 2A and repair, if recommended, or remove from service.	1. 1
1.04	NO_x Generation above action levels	1. High temperature (> 130 F) in Neutralization/ Precipitation Tanks.	1. Unlikely	1. Personnel injury/discomfort	1. Low	a. Tanks vented to scrubber and stack to remove NO_x, if generated, from work area. b. No external heating, tanks at ambient temperature. Process controlled to maintain heat of reaction below 130F to minimize NO_x generation. c. Air monitoring to indicate NO_x air concentration. d. PPE- Respirators available if action levels are exceeded.	1. 2

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Table C-1 Hazards Evaluation for Plant 2/3: Building 2A

I.D. NUMBER	HAZARD/EVENT	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
1.05	Direct contact with radioactive materials on skin, personal, or company issued "clean" clothing	1. Improper use of anti-Cs for intended scope of work 2. Anti-C failure 3. Inadequate plan for radiological work task	1. Unlikely 2. Unlikely 3. Unlikely	1. Personal contamination event with potential for increased radiation exposure to the contaminated worker. 2. Acid burn from nitric acid part of UNH solution	1. Low 2. Low	a. Proper work planning which identifies the intended scope of work. b. FERMCO Work Permit identifying proper anti-C requirements for intended scope of work. c. Pre-job brief with workers on work permit to ensure worker understanding of permit requirements for intended scope of work.	1. 2 2. 2 3. 2
1.06	UNH Spill - Inadvertent transfer of UNH solution between F1-25 and F1-26	1. Blockage of slurry transfer line to Plant 8, improper valve alignments or failure of valve, and failure of multiple engineered controls. Not considered credible in HAZOP.	1. Extremely Unlikely	1. Overflow of Tank F1-25 or F1-26 2. Contamination of immediate area	1. Low 2. Low	a. Multiple process controls installed including: level, temperature, pH, and position switches that will close valves and shut down transfer pumps. b. Procedures to be developed for emergency preparedness/spill response	1. 1
1.07	UNH Spill - Overfill of Tank F1-25 or F1-26 during transfer from a storage tank.	1. Improper valve alignments or valve failure, and incorrect transfer volume. Failure of multiple engineered and administative controls. Not considered credible in HAZOP.	1. Extremely Unlikely	1. Overflow of Tank F1-25 or F1-26. 2. Contamination of immediate area	1. Low 2. Low	a. Multiple process controls installed including: level, temperature, pH, and position switches that will shut down transfer pumps. b. Procedures to be developed for emergency preparedness/spill response	1. 1
1.08	Release of $Mg(OH)_2$ used for neutralization in Tanks F1-25 and F1-26	1. Pipe Rupture 2. Faulty quick disconnect connection 3. Improper draining/flushing during changeover to different caustic.	1. Extremely Unlikely 2. Unlikely 3. Unlikely	1. Release of caustic into secondary containment 2. Personnel exposure to caustic with potential for chemical burns	1. Low 2. Low	a. New system will be inspected and qualified prior to operation. b. Cleanout/Changeover procedure developed. c. Personnel Protective Equipment	1. 1 2. 2 3. 2

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Table C-1 Hazards Evaluation for Plant 2/3: Building 2A

I.D. NUMBER	HAZARD/EVENT	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
1.09	Spill/Release of UNH solution or high nitrate slurry	1. Pipe rupture 2. Leakage around pump discharge and flanged connections during disassembly 3. Leakage from liquid hammer 4. Damage during leak repair 5. Failure to test line/connection after maintenance 6. Pump seal failure 7. Improper valve alignment Events 1.06 and 1.07	1. Extremely Unlikely 2. Anticipated 3. Unlikely 4. Unlikely 5. Unlikely 6. Unlikely 7. Unlikely	1. Radiological contamination of immediate area 2. Potential personnel exposure to low pH material (UNH spill only) 3. Potential Personnel contamination (ref 1.05) 4. Shut-down of Neutralization process 5. Airborne release	1. Low 2. Low 3. Low 4. Low 5. Low	a. Piping testing and certification b. Leak repair plans constructed with input from safety disciplines c. Tank tie-in procedures prepared with input from safety disciplines d. Diked Area/Secondary containment. e. Work instructions for disassembly include precautions for residual solution that may be present. f. PPE is specified where there is a potential for the presense of solution	1. 1 2. 3 3. 2 4. 2 5. 2 6. 2 7. 2
1.10	Transfer of UNH Solution to Plant 8	1. Failure of pH indicator. 2. Procedure Violation.	1. Unlikely 2. Unlikely	1. Transfer of UNH solution to Plant 8 Filtering process, no release scenario, down-time for remediation and review. 2. Failure or damage to carbon steel transfer pipe and receiving tank due to nitric acid corrosion.	1. Low	a. pH indicators installed and tested prior to startup. b. Sampling/Analysis before transfer c. Installation of line to return off-spec. material to F1-25 or F1-26 aiding recovery.	1. 1 2. 1

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Table C-1 Hazards Evaluation for Plant 2/3: Building 2A

I.D. NUMBER	HAZARD/EVENT	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
1.11	Failure of the Scrubber/Exhaust Ventilation	1. A high concentration of NOx in the exhaust overwhelms the scrubber 2. Leak/rupture in the exhaust ducts 3. Fan failure	1. Extremely Unlikely 2. Unlikely 3. Unlikely	1. Release of NOx to the atmosphere below regulatory concern 2. Reduced removal of tank head space fumes with the potential for NO_x to migrate into the work area.	1. Low 2. Low	a. Previous analysis and bench scale testing have indicated that there is no potential for exceeding fence line concentrations and there is little potential for generating excessive NO_x b. Monitoring equipment alarms to indicate elevated NO_x concentrations in the work area. c. PPE available for worker protection d. Procedures address actions to take in the event of monitoring equipment alarms.	1. 1 2. 2 3. 2

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Table C-2 Hazards Evaluation for Plant 8 Filtering Operations

I.D. NUMBER	HAZARD	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
2.01	Overflow of EIMCO Filter Basin	1. Blockage in overflow line return to Tank F43-203 or F43-203A	1. Unlikely	1. Contamination of work area 2. Personnel exposure to neutralized UNH solution	1. Low 2. Low	a. High level alarm to be installed in both EIMCO Filter basins slightly above the overflow pipe that shuts down feed pump on high level. b. Overflow line cleaned and maintained between filter runs and is sloped to reduce slurry buildup.	1. 2
2.02	Overflow of Tank F43-203	1. High Level Sensor fails to shut inlet valve. 2. Improper valve alignment	1. Unlikely 2. Unlikely	1. Spill of Neutralized slurry inside Plant 8 2. Downtime for repair/investigation	1. Low 2. Low	a. New high level controls installed to disable transfer pump. b. Spill inside secondary containment	1. 2 2. 2
2.03	Overflow of Tank F43-203A	1. High Level Sensor fails to shut inlet valve 2. Improper valve alignment	1. Unlikely 2. Unlikely	1. Spill of Neutralized slurry inside Plant 8 2. Downtime for repair/investigation	1. Low 2. Low	a. New high level controls installed to disable transfer pump. b. Spill inside secondary containment	1. 2 2. 2
2.04	Overflow of Filtrate Hold Tank 25A	1. Failure to monitor 25A level	1. Unlikely	1. Spill of Filtrate water in Plant 8	1. Low	a. Controls are new and will be tested prior to operation. b. Spill inside secondary containment c. Filtrate not hazardous	1. 2

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Table C-2 Hazards Evaluation for Plant 8 Filtering Operations

I.D. NUMBER	HAZARD	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
2.05	Breakthrough of Filter Media on Rotary Drum of EIMCO Filter	1. Improper filter media 2. Improper Precoating 3. Scraping knife contacts drum surface 4. Improper Filter screen installed on drum	1. Extremely Unlikely 2. Unlikely 3. Extremely Unlikely 4. Extremely Unlikely	1. Contamination of Filtrate water in Tank 25A 2. Processing shutdown during repair/recoat 3. Filtrate water must be processed through filter a second time	1. Low 2. Low 3. Low	a. Procurement of proper filter materials b. Limit switch on knife prevents blade contact with filter drum. c. Trained operators in Plant 8 have experience running EIMCO Filters. d. Written operating procedures e. Formal qualification of operators	1. 1 2. 2 3. 1 4. 1
2.06	Exposure to Dicalite during Makeup of Filter Precoat mixture	1. Local exhaust ventilation failure at dumping station. 2. Improper loading of dump station.	1. Unlikely 2. Unlikely	1. Respirable quantities of Dicalite present above action levels	1. Low	a. Respirators are required b. Ventilation Flow Indicator at dumping station indicates if ventilation is operating properly.	1. 2 2. 2
2.07	Direct contact with radioactive materials on skin, personal, or company issued "clean" clothing	1. Improper use of anti-Cs for intended scope of work 2. Anti-C failure 3. Inadequate plan for radiological work task Events 2.08, 2.09, 2.10	1. Unlikely 2. Extremely Unlikely 3. Unlikely	1. Personal contamination event with potential for increased radiation exposure to the contaminated worker.	1. Low	a. Proper work planning which identifies the intended scope of work. b. Issuance of FERMCO Work Permit identifying proper anti-C requirements for intended scope of work. c. Pre-job brief with workers on work permit to ensure worker understanding of permit requirements for intended scope of work.	1. 2 2. 1 3. 2

Table C-2 Hazards Evaluation for Plant 8 Filtering Operations

I.D. NUMBER	HAZARD	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
2.08	Overflow of Precoat Makeup Tank	1. Process water not shut off	1. Unlikely	1. Spill of water or precoat slurry creating a slipping hazard. 2. Downtime Process delay 3. Potential process delay due to loss of filter media inventory	1. Low 2. Low 3. Low	a. Low hazard material b. Less potential for inhalation of wet material c. PPE protects worker d. Precoat mixing procedure	1. 2
2.09	Overflow of Drum at EIMCO Drumming Station	1. Failure of Seal 2. Failure of drumming station 3. Plugging of filter chute to drumming station. 4. Inattentiveness of operator checking drum fullness	1. Unlikely 2. Unlikely 3. Unlikely 4. Extremely Unlikely	1. Personnel exposure to filtered solids 2. Down time until clean-up	1. Low 2. Low	a. Calibrated scale indicate when storage containers are full b. Drumming station will contain spill c. PPE protects worker. d. Trained operators in Plant 8 or experienced running EIMCO filters	1. 2 2. 2 3. 2 4. 1
2.10	Discharge Filtrate with high U, Ba, or Cr to Biodenitrification	1. Failure to sample filtrate water before discharge. 2. Improper sampling methods 3. Improper sample results used as basis for discharge	1. Extremely Unlikely 2. Unlikely 3. Unlikely	1. Off spec. water sent to General Sump 2. Discharge of water above NPDES limits 3. Bugs in Biodenitrification are killed off by high heavy metals releasing uranium into BDN	1. Low 2. Low	a. Sample/analysis upon receipt at the General Sump prior to discharge to the BDN b. Water can be returned to Plant 8 for reprocessing.	1. 1 2. 2 3. 2

Table C-3 Hazards Evaluation for UNH Storage Tank Area

I.D. NUMBER	HAZARD	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
3.01	Inadvertent spill of UNH solution	1. Pipe rupture	1. Unlikely	1. Radiological contamination of immediate area	1. Low	a. Piping testing and certification	1. 2
		2. Pipe break during tie-in	2. Extremely Unlikely	2. Personnel exposure to UNH solution	2. Low	b. Leak repair plans constructed with input from safety disciplines	2. 1
		3. Leakage around pump discharge and flanged connections during disassembly	3. Anticipated	3. Shut-down of Neutralization process	3. Low	c. Tank tie-in procedures prepared with input from safety disciplines	3. 3
		4. Leakage from liquid hammer or freezing	4. Unlikely	4. Acid burn to skin due to nitric acid part of UNH solution	4. Low	d. Diked Area/Secondary containment	4. 2
		5. Damage during leak repair	5. Unlikely				5. 2

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Table C-3 Hazards Evaluation for UNH Storage Tank Area

I.D. NUMBER	HAZARD	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
3.02	Tank Overflow	1. Inadvertent transfer to full tank, improper valve alignment 2. Failure of engineered controls 3. Reversal of pump to clear blockage downstream 4. Process water not shut down 5. Level indicator and controller failure, pump controller failure, and valve failure initiated by the following: Mechanical or electrical failure, improper maintenance, corrosion. 6. Back siphon from higher elevation receiving tank	1. Unlikely 2. Unlikely 3. Extremely Unlikely 4. Unlikely 5. Unlikely 6. Unlikely	1. Release of UNH Solution or Slurry	1. Low	a. All storage tanks located in secondary containment b. Secondary containment integrity verified prior to transfers. c. New engineering controls to be installed and tested to increase reliability d. Control failures do not prevent placing system in safe configuration in the event of a control failure. e. Emergency Preparedness Procedures f. Positive displacement pumps prevent backflow	1. 2 2. 2 3. 1 4. 2 5. 2 6. 2
3.03	Electrical Shock during pump skid tie-ins	1. Failure to observe established safety procedures 2. Improper/missing/or inadequate labeling of power lines.	Standard Industrial Hazard I.13	1. Physical injury to personnel requiring hospital treatment 2. Personnel shock or electrocution		a. Lock and tag procedure b. GFCI installation	

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Table C-3 Hazards Evaluation for UNH Storage Tank Area

I.D. NUMBER	HAZARD	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
3.04	Direct contact with radioactive materials on skin, personal, or company issued "clean" clothing	1. Improper use of anti-Cs for intended scope of work 2. Anti-C failure 3. Inadequate plan for radiological work task	1. Unlikely 2. Unlikely 3. Unlikely	1. Personal contamination event with potential for increased radiation exposure to the contaminated worker. 2. Acid burns to skin from nitric acid part of UNH solution	1. Low 2. Low	a. Proper work planning which identifies the intended scope of work. b. Issuance of FERMCO Work Permit identifying proper anti-C requirements for intended scope of work. c. Pre-job brief with workers on work permit to ensure worker understanding of permit requirements for intended scope of work.	1. 2 2. 2 3. 2
3.05	Pipe Leak	1. "Liquid hammer" caused by pump 2. High pressure due to plug development 3. Improper anchoring of pump skid allows movement and loading of pipes. 4. Weld Leaks 5. Metallurgical Error	1. Extremely Unlikely 2. Extremely Unlikely 3. Unlikely 4. Unlikely 5. Extremely Unlikely	1. Personnel Exposure 2. Radiological contamination of immediate area 3. Processing delay	1. Low 2. Low 3. Low	a. Welding performed by qualified/ certified personnel b. Inspection and integrity testing c. Secondary containment of release d. Pump designed for smooth operation with reduced spiking	1. 1 2. 1 3. 2 4. 2 5. 1

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Table C-3 Hazards Evaluation for UNH Storage Tank Area

I.D. NUMBER	HAZARD	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
3.06	Spills/release outside of secondary containment	1. Temporary Secondary Containment inadequate 2. Pipe rupture in outside overhead transfer lines to Plt 8, OK Liquor to Plt 2/3, Raffinate to Plt 2/3, and NFS to Plt 2/3 3. Secondary Containment failure 4. Leakage from flange connections and worn pump parts	1. Extremely Unlikely 2. Extremely Unlikely 3. Extremely Unlikely 4. Extremely Unlikely	1. Spill and possible subsurface contamination based on building/ground absorption and dike/sump integrity.	1. Low	a. Dikes constructed of proper material and inspected for integrity. b. Insurance of pipe/connectors/valving integrity to be determined from analysis of system integrity and equipment start-up tests. c. Temporary Containment will meet all regulatory requirements. d. Daily inspection of pipe runs for leaks. e. Work procedures and training emphasize correct valves are open prior to pump initiation. f. Flange connections and pumps to be in temporary containment.	1. 1 2. 1 3. 1 4. 1

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Table C-3 Hazards Evaluation for UNH Storage Tank Area

I.D. NUMBER	HAZARD	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
3.07	Inadvertent transfer of UNH solution	1. Transfer of UNH solution before intended	1. Unlikely	1. Process shutdown to determine cause and repair	1. Low	a. Process controls	1. 2
		2. Leakage past closed valves	2. Unlikely			b. Positive displacement pump prevents backflow	2. 2
		3. Failure to ensure valve closure and blind-cap installation	3. Extremely Unlikely				3. 1
		4. Incorrect valve alignment	4. Unlikely				4. 2
		5. Back siphon from receiving tank at high elevation	5. Extremely Unlikely				5. 1

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Table C-4 Hazards Evaluation for External Events

I.D. NUMBER	HAZARD/ EVENT	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
E.01	Severe Natural Phenomena	1. Tornado 2. (BEBA) High Velocity Winds 3. (BEBA) Earthquake	1. Extremely Unlikely 2. Extremely Unlikely 3. Extremely Unlikely	1. Personal-contamination event with potential for increased radiation exposure to the contaminated worker. 2. Personnel injury or death (SIH) 3. Equipment damage 4. UNH dispersion	1. Low 2. SIH 3. Low 4. Low	a. Emergency response identifying proper anti-C requirements for intended scope of work. b. FEMP Emergency Warning System notifies workers to evacuate to safe locations.	1. 1 2. 1 3. 1
E.02	Natural Phenomena	1. (EBA) High Velocity Winds 2. (EBA) Earthquake	1. Unlikely 2. Unlikely	1. Personal contamination event with potential for increased radiation exposure to the contaminated worker. 2. Personnel injury or death (SIH) 3. Equipment damage 4. UNH solution release	1. Low 2. SIH 3. Low 4. Low	a. Emergency response identifying proper anti-C requirements for intended scope of work.	1. 2 2. 2

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Table C-4 Hazards Evaluation for External Events

I.D. NUMBER	HAZARD/ EVENT	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
E.03	Red Oil Explosion - the only tank (D1-7) containing an organic layer is outside the scope of this activity	1. No credible cause. the tank is isolated and controlled by Process Requirements. The material in the tank is of a low concentration and quantity and is not likely to sustain a reaction to produce Red Oil.	1. Not credible	1. Personal contamination event with potential for increased radiation exposure to the contaminated worker. 2. Personnel injury/death due to explosion 3. Equipment damage 4. UNH dispersion	1. Low	a. Defined scope of UNH project b. Pre-job brief with workers on work permit to ensure worker understanding of permit requirements for intended scope of work. c. D1-7 Inputs and Outputs are isolated d. PR to prevent processing e. Material in D1-7 is low risk for Red Oil.	1. n/a
E.04	External Explosion due to welding gas leak or due to propane gas leak.	Same as Number I.03					
E.05	Ignition of combustible material in UNH Project area.	1. Electrial short 2. Hot particles from welding or cutting	1. Unlikely 2. Unlikely	1. Personnel injury/ death 2. Equipment damage 3. UNH dispersion	1. SIH 2. Low 3. Low	a. Fire Extinguishers b. Emergency response c. Hot work permitting	1. n/a 2. 2

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Table C-4 Hazards Evaluation for External Events

I.D. NUMBER	HAZARD/ EVENT	CAUSE	FREQUENCY CLASS	CONSEQUENCE	CONSEQUENCE CLASS	CORRECTIVE ACTION/ MITIGATORS	ACCIDENT BIN
E.06	Vehicle Traffic Incident	1. Poor traffic patterns used by operations 2. Operator error	1. Unlikely 2. Unlikely	1. Possible serious personnel injury/death 2. Equipment damage 3. Possible release of radioactive or hazardous contaminants	1. SIH 2. Low 3. Low	a. Trades Supervisor shall ensure successful completion of qualification training for vehicle operators b. Project Engineer shall ensure that the Project Specific Health and Safety Plan is approved prior to work initiation and followed as work progresses c. Project Management ensures that the project design includes adequate designated personnel walkways d. Safety Engineer shall ensure that the project design restricts traffic in controlled areas e. Facility Owner shall ensure that the project design includes necessary traffic barriers and controls	1. n/a 2. 2
E.07	Loss of containment	1. Aircraft crash	1. Extremely Unlikely	1. Potential for multiple injuries and deaths at crash site. 2. Release of radionuclides	1. SIH 2. Low	a. Consequences qualitatively bounded by other accidents, such as NPH.	1. n/a
E.08	Flood	1. Large Dam break or over flow 2. Heavy rains	1. Incredible 2. Unlikely	1. Potential for spreading contamination to uncontaminated areas. 2. Diminished secondary containment.	1. n/a 2. Low	a. Not a credible scenario since there are no dams immediately upstream of facility. b. FEMP facilities posses local drainage to remove localized ponding.	1. n/a 2. 2

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Table C-5 - Standard Industrial Hazards

I.D. NUMBER	HAZARD	CAUSE	CONSEQUENCE	CORRECTIVE ACTION/ MITIGATORS	COMMENTS
I.01	Personnel Injury - Construction Related (Industrial)	1. Improper use of electrical supply, equipment, safety devices due to human error during construction 2. Equipment energized during installation/ testing activities 3. Slip, trip and fall. accidents 4. Material handling equipment is less-than-adequate 5. Vehicle impact 6. Eye injury 7. Ear injury - noise 8. Inhalation or skin contact with toxic chemical or radioactive	Possible serious personnel injury/death	a. Facility Owner shall verify and ensure that workers have received general site worker training in addition to task specific training as listed in the Project Specific Health and Safety Plan b. Facility Owner shall ensure successful completion of training on project procedures c. Project Engineer shall ensure that the Project Specific Health and Safety Plan is approved prior to work initiation and followed as work progresses d. QA/QC Engineer shall ensure adequate equipment inspection and testing prior to work initiation e. Facility Owner shall ensure that procedures for Excavation Penetration Permits and Facility Outage Permits are properly followed	

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Table C-5 - Standard Industrial Hazards

I.D. NUMBER	HAZARD	CAUSE	CONSEQUENCE	CORRECTIVE ACTION/ MITIGATORS	COMMENTS
I.02	Hoisting and Rigging Failure	1. Equipment failure 2. Operator error due to inadequate training 3. Lack of maintenance of lifting equipment 4. Inadequate rigging design	Possible serious personnel injury/death Equipment failure/damage Possible release of radioactive or hazardous contaminants	a. Project Engineer shall ensure that the Project Specific Health and Safety Plan is approved prior to work initiation and followed as work progresses b. Trades Supervisor shall ensure successful completion of training and qualification on hoisting and rigging c. Project Engineer shall ensure adequate equipment maintenance prior to initiation of work d. Construction Engineer shall ensure that a complete sitewide hoisting and rigging plan (SSOP) is available prior to initiation of work	
I.03	Flame ignition during welding	1. Explosive/flammable gas present in area of welding operations 2. Leak of explosive/ flammable gas from welding equipment	Personnel injury/death due to explosion Equipment damage Project delay	a. FERMCO Hot Work Permit b. Leak checks of welding gasses. c. Certified/experienced welders d. Fire watch e. Proper extinguishing agents present in immediate work area.	

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Table C-5 - Standard Industrial Hazards

I.D. NUMBER	HAZARD	CAUSE	CONSEQUENCE	CORRECTIVE ACTION/ MITIGATORS	COMMENTS
I.04	Violation of CERLCA Site-Controlled Area (minimum requirements)	1. Human error in following procedures 2. Training inadequate 3. Inadequate personnel protective equipment	Personal contamination event with potential for increased radiation exposure to the contaminated worker	a. Requirements for dosimeter (TLD) b. Requirements for PPE c. Site Worker and Refresher Training d. Site Specific Orientation Training e. Minimum Rad I Training f. Initial FERMCO or approved physical g. Initial, annual and termination - Invivo Testing h. Visitors must be escorted by personnel with proper training	Personnel, equipment and material monitoring required to exit the controlled area
I.05	Work conducted in the Construction Zone, which is also a controlled area (minimum requirements)	1. Human error in following procedures 2. Training inadequate 3. Inadequate personnel protective equipment	Possible serious personnel injury/death	a. Requirements for hard hat, safety glasses with rigid side shield, steel-toed shoes b. Construction rules/regulations, GET & refresher training - (all personnel, supervisors must have OSHA 500 training) c. All personnel who are to perform work in the construction zone will be orientated to the UNH SAR, Job Safety Analysis, CEOSH SPRs, Health and Safety Requirements Matrix d. General Work Permit requirements	
I.06	Crane accidents, employees struck by falling objects	1. Human error in following procedures 2. Training inadequate 3. Inadequate personnel protective equipment	Possible serious personnel injury/death	a. Competent operator (qualification cards per specifications)	

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Table C-5 - Standard Industrial Hazards

I.D. NUMBER	HAZARD	CAUSE	CONSEQUENCE	CORRECTIVE ACTION/ MITIGATORS	COMMENTS
I.07	Noise - ear injury	1. Human error in following procedures 2. Training inadequate 3. Inadequate personnel protective equipment	Possible serious personnel injury/death	a. Hearing protection for employees exposed to $\geq$85 dBA 8 hr. TWA b. Medical monitoring for employees exposed to $\geq$85 dBA 8 hr. TWA	
I.08	Falls from elevated surfaces	1. Human error in following procedures 2. Training inadequate 3. Inadequate personnel protective equipment	Possible serious personnel injury/death	a. Requirements for a safety harness and lifeline (retrieval system as required by FERMCO evaluation) b. Fall Protection Plan c. Fall protection training	
I.09	Exposure to fumes	Painting, welding or cutting	Possible serious personnel injury/death	a. Requirements FERMCO review MSDS for materials b. Respirator, if required by MSDS c. Respirator training and fit test (including annual refresher) d. Requirements for proper ventilation equipment e. General Work Permit requirements f. Hazardous Chemical Work Permit requirements	
I.10	Electrical	1. Human error in following procedures 2. Training inadequate 3. Inadequate personnel protective equipment	Possible serious personnel injury/death	a. FERMCO lockout/tagout procedure requirements b. Zero energy state verification requirements c. General Work Permit requirements d. Training e. PPE	

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Table C-5 - Standard Industrial Hazards

I.D. NUMBER	HAZARD	CAUSE	CONSEQUENCE	CORRECTIVE ACTION/ MITIGATORS	COMMENTS
I.11	Falls from scaffold/ladder	1. Human error in following procedures 2. Training inadequate 3. Inadequate personnel protective equipment	Possible serious personnel injury/death	a. Fall protection required b. Fall protection plan c. Training in scaffold erection, use, and dismantling d. Training in proper use of ladders, fall protection devices	
I.12	Oxygen deficiencies due to confined space	1. Human error in following procedures 2. Training inadequate 3. Inadequate personnel protective equipment	Possible serious personnel injury/death	a. Continuous air monitoring is required in confined spaces b. Safety harness and lifeline c. Fall protection requirements d. Entrant/attendant confined space training for permit required confined spaces e. FERMCO Confined Space Permit requirements f. Requirement for standby person for confined space g. Requirement for adequate ventilation	

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Table C-5 - Standard Industrial Hazards

I.D. NUMBER	HAZARD	CAUSE	CONSEQUENCE	CORRECTIVE ACTION/ MITIGATORS	COMMENTS
I.13	Electrical Shock Hazard	1. Shorts in electrical cables 2. Overhead lines in work area resulting in construction equipment accident 3. Lock and tag failures or procedures not followed	Possible serious personnel injury/death Impact on site safety function Loss of power for production, schedule impact Local fire	a. Electrician Supervisor shall ensure proper review of all electrical interfaces prior to implementation b. Project Engineer shall ensure that the Project Specific Health and Safety Plan is approved prior to work initiation and followed as work progresses c. Construction Engineer shall ensure an adequate Construction Environmental Health and Safety Work Survey d. Project Engineer shall ensure that the A/E design includes a process shutdown to safe condition upon electrical failure e. Project Engineer shall ensure that Ground Fault Interrupter (GFI) equipment is used f. Facility Owner shall ensure the proper implementation of SSOP-719 energy control lock and tag procedure g. Portable fire extinguishers and site fire fighting support	

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Table C-5 - Standard Industrial Hazards

I.D. NUMBER	HAZARD	CAUSE	CONSEQUENCE	CORRECTIVE ACTION/ MITIGATORS	COMMENTS
I.14	Heat Stress Leading up to Heat Exhaustion or Heat Stroke	1. Elevated worker temperatures from working in Personnel Protective Equipment (PPE) 2. Inadequate rest periods or failure to use coding devices 3. Worker failure to recognize symptoms of heat distress	Personnel injury	a. Project Engineer shall ensure that the Project Specific Health and Safety Plan is approved prior to work initiation and followed as work progresses b. Safety Engineer shall ensure the use of short-term work cycle or personal cooling devices are used as required by Industrial Hygiene c. Project Engineer shall ensure that the area includes an adequate ventilation system d. Safety Engineer shall ensure working conditions monitored and controlled e. Safety Engineer shall ensure that the project design includes adequate cooling apparatus f. Supervisor shall ensure air lines supplied to PPE as necessary g. Trades Supervisor shall ensure adequate use of buddy system among workers h. Trades Supervisor shall ensure successful completion of training in first aid and the symptoms of heat stress	

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Table C-5 - Standard Industrial Hazards

I.D. NUMBER	HAZARD	CAUSE	CONSEQUENCE	CORRECTIVE ACTION/ MITIGATORS	COMMENTS
I.15	Cold Stress	1. Inadequate work area heating. 2. Inadequate stay time determination for outside work on extremely cold days	Personnel injury	a. Project Engineer shall ensure that the Project Specific Health and Safety Plan is approved prior to work initiation and followed as work progresses b. Safety Engineer shall ensure the use of short-term work cycle are used as required by Industrial Hygiene c. Project Engineer shall ensure that the area includes an adequate heating system d. Safety Engineer shall ensure working conditions monitored and controlled e. Trades Supervisor shall ensure adequate use of buddy system among workers f. Trades Supervisor shall ensure successful completion of training in first aid and the symptoms of cold stress	
I.15	Equipment Failure Due to Cold Weather	1. Inadequate or failed freeze protection	Monetary loss due to equipment damage Possible injury to personnel	a. Project Engineer shall ensure that the area meets the cold protection provisions in DOE Order 6430.1A b. Facility Owner shall ensure that an adequate cold weather emergency plan is in place prior to work initiation	
I.16	General Lighting Failure/Poor Lighting	1. Inadequate lighting design 2. Power failure 3. Lighting fixture failure	Possible personnel injury Equipment damage	a. Project Engineer shall ensure that the area includes adequate lighting b. Project Engineer shall ensure that the area includes adequate emergency lighting	
I.17	Loss of Primary Electrical Distribution Power	1. Equipment failure 2. Human error 3. Natural catastrophe (lightning)	Loss of electrically-operated equipment and instrumentation Possible personnel injury	a. Facility Owner shall ensure routine preventive maintenance b. Trades Supervisor shall ensure operators are trained and qualified on equipment operation and proper shutdown procedures c. Emergency lighting & power	

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APPENDIX D

HAZOP

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1.0 Introduction

This report describes the method and results of a Hazard and Operability Analysis (HAZOP) of the UNH Neutralization System at the Fernald Environmental Management Project (FEMP). The UNH Neutralization System is designed to transfer UNH solution, currently stored in 18 tanks located in Plant 2/3, to processing tanks in Building 2A. In Building 2A, the solution will be diluted, neutralized, and the uranium precipitated. The resulting slurry will be transferred to the Plant 8 Waste Water Treatment Facility where the solids will be removed by filtration.

The HAZOP utilized an interdisciplinary team and a systematic approach to identifying hazard and operability issues resulting from deviations from the design intent that could lead to undesirable consequences. An experienced, independent team leader from Safety Management, Inc., systematically guided the team through the design using a set of guide words applied at specific design points. The team agreed upon possible causes of deviations, the consequences of deviations, and the applicable safeguards. Recommendations were made for management consideration.

2.0 Scope

The HAZOP addressed new and existing equipment associated with UNH processing that will contain uranium compounds under normal process conditions. The system analyzed includes the UNH storage tanks, the UNH transfer pumps, transfer piping, neutralization tanks and all lines feeding them, the magnesium hydroxide feed system, the vent line to the NO_x scrubber, the neutralized UNH transfer pumps and piping, the filter feed tanks and pumps, the filters and associated piping, and filter cake drumming equipment.

3.0 HAZOP Methodology

The first step in a HAZOP of a process is to divide the process into sections. There were twenty-four sections analyzed for the UNH Neutralization System.

1) UNH Storage Tank (typical)
2) Process water line to UNH Storage Tank
3) Line from UNH Storage Tank, through transfer pump, to dilution/neutralization tank
4) UNH transfer pump
5) UNH transfer pump recirculation line
6) UNH dilution/neutralization tank
7) Filtrate line from filtrate transfer pump to process water line
8) Filtrate line from Plant 8 Waste water filtrate

9) Process steam line to dilution water heater
10) Process water/steam line to UNH dilution/neutralization tank
11) Magnesium hydroxide tank truck
12) Magnesium hydroxide pump
13) Line from magnesium hydroxide tank truck to UNH dilution/neutralization tank
14) Line from UNH dilution/neutralization tank to NO_x scrubber
15) Neutralized UNH transfer pump
16) Recirculation line from neutralized UNH transfer pump to UNH dilution/neutralization tank
17) Line from dilution/neutralization tank, through pump, to filter feed tanks
18) Filter feed tank
19) Line from filter feed tanks, through pump, to rotary drum vacuum filters
20) Filter feed pump
21) Rotary drum vacuum filters
22) Filter cake drums
23) Filter overflow line to filter feed tanks
24) Line from filters to filtrate receiver

For each section, the team discussed *intentions*. Intentions describe the intended purpose and operation of the section.

Next, the team postulated *deviations* from the designated intentions. Deviations are process upsets such as high or low flow, level, temperature, pressure, or concentration. Leak and rupture deviations were also considered for each section.

For each postulated deviation, the team determined if there are any *consequences* of interest. The team defined a consequence of interest as a spill/release of UNH solution outside of secondary containment/spill control. The consequences stated for each deviation are reasonable worst case consequences that could occur if the causes were severe enough or lasted long enough.

For each deviation with one or more consequences of interest, the team identified credible *causes* of the deviation. Causes can initiate with the section and deviation being analyzed, or they can be initiated by another deviation within either the same section or another section. For example, high flow (or flow too long) in a line feeding a tank can cause the tank to overflow, releasing liquid inside secondary containment. There is no direct consequence of interest associated with high flow in the line where the original deviation occurs, but the consequence of high level in the tank is of interest. In this case the consequence of high flow in the line is linked as a cause of high level in the tank.

If a deviation has a consequence of interest and one or more credible causes, the team identified *safeguards* associated with the deviation. Safeguards are design features of operator actions that help prevent the deviation from occurring or limit the consequences if the deviation does occur. Continuing with the example above, the tank has a high level switch that shuts off the pump feeding it, thus reducing the likelihood of overflow. Also, the tank is located inside secondary containment, thus reducing the consequence of an overflow.

By considering the causes of each deviation (and their relative likelihoods), the consequences, and the existing safeguards, the team determined if any *action items* are necessary to reduce the risk posed by the deviation. Action items are recommendations for design, procedure, or administrative control changes aimed at reducing the likelihood of a deviation, or reducing the consequences of the deviation (i.e. action items are recommendations for additional safeguards). Action items are recommendations for further review or study before a recommendation for a costly change is justified.

The procedure described above was repeated for each deviation for each section in the process. The team's findings were recorded on a computer using HAZOP software, with the computer's display projected onto a screen for all participants to see. The HAZOP table generated in this fashion is Attachment 1 to this report. Table 3.1, excerpted from AIChE's, *Guidelines for Hazard Evaluation Procedures* (Ref. 1), defines common HAZOP terminology.

Table 3.1 Common HAZOP Analysis Terminology

Term	Definition
Process Sections (or Study Nodes)	Sections of equipment with definite boundaries (e.g. a line between two vessels) within which process parameters are investigated for deviations. The locations on P&IDs at which the process parameters are investigated for deviations (e.g. reactor)
Operating Steps	Discrete actions in a batch process or a procedure analyzed by a HAZOP analysis team. May be manual, automatic or software-implemented actions. The deviations applied to each step are somewhat different than the ones used for a continuous process
Intention	Definition of how the plant is expected to operate in the absence of deviations. Takes a number of forms and can be either descriptive or diagrammatic (e.g., process description, flow sheets, line diagrams, P&IDs)
Guide Words	Simple words that are used to qualify or quantify the design intention and to guide and stimulate the brainstorming process for identifying process hazards

Term	Definition
Process Parameter	Physical or chemical property associated with the process. Includes general items such as reaction, mixing, concentration, pH, and specific items such as temperature, pressure, phase, and flow
Deviations	Departures from the design intention that are discovered by systematically applying the guide words to process parameters (flow, pressure, etc.) resulting in a list for the team to review (no flow, high pressure, etc.) for each process section. Teams often supplement their list of deviations with ad hoc items
Causes	Reasons why deviations might occur. Once a deviation has been shown to have a credible cause, it can be treated as a meaningful deviation. These causes can be hardware failures, human errors, unanticipated process states (e.g., change of composition), external disruptions (e.g., loss of power), etc.
Consequences	Results of deviations (e.g., release of toxic materials). Normally, the team assumes active protection systems fail to work. Minor consequences, unrelated to the study objective, are not considered
Safeguards	Engineered systems or administrative controls designed to prevent the causes or mitigate the consequences of deviations (e.g., process alarms, interlocks, procedures)
Actions (or Recommendations)	Suggestions for design changes, procedural changes, or areas for further study (e.g., adding a redundant pressure alarm or reversing the sequence of two operating steps)

4.0 Team Members

The HAZOP core team consisted of:

Team Leader	Safety Management Inc. (Independent)
Safety Engineer	FERMCO Safety Analysis
Safety Engineer	Parsons Safety Analysis
Operations Manager	FERMCO Remediation Support Operations
Process Engineer	FERMCO Remediation Support Operations
Design Engineer	Parsons Engineering
Project Management	FERMCO Remediation Support Operations

The following team members participated in the analysis on an on-call basis to address specific concerns and areas of expertise and were not present for the full four days:

Operations Supervisor	FERMCO Remediation Support Operations
Plant 2/3 Supervisor	FERMCO Remediation Support Operations
Chemical Operator	FERMCO Remediation Support Operations
Engineering	FERMCO Engineering
DOE	Fernald Field Office, Facility Representative
Design Engineer	FERMCO Engineering
Design Engineer	Parsons Engineering

5.0 Resources

The team referenced the following drawings during the HAZOP analysis. Procedures for operating the system were not available at the time of the analysis.

92X-5900-F-00069, F0001, B
92X-5900-N-00074, N0002, A
92X-5900-N-00075, N0003, A
92X-5900-N-00076, N0004, A

6.0 Action Items

The action items resulting from the HAZOP are presented in this section. These are items that the team recommends to management for consideration. No serious problems were identified. The hazards identified during the HAZOP process will be incorporated into the Safety Analysis Report (SAR) Hazard Analysis.

6.1 **Ensure procedures address opening lines containing uranium compounds.**

The HAZOP team identified scenarios in which lines may become plugged and cannot be readily drained, pumped out, or flushed. An approved procedure for opening such lines to clear plugs is needed before processing begins.

Management Response

The general section of the neutralization procedure states that if a plug occurs, the transfer will be stopped and an evaluation performed before proceeding. Specific work instructions will be developed for each time opening a line is required.

6.2 **Consider installing a low pressure switch in the discharge lines of all pumps that could be operated in reverse.**

Pumps have low suction pressure interlocks to shut them off if the suction pressure is too low. These interlocks protect the pumps from burning up if suction flow is lost. However many of the pumps can and likely will be operated in reverse from time to time. Low suction pressure interlocks are needed to protect the pumps when they are operated in reverse.

Management Response

The substituted double-diaphragm pumps cannot be run in reverse.

6.3 **Review the relief protection on all lines that are heat traced and can be blocked at both ends to ensure protection is adequate.**

Thermal expansion of fluid in a heated, blocked-in line can cause extremely high pressure that can result in gasket or pipe failure. These lines may require thermal relief valves installed to relieve the pressure. The discharge of the thermal relief valve can be routed around the block valve at one end of a section that can be blocked in.

Management Response

No thermal reliefs are required because the lines will no remain standing full of liquid.

6.4 **Review the orientation of instrument taps on lines that will have slurry flowing in them.**

Instrument taps should be on the sides or top of piping that will have slurry to prevent slurry from plugging the taps.

Management Response

All instrument taps are on the top of the lines that transfer slurry.

6.5 **Consider installing coarse screens on pump suction lines to prevent foreign objects such as nuts and bolts from entering pumps and damaging them.**

Screens coarse enough to allow sludge to pass, but fine enough to catch objects that can damage pumps should be installed on all pump suction lines.

Management Response

Strainers were added to the suction of the pumps

6.6 **Consider locking all pump reverse switches and having the supervisor control the keys.**

Operating pumps in reverse is an off-normal operation that will occasionally be necessary. Valve line-ups and interlock alignments will need to be checked before operating any pump in reverse. Requiring the supervisor to unlock the pump reverse switch will help ensure proper procedures are followed.

Management Response

The pump controls and procedure will ensure that the pump cannot be inadvertently run in reverse.

6.7 **Consider performing preventive maintenance on process water backflow prevention devices.**

Under certain upset conditions, it may be possible to pump uranium compounds into the process water system if the backflow preventers do not work. Maintenance and testing will help improve the reliability of these devices.

Management Response

The backflow preventer has been added to the PM system.

6.8 **Consider a step in the operating procedures to sample filtrate for uranium and magnesium before reusing it.**

Uranium in the filtrate would indicate failure to neutralize a batch or loss of filter precoat. A high concentration of magnesium in the filtrate could prevent complete neutralization of the next batch.

Management Response

Filtrate is sampled for uranium and nitrates prior to transfer.

6.9 **Develop a procedure for verifying the contents of each magnesium oxide tank truck before accepting and using the shipment.**

Appropriate test methods should be employed to ensure the material delivered is within specifications. The manifest should also be checked to ensure it says the truck contains magnesium oxide.

Management Response

We will verify the contents of the tank truck by tank manifest and appropriate test.

6.10 **Modify the piping and instrument diagram to indicate that the line from the neutralized UNH transfer pumps to the filter feed tanks should be sloped with no pockets.**

This line will transfer solutions with considerable amounts of solids and must be sloped to allow it to drain or the solids can build up in the line, possibly causing flow blockage.

Management Response

A note has been added to the P&IDs requiring them to be sloped.

7.0 Conclusions

There were no major concerns identified that would pose a serious risk to the worker, public, or environment. The system is well instrumented and controlled. Procedural accuracy and compliance will be required to ensure the system is operated in a safe manner. The action items included in this report are provided for management consideration.

8.0 References

1. *Guidelines for Hazard Evaluation Procedures, 2nd Edition With Worked Examples*, Center for Chemical Process Safety, AIChE, New York, 1989.

Item Number	Deviation	Causes	Consequences	Safeguards	Actions
		1.0 Vessel - UNH storage tank (typical of 15)			
1.1	High level	Too much water added when priming pump	Spill of tank contents to secondary containment/spill control	Level monitored and alarmed in tank (LAH 101)	
		High flow in the process water line to UNH storage tank (Item 2.1)	Personnel contamination	Tank inlet lines blinded	
			Acid burn, respiratory problems	Procedures on priming pumps	
				Secondary containment	
1.2	Low level		No consequence of interest		
1.3	High temperature	Steam valve opened to tank heater	NOx formation, release	Steam valves locked or lines blinded	
1.4	Low temperature		No consequence of interest		
1.5	High pressure	No credible cause identified			
1.6	Low pressure	No credible cause identified			
1.7	High concentration of contaminants		No consequence of interest		
1.8	Leak	Weld failure	Spill of tank contents to secondary containment/spill control	Inspection	
		Flange, gasket leak	Personnel contamination	Preventive maintenance	
		External impact	Acid burn, respiratory problems	Maintenance procedures, conduct of operations	
		Valve packing leak		Hydrostatic testing	
		Instrument sensor tap leak		Forklift restrictions	
		Metal failure		Secondary containment	

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
1.9	Rupture	Agitator left on when tank pumped out, wobbles and damages tank	Spill of tank contents to secondary containment/spill control	Inspection	
		Weld failure	Personnel contamination	Preventive maintenance Maintenance procedures, conduct of operations	
		Flange, gasket failure	Acid burn, respiratory problems	Forklift restrictions	
		External impact		Procedures prohibit operation of agitator with low tank level	
		Metal failure		Secondary containment	
		2.0 Line - Process water line to UNH storage tank (dwg: 92X-5900-N-00074, N0002, A)			
2.1	High flow	Operator leaves water running too long	High level in UNH storage tank (typical of 15) (Item 1.1)	Operator training and procedures	
				Supervisor oversees operation	
2.2	Low/no flow		No consequence of interest		
2.3	Reverse/misdirected flow	Hose hooked to pump discharge	UNH in process water system	Backflow preventers	7
				Operating procedures	
2.4	High temperature	No credible cause identified			
2.5	Low temperature	Cold weather	Freezing, possible rupture (Item 2.10)	Heat tracing	
2.6	High pressure		No consequence of interest		
2.7	Low pressure		See reverse flow		
2.8	High concentration of contaminants		No consequence of interest		
2.9	Leak		No consequence of interest		
2.10	Rupture	Weld failure	Secondary containment filled with water	Operator rounds	
		Flange, gasket failure			
		External impact			
		Metal failure			
		Low temperature (Item 2.5)			

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
3.0	Line - Line from UNH storage tank, through transfer pump, to UNH dilution/neutralization tank (dwg: 92X-5900-N-00074, N0002, A and 92X-5900-N-00075, N0003, A)				
3.1	High flow	Totalizer set too high	High level in the UNH dilution/neutralization tank (F1-25) (Item 6.1)	Operator training	
		Pump switch fails to shut off pump		Procedures	
		Isolation valve sticks open	High concentration of nitric acid in the dilution/neutralization tank (F1-25) (Item 6.7)	LSH 250B and LSHH 250 close FV 250A	
		Improper valve line-up (wrong tank selected)		FQI 101/105 shuts off pump at selected total flow	
3.2	Low/no flow	Air lock in line (upstream of pump)	Internal leak in the UNH transfer pump (J-101 and J-105) (Item 4.1)	PSL 101 shuts off pump on low suction pressure	
		Line plugged (upstream of pump)		LI 101 indicates level in tank -- procedure to address monitoring tank level	
				Blockage downstream requires three failures before a consequence occurs	
3.3	Reverse/misdirected flow	Reverse operation of the pump is a design feature	Leak in the UNH transfer pump (J-101 and J-105) (Item 4.1)		2 6
3.4	High temperature	UNH or water in block-in, heat traced line	High pressure (Item 3.6)	Pressure relief valve on line--may not provide protection depending on which valves are closed	3
3.5	Low temperature	Line left full during cold weather	Freezing, possible rupture (Item 3.10)	Heat tracing	
				Cold weather operating procedures	
3.6	High pressure	High temperature (Item 3.4)	Possible rupture (Item 3.10)	Pressure relief valve on line--may not provide protection depending on which valves are closed	3
3.7	Low pressure		See low flow		
3.8	High concentration of contaminants	Storage tanks contain sludge	Erosion, plugging instrument taps from pumping sludge		4 5
		Foreign material (nuts, bolts, etc.) in tank			

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
3.9	Leak	Weld failure Flange, gasket failure External impact Valve packing leak Instrument sensor tap leak Metal failure Leaking drain valve Flexible hose cut Improper alignment of flanges or torquing bolts	Spill of line contents to floor sump or to ground Potential spray of material from leak site Personnel contamination Acid burn, respiratory problems	Inspection Preventive maintenance Maintenance procedures, conduct of operations Hydrostatic testing Forklift restrictions Drain lines plugged Part of line over secondary containment	
3.10	Rupture	Low temperature (Item 3.5) High pressure (Item 3.6) Weld failure Flange, gasket failure External impact Metal failure Flexible hose cut	Spill of line contents to floor sump or to ground Personnel contamination Acid burn, respiratory problems	Inspection Preventive maintenance Maintenance procedures, conduct of operations Hydrostatic testing Forklift restrictions Part of line over secondary containment	

4.0 Pump - UNH transfer pump (J-101 and J-105) (dwg: 92X-5900-N-00074, N0002, A)

Item Number	Deviation	Causes	Consequences	Safeguards	Actions
4.1	Leak	Weld failure	Spill to floor sump	Inspection	
		Seal, flange, gasket failure	Potential spray of material from leak site	Preventive maintenance	
		External impact	Personnel contamination	Maintenance procedures, conduct of operations	
		Valve packing leak	Acid burn, respiratory problems	Hydrostatic testing	
		Instrument sensor tap leak		Forklift restrictions	
		Metal failure		Drain lines plugged	
		Improper alignment of flanges or torquing of bolts		Secondary containment	
		Low/no flow in the Line from UNH storage tank, through transfer pump, to UNH dilution/neutralization tank (Item 3.3)			
		Reverse/misdirected flow in the Line from the UNH storage tank, through transfer pump, to UNH dilution/neutralization tank (3.3)			
4.2	Rupture	Weld failure	Spill to floor sump	Inspection	
		Seal, flange, gasket failure	Personnel contamination	Preventive maintenance	
		External impact	Acid burn, respiratory problems	Maintenance procedures, conduct of operations	
		Metal failure		Hydrostatic testing	
				Forklift restrictions	
				Secondary containment	
		5.0 Line - UNH transfer pump recirculation line (dwg: 92X-5900-N-00074, N0002, A)			
5.1	High flow	Recirculation with low level in storage tank	NOx generation, release	Operator procedures	
				Tank level monitored	

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
5.2	Low/no flow		See low flow in transfer line		
5.3	Reverse/misdirected flow		No consequence of interest		
5.4	High temperature	UNH or water blocked-in, heat traced line	High pressure (Item 5.6)	Pressure relief on line--may not provide protection depending on which valves are closed	3
5.5	Low temperature	Line left full during cold weather	Freezing, possible rupture (Item 5.10)	Cold weather operating procedures	
				Heat tracing on hard pipe portion of line	
5.6	High pressure	High temperature (Item 5.4)	Possible rupture (Item 5.10)	Pressure relief valve on line--may not provide protection depending on which valve are close	3
5.7	Low pressure		See low flow		
5.8	High concentration of contaminants	Storage tanks contain sludge	Erosion, plugging instrument taps from pumping sludge		5
5.9	Leak	Weld failure	Spill of line contents to secondary containment	Inspection	
		Flange, gasket failure	Potential spray of material from leak site	Preventive maintenance	
		External impact	Personnel contamination	Maintenance procedures, conduct of operations	
		Valve packing leak	Acid burn, respiratory problems	Hydrostatic testing	
		Instrument sensor tap leak		Forklift restrictions	
		Metal failure		Drain lines plugged	
		Leak drain valve		Secondary containment	
		Flexible hose cut			
		Improper alignment of flanges or torquing of bolts			

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
5.10	Rupture	Low temperature (Item 5.5)	Personnel contamination	Inspection	
		High pressure (Item 5.6)	Acid burn, respiratory problems	Preventive maintenance	
		Weld failure	Spill of line contents to secondary containment	Maintenance procedures, conduct of operations	
		Flange, gasket failure		Hydrostatic testing	
		External impact		Forklift restrictions	
		Metal failure		Secondary containment	
		Flexible hose cut			
6.0 Vessel - UNH dilution/neutralization tank (F1-25, typical of F1-25 and F1-26) (dwg: 92X-5900-N-00075, N0003, A)					
6.1	High level	High flow in the Process water/steam line from dilution water heater to UNH dilution/neutralization tank (Item 10.1)	Spill of tank contents to floor sump	LSH 250A alarms	
		High flow in the Line from UNH storage tank, through transfer pump, to UNH dilution/neutralization tank (Item 3.1)	Personnel contamination	LSH 250B and LSHH 250 close FV 250B (water line)	
		High flow in the line from magnesium tanker truck to UNH dilution/neutralization tank (Item 13.1)	Acid burn, respiratory problems	LSH 250B and LSHH 250 close FV 250B (UNH line)	
				LSHH 250 shuts off J-106 (Mg(OH)2 pump)	
				Secondary containment	
6.2	Low level	High flow in the Line form dilution/neutralization tank, through pump, to filter feed tanks (Item 17.1)	Rupture in the Neutralized UNH transfer pump (J-102) (Item 15.2)	PSL 102 shuts off J-102 on low suction pressure	
				LIR 250	

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
6.3	High temperature	High temperature in the Process water/steam line from dilution water heater to UNH dilution/neutralization tank (Item 10.4) High concentration of nitric acid (Item 6.7)	High concentration of NOx in the Line from UNH dilution/neutralization tank to NOx scrubber (Item 14.8)	Batch processing procedures Training Emergency procedures (addition of dilution water, batch splitting, suspend operation) TAH 250A, B, and C	
6.4	Low temperature		No consequence of interest		
6.5	High pressure	No credible cause identified			
6.6	Low pressure	No credible cause identified			
6.7	High concentration of contaminants	Failure to add water prior to addition of UNH and Mg(OH)2 High flow in the Line from UNH storage tank, through transfer pump to UNH dilution/neutralization tank (Item 3.1) Low/no flow in the Process water/steam line from dilution water heater to UNH dilution/neutralization tank (Item 10.2)	High temperature (Item 6.3)	Batch processing procedures Training Emergency procedures (addition of dilution water, batch splitting, suspend operation)	
6.8	Leak	Weld failure Flange, gasket leak External impact Valve packing leak Instrument sensor tap leak Metal failure	Spill of line contents to secondary containment Personnel contamination Acid burn, respiratory problems	Inspection Preventive maintenance Maintenance procedures, conduct of operations Hydrostatic testing Forklift restrictions Secondary containment	

Item Number	Deviation	Causes	Consequences	Safeguards	Actions
6.9	Rupture	Agitator left on when tank pumped out, wobbles and damages tank	Spill of tank contents to floor sump	Inspection	
		Weld failure	Personnel contamination	Preventive maintenance	
		Flange, gasket leak	Acid burn, respiratory problems	Maintenance procedures, conduct of operations	
		External impact		Hydrostatic testing	
		Metal failure		Forklift restrictions	
				Procedures prohibit operation of agitator with low tank level	
				Secondary containment	
6.10	Maintenance	Failure to follow safe work practices/permit requirements	Radiation hazards	Lock out/tag out procedure	1
			Chemical hazards	Confined space entry permit	
			Electrical hazards	radiation work permit	
			Mechanical hazards	Hot work permit	
				Work permit	
				Spill response procedures	
7.0 Line - Filtrate line from filtrate transfer pump to process water line (dwg: 92X-5900-N-00074, N0002, A)					
7.1	High flow		See high flow in process water line		
7.2	Low/no flow		No consequence of interest		
7.3	Reverse/misdirected flow		No consequence of interest		
7.4	High temperature	No credible cause identified			
7.5	Low temperature		No consequence of interest		
7.6	High pressure		No consequence of interest		
7.7	Low pressure		No consequence of interest		

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
7.8	High concentration of contaminants	High magnesium content in filtrate	High concentration of contaminants in the Line from dilution/neutralization tank, through pump, to filter feed tanks (Item 17.8)	pH monitoring before batch transferred from neutralization tank (continuous process probe and independent lab sample)	8
7.9	Leak	No consequence of interest			
7.10	Rupture	No consequence of interest			
	8.0 Line - Filtrate line from Plant 8 wastewater filtrate (dwg: 92X-5900-N-00074, N0002, A)				
8.1	High flow		See high flow in process water line		
8.2	Low/no flow		No consequence of interest		
8.3	Reverse/misdirected flow		No consequence of interest		
8.4	High temperature	No credible cause identified			
8.5	Low temperature		No consequence of interest		
8.6	High pressure		No consequence of interest		
8.7	Low pressure		No consequence of interest		
8.8	High concentration of contaminants		No consequence of interest		
8.9	Leak		No consequence of interest		
8.10	Rupture		No consequence of interest		
	9.0 Line - Process steam line to dilution water heater (dwg: 92X-5900-N-00074, N0002, A)				
9.1	High flow	TCV 608 sticks open TE 608 failure (fouled, internal failure)	High temperature in the Process water/steam line to UNH dilution/neutralization tank (Item 10.4)	TAH 608A Operating procedure requires checking tank temperature before addition of UNH	
9.2	Low/no flow		No consequence of interest		
9.3	Reverse/misdirected flow		No consequence of interest		
9.4	High temperature		No consequence of interest		

Item Number	Deviation	Causes	Consequences	Safeguards	Actions
9.5	Low temperature		No consequence of interest		
9.6	High pressure		No consequence of interest		
9.7	Low pressure		No consequence of interest		
9.8	High concentration of contaminants		No consequence of interest		
9.9	Leak		No consequence of interest		
9.10	Rupture	Weld failure Flange, gasket failure External impact Metal failure	Burn hazard	Inspection Preventive maintenance Maintenance procedures, conduct of operations Hydrostatic testing Forklift restrictions	
10.0 Line - Process water/steam line to UNH dilution/neutralization tank (dwg: 92X-5900-N-00074, N0002, A and 92X-5900-N-00075, N0003, A)					
10.1	High flow	Operator leaves valve open too long FV 250B sticks open ZY 250B sticks in supply air position	High level in the UNH dilution/neutralization tank (F1-25) (Item 6.1)	LSH 250A alarms LSH 250B and LSHH 250 close FV 250B Manual valves in Line Process water transfer monitored by operator	
10.2	Low/no flow	Failure to add water prior to addition of UNH and Mg(OH)2	High concentration of nitric acid in the UNH dilution/neutralization tank (F1-25) (Item 6.7)	Batch processing procedures Training Emergency procedures (addition of dilution water, batch splitting, suspend operation)	
10.3	Reverse/misdirected flow		Water directed to wrong tank, see high level in neutralization tank		

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
10.4	High temperature	High flow in the Process steam line to dilution water heater (Item 9.1)	High temperature in the UNH dilution/neutralization tank (F1-25) (Item 6.3)	TAH 608A Operating procedure requires checking tank temperature before addition of UNH	
10.5	Low temperature	Cold weather	Freezing, possible rupture (Item 10.10)	Heat tracing	
10.6	High pressure		No consequence of interest		
10.7	Low pressure		No consequence of interest		
10.8	High concentration of contaminants		No consequence of interest		
10.9	Leak		No consequence of interest		
10.10	Rupture	Low temperature (Item 10.5) Weld failure Flange, gasket failure External impact Metal failure	Secondary containment filled with water	Operator rounds	
		11.0 Vessel - Magnesium oxide tank truck (dwg: 92X-5900-N-00075, N0003, A)			
11.1	High level	No credible cause identified			
11.2	Low level		No consequence of interest		
11.3	High temperature	No credible cause identified			
11.4	Low temperature		No consequence of interest		
11.5	High pressure		No consequence of interest		
11.6	Low pressure		No consequence of interest		
11.7	High concentration of contaminants	Truck load of wrong material	Unknown, assumed severe		9
11.8	Leak		No consequence of interest		
11.9	Rupture		No consequence of interest		

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
		12.0 Pump - Magnesium hydroxide pump (J-106 (dwg: 92X-5900-N-00075, N0003, A)			
12.1	Leak		No consequence of interest		
12.2	Rupture		No consequence of interest		
		13.0 Line - Line from magnesium hydroxide truck to UNH dilution/neutralization tank (dwg: 92X-5900-N-00075, N0003, A)			
13.1	High flow	Incorrect batch setting FQI 106 failure	High level in the UNH dilution/neutralization tank (F1-25) (Item 6.1)	LSH 250A alarms LSHH 250 shuts off J-106 (Mg(OH)2 pump) AIC 250 shuts off pump on high pH in neutralization tank	
13.2	Low/no flow	Incorrect batch setting FQI 106 failure	High concentration of contaminants in the Line from dilution/neutralization tank, through pump, to filter feed tanks (Item 17.8)	pH monitoring before batch transferred from neutralization tank (continuous process probe and independent sample)	
13.3	Reverse/misdirected flow	No credible cause identified		Line does not dip into the neutralization tank	
13.4	High temperature	No credible cause identified			
13.5	Low temperature		No consequence of interest		
13.6	High pressure		No consequence of interest		
13.7	Low pressure		No consequence of interest		
13.8	High concentration of contaminants		See high concentration of contaminants in the tank truck		
13.9	Leak		No consequence of interest		
13.10	Rupture		No consequence of interest		
		14.0 Line - Line from UNH dilution/neutralization tank to NOx scrubber			
14.1	High flow		No consequence of interest		
14.2	Low/no flow	Stack blower failure	NOx leakage from neutralization tank	Procedure requires transfers to be stopped Air monitoring	

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
14.3	Reverse/misdirected flow	No credible cause			
14.4	High temperature		No consequence of interest		
14.5	Low temperature		No consequence of interest		
14.6	High pressure		No consequence of interest		
14.7	Low pressure		No consequence of interest		
14.8	High concentration of NOx	High temperature in the UNH dilution/neutralization tank (F1-25) (Item 6.3)	System boundary--consequence to be determined later		
14.9	Leak		System boundary--consequence to be determined later		
14.10	Rupture		System boundary--consequence to be determined later		
		15.0 Pump - Neutralized UNH transfer pump (J-102 and J-103) (dwg: 92X-5900-N-00075, N0003, A)			
15.1	Leak	Weld failure	Spill to floor sump	Inspection	
		Seal, flange, gasket failure	personnel contamination	Preventive maintenance	
		External impact		Maintenance procedures, conduct of operations	
		Valve packing leak		Hydrostatic testing	
		Instrument sensor tap leak		Forklift restrictions	
		Metal failure		Drain lines plugged	
		Leaking drain valve		Secondary containment	
		Improper alignment of flanges or torquing of bolts			

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
15.2	Rupture	Low level in the UNH dilution/neutralization tank (F1-25) (Item 6.2) Weld failure Seal, flange, gasket failure External impact Metal failure	Spill to floor sump Personnel contamination	Inspection Preventive maintenance Maintenance procedures, conduct of operations Hydrostatic testing Forklift restrictions Secondary containment	
	16.0 Line - Recirculation line from neutralized UNH transfer pump to UNH dilution/neutralization tank (dwg: 92X-5900-N-00075, N0003, A)				
16.1	High flow		No consequence of interest		
16.2	Low/no flow		No consequence of interest		
16.3	Reverse/misdirected flow	Valve line-up error	High concentration of contaminants in the Line from dilution/neutralization tank, through pump, to filter feed tanks (Items 17.8)	Administrative controls and procedures	
16.4	High temperature		No consequence of interest		
16.5	Low temperature	Line left full during cold weather	Freezing, possible rupture (Item 16.10)	Heat tracing Line drained after use	
16.6	High pressure		No consequence of interest		
16.7	Low pressure		No consequence of interest		
16.8	High concentration of contaminants		No consequence of interest		

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
16.9	Leak	Weld failure	Spill to floor sump	Inspection	
		Seal, flange, gasket failure	Personnel contamination	Preventive maintenance	
		External impact	Acid burn, respiratory problems	Maintenance procedures, conduct of operations	
		Valve packing leak		Hydrostatic testing	
		Instrument sensor tap leak		Forklift restrictions	
		Metal failure		Drain lines plugged	
		Leaking drain valve		Secondary containment	
		Improper alignment of flanges or torquing of bolts			
16.10	Rupture	Low temperature (Item 16.5)	Spill to floor sump	Inspection	
		Weld failure	Personnel contamination	Preventive maintenance	
		Flange, gasket failure	Acid burn, respiratory problems	Maintenance procedures, conduct of operations	
		External impact		Hydrostatic testing	
		Metal failure		Forklift restrictions	
				Secondary containment	
17.0 Line - Line from dilution/neutralization tank, through pump, to filter feed tanks (dwg: 92X-5900-N-00075, N0003, A and 92X-5900-N-00076, N0004, A)					
17.1	High flow	Improper batch transfer	Low level in the UNH dilution/neutralization tank (F1-25) (Item 6.2)	LSHH 203 closes FV 203 on high-high level in filter feed tank	
		Reverse/misdirected flow (Item 17.3)	High level in the Filter feed tank (F43-203) (Item 18.1)	LAHH 203	
				PSL 102 shuts off J-102 on low suction pressure	
				LIR 250	
17.2	Low/no flow		No consequence of interest		

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
17.3	Reverse/misdirected flow	Valve lineup error--transfer to wrong tank	High flow (Item 17.1)	Operator training and procedures	
17.4	High temperature		No consequence of interest		
17.5	Low temperature	Line left full during cold weather	Freezing, possible rupture (Item 17.10)	Heat tracing	10
				Line drained after transfer	
17.6	High pressure		No consequence of interest		
17.7	Low pressure		No consequence of interest		
17.8	High concentration of contaminants	High concentration of contaminants in the Filtrate Line from filtrate transfer pump to process water line (Item 7.8)	High concentration of uranium in the Line from filters to filtrate receiver (Item 24.8)	pH monitoring before batch transferred from neutralization tank (continuous process probe and independent sample)	
		Low/no flow in the Line from the magnesium hydroxide tank truck to UNH dilution/neutralization tank (Item 13.2)			
		Reverse/misdirected flow in the Recirculation line from neutralized UNH transfer pump to UNH dilution/neutralization tank (Item 16.3)			
17.9	Leak	Weld failure	Spill of line contents to floor sump or to ground	Inspection	
		Flange, gasket failure	Personnel contamination	Preventive maintenance	
		External impact		Maintenance procedures, conduct of operations	
		Valve packing leak		Hydrostatic testing	
		Instrument sensor tap leak		Forklift restrictions	
		Metal failure		Drain lines plugged	
		Leaking drain valve		Secondary containment on part of line	
		Improper alignment of flanges or torquing of bolts			

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
17.10	Rupture	Weld failure Flange, gasket failure External impact Metal failure Low temperature (Item 17.5)	Spill of line contents to floor sump or to ground Personnel contamination	Inspection Preventive maintenance Maintenance procedures, conduct of operations Hydrostatic testing Forklift restrictions Secondary containment on part of line	
18.0 Vessel - Filter feed tank (F43-203, typical of F43-203 and F43-203A) (dwg: 92X-5900-N-00076, N0004, A)					
18.1	High level	High flow in the Line from dilution/neutralization tank, through pump, to filter feed tanks (Item 17.1)	Spill of tank contents to floor sump Personnel contamination	LSHH 203 closes FV 203 on high-high level in filter feed tank LAHH 203 Administrative control on batch transfers Secondary containment	
18.2	Low level	High flow in the Line from filter feed tanks, through pump, to rotary drum vacuum filters (Item 19.1)	Rupture in the Filter feed pump (J-104) (Item 20.1)	LI 203 PSL 104 shuts off pump	
18.3	High temperature		No consequence of interest		
18.4	Low temperature		No consequence of interest		
18.5	High pressure	No credible cause identified			
18.6	Low pressure	No credible cause identified			
18.7	High concentration of contaminants		No consequence of interest		

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
18.8	Leak	Weld failure	Spill of tank contents to floor sump	Inspection	
		Flange, gasket failure	Personnel contamination	Preventive maintenance	
		External impact		Maintenance procedures, conduct of operations	
		Valve packing leak		Hydrostatic testing	
		Instrument sensor tap leak		Forklift restrictions	
		Metal failure		Secondary containment	
18.9	Rupture	Agitator left on when tank pumped out, wobbles and damages tank	Spill of tank contents to floor sump	Inspection	
		Weld failure	Personnel contamination	Preventive maintenance	
		Flange, gasket failure		Maintenance procedures, conduct of operations	
		External impact		Hydrostatic testing	
		Metal failure		Forklift restrictions	
				Procedures prohibit operation of agitator with low tank level	
				Secondary containment	
19.0 Line - Line from filter feed tanks, through pump, to rotary drum vacuum filters (dwg: 92X-5900-N-00076, N0004, A)					
19.1	High flow	Operator inattention to tank level	Low level in the Filter feed tank (F43-203) (Item 18.2)	LI 203	
				PSL 104 shuts off pump	
19.2	Low/no flow		No consequence of interest		
19.3	Reverse/misdirected flow		No consequence of interest		
19.4	High temperature		No consequence of interest		
19.5	Low temperature	No credible cause identified			
19.6	High pressure		No consequence of interest		

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
19.7	Low pressure		No consequence of interest		
19.8	High concentration of contaminants		No consequence of interest		
19.9	Leak	Weld failure	Spill of tank contents to floor sump	Inspection	
		Flange, gasket failure	Personnel contamination	Preventive maintenance	
		External impact		Maintenance procedures, conduct of operations	
		Valve packing leak		Hydrostatic testing	
		Instrument sensor tap leak		Forklift restrictions	
		Metal failure		Drain lines plugged	
		Leaking drain valve		Secondary containment on part of line	
		Improper alignment of flanges or torquing of bolts			
19.10	Rupture	Weld failure	Spill of tank contents to floor sump	Inspection	
		Flange, gasket failure	Personnel contamination	Preventive maintenance	
		External impact		Maintenance procedures, conduct of operations	
		Metal failure		Hydrostatic testing	
				Forklift restrictions	
				Secondary containment	

20.0 Pump - Filter feed pump (J-104) (dwg: 92X-5900-N-00076, N0004, A)

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
20.1	Leak	Weld failure	Spill to floor sump	Inspection	
		Seal, flange, gasket failure	Personnel contamination	Preventive maintenance	
		External impact		Maintenance procedures, conduct of operations	
		Valve packing leak		Hydrostatic testing	
		Instrument sensor tap leak		Forklift restrictions	
		Metal failure		Drain lines plugged	
		Leaking drain valve		Secondary containment	
		Improper alignment of flanges or torquing of bolts			
20.2	Rupture	Low level in the Filter feed tank (F43-203) (Item 18.2)	Spill to floor sump	Inspection	
		Weld failure	Personnel contamination	Preventive maintenance	
		Seal, flange, gasket failure		Maintenance procedures, conduct of operations	
		External impact		Hydrostatic testing	
		Metal failure		Forklift restrictions	
				Secondary containment	
21.0 Filter - Rotary drum vacuum filters (dwg: 92X-5900-N-00076, N0004, A)					
21.1	High flow		No consequence of interest		
21.2	Low/no flow		No consequence of interest		
21.3	High temperature		No consequence of interest		
21.4	Low temperature		No consequence of interest		
21.5	High level	Low/no flow in the Filter overflow line to filter feed tanks (Item 23.2)	Spill of tank contents to floor sump	Secondary containment	
			Personnel contamination	Interlock on return valve to filter feed tank	
				High level alarms on filters	

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
21.6	High differential pressure		No consequence of interest		
21.7	Low differential pressure		Loss of precoat, no filtration)Item 24.8)		
21.8	Leak	Weld failure	Spill of tank contents to floor sump	Inspection	
		Flange, gasket failure	Personnel contamination	Preventive maintenance	
		External impact		Maintenance procedures, conduct of operations	
		Valve packing leak		Forklift restrictions	
		Instrument sensor tap leak		Secondary containment	
		Metal failure			
		Filter agitator rubs hole in basin			
21.9	Rupture	Weld failure	Spill of tank contents to floor sump	Inspection	
		Flange, gasket failure	Personnel contamination	Preventive maintenance	
		External impact		Maintenance procedures, conduct of operations	
		Metal failure		Forklift restrictions	
		Filter agitator rubs hole in basin		Secondary containment	
		22.0 Vessel - Filter cake drums (dwg: 92X-5900-N-00076, N0004, A)			
22.1	High level	Operator error	Spill inside secondary containment, personnel contamination possible during clean up	Operator training and procedures	
				Secondary containment	
		23.0 Line - Filter overflow line to filter feed tanks (continued)			
23.1	High flow		No consequence of interest		

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
23.2	Low/no flow	Recycle valve closed	High level in the Rotary drum vacuum filters (Item 21.5)	Operator training and procedures	
		Recycle line plugged		Interlock on return valve to filter feed tank	
				High level alarms on filters	
				Interlocks prevent both return valves from opening	
23.3	Reverse/misdirected flow	No credible cause identified			
23.4	High temperature		No consequence of interest		
23.5	Low temperature	No credible cause identified			
23.6	High pressure	No credible cause identified			
23.7	Low pressure		No consequence of interest		
23.8	High concentration of contaminants		No consequence of interest		
23.9	Leak	Weld failure	Spill of tank contents to floor sump	Inspection	
		Flange, gasket failure	Personnel contamination	Preventive maintenance	
		External impact		Maintenance procedures, conduct of operations	
		Valve packing leak		Hydrostatic testing	
		Instrument sensor tap leak		Forklift restrictions	
		Metal failure		Drain lines plugged	
		Leaking drain valve		Secondary containment	
		Improper alignment of flanges or torquing of bolts			

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Item Number	Deviation	Causes	Consequences	Safeguards	Actions
23.10	Rupture	Weld failure Flange, gasket failure External impact Metal failure	Spill of tank contents to floor sump Personnel contamination	Inspection Preventive maintenance Maintenance procedures, conduct of operations Hydrostatic testing Forklift restrictions Secondary containment	
	24.0 Line - Line from filters to filtrate receiver (dwg: 92X-5900-N-00076, N0004, A)				
24.1	High flow		No consequence of interest		
24.2	Low/no flow		No consequence of interest		
24.3	Reverse/misdirected flow		No consequence of interest		
24.4	High temperature		No consequence of interest		
24.5	Low temperature		No consequence of interest		
24.6	High pressure		No consequence of interest		
24.7	Low pressure		No consequence of interest		
24.8	High concentration of uranium	High concentration of contaminants in the Line from dilution/neutralization tank, through pump, to filter feed tanks (Item 17.8) Loss of precoat, no filtration in the Rotary drum vacuum filters (Item 21.7)	High concentration of uranium downstream	Procedures require sampling filtrate receiver before transferring contents	
24.9	High concentration of barium	Neutralization/filtration process does not remove barium that is present in the storage tanks	High concentration of barium downstream	Procedures require sampling filtrate receiver before transferring contents Sodium sulfate added to precipitate barium from rerun stream	

Item Number	Deviation	Causes	Consequences	Safeguards	Actions
24.10	Leak		No consequence of interest		
24.11	Rupture		No consequence of interest		

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APPENDIX E

CONSEQUENCE CALCULATION

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E.1 Objectives

To determine the hazard classification and consequences of accidents involving Uranyl Nitrate Hexahydrate (UNH) tanks.

E.2 Background and Approach

The primary concern with the UNH neutralization project is with the UNH inventory itself. This calculation examines the consequences of one or all tanks of UNH being subject to accident conditions. The accidents are selected to provide bounding consequences. The inventory for all calculations are taken from the UNH Bench Test Report (Reference E.7.1).

Releases for the inventories from all tanks are modelled as a point source release. The inventories used for each accident condition are discussed separately. The assumptions for each event initiator are presented in the corresponding subsection. The consequence analysis encompasses earthquake and high wind , as natural phenomena, and fire, explosion and spill as manmade.

E.2.1 Earthquake

The earthquake scenario is based on an earthquake at the FEMP which results in the release of 50 percent of the UNH inventory. All project related facilities are assumes to fail. The tanks release their contents from a height of 2.5 meters. From DOE-STD-1020-94 (Reference E.7.2), the lower end of a severe earthquake for a hazard category 3 (Performance Category 2) facility is $0.13g_a$ with an exceedance frequency of 1E-3 earthquakes/year.

E.2.2 High Winds

High Winds are assumed to affect the entire site. Therefore, they are assumed to cause a common mode failure of all UNH tanks. All tanks are overturned, or ruptured, and spill their entire contents. The High Winds disperse the UNH. All project related facilities are assumed to fail.

The windspeed and the original Airborne Respirable Fraction (ARF) for aerodynamic entrainment is 9E-5 for 50 mph winds in Reference E.7.3, page 3-3. Based on DOE-STD-1020-94 (Reference E.7.1), a High Wind event is 70 miles per hour. Therefore, to scale up the ARF, and to account for the change in wind energy, the square of the velocities was used. $9E\text{-}5*(70^2)/(50^2) = 1.76E\text{-}4$. The meteorology for the high wind event is Pasquill Stability Class A at 31 m/s (70 mph) based on Reference E.7.4. The 70 mph high winds exceedance frequency shown on page 3-4 of DOE-STD-1020-94 is 2.0E-2.

Note that DOE-STD-1020-94 does not require an evaluation of tornados.

E.2.3 Fire

The fire scenario is based on a Facility area fire which engulfs the area where the largest continuous group of UNH tanks (F1-605, F1-606, F1-607, and F1-608) are located. This group of tanks was selected because they would yield the greatest inventory of UNH. The specific project related facility that is affected is assumed to fail. These large tanks are heated by a fire, rupture open at the top, and release their contents. Since no conceivable fire scenario could cause these tanks to boil in the 15 minute accident scenario, the analysis assumes a release as described in NUREG-1320, page 4.9, (Reference E.7.5) "preboiling" from "heating of unpressurized radioactive liquids" affecting the top 10% of the tanks at risk. An ARF of (1.06E-8/sec * 900 sec * 10%) = 9.5E-7 of the material at risk is assumed with 100 percent respirable.

The frequency for the incipient fires which could result in this accident sequence above is quantified by using historical data. The frequency was calculated by first compiling the number of incipient fires and initiators that have occurred in Plants 2/3 and 8. This data is presented in Table E-1. Based on FEMP emergency incident data, there have been 1505 incipient fires at the FEMP during the period from 1962 to 1992. Of these fires, only 1 in the Boiler plant became a facility fire. Additionally, due to the lack of combustible materials in the F1-600 series tank farm area, the analysis assumes that there is a 10% chance of a source of highly combustible fuel will be released into the area.

The fire frequency is 10% * f_1 (0.85 fires per year) * p_1 (1/1505 facility fires per fire) = 5.6E-5 fires/year.

Table E-1 - Base Fire Frequency

Plant Fires from 1971 to 1992 (excluding drum fires)				
Category of actual fires	**Number of Plant 2/3 fires in this category**	**Number of Plant 8 fires in this category**	**Other potential causes of fires which were investigated but did not occur**	
Welding	1		Gas	Oil
Insulation	1	1	Grass	Magnesium
Sludge		3	Cloth	Liquid
Dust		1	Plastics	Miscellaneous
Electrical	1	3	Equipment	Explosion
Paper	2	1		
Rubber	1			
Automotive	1	2		
Totals	7	11	**Grand Total**	
Annual Frequency	0.33	0.52	0.85	

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The frequency is based on the occurrence of incipient fires and their associated causes. The fires did not activate the fire sprinkler system in any case except the boiler plant fire. The reason for the other fires not activating the sprinkler system is the lack of combustible material to support a fire. The fire frequency is valid without the fire sprinkler system being active. The sprinkler systems are not required because there is little combustible loading in the area. The fire inspection performed during the OSHA assessment did not recommend placing the sprinkler system back in service.

E.2.4 Explosion

The explosion scenario is based on explosive or flammable gas leaking from welding equipment present in the area. The gas concentration reaches the Lower Explosive Limit (LEL) in a confined area and detonates. The explosion is near enough to a tank to rupture it and disperse the UNH in the tank equivalent to a free fall 4 meters in height. The worst case inventory has been used since this event is likely to affect only one tank. An ARF from NUREG-1320, Equation 4.59 (Reference E.7.5) of 3.2E-6 is assumed with 100 percent respirable.

E.2.5 UNH Spill

The UNH spill scenario is based on a variety of initiators including:

1) a blockage of slurry transfer line to Plant 8
2) improper valve alignments
3) failure of a valve
4) failure of multiple engineered controls
5) leakage/pipe break around pump discharge and flanged connections

The initiators above result in an inadvertent transfer of UNH solution from or to tanks F1-25 or F1-26. This results in the overflow and spill of UNH from tank F1-25 or F1-26. One tank of UNH (one with the largest inventory of the chemical or radionuclides) is overflowed and released. The ARF is based on the methodology of NUREG-1320, Equation 4.59 (Reference E.7.5) for the free fall spill of liquids at a height of 2 meters resulting in an ARF of 9.8E-7.

The frequency of this accident is qualitatively evaluated to be "Extremely Unlikely" and uses a point estimate of 2.0E-5 events per year.

E.3 Assumptions

E.3.1 When a concentration for a specific tank, for a specific chemical is not known, the worst known concentration of any sample value is used.

E.3.2 The entire inventory is assumed to be at risk in the High Wind accident. For the Earthquake accident the entire tank contents cannot drain from a tank with a rupture of a nozzle or pipe in the 15 minute time. The inventory released is assumed to be 50 percent of the total inventory for this time period. The Fire scenario assumes the largest continuous tank group is at risk. All other accidents assume the worst tank (highest inventory) is released.

E.3.3 Dilution Factors were calculated based on NUREG/CR-3332 (Reference E.7.6) for a Pasquill-Gifford system. The 95 percentile meteorological data for the FEMP was used (Reference E.7.7).

E.3.4 Earthquake, Fire, Explosion, and Spill scenarios use worst case, stability class G, 0.52 m/s windspeed, ground level release.

E.3.5 High Wind is calculated using Stability Class A, 31 m/s windspeed, ground level release.

E.3.6 The Neptunium isotope was unknown. However, the length of time the tanks have been standing indicate (by comparison of radioisotope half-lives) that it is a long lived radioisotope. Np-237 has a sufficient half-life to be present while other radioisotopes would have decayed away.

E.3.7 The wind direction is assumed to not waver for accident durations shorter than 8 hours.

E.3.9 An assumed Release Duration of 900 seconds (15 minutes) is used to enable the toxilogical concentrations reasonable comparison against the short term exposure criteria based on WSRC-MS-92-206, Revision 1 (Reference E.7.8). Note that increasing this release time as allowed by LA-10294 (2 hours) will reduce the toxilogical concentration by lowering the release concentration by increasing time. Since the uranium toxicology is the most limiting hazard, the use of the short 900 second release time is very conservative.

E.4 Calculations

The attached spreadsheet on pages 15 through 17 provides the inventory at risk and the calculations used. This is based upon bench test data (Reference E.7.1).

The calculation uses the basic formula for radionuclides is:

$$\text{CEDE (mrem)} = [\text{Inventory (pCi)} * \chi/Q\ (s/m^3) * \text{ARF} / \text{RD (s)}] * \text{DCF (mrem/pCi)} * \text{BR}\ (m^3/s) * \text{ED (s)}$$

Where:

ARF = Airborne Respirable Fraction (unit less)
CEDE = Committed Effective Dose Equivalent
RD = Release Duration
DCF = Dose Conversion Factor (Reference 7.9)
BR = Breathing Rate (Reference 7.10)
ED = Exposure Duration (equal to release duration)
χ/Q = Dispersion Factor (Reference 7.6)

and the basic formula for chemicals is:

Concentration (mg/m^3) = [Inventory (mg) * χ/Q (s/m^3) * ARF/ RD] with the same variables as above.

Table E-2 below provides a summary of the ARF used in the analysis

Table E-2 - ARFs

Scenario	ARF	Source
Earthquake	1.2E-6	Due to the low evaporation rate of UNH, splatter using Equation. 4.59, from NUREG-1320 (Reference E.7.5)
High wind	1.7E-4	DOE-HDBK-0013-93 (Reference E.7.3)
Fire	9.5E-7	NUREG-1320, Heating of Unpressurized Radioactive Liquids, Boiling. (Reference E.7.5), Table 4.2, with 10% of the inventory at risk.
Explosion	3.2E-6	NUREG-1320 (Reference E.7.5)
Spill	9.8E-7	Due to the low evaporation rate of UNH, splatter using Equation 4.59, from NUREG-1320 (Reference E.7.5)

The dilution factor is determined through the application of a gaussian plume model (from References E.7.6 and E.7.7) to the release estimate. The assumptions used to develop the dilution factor for each accident are listed in subsection E.3.

E.5 Summary

DOE-STD-3005-YR (Reference E.7.11) establishes the radiological guidelines and has been used to prepare Table E-3. Neither DOE Order 5480.23, nor DOE-STD-1027-92 provide quantitative guidelines for the evaluation of exposures to toxic chemicals for the Safety Analysis. Therefore, the toxicological risk acceptance criteria established in WSRC-MS-92-206, Revision 1 (Reference E.7.8) has been used for comparison. Criteria for natural phenomena hazards (NPH) due to toxic materials are not evaluated based on an EG and related frequency as given for other consequences in DOE-STD-3005-YR. Guidelines for worker safety Criteria were adopted from DOE-STD-3009-94 (Reference 7.12). The radiological and toxicological consequences from the selected accident scenarios are compared to the Evaluation Criteria in Table E-3. The Integral Cancer Risk (ICR) is included in the end of this Appendix and all ICRs are below corresponding limits.

Table E-3 - Evaluation Guidelines

Receptor Location:		Off-site		On-site and Worker		
Source Reference:		STD-3005-YR (draft)	WSRC-MS-92-206, Revision 1	STD-3005-YR (draft)	WSRC-MS-92-206, Revision 1	STD-3009-94
Frequency (events/year)	**Category**	**Radiological (REM)**	**Chemical**	**Radiological (REM)**	**Chemical**	**Industrial**
> 1E-1	Normal	EPA and Other Legal Limits on Normal Emissions	EPA and Other Legal Limits on Normal Emissions	1 Radiological control manual	PEL-TWA 2E-6 ICR	No severe injuries
1E-1 to 1E-2	Anticipated	0.5 (DOE Order 5400.5)	PEL-TWA 2E-6 ICR	5 (5480.11)	ERPG-1 2E-4 ICR	No prompt death Less than 5 severe injuries
1E-2 to 1E-4	Unlikely	5 (10CFR72)	ERPG-1 2E-4 ICR	25	ERPG-2 2E-2 ICR	
1E-4 to 1E-6 (NPH)	Extremely Unlikely	25 (10CFR100)	ERPG-2 2E-2 ICR	100	ERPG-3 2E+0 ICR	NPH No criteria
< 1E-6	Incredible	If consequences could be severe, then demonstrate 95% certainty that frequency is below 1E-6.				

Since there are only a few ERPGs available at the time this SAR was written, the following hierarchy of references was used to select an appropriate concentration when an ERPG was not available. These are presented in Table E-4 which has been adopted from WSRC-MS-92-206, Revision 1.

Table E-4 - Hierarchy of Alternatives for Evaluation Guidelines

Primary Guideline	Hierarchy of Alternative Guidelines	Source of Concentration Parameter
ERPG-3		**AIHA 1991**
	EEGL (30-min)	NAS 1985
	IDLH	NIOSH 1990
ERPG-2		**AIHA 1991**
	EEGL (60-min)	NAS 1985
	LOC	EPA 1987
	PEL-C	CFR29:1910.1000
	TLV-C	ACGIH 1992
	TLV-TWA * 5	ACGIH 1992
ERPG-1		**AIHA 1991**
	PEL-STEL	CFR 29:1910.1000
	TLV-STEL	ACGIH 1992
	TLV-TWA * 3	ACGIH 1992
PEL-TWA		**CFR 29:1910.1000**
	TLV-TWA	ACGIH 1992
	SPEGL (60-min)	NAS 1985
	CEGL	NAS 1985

Agencies:
ACGIH - American Conference of Governmental Industrial Hygienists
AIHA - American Industrial Hygiene Association
EPA - Environmental Protection Agency
FEMA - Federal Emergency Management Agency
NAS - National Academy of Sciences
NIOSH - National Institute of Occupational Health and Safety
OSHA - Occupational Safety and Health Administration
USDOT- U.S. Department of Transportation

This hierarchy resulted in the following limits being used in the Evaluation Guidelines as shown in Table E-5. Note for uranium the OSHA PEL is 0.05 mg/m^3 and the TLV-TWA is 0.2 mg/m^3. By the guidance of WSRC-MS-92-206, Revision 1, the TLV-TWA from the ACGIH Guide to Occupational Exposure Values - 1993 is used to determine values for the ERPG categories.

Table E-5 - Numerical Chemical Limits used for Evaluation Guidelines

Chemical	ERPG-3		ERPG-2		ERPG-1		PEL-TWA	
	Limit (mg/m3)	Reference	Limit (mg/m3)	Reference	Limit (mg/m3)	Reference	Limit (mg/m3)	Reference
Chromium	250	IDLH	5	TLV-TWA * 5	3	TLV-TWA * 3	1	PEL-TWA
Barium	50	IDLH	2.5	TLV-TWA * 5	1.5	TLV-TWA * 3	0.5	PEL-TWA
Nitric Acid	78	AIHA	39	AIHA	5.2	AIHA	5	PEL-TWA
Uranium	20	IDLH	1.0	TLV-TWA * 5	0.6	TLV-TWA * 3	0.05	PEL-TWA

E.6 Recommendations

Note that in some cases, the values plotted on the Risk Acceptance curves differ from chemical to chemical. For example, compare the Fire scenario (#3) to the Spill scenario (#5) in regards to chromium, nitric acid, and uranium. Finally, review the barium results when comparing these scenarios. These differences are due to the source terms for each scenario being different. The source term for the fire scenario (tanks F2-605, F2-606, F2-607, F2-608) are being compared against the worst barium tank F3E-223, which has a barium content higher than all four tanks in the fire scenario source term.

E.7 References

E.7.1 FERMCO, June, 1994. UNH Bench Test Report.

E.7.2 DOE-STD-1020-94, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities, April, 1994

E.7.3 DOE-HDBK-0013-93, Recommended Values and Technical Bases for Airborne Release Fractions (ARFs), Airborne Release Rates (ARRs), and Respirable Fractions (RFs) at DOE Non-Reactor Nuclear Facilities, July, 1993

E.7.4 SP-A-01-013, Rev 1, Preparation of Safety Assessments, Westinghouse Environmental Management Company of Ohio, September, 1992.

E.7.5 NUREG-1320, Nuclear Fuel Cycle Facility Accident Analysis Handbook. J.E. Ayer, J. Mishima, U.S. Nuclear Regulatory Commission, May, 1988.

E.7.6 NUREG/CR-3332, Radiological Assessment, A Textbook on Environmental Dose Analysis. J. E. Till, H. R. Meyer, U.S. Nuclear Regulatory Commission, September, 1983.

E.7.7 FERMCO, Memorandum, M:RP(RTS):94-0108, Site Chi/Q Values. May 9, 1994.

E.7.8 WSRC-MS-92-206, Revision 1, "Toxic Chemical Hazard Classification and Risk Acceptance Guidelines for use in DOE Facilities", April 1993.

E.7.9 U.S. EPA Federal Guidance Report No. 11, September 1988. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Factors for Inhalation, Submersion, and Ingestion*. Washington D.C.

E.7.10 U.S. EPA *Methodology for Characterization of Uncertainty in Exposure Assessments*, Office of Health and Environmental Assessment, Exposure Assessment Group, USEPA. EPA/600/8-85-009; Washington, D.C; 1985.

E.7.11 DOE-STD-3005-YR, Draft, Evaluation Guidelines for Accident Analysis and Safety Structures, Systems, and Components, February, 1994.

E.7.12 DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, U.S. DOE, Washington D.C., July, 1994.

Figure E-1 - Onsite Radiological Risk

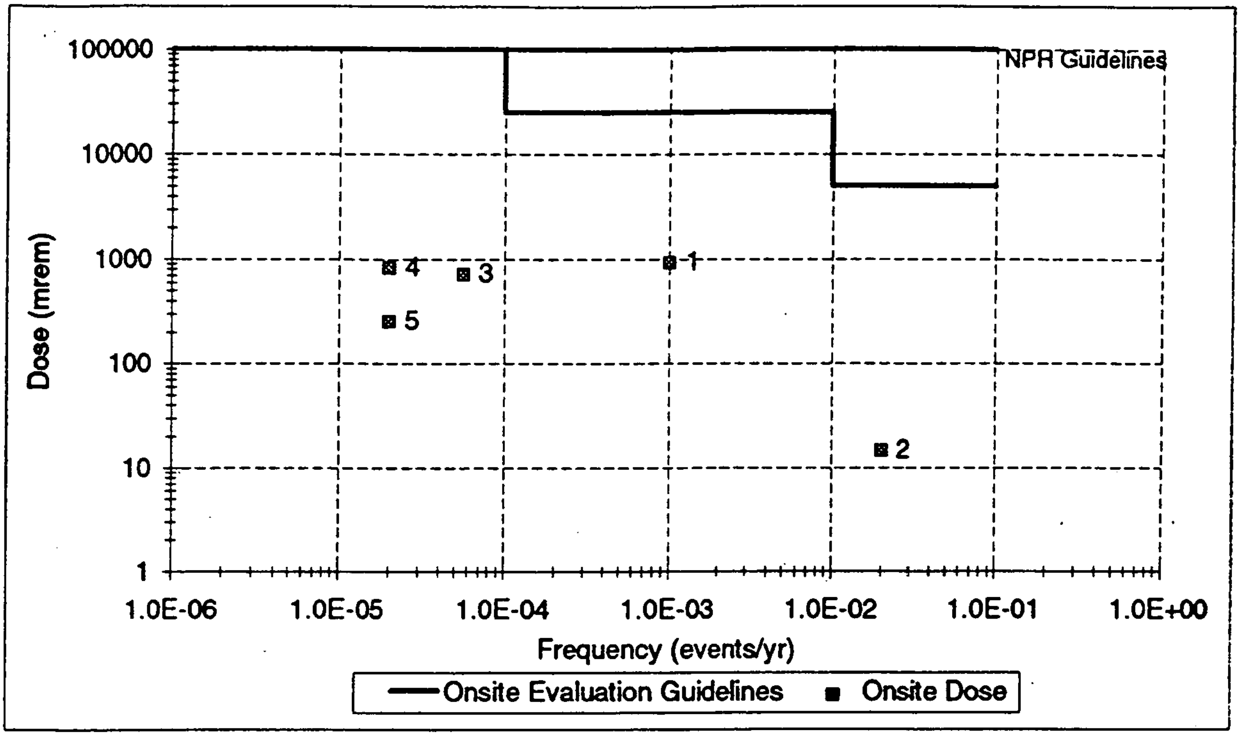
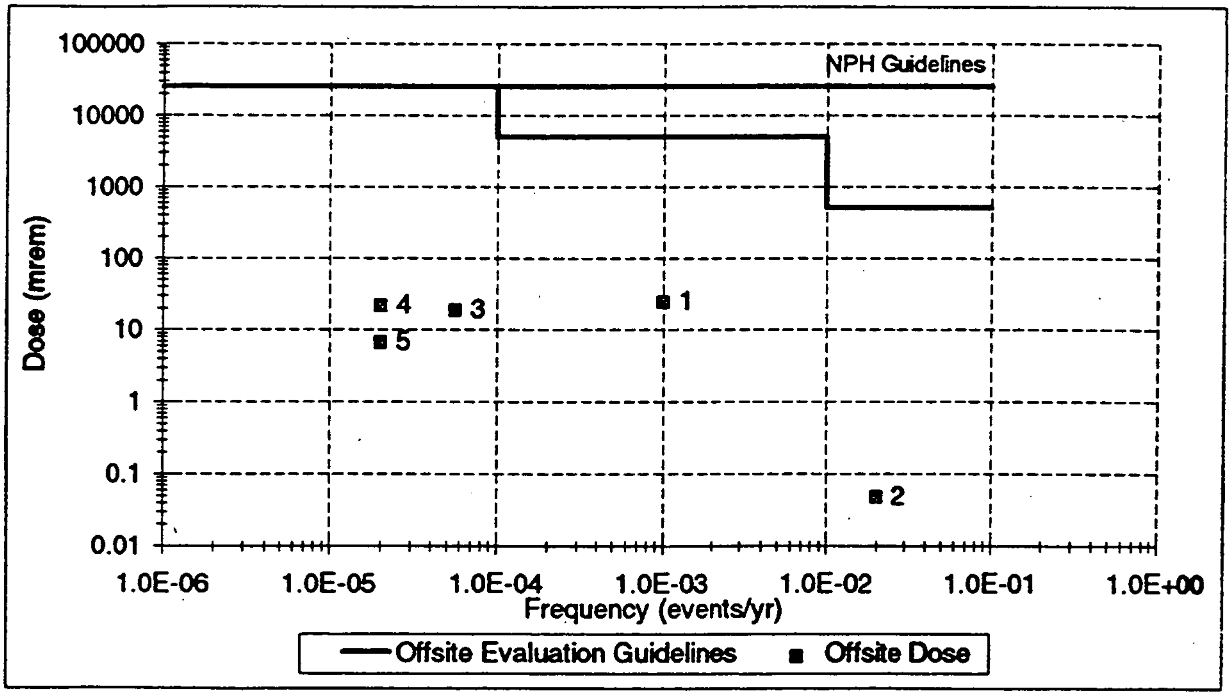


Figure E-2 - Offsite Radiological Risk



KEY: 1 = Earthquake, 2 = High Wind, 3 = Fire, 4 = Explosion, 5 = Spill

Figure E-3 - Onsite Chromium Risk

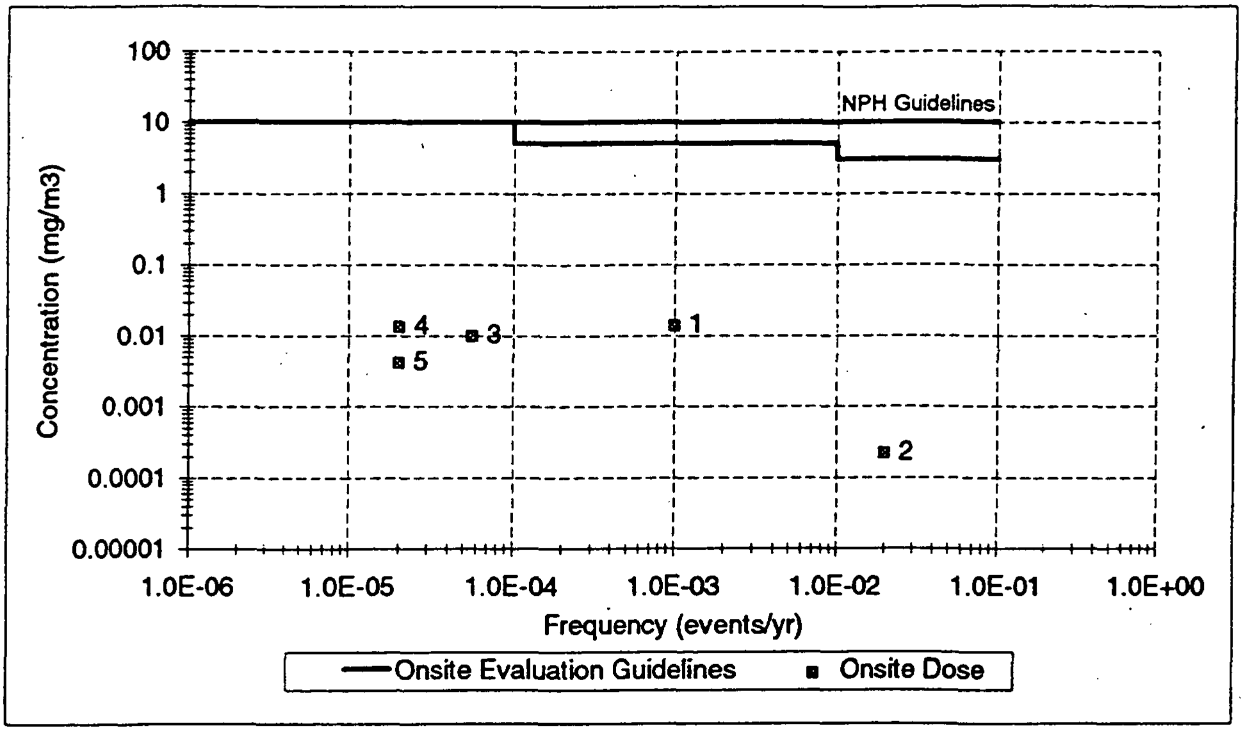
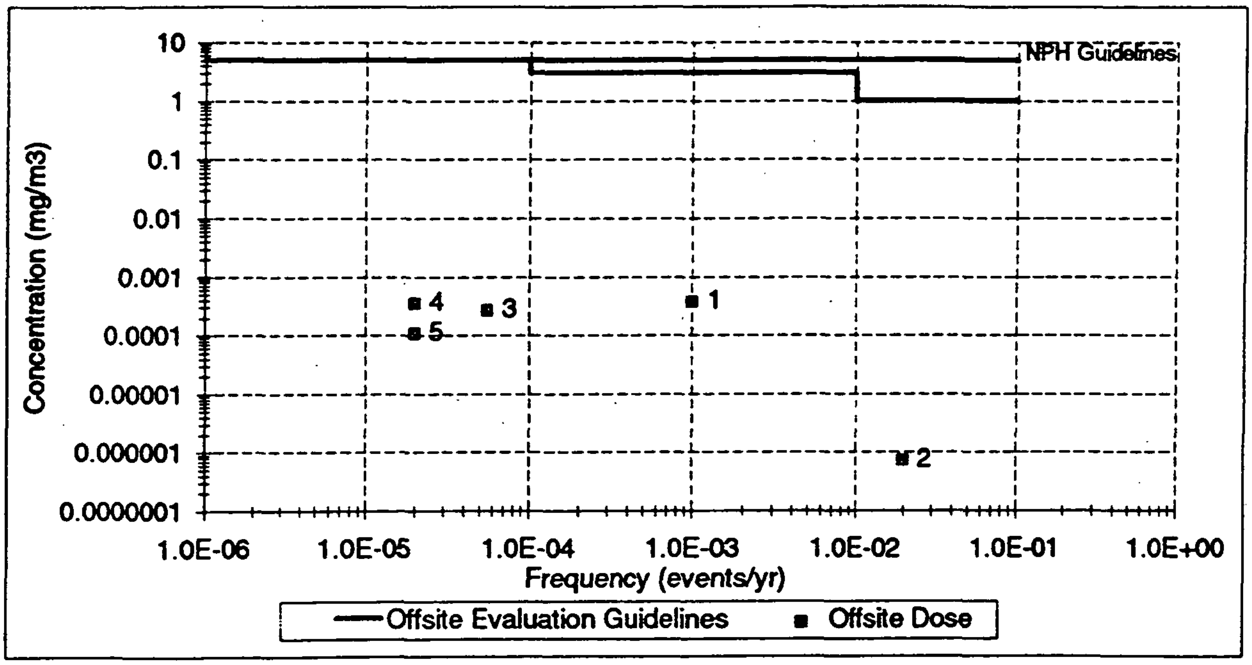


Figure E-4 - Offsite Chromium Risk



KEY: 1 = Earthquake, 2 = High Wind, 3 = Fire, 4 = Explosion, 5 = Spill

Figure E-5 - Onsite Barium Risk

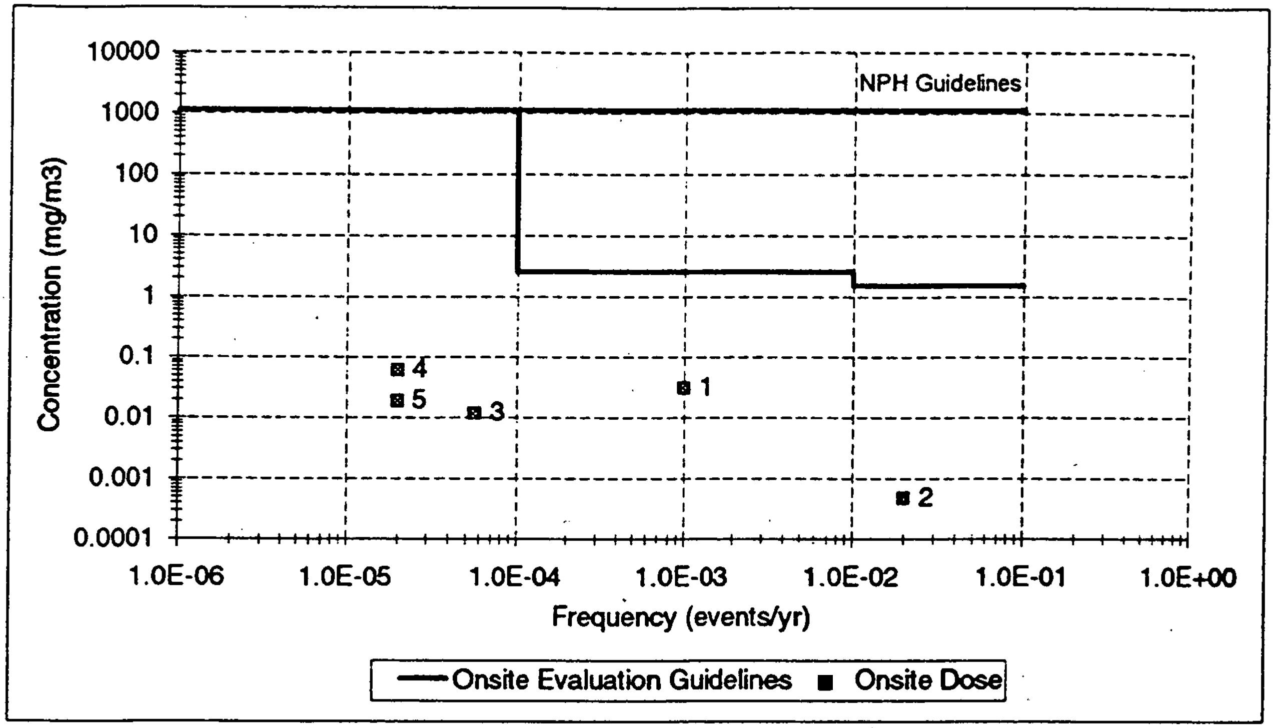
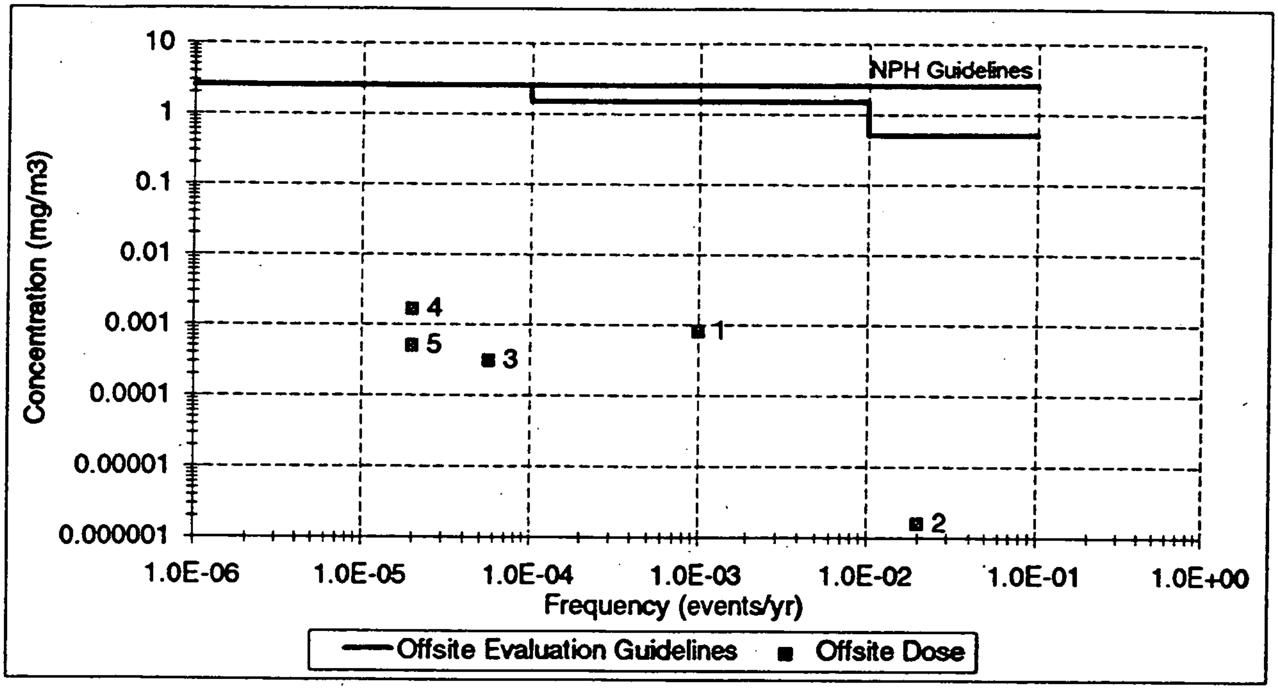


Figure E-6 - Offsite Barium Risk



KEY: 1 = Earthquake, 2 = High Wind, 3 = Fire, 4 = Explosion, 5 = Spill

Figure E-7 - Onsite Nitric Acid Risk

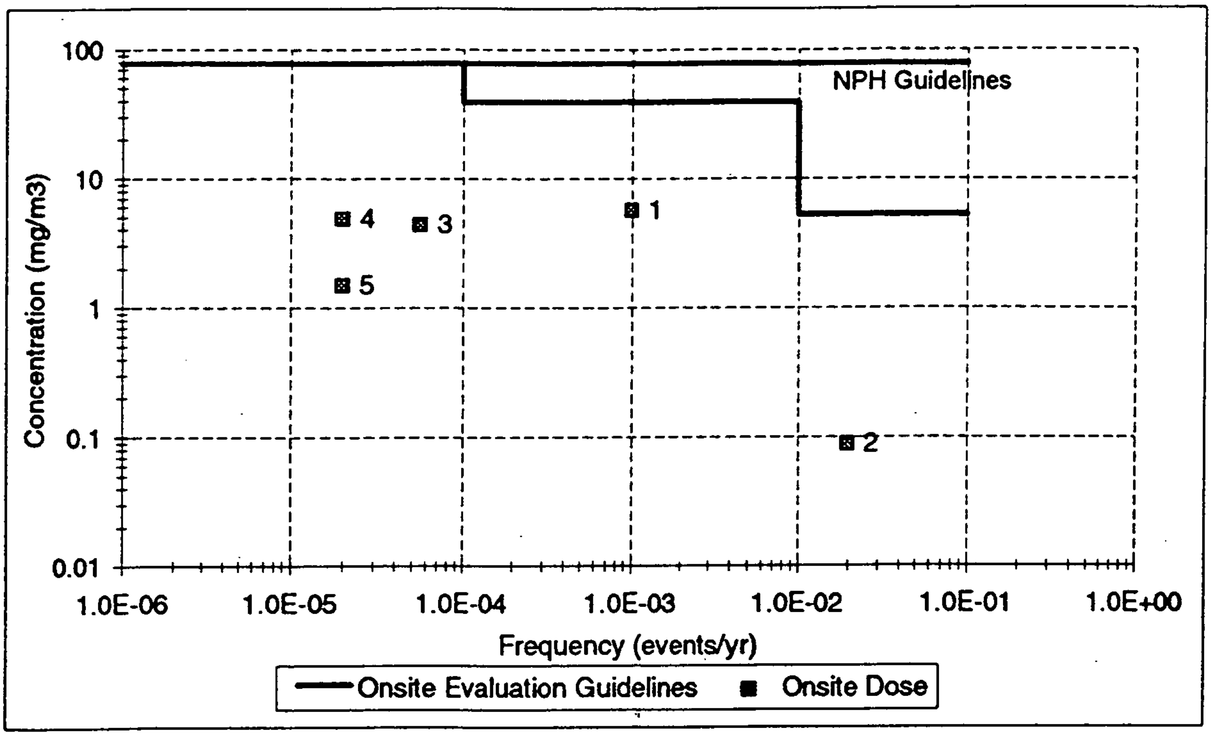
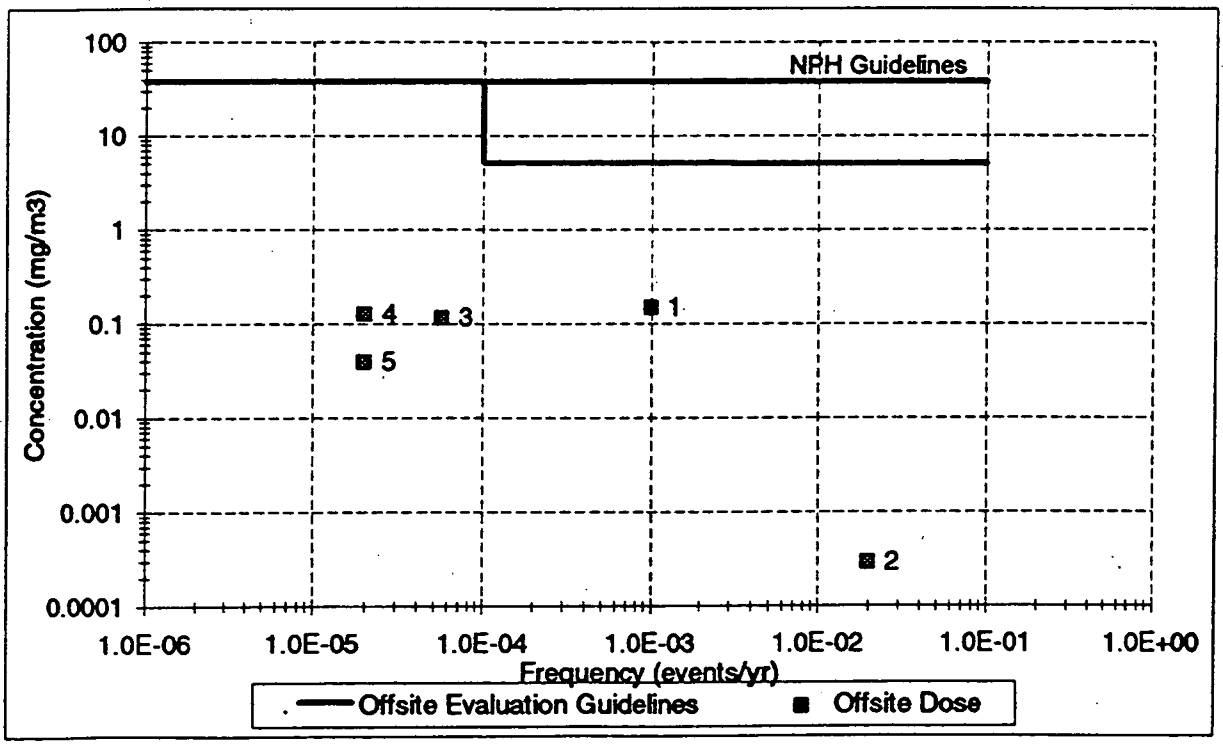


Figure E-8 - Offsite Nitric Acid Risk



KEY: 1 = Earthquake, 2 = High Wind, 3 = Fire, 4 = Explosion, 5 = Spill

Figure E-9 - Onsite Uranium Risk

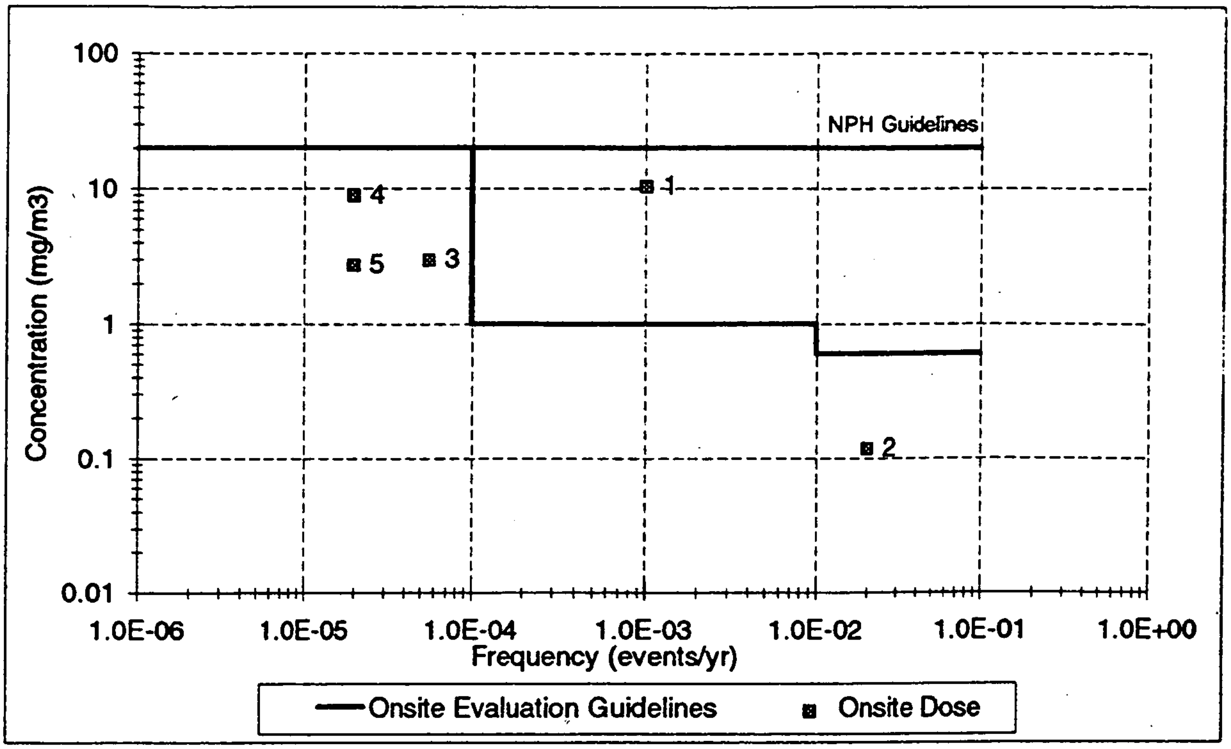
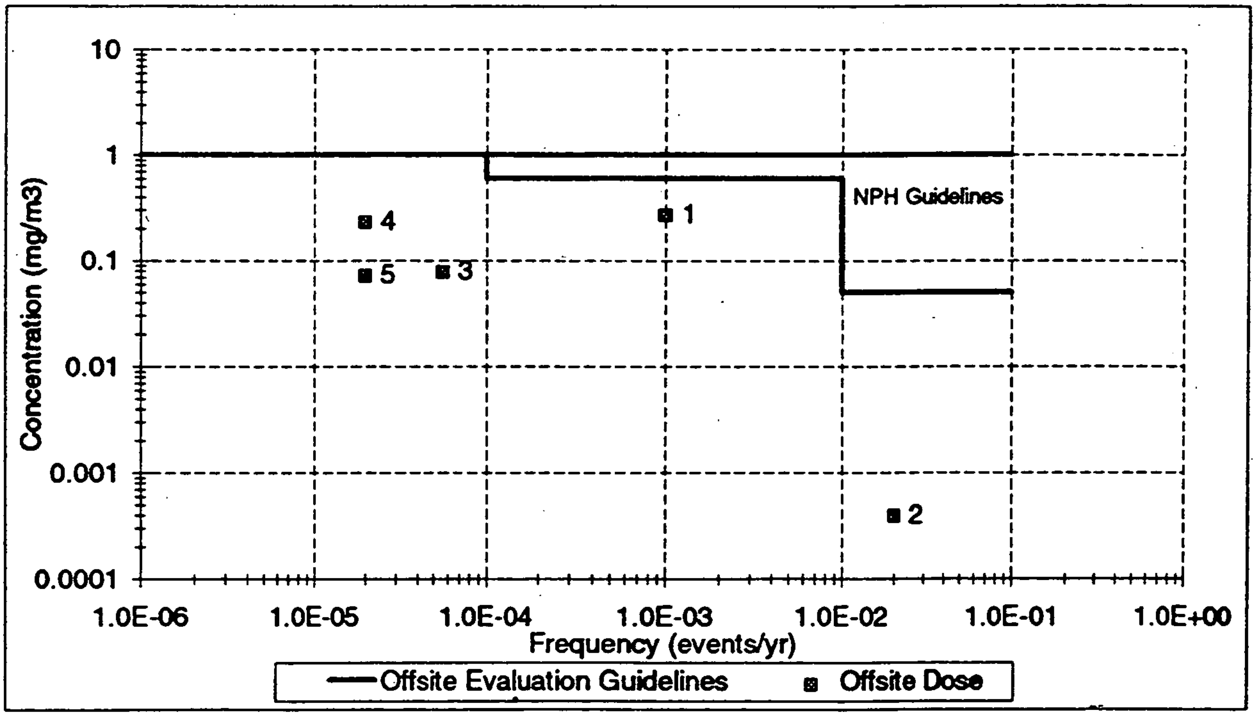


Figure E-10 - Offsite Uranium Risk



KEY: 1 = Earthquake, 2 = High Wind, 3 = Fire, 4 = Explosion, 5 = Spill

Constants

3.33E-04	Breathing Rate (m3/s)
900	Release Duration (sec)
2.8070	UNH Specific Gravity
6.02E+23	Avagadro's number
3.15E+07	Seconds per year
63	GMW of HNO3
0.2642	liters->Gallons

Event	Freq
EQ	1.00E-03
High Wind	2.00E-02
Fire	5.60E-05
Explosion	2.00E-05
Spill	2.00E-05

Radiological Hazard Classification

	Mass	Category 2		Category 3	
Isotope	(grams)	(grams)	result	(grams)	result
U-235	7.44E+05	1.1E+08	6.76E-03	1.9E+06	3.92E-01
U-234	7.58E+03	3.5E+04	2.17E-01	6.7E+02	1.13E+01
U-238	7.39E+07	7.1E+08	1.04E-01	1.3E+07	5.68E+00
Pu-239	2.19E+01	9.0E+02	2.43E-02	8.4E+00	2.60E+00
Np-237	9.15E+02	8.3E+04	1.10E-02	6.0E+02	1.52E+00
Total			3.63E-01		2.15E+01

Uranium Inventory

Tank	Vol (gallons)	Concentration (g-U/l)	Concentration (g-U/gal)	Mass U (grams)	Enrichment %U-235	%U-234	%U-238	U-235 (grams)	U-234 (grams)	U-238 (grams)	TOTAL Uranium (Grams)	By tank: Total U (grams)
NB (F2E-6)	21423	202	7.65E+02	1.64E+07	0.952%	7.97E-05	9.90E-01	1.56E+05	1.31E+03	1.62E+07		1.64E+07
SB (F2E-5)	23645	122	4.62E+02	1.09E+07	1.018%	8.68E-05	9.90E-01	1.11E+05	9.47E+02	1.08E+07		1.09E+07
SW (F2E-8)	21740	57	2.16E+02	4.69E+06	0.997%	8.46E-05	9.90E-01	4.68E+04	3.97E+02	4.64E+06		4.69E+06
D1-1	3150	135	5.11E+02	1.61E+06	0.955%	7.97E-05	9.90E-01	1.54E+04	1.28E+02	1.59E+06		1.61E+06
D1-10	2648	154	5.83E+02	1.54E+06	1.290%	1.19E-04	9.87E-01	1.99E+04	1.84E+02	1.52E+06		1.54E+06
F1-1	1825	173	6.55E+02	1.20E+06	0.962%	8.04E-05	9.90E-01	1.15E+04	9.61E+01	1.18E+06		1.20E+06
F1-2	1454	85	3.22E+02	4.68E+05	0.950%	7.91E-05	9.90E-01	4.44E+03	3.70E+01	4.63E+05		4.68E+05
F1-25	12875	133	5.03E+02	6.48E+06	0.994%	8.46E-05	9.90E-01	6.44E+04	5.48E+02	6.42E+06		6.48E+06
F1-301	1990	60	2.27E+02	4.52E+05	0.872%	6.79E-05	9.92E-01	3.94E+03	3.07E+01	4.48E+05		4.52E+05
F1-302	2309	13	4.92E+01	1.14E+05	0.960%	8.04E-05	9.90E-01	1.09E+03	9.14E+00	1.13E+05		1.14E+05
F1-303	2104	19	7.19E+01	1.51E+05	0.801%	8.38E-03	9.92E-01	1.21E+03	1.27E+03	1.50E+05		1.53E+05
F1-308	1894	30	1.14E+02	2.15E+05	1.000%	8.53E-05	9.90E-01	2.15E+03	1.83E+01	2.13E+05		2.15E+05
F2-605	23463	59	2.23E+02	5.24E+06	0.991%	8.39E-05	9.90E-01	5.19E+04	4.39E+02	5.19E+06		5.24E+06
F2-606	23427	55	2.08E+02	4.88E+06	1.010%	8.60E-05	9.90E-01	4.93E+04	4.20E+02	4.83E+06		4.88E+06
F2-607	22726	36	1.36E+02	3.10E+06	1.090%	9.52E-05	9.89E-01	3.38E+04	2.95E+02	3.06E+06		3.10E+06
F2-608	19996	68	2.57E+02	5.15E+06	1.000%	8.53E-05	9.90E-01	5.15E+04	4.39E+02	5.09E+06		5.15E+06
F3E-220	2036	20	7.57E+01	1.54E+05	0.995%	8.46E-05	9.90E-01	1.53E+03	1.30E+01	1.53E+05		1.54E+05
F3E-223	9231	341	1.29E+03	1.19E+07	0.993%	8.46E-05	9.90E-01	1.18E+05	1.01E+03	1.18E+07		1.19E+07
Totals	1.98E+05							7.44E+05	7.58E+03	7.39E+07	7.46E+07	1.64E+07
Fire Total	8.96E+04							1.86E+05	1.59E+03	1.82E+07	1.84E+07	(worst tank)

Plutonium, Neptunium, Chromium, Barium and Nitric Acid Inventory

Tank	Vol (gallons)	Mass (grams)	Pu (dpm/g)	Pu (ppb)	Pu (grams)	Np (dpm/g)	Np (ppb)	Np (grams)	Cr (ppm)	Cr (grams)	Ba (ppm)	Ba (grams)	HNO3 (N)	HNO3 (grams)	HNO3 (ppm)
NB (F2E-6)	21423	2.28E+08	5.40E+02	4.00E+00	9.10E-01	5.30E+02	3.38E+02	7.70E+01	9.00E+01	2.05E+04	7.23E+01	1.65E+04	0.53	2.71E+06	1.19E+04
SB (F2E-5)	23645	2.51E+08	8.40E+02	6.20E+00	1.56E+00	6.50E+02	4.15E+02	1.04E+02	1.91E+01	4.81E+03	2.18E+01	5.47E+03	0.42	2.37E+06	9.43E+03
SW (F2E-8)	21740	2.31E+08	1.10E+03	8.10E+00	1.87E+00	5.90E+02	3.77E+02	8.70E+01	6.41E+01	1.48E+04	2.17E+02	5.00E+04	1.50	7.78E+06	3.37E+04
D1-1	3150	3.35E+07	6.40E+02	4.70E+00	1.57E-01	5.40E+02	3.45E+02	1.15E+01	8.24E+01	2.76E+03	1.22E+01	4.08E+02	4.02	3.02E+06	9.02E+04
D1-10	2648	2.81E+07	6.20E+02	4.50E+00	1.27E-01	5.10E+02	3.26E+02	9.16E+00	4.04E+02	1.14E+04	7.47E+01	2.10E+03	4.65	2.94E+06	1.04E+05
F1-1	1825	1.94E+07	9.70E+02	7.20E+00	1.40E-01	1.40E+03	8.94E+02	1.73E+01	6.93E+01	1.34E+03	8.78E+01	1.70E+03	0.84	3.66E+05	1.89E+04
F1-2	1454	1.54E+07	1.30E+03	9.30E+00	1.44E-01	7.40E+02	4.73E+02	7.30E+00	5.91E+01	9.13E+02	1.87E+01	2.89E+02	2.42	8.39E+05	5.43E+04
F1-25	12875	1.37E+08	9.30E+02	6.30E+00	8.62E-01	6.20E+02	3.96E+02	5.42E+01	4.47E+01	6.11E+03	5.16E+01	7.05E+03	1.38	4.24E+06	3.10E+04
F1-301	1990	2.11E+07	2.00E+03	1.47E+01	3.11E-01	1.40E+03	8.94E+02	1.89E+01	6.90E+01	1.46E+03	1.08E+02	2.29E+03	0.59	2.80E+05	1.32E+04
F1-302	2309	2.45E+07	2.00E+03	1.47E+01	3.61E-01	1.40E+03	8.94E+02	2.19E+01	4.24E+01	1.04E+03	4.72E+01	1.16E+03	0.20	1.10E+05	4.49E+03
F1-303	2104	2.24E+07	2.00E+03	1.47E+01	3.29E-01	1.40E+03	8.94E+02	2.00E+01	4.69E+01	1.05E+03	2.82E+01	6.31E+02	1.57	7.88E+05	3.52E+04
F1-308	1894	2.01E+07	2.00E+03	1.47E+01	2.96E-01	1.40E+03	8.94E+02	1.80E+01	7.13E+01	1.43E+03	6.22E+01	1.25E+03	2.27	1.03E+06	5.09E+04
F2-605	23463	2.49E+08	2.00E+03	1.47E+01	3.66E+00	7.00E+02	4.47E+02	1.11E+02	6.95E+01	1.73E+04	9.23E+01	2.31E+04	1.60	8.95E+06	1.59E+04
F2-606	23427	2.49E+08	2.00E+03	1.47E+01	3.66E+00	7.00E+02	4.47E+02	1.11E+02	5.99E+01	1.49E+04	9.28E+01	2.31E+04	1.04	5.81E+06	2.33E+04
F2-607	22726	2.41E+08	2.00E+03	1.47E+01	3.55E+00	7.00E+02	4.47E+02	1.08E+02	2.26E+01	5.45E+03	4.29E+01	1.03E+04	0.94	5.09E+06	2.11E+04
F2-608	19996	2.12E+08	2.00E+03	1.47E+01	3.12E+00	7.00E+02	4.47E+02	9.50E+01	1.18E+02	2.52E+04	8.15E+01	1.73E+04	1.48	7.06E+06	3.32E+04
F3E-220	2036	2.16E+07	2.00E+03	1.47E+01	3.18E-01	1.40E+03	8.94E+02	1.93E+01	4.04E+02	8.74E+03	1.18E+03	2.56E+04	3.54	1.72E+06	7.95E+04
F3E-223	9231	9.81E+07	6.90E+02	5.00E+00	4.90E-01	3.70E+02	2.36E+02	2.32E+01	0.00E+00	0.00E+00	1.18E+03	1.16E+05	0.19	4.18E+05	4.26E+03
Totals	1.98E+05	2.10E+09			2.19E+01			9.15E+02		1.39E+05		3.04E+05		5.55E+07	
Worst					3.66E+00			1.11E+02		2.52E+04		1.16E+05		8.95E+06	
Fire	8.96E+04	9.52E+08			1.40E+01			4.26E+02		6.28E+04		7.38E+04		2.69E+07	

Determining Neptunium (ppb per dpm/g).

Isotope	(dpm/g)	(dps/g)	T(1/2) (years)	Lambda (1/sec)	Atoms/ gram	moles/ gram	grams/ gram	ppb per (dpm/g)
Np-237	1	1.67E-02	2.14E+06	1.03E-14	1.62E+12	2.69E-12	6.39E-10	6.39E-01

Inventory Development - (grams -> mrem) Conversion

Isotope	mass (g)	(g/mole)	Lambda (1/sec)	(# atoms)	(dis/sec)	(pCi)	DCF (mrem/ pCi)	(mrem)
			Total UNH Inventory					
U-235	7.44E+05	2.35E+02	3.10E-17	1.91E+27	5.91E+10	1.60E+12	1.20E-01	1.92E+11
U-234	7.58E+03	2.34E+02	8.97E-14	1.95E+25	1.75E+12	4.73E+13	1.30E-01	6.15E+12
U-238	7.39E+07	2.38E+02	4.92E-18	1.87E+29	9.20E+11	2.49E+13	1.20E-01	2.98E+12
Pu-239	2.19E+01	2.39E+02	9.12E-13	5.51E+22	5.02E+10	1.36E+12	1.20E+01	1.63E+13
Np-237	9.15E+02	2.37E+02	1.03E-14	2.32E+24	2.39E+10	6.45E+11	7.80E+00	5.03E+12
Liters	**7.49E+05**	Total of all tanks					**per gram**	**1.46E+04**
			Worst Case UNH Inventory					
U-235	1.56E+05	2.35E+02	3.10E-17	4.00E+26	1.24E+10	3.35E+11	1.20E-01	4.02E+10
U-234	1.31E+03	2.34E+02	8.97E-14	3.36E+24	3.02E+11	8.15E+12	1.30E-01	1.06E+12
U-238	1.62E+07	2.38E+02	4.92E-18	4.11E+28	2.02E+11	5.46E+12	1.20E-01	6.55E+11
Pu-239	3.66E+00	2.39E+02	9.12E-13	9.23E+21	8.42E+09	2.28E+11	1.20E+01	2.73E+12
Np-237	1.11E+02	2.37E+02	1.03E-14	2.83E+23	2.91E+09	7.86E+10	7.80E+00	6.13E+11
Liters	**8.11E+04**	Worst Tank is (NE) F2E-6					**per gram**	**2.24E+04**
			UNH Fire Inventory					
U-235	1.86E+05	2.35E+02	3.10E-17	4.78E+26	1.48E+10	4.00E+11	1.20E-01	4.80E+10
U-234	1.59E+03	2.34E+02	8.97E-14	4.10E+24	3.68E+11	9.94E+12	1.30E-01	1.29E+12
U-238	1.82E+07	2.38E+02	4.92E-18	4.60E+28	2.26E+11	6.12E+12	1.20E-01	7.34E+11
Pu-239	1.40E+01	2.39E+02	9.12E-13	3.53E+22	3.22E+10	8.69E+11	1.20E+01	1.04E+13
Np-237	4.26E+02	2.37E+02	1.03E-14	1.08E+24	1.11E+10	3.00E+11	7.80E+00	2.34E+12
Liters	**3.39E+05**	Tanks: F1-605, F1-606, F1-607, F1-608					**per gram**	**1.56E+04**

UNH Radiological Consequences

UNH Events	Location	Release Duration (sec)	Inventory (mrem per gram)	Number of (grams)	ARF	Dispersion (X/Q) (s/m3)	50 year CEDE (mrem)
Earthquake (total)	Onsite	900	1.46E+04	1.05E+09	1.20E-06	1.52E-01	9.32E+02
	Offsite	900	1.46E+04	1.05E+09	1.20E-06	3.98E-03	2.44E+01
High Wind (total)	Onsite	900	1.46E+04	2.10E+09	1.73E-04	8.22E-06	1.45E+01
	Offsite	900	1.46E+04	2.10E+09	1.73E-04	2.73E-08	4.82E-02
Fire (Group)	Onsite	900	1.56E+04	9.52E+08	9.54E-07	1.52E-01	7.17E+02
	Offsite	900	1.56E+04	9.52E+08	9.54E-07	3.98E-03	1.88E+01
Explosion (worst case)	Onsite	900	2.24E+04	2.28E+08	3.19E-06	1.52E-01	8.24E+02
	Offsite	900	2.24E+04	2.28E+08	3.19E-06	3.98E-03	2.16E+01
Spill (worst case)	Onsite	900	2.24E+04	2.28E+08	9.83E-07	1.52E-01	2.54E+02
	Offsite	900	2.24E+04	2.28E+08	9.83E-07	3.98E-03	6.64E+00

Notes:
Release Duration is 900 seconds based on assumption E.9
Breathing rate is 3.33E-4 m3/sec based on reference EPA data
Dispersion calculated using NUREG/CR-3332 (ORNL-5968) model,
100 meters onsite, 820 meters offsite
Release height is ground level for all events
Pasquill Stability Class A: High Wind @ 31 m/s windspeed
Pasquill Stability Class G @ 0.52 m/s windspeed for all others

UNH Chemical Consequences

UNH Events	Chemical Name	Chemical (grams)	ARF	Onsite Dispersion (X/Q) (s/m3)	Offsite Dispersion (X/Q) (s/m3)	Onsite Material Conc. (mg/m3)	Offsite Material Conc. (mg/m3)
Earthquake EXTERNAL (total)	Uranium	3.73E+07	1.20E-06	1.52E-01	3.98E-03	7.57E+00	1.98E-01
	Chromium	6.96E+04	1.20E-06	1.52E-01	3.98E-03	1.41E-02	3.70E-04
	Barium	1.52E+05	1.20E-06	1.52E-01	3.98E-03	3.09E-02	8.08E-04
	Nitric Acid	2.78E+07	1.20E-06	1.52E-01	3.98E-03	5.63E+00	1.47E-01
High Wind EXTERNAL (total)	Uranium	7.46E+07	1.73E-04	8.22E-06	2.73E-08	1.18E-01	3.92E-04
	Chromium	1.39E+05	1.73E-04	8.22E-06	2.73E-08	2.20E-04	7.30E-07
	Barium	3.04E+05	1.73E-04	8.22E-06	2.73E-08	4.80E-04	1.60E-06
	Nitric Acid	5.55E+07	1.73E-04	8.22E-06	2.73E-08	8.77E-02	2.91E-04
Fire INTERNAL (group)	Uranium	1.84E+07	9.54E-07	1.52E-01	3.98E-03	2.96E+00	7.75E-02
	Chromium	6.28E+04	9.54E-07	1.52E-01	3.98E-03	1.01E-02	2.65E-04
	Barium	7.38E+04	9.54E-07	1.52E-01	3.98E-03	1.19E-02	3.11E-04
	Nitric Acid	2.69E+07	9.54E-07	1.52E-01	3.98E-03	4.34E+00	1.14E-01
Explosion INTERNAL (worst case)	Uranium	1.64E+07	3.19E-06	1.52E-01	3.98E-03	8.83E+00	2.31E-01
	Chromium	2.52E+04	3.19E-06	1.52E-01	3.98E-03	1.36E-02	3.55E-04
	Barium	1.16E+05	3.19E-06	1.52E-01	3.98E-03	6.25E-02	1.64E-03
	Nitric Acid	8.95E+06	3.19E-06	1.52E-01	3.98E-03	4.83E+00	1.26E-01
Spill INTERNAL (worst case)	Uranium	1.64E+07	9.83E-07	1.52E-01	3.98E-03	2.72E+00	7.12E-02
	Chromium	2.52E+04	9.83E-07	1.52E-01	3.98E-03	4.18E-03	1.09E-04
	Barium	1.16E+05	9.83E-07	1.52E-01	3.98E-03	1.92E-02	5.04E-04
	Nitric Acid	8.95E+06	9.83E-07	1.52E-01	3.98E-03	1.49E+00	3.89E-02

Notes:
Release Duration is 900 seconds based on assumption E.9
Dispersion calculated using NUREG/CR-3332 (ORNL-5968) model,
100 meters onsite, 820 meters offsite
Release height is ground level for all events
Pasquill Stability Class A: High Wind @ 31 m/s windspeed
Pasquill Stability Class G @ 0.52 m/s windspeed for all others

Integral Cancer Risk (ICR)

Body 70 Kg

	ICR		Event				
			Earthquake	High Wind	Fire	Gas Explosion	Spill
		Frequency	NPH	NPH	5.60E-05	2.00E-05	2.00E-05
1.29%	OFF-SITE	ICR Limit	2.00E-02	2.00E-02	2.00E-02	2.00E-02	2.00E-02
U		Uranium (mg)	5.94E-02	1.17E-04	2.32E-02	6.93E-02	2.13E-02
Fraction	Chemical	(ICR/mg)					
1.19E-04	U-234	1.62E-01	1.14E-06	2.26E-09	4.47E-07	1.33E-06	4.11E-07
1.29E-02	U-235	5.44E-05	4.17E-08	8.24E-11	1.63E-08	4.87E-08	1.50E-08
9.87E-01	U-238	8.06E-06	4.73E-07	9.34E-10	1.85E-07	5.52E-07	1.70E-07
	Chromium	3.48E-04	3.86E-08	7.62E-11	2.77E-08	3.71E-08	4.36E-07
	ON-SITE	ICR Limit	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00
		Uranium (mg)	2.27E+00	3.53E-02	8.87E-01	2.65E+00	8.15E-01
	Chemical	(ICR/mg)					
1.19E-04	U-234	1.62E-01	4.37E-05	6.80E-07	1.71E-05	5.09E-05	1.57E-05
1.29E-02	U-235	5.44E-05	1.59E-06	2.48E-08	6.22E-07	1.86E-06	5.72E-07
9.87E-01	U-238	8.06E-06	1.81E-05	2.81E-07	7.05E-06	2.11E-05	6.48E-06
	Chromium	3.48E-04	1.47E-06	2.30E-08	1.06E-06	1.42E-06	4.36E-07

Isotope	(ICR/Bq)	(Bq/TBq)	(TBq/g)	(g/mg)	(ICR/mg)
U-234	7.00E-07	1.00E+12	2.31E-04	1.00E-03	1.62E-01
U-235	6.80E-07	1.00E+12	8.00E-08	1.00E-03	5.44E-05
U-238	6.50E-07	1.00E+12	1.24E-08	1.00E-03	8.06E-06

Notes
1. Limits are based on Table E-3 of Appendix E of UNH SAR
2 Assumed worst case (highest level of enrichment) for Uranium (Tank D1-10)
3 Body weight is 70 Kg (EPA)
4 Release Duration is 900 seconds (see calc sheet)
5 Breathing rate is 3.3E-4 m3/s (see calc sheet)
6 See ICR/Bq to ICR/mg conversions.