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FINAL REPORT

HYDRAZINE BLENDING AND STORAGE FACILITY WASTEWATER TREATMENT AND DECOMMISSIONING ASSESSMENT

VERSION 3.1

June 1988

Contract No. DAAK11-84-D-0017

S NOV 03 1993 E

EBASCO SERVICES INCORPORATED
R. L. Stollar and Associates
California Analytical Laboratories, Inc.
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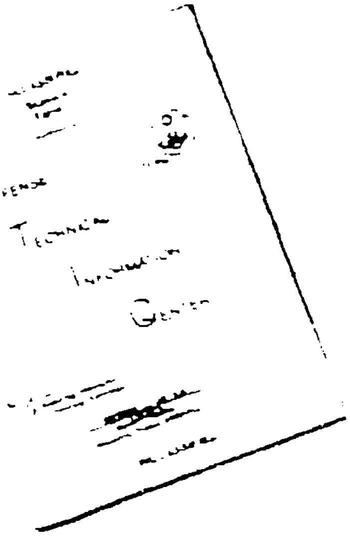

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FINAL REPORT

HYDRAZINE BLENDING AND STORAGE FACILITY WASTEWATER TREATMENT AND DECOMMISSIONING ASSESSMENT

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Task No. 34

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THE PURPOSES OF THIS STUDY ARE TO:

1. INVESTIGATE TECHNOLOGIES FOR TREATING HYDRAZINE CONTAMINATED WASTEWATER
2. CONDUCT TREATABILITY STUDIES ON PROMISING TECHNOLOGIES
3. DEVELOP AN ASSESSMENT OF THE DECOMMISSIONING OF THE HYDRAZINE BLENDING AND STORAGE FACILITY.

THE REPORT IS DIVIDED INTO THE FOLLOWING SECTIONS:

1. DESCRIPTION OF THE FACILITY, ITS OPERATING HISTORY, PREVIOUS INVESTIGATIONS, RESULTS OF CHEMICAL ANALYSES OF THE SITE
2. EVALUATION AND SCREENING OF TECHNOLOGIES FOR TREATING WASTEWATER; RESULTS OF THE RECENT CHEMICAL ANALYSIS OF HYDRAZINE WASTEWATER ALONG WITH TREATABILITY STUDIES.
3. DECOMMISSIONING ASSESSMENT WHICH INCLUDES WASTE INVENTORY, DECOMMISSIONING PLAN, EQUIPMENT, PERSONNEL, QA/QC PLAN, SCHEDULE, COST ESTIMATES.

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1.0 INTRODUCTION

1.1 STUDY OBJECTIVES

Task 34 involves the development of methods for the decommissioning and remediation of the Hydrazine Blending and Storage Facility (HBSF). Part of the HBSF study is an evaluation of options for the treatment/removal of associated wastewater. The specific objectives of the study are:

- To investigate alternative approaches for treatment/removal of wastewater contaminated with low levels of hydrazine and hydrazine related compounds. The technologies to be investigated will include those listed in Table 1-1.
- To conduct treatability studies with the most promising candidate technology(s) to verify treatment effectiveness and identify key design variables.
- To develop a comprehensive decommissioning assessment. The decommissioning assessment will support and be incorporated into the Rocky Mountain Arsenal (RMA) wide feasibility study alternative assessment (Task 28).

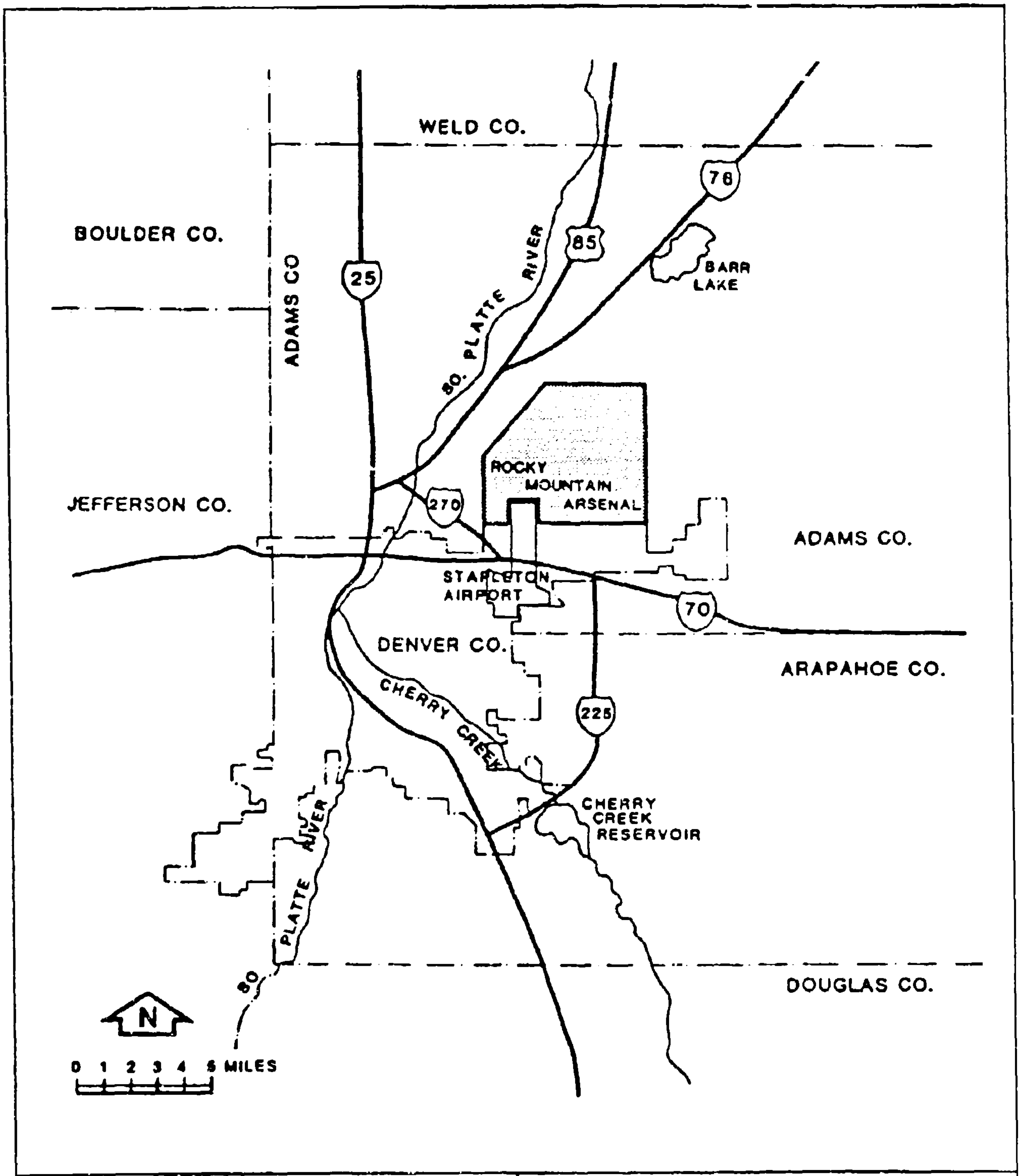
1.2 PROCESS DESCRIPTION AND PHYSICAL FACILITY

The RMA is located in Adams County, Colorado, about 10 miles northeast of the central business district of Denver and encompasses an area of 17,238 acres (Figure 1-1). The HBSF is located east of the South Plants area in the northeast corner of Section 1 (Figure 1-2).

TABLE 1-1

POTENTIAL TREATMENT TECHNOLOGIES

- Biological Treatment
    - Conventional technologies
    - Discharge to publicly owned treatment works (POTW)
- Chemical Treatment
    - Chlorine (various forms) and chlorine/ultraviolet light (UV)
    - Ozone and ozone/UV
    - Permanganate
    - Hydrogen peroxide and hydrogen peroxide/UV
    - Reduction processes
- Physical Treatment
    - Activated carbon adsorption
    - Metal oxide adsorption/catalysis
    - Evaporation pond
    - Air stripping
    - Steam stripping
    - Spray irrigation
- Thermal Treatment
    - Off-site incineration
    - On-site incineration
        - North Plants incineration
        - Other



Prepared for:

Program Managers Office For
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

Figure 1-1.

ROCKY MOUNTAIN ARSENAL
LOCATION MAP

ROCKY MOUNTAIN ARSENAL, TASK 34
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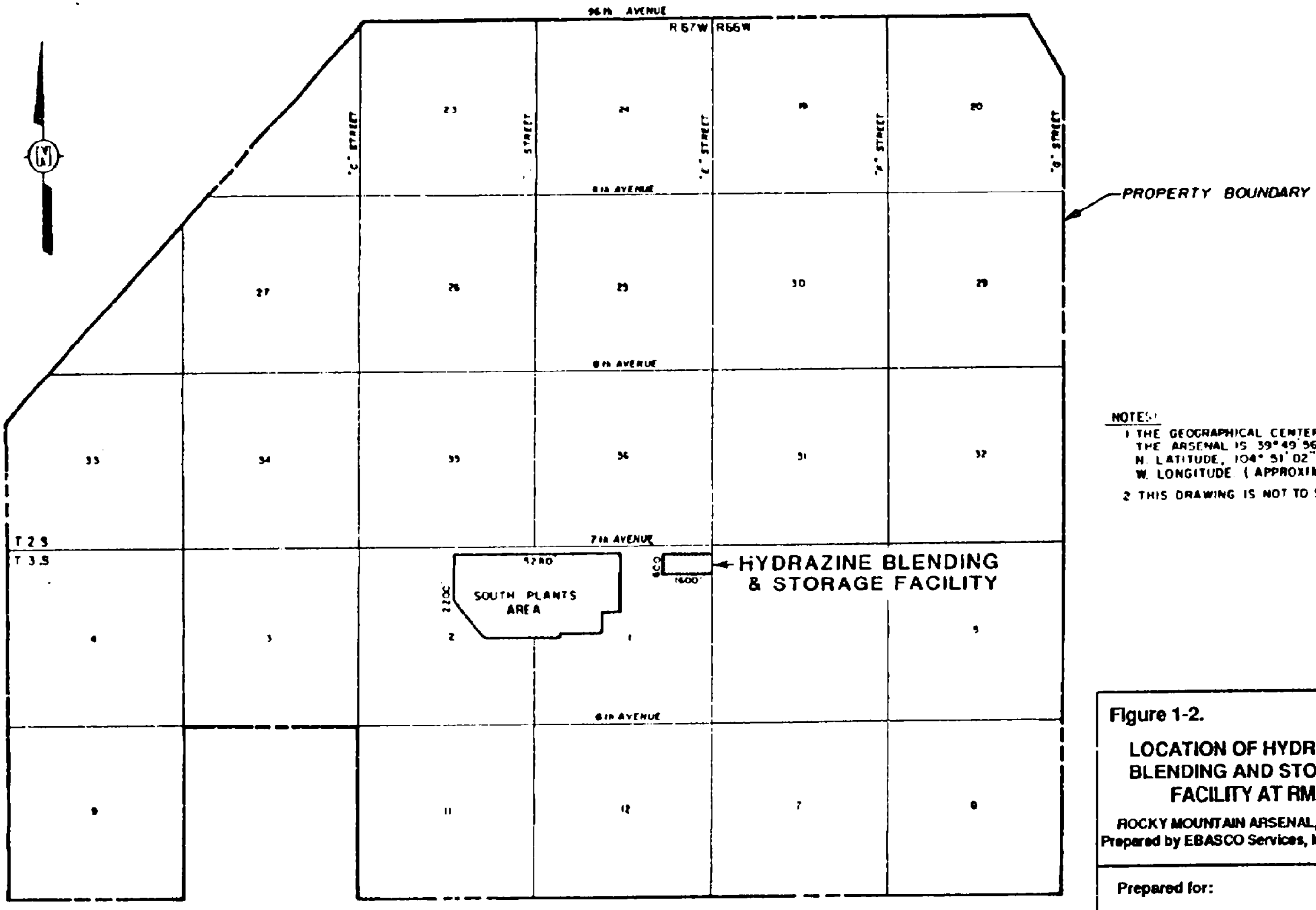

NOTES:
1 THE GEOGRAPHICAL CENTER OF THE ARSENAL IS 39°49'56" N. LATITUDE, 104°51'02" W. LONGITUDE (APPROXIMATE)
2 THIS DRAWING IS NOT TO SCALE.

Figure 1-2.

LOCATION OF HYDRAZINE BLENDING AND STORAGE FACILITY AT RMA

ROCKY MOUNTAIN ARSENAL, TASK 34
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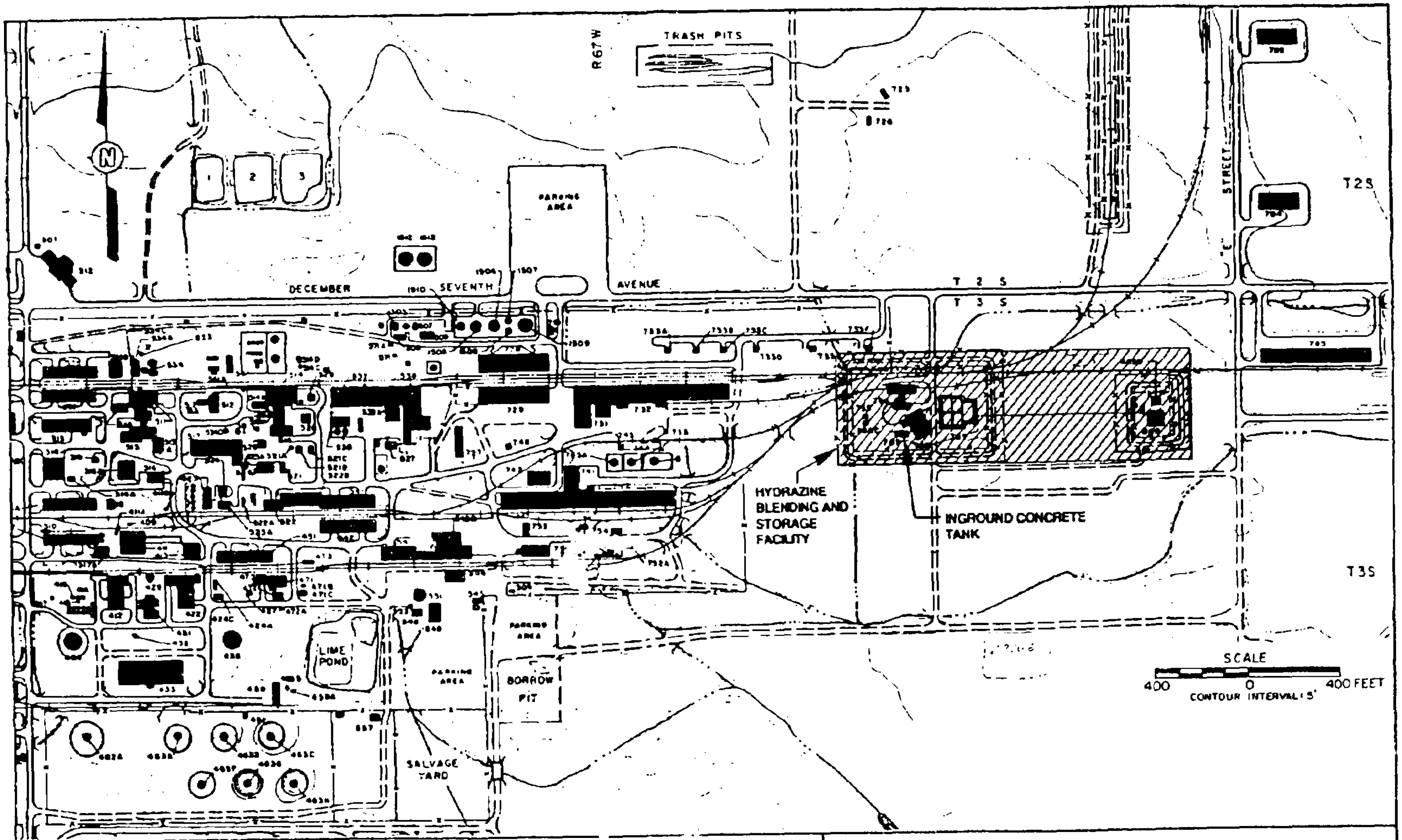
The HBSF was constructed in 1959 for the U.S. Air Force (USAF) as a depot to receive, store, and blend hydrazine fuels and to issue these fuels to various customers. The facility is owned by the USAF, but has been operated by the RMA, a U.S. Army operation under an Interservice Support Agreement (ISSA) since 1960 (PM-RMA, 1982).

The primary objective of the HBSF was the production of the rocket fuel Aerozine 50. Aerozine 50 was produced at the facility by blending anhydrous hydrazine (AH) with unsymmetrical dimethylhydrazine (UDMH). These constituents were manufactured elsewhere and shipped to the RMA for the purpose of rocket fuel production.

Hydrazine operations consisted of downloading/uploading of railroad cars and tanker trucks, storage of rocket fuel and rocket fuel constituents, and blending of rocket fuels. Chemicals stored at the facility for fuel production included AH, UDMH and Aerozine 50. This facility was also used to store other fuels such as monomethyl hydrazine (MMH), monopropellant hydrazine (MPH) and hydrazine 70 (a hydrazine/water mixture). Chemicals to be transported were removed from bulk storage and placed in drums, rail cars or trucks (PM-RMA 1982).

The existing hydrazine blending facility area is a limited access site which occupies approximately 960,000 square feet (see Figure 1-3), (1,600 ft by 600 ft). It is completely enclosed by two concentric security fences.

The facility consists of four carbon steel tanks (one 50,000-gallon, one 200,000-gallon, and two 19,000-gallon capacity) that are compatible with UDMH and water only; four stainless steel tanks (24,900-gallon capacity each) compatible with all of the fuels; a 44,000-gallon capacity inground concrete tank for the collection of wastewaters and area runoff; a blender; a drum filling station; truck and railcar loading and offloading station; concrete pads and dikes; a drum storage



REFERENCE:

GENERAL SITE MAPS, AREAS 2
AND 5, ROCKY MOUNTAIN ARSENAL,
DENVER, CO., DWG. NO. 18-02-01, SHEETS
16 AND 33 OF 67, DATED 3-1-77. SCALE: 1"= 400'

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Figure 1-3.
HYDRAZINE BLENDING AND STORAGE FACILITY
ROCKY MOUNTAIN ARSENAL, TASK 34
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pad; a storage shed; a tool shed; an office shed, and associated piping. Two carbon steel storage tanks (the 50,000-gallon and the 200,000-gallon tanks), located on the eastern end of the facility, have been used since 1982 only for wastewater storage. Each group of tanks has its own catch basin which drains to the main inground concrete tank (44,000 gallons). Figure 1-4 presents a schematic layout of the HBSF. A process flow schematic for the HBSF is shown in Figure 1-5.

Railroad tracks pass through the facility. The HBSF also is served by water, electric power, and steam lines, and a nitrogen gas storage and feed system. The fuel handling facilities contain waterflood fire protection fixtures and a circulating ethylene glycol-based heating system. Table 1-2 lists the major equipment and structures of the hydrazine blending and storage facility.

1.3 OPERATING HISTORY

This section provides a brief background on the operating history of the hydrazine blending facility, including the types of materials processed, the wastes generated, the disposal methods used, a description of major spills and other events that happened prior to the shutdown of the facility, and activities which have occurred since the shutdown.

1.3.1 Types of Material Processed

The hydrazine blending facility had been used primarily for the production of Aerozine 50 missile fuel which is approximately 50 percent AH and 50 percent UDMH. Blending operations were not continuous, but occurred in response to requests by the USAF. The facility also was used to store other fuels such as monopropellant hydrazine (MPH) and hydrazine 70 (hydrazine/water mixture). The USAF utilized the RMA facility as a depot to receive, store, blend and issue hydrazine fuels to various customers.

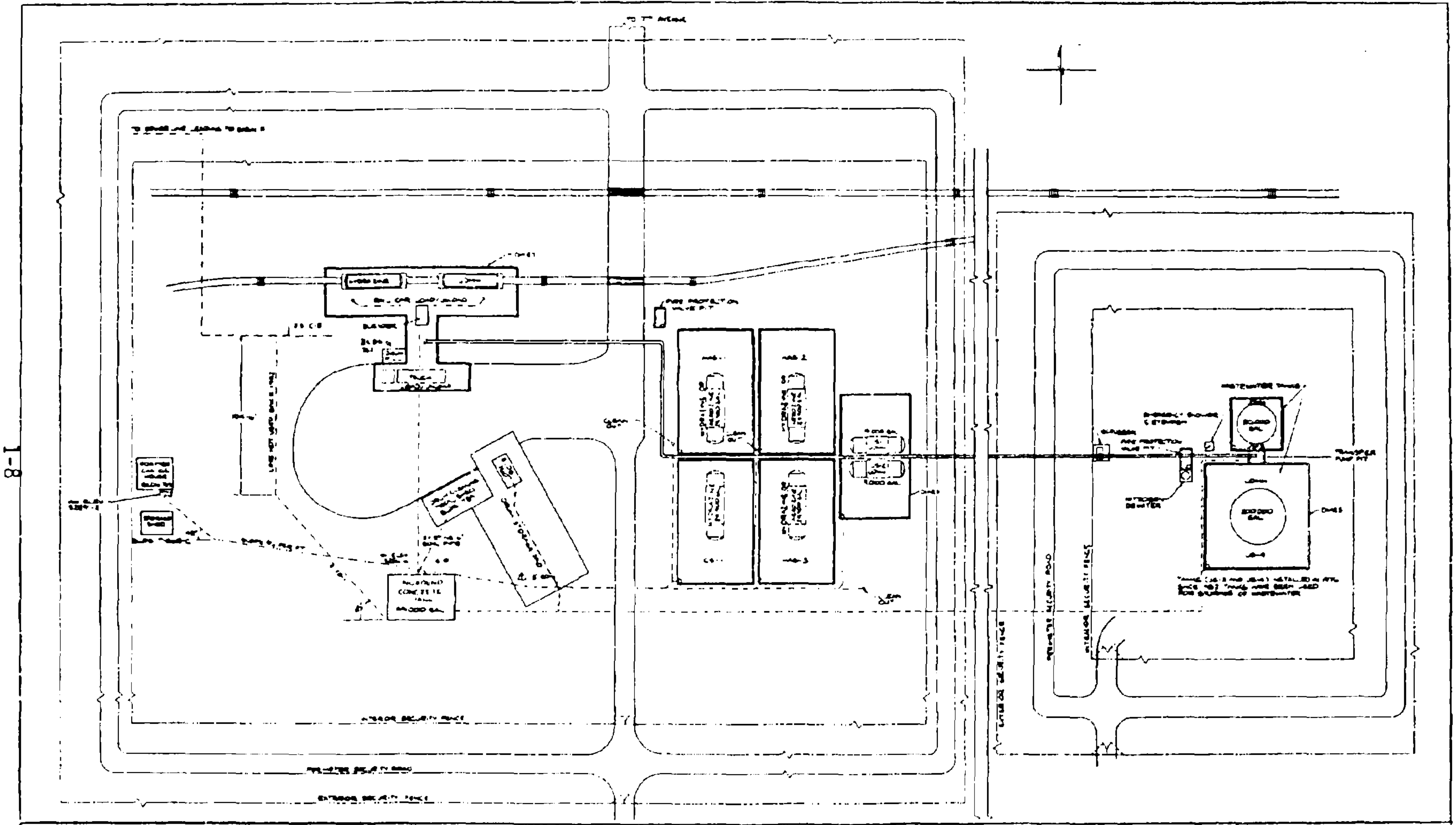

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Figure 1-4.
SCHEMATIC LAYOUT, HYDRAZINE BLENDING AND STORAGE FACILITY
ROCKY MOUNTAIN ARSENAL, TASK 34
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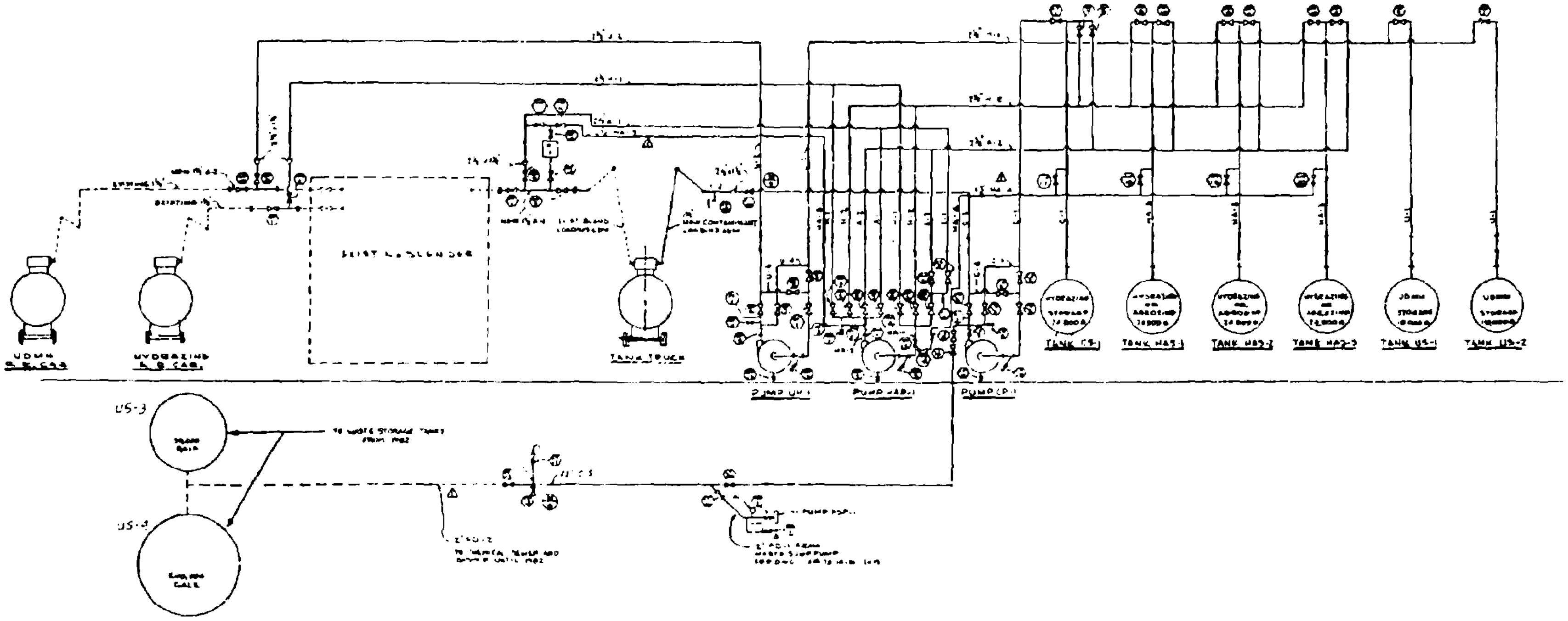

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Figure 1-5.

PROCESS FLOW DIAGRAM, HYDRAZINE BLENDING AND STORAGE FACILITY

ROCKY MOUNTAIN ARSENAL, TASK 34
Prepared by EBASCO Services, Incorporated

TABLE 1-2

MAJOR EQUIPMENT AND STRUCTURES OF THE HYDRAZINE BLENDING AND STORAGE FACILITY

	Item	Description
1.	Railroad Tank Car Facility	
	Enclosed Area	120 ft x 30 ft
	Function	Unloading of anhydrous hydrazine and UDMH from railroad tanker cars
	Construction Material	Reinforced concrete, metal sheets.
2.	Blender	
	Function	Blend hydrazine and UDMH to produce Aerozine 50
	Construction Material	Reinforced concrete, metal sheets
3.	Drum Loading Station (Bldg 761)	
	Area	22 ft x 10 ft
	Function	Loading of Aerozine 50
	Construction Material	Reinforced concrete
4.	Truck Loading Station	
	Area	60 ft x 18 ft
	Function	Loading of Aerozine 50 into tanker trucks
5.	Office Shed/Change House (Bldg 755)	
	Size	20 ft x 24 ft x 9 ft
	Function	Clothing change and showers (until late 1970s). Glycol recirculating pump and heat exchanger housing.
	Construction Material	8-inch masonry (concrete block)
6.	Inground Concrete Tank	
	Area	40 ft x 26 ft
	Volume	44,000 gallons
	Function	Receive wastewater and stormwater runoff
	Construction Material	Concrete
7.	Building 759	
	Size	40 ft x 20 ft x 10 ft
	Function	Drum cleaning
	Construction Material	Metal siding and roofing

TABLE 1-2 (Continued)

MAJOR EQUIPMENT AND STRUCTURES OF THE HYDRAZINE BLENDING AND STORAGE FACILITY

	Item	Description
8.	Shelter (Bldg. 760)	
	Location	In drum storage area
	Function	Forklift storage
	Size	20 ft x 10 ft-10 in
9.	Storage Shed (Bldg. T-868-C)	
	Size	13.5 ft x 22 ft (estm.)
	Function	Storage of miscellaneous building materials
	Construction Material	Wood
10.	Drum Storage Pad	
	Size	70 ft x 45 ft x 0.5 ft
	Function	Storage of drums
11.	Aerozine Storage Tanks	
	Number of Tanks	3 (HAS 1, HAS 2, HAS 3)
	Geometric Shape	Cylindrical, horizontal
	Volume	24,900 gallons
	Construction Material	Stainless steel
	Location	Inside concrete dikes
	Size of Dike	53.5 ft x 47 ft x 5 ft
12.	Anhydrous Hydrazine Storage Tank	
	Number of Tanks	1 (CS 1)
	Geometric Shape	Cylindrical, horizontal
	Volume	24,900 gallons
	Construction Material	Stainless steel
	Prior use	Wastewater storage
	Location	Inside concrete dike
	Size of Dike	53.5 ft x 47 ft x 5 ft
13.	UDMH Storage Tanks	
	Number of Tanks	2 (US-1, US-2)
	Geometric Shape	Cylindrical, horizontal
	Volume	19,000 gallons
	Construction Material	Carbon steel
	Location	Inside concrete dike
	Size of Dike	43 ft x 77 ft x 5 ft

TABLE 1-2 (Continued)

MAJOR EQUIPMENT AND STRUCTURES OF THE HYDRAZINE BLENDING AND STORAGE FACILITY

	Item	Description
14.	Wastewater Tanks	
	Number of Tanks	2 (US-3, US-4)
	Geometric Shape	Cylindrical, vertical
	Volume	50,000 gallons and 200,000 gallons
	Construction Material	Carbon steel
	Prior use	UDMH storage
15.	Pumps	
	Number	6 (HWP-1, HWP-2, UP-1, HAP-1, CP-1, FDP-1)
	Liquids	Hot water, wastewater, UDMH, hydrazine, aerozine, contaminants
16.	Pipes* (Above Ground)	
	Diameter	2.5 in
	Number	18 (U-1, U-2, U-3, U-4, HA-1, HA-2, HA-3, HA-4, HA-5, A-1, A-2, H-1, H-2, C-1, C-2, C-3, C-4, C-5)
	Diameter	3.0 in
	Number	2 (HWR-1, HWS-2)
	Diameter	4.5 in
	Number	1 (V-1)
17.	Scrubbers	
	Number	2
	Location	One at blender area, one at wastewater tank area
18.	Fire Protection Valve Pit	
	Number	2
	Location	One near hydrazine/aerozine tank area and one near wastewater tank area

*There is a variety of underground piping at the HBSF. This piping will also be removed as part of the decommissioning activities.

1.3.2 Generation and Disposal of Wastes

A maximum of approximately 300,000 gallons of wastewater was generated annually from the HBSF. Most of the wastewater from this facility was generated during blending operations. During the blending process, the off-gases were scrubbed with water. This water was then collected by gravity in the 44,000-gallon inground concrete tank located south of the hydrazine blender (Figure 1-4). The storage area catch basins, waste drains in the blender facility, and the steam expansion line from Building 755 also drained into the inground concrete tank. Waste materials were carried to the inground concrete tank by underground pipes.

During years of active facility production, hydrazine drums were filled. Dirty drums and drums to be refilled with a different fuel were cleaned before filling. Residues from these operations were poured into the inground concrete tank. These drums were then washed in the open area south and east of Building 759 (Figure 1-4).

The contents of the inground concrete tank were neutralized by batch treatment with solid calcium hypochlorite to oxidize the hydrazine t ammonia, nitrogen, and water. It was necessary to maintain a pH between 7 and 10 for effective neutralization to occur. Mixing of the waste and hypochlorite was accomplished by recirculating the inground concrete tank contents through a transfer pump, located in the southwest corner of the inground concrete tank. The neutralization process resulted in the accumulation of large amounts of sediment or solid sludge in the inground concrete tank. This sludge was collected and transported to pits in Section 30 and 36 for disposal from 1975 through 1978 (Kuznear and Trautmann, 1980). Until 1982 the treated wastewater from the inground concrete tank was pumped into Basin F (located in Section 26) through the industrial sewer. In 1982, the industrial waste discharge into Basin F was eliminated by excavating the portion of industrial (chemical) sewer feeding the basin. After that, the neutralized wastewater from the inground concrete tank was pumped to two storage tanks (tanks US-3 and US-4) originally used for UDMH storage. An exception was about 10,000 gallons of wastewater which was shipped to Lowry Air Force Base.

1.3.3 Spill History

A detailed HBSF spills history has been discussed in the Task 11 Contamination Assessment Report (Ebasco 1987). A brief summary is provided here.

In November 1975, the fire protection system at the hydrazine facility malfunctioned as a result of a power outage. Several hundred thousand gallons of water filled the pit around the largest UDMH storage tank, causing it to float. No fuels or wastewaters were spilled. To remedy this situation, the water from the pit area was pumped onto the fields to the east and south of the east yard (Trautmann, undated).

In May 1976, approximately 4 inches of UDMH leaked from the largest tank into the surrounding dike area. The UDMH was pumped to the inground concrete tank and was neutralized for disposal in Basin F (Trautmann, undated).

1.3.4 U.S. Occupational Safety and Health Administration Survey

During January, February, and March 1982, the U.S. Occupational Safety and Health Administration's (OSHA) District Office conducted sampling of the HBSF work area during both operational and nonoperational periods. The sampling and analysis were limited to hydrazine, UDMH, and N-nitrosodimethylamine (NDMA). Analysis of the OSHA sample indicated the presence of airborne NDMA at various locations within the HBSF. Table 1-3 presents the location and concentration of contaminants found by OSHA at the HBSF (PM-RMA, 1982). OSHA advised RMA to upgrade worker health and safety protection level before continuing operation of the HBSF.

TABLE 1-3

RESULT OF ANALYSIS OF SAMPLES TAKEN BY OSHA AT VARIOUS LOCATIONS AT HBSF

Date	Sample Identification	Type	Operation	Location of Sampler	Sampling Period (Minutes)	Contaminant	Exposure	Time Weighted Average
01/28/82	RMA 1 and 3	Area	Transfer from storage tank to truck tanker	In office	50	Dimethyl Amine	N.D.	--
	RMA 2 and 4	Area		Sump (north side)	50	Dimethyl Amine	N.D.	--
	RMA 11	Area		Office	200	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 17	Area		Office	51	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 12	Area		Sump (north side)	200	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 18	Area		Sump (north side)	43	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 13	Area		Support beam near office	200	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 19	Area		Support beam near office	41	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 23	Area		Office	252	NDMA	10.0 ug/m^3	5.25 ug/m^3
	RMA 24	Area		Sump (north side)	242	NDMA	4.1 ug/m^3	2.1 ug/m^3
	RMA 25	Area		Support beam near office	240	NDMA	1.5 ug/m^3	0.25 ug/m^3
02/25/82	RMA 40	Area	Background levels	Northwest corner tank farm	276	NDMA	0.58 ug/m^3	0.33 ug/m^3
	RMA 41	Area		Office	274	NDMA	2.7 ug/m^3	1.54 ug/m^3
	RMA 42	Area		Sump (northeast corner)	274	NDMA	2.7 ug/m^3	1.54 ug/m^3
	RMA 43	Area		Sump (southwest coner)	274	NDMA	1.8 ug/m^3	1.03 ug/m^3
	RMA 44	Area		North out building	270	NDMA	0.37 ug/m^3	--
	RMA 45	Area		Truck loading bay	269	NDMA	2.6 ug/m^3	1.46 ug/m^3
	RMA 46	Area		Rail car loading bay	268	NDMA	1.5 ug/m^3	0.84 ug/m^3
	RMA 47	Area		Control station	267	NDMA	2.6 ug/m^3	1.45 ug/m^3
	RMA 48	Area		Drum storage	256	NDMA	0.43 ug/m^3	0.74 ug/m^3
	RMA 49	Area		Tank farm between NAS and CS 1	265	NDMA	2.3 ug/m^3	1.3 ug/m^3
	RMA 50	Area		S.E. corner tank farm	263	NDMA	1.0 ug/m^3	0.55 ug/m^3
	RMA 51	Area		Outer gate (north)	262	NDMA	0.30 ug/m^3	--
03/10/82	RMA 55	Area	Background levels at other parts of the RMA	North side Building 111	252	NDMA	N.D.	--
	RMA 56	Area		Northeast side Basin "F"	198	NDMA	N.D.	--
	RMA 58	Area		South side building 831	193	NDMA	N.D.	--
	RMA 60	Area		East side building 1710 (Clinic)	191	NDMA	N.D.	--
	RMA 62	Area		South of building 538	172	NDMA	N.D.	--
	RMA 64	Area		Building 314 in lunch room	171	NDMA	N.D.	--
	RMA 57	Area		Northeast side Basin "F"	193	Hydrazine	N.D.	--
						UDMH	N.D.	--

TABLE 1-3 (Continued)

RESULT OF ANALYSIS OF SAMPLES TAKEN BY OSHA AT VARIOUS LOCATIONS AT HBSF

Date	Sample Identification	Type	Operation	Location of Sampler	Sampling Period (Minutes)	Contaminant	Exposure	Time Weighted Average
	RMA 59	Area		South side building 831	193	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 61	Area		East side building 1710 (clinic)	190	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 63	Area		South of building 538	172	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 65			Building 314 in lunch room	170	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 69	Area	Draining sump	On retaining wall of storage tank east of hydrazine facility	60	NDMA	N.D.	--
	RMA 68	Area		On retaining wall of storage tank east of hydrazine facility	60	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 93	Area	Transfer UDMH from rail car to storage tank	Near scrubber vent	183	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 94	Area		Near scrubber vent	120	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 95	Area		Near scrubber vent	186	NDMA	1.3 ug/m^3	1.81 ug/m^3
	RMA 96	Area		Near scrubber vent	118	NDMA	5.3 ug/m^3	--
	RMA 98	Area		In office	235	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 99	Area		In office	66	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 100	Area		In office	303	NDMA	1.1 ug/m^3	0.69 ug/m^3
	RMA 102	Area		At control panel	230	Hydrazine	16.0 ug/m^3	9.9 ug/m^3
						UDMH	56.0 ug/m^3	43.01 ug/m^3
	RMA 103	Area		At control panel	67	Hydrazine	N.D.	--
						UDMH	116.0 ug/m^3	--
	RMA 104	Area		At control panel	298	NDMA	30.0 ug/m^3	18.63 ug/m^3
3/82	RMA 78	Area	Draining sump	In office near drain	240	NDMA	3.5 ug/m^3	1.25 ug/m^3
	RMA 79	Area		North out building on refrigerator	240	NDMA	0.42 ug/m^3	--
	RMA 81	Bulk		Sump water		NDMA	180.0 ug/m^3	--
	RMA 82	Bulk		Sump water		Hydrazine		
						UDMH		

TABLE 1-3 (Continued)

RESULT OF ANALYSIS OF SAMPLES TAKEN BY OSHA AT VARIOUS LOCATIONS AT HBSF

Date	Sample Identification	Type	Operation	Location of Sampler	Sampling Period (Minutes)	Contaminant	Exposure	Time Weighted Average
3/82	RMA 92	Area	Transfer of rail car of UDMA	Scrubber near vent pipe (Bubbler)	300	NDMA	1.8 ug/m^3	1.13 ug/m^3
	RMA 97	Area		Office (bubbler)	298	NDMA	0.27 ug/m^3	0.17 ug/m^3
	RMA 101	Area		Control panel (bubbler)	249	NDMA	16.9 ug/m^3	10.35 ug/m^3
	RMA 105	Area		Tank farm, east side of US 1	293	NDMA	0.14 ug/m^3	0.045 ug/m^3
	RMA 106	Area		On top tank CS 1	228	Hydrazine	N.D.	--
						UDMH	N.D.	--
03/17/32	RMA 107	Area	Transfer UDMH from rail car to storage tank	On top tank CS 1	66	Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 108	Area		On top tank CS 1	294	NDMA	N.D.	--
	RMA 112	Wipe		Abe Padilla's apron	N/A	NDMA	N.D.	--
						Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 113	Wipe		Rudy Martinez's apron	N/A	NDMA	N.D.	--
						Hydrazine	5.7 ug/m^3	--
						UDMH	N.D.	--
	RMA 114	Wipe		Dip sticks used to gauge tanks	N/A	NDMA	N.D.	--
						Hydrazine	N.D.	--
						UDMH	N.D.	--
	RMA 115	Wipe		Desk in office	N/A	NDMA	N.D.	--
						Hydrazine	N.D.	--
						UDMH	N.D.	--

N/A - not applicable
N.D. - not detected

Source: PM - RMA, 1982.

1.3.5 U.S. Army Environmental Hygiene Agency Survey

In December 1982, U.S. Army Environmental Hygiene Agency (AEHA) conducted a sampling program at the HBSF to quantify worker exposures to NDMA, UDMH, and hydrazine (AEHA, 1982). AEHA collected samples at specific work locations based on known or potential hydrazine, UDMH and/or NDMA release or contamination. Sampling locations used by AEHA are shown in Figure 1-6. Results of this sampling program are presented in Tables 1-4 and 1-5.

The significant findings of this sampling program were:

a. The samples from the general area contained insignificant levels of both hydrazine and UDMH as indicated in Table 1-4. The detection limits were 0.05 micrograms per cubic meter (ug/m^3) for hydrazine and 0.1 ug/m^3 for UDMH.

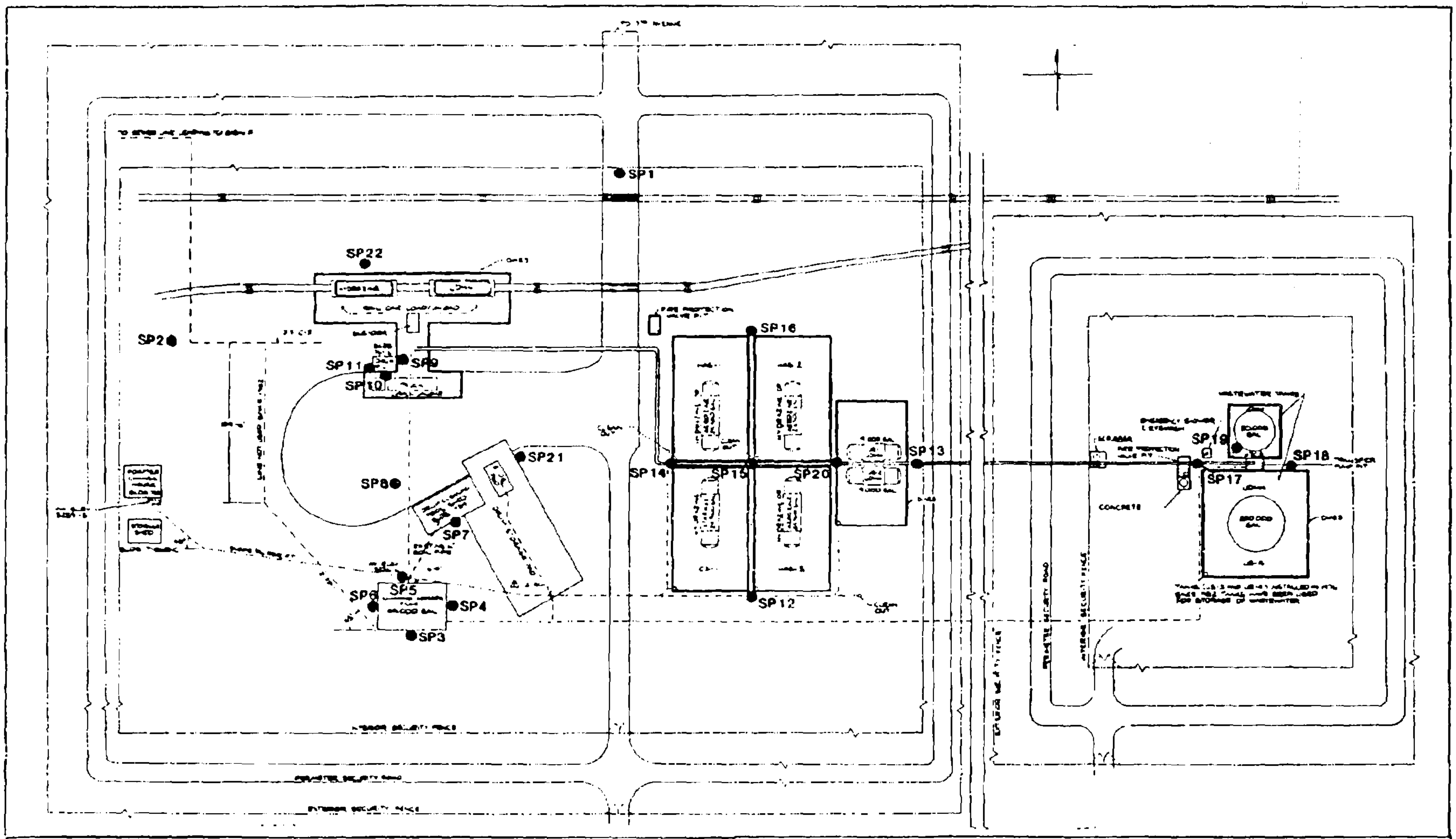
b. The wipe samples from the drum filling nozzles and connectors and the mixing and blending area showed relatively low levels of hydrazine and UDMH as indicated in Table 1-5.

c. The atmospheric samples taken from the work area showed low but detectable levels of contamination with NDMA as indicated in Table 1-4.

Based on these findings AEHA concluded:

a. No sources of detectable quantities of hydrazine or UDMH contamination were identified by air sampling.

b. Wipe sampling identified the drum loading station filler nozzles and connectors, the control panel of the mixing and blending area, and the electrical outlet north of Tank HAS-1 as sites of potential hydrazine or UDMH contact exposure.



Prepared for:

Program Manager's Office For
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

Figure 1-6.

AEHA SURVEY SAMPLING LOCATIONS IN HBSF

ROCKY MOUNTAIN ARSENAL, TASK 34
Prepared by EBASCO Services, Incorporated

TABLE 1-4

RESULTS OF ANALYSES OF ATMOSPHERIC SAMPLES
COLLECTED BY U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY, DECEMBER 1982

Sampling Point	Simultaneous Samples		Sample Results (in micrograms/cubic meter-ug/m^3)		
	Hyd/UDMH Sample No.	NDMA Sample No.	Hydrazine	UDMH	NDMA
SP-1	SG-47, FB-03, FB-38	AO 3489, AO 3407	< 0.05	< 0.10	ND - Traces
SP-2	FB-07, FB-09	AO 3410, AO 3486	< 0.05	< 0.10	ND
SP-3	SG-10, SG-37, FB-23, FB-52, FB-36	AO 3066, AO 3475, AO 3401, AO 3480	< 0.05	< 0.10	Trace - 1.70
SP-4	SG-06, SG-36, FB-08 FB-10, FB-42	AO 3061, AO 3476, AO 3478, AO 3488	< 0.05	< 0.10	0.18 - 1.50
SP-5	SG-09, SG-38, FB-24, FB-16, FB-13	AO 3063, AO 3491, AO 3399, AO 3482	< 0.05	< 0.10	Trace - 2.60
SP-6	SG-08, SG-33, FB-31, FB-22, FB-41	AO 3059, AO 3073, AO 3409, AO 3481	< 0.05	< 0.10	ND - 1.50
SP-7	SG-03, SG-12	AO 3071, AO 3069	< 0.05	< 0.10	1.30 - 1.70
SP-8	SG-07, SG-18	AO 3058, AO 3070	< 0.05	< 0.10	4.20 - 10.0
SP-9	SG-11, SG-34, SG-32 FB-21, FB-12	AO 3064, AO 3068, AO 3490, AO 3411, AO 3427	< 0.05	< 0.10	3.40 - 18.0
SP-10	SG-13, SG-16, SG-31 FB-01, FB-40	AO 3072, AO 3060, AO 3479, AO 3406	< 0.05	< 0.10	0.27 - 12.0
SP-11	SG-14, SG-15, SG-39 FB-02, FB-43	AO 3074, AO 3065, AO 3477, AO 3402	< 0.05	< 0.10	0.55 - 20.0

Trace - Value between 0.05 and 0.15 ug/m^3.
ND - None Detected, value < .05 ug/m^3.

TABLE 1-4 (Continued)

Sampling Point	Simultaneous Samples Hyd/UDMH Sample No.	 NDMA Sample No.	Sample Results Hydrazine	(in micrograms/cubic meter-ug/m^3) UDMH	 NDMA
SP-12	FB-04, FB-15	AC 3487, AO 3398	< 0.05	< 0.10	0.50 - 1.90
SP-13	FB-63, FB-18	AO 3393, AO 3396	< 0.05	< 0.10	1.00 - 4.70
SP-14	FB-47, FB-27	AO 3397, AO 3394	< 0.05	< 0.10	0.63 - 1.20
SP-15	FB-58, FB-37	AO 3404, AO 3484	< 0.05	< 0.10	0.92 - 1.00
SP-16	FB-45, FB-36	AO 3392, AO 3483	< 0.05	< 0.10	0.62 - 1.10
SP-17	FB-33, FB-59	AO 3413, AO 3417	< 0.05	< 0.10	Trace 0.16
SP-18	FB-39, FB-17	AO 3412, AO 3416	< 0.05	< 0.10	0.24 - 0.62
SP-19	FB-06, FB-28	AO 3415, AO 3418	< 0.05	< 0.10	0.17 - 0.50
SP-20	FB-49, FB-29	AO 3395, AO 3400	< 0.05	< 0.10	0.92 - 1.20
SP-21	SG-04, SG-19, SG-46, FB-44, FB-46	AO 3057, AO 3062, AO 3473, AO 3405	< 0.05	< 0.10	1.00 - 1.40
SP-22	SG-20, SG-17, SG-36, FB-20, FB-65	AO 3067, AO 3056, AO 3472, AO 3408	< 0.05	< 0.10	ND - 0.94
SP-FH	SG-05, SG-51, FB-05	AO 3075, AO 3474	< 0.05	< 0.10	ND
SP-NQ	SG-55, FB-26, Fb-32	AO 3485, AO 3403	< 0.05	< 0.10	ND

Trace - Value between 0.05 and 0.15 ug/m^3.
ND - None Detected, value < .05 ug/m^3.

Detection Limits

Hydrazine	0.05 ug/m3
UDMH	0.10 ug/m3
NDMA	0.05 ug/m3

TABLE 1-5

RESULTS OF WIPE SAMPLES FOR HYDRAZINE AND UNSYMMETRICAL DIMETHYLHYDRAZINE

Sample Number	Location	Results (in micrograms-total) Hydrazine	UDMH 1/
W-100	Electrical control panel (west fence)	<5	0.2
W-101	Ground wipe, Drum Steamout (SP-8)	<5	<0.2
W-102	Electrical outlet north of Tank HAS-1	<5	0.3
W-103	Desktop and telephone inside Building 759	<5	<0.2
W-104	Empty barrel storage south of SP-21	<5	<0.2
W-105	Gauges and piping around sump pump at Waste Sump	<5	<0.2
W-106	Control Panel (SP-9)	<5	6
W-107	Water Sample from Waste Sump	<5	<0.2
W-108	Drum loading station (wipe of drum filling nozzles/connectors)	3,475	19.0
W-109	Tank HAS-2, drain value (Tank pit valve)	<5	<0.2
W-110	Tank HAS-1, control valve (on top)	sample bottle broken	
W-111	Tank Truck Station, Truck loading filler nozzle and boom	sample bottle broken	

1/ UDMH - 1,1-Dimethylhydrazine

Detection Limits: Hydrazine 5.0 ug
UDMH 0.2 ug

Source: AEHA, 1982.

c. Detectable quantities of NDMA were present, as air contaminants, throughout the HBSF.

d. The potential exists for worker exposure to detectable amounts of NDMA at the personnel change facility trailer located approximately 50 feet from the north fence entrance (SP-1).

1.3.6 Current Status

The RMA stopped routine HBSF operations after the OSHA and AEHA surveys. The USAF and RMA jointly developed a hazard abatement plan for the facility, and removal of remaining fuels and fuel residuals is complete. Currently, the facility is regularly inspected to check the automatic sprinkler system, the ethylene glycol heating system, the nitrogen storage tank and the nitrogen blanket for the storage and fuel transfer system, and the inground concrete tank level. The USAF commissioned a study to recommend a detailed cleanup procedure for the severable equipment at the HBSF; a draft report was released in October 1985. In September 1985, the Program Manager for RMA Contamination Cleanup (PM-RMA) initiated the preparation of a preliminary cleanup plan which was completed and submitted to the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) in December 1985 (USAF, 1985). PM-RMA also initiated a soil and groundwater study, which is currently ongoing. RMA personnel have completed rinsing all accessible piping and tanks with the stored wastewater to remove any residual fuel from these structures (James, 1986). Two additional cleaning and flushing processes using a sodium hypochlorite solution were begun during August 1986 and finished in February 1987 (James, 1987). Water from the eastern tanks and the inground concrete tank was pumped to the horizontal tanks, sodium hypochlorite solution was added, the water was recirculated and then allowed to sit. Chemical analyses were conducted to determine if hydrazine compounds remained. If found, additional hypochlorite solution was added until chemical analyses indicated that the compounds were not detectable. The water was then pumped to the eastern tanks (James, 1986; James, 1987). Fuel and heel removal and equipment rinsing were consistent with the initial decontamination steps specified in the December 1985 Preliminary Cleanup Plan.

1.4 PREVIOUS INVESTIGATIONS

1.4.1 OSHA/AEHA Reports

During 1982, OSHA and the AEHA conducted surveys to quantify exposures of hydrazine related compounds. The findings of these surveys led to the cessation of operations at the HBSF and have been described in Section 1.3.

1.4.2 HBSF Preliminary Cleanup Plan

In December 1985, PM-RMA submitted a Preliminary Cleanup Plan for the HBSF to EPA and CDH (PM-RMA, 1985). The report included a site description and process history, a characterization of all wastes, and a cleanup plan with attendant schedule. Materials which were listed and described include:

- o Hydrazine, UDMH, Aerozine 50, and MMH fuels;
- o Wastewater in concrete tanks and storage tanks;
- o Surface contamination, contaminated construction materials, asbestos, and possibly polychlorinated biphenyl (PCB) containing transformers.

The cleanup plan was developed to meet the goals of health protection, and control of waste releases. Essential components of the cleanup plan included:

- o A sampling and analysis program to determine the extent of contamination;

- o Cleanup procedures, including wastewater treatment, air monitoring, decontamination, dismantling, and removal.

1.4.3 U.S. Air Force Decommissioning Study

The U.S. Air Force conducted a study for the decommissioning of the HBSF (USAF 1985). This study consisted of sampling, a survey of the site background and description, a discussion of institutional considerations, a sampling program, and a consideration of wastewater treatment and decommissioning of the HBSF. The findings of the U.S. Air Force Decommissioning Study are summarized in this section.

Sampling at the HBSF was conducted during June 11 through 13, 1985 for the USAF. The objective of the field sampling program was to sample surfaces and bulk materials of unknown contamination. Those surfaces and bulk materials that were known to be contaminated (such as the inside surfaces of fuel storage tanks) were not sampled. Samples of various insulation materials present on the site were obtained for asbestos analysis. The results of chemical analyses of wipe, bulk, asbestos, and PCB samples are discussed below. Table 1-6 is a summary of the analytical results that were above the limit (USAF, 1985).

Wipe Samples

The purpose of a wipe sample was to provide an indication of contaminant presence, not a quantitative measure of its concentration. Each sample came from wiping a 100 cm^2 area (10 by 10 cm) with a dry Whatman No. 41 filter paper. Two adjacent 100 cm^2 areas were sampled at each sample location. Because of different extraction and analytical procedures, one wipe sample, or filter paper, was analyzed for NDMA and the other for hydrazine, MMH, and UDMH.

Wipe sample locations included product tank exterior surfaces (cladding), pipe supports, handrails, the office building, the glycol building, the storage shed, the blending skid, railroad rails, the liquid nitrogen tank, concrete containment dikes, the inground wastewater tank, chain link fence supports, the drum storage pad, and the east scrubber.

TABLE 1-6

ANALYTICAL RESULTS OF WIPE, BULK AND ASBESTOS SAMPLES (ABOVE METHOD DETECTION LIMITS)

Sample Number	Sample Type	Parameter	Method	Unit	Detection Limit	Concentration
42B	Wipe	MMH	S149 1/	ug/sample (ug/100 cm^2)	25	26
43B	Wipe	MMH	S149	ug/sample (ug/100 cm^2)	25	25
2B	Bulk	Hydrazine	S149	ug/g	0.02	350
2B	Bulk	UDMH	S149	ug/g	0.05	2.3
2B	Bulk	MMH	S149	ug/g	0.05	18
ASB-1	Insulation	Asbestos	---	percent	0.5	5 - 10

1/ NIOSH Method S149, USAFSAM Report TR-82-29 and USAF "The Firebrick Method" by Tom Thomas.

Source: U.S. Air Force, 1985

With the [illegible] of two samples (Samples 42B and 43B, which were taken from [illegible] face of Tank HAS-3) all of the wipe samples analyzed were below t[illegible]tection limit for hydrazine, NDMA, MMH, and UDMH (5.0, 0.6, 25, and 25 ug/sample, respectively). Samples 42B and 43B had reported MMH concentration of 26 and 25 ug/sample, respectively, near the limit of detection for MMH.

Bulk Samples

The collection of bulk samples was limited by the requirements of working in a spark-free environment and avoiding destruction of facilities. Bulk samples could only be taken where materials were easily obtainable, because no chipping, sawing, or use of power tools was allowed. The two bulk samples that were taken included: 1) loose concrete near the drum weigh scale and 2) wood from the railroad ties opposite and north of the drum blend pumping skid.

Analyte levels in Bulk Sample 1, a piece of loose concrete taken from near the drum scale, were all below the detection limit (hydrazine, 20 ug/g; NDMA, 0.1 ug/g; UDMH, 50 ug/g; MMH, 50 ug/g).

The concentrations of hydrazine, UDMH, and MMH detected in Bulk Sample 2, pieces of wooden railroad tie, were 350, 2.3, and 18 ug/g, respectively. The detection limits for these substances in wood samples are 0.5 ug/g for hydrazine, 3.0 ug/g for UDMH, and 3.0 ug/g for MMH. The concentration of NDMA was below the detection limit of 0.1 ug/g for this sample.

Asbestos Samples

Several samples were obtained of insulation materials suspected of containing asbestos. Two types of insulation material were sampled above the northwest Aerozine Tank HAS-3, on an inlet pipe located near the catwalk. One sample was of a hard, matrix type of insulation, and the other was of a fiberglass-like piece of insulation. The other sample location was piping insulation south of the blend pump building. Each sample was placed in a plastic screw-top container. Additional samples were not obtained because of the limited amount of accessible, visible insulation.

The only insulation sample with a detected concentration of asbestos was ASB-1. This sample was taken from an inlet pipe near the catwalk above Tank HAS-3 and contained both fibrous and solid gray material. The fiber material did not contain any detected asbestos. The gray material, however, contained 5 to 10 percent Chrysolite, a common form of asbestos. Analyses of split samples of ASB-1 resulted in 5 to 10 percent asbestos in both samples.

PCB Samples

Four transformers were reported to be present at the HBSF. Analyses for PCBs were conducted on oil from each. One transformer (No. 755 West, Serial No. 5977576) contained 50 ppm of a PCB compound, Arochlor 1260. Other transformers are believed to contain less than 50 ppm of PCBs.

Wastewater Treatment

Wastewater treatment possibilities were also reviewed as part of this study. The ultimate disposal of the treated or untreated wastewater and treatment alternatives were discussed separately. Four disposal options were listed:

- Discharge through natural drainage to a surface water body;
- Transport to a publicly owned treatment works (POTW);
- Discharge through a National Pollutant Discharge Elimination System (NPDES) permitted outfall;
- Transport to an off-site treatment or disposal facility.

The regulatory, scheduling, and cost issues of each option were discussed along with the level of treatment which would be required prior to disposal.

Several methods were presented in the Air Force decommissioning study for treatment and disposal of the wastewater:

- Activated carbon adsorption;
- Chlorination;
- Ozonation;
- Chemical oxidation;
- Biological treatment;
- Incineration;
- Deep well injection.

On-site and off-site implementation of these options was investigated along with the technical feasibility of each and potential suppliers for options judged to be feasible.

The report stated that activated carbon adsorption of hydrazine compounds and NDMA is low and excluded this option. Chlorination was listed as a viable option, although the reaction pH and hypochlorite dosing must be carefully controlled and undesirable reaction products are possible. The availability of portable chlorination units was discussed, and it was anticipated that chlorination would treat contaminants to non-detectable levels.

Several chemical oxidation processes were included. Ozonation was determined to be a feasible treatment option. Combined ozone and ultraviolet light exposure (ozone/UV) was reported to degrade hydrazine compounds and also undesirable reaction products by the IIT Research Institute. A mobile treatment unit utilizing ozone/UV was identified, although it has not been used to treat hydrazine wastewater. Hydrogen peroxide and potassium permanganate were listed as other chemical oxidants available to treat hydrazine related compounds, but no information was provided regarding their effectiveness.

Biological oxidation was discussed as a treatment method. Based on studies of the effects of hydrazine compounds on bacterial metabolism, the report concluded that although low concentrations (less than 1 ppm) may be successfully treated, the potential toxicity of higher concentrations precluded utilization of biological waste treatment.

Incineration of the wastewater was another treatment option offered, but was considered economically infeasible for both on- and off-site application. Deep well injection was also considered, but was not recommended because the contaminants would not be treated or destroyed.

1.4.4 PM-RMA Task 11: Hydrazine Blending and Storage Facility

The PM-RMA conducted a contamination survey of soils and groundwater at the HBSF through Task 11 during 1986 (Ebasco, 1987). Based on a review of existing data, literature, and contamination sources, a field sampling program was designed to assess the extent of contamination. Soil and groundwater chemical analyses were conducted. Following data analysis, the following issues were addressed:

- Local geologic and hydrologic conditions;
- Extent of contamination;
- Future monitoring requirements; and
- Further sampling needs for the Phase II soil sampling plan.

The analyses of soil samples indicated the presence of heavy metals in the soil, most of which were at concentrations within the indicator ranges. Samples from six borings contained zinc which exceeded the indicator range of 60 to 80 ug/g. The copper concentration exceeded the indicator range in one boring. In two borings, lead concentrations were greater than indicator levels of 25 to 40 ug/g. Of the samples analyzed for target organic contaminants, only one sample contained an organic contaminant, methyl isobutyl ketone (MIBK) at 1 ppm. This compound may have been a laboratory contaminant. A number of nontarget organic compounds were also detected. However, hydrazine compounds and NDMA were below certified reporting limits (CRLs) for hydrazine, MMH, UDMH, and NDMA which were 50 ug/g, 200 ug/g, 200 ug/g, and 0.26 ug/g, respectively. Based on these results, remediation of HBSF area soils is not warranted and was not included within the scope of the decommissioning assessment. Any contaminated groundwater below the HBSF will be remediated as part of the Arsenal-wide program.

1.4.5 Wastewater Characterization Studies

The waters in the inground concrete tank were analyzed on several occasions for hydrazine, UDMH and NDMA concentrations by the Analytical Systems Branch Laboratory of the Environmental Division at RMA (RMA laboratory). The analyses of samples indicate the following results (PM-RMA, 1983):

pH (standard units)	7.1
Hydrazine (ug/l)	0.69-0.73
UDMH (ug/l)	1.81-2.40
NDMA (ug/l)	0.3

The wastewater in the inground concrete tank has also been analyzed for EP toxicity parameters (Table 1-7). Concentrations of parameters of interest did not exceed the substantive Resource Conservation and Recovery Act (RCRA) criteria (PM-RMA, 1983). GC/MS analyses indicated the presence of dimethylcyanamide, N,N-dimethylformamide, tetrachloroethane, and 1-ethyl-1H-1,2,4,-triazole. However, the concentrations of these organic compounds were very small (less than 20 ug/l) and, therefore, they were not quantified (PM-RMA, 1983).

The results of 1983 and 1985 analyses of the wastewater stored in the 50,000 and 200,000 gallon storage tanks are presented in Table 1-8. The 1983 samples were analyzed by the RMA laboratory. The 1985 samples were analyzed for the USAF (USAF, 1985).

TABLE 1-7

RESULTS OF ANALYSES OF EXTRACTS FROM EP TESTS INGROUND CONCRETE TANK WASTEWATER[1]

Parameters	Units	Substantive RCRA Concentration Limits 2/	Inground Concrete Tank Wastewater
pH	s.u.	-- 3/	--
Trace Metals:			
Arsenic	mg/l	5.0	0.007
Barium	mg/l	100	--
Cadmium	mg/l	1.0	0.0022
Chromium	mg/l	5.0	0.001
Lead	mg/l	5.0	0.001
Mercury	mg/l	0.2	0.005
Selenium	mg/l	1.0	0.0004
Silver	mg/l	5.0	0.002
Organics:			
Endrin	ug/l	20	0.01
Lindane	ug/l	400	0.01
Methoxychlor	ug/l	10,000	0.2
Toxaphene	ug/l	500	0.01
2, 4-D	ug/l	10,000	0.5
2, 4, 5-TP (Silvex)	ug/l	1,000	0.1

1/ The samples were analyzed by Environmental Laboratory Analytical Laboratory Group, Waterways Experiment Station, Vicksburg, Mississippi.

2/ CDH Part 261.24.

3/ -- = Not determined.

Source: PM-RMA, 1983; USAF, 1985.

TABLE 1-8

ANALYTICAL RESULTS - WASTEWATER HYDRAZINE BLENDING AND STORAGE FACILITY

Parameter	50,000 Gallon Tank		200,000 Gallon Tank	
	mg/l	Date	mg/l	Date
Hydrazine	444.4	6-83	2.96	6-83
	225.36	8-83	0.71	8-83
	140.	6-85	BDL	6-85
MMH	505.3	6-83	28.4	6-83
	1,300.	6-85	8.	6-85
UDMH	4-5.6	6-83	3.04	6-83
	213.58	8-83	2.03	8-83
	470.	6-85	BDL	6-85
NDMA	1.	6-83	1.	6-83
	0.805	8-83	0.134	8-83
	0.021	6-85	0.007	6-85

BDL = Below detection limit. Detection limits for 6/85 analyses were:

Hydrazine	0.2 mg/L
MMH	1.0 mg/L
UDMH	1.0 mg/L
NDMA	0.0002 mg/L

Sources: PM-RMA, 1983; USAF, 1985

Some variation between the 1983 and 1985 data can be noted. Possible explanations include additional pumping of wastewater to the tanks; different analytical methods; different sampling techniques; and chemical reactions and degradation.

1.5 ACTION LEVELS

In any contamination situation, there is the potential for adverse impacts to human health or the environment resulting from exposure to the contaminants. The amount of contaminant which poses a significant risk depends not only on its concentration and disposition but also on the routes of exposure, that is, the fraction of the contaminant which leaves the site and through various transport mechanisms reaches the receptors. The determination of action levels for cleanup relies first on potential human and environmental risks associated with the contaminant. In addition, there are practical constraints such as treatment technology and analytical detection limitations.

The contaminants of concern at HBSF include hydrazine, MMH, UDMH, and NDMA. These substances, especially NDMA, have carcinogenic potential through several modes of contact, such as ingestion and dermal exposure. The wastewater, groundwater, and equipment and building surfaces may all be contaminated by these compounds.

NDMA is the most toxic of the contaminants in the wastewater and often the most resistant to treatment. Accordingly, action levels have been initially defined for NDMA. Although destruction of NDMA to desired concentrations ensures that hydrazine, MMH, and UDMH are destroyed virtually completely, action levels are determined for other contaminants of concern in a manner similar to the process used for NDMA. Appropriate decomposition of these compounds would yield carbon dioxide, water, nitrogen and nitrates; all environmentally benign chemicals.

Precedent for NDMA action levels has been set in the issuance of the NPDES permit for Aerojet-General Corporation in Sacramento, California. A method detection limit (MDL) of 500 parts per trillion (ppt) limited the desired health-based limit of zero, and because of analytical uncertainty, a maximum effluent concentration limit of 1,000 ppt was designated in that permit (CRWQCB, 1985). A similar rationale balancing health-based treatment levels, analytical limits of detection, and the uncertainty of analytical values is used in this report to establish an action level for NDMA. From a health perspective, the allowable concentration of NDMA in water has been calculated as 1.4 ppt based on values computed by the USEPA Cancer Assessment Group (CAG) and assuming an increased cancer incidence after consuming contaminated water of one out of a million persons (10^{-6} risk). Although treatment to this level is desirable, analytical detection limitations preclude measurement of such low concentrations. The analytical method certified for use at RMA has a detection limit of 200 ppt. However, as the detection limit is approached the precision and accuracy of the analytical method became more uncertain and, therefore, the results are more questionable (Lessley, 1986). Nonetheless, the 200 ppt action level is proposed.

Concentrations of 12 ppt hydrazine and 4.0 ppt UDMH in drinking water would result in a 10^{-6} risk of contracting cancer for lifetime exposures (USEPA 1984a; USEPA 1984b). A comparable value for MMH is unavailable. These values are less than analytical reporting limits for these compounds. Therefore, the action levels for hydrazine, MMH, and UDMH are set at their respective MDLs of 2.5 parts per billion (ppb), 20 ppb, and 25 ppb. Although no allowance is made for quantitative uncertainty near the reporting limits, it is anticipated that since NDMA is generally the compound most resistant to destruction, the remaining hydrazine compounds will be destroyed to concentrations well below reporting limits.

2.0 WASTEWATER TREATMENT ASSESSMENT

2.1 PURPOSE

Wastewater generated from operations at the HBSF are addressed as an interim response action under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). The purpose of this assessment is to identify the most favorable treatment alternative to be used in the interim response action. All candidate treatment technologies were identified. Those technologies which clearly could not meet the treatment objectives were eliminated from further consideration. The remaining treatment technologies were described in more detail. A second screening eliminated less favorable technologies, leading to identification of the final candidate technologies. These final technologies were then the subjects of a detailed analysis which focused on cost, ease of implementation, treatment effectiveness, permanence of remediation, and compliance with institutional factors, as well as on the results of treatability studies for certain technologies. Consistent with current regulatory policy, those technologies which destroy the contaminants or reduce the toxicity, mobility, or volume of the wastewater were given preference. Based on these analyses, a preferred system was recommended. Applicable or relevant and appropriate requirements (ARARs) will be addressed in the Decision Document for the HBSF.

2.2 TREATMENT OBJECTIVES

Past activities at the HBSF produced wastewaters from container rinsing and air scrubbing. The wastewater is stored in the 50,000-gallon tank (US-3), the 200,000-gallon tank (US-4), and the inground concrete tank. Approximately 270,000 gallons of wastewater are currently stored in these tanks (see Section 2.6). The concentrations of hydrazine and other contaminants measured in 1985 are listed in Tables 1-7 and 1-8 in the previous chapter. Various chlorinated compounds, including methylene chloride and chloroform, are also present in the wastewater from past practices of decontamination using chlorination. More wastewater would be generated from decontamination during the facility cleanup. In its current location in the storage tanks and inground concrete tank, the wastewater presents little hazard. Nonetheless, the wastewater cannot be stored indefinitely but rather must be treated and disposed. The primary concern with the wastewater is the impact hydrazine, MMH, UDMH, and NDMA may have on human health and the environment if released. Human carcinogenesis is one potential outcome of exposure to these substances. NDMA has the greatest toxicity and may be the most resistant to degradation, so it receives particular attention. UDMH is also a significant concern as it may be volatilized and oxidized to NDMA.

The overall treatment objective is to treat the wastewater such that the contaminants of concern will not endanger human health or the environment. Specifically, the hazardous compounds present must be destroyed to the action levels proposed in Section 1.6, for example 200 ppt NDMA, without producing equally hazardous end products, thus providing permanent cleanup. Rapid implementation as an interim response action is also required. Thus, processes which have been demonstrated as effective were favored while processes which require considerable development were eliminated. Cost is an important factor insofar as the lowest cost technologies which meet the treatment and implementation objectives were preferred.

2.3 CANDIDATE TREATMENT TECHNOLOGIES

As determined from technical papers, previous hydrazine wastewater treatment studies, a review of existing treatment processes, and personal communication with a number of research scientists, several candidate technologies are available to treat the wastewater at the HBSF (Table 2-1). These technologies are reviewed in the following section. The review was restricted to a discussion of major process reactions and operations and was only a means to identify options that clearly cannot meet the treatment and implementation requirements. If the process would not remove the hydrazine and related compounds efficiently or reliably without producing hazardous byproducts, or if much development would be required to evaluate treatment efficiency and

TABLE 2-1
CANDIDATE TREATMENT TECHNOLOGIES

- Biological Treatment
  - On-site biological treatment
  - Discharge to a Publicly Owned Treatment Works (POTW)
- Chemical Treatment
  - Chlorination and chlorination/ultraviolet light (UV)
  - Ozonation and ozone/UV
  - Permanganate
  - Hydrogen peroxide and hydrogen peroxide/UV
  - Reduction processes
- Physical Treatment
  - Activated carbon adsorption
  - Metal oxide adsorption/catalysis
  - Evaporation pond
  - Air stripping
  - Steam stripping
  - Spray irrigation
- Thermal Treatment
  - Off-site incineration
  - On-site incineration
    - North Plants incinerator
    - Other

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implement the process, the technology was eliminated from further consideration. Specifically, the technology or the reactions comprising the technology must have been demonstrated in the laboratory or in practice to be effective in destroying hydrazine, MMH, UDMH, and NDMA to detection limits so that major experimentation would be required to prove process feasibility. A technology was retained if it has not been demonstrated on the contaminants of concern but the underlying treatment principals indicate successful treatment is probable.

Technologies which generate hazardous byproducts in quantities requiring supplemental treatment were rejected. Those technologies which can attain the desired level of treatment and which can be rapidly implemented were analyzed in more detail.

2.3.1 On-site Biological Treatment

Biological treatment, such as activated sludge, trickling filters, and rotating biological contactors, has been successfully applied to a number of organic and industrial chemicals. Packaged treatment plants or existing RMA facilities could potentially be utilized to treat the wastewater. Kane and Williamson (1980) conducted batch bioassay studies on many of the hydrazine compounds of concern with several bacteria common in biological treatment plants. Their results are presented below:

EFFECTS OF HYDRAZINE, MMH, AND UDMH
ON BACTERIAL METABOLISM

	Concentration Causing 50 Percent Reduction in Metabolism (mg/l)		
Bacteria	Hydrazine	MMH	UDMH
Nitrobacter	15	15	1800
Nitrosomas	165	<1	35
Anaerobic bacteria	100	75	2300
Denitrifying bacteria	100	10	12,500

Since the HBSF wastewater contaminant concentrations (see Table 1-8) exceed most of the levels identified as reducing metabolic rates, undiluted wastewater would inhibit, if not destroy, bacterial activity. A combination of dilution and acclimation may result in successful biodegradation of the contaminants. Based on the Kane and Williamson results, a dilution of at least 100 to 1 may be required. Assuming biological treatment at 100 to 1 dilution is effective, a package or mobile treatment operation with a minimum capacity of 70,000 gallons per day and a source of dilution water would be required if on-site biological treatment is utilized and completed in one year. NDMA, however, does not appear amenable to biodegradation. Studies by Tate and Alexander (1975, 1976) indicated that NDMA incubated with numerous bacterial strains for 72 hours is not degraded and its destruction in sewage is 50 percent in 14 days. Thus, although biological degradation of the contaminants may be successful under the proper conditions, the treatment effectiveness, especially regarding NDMA, is uncertain at best. Therefore, on-site biological treatment as the primary treatment operation was eliminated from further consideration, although it could be utilized as a disposal option for treated wastewater.

2.3.2 Discharge to a Publicly Owned Treatment Works

Discharge to a POTW is merely biological treatment performed by an existing public facility. One improvement over on-site biological treatment is that the wastewater can be diluted to virtually any level. However, dilution is not generally accepted as a treatment option and it does not ensure that degradation will occur. In addition, regulatory complications associated with acceptance of the wastewater would arise. Therefore, this alternative was considered unacceptable as a complete treatment option.

2.3.3 Chlorination and Chlorination/UV

Chlorination of hydrazine compounds is a commonly suggested hydrazine detoxification and spill mitigation measure in which the compounds are oxidized. Chlorination can be effected using different forms of chlorine, specifically, chlorine gas, hypochlorous acid, hypochlorite, or chlorine dioxide. If oxidation proceeds to completion, the expected reaction products are hydrochloric acid, methanol, and nitrogen gas, all of which would require relatively minor treatment. In practice, however, oxidation is often incomplete and miscellaneous undesirable chlorinated compounds are produced.

Brubaker et al. (1985) reported that hydrazine was completely oxidized by chlorination. On the other hand, chlorination of MMH and UDMH was incomplete and produced chloroform, various hydrazines, several miscellaneous chlorinated compounds, as well as NDMA in the case of UDMH chlorination. Castegnaro et al. (1986) reported similar findings using sodium and calcium hypochlorite; part per million concentrations of NDMA and the related NMEA (N-nitrosomethylethylamine) were generated from UDMH and MMH solutions originally in the 1,000 ppm concentration range. NDMA may also be oxidized by chlorination, as has been demonstrated by Neumann and Jody (1986), who removed NDMA to below 20 ppt. Again, though, undesirable chlorinated organic compounds including chloroform were generated during the course of treatment. When a solution of hydrazine, MMH, and UDMH with concentrations in the 1,000 ppm range was first subjected to ozonolysis, then chlorination, chlorinated compounds in the part per million concentration range resulted. Chlorine dioxide used in drinking water and wastewater treatment produces substantially less chloroform and other trihalomethanes (THM) than other forms of chlorine (Lykins and Griese 1986). Reduced generation of chlorinated byproducts may hold for hydrazine related wastewater, but this has yet to be confirmed.

Although chlorination may destroy the hydrazine related compounds, the resulting chlorinated byproducts would be present in concentrations that would require additional treatment. Thus, chlorination alone would produce an unacceptable end-product and was eliminated as an alternative.

Ultraviolet light used in conjunction with chlorination may destroy the chlorinated side products. Fochtman and Koch (1979) found that chlorinolysis/UV treatment of hydrazine compounds produced undetectable concentrations of chloroform (less than 0.3 ppm), carbon tetrachloride (less than 0.3 ppm), and chlorinated amines (less than 0.1 ppm), while chlorinolysis without UV generated 1 ppm concentrations of these compounds. Prengle et al. (1976) demonstrated that UV exposure contributes significantly to the degradation of chlorinated compounds. In experiments with sequential ozone and UV exposure, the ultraviolet portion of the treatment successfully removed chlorine atoms from pentachlorophenol, chloroform, and other chlorinated compounds. UV treatment may in general complement chlorination to provide effective destruction of the contaminants of concern and byproducts. Therefore, chlorination/UV was considered further as a treatment alternative.

2.3.4 Ozonation and Ozone/UV

Ozonation is another oxidation process which can and has been utilized to treat aqueous hydrazine compounds. Ozone is a stronger oxidizing agent than the various chlorine compounds (Table 2-2) and the process is not constrained by the formation of chlorinated byproducts. There is formation of miscellaneous byproducts following ozonotion, and UDMH may be converted to tetramethyltetrazone (TMTZ) and NDMA. Continued ozonation converts TMTZ and NDMA to carbon dioxide, water, nitrogen, and nitrates, and may destroy other byproducts in the 1,000 ppm range. In one experiment, a solution of MMH and hydrazine with trace quantities of UDMH was oxidized with ozone. The hydrazine, MMH, and UDMH were destroyed to concentrations below detection limits of

TABLE 2-2

OXIDATION POTENTIAL OF OXIDANTS[1/]

Species	Oxidation Potential (volts)
Fluorine	3.03
Atomic oxygen (singlet)	2.42
Ozone	2.07
Hydrogen peroxide	1.78
Perhydroxyl radical	1.70
Permanganate	1.68
Chlorine dioxide	1.56
Hypochlorous acid	1.49
Hydroxyl radical	1.40
Chlorine (gas)	1.36

[1/] The oxidation potential of a compound is a relative measure of its ability to remove electrons from (oxidize) a second compound. Generally, the higher a compound's oxidation potential, the more likely it is to convert a second compound to simpler, common molecules.

Source: Hunsberger 1978.

5 ppm, 50 ppb, and 10 ppb, respectively, while the NDMA which was produced (approximately 150 ppm) was oxidized to less than 2.4 ppb in 20 hours (Neumann and Jody 1986). Because of its success in destroying hydrazine related compounds, ozonation was further investigated as a treatment alternative.

In conjunction with UV light, ozonation provides a very effective treatment system. Extensive research and pilot scale studies have been conducted on simulated hydrazine wastewater by IITRI (Neumann and Jody 1986). Hydrazine, UDMH, and MMH are rapidly oxidized with this system, and NDMA has been oxidized to below a detection limit of 16 ppt. In addition, miscellaneous byproducts of ozonolysis are readily destroyed by ultraviolet light. Gas chromatography/mass spectrometry (GC/MS) scans done on simulated hydrazine wastewater following ozone/UV treatment indicate that very few compounds at very low concentrations remain. Ozone/UV is currently used in conjunction with other treatment units at the Aerojet-General Corporation facility in Sacramento, California, for wastewater containing hydrazine and NDMA. Discharge limits for NDMA of 1 ppb (2 ppb daily maximum) and 10 ppm hydrazine (20 ppm daily maximum) are achieved by the facility (NPDES No. CA0004111). Thus, ozone/UV has been demonstrated as an effective treatment process for hydrazine and related compounds and was reviewed in more detail.

2.3.5 Permanganate

Other chemical oxidants are available and potentially applicable in treating the HBSF wastewater. Permanganate, a common, strong oxidizing agent (Table 2-2) has been examined for treatment of hydrazine compounds. Potassium permanganate added to an acidified solution of NDMA destroyed the NDMA, apparently without production of harmful end-products (Castegnaro et al. 1982). However, in a later study, permanganate and sulfuric acid added to solutions of hydrazine, MMH and UDMH destroyed much of the original compound but resulted in the formation of NDMA from MMH and UDMH. Continued reaction time resulted in some degradation of the NDMA from the MMH solution, but no significant degradation of NDMA in the UDMH solution (Castegnaro et al., 1986). It is not clear why the NDMA generated from the UDMH solution resisted further oxidation while NDMA produced from other solutions was degraded. It may be that more NDMA was formed from the UDMH than from the hydrazine and MMH and insufficient permanganate remained to oxidize the NDMA. Permanganate treatment may be capable of destroying the contaminants of concern, but this has not been confirmed. In addition, manganous oxide solid is produced as the permanganate is reduced and would require disposal. Preliminary estimates indicate that 2,700 kg of manganous oxide would be generated. The potential failure of permanganate in treating the wastewater and the requirement for disposal of a solid waste were judged to be constraints which dismiss this alternative as a feasible treatment method.

2.3.6 Hydrogen Peroxide and Hydrogen Peroxide/UV

Hydrogen peroxide is an oxidizing agent receiving increasing attention for treatment of various chlorinated compounds and other chemicals. Used alone, hydrogen peroxide destroyed NDMA with an efficiency of about 60 percent (Castegnaro and Walker 1976). However, combined ultraviolet light and hydrogen peroxide has a much greater destruction efficiency and rate than peroxide alone, as has been demonstrated by Sundstrom and Klei (1983) with trichloroethylene and dichloromethane. Hydrogen peroxide/UV successfully destroyed 100 ppm hydrazine in wastewater to below detection limits (Hager and Smith 1985). The mechanism of action of hydrogen peroxide/UV is suspected to be similar to ozone/UV, with ozone a somewhat stronger oxidizing agent than hydrogen peroxide. Therefore, the MMH, UDMH, and NDMA treatment capabilities of ozone/UV are likely to be closely approximated by hydrogen peroxide/UV. Because of the success in treating hydrazine and the likelihood of efficient oxidation of MMH, UDMH, and NDMA, the hydrogen peroxide/UV process was considered in more detail.

2.3.7 Reduction Processes

Miscellaneous reduction processes have been studied for converting hydrazine compounds and NDMA to their corresponding amines. Of these processes, reduction with nickel or aluminum-nickel based catalysts in an alkaline solution appears to be the most promising of the reduction processes. Lunn et al. (1983b) observed complete reduction of 11 nitrosamines including NDMA. Products included amines, ammonia, and alcohols, and hydrogen gas is released during the reaction. Lunn et al. (1983a) successfully reduced hydrazine, MMH, UDMH, and other hydrazine compounds to corresponding amines. The method is a one step process utilizing common reagents. Potassium hydroxide is first added to elevate the solution pH and is followed by addition of aluminum-nickel alloy powder to produce reducing conditions. However, the process has not been developed beyond the laboratory stage. Furthermore, reduction of NDMA and UDMH generates equal quantities of dimethylamine, which is listed as a hazardous waste under 40 CFR 261. Thus, subsequent treatment of a hazardous substance would be required if reduction procedures are utilized, so this method was eliminated from further consideration.

2.3.8 Activated Carbon Adsorption

Activated carbon adsorption is an effective treatment process for removing high molecular weight organic compounds. However, the chemical structures of the hydrazine related compounds are such that adsorption is unfavorable. Research conducted by IITRI (EPA 1979) indicates that NDMA is poorly adsorbed onto activated carbon. Activated carbon also was found to adsorb "very little" MMH or UDMH

(Fochtman and Koch 1979). Thus, this process was eliminated because of its ineffective waste treatment capability.

2.3.9 Metal Oxide Adsorption/Catalysis

Metal oxide adsorption is a potential treatment technology based on studies of the adsorption of hydrazine compounds to soils (Braun and Zirroli 1983; Hayes et al. 1982; Heck et al. 1963). In addition, the metal oxide surface may catalyze the destruction of the hydrazine related compounds. Studies by Hayes et al. (1982) and by Braun and Zirroli (1983) indicate that partitioning of hydrazine and MMH onto iron oxides and silicates is favorable. In the former study, it was shown that at pH 8, hydrazine adsorbs to iron oxide with greater than 99 percent efficiency and hydrazine and MMH exhibit the same high adsorption onto clay materials. Two complications arise, however, with the potential utilization of adsorption to treat the wastewater. First, adsorption of NDMA onto metal oxides has not been well studied and removal efficiency is uncertain. Second, although adsorption is accompanied by catalytic oxidation of the contaminants to a limited degree, adsorption onto metal oxides essentially transfers the hydrazine compounds to a different media (liquid to solid) rather than destroying them. Thus, metal oxide adsorption was eliminated from further consideration because it does not attain the treatment objective of reliably destroying the contaminants of concern.

2.3.10 Evaporation Pond

Evaporation of the wastewater after transfer to a shallow pond relies on natural degradation of the hydrazine compounds. The total annual evaporation rate at RMA exceeds 40 inches (net evaporation exceeds 28 inches), with most evaporation occurring from May through September (NOAA 1983). Exposure of hydrazine, MMH, and UDMH to air allows the oxidation of these compounds while sunlight provides ultraviolet photolysis of NDMA. The oxygen scavenging properties of the hydrazine compounds suggest that oxidation should be successful. Vapor-phase

NDMA is reported to have a half-life of 30 minutes in sunlight (Hanst et al. 1977). Residues which may remain may be disposed of as appropriate following chemical analysis. An evaporation pond may also be used in conjunction with other treatment processes. For example, it may be utilized as a disposal method following treatment by another technique. As a result, evaporation with natural oxidation and photolysis was retained for further consideration, either as the primary treatment system or as a follow-up process to other treatment.

2.3.11 Air Stripping or Steam Stripping

Air or steam stripping of the hydrazine compounds is another possible treatment method. Stripping operations rely on the preferential partitioning of one or more compounds of a mixture into a vapor phase relative to a liquid phase. The hydrazine and related compounds must partition preferentially into the vapor phase for successful stripping to occur. Based on vapor-liquid equilibrium diagrams (Wilson et al. 1955), hydrazine partitions strongly into water at low concentrations, implying that stripping would be unfavorable. Associated with the difficulty of stripping is the lack of destruction of the contaminants. Stripping, for the most part, transfers the contaminants from one medium (water) to a second (air). Thus, inefficient separation and lack of contaminant destruction eliminated stripping as an acceptable alternative.

2.3.12 Spray Irrigation

The HBSF wastewater may be treated by spray irrigation. This technique relies on several natural mechanisms to destroy the hydrazine related compounds. Adsorption and catalyzed oxidation by soils, oxidation by air, photolysis by sunlight, and perhaps biological degradation are contributing factors in the destruction. Results of soil surveys on the HBSF grounds indicate no contamination by hydrazine, MMH, and UDMH (Ebasco 1987), suggesting that spray irrigation would be effective. Despite the strong likelihood of success, the consequences if the method failed are undesirable. Potential groundwater contamination is the most significant consequence. Although contaminated groundwater could be treated, the goal of avoiding endangerment of the environment and human health would not be met. Therefore, spray irrigation was eliminated as an alternative.

2.3.13 Incineration

Incineration of the contaminated water is another available option, either in an on-site incinerator or at an off-site facility. The existing RMA North Plants incinerator is likely inadequate for assured destruction of the hydrazine compounds (Tillman 1986). The use of a mobile incinerator or construction of a new on-site incinerator would require test burns, and mobilization or construction time delays may occur. Thus, on-site incineration cannot meet the need for rapid implementation. Off-site incineration is a favorable treatment process. Two facilities were contacted (SCA, Chicago, Illinois, and Rollins, Deer Park, Texas) which have the capability, capacity, and availability to incinerate the wastewater and contaminants with essentially 100 percent efficiency. The high degree of destruction and the assurance of rapid implementation makes off-site incineration a promising alternative which was further investigated.

2.3.14 Summary of Initial Screening

Of the preliminary candidate technologies listed in Table 2-1, only six were judged to be capable of achieving the desired level of destruction of hydrazine, MMH, UDMH, and NDMA without generating hazardous byproducts, and could be implemented in a time frame of a few months (Table 2-3). These alternatives are chlorination/UV, ozonation, ozone/UV, hydrogen peroxide/UV, evaporation pond, and off-site incineration.

TABLE 2-3
SUMMARY OF INITIAL TECHNOLOGY SCREENING

Technology	Effective Destruction of Hydrazine-Related Compounds	Rapid and Simple Implementation	Nonhazardous Byproducts and End Products
On-site biological treatment	Uncertain	Yes	Uncertain
Discharge to a POTW	Uncertain	Yes	Uncertain
Chlorination	Yes	Yes	No
Chlorination/UV	Yes	Yes	Yes
Ozonation	Yes	Yes	Yes
Ozone/UV	Yes	Yes	Yes
Permanganate	Uncertain	No	Uncertain
Hydrogen peroxide	Uncertain	Yes	Uncertain
Hydrogen peroxide/UV	Highly probable	Yes	Yes
Reduction processes	Yes	No	No
Activated carbon adsorption	No	Yes	No
Metal oxide adsorption/catalysis	No	No	No
Evaporation pond	Highly probable	Yes	Likely; potential residues easily disposed
Air stripping or steam stripping	No	Yes	No
Spray irrigation	Uncertain	Yes	Uncertain
Incineration	Yes	Yes	Yes

2.4 SECONDARY SCREENING OF TECHNOLOGIES

The six technologies identified in the previous section which meet the treatment and implementation time requirements are reviewed in this section to determine the final candidate technologies. The technologies are first described according to their major components and ancillary operations, and various pertinent aspects of the treatment are discussed. A discussion follows in which the technologies which consist of similar operations are compared for treatment effectiveness, as indicated by reaction rate and destruction of byproducts. Those technologies found to be inferior to similar processes were eliminated. Technologies which are distinctly different or which have similar treatment effectiveness were retained. The remaining technologies are later reviewed in detail to provide a basis for recommending a preferred alternative.

2.4.1 Descriptions of Technologies

Six technologies, chlorination/UV, ozonation, ozone/UV, hydrogen peroxide/UV, evaporation pond, and off-site incineration, could effect the desired destruction of the hydrazine compounds in a time frame of a few months. These technologies are described below in more detail in order to compare the processes. The major and ancillary components and a brief description of the system operation are presented for each technology. For technologies in which a treated water product results, there are a number of disposal options available, including discharge to a waterway, a sanitary waste treatment plant, or an evaporation pond. The specific disposal method was not determined at this stage; rather, the need for disposal or lack thereof is mentioned. Each technology was then evaluated according to treatment capabilities and side reactions, subsequent treatment requirements, the need for treatability studies, potential hazards, MOA requirements, and ease of implementation.

2.4.1.1 Chlorination/UV

The chlorination/UV treatment option would consist of a recirculating or batch wastewater system incorporating chlorine contact followed by ultraviolet light exposure. The wastewater could be treated by contacting and recirculating the water using the existing piping and tanks, or a mobile treatment system operating in a batch mode could be utilized. If the recirculating system was used, a chlorine contact chamber and a UV light chamber could be installed on existing piping or could require new piping. A pH-monitoring and control system would be necessary and a sulfite system could be required to eliminate residual chlorine prior to discharge to a waterway, although chlorine would dissipate if the water was retained. Gas vents and possibly scrubbing units would be necessary for release of reaction gases. Treatment would be continued until an acceptable product was generated, after which the treated wastewater would be discharged. Use of a mobile treatment system would involve the same process operations as would the recirculating system, but could also be operated in a batch mode with intermittent discharge.

As has been discussed, chlorination can destroy NDMA to 20 ppt and is effective in destroying hydrazine, MMH, and UDMH. However, miscellaneous chlorinated byproducts such as chloroform and methylene chloride could be produced and require subsequent treatment. UV light exposure aids in the destruction of the contaminants and byproducts, but additional treatment of the chlorinated byproducts could still be required. Treatability studies would be required to determine the identity of the chlorinated byproducts and the effect of UV exposure on degradation. MOA approval would be required if discharge of the treated water to a sanitary treatment facility or waterway occurs, as would be the case with all water discharge during hazardous waste cleanup operations. There would be no significant hazards associated with implementing this system, as the reaction would be contained, the reactants would be easily handled, and contaminant releases would be unlikely. Implementation of chlorination/UV would require installation of a chlorine dispensing system and a UV contact chamber along with the associated monitoring equipment and piping and possibly a sulfite dispensing unit. A moderate amount of effort and time would be required to install the equipment assuming personal protection is required. Alternatively, the use of a mobile treatment unit only would require hookup to the existing piping or tanks.

2.4.1.2 Ozonation

The ozonation option would consist of on-site generation of ozone and its introduction either into a recirculating flow of the wastewater through existing piping or directly into the tanks and sump. It would also be possible to treat the wastewater internally within a mobile treatment system. Venting, scrubbing, and possibly recycling of off-gases would be necessary to release reaction products and recover oxygen. A pH monitoring and control system could be necessary. Treatment would be continued until the wastewater meets concentration requirements, after which the water would be discharged.

Ozonation is a very effective means of oxidizing hydrazine, MMH, and UDMH to primarily nitrogen, water, carbon dioxide, and some nitrate. Oxidation of UDMH also produces NDMA which can eventually be destroyed by continued ozonation. Most of the miscellaneous side-products produced during the reactions are also oxidized in time to innocuous end-products. Prengle et al. (1976) demonstrated that ozonation aids in the destruction of chloroform and other chlorinated compounds, so such compounds present in the wastewater would also be destroyed to some extent. The treated water could be discharged either to a waterway or sanitary treatment plant assuming MOA approval or to an evaporation pond. Only minor treatability studies would be required to determine the effectiveness of ozonation on the actual wastewater as ozonation has already been tested on simulated hydrazine wastewaters. If ozonation were to be found in practice to not produce the desired level of treatment, a supplementary or alternate system could be easily installed and no adverse environmental impacts would result. Hazards associated with ozone would be avoidable with proper generation, dispensing, and degeneration of unreacted ozone. Installation complexity and time requirements would be minor because of the utilization of existing tanks and piping and the simplicity of the operation. A mobile treatment system would be even simpler and require less time to implement.

2.4.1.3 Ozone/UV

This technology is virtually identical to the ozonation alternative except for the addition of an ultraviolet light contact chamber. The operation would be comprised of recirculating water with initial ozone contact, pH control, and venting of off-gases. UV light exposure would follow the ozonation and could take place in the same chamber. Recirculation of water and treatment would continue until the desired destruction of contamination was achieved, after which the treated water would be discharged. Again, mobile treatment systems would be available for these same operations.

The treatment efficiency of this system would be improved over ozonation alone. The UV light would assure rapid and complete destruction of NDMA and side-products of the oxidation reactions. Furthermore, combined ozone/UV exposure would be effective in oxidizing chlorinated compounds. No subsequent treatment would be required, and the treated water could be discharged following MOA approval or could be evaporated in a pond. Possible, though unlikely, failure of the system would produce no hazardous releases. Fugitive ozone releases could be a concern, but would be avoidable with proper equipment connections and degeneration of unreacted ozone. Treatability studies would be necessary to verify the treatment effectiveness with actual wastewater, especially for chlorinated compounds. Installation time requirements would be minor, as the equipment would be simple and existing tanks and piping would be utilized or a mobile treatment facility brought on-site.

2.4.1.4 Hydrogen Peroxide/UV

This option is similar to the ozone/UV process, except that hydrogen peroxide solution would be substituted for gaseous ozone. About 1,000 to 2,000 gallons of 30 percent hydrogen peroxide solution would be added to the entire volume of wastewater. A single chamber would be used for the UV exposure and addition and mixing of hydrogen peroxide. This chamber and the necessary reaction monitoring equipment could be hooked up to existing piping and used to treat the wastewater in a recirculation mode. Treatment equipment could be brought on-site as a mobile unit and the wastewater treated in a batch mode. The wastewater would be treated until the action levels were attained, after which the water would be discharged or evaporated in a pond.

The treatment effectiveness of this method is believed to be similar to ozone/UV, although the oxidation potential of hydrogen peroxide is slightly less than that of ozone. The hydroxyl radicals formed from the hydrogen peroxide/UV would oxidize the contaminants, and continuation of the treatment would likely destroy byproducts and chlorinated compounds. It is expected that the treated water would require no additional treatment. MOA approval would be necessary if the water was to be discharged to a sanitary treatment plant. The hazards associated with this alternative would be very low because the wastewater treatment would be conducted within the equipment. Accidental releases would be unlikely and the hydrogen peroxide and UV light present little hazard. Treatability studies would be necessary to verify the treatment effectiveness of hydrogen peroxide/UV on MMH, UDMH, and NDMA, as well as other contaminants. Implementation of this process would involve either the installation of the UV contact equipment, hydrogen peroxide dispensing system, and the necessary monitoring devices to existing piping or the use of a mobile treatment system. In the former case, time requirements would be modest while in the latter, minimal set-up would be required.

2.4.1.5 Evaporation Pond

In this alternative, a lined pond would be constructed according to RCRA guidelines and the HBSF wastewater pumped into it. Alternatively, existing containment structures at the HBSF could be modified to create a pond. Access control devices such as fencing, netting, or air guns to frighten birds could be necessary. A pump would be initially available to return the water to the existing tanks to avoid accidental overflowing should adverse meteorological conditions warrant. Natural degradation processes would destroy the hydrazine compounds while the water evaporated. Air monitoring devices could be placed around the pond to measure fugitive contaminant releases. Treatment would continue until all the water evaporated, after which residues would be disposed with the liner as hazardous waste.

Although the treatment level is not easily quantifiable using this method, it is believed that virtually complete destruction of the hydrazine related compounds and chlorinated compounds could be assured. The exposure of the wastewater to air should provide sufficient oxidation. Releases of the compounds into the atmosphere would actually facilitate destruction by increasing the contact with oxygen and the ultraviolet fraction of sunlight. Potential fugitive emissions could be monitored and if found to be excessive, the water could be returned to the tanks. Since no water discharges occur, there would be no associated impacts.

Implementation of this treatment option would involve the excavation of a shallow pond, placement of an impermeable liner and fencing, pumping of the wastewater, and possibly air monitoring. One possible advantage of the evaporation pond would be that much of the operation could be conducted outside of the restricted HBSF area, so personal protection requirements could be reduced. On the other hand, it could be more desirable to construct the pond within the HBSF boundaries in order to contain potential contaminants within this area or use existing bermed areas surrounding the fuel tanks. Existing containment structures would have to be inspected and sealed prior to use.

2.4.1.6 Off-Site Incineration

Off-site incineration would be a means to quickly and reliably destroy all contaminants present. Wastewater would be pumped into tanker trucks which transport the contaminated water to a RCRA approved incineration facility. Tanker trucks with 3,000 to 5,000 gallon capacities would transport the wastewater to the Rollins incinerator in Deer Park, Texas, or the SCA facility in Chicago, Illinois. Approximately 50 to 80 loads would be required to transport the 285,000 gallons. Incineration would be conducted after a test burn and could be completed within 60 days.

Essentially 100 percent destruction of all possible contaminants would be guaranteed with incineration. Health hazards due to the handling and transport of the wastewater would be low if there was a spill or a motor vehicle accident. Less than one truck accident would occur based on statistics of truck accident frequency (WUTC 1987). Otherwise, the risk of exposure would be eliminated. A test burn and chemical analysis of the wastewater would be required. If the incineration was not sufficiently complete, which would be highly unlikely, burn conditions would have to be modified or an alternate treatment utilized, which could involve additional transport of the water. No monitoring of discharges would be required beyond that required by the incineration facility. Implementation of the process would involve pumping wastewater into tanker trucks and transport to the incinerator locations.

2.4.2 Discussion and Secondary Screening of Technologies

The six technologies described in the preceding section would all be capable of destroying the hydrazine compounds to the defined action levels (Section 1.5). In some cases, undesirable intermediates would be generated but these substances could be treated as well. Despite the capacity of each technology to produce an acceptable product, some technologies would be more advantageous than others from a standpoint of overall treatment efficiency.

Ozonation combined with UV differs from ozonation alone only with the addition of a UV contact chamber or UV lamps placed in the main reaction vessel, yet provides enhanced treatment. The UV light accelerates NDMA destruction, which is the treatment rate limiting step, and facilitates the destruction of reaction byproducts (Neumann and Jody 1986). Thus ozonation was excluded in favor of ozone/UV.

Combined chlorination and UV is also a reliable method, yet it would have complications which are not inherent in the ozone/UV process. An example is the generation of undesirable chlorinated compounds which does not occur with ozone/UV. The amount of generated chlorinated compounds might be small in comparison to the quantities already present as a result of past chlorination activities. Nonetheless, while chlorination would contribute undesirable chlorinated compounds, ozonation would destroy them. UV light would destroy some of these chlorinated byproducts, but the time required to do so could be extensive. Additionally, a sulfite contact dechlorination system or extended time for residual chlorine dissipation could be required but is unnecessary with ozone/UV. Thus, ozone/UV was preferred over chlorination/UV because it does not require extended treatment to destroy compounds generated during the initial reaction.

Hydrogen peroxide/UV would have similar advantages to ozone/UV in the oxidation of hydrazine, although it has yet to be demonstrated as effective on MMH, UDMH, and NDMA. Since the reaction mechanisms of hydrogen peroxide and ozone are probably similar, hydrogen peroxide/UV would be nearly as effective as ozone/UV. In addition, hydrogen peroxide is generally easier to handle than ozone, and has fewer potential safety complications. Therefore, hydrogen peroxide/UV was studied in more detail as a treatment method.

The evaporation pond would have the advantages of simplicity, speed, and safety in its implementation. There would be no concern in this alternative with discharge of treated water. Some residual hazardous waste may be generated which could be disposed of with the pond liner and demolition debris. Therefore, this alternative was retained for detailed evaluation.

Off-site incineration would be another promising cleanup method. It would offer ease and rapidity of implementation, would require no monitoring of releases beyond that required of the incineration facility, and would assure destruction. There would be only minor hazards associated with handling and transport. Because of its favorable treatment effectiveness, off-site incineration was also evaluated in detail.

A summary of the secondary screening of the treatment technologies is presented in Table 2-4.

2.5 FINAL CANDIDATE TECHNOLOGIES

Of the original candidate technologies, six could provide adequate destruction of hydrazine, MMH, UDMH, and NDMA and be implemented in a few months time. Of these six, four were judged to be superior because of simplicity, treatment efficiency without the need for subsequent treatment, rapid implementation, and permanence of cleanup. The four final candidate technologies are:

- Ozone/UV,
- Hydrogen peroxide/UV,
- Evaporation pond, and
- Off-site incineration.

The first two of these technologies would require treatability studies to verify treatment effectiveness with the actual wastewater, and to identify key design parameters. These studies were conducted and the results are discussed in the succeeding section. The four technologies were then assessed in more detail and their relative merits compared.

TABLE 2-4

SUMMARY OF SECONDARY TECHNOLOGY SCREENING

Technology	Criteria Treatment Efficiency
Chlorination/UV	Chlorinated intermediates formed which may not be rapidly or completely destroyed.
Ozonation	Destruction of hydrazine-related compounds assured but destruction of intermediates may be slow or incomplete.
Ozone/UV	Destruction of hydrazine compounds and intermediates assured; process is simple.
Hydrogen peroxide/UV	Destruction of hydrazine compounds and intermediates highly probable; ease of implementation improved over ozone/UV.
Evaporation pond	Destruction of hydrazine-related compounds highly probable; process is easily implemented; potential hazardous residues easily disposed.
Off-Site incineration	Assured destruction of all contaminants and rapid implementation.

2.6 CHEMICAL ANALYSIS AND TREATABILITY STUDIES

2.6.1 Chemical Analysis of the Wastewater

The wastewater at the HBSF was previously analyzed in June 1985. The results were presented in Section 1.4.5 and Tables 1-7 and 1-8. Natural processes may have altered the chemical composition since that time. In addition, wastewater has been withdrawn from the inground concrete tank and one of the eastern tanks and used for rinsing the horizontal tanks. Some of this water has been returned to the eastern tanks and the remainder may be added at a future date (James 1986; James 1987).

Samples were taken from tanks US-3, US-4, and the inground concrete tank during February 1987 to obtain a current chemical analysis. Samples were taken at four depths from US-3 and US-4 (6 inches below the surface, one-third depth, two-thirds depth, and bottom). These samples were analyzed for hydrazine (HZ), MMH, and UDMH to determine if the wastewater in these tanks is stratified or homogeneous. Composite samples from these tanks were analyzed for NDMA and a suite of chlorinated hydrocarbons including chloroform, methylene chloride, and ten other compounds. A single sample from the inground concrete tank was analyzed for the hydrazine compounds, NDMA, and the chlorinated compounds.

Hydrazine compounds were analyzed by gas chromatography (GC) using a flame ionization detector following derivitization with acetone; detection limits were 5 ppm for each of the hydrazine compounds. NDMA analyses were conducted using GC with a nitrogen/phosphorus detector. Samples containing more than 1 ppm NDMA were analyzed directly; extraction and concentration methods were used for samples containing less than 1 ppm, providing a detection limit of 16 ppt. Chlorinated compounds were analyzed using the purge and trap GC method (EPA Method 601) (EPA 1985b). Detection limits vary but are typically about 1 ppb.

The results of the analyses are presented in Table 2-5. The concentrations of the hydrazine compounds are fairly constant with depth, indicating that the wastewater in the vertical tanks is not stratified. The values do not show any significant trends and differences may be a result of handling, sampling, and analytical variation. Thus, the contents of the tanks are considered to be homogenous. No hydrazine compounds were detected in the inground concrete tank.

NDMA was detected in all three tanks: in US-3, its concentration was 360 ppb; in US-4, 64 ppb; and in the inground concrete tank, 2.9 ppb. Chlorinated compounds, especially methylene chloride and chloroform were detected in several samples. In US-3, methylene chloride was detected at 22 ppm, chloroform was not detected, and 1.98 ppb of 1,1-dichloroethane was detected. In US-4, methylene chloride was measured at 33 ppm, chloroform at 15 ppm, and 1,1-dichloroethylene at 5.0 ppb. The inground concrete tank contained 60 to 200 ppb methylene chloride and 130 ppb chloroform. The presence of the chlorinated compounds is probably a result of the historical use of calcium hypochlorite at the site and the 1986/1987 rinsing of the tanks with hypochlorite solution.

Water from rinsing the hydrazine storage tanks was returned to the eastern tanks, which accounts in part for the difference between the latest and previous analyses (see Section 1.4.5 and Tables 1-7 and 1-8). Water used to rinse tank US-2 with hypochlorite solution was analyzed to verify that hydrazine destruction was complete. Some of this water was transferred to tank US-1 for rinsing and additional hypochlorite solution was added. Chemical analyses were again conducted. The results of these analyses, conducted by the RMA Laboratory, are listed below.

TABLE 2-5

CHEMICAL ANALYSIS OF THE WASTEWATER AT THE HBSF

		Compound and Units							
Tank	Sample	HZ (ppm)	MMH (ppm)	UDMH (ppm)	NDMA (ppb)	Methylene Chloride (ppm)	Chloroform (ppm)	1,1-Dichloroethane (ppb)	1,1-Dichloroethylene (ppb)
US-3	Near surface	38	74	330					
(50,000 gallon)	One-third depth	40	81	352					
	Two-thirds depth	42	80	352					
	Tank bottom	44	74	350					
	Composite*				360	22	<0.0005	1.98	<0.73
US-4	Near surface	1,200	84	1,400					
(200,000 gallon)	One-third depth	1,500	104	1,600					
	Two-thirds depth	1,200	87	1,300					
	Tank bottom	950	94	930					
	Composite*				64	33	15	<1.7	5.0
Inground Concrete Tank	One-half* depth	<5	<5	<5	2.9	0.06-0.20	0.013	<1.7	<0.73

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* These samples were analyzed for eight other chlorinated compounds, none of which was detected. The compounds and the indicated method detection limits are: 1,2-dichlorethane (0.76 ppb), 1,2-dichloroethylene (1.1 ppb), 1,1,1-trichloroethane (0.76 ppb), carbon tetrachloride (0.99 ppb), trichloroethylene (0.56 ppb), 1,1,2-trichloroethane (0.78 ppb), tetrachloroethylene (0.75 ppb), and chlorobenzene (0.82 ppb).

Compound	US-1	US-2
Hydrazine	<0.02 ppm	<0.02 ppm
UDMH	<0.07 ppm	<0.07 ppm
NDMA	1.98 ppb	13 ppb
Chlorine residual	0.14 percent	-
Sodium hypochlorite	-	0.025 ppm

The rinse water will be transferred to the eastern tanks. If there is insufficient capacity in the eastern tanks, the remaining water will be retained in US-1 and US-2 (James 1987).

2.6.2 Treatability Studies

Results of laboratory studies, actual field applications, and literature data are available which suggest the final candidate technologies should be effective in treating the wastewater at the HBSF. The proposed technology could be successfully applied without further study in some cases. For example, incineration technologies are well established and under the correct operating conditions the contaminated water could be burned and virtually complete destruction assured. The hydrogen peroxide/UV technology, however, has been applied in experimental settings and has not been used to treat actual wastewater containing hydrazines and NDMA. Ozone/UV has been used in conjunction with other treatment units at Aerojet-General, but has not been used alone in field applications. Although the laboratory results are promising, unknown constituents in the wastewater could interfere with the treatment. Treatability studies were conducted using these latter two technologies to more fully evaluate their effectiveness.

IITRI conducted the ozone/UV and hydrogen peroxide/UV technology treatability studies. Wastewater samples from tank US-4 were used in the studies because of the high concentrations of hydrazine compounds in the tank (which may be converted to NDMA). Descriptions of the experimental apparatus and reaction conditions are given in the following Sections (Sections 2.6.2.1 - 2.6.2.5), then the results are presented and discussed (Section 2.6.2.6).

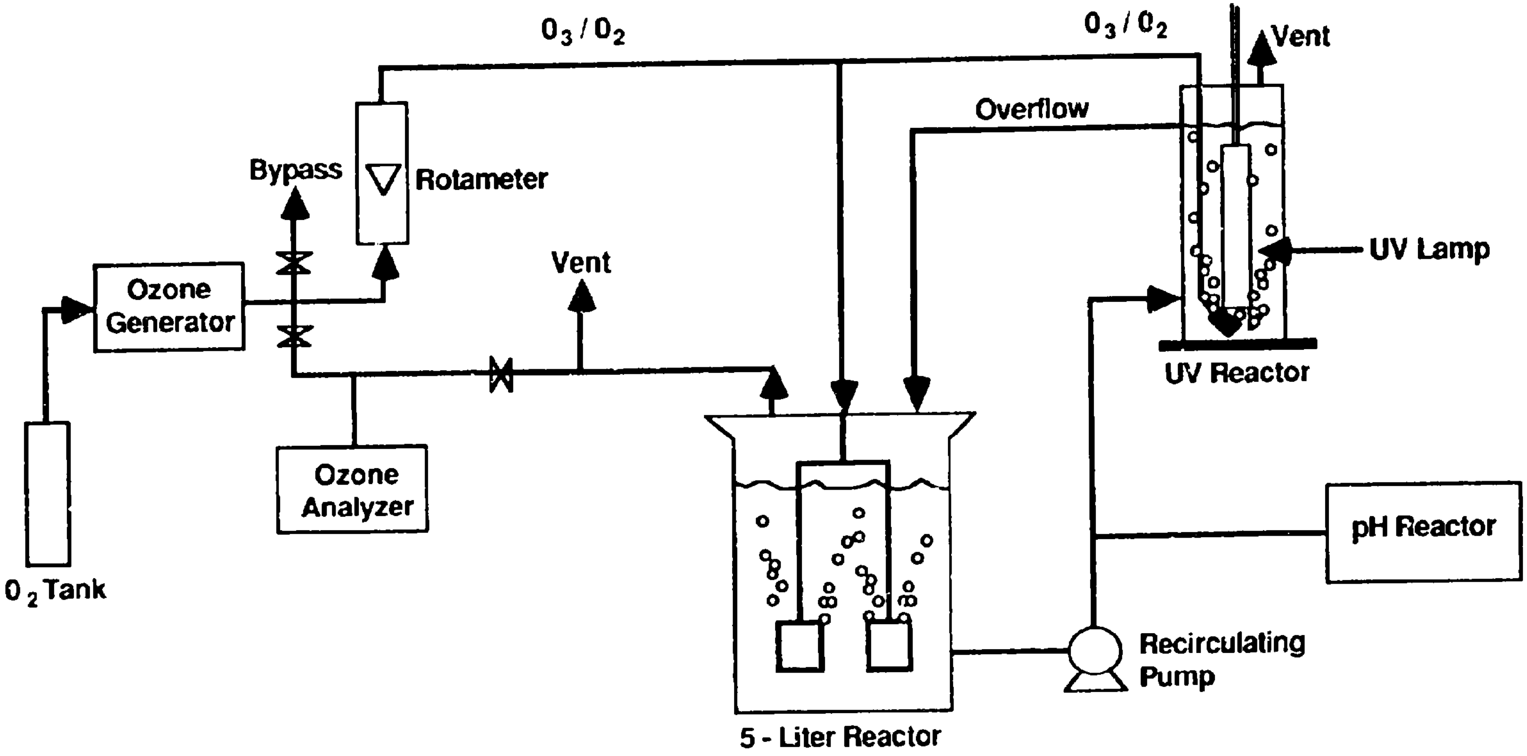
2.6.2.1 Apparatus and Procedures

IITRI has extensive experience using ozone/UV treatment to destroy hydrazine compounds. Previous studies have shown that hydrazine compounds can be destroyed below detection limits of 5 ppm in less than 240 minutes when initial concentrations in simulated wastewater samples were between 1,000 and 10,000 ppm. NDMA was reduced from between 100 and 1,000 ppm to 1 ppm after about 3,000 minutes of reaction and was less than 16 ppt after 4,200 minutes.

The flow of the experimental apparatus is depicted in Figure 2-1. A 1.5-liter glass reactor houses a low pressure UV lamp enclosed in a quartz glass sleeve. The UV lamp has an output of 1.9 watts (W), 86 percent of which is at 254 nanometers. Oxygen is supplied to a Welsbach T-23 ozonator which produces an ozone concentration of 3 weight percent ozone. The ozone/oxygen stream is bubbled into the reactor at the base through a fritted glass fitting. Water is recirculated between the 1.5-liter reactor and a 5-liter reactor into which ozone is also bubbled. Samples are drawn from a sampling port.

The hydrogen peroxide/UV experiments were conducted using the same apparatus. Modifications included the replacement of the oxygen supply and ozonator with a feed system for 30 percent hydrogen peroxide and a pH control system using sodium hydroxide.

The analytical methods used for the NDMA, hydrazine compounds, and the chlorinated compounds were the same as described in Section 2.6.1.



Prepared for:

Program Manager's Office For
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

Figure 2-1.
SCHEMATIC DIAGRAM OF OZONE / UV REACTOR SYSTEM

ROCKY MOUNTAIN ARSENAL, TASK 34
Prepared by EBASCO Services, Incorporated

2.6.2.2 Treatability Study No. 1

In the first treatability study, 6 liters of wastewater from tank US-4 were filtered to remove the orange and black precipitate found in the bottom of the sample bottles. The wastewater was then added to the reaction vessel and ozone/UV supplied as described in Section 2.6.2.1. Prior to the reaction, the sample was slightly yellow and cloudy. As the reaction progressed, the yellow color diminished, then a deeper amber color developed. The amber color was believed to be due to the precipitation of ferric hydroxide. The reaction was continued for 3,025 minutes. The results of the experiment are presented below.

	Concentration of Compound (ppm)						
Time (min)	HZ	MMH	UDMH	NDMA	CF	MC	pH
0	≈1,200	≈90	≈1,300	0.064	0.8	1.6	9.2
400	<5	<5	<5	250	*	*	
450	*	*	*	310	1.1	"small"	7.4
1,422	*	*	*	0.026	*	*	3.5
1,890	*	*	*	0.0039	*	*	2.3
3,025	*	*	*	0.0014	1.0	ND	2.6

CF - Chloroform
MC - Methylene chloride
HZ - Hydrazine

*Not Analyzed
ND - No data

The data indicate that hydrazine destruction was very rapid. The NDMA concentration, which increased to 310 ppm as the hydrazine compounds were oxidized, dropped to a concentration of 1.4 ppb after 3,025 minutes of reaction. Methylene chloride was destroyed to below the detection limit, but chloroform remained. The pH dropped over the course of the reaction due to the addition of ozone. A final concentration of chloride was found to be 450 ppm. A gas chromatogram of the final sample indicated the presence of other unidentified compounds. An initial concentration of 8 ppm iron was detected which increased to 32 ppm by the end of the experiment. The source of additional iron was believed to be stainless steel fittings within the reactor.

The destruction of the contaminants was less efficient than had been observed using simulated wastewater samples. The presence of the iron precipitate may have hindered the destruction of NDMA. A coating of this precipitate was found on the quartz sleeve. Nevertheless, the NDMA concentration was reduced to 0.0014 ppm, roughly seven times greater than the proposed action level. Presumably, the proposed action level of 0.20 ppb could be attained with longer treatment.

2.6.2.3 Treatability Study No. 2

The second treatability study was conducted using hydrogen peroxide/UV. A wastewater sample from tank US-4 was again used for this experiment and was filtered as in the first experiment. Hydrogen peroxide was added to produce a concentration of 1.4 weight percent. Hydrogen peroxide was periodically added during the course of the reactor to maintain this concentration. After 2,000 minutes of reaction, hydrogen peroxide was no longer added. The pH was maintained between 9.5 and 10.0, based on other studies which showed that hydrazine destruction improved at higher pH. As the reaction commenced, the reaction vessel became dense with bubbles, perhaps from the disassociation of the hydrogen peroxide into water and oxygen. No discoloration or precipitation of iron compounds was observed throughout the reaction. A total of 980 milliliters (ml) of 30 percent hydrogen peroxide was added. The results of the chemical analyses are presented below:

	Concentration of Compound (ppm)					
Time (minutes)	HZ	MMH	UDMH	NDMA	CF	MC
0	1,144	145	1,1[illegible]	0.064	1.2	2.8
22	913	215	817	*	*	*
80	526	240	482	*	*	*
190	402	272	134	197	*	*
555	20	6	14	134	*	*
1,174	*	*	*	64	*	*
1,431	*	*	*	59	*	*
1,581	*	*	*	53	*	*
2,832	*	*	*	0.013	*	*
4,655	*	*	*	0.002	0.7	1.6

HZ - Hydrazine
CF - Chloroform
MC - Methylene chloride

* - Not analyzed

The destruction of the hydrazine compounds was slightly slower than with the ozone/UV process (greater than 555 minutes to reach nondetectable levels compared to approximately 400 minutes using the ozone/UV process). The destruction of the NDMA also proceeded more slowly; comparable concentrations of NDMA were reached after 4,655 minutes of reaction using hydrogen peroxide/UV compared to 3,025 minutes using ozone/UV, a difference of about 1,600 minutes. The gas chromatogram of the final sample showed more and larger peaks than did the chromatogram from the ozone/UV runs, indicating that the overall treatment was less complete with hydrogen peroxide/UV.

2.6.2.4 Treatability Study No. 3

The third treatability study was a variation of the first in that the same water sample was tested using ozone/UV treatment. The major difference was that iron present as precipitate and in solution was removed and stainless steel fittings were replaced to prevent possible interference with the treatment due to reduction in the penetration of UV light and consumption of ozone by the iron. After the original sample was filtered, 2 ppm of iron remained. Sodium sulfide was added to a concentration of about 10 ppm to precipitate the remaining iron. The residual iron concentration was less than 1 ppm following a second filtration step.

The experiment was then continued as in the first study. A slight yellowish color diminished after 300 minutes of reaction and the solution remained colorless thereafter. The results of this experiment are presented below.

	Concentration of Compound (ppm)				
Time (minutes)	HZ	MMH	UDMH	NDMA	pH
0	1,188	110	1070	*	*
44	902	120	777	*	*
120	643	126	563	*	*
216	303	61	213	*	*
314	18	<5	<5	441	*
356	<5	*	*	386	*
407	*	*	*	364	*
464	*	*	*	351	*
532	*	*	*	268	*
600	*	*	*	189	*
685	*	*	*	111	5.0
NR	*	*	*	[illegible]	3.1
1,808	*	[illegible]	[illegible]	0.007	2.8
2,807	*	[illegible]	*	0.0007	2.5
4,300	*	*	*	0.0008	2.5

HZ - Hydrazine

NR - Not reported

* - Not Analyzed

The destruction of the hydrazine compounds occurred in times comparable to those in the first study. NDMA destruction was only slightly increased after about 2,800 minutes. Final concentrations were 0.7 to 0.8 ppb, somewhat above the proposed action level of 0.20 ppb. The destruction of the NDMA apparently was not greatly influenced by presence or absence of low concentrations of iron over the range of contaminant concentrations present.

2.6.2.5 Treatability Study No. 4

The same baseline water sample from tank US-4 and ozone/UV treatment were used for the fourth and final treatability study. A more powerful UV lamp was used based on discussions with vendors of photo-oxidation systems. The original lamp, which had an input power of about 5W, was replaced with a lamp with a 40W input and approximately 14W output. A second major change was the acidification of the water sample prior to treatment. Evidence from other studies suggested that NDMA destruction might be more rapid at lower pH, although hydrazine destruction is less rapid. The pH of the water samples was lowered to 2.5 by the addition of 42 ml of 28 percent HCl to 7.75 liters of sample. The water was then treated with the higher-power lamp and a flow rate of 1.5 standard liters per minute of 3 weight percent ozone in oxygen. After about 2,000 minutes of treatment, the 40W UV lamp burned out and was replaced with a lamp with a 4W output. The results of this experiment are presented below.

	Concentration of Compound (ppm)				
Time (minutes)	HZ	MMH	UDMH	NDMA	pH
0	960	135	1,067	*	2.5
113	680	87	838	*	1.9
254	450	81	500	*	1.5
401	165	53	537	<1.0	1.2
1,533	<10	<10	<10	<1.0	1.2

Time (minutes)	Concentration of Compound (ppm) HZ	MMH	UDMH	NDMA	pH
1,850	*	*	*	0.0003	1.2
3,289	*	*	*	0.0004	1.2
5,000	*	*	*	0.0002	1.2

HZ - Hydrazine
* - Not Analyzed

Although the destruction of the hydrazine compounds was slower than in previous studies, the destruction of the NDMA was significantly increased. The proposed action level of 0.20 ppb was achieved due to the combination of the high-power lamp and the low initial pH.

It is possible that the low initial pH prevented the formation of NDMA from the hydrazine compounds and that the higher UV dose destroyed the NDMA present more rapidly. The NDMA levels in the fourth and fifth samples could not be determined because of interference caused by other compounds, indicating that the NDMA concentrations were less than 1 ppm. Nonetheless, the study indicated that the action level could be attained in just over one day of elapsed time under the proper conditions. Higher intensity UV lamps could decrease the required time significantly.

Chemical analyses were conducted on the initial and final samples from the fourth treatability study. Semivolatile and volatile compounds from the Hazardous Substance List (USEPA 1984c) were analyzed by Data Chem using GC/MS. The concentrations or estimated concentrations of detected compounds are presented below.

Compound	Concentration in Untreated Sample (ppm)	Concentration in Treated Sample (ppm)
Chloromethane	0.17	0.0099
Methylene chloride	1.0	0.019
Acetone	<0.05	0.39
1,1-Dichloroethane	0.021	<0.005
Chloroform	0.93	<0.005
Dimethylhydrazone formaldehyde	0.068	<0.005
Dimethyl disulfide	0.54	<0.005
Unknown possible ketone	0.068	<0.005
Unknown disulfide	0.054	<0.005
Isophorone	0.0021	0.0017
Unknown alkylated cyclic compound	0.0081	0.011

These results indicate that other compounds present in the water can be effectively destroyed by ozone/UV treatment to levels below reporting limits as would be done during actual system operation. One exception is the increase in the concentration of acetone, which may be an oxidation product of the hydrazine compounds. The concentration of acetone is, however, an order of magnitude below water quality levels associated with any toxicological effects.

2.6.2.6 Discussion of Results

The primary purpose of the treatability studies was to demonstrate the effectiveness of hydrogen peroxide/UV and ozone/UV technologies on samples of the wastewater. The experiments showed that the hydrazine compounds are destroyed to below 5 to 10 ppm and the destruction of the

NDMA limits the overall treatment rate. The first three studies were conducted on the same water sample using similar reaction conditions, although hydrogen peroxide was used as the oxidant in one study and ozone in the others. Similar treatment performance was observed. Hydrogen peroxide did not provide treatment as rapidly and completely as ozone, but the use of high pH conditions during the peroxide run may have reduced the treatment rate and increased the formation of NDMA. Furthermore, the high pH may have contributed to the decomposition of the hydrogen peroxide. Hydrogen peroxide may be as effective as ozone in oxidizing the contaminants under the appropriate pH and higher wattage UV lamp conditions.

The fourth treatability study demonstrated that pH and UV intensity are important factors in the destruction of the contaminants. The reaction time to achieve the desired concentrations was more than one day. However, the actual retention time may be significantly less than one day using more powerful UV lamps and balancing the UV input with the dose of ozone or hydrogen peroxide. Commercial reactors provide a UV dosage of approximately 200 watts/l (Hager and Smith 1985), compared to 0.8-6 watts/l utilized in the treatability studies. Chemical analysis of the treated and untreated water samples indicated that ozone/UV effectively destroyed the other compounds present except acetone.

In summary, both ozone/UV and hydrogen peroxide/UV are judged to be capable of meeting the action levels defined in Chapter 1. Ozone/UV was demonstrated to attain these levels. Hydrogen peroxide/UV is believed to be capable of achieving comparable treatment objectives. This belief is based on the essentially equivalent results provided by it and ozone/UV under similar reaction conditions, and on common reaction mechanisms involving hydroxyl radicals that would be involved with both hydrogen peroxide and ozone treatment.

2.7 DETAILED EVALUATION OF TECHNOLOGIES

Four technologies were identified in Section 2.5 as final candidates for treating the wastewater at the HBSF: ozone/UV; hydrogen peroxide/UV; evaporation pond; and off-site incineration. The discussion of these technologies is expanded to a conceptual engineering level. Each technology is evaluated in detail according to its technical feasibility, the permanence of remediation, public health impacts, and environmental impacts. The technologies are given overall ratings for each of these categories. The costs of the treatment options are also estimated. The Decision Document for the HBSF will thoroughly address applicable or relevant and appropriate requirements (ARARs).

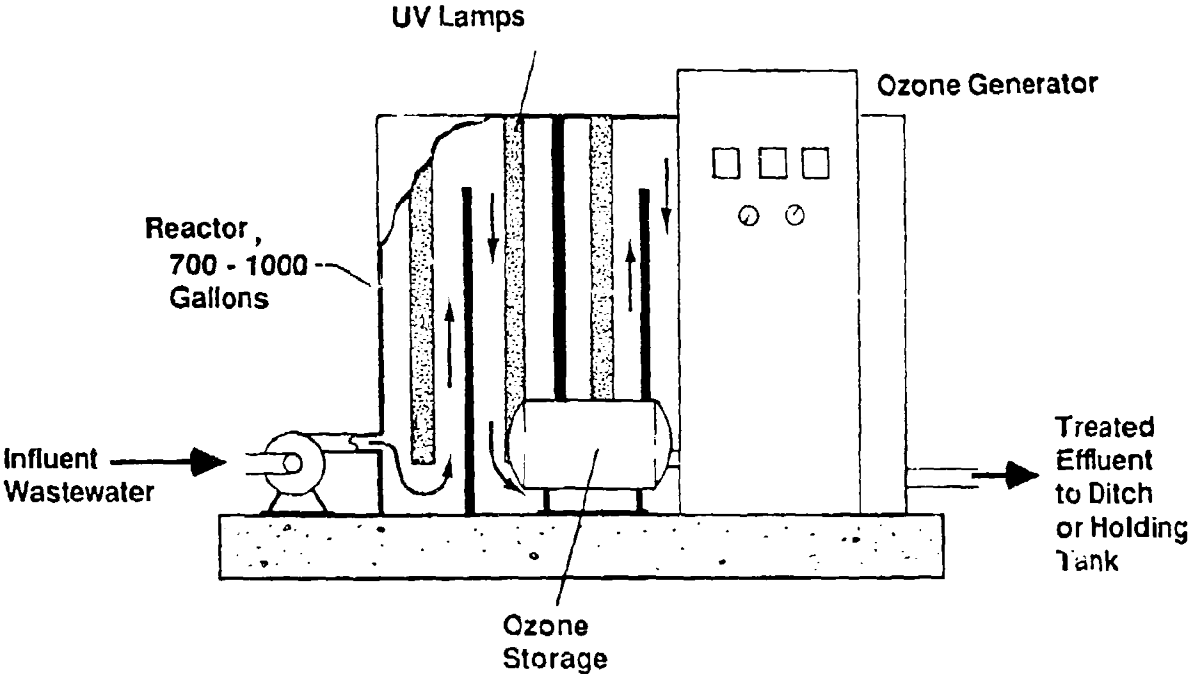
2.7.1 Detailed Descriptions of Final Candidate Technologies

This conceptual engineering evaluation considers specific operations, equipment, and siting of the final candidate technologies. However, the details of the treatment options are not intended as final decisions, but may be revised as more information is obtained on treatment effectiveness, costs, institutional considerations, implementability, and health protection.

2.7.1.1 Ozone/UV

Of the available ozone/UV treatment methods, an on-site mobile treatment is considered the most appropriate system because of the limited amount of wastewater at the HBSF. The use of an installed system would involve the costs of purchased equipment and its installation. These costs are not warranted for a short-term treatment. An installed system has the same components as a mobile system.

A schematic diagram of the ozone/UV system is shown in Figure 2-2. The system would be skid-mounted and would be approximately 15 feet by 8 feet by 10 feet high. The mobile system would be located outside the fenced yard. This location may reduce the level of protection required by the operators and may facilitate decommissioning. Hookups to a 10 gallon per minute (gpm) source of potable water and 480V source of electricity are required. Temporary piping would connect the 700 to 1,000-gallon ozone/UV reactor to the pumps at the blender. A portable pump would be used to transfer the water from the inground concrete



Prepared for:

Program Manager's Office For
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

Figure 2-2.

SCHEMATIC DIAGRAM OF OZONE / UV TECHNOLOGY

ROCKY MOUNTAIN ARSENAL, TASK 34
Prepared by: EBASCO Services, Incorporated

tank to the treatment system. Oxygen, rather than air, would be used for ozone production in order to avoid the formation of additional nitrosamine compounds from nitrogen. The oxygen would be supplied from liquid oxygen tanks. Approximately 30 pounds of ozone would be generated daily. The wastewater may be acidified prior to treatment to improve the treatment efficiency.

Regular operation of the mobile system would begin following about one week of minor setup and shakedown. Operating parameters would be optimized during these preliminary phases. Initially, a full-time operator and frequent (perhaps hourly) sampling would be required to verify treatment and improve treatment efficiency. Wastewater would be treated in batches during the preliminary runs. Treated water from these operations would be stored until laboratory results verified the destruction of the contaminants of concern. The acidic water would be neutralized, then discharged to the drainage ditch located north of the fenced area. Once the operating parameters are established, the system would be operated in a continuous flow mode with periodic inspections and servicing. The system may be operated in a batch or recirculation mode if continuous operation is infeasible. An alarm system would be used to shut down the pumps, reactor, and ozone generator if malfunctions occur. The results from the treatability studies (see Section 2.6.2) indicate that, with high intensity UV lamps and the appropriate pH, a contact time of 24 hours or less should be sufficient to destroy NDMA to below the proposed action level of 0.20 ppb. Water from the inground concrete tank would be filtered with cartridge filters prior to treatment to remove particulates. These particulates would interfere with the contaminant destruction by reducing the penetration of UV light. The filters and particulate matter would be disposed with the demolition debris.

The treated water would be discharged continuously if the initial treatment runs demonstrate the feasibility of reliable, consistent destruction of contaminants to below action levels. Treated water would be sampled and analyzed regularly once the system begins continuous operation. Neutralization of the effluent would be necessary prior to discharging the water if it is acidic. If continuous discharge is not possible because of concerns of incomplete treatment, the effluent would be stored in a holding tank. One of the horizontal tanks may be used. A vertical tank or the inground concrete tank may also be used once emptied and decontaminated. The treated water in the holding tank would be analyzed to verify that contaminant concentrations are below action levels. The water would then be neutralized and discharged to the drainage ditch if action levels are attained. The water would be treated again and reanalyzed if action levels are not attained.

It is estimated that six months or less would be required to treat the existing wastewater using a single mobile system. This estimate is based on the assumption that an average of at least 1,500 gallons of water could be treated per day and that the system would operate 30 days per month. Once the water has been treated, the tanks and piping would be triple rinsed as described in the decommissioning plan and the rinsewater treated and discharged.

Decontamination water collected and stored during the facility decommissioning may require treatment. This treatment would be similar to the original operation with two potential changes. First, the wastewater may require filtration to remove particulate matter; second, the treated effluent may be discharged continuously to the drainage ditch rather than a holding tank, in which case more frequent sampling and analysis would be necessary. It may be less costly to demobilize the system after treating the existing wastewater if the wastewater from the decommissioning is generated several months later. The system would be remobilized at that time if it is needed. The mobile system may be left on the site if the decommissioning wastewater is generated soon after treatment of the existing wastewater is complete.

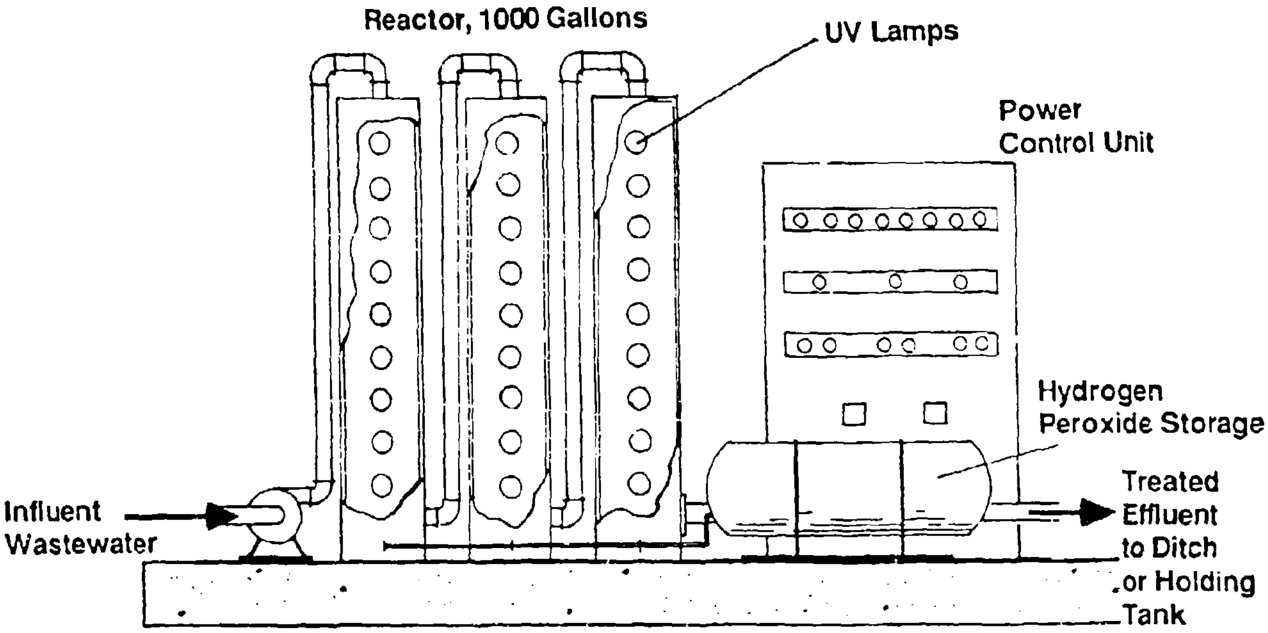
Following completion of wastewater treatment, the mobile treatment system would be disconnected from the potable water, electrical, and wastewater hookups. The temporary piping would be disposed of or decontaminated as necessary. The system would then be transported off-site.

2.7.1.2 Hydrogen Peroxide/UV

A mobile treatment system would also be used for hydrogen peroxide/UV treatment. A schematic diagram of the hydrogen peroxide/UV process is shown in Figure 2-3. The system would be located outside the fenced area and would be connected to a potable water supply, electricity, and pumps and piping for the wastewater. Existing pumps and piping would be used to the extent possible, supplemented with temporary piping and portable pumps as necessary.

Trial batch runs would be performed after process equipment has been installed. Concentrated hydrogen peroxide solution (30 or 50 percent) would be fed to the reactor from a storage tank. UV lamps within the reactor would activate the contaminants to aid in their destruction and cleave the hydrogen peroxide to form hydroxyl species. These species would react with the contaminants. From 12 to 24 hours of contact may be required to attain the treatment action levels. The reaction may be conducted in a continuous flow mode with discharge to a holding tank after operating conditions are established. The reactor volume would be approximately 1,000 gallons in this case. Alternatively, the system may be operated in a batch mode with water recirculated between the reactor and a holding tank until the desired contaminant destruction is achieved. A 50-gallon reactor connected to a 1,000-gallon holding tank would be used. Initially, samples would be collected and analyzed frequently to verify treatment and improve treatment efficiency. Successfully treated water generated during these initial runs would then be tested and, if found clean, discharged to a drainage ditch.

The system may be automated and the need for operators reduced after operating conditions have been established. One technician would be needed for about 8 hours for each continuous day of operation. Control



Prepared for:

Program Manager's Office For

Figure 2-3.

SCHEMATIC DIAGRAM OF HYDROGEN PEROXIDE / UV TECHNOLOGY devices would be installed to shut down the process in the event of a failure. The treated wastewater would be discharged continuously if treatment below the action levels is consistently attained. If there are concerns that treated effluent may not meet action levels, the effluent may be stored temporarily while chemical analyses are conducted. Water which meets the action levels is discharged to drainage ditches, whereas water which exceeds the action levels receives additional treatment.

The effluent may be acidic, so the pH may be adjusted prior to discharge. Water from the inground concrete tank would be filtered as necessary prior to treatment. Filtered solids would be disposed with the demolition debris. It is estimated that six months or less would be required to treat the existing wastewater at the HBSF using hydrogen peroxide/UV, based on at least 1,500 gallons of water treated per day, 30 days per month.

Following the treatment of the existing wastewater, the system would be decontaminated, demobilized, and transported off-site. If wastewater generated during the decommissioning of the HBSF requires treatment, the mobile system would be returned to the site. This wastewater would be filtered if necessary and may be discharged continuously after treatment.

2.7.1.3 Evaporation Pond

An evaporation pond may be used to simultaneously treat and dispose of the wastewater. A schematic diagram of the pond is shown in Figure 2-4. The pond would be located north of the HBSF just outside of the fenced area along the service road. The evaporation pond design is based on climatological data, namely the regional net evaporation from May througn October (U.S. Department of Commerce 1968). For the Denver area, the mean annual lake evaporation is 41 inches, with a 6 inch standard deviation. Seventy-one percent of the annual evaporation occurs May through October, and during this period 10 inches of precipitation falls. The net mean May-October evaporation is 41 x 0.71 - 10 = 19 inches. Basing the pond design on a worst case in

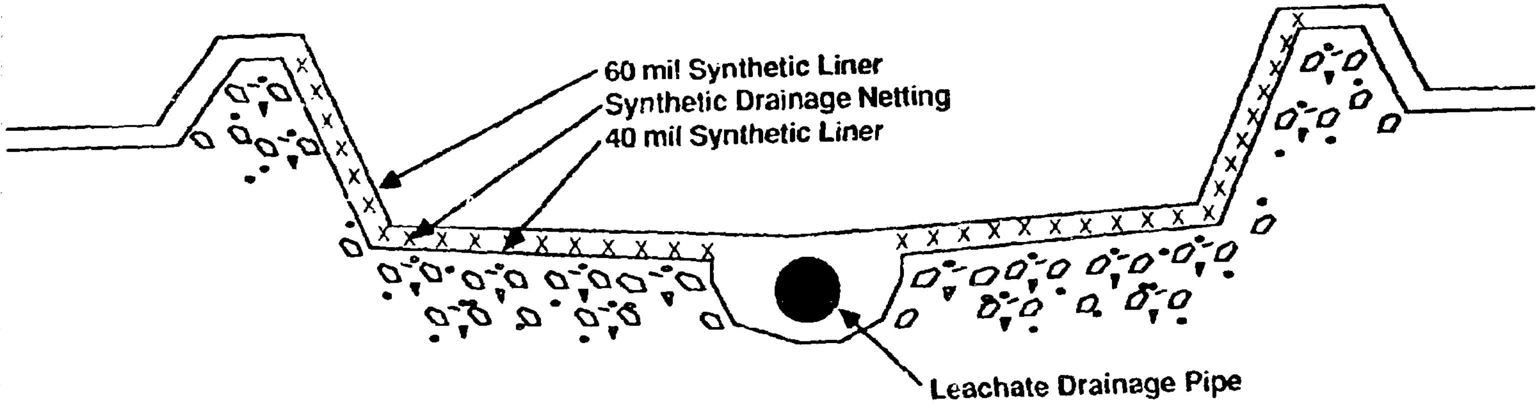


Figure 2-4.

SCHEMATIC DIAGRAM OF EVAPORATION POND

ROCKY MOUNTAIN ARSENAL, TASK 34
Prepared by EBASCO Services, Incorporated

Prepared for:

Program Managers Office For
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

which the annual evaporation is low by one standard deviation, the maximum depth to evaporate from May-October is (41-6) x 0.71 - 10 = 14 inches. This should provide a sufficient safety factor for evaporation of the HBSF wastewater in a 4-6 month period.

The pond would be excavated to a depth of 15-18 inches so that its high water mark corresponds with grade. Excavated soil would be graded and compacted to form a bermed area of about 185 feet by 185 feet. Two feet of free board would be allowed to prevent overflowing due to precipitation or overtopping due to wave action. If a severe water level problem was encountered, portable pumps would be used to transfer the liquid back to the wastewater storage tanks or to separate holding tanks. A chain link fence would surround the pond to restrict access.

The design of the liner system would comply with 40 CFR 264.221 and the 1984 Hazardous Solid Waste Amendments (HSWA). The HSWA provides a specific interpretation of 40 CFR 260.221 and requires surface impoundments to have double liners and a leachate detection system. In accordance with the HSWA, the USEPA has published a guidance document (USEPA, 1985) on the design, construction, and operation of surface impoundments. The design of the HBSF evaporation pond would be based on this document and consist of a double liner system composed of an upper, flexible-membrane liner (FML) and a lower liner with a leak detection layer in between.

Smooth bedding material would provide the base for the pond. The base would be sloped at a 3 percent grade toward the location of perforated leachate collection pipe. Six inches of sand would be placed on the bedding material and two flexible membrane liners would overlie the sand layer. High-density polyethylene (HDPE) would be the material of choice due to its chemical compatibility and its physical strength and flexibility. The liner would be fabricated in the field with patented thermal welding techniques. A leachate detection system would be placed between the liners along with a perforated pipe to collect any leachate. The pipe would be connected to a leachate collection sump to retain any leachate that may be present.

At this stage of the evaluation, preliminary calculations were performed and indicate that if untreated water is directly discharged to the pond, volatilization of UDMH and its conversion to NDMA may result in detectable levels of NDMA near the pond and for some distance downwind of the pond. Concentrated hydrogen peroxide solution would therefore be added to tanks US-3 and US-4 to oxidize the hydrazine compounds before they are transferred to the ponds. NDMA which may form is much less volatile than the hydrazine compounds. The Henry's Law constant, which is a measure of a compound's volatility, for NDMA at 40°C is approximately 1×10^{-10} atmosphere cubic meter per mole (atm m^3/mol) (Chang 1976). A value of less than 1×10^{-7} atm m^3/mol is indicative of nonvolatile compound. The air space above the tanks would be monitored for NDMA release. If the concentration of NDMA in this airspace is below detectable levels, the water would be discharged to the evaporation pond. If not, additional hydrogen peroxide would be added to the tanks until all of the UDMH has been destroyed. The NDMA produced by oxidation with hydrogen peroxide would be destroyed in the evaporation pond by sunlight.

After pretreatment, all the wastewater would be discharged to the pond using existing pumps and piping. Temporary piping and pumps would be used as needed. Wastewater currently on site would be treated. As decontamination wastewater was generated, it would be discharged directly to the pond or stored initially, then discharged. Periodic air monitoring would be conducted to verify that potential contaminant releases off-site were below levels of concern. The pond and leachate collection system would be inspected in accordance with 40 CFR 264. The pond would be designed to be operated during the months of May through October when evaporation in the Denver area is most significant. It is estimated that five months would be required to evaporate the wastewater. If the pond was operated during months in which precipitation exceeds evaporation, or if lower than normal evaporation rates were encountered during the summer, more time would be required. The use of the evaporation pond during winte months should be avoided because of potential freezing and the accumulation of snow in the pond.

Following treatment of all the wastewater, the pond would be decommissioned. Fencing would be removed. The HDPE liners and solid residual would be disposed in a hazardous waste landfill. The underlying soil would be spot sampled for the presence of contaminants if any spills occurred. The pond depression would be backfilled. Material which has come in contact with the wastewater would be recycled or disposed as appropriate. The site would then be regraded, mulched, and seeded.

2.7.1.4 Off-Site Incineration

Off-site incineration may be used to destroy the contaminated water at the HBSF. Wastewater would be pumped from the tanks using existing pumps and piping. Temporary equipment would be used as necessary. Wastewater generated during the facility decommissioning would be stored in holding tanks as it was produced. Rail tank cars or tanker trucks would be used to transport the water. About 36 7,500-gallon tanker trucks would be needed to transport the existing wastewater and five trucks to transport water generated during the decommissioning. Alternatively, eighteen 15,000-gallon rail cars could be used to transport the existing wastewater followed by three to transport the decommissioning wastewater.

The water would be shipped to an approved RCRA incineration facility. At least two facilities, SCA in Chicago, Illinois and Rollins in Deer Park, Texas, currently have the ability to completely destroy the contaminants. The wastewater would be stored at the incineration facility during analytical tests and, possibly, test burns. Then the wastewater would be destroyed. Following receipt of the wastewater, the incineration would be completed in one to two months.

2.7.2 Technical Feasibility

The technical feasibility of each of the final candidate technologies is an important consideration in the evaluation process. Each technology was rated according to performance, including the permanence of the remedy, reliability, implementability, and safety.

Performance is the ability to attain the intended objective and is comprised of two factors: effectiveness and useful life. Effectiveness refers to how well the technology meets the treatment goals, which in this case are the attainment of the action levels set forth in the previous chapter, as well as the permanence of the remediation. The useful life is the amount of time the effectiveness can be maintained. Because the quantity of wastewater at the HBSF is limited, performance is evaluated in terms of the effectiveness of the technology.

The reliability of a technology is the likelihood that the desired result will be achieved. The assessment is an evaluation of operation and maintenance requirements and the demonstrated performance of the technology. Generally, the less operation and maintenance required and the more often the technology has been used in similar applications, the more reliable the process is.

Implementability is the relative ease of installation or construction of a treatment technology and the time required to treat and release the water. It is a measure of the effort required to implement the technology based on existing site conditions and the availability of necessary equipment or facilities. The time factor includes the time required to implement the technology, the time required to see beneficial results, and the time to complete the treatment. An added consideration is how the wastewater treatment would affect the overall decommissioning schedule. All else being equal, technologies which would be more easily and quickly implemented and require less time to complete are favored.

Safety to workers and the neighboring environment is an evaluation of the potential impacts during implementation and operation of the technology. Assessments of safety at this point are restricted to the actual equipment, materials, and operations involved and do not include possible effects of the release of treated water or byproducts.

2.7.2.1 Ozone/UV

Performance:

The ozone/UV process is very effective in destroying hydrazine compounds and NDMA. In previous work conducted by IITRI on simulated hydrazine wastewaters, the hydrazines (hydrazine, MMH, and UDMH) and NDMA were destroyed to below their detection limits of 5 ppm and 16 ppt, respectively (see Section 2.3.4). In the treatability studies performed on a wastewater sample from tank US-4, the total hydrazine concentration of about 2,600 ppm was reduced to below detection limits of 15 ppm in less than 400 minutes of reaction. NDMA was reduced to 0.3 ppb in 1,850 minutes of reaction. The action level for NDMA (0.20 ppb) was achieved in 5,000 minutes. Other unidentified compounds remained but, again, continued treatment would destroy these compounds.

The use of this technology would permanently destroy the hydrazine compounds, NDMA, and other contaminants to the desired level.

A high performance rating is given for the ozone/UV technology.

Reliability:

The operation and maintenance requirements for the ozone/UV process would initially consist of adjusting the flow of ozone and water through the reactor to attain adequate treatment. Samples must be taken frequently and analyzed to verify destruction of the contaminants. However, once the operating conditions were established, the operation could be automated and control systems activated which would shut the system down in the event of a failure (Kurzweg 1987). Periodic inspections and sampling would be necessary and liquid oxygen would be replaced occasionally. Equipment servicing would be minimal. The ozonator, oxygen feed system, reactor, and UV lamps characteristically require minor annual servicing which would not be a constraint because of the anticipated 6-month operation.

Ozone/UV has been successfully used at the Aerojet facility in Sacramento to meet discharge limits of 1.0 ppb NDMA and 10 ppm hydrazine (CRWQCB 1985). The technology has also been successfully applied at numerous other sites on different compounds. The results of the treatability studies indicate that the wastewater at the HBSF is amendable to ozone/UV treatment.

A high reliability rating is given.

Implementability:

An ozone/UV treatment system could be easily and rapidly implemented. Mobile units are available which could be brought to the site so that no construction or design is required. One to two weeks may be needed by the vendor to optimize system performance prior to full scale operation. Treatment with a mobile ozone/UV system could begin within one week of arrival. Preparation would consist of hookup to potable water and electricity, both of which are available at the HBSF (James 1987). Connections to liquid oxygen tanks would also be necessary. Pumping and piping system from the wastewater tanks to the reactor could then be assembled and the trial runs begun.

Frequent analysis would be required initially. However, because the treated water would be stored prior to discharge, the process could be run continuously while waiting for results of chemical analyses. Once the system was operating on a regular basis, no interruptions would be likely. After the contents of one tank are treated, disconnection from the tank, hookup to the next tank, and trial runs would be necessary. However, this transition could be completed within a week. Therefore, it is estimated that the treatment of the existing wastewater using ozone/UV would require approximately 6 months. Decommissioning of the tanks could begin after emptying of the first tank, but could not be finished until after the treatment is complete. Wastewater generated during decommissioning would be stored if treatment is necessary, and the treatment system remobilized. Operation is infeasible during the winter months because of possible freezing of piping and other cold weather restrictions.

A moderate implementability rating is assigned, due to potential for remobilization and minor delays in decommissioning while the decommissioning related wastewater is treated.

Safety:

The only significant safety concerns in using the ozone/UV process would be potential exposures to contaminated water, releases of ozone, high voltage, and handling and transport of liquid oxygen. Nevertheless, these potential exposures can be controlled and safety assured. Because the contaminated water is contained within piping and reactors, there is little chance of exposure if the piping is properly connected. Ozone releases are unlikely as a non-venting reactor could be used and ozone destruction units are included in the process equipment. The liquid oxygen will present no safety hazard if it is contained properly, stored away from reducing agents, and connected to the reaction vessel correctly.

In the event of releases of the contaminated water, ozone, or liquid oxygen, short-term exposures would be limited since safety equipment would be available and evacuation to a safe distance would require only tens of seconds if an operator is present. Long-term exposures would be insignificant because each of the materials would be released in only minor quantities, the substances may be converted to innocuous products (e.g., ozone decomposition to oxygen), and few receptors are located in the vicinity.

Therefore, the safety rating for the ozone/UV process is high.

Overall Technical Feasibility:

The ratings for performance, reliability, and safety of the ozone/UV process are high and the implementability rating is moderate. An overall technical feasibility rating of high is given.

2.7.2.2 Hydrogen Peroxide/UV

Performance:

The chemistry of the hydrogen peroxide/UV process is very similar to the ozone/UV process. Therefore, similar performance would be expected. Results of the treatability studies indicate that hydrazine concentrations were reduced from 2,600 ppm to less than 15 ppm in less than 600 minutes. NDMA, which reached a maximum of 197 ppm during the treatment, was reduced to 2 ppb after 4,655 minutes of treatment. Hydrogen peroxide provides essentially equivalent treatment to ozone/UV under the proper conditions. Byproducts can be destroyed to any desired level.

The use of this technology would permanently destroy the contaminants of concern.

A high rating is given to the performance of hydrogen peroxide/UV technology.

Reliability:

The hydrogen peroxide/UV process requires relatively little effort to operate and maintain. Initially, adjustments to the chemical feed and flow rate would be necessary to establish efficient operating conditions. The process can be automated for continuous use once these conditions are identified. Daily inspections and periodic refilling of the hydrogen peroxide tanks would be necessary, but otherwise the process would require little servicing. Because the equipment would be used on a temporary basis, and because the process components such as the pumps and reactor have several years of service life, there is little chance of equipment failure. If the equipment did fail, parts are readily available so that operations could resume quickly.

Hydrogen peroxide/UV has not been used in field applications for hydrazine and NDMA containing wastewaters, but has been used for many other wastewater applications. The treatability studies suggest that the process can successfully destroy hydrazines and NDMA to below their action levels. Therefore, the process should be effective in treating the HBSF wastewater.

A high reliability rating is given.

Implementability:

The hydrogen peroxide/UV process may be readily and easily implemented. About a two week lab-scale treatability study by the vendor may be necessary because of differences between vendors' treatment systems. Skid-mounted units are available which could be set up on site. A temporary shelter for the system would be necessary to protect the equipment and the technicians. Hookups to electricity and potable water would be necessary, both of which are available at the HBSF. The pumps and piping at the facility may be used to convey the water to the treatment system; temporary piping and portable pumps may also be needed, but could be readily acquired and connected. Thus, within a week to two weeks of arrival, the system could begin operation.

Trial runs with field equipment could be completed within a week. Treatment of the existing wastewater would be expected to take at most 6 months, allowing about 1 week to move piping to the next tank and perform trial runs. Once a tank has been emptied, it would be ready for decommissioning. After completing treatment of the existing wastewater, the system could be demobilized and transported off site within a week. Decommissioning of the facility may begin during the treatment of the wastewater, but could not be finished until the treatment is complete. If treatment of the water generated during decommissioning is required, the system could be remobilized and operation could begin within a few weeks provided potable water and electrical hook ups are still available. Alternatively, the mobile system may be left on the site and restarted to treat the decommissioning wastewater. Operation during the winter months is infeasible because of restrictions imposed by the cold weather.

The hydrogen peroxide/UV process is rated moderate for implementability because of the potential delay of decommissioning and the potential inconvenience if remobilization to treat additional wastewater is required.

Safety:

The use of the hydrogen peroxide/UV technology would potentially introduce hazards associated with exposure to contaminated water and concentrated hydrogen peroxide. However, the likelihood or consequences of exposure are minimal. Contaminated water must be introduced into the reactor, but the system is closed so that breakage in the piping or reactor would have to occur to result in exposures. This possibility is unlikely considering the short duration of the treatment. The concentrated hydrogen peroxide solution could present short-term hazards if it were released near the system operators. Release would occur if the system piping became disconnected, but this event is considered unlikely. If releases of hydrogen peroxide did occur, the operators would be able to don respirators and/or evacuate readily to a safe distance. Because the hydrogen peroxide would rapidly decay with exposure to sunlight or contact with soils, no long-term exposure would be expected. Furthermore, the absence of receptors in the vicinity improves the safety of the process if any hazardous materials were released.

The safety of the hydrogen peroxide/UV process is rated high.

Overall Technical Feasibility:

The overall technical feasibility rating of hydrogen peroxide/UV is high because of its high performance, reliability, and safety ratings, and its moderate implementability rating.

2.7.2.3 Evaporation Pond

Performance:

An evaporation pond combined with pretreatment with hydrogen peroxide should ensure the destruction of the hydrazine and NDMA contaminants. Addition of hydrogen peroxide to the wastewater would destroy the more volatile hydrazine compounds. Some NDMA would be formed, but the ultraviolet fraction of sunlight would decompose the NDMA. Other compounds which are sensitive to hydrogen peroxide or sunlight would also be decomposed. Small amounts of contaminants may be released to the atmosphere and not be destroyed rapidly but would likely disperse to nondetectable levels. NDMA is far less volatile than the hydrazine compounds, so conversion of hydrazines to NDMA would greatly reduce the potential for atmospheric releases.

In addition to providing an effective means of destroying the contaminants, an evaporation pond would dispose of the water. Contaminant residuals which may remain would be discarded as hazardous waste in an approved landfill. Thus, the major contaminants of concern would be permanently treated and remaining contamination is safely contained.

A high performance rating is given to the evaporation pond option.

Reliability:

There are few operation and maintenance requirements for the use of an evaporation pond. Once constructed and filled, the treatment proceeds without operator assistance or the use of mechanical equipment. Pretreatment with hydrogen peroxide, if effective, minimizes potential volatilization of hydrazine compounds which could be converted to NDMA in the atmosphere. Periodic water sampling and analysis would be used to monitor the progress of treatment and the leachate collection sump and integrity of the pond would be inspected visually on a regular basis. One potential drawback is the lack of data on the treatment of NDMA by photolysis in an evaporation pond. Occasional air monitoring may be necessary if concerns arise regarding contaminant emissions. The possibility of overflow or overtopping should be insignificant because the water depth and freeboard height would be conservatively sized.

Operation and maintenance requirements are minimal and the pond would be overdesigned to prevent water releases. However, the lack of data on evaporation pond performance with NDMA and the need for air monitoring result in a moderate reliability rating.

Implementability:

The use of an evaporation pond would require its construction before treatment began. The grounds around the HBSF are suitable for construction. No difficulties would be expected because the pond would be relatively small and would require minor earth-moving, placement of the liner materials, and quality assurance checks. All necessary materials are readily available and many contractors have the capability to construct the pond. Three weeks for design and about three weeks for construction and inspection of the pond would be needed.

The pretreatment with hydrogen peroxide could be conducted in a few weeks by adding the chemical solution directly to the tanks. All the hydrogen peroxide treated wastewater could be pumped into the pond for treatment after its construction. Wastewater generated during the decommissioning could be added as it is generated. As little as 5 months would be needed to treat all the wastewater assuming typical meteorological conditions were encountered. Operation during winter months is infeasible because of freezing and snow. The tanks would not immediately be decommissioned until results of air monitoring show non-detectable levels of NDMA. If after a period of time air sampling results are favorable, the tank decommissioning could begin. Otherwise the tanks would be kept in the event the wastewater would have to be recontained and treated in an alternate manner.

Following the treatment, approximately 3 weeks would be necessary to decommission the pond, dispose of the liner, and restore the site. The overall time for construction, operation, and decommissioning would be about 7 to 14 months. Weather variations could, however, influence treatment time. An unseasonally cold or wet period could require an extra summer to evaporate the wastewater.

An evaporation pond would require minimal construction, but the possibility of weather variations and the contingency of delaying tank decommissioning add uncertainty to the evaluation. Therefore, only a moderate rating for implementability is assigned.

Safety:

The use of an evaporation pond would involve potential safety hazards associated with the use of hydrogen peroxide, construction, and exposure to the contaminated water. However, appropriate health and safety equipment would be worn by workers while the hydrogen peroxide is added. The construction would be small scale and involve only backhoes, bulldozers, and delivery trucks. Excavation would be to a depth of only two feet. Therefore, construction accidents would be very unlikely.

Because the pond would be constructed outside of the fenced zone in areas where no contamination is expected, no exposure to contaminated materials would be expected. There would be little possibility of contaminant releases due to spillage of water during filling of the pond. Workers would be equipped with respirators in the event of contaminant emissions from volatilization. After filling, workers inspecting the pond would use the appropriate safety equipment to prevent potential exposure, while the fencing would limit exposure to other workers.

A high safety rating is given to the evaporation pond option.

Overall Technical Feasibility:

The performance and safety ratings of an evaporation pond are high but the reliability and implementability ratings are moderate, so the overall technical feasibility is rated as moderate.

2.7.2.4 Off-Site Incineration

Performance:

Off-site incineration would effectively destroy all contaminants in the hydrazine wastewater. Using rotary kiln, liquid injection, or other incineration technologies, 99.9999 percent destruction could be achieved.

Incineration technologies are well-established and have been widely used for destruction of many compounds. Virtually complete, permanent destruction of the contaminants is assured.

A high performance rating is given.

Reliability:

The only operation and maintenance requirements for the use of off-site incineration would be performed by the incineration facility as part of their routine procedures. The facilities considered for use are permitted for PCBs, one of the most difficult compounds to incinerate. Thus, destruction of the hydrazine compounds and NDMA would be assured. Hydrazine fuels previously stored at the HBSF were destroyed using incineration.

A high reliability rating is given.

Implementability:

Off-site incineration would be easy to implement. Treatment would involve loading the wastewater into tanker trucks or rail tank cars, transporting the wastewater to the incineration facility, storing the water, and incinerating the water. Functional loading facilities are available at the HBSF, as are roads and rail lines. The evaluated incineration facilities can accommodate both trains and trucks. Approximately three weeks would be required to empty the existing 269,000 gallons of wastewater. Immediately after transporting the water off site, decommissioning of the wastewater tanks could begin. Transport to the incineration facility would require about one week using rail shipment. Once at the facility, incineration may take seven to twelve weeks. In total, eight to thirteen weeks would be necessary to load, transport, and incinerate the wastewater.

Off-site incineration could be simply and rapidly implemented and is given a high rating.

Safety:

The potential hazards of using off-site incineration include exposures during loading of the wastewater and potential spillage during transport. However, the likelihood of either occurrence is low, preventive measures are available, and any impacts would be short-term and minor. Specifically, loading the wastewater can be carefully controlled using the loading arm previously used for loading hydrazine. Appropriate safety equipment would be worn by the workers. There is a slight possibility that the transport vehicles would be involved in an accident. Even if contaminated water were spilled, acute exposures would not be significant because the contamination in the water is dilute. Long-term exposures would be insignificant because the hydrazine compounds would degrade over time and NDMA would be photolyzed. In addition, the contaminants would be dispersed to virtually undetectable concentrations.

A high safety rating is given.

Overall Technical Feasibility:

Performance, reliability, implementability, and safety ratings are high, so the overall technical feasibility of incineration is high.

2.7.3 Permanence of Remediation

Under SARA, remediation alternatives which result in the reduction or elimination of toxicity, mobility, or volume of contaminated material are preferred. All of the final candidate alternatives considered for the HBSF interim action should result in destruction of hydrazine compounds and NDMA to below detection limits, and are, therefore, permanent remedies. In addition to destruction, the incineration and evaporation pond alternatives also greatly reduce the volume of treated wastewater due to volatilization of water.

Contaminants are essentially all destroyed using ozone/UV, hydrogen peroxide/UV, the evaporation pond, and off-site incineration, so the permanence of remediation ratings for all the alternatives are high.

2.7.4 Human Health and Environmental Impacts

The protection of human health and the environment from potential current and future exposure to the contaminants is an important consideration in evaluating the candidate technologies. Three criteria are generally considered: first, how well the technology minimizes or prevents chemical releases; second, the potential for exposure while the treatment is in progress; and third, the potential for exposures after the treatment is completed. Because there is restricted access to the HBSF and the wastewater is stored in sealed tanks, the current threat of chemical release and exposure to humans is minimal. Therefore, the governing considerations are the extent of contaminant destruction, possible contaminant release during treatment or transport, and disposal of the treated water or residuals.

2.7.4.1 Ozone/UV

The use of ozone/UV would destroy the contaminants of concern and eliminate potential future exposures to humans and the environment. While treatment is in progress, the nonventing reactor would minimize releases of contaminants through the vapor phase. An ozone destruction unit would prevent releases of ozone in the work area. The release of the treated water to the discharge ditch would have no adverse effects because the hydrazine compounds, NDMA, and other possible contaminants would be destroyed to the desired levels. Possible residual contaminants would be degraded by photolysis and other natural processes, and few, if any receptors would be exposed to significant concentrations of contaminants. If the discharged water reaches a waterway, dilution would disperse any residual contaminants. If the water percolated into the ground, no health hazards would be associated with its potential future use because of the low quantities of contaminants and natural degradation.

A high rating is given for human health and environmental impacts of the ozone/UV technology.

2.7.4.2 Hydrogen Peroxide/UV

The hydrogen peroxide/UV process would have human health and environmental impacts similar to the ozone/UV process. The contaminants, particularly the hydrazine compounds and NDMA, would be destroyed to the action levels or lower concentrations. Thus, potential exposures of humans to contaminants in the environment would be prevented. The reaction system would be closed so that contaminant releases would not occur during treatment. Because of the completeness of treatment, release of the treated water to the drainage ditch would pose no significant hazard. Natural degradation and dispersion would further reduce concentrations of residual compounds, whether the water reached a waterway or percolated into the ground. Residual hydrogen peroxide would rapidly decompose with exposure to light or contact with metals.

A high rating is given for the public health and environmental impacts of hydrogen peroxide/UV process because no appreciable hazard to human health and the environment would be associated with the treatment and discharge of the wastewater.

2.7.4.3 Evaporation Pond

Hydrogen peroxide pretreatment of the wastewater in tanks US-3 and US-4 would oxidize hydrazine compounds to prevent possible volatilization of the hydrazines and their subsequent conversion to NDMA. Photolysis and other natural degradation processes would destroy NDMA and other contaminants if an evaporation pond was used. NDMA, although nonvolatile, would be readily photolyzed in the atmosphere if small releases did occur. In addition, the fencing would limit access to the immediate area, dispersion would markedly reduce the contaminant concentrations in the air, and there are no residents located near the facility. Therefore, the contaminant levels reaching potential receptors would not be significant.

Because there would be no discharge of water, potential exposures through water contact routes would be eliminated. Residuals left after the evaporation is complete, if found to be contaminated, would be disposed in a secure RCRA-type landfill. Thus, exposures to these compounds would be minimized.

Although minor airborne releases of NDMA and hydrazines from the pond surface may occur, the concentration would be very low, so the destruction of the contaminants in the atmosphere, their dispersion, and the absence of receptors combine to minimize potential exposure. No water discharges result, and contaminant residuals would be isolated in a landfill. Thus, the rating for human health and environmental impacts is high.

2.7.4.4 Off-Site Incineration

The use of off-site incineration would virtually eliminate the possibility of exposure to contaminants. Greater than 99.[illegible] percent destruction of the contaminants would be expected. The [illegible], potential exposures through air emissions would be negligible, especially considering the dispersion of exhaust gases.

There is the potential for exposure during the handling and transport of the wastewater. However, with proper equipment for filling and unloading the water, volatile emissions would be minimal and spillage avoided. In the event of an accident, contaminant may be released in the immediate area. Nevertheless, the relatively small quantity of wastewater and its dilute nature would result in a low acute hazard to humans. Natural degradation and dispersion processes would reduce long-term hazards. Spilled liquid could be recovered if necessary, perhaps by soil washing or groundwater extraction. Overall the risks of exposure through handling or spills are considered negligible.

A high rating is given to off-site incineration for its public health and environmental impacts.

2.7.5 Cost Analysis of Final Candidate Technologies

The detailed descriptions of the final candidate technologies are used to estimate their costs. The cost estimates are considered in the selection of the preferred technology. Technologies which provide adequate protection of human health and the environment are more favored if they are less costly, assuming all other factors are equal.

The cost estimates are comprised of capital cost alone, because the wastewater treatment is short-term. There are no ongoing operation and maintenance requirements. The major cost items are identified and, where uncertainties exist, a range of values is provided. The resulting estimates are accurate to within -30 to +50 percent of the actual costs. The cost estimates are presented in Tables 2-6 through 2-9.

The direct costs such as equipment lease or purchase, materials, labor, installation, transport, and disposal are estimated from vendor quotes, literature sources, or are based on experience gained during previous projects. Indirect costs such as engineering, administration, and contingency are estimated as a percentage of the total direct capital cost.

The costs of ozone/UV, hydrogen peroxide/UV, and evaporation pond technologies are all about $300,000. The cost of off-site incineration is approximately $933,000. The costs for the ozone/UV and hydrogen peroxide/UV technologies were estimated assuming the equipment would be leased. The purchase price for similar sized equipment would be about $150,000 to $200,000. The cost of these technologies would therefore increase by $100,000 to $150,000 if the treatment equipment was purchased rather than leased.

TABLE 2-6

COST ESTIMATE, OZONE/UV

Item	Estimated Cost	Cost Range
Direct Costs:		
Mobilization	$11,000	$10,000-12,000
Transport	2,500	2,000-3,000
Field set-up, testing	8,000	7,000-9,000
Lease, 3-6 months	48,000	36,000-72,000
Support trailer	3,800	2,900-5,700
Field technician	22,000	16,500-33,000
Field engineer	15,000	10,000-17,500
Per diem	16,000	12,000-24,000
Oxygen	12,000	4,800-24,000
Electricity	1,000	500-2,000
pH adjustment	4,000	2,000-6,000
Regulatory activities	40,000	25,000-60,000
Chemical analysis	50,000	30,000-70,000
Demobilization	2,500	2,000-3,000
Transport	2,500	2,000-3,000
Subtotal	$239,000	$163,000-345,000
Indirect Costs:		
Administration, project management: 15 percent of direct costs	35,900	24,500-51,800
Contingency: 10 percent of direct costs	23,900	16,300-34,500
Total	$299,000	$204,000-431,000

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TABLE 2-7

COST ESTIMATE, HYDROGEN PEROXIDE/UV

Item	Estimated Cost	Cost Range
Direct Costs:		
Mobilization	$12,000	$11,000-13,000
Transport	2,500	2,000-3,000
Field set-up, testing	8,000	7,000-9,000
Lease, 3-6 months	28,000	21,000-42,000
Support trailer	3,800	2,900-5,700
Field technician	22,000	16,500-33,000
Field engineer	15,000	10,000-17,500
Per diem	16,000	12,000-24,000
Hydrogen Peroxide	21,900	9,000-44,000
Electricity	3,500	2,600-5,200
pH adjustment	4,000	2,000-6,000
Regulatory activities	40,000	25,000-60,000
Chemical analysis	50,000	30,000-70,000
Demobilization	2,500	2,000-3,000
Transport	2,500	2,000-3,000
Subtotal	$232,000	$154,000-338,000
Indirect Costs:		
Administration, project management: 15 percent of direct costs	34,800	23,100-50,700
Contingency: 10 percent of direct costs	23,200	15,500-33,800
Total	$290,000	$193,000-423,000

TABLE 2-8

COST ESTIMATE, EVAPORATION POND

Item	Estimated Cost	Cost Range
Direct Costs:		
Hydrogen peroxide	$21,900	$9,000-44,000
Excavation	5,000	4,000-6,000
Berm construction	700	600-800
Double liner system	102,000	84,000-145,000
Leak detection pipe	700	500-1,000
Fencing	14,800	13,000-16,000
Pond dismantling	15,000	12,000-20,000
Transport to landfill	5,000	4,000-6,000
Disposal at hazardous waste landfill	2,500	2,000-3,000
Backfill pond	15,000	14,000-16,000
Fence removal	1,500	1,000-2,000
Mulch and seed	1,000	800-1,200
Regulatory activities	40,000	25,000-60,000
Air monitoring and chemical analysis	50,000	30,000-70,000
Subtotal	$275,100	$199,900-390,000
Indirect Costs:		
Engineering, design, 5 percent of direct costs	13,800	10,000-19,500
Administration, project management, health and safety; 15 percent of direct costs	41,300	30,000-58,500
Contingency, 10 percent of direct costs	27,500	20,000-39,000
Total	$357,700	$259,900-507,000

TABLE 2-9

COST ESTIMATE, OFF-SITE INCINERATION

Item	Estimated Cost	Cost Range
Direct Costs:		
Chemical Analysis	$4,000	$3,000-5,000
Monitoring during liquid transfer	38,000	30,000-50,000
Pumping/loading	10,000	8,000-12,000
Liquid transport	85,000	80,000-255,000
Incinerator	600,000	550,000-730,000
Regulatory activities	40,000	25,000-60,000
Subtotal	$777,000	$696,000-1,110,000
Indirect Costs:		
Administration, project management, health and safety engineering; 15 percent of direct costs	117,000	104,000-167,000
Contingency, 5 percent of direct costs	38,900	34,800-55,500
Total	$933,000	$835,000-1,330,000

2.7.6 Summary of Final Candidate Alternatives

The results of the detailed evaluation of the final candidate technologies are summarized in in Tables 2-10 through 2-13. The ratings for each alternative are presented according to the criteria of technical feasibility, permanency of remediation, human health and environmental impacts, and estimated cost. All final criteria ratings for each technology are presented in Table 2-14.

2.8 RECOMMENDATION OF THE PREFERRED TECHNOLOGY

The final candidate technologies have been compared in this section to determine the preferred technology. Factors influencing the recommendation are discussed in Section 2.8.1. The advantages and disadvantages of each technology and its criteria ratings are compared to treatment objectives in Section 2.8.2. The technology recommended for implementation is identified along with the reasons for its recommendation in Section 2.8.3. Finally, considerations involved in implementing the preferred technology are discussed and back-up options presented in Section 2.8.4.

2.8.1 Factors in the Recommendation of the Preferred Technology

The primary objective in treating the wastewater is the protection of human health and the environment. The hydrazine compounds and NDMA present the greatest potential hazard, so treatment is rated in terms of the destruction of these compounds. The action levels presented in Chapter 1 represent health-based limits taking into account analytical detection limits. Technologies must at a minimum attain the action levels.

The remaining criteria of technical feasibility, permanency of remediation, and cost are significant in distinguishing technologies that attain the action levels. Technical feasibility is important not only in connection with the wastewater treatment but also how it

TABLE 2-10

SUMMARY OF OZONE/UV TECHNOLOGY

Technical Feasibility: High

Performance: High - Effective destruction of hydrazines and NDMA to action levels

Reliability: High - Treatability studies demonstrate effectiveness

Implementability: Moderate
- Mobile system easily set up
- Partial delay in decommissioning
- Remobilization may be necessary to treat additional wastewater

Safety: High
- Wastewater contained in a closed system
- Ozone releases unlikely

Permanence: High - Contaminants destroyed to below detection limits

Human health and environmental impacts: High
- Clean water is discharged
- No fugitive releases
- Permanent treatment

Cost:

Estimated cost: $299,000
Cost range: $204,000 - $431,000

TABLE 2-11

SUMMARY OF HYDROGEN PEROXIDE/UV TECHNOLOGY

Technical feasibility: High

Performance: High - Effective destruction of hydrazines and NDMA to action levels

Reliability: High - Chemical mechanism is similar to ozone/UV

Implementability: Moderate
- Mobile system easily set up
- Partial delay in decommissioning
- Remobilization may be necessary to treat additional wastewater

Safety: High
- Wastewater contained in a closed system
- Exposure to hydrogen peroxide unlikely

Permanence: High - Contaminants destroyed to below detection limits

Human Health and Environmental Impacts: High
- Clean water is discharged
- No fugitive releases
- Permanent treatment

Cost:

Estimated cost: $290,000
Cost range: $193,000 - $423,000

TABLE 2-12

SUMMARY OF EVAPORATION POND TECHNOLOGY

Technical feasibility: High

Performance: High
- Hydrogen peroxide pretreatment destroys hydrazines
- NDMA photolyzed in evaporation pond
- No water discharge necessary

Reliability: Moderate:
- Monitoring must be conducted to ensure destruction of contaminants and no releases otherwise

- Limited data on performance

Implementability: Moderate:
- Constructed near site in area well-suited for pond
- Wastewater generated during decommissioning can be added as it is generated
- Weather and air monitoring contingencies could delay decommissioning

Safety: High
- Minor construction hazard
- Exposures to water contaminants prevented by use of protective gear
- Exposures to hydrogen peroxide prevented using appropriate dispensing methods and protective gear

Permanence: High
- Hydrazines and NDMA destroyed by oxidation and photolysis
- No wastewater remaining after evaporation

Human health and environmental impacts: High
- Permanent treatment of hydrazines and NDMA
- Minor fugitive releases of NDMA

Cost:

Estimated cost:	$358,000
Cost range:	$260,000 - $507,000

TABLE 2-13

SUMMARY OF OFF-SITE INCINERATION TECHNOLOGY

Technical feasibility: High

Performance: High - All contaminants completely destroyed

Reliability: High: - Established technology
- Test burn conducted to identify appropriate operating conditions

Implementability: High: - Only involves pumping wastewater into tankers for transport
- Decommissioning not delayed
- Wastewater from decommissioning can be stored, then shipped

Safety: High - Personnel wear protective gear while pumping water
- Minor potential for spill during transport

Permanence: High - Organic contaminants completely destroyed

Human health and environmental impacts: High - Permanent treatment
- No contaminant discharges
- Negligible releases during handling

Cost:

Estimated cost: $933,000
Cost range: $835,000 - $1,330,000

TABLE 2-14

SUMMARY OF FINAL CANDIDATE TECHNOLOGIES

Technology	Technical Feasibility	Permanence of Remedy	Human Health and Environmental Impacts	Estimated Cost (-30 to +50 percent)
Ozone/UV	High	High	High	$299,000
Hydrogen peroxide/UV	High	High	High	$290,000
Evaporation pond	Moderate	High	High	$358,000
Off-site incineration	High	High	High	$933,000

affects the decommissioning of the facility. Cost may influence the selection inasmuch as technologies which are otherwise equivalent may vary widely in cost. These remaining criteria may be used to distinguish technologies which meet the action levels. Institutional considerations and ARARs will be addressed in the HBSF Decision Document.

2.8.2 Evaluation of Final Candidate Technologies

Each of the final candidate technologies is capable of permanently destroying the hydrazine compounds and NDMA to below their action levels. Therefore, they are all permanent remedies. There is a minor potential for fugitive releases in all cases from handling the wastewater and the high volatility of the hydrazine compounds. An evaporation pond has the greatest additional potential for fugitive releases. Pretreatment of wastewater in tanks US-3 and US-4 with hydrogen peroxide, however, destroys the volatile compounds. The wastewater is then monitored to determine if contaminant emissions are significant. If so, additional treatment would be considered. Off-site incineration provides the greatest degree of reliability in destroying all the contaminants. Nevertheless, all the final candidate technologies are judged to be protective of human health and the environment.

The technical feasibility criterion helps distinguish the technologies. For example, the implementability of the technologies is significant, particularly as it relates to the schedule and performance of the facility decommissioning. The use of hydrogen peroxide/UV or ozone/UV may require three to six months for treatment to be completed. The time required for decommissioning could be extended because the wastewater is contained in tanks on the facility. The incineration and evaporation pond options should not significantly delay decommissioning because all the existing wastewater would be quickly pumped off site so pipes and tanks could be decommissioned.

However, tank decommissioning could be significantly delayed if hydrogen peroxide pretreatment failed to eliminate NDMA air emissions to below detectable levels. Freezing and snowfall during the winter would hinder the ozone/UV, hydrogen peroxide/UV, and evaporation pond technologies. Major variations in the evaporation rate could significantly affect pond performance and possibly delay full decommissioning until the following season. Pumping of wastewater into tanks which is necessary for off-site incineration would also be somewhat affected by weather conditions.

Treatment of the water generated during the decommissioning is also a consideration. With the ozone/UV and hydrogen peroxide/UV technologies, the treatment systems must be leased while inactive or remobilized to treat additional wastewater. Off-site incineration requires that the water be stored, then transported to an off-site facility. On the other hand, wastewater may be continuously pumped to an evaporation pond after it is generated. The evaporation pond is, however, less proven than the ozone/UV or peroxide/UV or incineration technologies, and monitoring of air emissions will be required. Preliminary calculations indicate that potential volatilization of NDMA would not produce detectable levels in the air at the edge of the pond, assuming effective pretreatment with hydrogen peroxide, i.e., conversion of the volatile hydrazine compounds into less volatile NDMA.

The cost of both the ozone/UV and hydrogen peroxide/UV technologies are about $300,000. The evaporation pond is estimated to cost $358,000. Off-site incineration is much more expensive at about $930,000. Cost may be used to screen out the incineration technology, but the remaining technologies are similarly priced.

In summary, the four final candidate technologies all protect human health and the environment, and are permanent cleanup remedies. There are some implementation advantages associated with the chemical oxidation systems while ease of operation favors the evaporation pond. A number of uncertainties are associated with the evaporation pond however; specifically the effectiveness of pretreatment and the vagaries of meteorological conditions. The costs of the evaporation pond, ozone/UV, and hydrogen peroxide/UV are similar, while the cost of off-site incineration is much higher. ARARs for the various alternatives will be discussed in the Decision Document for the HBSF.

2.8.3 Recommendation of the Preferred Technology

The recommendation of the preferred technology is based on issues of technical feasibility and cost, since all should achieve the goal of permanent cleanup. All the final candidate technologies provide very good protection of human health and the environment, so according to this criterion, all are satisfactory.

The evaporation pond has some practical advantages, but limited performance data, and the potential for delayed decommissioning of the site due to weather variations and air quality concerns hinder its applicability. The remaining three technologies are similarly feasible, but cost of the off-site incineration option is approximately three times that for the ozone/UV or hydrogen peroxide/UV alternatives.

The effectiveness of ozone/UV and hydrogen peroxide/UV has been demonstrated with HBSF wastewater. Because technical feasibility and treatment costs are similar, either ozone/UV or hydrogen peroxide/UV are recommended for treating the HBSF wastewater. The final selection between the two alternatives should be based upon more detailed engineering designs and cost estimates. Both systems are capable of destroying the contaminants to below detectable levels, ensuring permanent treatment and protecting human health and the environment. Potential problems associated with the discharge of treated wastewater could be overcome by analyzing the wastewater and documenting treatment effectiveness.

3.0 DECOMMISSIONING ASSESSMENT

3.1 PURPOSE

The decommissioning assessment is a detailed description of the activities required to remediate the HBSF site, and is divided into eight activities as follows:

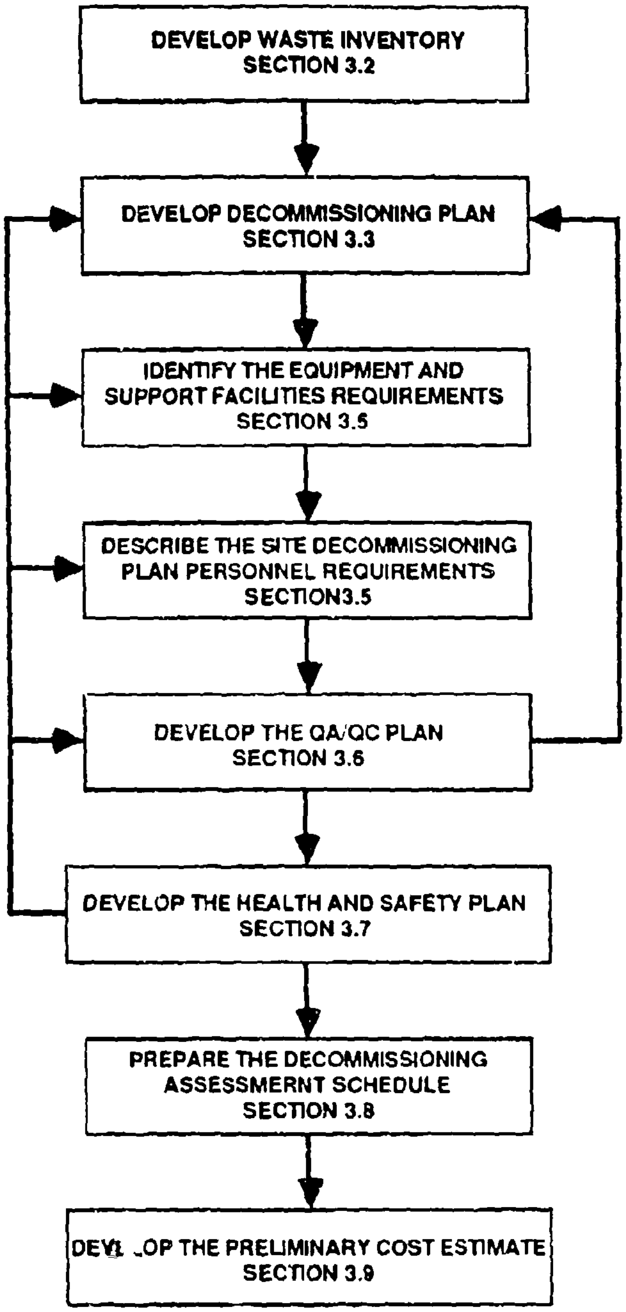
- Waste Inventory
- Decommissioning Plan
- Decommissioning Equipment and Support Facilities
- Decommissioning Site Personnel
- Quality Assurance/Quality Control (QA/QC) Plan
- Health and Safety Plan
- Decommissioning Schedule
- Preliminary Cost Estimate

The relationship between these activities and subsequent report sections is shown in Figure 3-1. The work tasks and costs developed as part of this assessment are consistent with the responsibilities agreed to by the U.S. Air Force (USAF) and Project Manager's Office of the Rocky Mountain Arsenal Cleanup (PMO-RMA) under their Memorandum of Understanding (MOU) regarding the remediation of the HBSF site.

3.2 WASTE INVENTORY

The purpose of the waste inventory was to estimate the volumes of waste material to be generated from decommissioning operations and to denote the party responsible (USAF or PMO-RMA) for waste removal and disposal. This designation of responsibilities was then used to allocate costs for the decommissioning project.

The waste inventory was divided into two categories of materials: solid and liquid waste. Solid waste consists of all debris generated from the demolition of equipment and facilities, piping, and the



Prepared for:

Program Manager's Office For
Rocky Mountain Arsenal Cleanup
Aberdeen Proving Ground, Maryland

Figure 3-1.

HYDRAZINE BLENDING AND STORAGE FACILI
DECOMMSSIONING ASSESSMENT LOGIC
DIAGRAM

ROCKY MOUNTAIN ARSENAL, TASK 34
Prepared by EBASCO Services, Incorporated

removal of contaminated soils (if required). Liquid waste consists of wastewaters currently in the storage tanks, wastewater generated from decontamination operations, and miscellaneous liquids contained in equipment and found in some buildings.

The site is divided into two discrete areas, each of which is surrounded by separate chain link and barbed wire fences (Figure 1-4). The west area is approximately 356,000 square feet and the east area is approximately 103,000 square feet. The two areas are, however, interconnected by an overhead pipeline. To facilitate the assessment, a waste inventory was prepared for each area. This allows the decommissioning activities to be conveniently located and the responsible party identified. Division of responsibility for most items is clearly stated in the MOU (Appendix A), although some items are not covered. Non-specified items were assigned based on engineering judgment.

3.2.1 Solid Waste

The solid waste inventory was prepared from quantity take-off estimates of 96 facility drawings. Where drawings were not available for buildings or equipment, site photographs or a 1982 aerial photograph were used to make estimates.

Equipment and Facilities

Equipment and facilities consist of buildings, pipe supports, storage tanks, fencing, concrete pads, concrete bermed areas, electrical equipment, metal items, mechanical equipment, and scattered miscellaneous debris.

The equipment and facilities were summarized on either a unit-weight or unit-volume basis. Metal items, because of their high density, were summarized by weight. Metal items consist of structural steel grating, storage tanks and railroad rails. The remaining concrete pads, fencing, electrical conduits and other items were estimated on a volume basis because they have a lower unit weight after demolition.

An expansion factor was applied to items which were estimated on a volume basis. Expansion factors range from 1.5 for concrete to 3.0 for electrical cables and conduits. More information on estimating weights and volumes is provided in Section 3.3.4 Solid Waste Handling/Disposal, and Appendix B, Demolition Volume and Weight Calculations.

Tables 3-1 and 3-2 contain demolition debris estimates of the equipment and facilities in the west and east areas, respectively. Section A of the tables summarizes the above ground items while Section B summarizes the at grade and below grade items. This division facilitates the location of items and is convenient for evaluating alternatives in which some below ground items may be left in place. Additionally, total quantities attributable to the Army and to the Air Force are presented at the end of the tables.

The building debris volumes in Table 3-1 include all material contained inside the buildings. This material was considered to be the responsibility of the Army and includes the heat exchanger and water heater in Building 755. Estimating the quantity of debris in buildings was based on site reconnaissance. Debris located outside of buildings in the east and west areas is summarized in Table 3-3. Outside debris, which includes drums and miscellaneous items scattered on the ground, was considered to be the Air Force's responsibility. Outside debris estimates were also taken from the site reconnaissance and subsequent photographs, and includes leased equipment (compressed gas cylinders and a large nitrogen storage tank) that will be returned to the vendor.

Piping

A summary of the piping at the HBSF is listed in Tables 3-4 and 3-5. Section A of these tables identifies above ground piping while Section B identifies underground piping. Again, metal piping was summarized on a unit-weight basis while concrete and PVC piping were summarized on a unit-volume basis.

TABLE 3-1

DEMOLITION DEBRIS - WEST AREA[1/]

Item	Responsi-ability	Unit	Metal (lbs)	Expanded Volume (cy)
Above Ground Items:				
Buildings				
755	A	480 ft^2		59.7
759	A	800 ft^2		47.9
760	A	200 ft^2		1.8
761	A	210 ft^2		14.9
868C	A	297 ft^2		36.6
Pipe supports				
71-75	A	5 ea	1,354	3.5
76-91	AF	16 ea	6,138	2.7
60-67	AF	8 ea	882	7.8
7-34	AF	28 ea	27,278	14.5
Miscellaneous metal				
Unloading/loading platforms	AF	3 ea	7,068	
Grating	AF	212 ft^2	764	
Stairs	AF	1 ea	391	
Fire deluge support structure				
Railroad unloading	AF	12 ea	8,699	
Truck loading area	AF	6 ea	3,866	
Tanks HAS-1, 2, 3, and CS-1	AF	4 ea	12,233	
Tanks US-1 & US-2	AF	1 ea	8,266	
Dismantle tanks				
HAS-1, 2, 3, and CS-1	AF	4 ea	94,364	
US-1, US-2	AF	2 ea	34,852	
Insulation	AF	6 ea		72.3

TABLE 3-1 (Continued)

DEMOLITION DEBRIS - WEST AREA[1/]

Item	Responsi-ability	Unit	Metal (lbs)	Expanded Volume (cy)
Miscellaneous items				
Blender	AF	1 ea		5.9
Scrubber	AF	1 ea		0.3
Sump handrail	AF	1 ea		0.5
Loading arms	AF	3 ea		0.3
Outside debris	AF	1 ls		22.0
Electrical items above ground				
Power poles	AF	18 ea		30.4
Transformers	AF	4 ea		2.0
Miscellaneous	AF	1 ls		9.1
Fencing				
Interior and posts	A	1,812 ft		65.0
Exterior and posts	A	2,263 ft		18.6
Below Ground Items:				
In-ground concrete tank	A	1 ea		114.9
Fire protection valve pit	A	1 ea		15.3
Drum storage pad	A	1 ea		119.0
Nitrogen pad	A	1 ea		1.7
Railroad rails	A	120 ft	4,800	
Railroad ties	A	2,520 bf		11.7
Hydrazine blender pad	A	1 ea		201.0
Septic tank	A	1 ea		1.5
Tank storage berms				
HAS-1, 2, 3 and CS-1	A	4 ea		558.8
US-1 and US-2	A	4 ea		177.6

TABLE 3-1 (Continued)

DEMOLITION DEBRIS - WEST AREA[1]

Item	Responsi-ability	Unit	Metal (lbs)	Expanded Volume (cy)
Buried electrical				
1" - dia.	A	360 ft		0.7
1 1/2" - dia.	A	745 ft		1.5
No. 1 - dia.	A	195 ft		0.6
No. 4 - dia.	A	380 ft		0.8
Pavement	A	19,860 ft^2		368.0
Subtotal	A		6,154	1,821.1
	AF		204,801	167.8
Total			210,955	1,988.9

---

[1] Abbreviations:

A - U.S. Army
AF - U.S. Air Force
bf - board feet
cy - cubic yards
ea - each
ft - feet
ft^2 - square feet
ls - lump sum

TABLE 3-2

DEMOLITION DEBRIS - EAST AREA[1/]

Item	Responsi-ability	Unit	Metal (lbs)	Expanded Volume (cy)
Above Ground Items:				
Stanchions 35-53	AF	19 ea	47,803	9.9
Fire deluge support structures				
Tank US-3	AF	1 ea	5,314	
Tank US-4	AF	1 ea	11,766	
Transfer pit structure	AF	1 ea	866	
Storage tanks				
Tank US-3	AF	1 ea	27,706	
Tank US-4	AF	1 ea	80,916	
Insulation Tank US-3	AF	1 ea		10.2
Insulation Tank US-4	AF	1 ea		24.1
Above ground electrical				
Transformer	AF	1 ea		0.4
Cables lighting (2-No. 6)	AF	762 ft		1.0
Cable to west area (2-No. 6)	AF	710 ft		0.9
Power poles AL20-43 thru 56	AF	14 ea		23.6
Distribution panel	AF	1 ea		0.3
Miscellaneous				
Interior fence	A	812 ft		18.6
Exterior fence	A	1,212 ft		3.0
Scrubber	AF	1 ea		4.5
Pumps	AF	3 ea		0.5
Nitrogen pad	A	1 ea		1.6
Shower pad	A	1 ea		0.7
Scrubber pad	A	1 ea		3.8
Outside debris	AF	1 ls		2.0

TABLE 3-2 (Continued)

DEMOLITION DEBRIS - EAST AREA

Item	Responsibility	Unit	Metal (lbs)	Expanded Volume (cy)
Below Ground Items:				
Concrete berms				
Tank US-3	A	1 ea		99.0
Tank US-4	A	1 ea		258.0
Fire protection value pit	A	1 ea		15.3
Underground conduit	A	230 ft		0.6
Subtotal	A		---	402.6
	AF		174,371	75.4
Total			174,371	478.0

1/ Abbreviations:

A - U.S. Army
AF - U.S. Air Force
cy - cubic yard
ea - each
ft - feet
ls - lump sum

TABLE 3-3

MISCELLANEOUS DEBRIS
OUTSIDE BUILDINGS*

Description	Location	Quantity	Volume (cy)
West Area:			
Empty 42-gallon drums	South of horizontal tanks	78**	1.6
Railroad rails and tank	South of horizontal tanks	Estimate	10.0
Empty drums	Drum storage pad	10**	0.2
Gas cylinders	Drum storage pad	10***	-
Nitrogen storage tank	Rail loading facility	1***	-
Miscellaneous debris	Drum storage pad	Estimate	2.0
Empty 42-gallon drums	West of building 759	59**	1.2
Miscellaneous debris	East of building 755	Estimate	2.0
Miscellaneous debris	NE of building 755	Estimate	2.0
Drum scales	Building 761	Estimate	2.0
Scattered debris	West area	Estimate	1.0
Subtotal			22.0
East Area			
Scattered debris	East area	Estimate	2.0
Total			24.0

---

* Considered to be USAF responsibility.
** Drums will be crushed on-site to 1/10 their volume
*** Cylinders and storage tank will be decontaminated and returned to vendor.

TABLE 3-4

PIPING - WEST AREA[1/]

Item	Responsi-ability	Unit (lf)	Metal (lbs)	Expanded Volume (cy)
Above Ground Piping:				
Stanchions 71 thru 75				
2" dia. steel with asbestos wrap	A	80	292	
Stanchions 76 thru 91				
3" dia. steel with asbestos wrap	AF	360	2,728	
1 1/2" dia. steel with asbestos wrap	AF	422	1,148	
1/2" dia. copper	AF	211	179	
Stanchions 60 thru 67				
2" dia. steel with asbestos wrap	AF	111	405	
Stanchions 7 thru 34				
1/2" dia. steel	AF	3,361	2,857	
1" dia. steel	AF	1,027	1,725	
2 1/2" dia. steel with asbestos wrap	AF	2,066	11,962	
3" dia. steel with asbestos wrap	AF	1,108	8,348	
Fire Protection Piping				
2" dia. steel	AF	888	3,242	
3" dia. steel	AF	60	455	
4" dia. steel	AF	363	3,917	
6" dia. steel	AF	228	4,325	

TABLE 3-4 (Continued)

PIPING - WEST AREA

Item	Responsiability	Unit (lf)	Metal (lbs)	Expanded Volume (cy)
Underground Piping:				
Drainage lines				
2" dia. cast iron and stainless steel	A	395	1,442	
2 1/2" dia. stainless steel	A	370	2,142	
3" dia. cast iron	A	460	3,486	
4" dia. cast iron	A	262	2,827	
6" dia. cast iron	A	110	2,086	
Water supply lines				
2" dia. PVC	A	105		0.1
2 1/2" dia. PVC	A	825		1.5
6" dia. cement asbestos	A	86		0.9
8" dia. cement asbestos	A	1,618		31.4
Septic tank lines				
4" dia. cast iron	A	110	1,187	
4" dia. clay tile	A	195		0.9
Subtotal	A		13,462	34.8
	AF		41,291	---
Total			54,753	34.8

1/ Abbreviations:

A - U.S. Army
AF - U.S. Air Force
cy - cubic yards
lbs - pounds
lf - linear feet

TABLE 3-5

PIPING - EAST AREA[1]

Item	Responsi-ability	Unit (lf)	Metal (lbs)	Expanded Volume (cy)
Above Ground Piping:				
Stanchions 35 thru 53				
1" dia.	AF	854	1,452	
2" dia.	AF	844	3,081	
3" dia.	AF	838	6,369	
Fire deluge piping 4" dia. steel	AF	587	6,334	
Underground Piping:				
Drainage lines				
2" dia. black iron	A	1,060	3,869	
3" dia. black iron	A	795	6,042	
Water Supply Lines				
8" dia. cement asbestos	A	806		20.8
Subtotal	A		9,911	20.8
	AF		17,236	--
Total			27,147	20.8

---

[1] Abbreviations:

A - U.S. Army
AF - U.S. Air Force
cy - cubic yards
lbs - pounds
lf - linear feet

Above ground piping consists of process and fire protection piping. The process piping consists of five runs whose location is discussed in Section 3.3.3. Fire protection piping includes piping used in the sprinkler deluge system over the rail car and truck loading areas and the tank storage areas. Based on the MOU, all above ground piping except that connecting the west fence to the change house (stanchions 71-75) is considered to be the Air Force's responsibility.

Underground piping consists of drain lines, water supply lines, and septic tank piping. Location of these lines is discussed in Section 3.3.3. Removal of the underground piping was considered to be the responsibility of the Army.

The quantity of asbestos insulation, estimated from lengths of insulated piping and vessels, is summarized in Table 3-6. Based on design drawings and field inspection, only the above ground piping in the west area is insulated with lagging material which may contain asbestos.

For cost estimating purposes, all of the above ground piping insulation was assumed to contain asbestos. This is a "worst-case" scenario which would be modified should field sampling prove otherwise.

Soils

Preliminary results of Task 11 soils sampling at the HBSF do not indicate the presence of soils contaminated with NDMA or hydrazines (Ebasco 1987). Other soils which may be potentially contaminated include those found directly under the concrete bermed areas, the drum storage pad, the truck and rail loading pads, the septic tank, and the draining piping. In addition, a 3-inch sand layer underlying tank US-4 may contain residual UDMH contamination from an earlier spill (see Section 1.3.3).

For cost estimating purposes, only the sand under tank US-4 (8.0 yd^3) was considered to be contaminated. It is the responsibility of the Air

TABLE 3-6

ASBESTOS INSULATION[1]

	Responsi-ability	Unit (ft)	Insulation Thickness (in)	Expanded Volume (cy)
West Area:				
Stanchions 71 - 75				
2" dia. steel pipe	A	80	2	0.2
Stanchions 60 - 65				
2" dia. steel pipe	AF	111	2	0.2
Stanchions 77 - 91				
3" dia. steel pipe	AF	360	2	1.1
1 1/2" dia. steel pipe	AF	422	2	0.9
Stanchions 7 - 34				
2 1/2" dia. steel	AF	2,066	2	6.7
3" dia. steel	AF	1,108	2	4.0
Building 755				
Heat exchanger and expansion tank	A	ls	2	1.0
Subtotal	A	80		1.2
	AF	4,067		12.9
		4,147		14.1

---

[1] Abbreviations:

A - U.S. Army
AF - U.S. Air Force
cy - cubic yards
ft - feet
in - inches
ls - lump sum

Force to dispose of the sand since it is an integral part of the tank. The sand is included in the total volume estimate of the tank US-4 below ground items in Table 3-2.

3.2.2 Liquid Wastes

Liquid wastes at the HBSF were divided into four categories: process wastewaters, ethylene glycol, flammable liquids, and transformer oils. A complete inventory is presented in Table 3-7. Process wastewaters were considered to be liquids potentially contaminated with hydrazine compounds including liquids presently in the storage tanks, in the bermed areas around the storage tanks, and in the in-ground concrete tank. Wastewater that would be generated during decommissioning from decontamination of piping, tanks, and equipment is also included.

Decontamination of piping and tanks (see the Hazard Reduction Plan-NDMA Hazard Reduction, Section 3.3.1.1) includes triple rinsing the interior surfaces preceding demolition activities. Rinse volumes for piping were calculated based on passing one unit volume of water through the piping per wash. These rinses are intended to remove the majority of contamination for hazard reduction. The rinsed materials would still be handled and disposed as hazardous waste.

The rinse volume estimated for the storage tanks was calculated using a 3-gpm pressure cleaner covering 10 square feet per minute over the interior surface area per wash.

Based on current information, the horizontal storage tanks have been double rinsed and would require only a final rinse. The vertical storage tanks contain wastewater and would require a triple rinse. The volumes of wastewater in the vertical storage tanks and the in-ground concrete tank were based on the site reconnaissance.

Above ground piping was assumed to have been double rinsed with the horizontal storage tanks although there may still be sections which would require triple rinsing. Underground piping would require triple

TABLE 3-7

LIQUID WASTEWATER INVENTORY[1/]

Item	Current Volume (gal)	Remarks	Rinse (gal)	Total Volume (gal)	Respon- sibility
Process Wastewaters:					
US-4 (200,000 gal)	169,000	FR	2,000	171,000	AF
US-3 (50,000 gal)	31,500	FR	1,000	32,500	AF
Waste sump	46,700	FR	1,000	47,700	AF
Horizontal tanks					
HAS-1	0	FR	1,000	1,000	AF
HAS-2	0	FR	1,000	1,000	AF
HAS-3	0	FR	1,000	1,000	AF
CS-1	0	FR	1,000	1,000	AF
US-1	19,000 E	FR	1,000	20,000	AF
US-2	19,000 E	FR	1,000	20,000	AF
Above ground piping	0	FR	3,400	3,400	AF
Underground piping	0	R/W/FR	4,800	4,800	A
Equipment rinsing	0	FR	20,000	20,000	AF/A
SUBTOTAL				20,800	A
				304,600	AF
TOTAL	285,200		40,200	325,400	
Ethylene Glycol	4,500	BD	0	4,500	AF
Flammable Liquids (Ref. Table 3-8)			0	44	A
Transformer Oil	60	SR	40	100 E	AF

[1/] Abbreviations:

BD - Blow Dry
W - Oxidizing Wash
R - Water Rinse
FR - Final Water Rinse
SR - Solvent Rinse
E - Estimated Volume

rinsing with the exception of the potable water and fire protection supply systems which have not come into contact with hydrazine compounds.

Prior to removal of demolition equipment from the exclusion work zones, a decontaminating rinse with either steam or water would be performed. (See Section 3.4.2, Support Facilities and Work Zones, for more details). The majority of water generated from the decontaminating process would be associated with the decontamination of vehicles. Vehicle rinse volumes were estimated using 100 gallons per large vehicle and 50 gallons per small vehicle.

The number of required vehicle washes is associated with the solid waste haul trucks described in the Solid Waste Handling Disposal Plan (Section 3.4.3.4.). As an added factor of safety, the equipment rinsing volume was increased by 50 percent to cover unforeseen problems.

Responsibility for the disposal of process wastewater has been divided between the Army and Air Force based on an interpretation of the MOU. The Army would be responsible for disposal of water associated with the underground piping and a portion of the equipment rinsing water. The equipment rinsing water may be divided proportionately between the Army and Air Force based on the total volume of debris for which they are responsible as shown in Section 3.3.4, Solid Waste Plan. The Army's portion would represent about 16,000 gallons of equipment decontamination rinsing water while the Air Force's portion would be about 4,000 gallons. This division of process wastewaters yields about 306,000 gallons as the Air Force's responsibility and about 20,800 gallons as the Army's responsibility.

Ethylene Glycol

Ethylene glycol was used as a "heat transfer" fluid in the heat exchanger unit. Prior to dismantling the heat exchanger, the ethylene glycol would be bled from the unit and drummed for disposal. The total volume of ethylene glycol was estimated to include that contained in the heat exchanger unit, heat traced piping, supply lines, and heated jackets associated with the horizontal storage tanks. The Air Force was considered to be responsible for disposal of the glycol since the bulk of the liquid is associated with removal of their items (i.e. double walled horizontal storage tanks).

Flammable Liquids

Flammable and other miscellaneous liquids were found in Buildings 759 and 868 during the site reconnaissance. Flammable liquids consist of solvents and aerosol spray cans of paints and lacquers. Miscellaneous liquids consist of small quantities of hydrochloric acid, roofing tar, and insecticide. A volume estimate of these liquids is presented in Table 3-8. Disposal of these liquids was considered to be the responsibility of the Army since they are responsible for the removal of Buildings 759 and 868.

Transformer Oil

Four 25 kVA and one 10 kVA transformers were found at the HBSF. Prior to disposal of the transformers, oil contained in the transformers must be drained and disposed of according to federal regulations. Disposal of the transformer oil was considered to be the responsibility of the Air Force, based on the MOU.

3.3 DECOMMISSIONING PLAN

The decommissioning plan is divided into five parts: hazard reduction, liquid waste handling and disposal, dismantling and demolition, solid waste handling and disposal, and site restoration. The rationale for selecting these divisions was based on the logical progression of work which would occur in the field during the decommissioning operation.

The hazard reduction plan is intended to minimize the exposure of site workers to hazardous substances at the HBSF. For this reason, execution of the hazard reduction plan would precede demolition

TABLE 3-8

FLAMMABLE AND OTHER MISCELLANEOUS LIQUIDS*

Building	Description	Volume (gal)
759	Acetone (5 gallon can)	2.0
	Paint (1 and 5 gallon cans)	11.0
	101-13 oz. spray paint and lacquer cans	10.2
	Hydrochloric acid (1 gallon glass container)	0.3
	Insecticide type II (12 oz. spray can)	0.1
868	Roofing tar (5 gallon cans)	10.0
	Paint (5 gallon can)	5.0
	Paint thinner (5 gallon can)	5.0
Total		43.6

*Considered to be Army responsibility. Volume estimates determined by visual inspection.

activities. As an example, insulation on piping would be removed prior to pipe demolition thereby eliminating special handling procedures required to prevent the spread of airborne asbestos.

Another purpose of the hazard reduction plan is to separate known hazardous materials from those that are merely suspected of being contaminated. This would minimize the spread of contamination to noncontaminated material. After completion of the hazard reduction plan it may be possible to downgrade the level of worker protection. This would reduce costs without jeopardizing worker safety.

The liquid waste disposal plan describes how the recommended waste treatment technology described in Section 2.0 was selected from among 14 different methods and how the selected technology would be used to treat process wastewaters. The process wastewater would be removed before the dismantling and demolition begins on the HBSF as would other liquid wastes.

One exception to the liquid waste disposal plan's schedule concerns the disposal of transformer oil. Since the transformers would be used to supply power during the demolition phase, they would not be removed until the project is near completion.

The dismantling/demolition plan provides a detailed multiple task description of the demolition activities for the HBSF equipment, facilities, and piping. The section also describes the division of responsibilities between the Army and Air Force and provides the framework for the preliminary cost estimate presented in Section 3.10.

The solid waste handling/disposal plan summarizes weights and volumes, and describes waste handling, selection of the transportation mode, and potential disposal sites. It also discusses the procedures to be used for tarping and loading operations.

The site restoration plan presents the closure procedures and postclosure care of the HBSF after completion of decommissioning. The closure procedures briefly describe the equipment decontamination facilities and liquid waste disposal facilities required as well as the disking and reseeding of the decommissioned HBSF areas.

3.3.1 Hazard Reduction Plan

The goal of the hazard reduction plan is to minimize the exposure of site workers to hazardous substances by separating known hazardous substances from those suspected of being hazardous. The hazard of primary concern during the HBSF decommissioning is associated with the presence and exposure to N-nitrosodimethylamine (NDMA), a carcinogen. The NDMA is believed to have been produced by the chemical degradation of unsymmetrical dimethylhydrazine. Its presence has been detected in the hydrazine contaminated wastewater stored in vertical tanks in the east end of the HBSF. Site investigations found detectable levels of NDMA in the breathing zone air monitors for the east end of the HBSF only (Johnson 1986). If airborne NDMA levels could be reduced to nondetectable levels, the personnel protective equipment levels could be reduced from level B, which is currently required, to level C or modified level D for more cost-effective decommissioning.

With the assumption that groundwater treatment is a part of an overall RMA cleanup effort, hazard reduction was directed primarily at the final decontamination of the hydrazine fuel system and the hydrazine and NDMA contaminated wastewaters rather than the site soils or groundwater.

Other potential hazards that would be encountered at the site include asbestos-containing insulation material; PCB-containing electrical equipment; possible burning of polyurethane tank insulation; flammable liquids and miscellaneous liquids handling; and falling debris from dismantling overhead piping, equipment and platforms.

3.3.1.1 NDMA Hazard Reduction

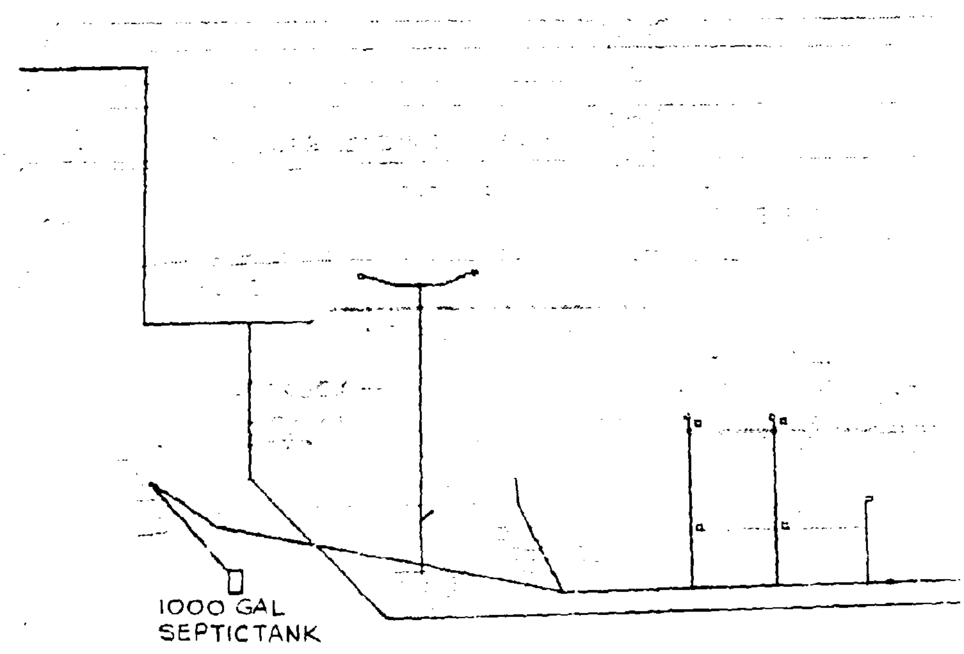
The exposure to NDMA would be reduced by triple rinsing above ground and below ground piping, pumps, and tanks interiors. The triple rinsing process would consist of a preliminary rinse, an oxidizing rinse, and a final rinse. The preliminary rinse may use contaminated wastewater or fresh water. The oxidizing rinse may use hypochlorite or hydrogen peroxide solution. The final rinse would use fresh water. The detailed procedures for rinsing various site components follow.

Piping

Above-ground hydrazine piping, underground drainage piping, and water supply piping are shown on Figures 3-2 and 3-3, respectively. Water supply piping consists of potable and fire protection piping, none of which has come in contact witn hydrazine and hence would not be rinsed. The drainage lines may be potentially contaminated and would be rinsed. The hydrazine piping from the loading areas to tanks US-3 and 4 have been rinsed by RMA. RMA would confirm that the decontamination has been successful prior to demolition.

Drainage piping includes all underground piping connected to the in-ground concrete tank and the change house septic tanks. Drainage lines would be rinsed by circulating the rinse solutions through the lines either by pumping or gravity flow. All rinse solutions would be collected in the in-ground concrete tank for disposal as discussed in Section 3.3.2.

An exception to the rinsing procedure for underground pipe is the waste discharge line which runs underground from a 3-valve tee off-site to Building 538. This line carried hydrazine wastewater and waste hydrazine. Before cleaning this line, the tee would be disassembled at the valve, and the line would be monitored for explosive gases with this valve opened. If explosive gases are not found, the pipe would be severed and capped close to the interior fence. The severed pipe, back



STORAGE TANKS TANK	SIZE (GAL)	CONSTRUCTION
[illegible] 2 & 3	14,900	STAINLESS STEEL
[illegible]	14,900	STAINLESS STEEL
[illegible]	15,000	CARBON STEEL
[illegible]	[illegible]1,000	CARBON STEEL
[illegible]	200,000	CARBON STEEL
WASTE SUMP	44,000	IN GROUND CONCRETE

WEST AREA

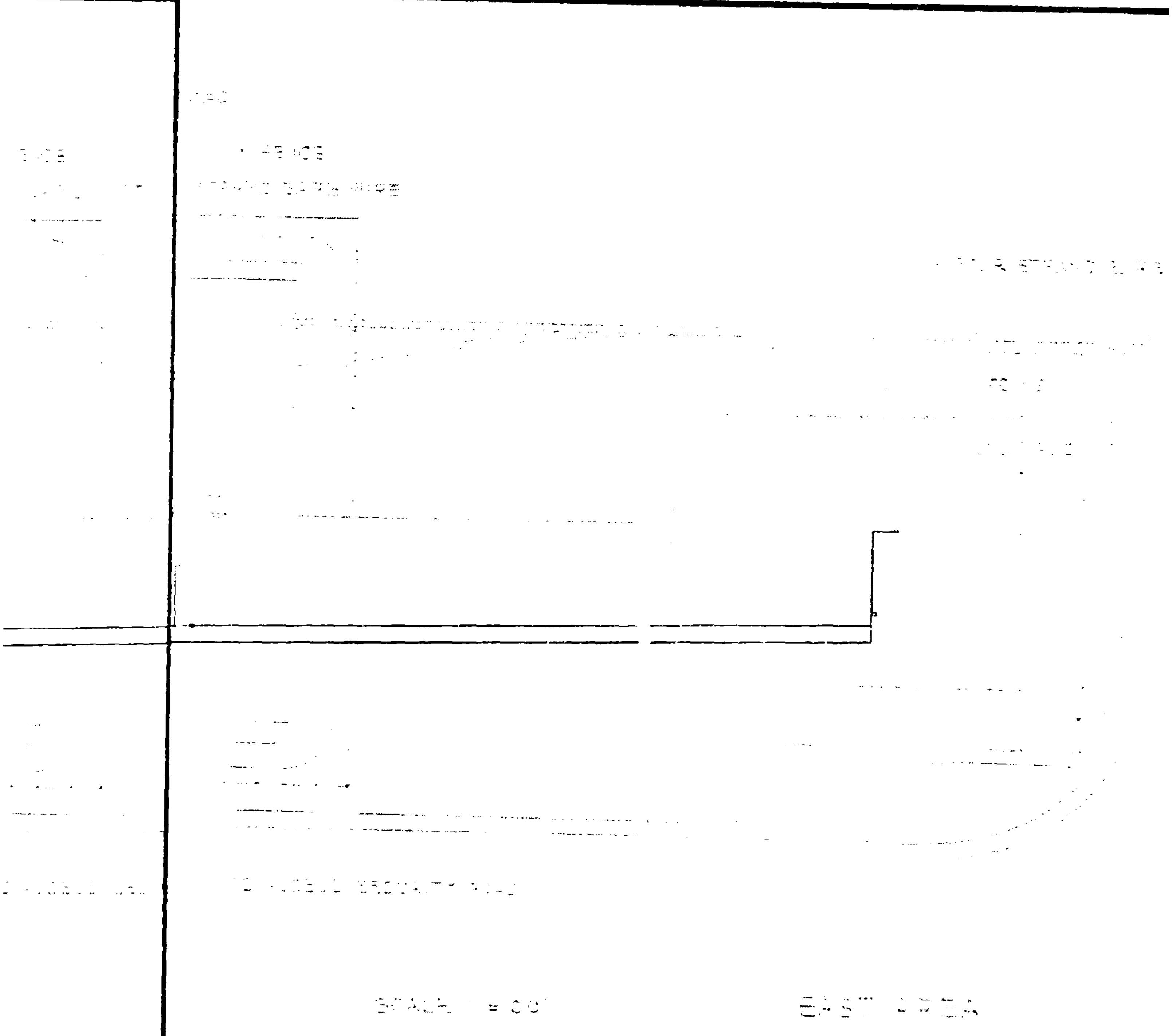


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Figure 3-2.

WASTE DRAINAGE PIPING

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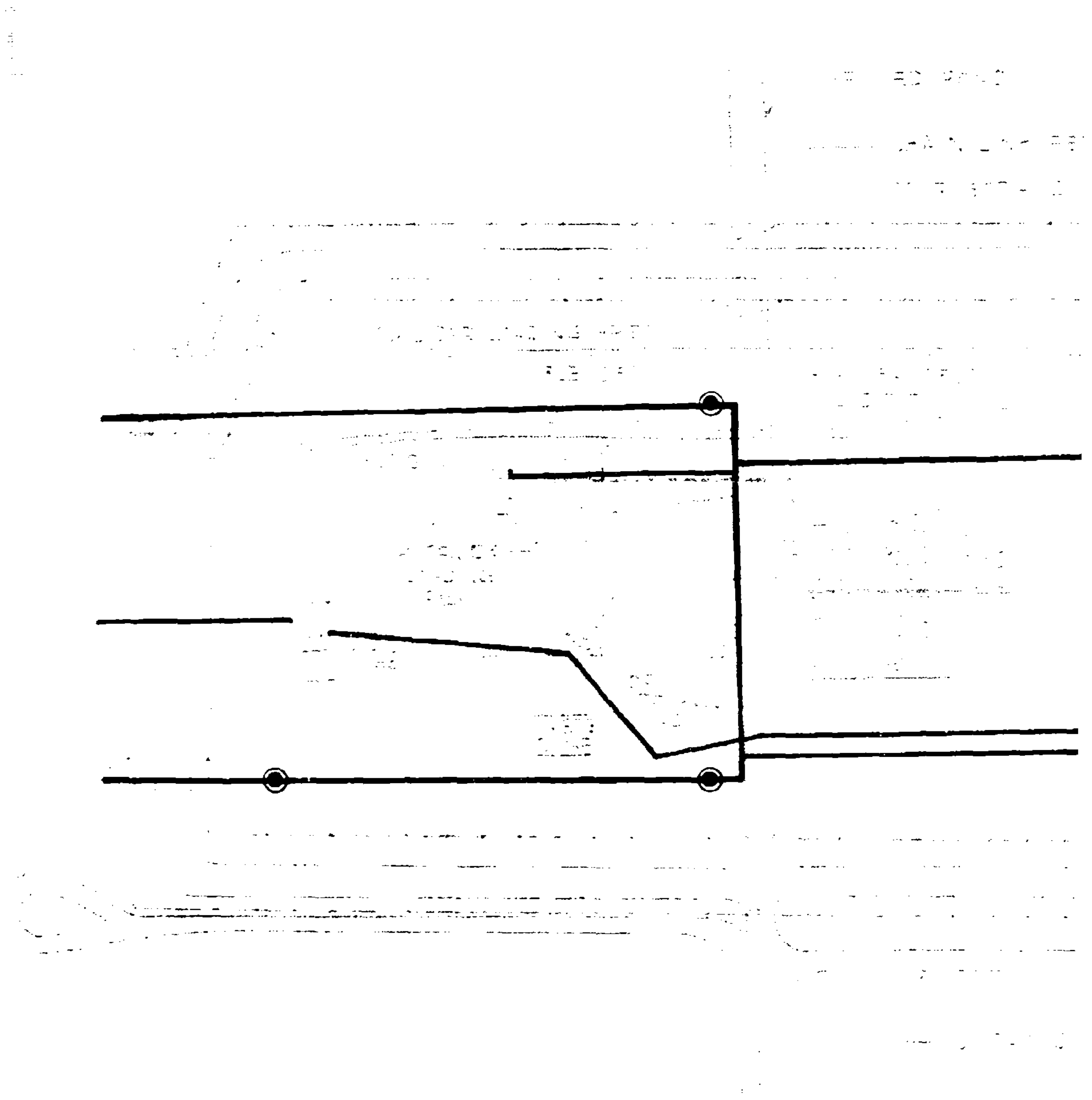

STORAGE TANKS		CONSTRUCTION
TANK	SIZE(GAL)	
[illegible]	24,900	STAINLESS STEEL
CS-1	24,900	STAINLESS STEEL
US-1 & 2	19,000	CARBON STEEL
US-3	50,000	CARBON STEEL
US-4	200,000	CARBON STEEL
WASTE SUMP	44,000	IN GROUND CONCRETE

WEST AREA

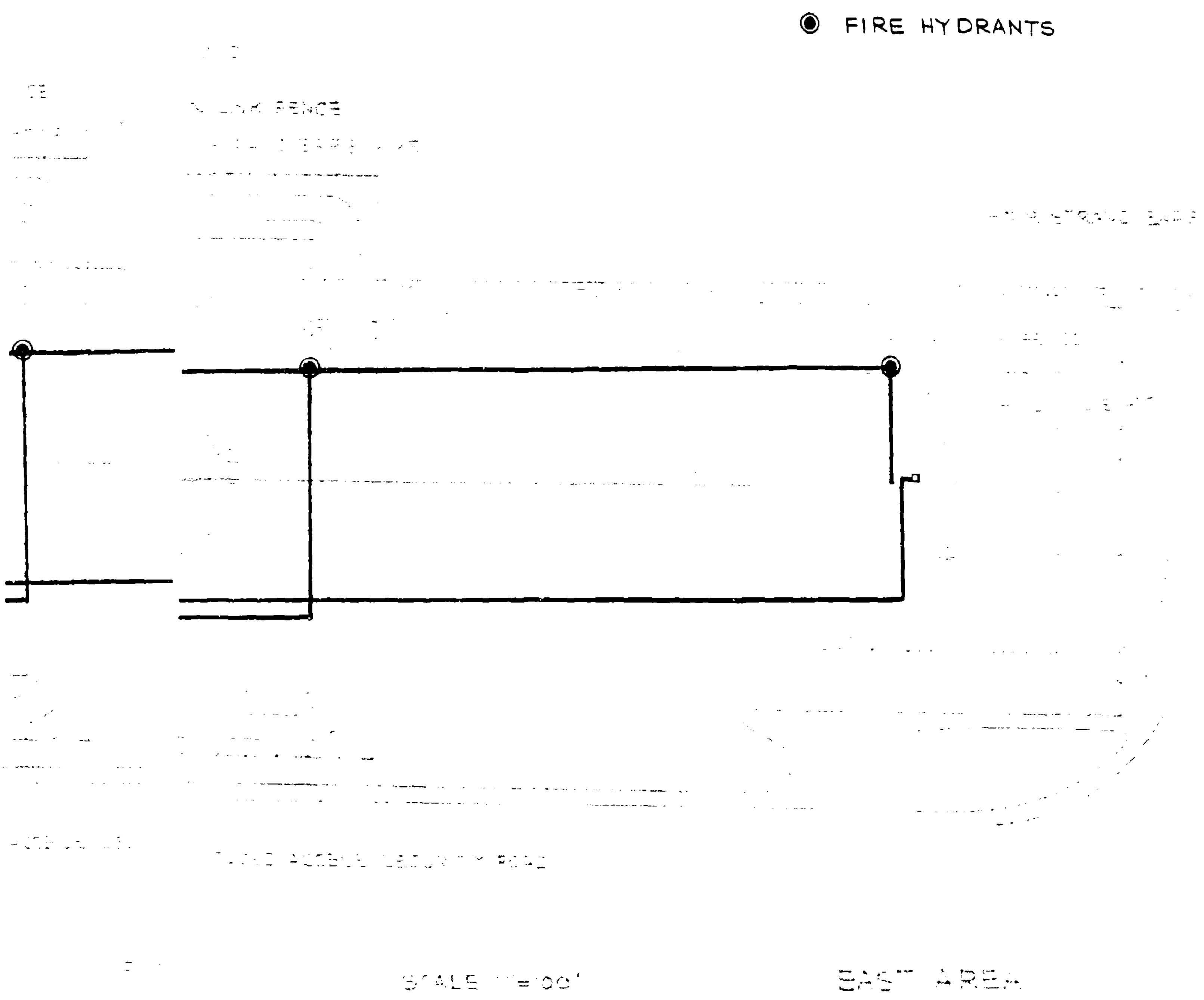

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Figure 3-3.

WATER SUPPLY PIPING

ROCKY MOUNTAIN ARSENAL, TAS
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to the valve near the tee, could be rinsed, as specified above, and removed. If explosive gases are found, the line would be purged by venting or with inert gas before severing and capping the line at the fence and rinsing the pipe from the fence to the tee.

The change house septic tank would not be rinsed prior to removal, eliminating collection of water in the septic tank that would later have to be removed for disposal. Also, addition of water could hinder the removal of the septic tank leach field and increase the potential of contaminant migration into the groundwater.

Tank Cleaning and Entry

The horizontal storage tanks HAS-1, 2, and 3 and CS-1 have been double rinsed and would be ready for demolition after a final rinse. Storage tanks US-1 and 2, containing hydrazine wastewater, were treated to undetectable levels of hydrazine and UDMH with hypochlorite (James 1987).

The vertical storage tanks US-3 and 4 contain hydrazine wastewater that would be pretreated with oxidizing chemicals. The tanks would require a final rinse before demolition. Rinsing would be accomplished using a pressure washer, with wastewater generated from the rinsing process pumped to the in-ground concrete tank.

Before cleansing operations begin, all tanks must be certified safe for entry. Certification would include determination of oxygen content and flammable/explosive levels, in addition to monitoring for NDMA, Hydrazine, MMH, and UDMH, as part of the project monitoring discussed in the Health and Safety Plan (Section 3.7).

Access to the horizontal and vertical tanks for cleaning and staging equipment, as well as for subsequent demolition efforts would be gained by cutting a hole through the tank wall at ground level. Storage tank US-4 would require special sampling procedures to assure that the sand underlying the tank bottom has not been contaminated with UDMH due to the potential for minor leakage from past activities. If the sand under the tank is contaminated, it would need to be flushed with an oxidizing rinse to reduce the risk of explosion and then disposed with the concrete debris.

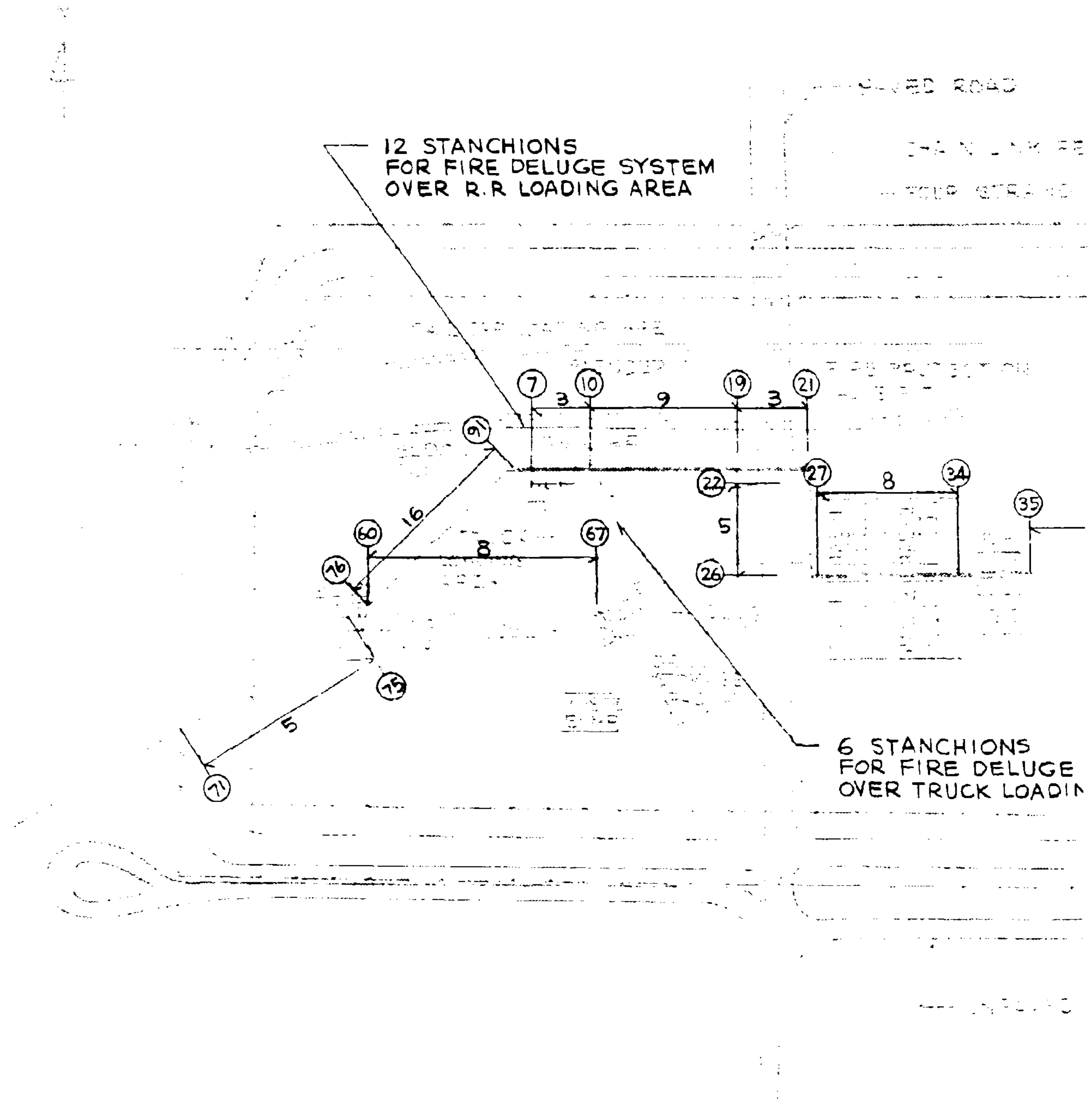
3.3.1.2 Asbestos Hazard Reduction

Sources suspected of containing asbestos material are the above ground piping, insulation on mechanical equipment, building insulation, and insulation on piping within the buildings. Review of available information indicates the use of asbestos containing materials on 4,157 ft of piping, and the heat exchanger and expansion tank in Building 755.

Four sections of piping are suspected of containing insulation with an asbestos content greater than 1 percent by weight. Three of these sections originate from the change house, while the fourth is on the main pipe run between the hydrazine blender and the horizontal storage tanks. The four sections are between stanchions 71-75, 60-67, 76-91, and 7-34 (see Figure 3-4). Testing of these insulation materials, as well as insulation in the walls and ceilings of Buildings 868, 759, and 755, as well as the piping in these buildings, would be necessary to determine the actual quantities of asbestos present on site. Additionally, for waste disposal purposes, the asbestos would be considered a hazardous waste because of the potential for NDMA contamination through reported leaks at pipes and flanges.

Removal of asbestos containing materials (ACM) is subject to the following regulations:

- When a building is demolished, more than 250 linear ft of asbestos pipe insulation removed, or 160 sq. ft of asbestos surfacing material removed during renovation, advance notice



WEST AREA

STORAGE TANKS TANK	SIZE(GAL)	CONSTRUCTION
[illegible]-1,2 & 3	24,900	STAINLESS STEEL
[illegible]	24,900	STAINLESS STEEL
[illegible] & 2	19,000	CARBON STEEL
[illegible]-3	50,000	CARBON STEEL
[illegible]-1	[illegible],000	CARBON STEEL
WASTE SUMP	[illegible]	IN GROUND CONCRETE

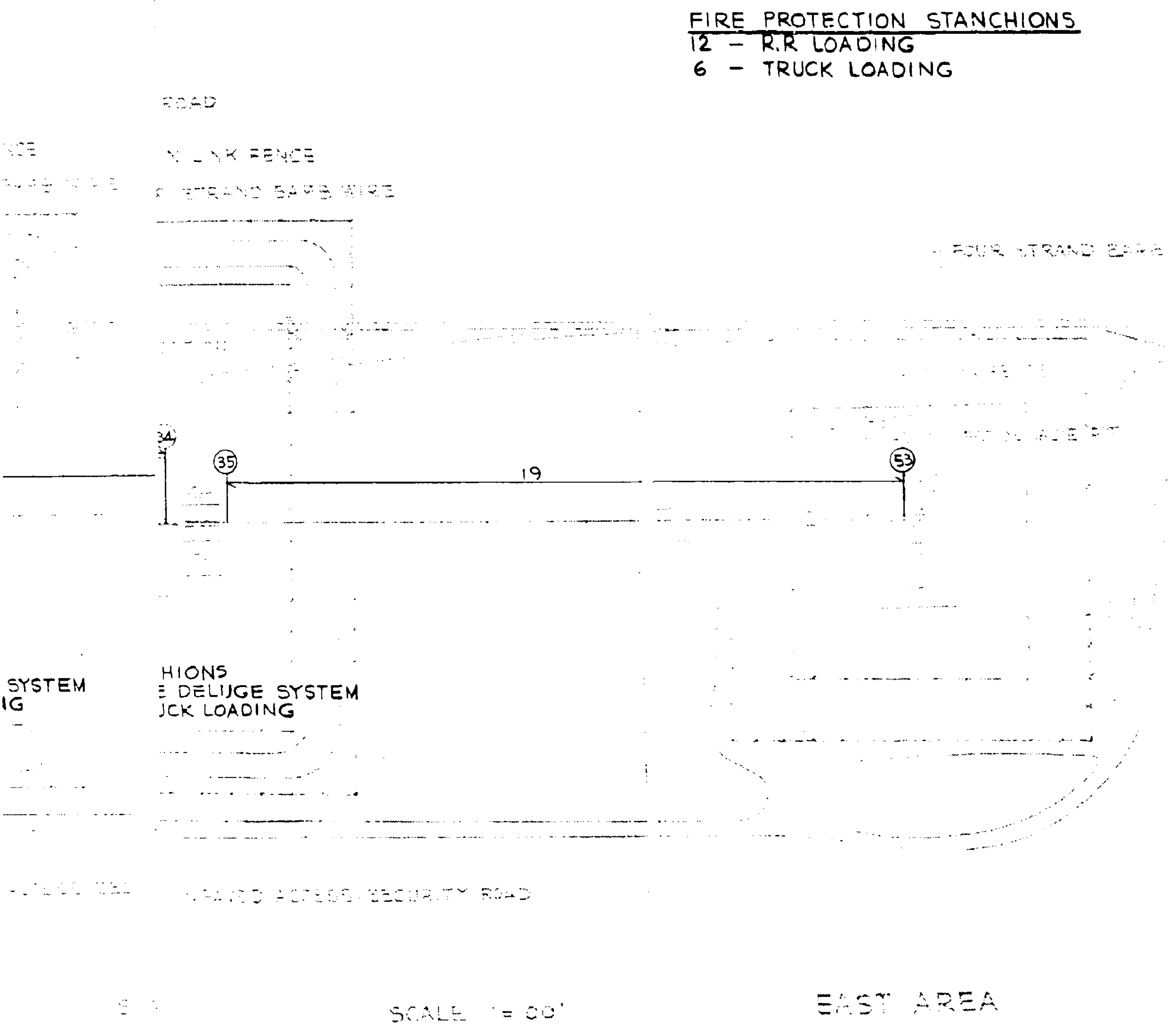


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Figure 3-4.
LOCATION OF PIPE SUPPOF
STANCHIONS
ROCKY MOUNTAIN ARSENAL, TASK
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must be filed with the EPA regional office and/or the state, giving:

- name and address of the building owner or manager;
- description and location of the building;
- scheduled starting and completion dates of ACM removal;
- description of the planned removal methods; and
- name, address, and location of disposal site.

o ACM can be removed only with wet removal techniques. Dry removal is allowed only under special conditions and only with written EPA approval. In this case, however, dry removal is required because of the potential NDMA contamination and the hazardous waste disposal requirements to eliminate free liquids in wastes disposed of in landfills.

o No visible emissions of dust are allowed during removal, transportation, and disposal of ACM.

Complete removal of all asbestos materials prior to demolition would prevent violation of either 29 CFR 1910, 1001 Asbestos, and 40 CFR 61 Subpart M, National Emission Standards for Asbestos. These regulations describe limits on workplace exposure to asbestos (29 CFR 1910), 1001 and environmental limits on air emission levels of asbestos during demolition (40 CFR 61). Removal techniques should result in no visible emission of asbestos. Complete removal, as well as proper handling of asbestos during the hazard reduction phase would ensure that timely demolition can take place as part of the decommissioning project.

Piping insulation is expected to be the largest single source of asbestos material. Two alternatives were evaluated for disposal of insulated piping: removal of piping with encapsulated insulation intact, and stripping the insulation prior to removal. Stripping the insulation is the recommended procedure based on the following rationale.

- Disposal of insulated piping requires the piping to be double-wrapped. This is time-consuming and limits the removal of piping in sections.

- Wrapped piping requires special handling to avoid tears.

- Some hazardous waste land disposal facilities require asbestos to be drummed for disposal purposes.

- Encapsulation has the potential for asbestos emissions during loading and unloading operations and transportation.

Insulation on process piping would be removed using the glove-bag method. This method uses a plastic bag fitted with gloves which attaches to the pipe. The bag is sealed around the pipe and the insulation removed inside the bag. After insulation removal, the bag is moved to the next section of pipe. This process is repeated until the bag is full at which time the bag is removed, sealed, and drummed for disposal. It is expected that a demonstration for the EPA Regional Administrator of the dry technique would be required for compliance with air emission regulations (40 CFR 61.147 and 61.152). It is recommended that free adsorbent material be added to the sealed containers to minimize the minimal amounts of free water that may be unavoidably added.

Underground fire protection piping contains a concrete asbestos mixture. The piping was not considered in the hazard reduction plan because the asbestos is in a nonfriable state. It may be necessary to shorten the piping for disposal, although breaking should be minimized. During removal, this piping should be broken into smaller sections and not cut since the latter would produce a dust containing asbestos. Breaking of the pipe should be conducted in an enclosed space.

If asbestos is found in the building insulation, it would be removed using standard techniques. These techniques establish an asbestos control area under negative pressure with respect to the surrounding area. To support the asbestos control area, a decontamination chamber would be used to decontaminate workers. Dry asbestos removal techniques would be used to the extent possible to limit the water content of the insulation waste. This would comply with hazardous waste regulations prohibiting the disposal of free water into a hazardous waste landfill. The dry asbestos material should be disposed of in drums or other containers of sufficient strength to prevent being crushed during landfill operations.

Mechanical items suspected of having asbestos insulation are located in building 755 and consist of the heat exchanger and associated piping. Prior to demolition, this insulation would be removed in a manner consistent with the wall and ceiling insulation removal procedure discussed above.

3.3.1.3 Polyurethane Insulation

The polyurethane insulation on the horizontal and vertical storage tanks would be removed prior to dismantling the tanks. Because of access problems, the fire deluge sprinkler system would have to be removed before the insulation can be removed. The insulation would be removed to reduce fire safety hazards. Polyurethane insulation can produce toxic oxides of nitrogen and other chemical irritants when burned. To prevent combustion, polyurethane insulation is usually treated with fire retardants, but some of the earlier polyurethane formulations have poor or no fire retardant capabilities. Since the polyurethane insulation at the HBSF has not been tested, and there is no assurance that the insulation is from a manufacturer that used fire retardants, it is recommended that the insulation be removed.

The horizontal storage tanks (HAS-1, 2, and 3, CS-1 and US-1 and 2) are presumed to be coated with a 3-inch layer of polyurethane covered with a thin metal shielding. Likewise, storage tanks US-3 and 4 are also covered with a 3- to 6-inch layer of polyurethane insulation.

The methods evaluated for insulation removal included sand blasting and stripping. Sand blasting is ruled out because it produces large quantities of finely divided material which can easily be dispersed off-site by wind. Scraping appears to be the most viable alternative, using power hand tools or shovels to facilitate the process. In some cases, a backhoe may be used to scrape large portions of the storage tanks, thereby greatly speeding the process. The insulation would be picked up or vacuumed up and then drummed for disposal.

3.3.1.4 PCB-Containing Electrical Equipment

Results from earlier testing show that only one of the five transformers on-site contains PCB contaminated oil, in the 50-500 ppm PCB range. To simplify the oil disposal, it is recommended that all the oil be treated as PCB-contaminated. This should not add significantly to the disposal cost since the total oil volume is relatively small. Oil from the transformers would be drained and the transformers rinsed with a solvent according to 40 CFR 761. These regulations prescribe how PCB-contaminated items are to be handled and disposed. PCB oil would be removed, drummed, and shipped in accordance with TSCA regulations 40 CFR 761.60 and 761.65 and the Department of Transportation hazardous material regulation 49 CFR 173.510. The transformer carcasses would be triple solvent rinsed before disposal. The PCB oil would then be disposed according to Section 3.3.2

Two options are available for disposal of PCB-contaminated oil greater than 50 ppm according to 40 CFR 761. Those options are TSCA Annex III incineration or detoxification. Detoxification is not suggested since the waste oil would not be reused and there are high costs for mobile detoxification operations.

Several commercial waste incineration facilities would accept PCB-contaminated oil. The closest hazardous waste incineration facilities to RMA as of July 1987 are Rollins Environmental Services in Deer Park, Texas; Westinghouse facilities in Coffeeville, Iowa; the ENESCO facility in El Dorado, Arkansas; and the Chemical Waste Management facility in Chicago, Illinois.

3.[illegible] mmable and Other Miscellaneous Liquids

Flammable liquids would be handled in such a manner as to reduce the risk of explosion or fire. The majority of flammable liquids at the HBSF consist of paints and solvents and are found as miscellaneous debris in Buildings 759 and 868 (refer to Table 3-8). Flammable liquids such as cleaning solvents would be allowed to evaporate on site in open containers. Containers would be placed on the drum cleaning pad away from buildings to minimize the risks associated with a fire. The contents of aerosol cans would be discharged prior to disposal. The empty aerosol containers would then be packed in drums for disposal as a safety precaution. The existing drums on-site should be suitable packing containers for this purpose.

Liquids which are unsuitable for evaporation or have no markings would be analyzed and packaged for disposal at a hazardous waste incinerator.

3.3.1.6 Overhead Equipment

The dismantling of platforms, fire protection piping, overhead process piping, and unloading and loading arm support structures would be done with the help of a scissors manlift and scaffolding. Since workers may be in level B personal protective equipment, close attention would be given to the Occupational Safety and Health Standards 29 CFR 1910.21, Subpart D, Walking-Working Surfaces, and 29 CFR 1910.66 Subpart F, Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms. These regulations provide for the safe use and handling of scaffolds and powered manlifts.

3.3.2 Liquid Waste Disposal Plan

Liquid waste at the HBSF can be divided into four categories:

- Process wastewaters
- Ethylene glycol
- PCB-contaminated transformer oil
- Flammable and other miscellaneous liquids

Of the four categories, only process wastewaters and ethylene glycol are of primary concern because of their volumes and distribution in large tanks. PCB-contaminated transformer oil and flammable liquids were previously discussed in the Hazard Reduction Plan.

Process Wastewaters

Waste liquid inventories for the four categories are presented in Table 3-7. The bulk of liquid disposal costs would be associated with the 300,000 gallons of process wastewaters, including water found in tanks US-1, US-2, US-3, and US-4 and bermed areas, and water generated from equipment, pipe, and tank rinsing.

The preferred wastewater treatment alternative is chemical oxidation with either hydrogen peroxide/UV or ozone/UV followed by the discharge of treated wastewater to a drainage system. Details of the treatment system were presented in Sections 2.7.1 1 and 2.7.1.2. The equipment, piping and tank rinse water and decontamination wastewaters from demolition equipment and personnel would also be transferred to the chemical oxidation system for treatment and disposal if required. The treatment system would permit the rapid removal of process wastewater and would be constructed at the beginning of the decommissioning. This timing of wastewater removal would be necessary to ensure that dismantling and demolition could proceed without delay during the same construction season.

Ethylene Glycol

An ethylene glycol and water mixture was used as a "heat transfer" fluid in the heat exchanger system. This mixture is in the piping connected to the heat exchanger, comprised of the supply and return lines to water jackets on the horizontal tanks and heat tracer pipes. Most of the above-ground process piping has heat tracing.

Ethylene glycol would be drained from the heat exchanger piping system. The system would then be blown dry with air. Special care would be exercised to assure that the glycol has been totally removed from the horizontal tank water jackets. As listed in Table 3-7, there are approximately 4,500 gallons of glycol in the heat exchanger system. The glycol water mixture would be drummed for treatment and disposal purposes.

It is anticipated that the glycol mixture would be incinerated, based on the following:

- The glycol is liquid waste that cannot be landfilled. Land treatment would require extensive testing to properly assure public health and safety;
- The volume of glycol is small such that further study would be inappropriate given the expense and proven destruction characteristics of high temperature incineration for organic wastes; and
- It is uncertain whether the evaporation pond or the other wastewater treatment processes considered would be amenable to treatment of NDMA contaminated ethylene glycol.

The removal of ethylene glycol liquid waste is essential because much of the west end piping is heat traced and horizontal tanks are jacketed with glycol. The removal of ethylene glycol allows dismantling and demolition to proceed without the release of glycol liquid.

3.3.3 Dismantling/Demolition Plan

The Dismantling/Demolition Plan would be implemented after the Hazard Reduction and Liquid Waste Disposal Plans are complete, except for removal of polyurethane insulation, and disposal of transformer oil and decontamination wastewaters.

The use of standard demolition techniques is anticipated, however, personal protective equipment and clothing will be level B or less as described in the Health and Safety Plan.

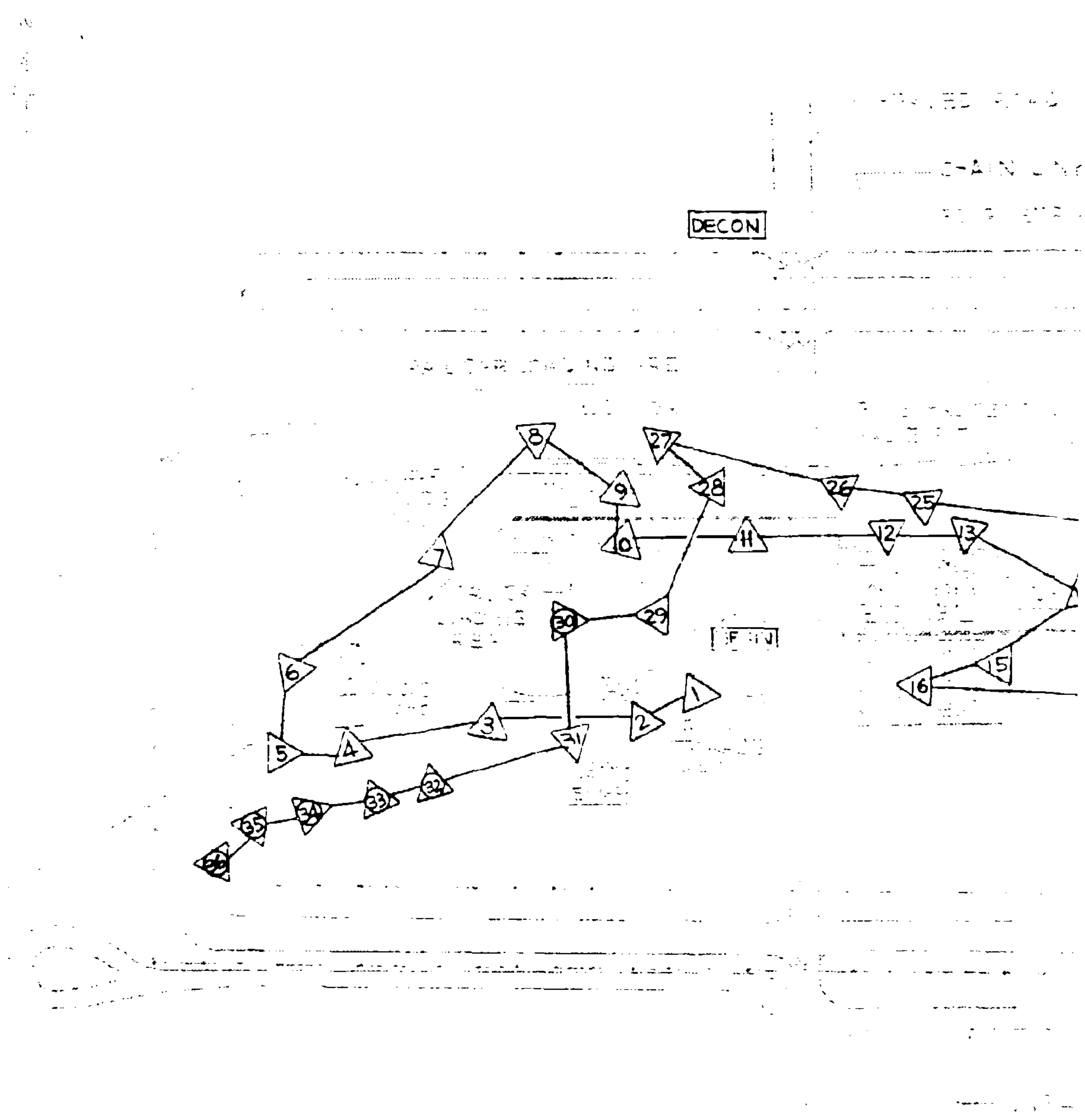
The dismantling and demolition plan for the HBSF is divided into 36 tasks and divided between the responsible parties, the Air Force and the PMO-RMA. Section 3.3.3.1 identifies the 36 tasks. Subsequent sections identify a potential division of responsibilities between the Army and the Air Force.

This division of responsibility was based on the Memorandum of Understanding (Appendix A). The tasks were chosen to facilitate the division of responsibility between the U.S. Air Force and PMO-RMA, and to give a convenient point of reference for cost estimating. An item not covered by the division of responsibility is miscellaneous debris. The debris located inside buildings was assumed to be the PMO-RMA's responsibility while debris located outside of buildings was considered the Air Force's responsibility.

The task sequencing has some flexibility to accommodate unforeseen field problems or improved productivity. Tasks were divided up to remove above ground or below-ground items. For simplicity, pipe supports and their foundations were considered to be one severable item. The sequence of the 36 tasks is influenced by the hazard reduction plan and the hydrazine contaminated wastewater treatment, both of which can occur simultaneously.

Figure 3-5 shows the general progression of tasks over the HBSF. The demolition tasks would begin with the removal of above-ground equipment in the west area, followed by removal of the above-ground equipment in the east area. Conversely, removal of the at-grade and below-ground equipment would begin in the east area and conclude in the west area.

To facilitate discussion of the tasks, 32 plates are provided in Appendix C. The plates have been sequenced to follow the tasks. An index is provided in Appendix C to cross-reference tasks and plates.



STORAGE TANKS TANK	SIZE (GAL)	CONSTRUCTION
[illegible] 1,2 & 3	24,900	STAINLESS STEEL
[illegible]	24,900	STAINLESS STEEL
US-1 & 2	19,000	CARBON STEEL
US-3	50,000	CARBON STEEL
US-4	200,000	CARBON STEEL
WASTE [illegible]	44,000	IN GROUND CONCRETE

WEST AREA

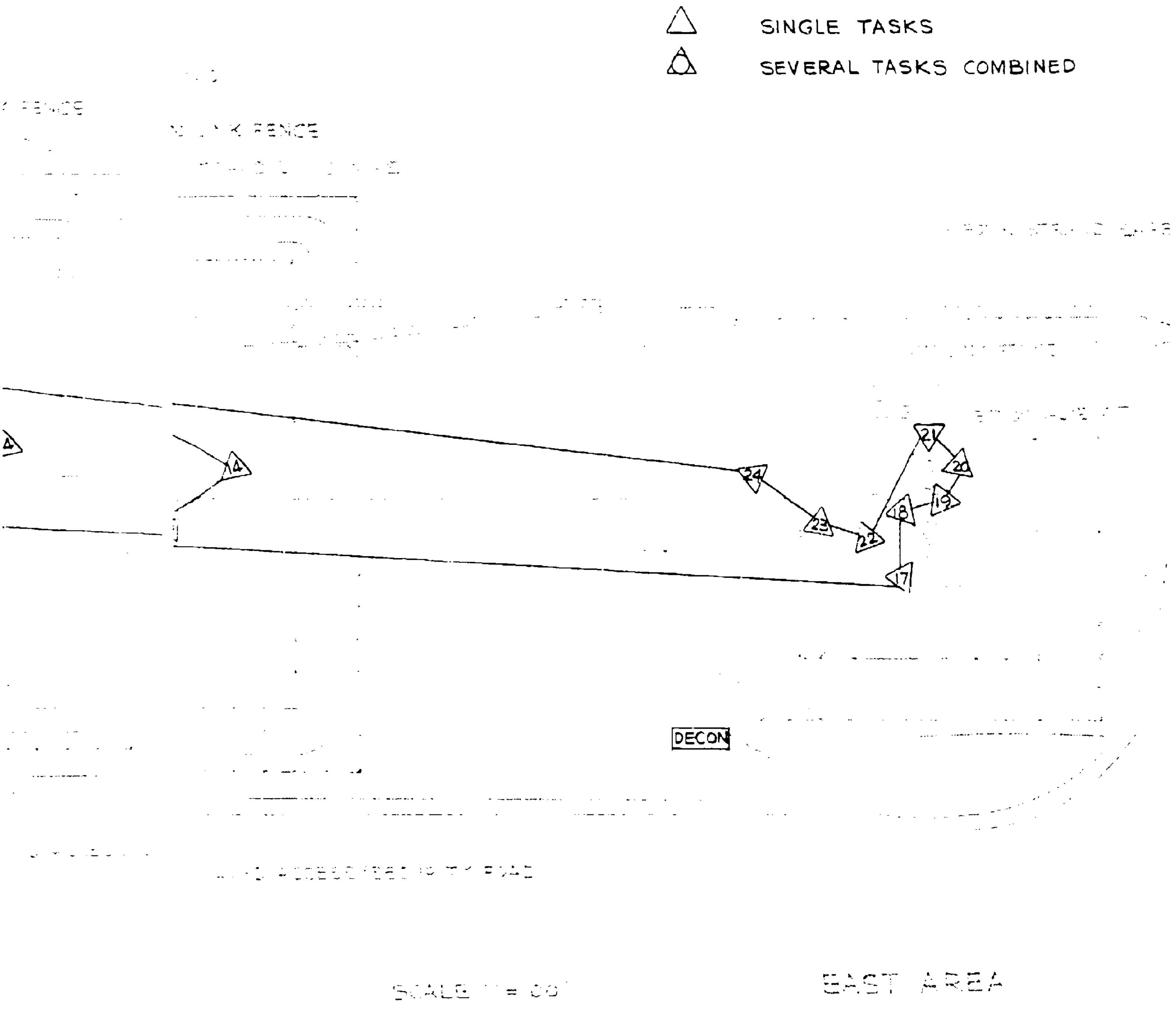


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Figure 3-5.

GENERAL PROGRESSION
DEMOLITION TASKS

ROCKY MOUNTAIN ARSENAL, TASK
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3.3.3.1 Dismantling/Demolition Tasks

The tasks are as follows:

1) Demolish Building 760 leaving the floor slab which would be removed with the nonseverable equipment.
2) Demolish Building 759 leaving the floor slab which would be removed with the nonseverable equipment.
3) Demolish piping and 8 stanchions between Buildings 759 and 755. Stanchions would be cut at ground level and their footings removed. The stanchions locations are shown in Figure 3-4 (Numbers 60 - 67). Remove and crush drums located near the truck turnaround.
4) Demolish Building 868 leaving the floor slab which would be removed with the nonseverable equipment.
5) Demolish piping and 5 stanchions between the west fence and Building 755. Stanchions would be cut at ground level and the footings removed. Stanchion locations are shown in Figure 3-4 (Numbers 71 - 75).
6) Demolish Building 755 leaving the floor slab which would be removed with the nonseverable equipment including disposal of miscellaneous debris located inside the building.
7) Demolish piping and the 16 stanchions between Building 755 and the hydrazine loading area. Stanchions would be cut at ground level and their footings removed. Stanchion locations are shown on Figure 3-4 (Numbers 76 - 91).
8) Demolish fire protection piping and 12 support stanchions located over the railroad loading facility. Support stanchions are bolted to a concrete slab and hence do not have foundations. Stanchion locations are shown in Figure 3-4.
9) Demolish miscellaneous equipment in the hydrazine blender area including the blender, scrubber, drum filler, loading arms, and surrounding miscellaneous debris. (See Tables 3-2 and 3-3 for miscellaneous debris.)
10) Demolish the railroad loading and truck loading platforms in the hydrazine blender area.

11) Demolish piping and 28 support stanchions between the hydrazine blender and the horizontal storage tanks including removal of stairs, handrails and metal grating attached to the stanchions. Stanchions are bolted to concrete foundations which would also be removed. Stanchion locations are shown on Figure 3-4 (Numbers 7 - 34).

12) Demolish horizontal storage tank HAS-1. This includes removal of the fire deluge sprinkler system and stripping the insulation. Dismantlement of tanks is further discussed in Section 3.3.3.3.

13) Demolish horizontal storage tank HAS-2. Refer to item 12 for work description.

14) Demolish storage tanks US-1 and 2. Refer to item 12 for work description.

15) Demolish horizontal storage tank HAS-3. Refer to item 12 for work description.

16) Demolish horizontal storage tank CS-1. Refer to item 12 for work description.

17) Demolish the fire protection deluge system over tank US-4 (200,000 gal).

18) Strip polyurethane insulation from tank US-4 and dismantle. Dismantlement of tanks is further discussed in Section 3.3.3.3.

19) Demolish the fire protection deluge system over tank US-3 (50,000 gal).

20) Strip polyurethane insulation from tank US-3 and dismantle. Dismantlement of tanks is further discussed in Section 3.3.3.3. Also remove all above-ground structural steel, pumps, and piping from the transfer pit.

21) Demolish and remove the concrete bermed area around tank US-3 and the concrete transfer pit. Backfill area to grade with noncontaminated soil.

22) Demolish and remove the concrete bermed area around tank US-4. Backfill area to grade with noncontaminated soil.

23) Remove miscellaneous concrete pads and structures: nitrogen pad, emergency eye wash pad, and the fire protection valve pit and outside debris. Backfill any remaining depressions with noncontaminated soil.

24) Demolish piping and 19 support stanchions connecting tanks US-3 and 4 to US-1 and 2. The stanchion foundation would be removed to a depth of 3 feet below the ground surface and backfilled with uncontaminated soil. Stanchion locations are shown on Figure 3-4 (Numbers 35-53).

25) Demolish and remove the concrete berms around tanks HAS-1, 2, 3, and US-1 and 2. Backfill area to grade with noncontaminated soil.

26) Demolish and remove the concrete fire protection valve pit and backfill with noncontaminated soil.

27) Remove and dispose of 120 feet of railroad track and ties from the hydrazine blender pad. Remove the underlying drainage piping below the pad.

28) Demolish and remove the concrete slabs for Buildings 755, 868, and 759. Remove underlying drainage piping below these slabs.

29) Remove underground piping in the east and west areas. This includes drainage lines, potable water lines, fire protection lines, and the change house septic tank and leach field. Figures 3-2 and 3-3 show the location of wastewater drainage lines and water supply lines, respectively.

30) Remove buried conduits located in the east and west areas. Figure 3-6 shows the location of buried conduits.

31) Remove above-ground electrical conduits, poles and transformers located in the east and west areas.

32) Remove the pavement for the truck turnaround and other pavement in the west area.

33) Demolish and remove in-ground concrete tank or waste sump. Backfill area to grade with noncontaminated soil.

34) Demolish and remove the drum storage pad, with underlying piping and backfill to grade with noncontaminated soil.

35) Remove the interior chain link fences around the east and west areas.

36) Remove the exterior barbed-wire fences around the east and west areas.

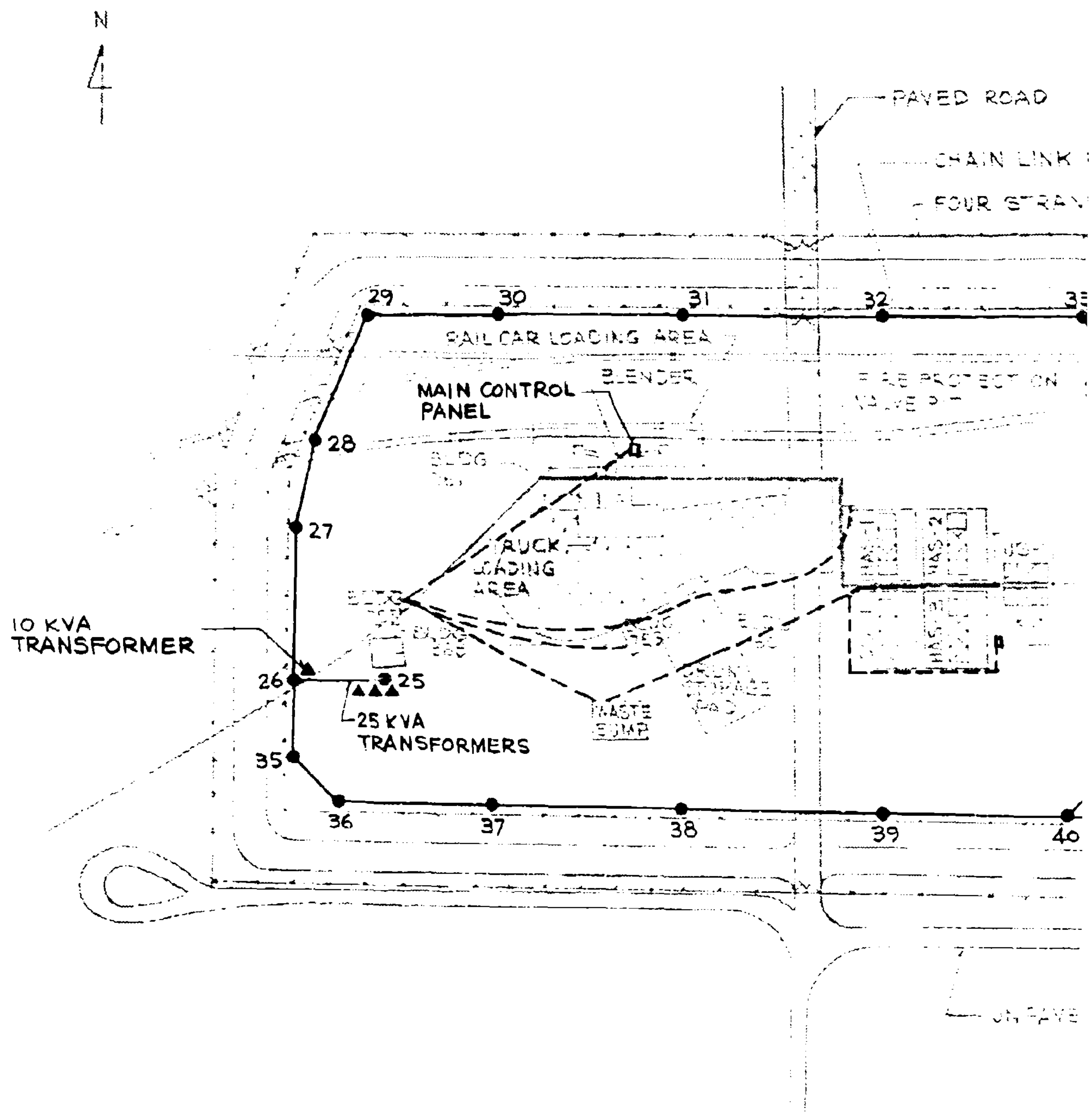
3.3.3.2 USAF Responsibilities

Based on the MOU, the Air Force, with some exceptions, is responsible for the removal of severable equipment consisting of: storage tanks; the above-ground piping and its associated support stanchions; and the above-ground electrical system including power poles, junction boxes, and transformers. Additionally, the Air Force would remove portions of miscellaneous debris. Based on these delineations, the Air Force is responsible for Tasks 3, 7 through 20, 24, and 31, while the Army is responsible for the remainder of the tasks.

Above Ground Piping and Support Stanchions

Above-ground piping and support stanchions would be removed in Tasks 3, 7, 8, 11, and 24. In general, piping would be dismantled in 20- to 40-foot sections with cuts being made with an acetylene torch. Piping would be neatly stacked on a tarped flat bed trailer or in a tarped-end dump truck to conserve site space. Support stanchions would be cut at ground level and their foundations removed with a backhoe.

Included with the removal of stanchions, Numbers 7 through 34 is the removal of all attached handrails, cross-bracing, and grating. Figure 3-5 shows a sketch of stanchion locations and the corresponding numbering system used in the design drawings. This includes items which are "unattached" or lying on the hydrazine area pad such as old pump motors.



STORAGE TANKS TANK	SIZE (GAL)	CONSTRUCTION
HAS-1, 2 & 3	24,900	STAINLESS STEEL
CS-1	24,900	STAINLESS STEEL
US-1 & 2	19,000	CARBON STEEL
US-3	50,000	CARBON STEEL
US-4	200,000	CARBON STEEL
WASTE SUMP	44,000	IN GROUND CONCRETE

WEST AREA

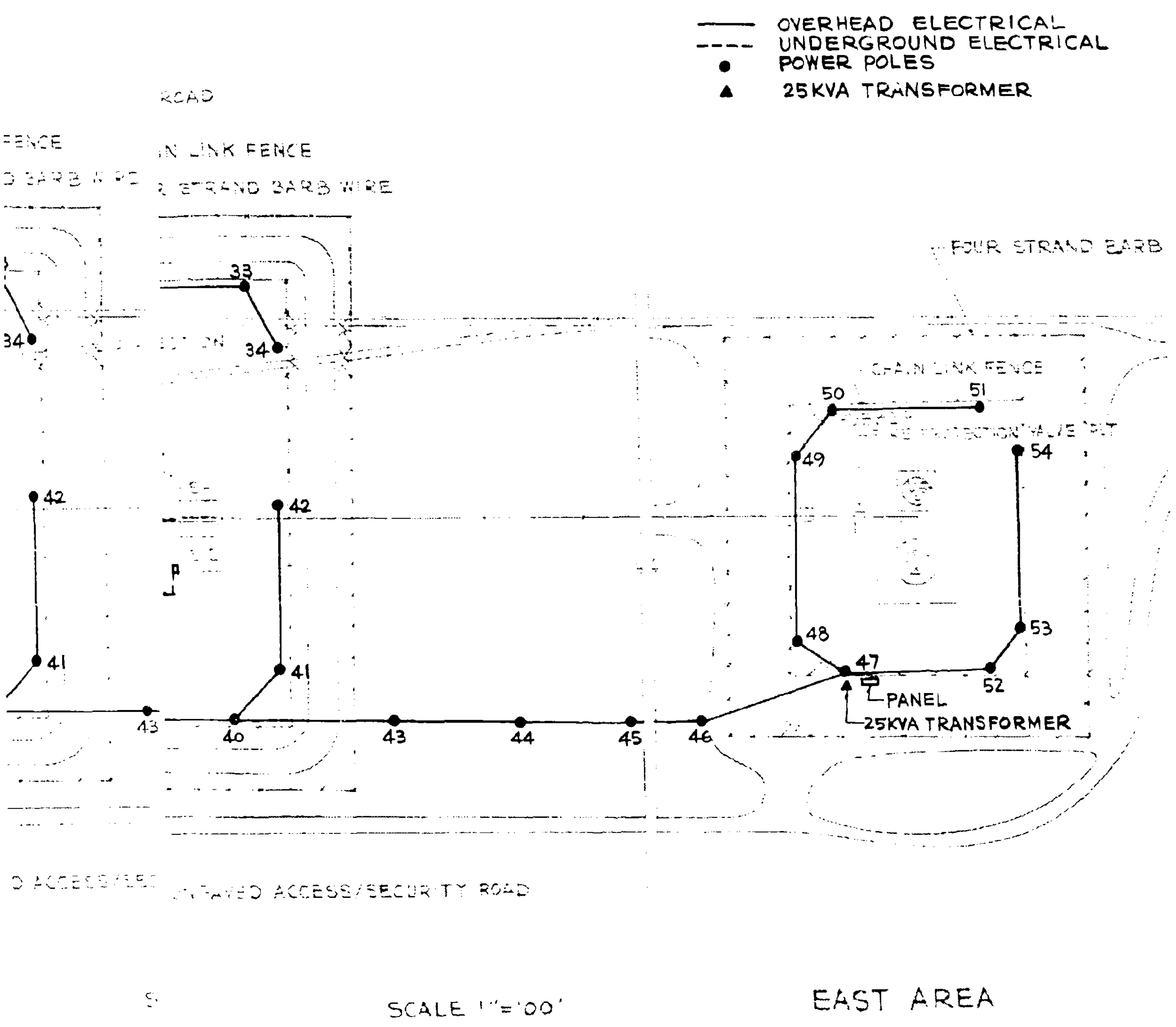


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Figure 3-6.

LOCATION OF OVERHEAD AN
UNDERGROUND ELECTRICAL SY

ROCKY MOUNTAIN ARSENAL, TASK 3
Prepared by EBASCO Services, Incorpor

Task 3 also includes the removal of empty drums on site. Drums would be crushed on-site using either a dozer or a hydraulic drum crusher. Table 3-3 lists the number and location of drums.

Miscellaneous Debris in the Blender Area

Tasks 9 and 10 describe the removal of equipment and debris in the hydrazine blender area. To decrease the waste volumes the hydrazine blender area, air scrubber, drum filler, and loading arms 4211 would be dismantled. Any miscellaneous debris in the hydrazine area would be removed. This includes items which are "unattached" or lying on the hydrazine area pad such as old drums or insulation.

Demolition of Storage Tanks

The horizontal and vertical storage tanks would be demolished in Tasks 12 through 20. All storage tanks have a fire deluge sprinkler system which would be removed prior to demolition. The deluge system consists of piping and a support structure which surrounds the tank.

It was anticipated that the storage tanks could be dismantled by means of an acetylene torch, after stripping away the insulation coating.

Horizontal Tanks

After wastewater and insulation removal, storage tanks HAS-1, 2, and 3, CS-1, and US-1 and 2 would be dismantled by vertically cutting off their hemispherical ends. The remaining cylindrical sections would be cut horizontally leaving two sections which can be stacked. If necessary, the water jacket on the cylindrical tank section may have to be removed prior to stacking.

Vertical Tanks

After wastewater removal, insulation removal and tank cleaning, the tank lids for US-3 and 4 would be cut and removed in one section to a ground-level work area. The lids would then be cut into 8-foot wide strips to fit onto the transport vehicles. The cylindrical sides of the tanks would be cut into 8 feet wide vertical strips. Tank US-3 would be cut into nine strips and US-4 would be cut into 12 strips. These strips can be stacked horizontally to minimize volumes for removal and transportation to disposal. Tank floors would be disassembled using the procedures outlined for the lids.

Above Ground Electrical System

The removal of the above-ground electrical system is described in Task 31. This task includes deenergizing the electrical system, and the removal of conduit, junction boxes, poles, wire, and transformers in the east and west areas. Disposal of the transformer is further discussed in the Hazard Reduction Section 3.3.1.

3.3.3.3 U.S. Army Responsibilities

Based on the MOU, the Army is responsible for removal of the nonseverable equipment including buildings, concrete bermed areas, building floor slabs, equipment pads, underground piping, underground conduits, and fencing. In addition, the Army is responsible for the removal of some above-ground piping and support stanchions. Based on these delineations, the Army is responsible for Tasks 1, 2, 4, 5, 6, 21, 22, 23, 25 through 30, and 32 through 36.

Demolition of Buildings

Tasks 1, 2, 4, and 6 describe the demolition of Buildings 760, 754, 755, and 868. Before demolition, any liquid wastes in these buildings would be removed in accordance with the hazard reduction and liquid waste handling/disposal plans.

Mechanical items containing liquids are located mainly in the change house and include the heat exchanger, water heater, and expansion tanks. Prior to demolition, these items would be removed and their contents drained or flushed with compressed air and disposed of during liquid waste handling/disposal.

Buildings 760, 759, 755, and 868 would be demolished using conventional construction equipment. Building debris would be compacted using heavy equipment to reduce void spaces prior to disposal. Buildings 759 and 760 are modularly constructed metal structures. The buildings would be taken apart piecewise to generate minimum debris volumes.

Pipe Supports and Associated Piping

Task 5 deals with the removal of stanchions 71 through 75 located between the west fence and Building 755. Pipe stanchions would be cut at ground level and their foundations removed with a backhoe.

Concrete Berms, Pads, and Pavement

The removal of the concrete berms around the storage tanks, the building and equipment pads, and the paved areas is described in Tasks 21, 22, 23, 25, 28, 32, and 34. Berm walls, floor slabs, and pavement would be demolished and removed with conventional construction equipment. Soil beneath the floor slabs and pavement would be tested for hydrazine fuels and NDMA contamination and removed if contaminated. Drainage piping located beneath floor slabs and pavement would also be removed. Bermed areas would be backfilled with uncontaminated soil and lightly compacted.

Valve Pit

Task 26 is the demolition of the fire protection valve pit. The fire protection system for the HBSF would be shut down. Piping and other mechanical equipment would be taken out before demolition of the concrete structure. After removal of the concrete debris, the pit would be backfilled and compacted.

Railroad Tracks

The removal of the railroad tracks from the hydrazine loading/blending area is described in Task 27. Approximately 120 feet of railroad tracks and ties would be removed from the hydrazine blender slab. Both air monitoring and soil sampling would be performed in accordance with the Health and Safety Plan and QA/QC requirements. No provisions are made in the decommissioning plan for replacement of the tracks.

Underground Piping

Task 29 is the removal of underground piping in the west and east areas. All pumps or shutoff valves would be secured to isolate the underground piping. Piping includes drainage lines, potable water lines, fire protection lines, and the change house septic tank. The change house septic tank and its associated piping would be removed along with its tile leach field. Piping would be excavated using a backhoe.

The drainage piping would be inspected for holes or leaky joints upon removal. Sampling would be done where contamination is suspected. Both the health and safety plan and the quality assurance and quality control plans would be followed for air monitoring, visual inspection of deteriorated piping, or soil sampling for hydrazine fuels or NDMA. Any contaminated soil would be removed and the trench backfilled.

Underground Conduits

Task 30 is the removal of underground conduit in the west and east areas. Conduit locations are shown in Figure 3-5. In general, conduits are buried close to the ground surface and should be removed with a minimal amount of excavation after deactivating the electrical system.

In-Ground Concrete Tank

Task 33 is the removal of the in-ground concrete tank. During most of the decommissioning plan, the tank can be used to collect and store wastewater. Before demolition the wastewater in the in-ground concrete tank would be removed and disposed of as described in the Liquid Waste Handling/Disposal Plan. The in-ground concrete tank would be demolished, concrete removed, and the area backfilled. Both air monitoring and soil sampling would be performed in accordance with the Health and Safety Plan and QA/AC requirements.

Fencing

Tasks 35 and 36 are the removal of the interior and exterior fences around the west and east areas. Fencing would be rolled after removal for disposal. Fence posts would be removed and bundled for disposal.

3.3.4 Solid Waste Handling/Disposal Plan

While dismantling/demolition is in progress, solid waste would be generated for disposal. To avoid multiple handling steps, the demolished materials would be loaded into transport trailers for disposal at a permitted hazardous waste land disposal facility. The solid waste handling/disposal plan describes the recommended options for HBSF solid waste handling and disposal.

Two options were evaluated for solid waste disposal: on-site and off-site disposal facilities. Since the decontamination of the HBSF solid wastes cannot completely confirm the elimination of the carcinogen NDMA, all HBSF solid wastes are considered to be hazardous waste for disposal. On-site disposal of solid waste was not considered a feasible alternative because there are no permitted hazardous waste land disposal facilities located at RMA. Permitting of a land disposal facility was not considered because of the relatively small amount of debris generated from decommissioning operations (less than 3,000 cubic yards).

Table 3-9 lists the closest known permitted hazardous waste landfills along with their corresponding distance from Denver. Based on work completed in the January 1984 "Decontamination Assessment for Land and Facilities at RMA" (RMACCPMT 1984/RIC 84034R01), transportation by rail is more economical than public highway for distances greater than 400 miles. Since few of the six facilities listed in Table 3-9 are known to have direct access to railroad unloading facilities, railroad transportation would be limited to piggy-backing trailers to the nearest unloading facility.

Regardless of whether solid wastes are shipped via rail or public highway, they would be hauled in 25-ton rear dump (gondola) trailers or on flatbed trailers. The tractor and trailer have a tare weight of approximately 36,000-pounds with a capacity for 50,000-pounds of waste. The Colorado Department of Transportation has an 80,000-pound gross vehicle weight limitation for the transport of hazardous wastes (CSP 1986). Based on this limitation, trailers can haul 44,000-pounds of waste with an effective volume of about 20 cubic yards.

The Gondola or flatbed trailers are recommended for hauling solid waste debris because they can be more easily lined and tarped. In addition, these trailers are constructed to handle the impact loading associated with demolition work.

To minimize the risk associated with transportation and possible spread of NDMA-contaminated materials, the solid wastes would be shipped in double-lined trailers. Liner materials, commonly 10 to 20 mil polyethylene sheets, would be used to wrap the solid wastes. After

TABLE 3-9
HAZARDOUS WASTE DISPOSAL SITES

Location	Operator	Miles from Denver
Grassy Mountain, 48 miles east of Wendover, UT	U.S. Pollution Control	635
Gradview, ID	Envirosafe Services of Idaho, Inc.	951
Beatty, NV	U.S. Ecology	900
Kettleman Hills, CA	Chemical Waste Management	1,288
Arlington, OR	Chem-Securities, Inc.	1,132

loading, the trailers would be covered with a heavy duty tarp to protect the liners. Trailers would be double-lined to reduce trailer cleanup and maximize waste isolation during transportation.

Solid waste was estimated using two units of measurement. Metal items were estimated on a unit weight basis because of the possibility of exceeding highway weight restrictions before a haul truck has been completely filled. Building debris, on the other hand, has a lower unit weight compared to metal items which would result in haul trucks being filled before the weight restriction is met.

Metal weights can be conveniently converted into a unit volume by dividing by the unit weight of steel (490 lb/ft^3) and multiplying by an expansion factor of 2 to 7 depending on the bulkiness of the steel and how tightly it can be packed. This volume could represent an additional 70 to 250 cy to the total solid waste reported in Table 3-10.

Building debris and other items were estimated on a unit volume basis. A swell factor of 1.5 or 2.0 was used to calculate the expanded volume after demolition. The 1.5 factor was applied to concrete pads, walls, footings, and paved areas, while a 2.0 factor was applied to building debris and other miscellaneous items. Volumes of electrical cables and conduits were estimated on a linear-foot basis after being rolled on a spool for disposal. Miscellaneous items such as the blender, heat exchanger, and scrubber would be dismantled prior to disposal. Volumes listed in the waste inventory reflect the dismantled volumes.

Based on the summary of solid waste quantities presented in Table 3-10, there are approximately 470,000 pounds of metal and 2,500 cubic yards of debris generated from decommissioning operations at the HBSF. Using a 44,000-pound of solid waste payload with a 20-cubic yard trailer, there would be approximately 11 loads of metal debris and 127 loads of other debris. In total, approximately 140 trailer loads of debris, approximately 115 Army loads and 25 Air Force loads, would be required for transporting the solid wastes to an off-site land disposal facility.

TABLE 3-10
SUMMARY OF SOLID WASTES

Item	Table	Responsi-ability	Metal (lbs)	Expanded Volume (cy)
Demolition debris west area	3-1	A	6,154	1,821
	3-1	AF	204,801	168
Demolition debris east area	3-2	A	---	403
	3-2	AF	174,371	75
Piping - west area	3-4	A	13,462	35
	3-4	AF	41,291	---
Piping - east area	3-5	A	9,911	21
	3-5	AF	17,236	---
Asbestos - insulation	3-6	A	---	1.2
	3-6	AF	---	12.9
Subtotal		A	29,527	2,281
		AF	437,699	246
Total			467,226	2,537

3.3.5 Site Restoration Plan

The site restoration plan is divided into the closure plan and postclosure care. The closure plan deals with the decontamination and removal of equipment and subsequent revegetation of the HBSF after the demolition debris and solid wastes are removed. Postclosure care deals with vegetation maintenance.

The first step of the closure plan is decontamination and removal of the equipment decontamination area at the east end of the HBSF upon completion of demolition facilities and removal of solid wastes from this area of the facility. Procedures are discussed in Section 3.4.2, Support Facilities and Work Zones. The wastewater generated from the process would be directed to the evaporation pond discussed in Section 2.7. The removal of the west end equipment decontamination area would follow once the dismantling/demolition of the east end is completed.

Following removal of equipment from the west and east end of the HBSF and removal of any contaminated soil, the disturbed areas in the HBSF including the roads and areas previously covered with concrete or pavement would be disked and reseeded.

Minimal post closure care would be required at the HBSF since all contaminated materials would be removed. Vegetated areas should be monitored long enough to ensure a fully developed grass cover. The vegetated area may be watered to maintain the grass cover. Any ground water contamination identified in Task 11 would be subjected to the arsenal-wide ground water cleanup program.

3.4 DECOMMISSIONING EQUIPMENT AND SUPPORT FACILITIES

The decommissioning process requires the coordination of equipment, support facilities, and skilled personnel. This section describes equipment and support facilities requirements. A description of skilled personnel recommended for the HBSF site cleanup work is in Section 3.5 - Decommissioning Site Cleanup Personnel.

3.4.1 Equipment Requirements

The equipment requirements for the decommissioning plan are presented for each of the five decommissioning work plans:

- Hazard Reduction Plan
  - 1 Air compressor (185 cfm)
  - 1 Portable sump pump (50 gpm low head)
  - 2 Portable tank cleaning pressure washers (100 to 400 psi)
  - At least two chemical feed pumps (0-5 gpm and greater than 5 gpm)
  - Transfer pump and at least 500 feet of 3-inch industrial hose
  - Water truck
  - Pickup truck, F-150 or equivalent (supervisor pickup)
  - Fork lift 6,000-lb capacity
  - Scissors manlift SM 428
  - Health and safety equipment described in Section 3.7
  - Flatbed truck, F-600 or equivalent

- Liquid Waste Handling and Disposal Plan
  - Same as Hazard Reduction

- Demolition/Dismantling Plan
  - Air compressor, 185-cfm
  - Bulldozer, Caterpillar D-8 or equivalent
  - Wheel loader and back hoe, JD 510 FEL/B-H 0.5-cubic yard bucket or equivalent

- Tracked pipe layer, Caterpillar 955 FEL 2-cubic yard or equivalent
- Crane, Grove RT518, 18-ton or equivalent
- Water truck
- Pickup truck F-150 or equivalent
- Flatbed truck F-600 or equivalent
- Forklift 6000
- Scissor manlift
- Health and safety equipment as described in Section 3.7

o Solid Waste Handling/Disposal Plan

- Wheel loader and backhoe
- Crane, 18-ton
- Forklift
- Water truck
- Pickup truck, F150 or equivalent
- Flatdeck/flatbed, F-600 or equivalent
- Demolition 25-ton end-dump or flatbed 35-cubic yard trailer and tractor

o Site Restoration Plan

- Wheel loader and backhoe
- Seed drill
- Disc
- Demolition 25-ton end-dump trailer and tractor.

The equipment list is developed as a preliminary assessment of decommissioning equipment for the dismantling and demolition work. This equipment provided the basis for the preliminary cost estimate for the complete decommissioning assessment.

3.4.2 Support Facilities Requirements and Work Zones

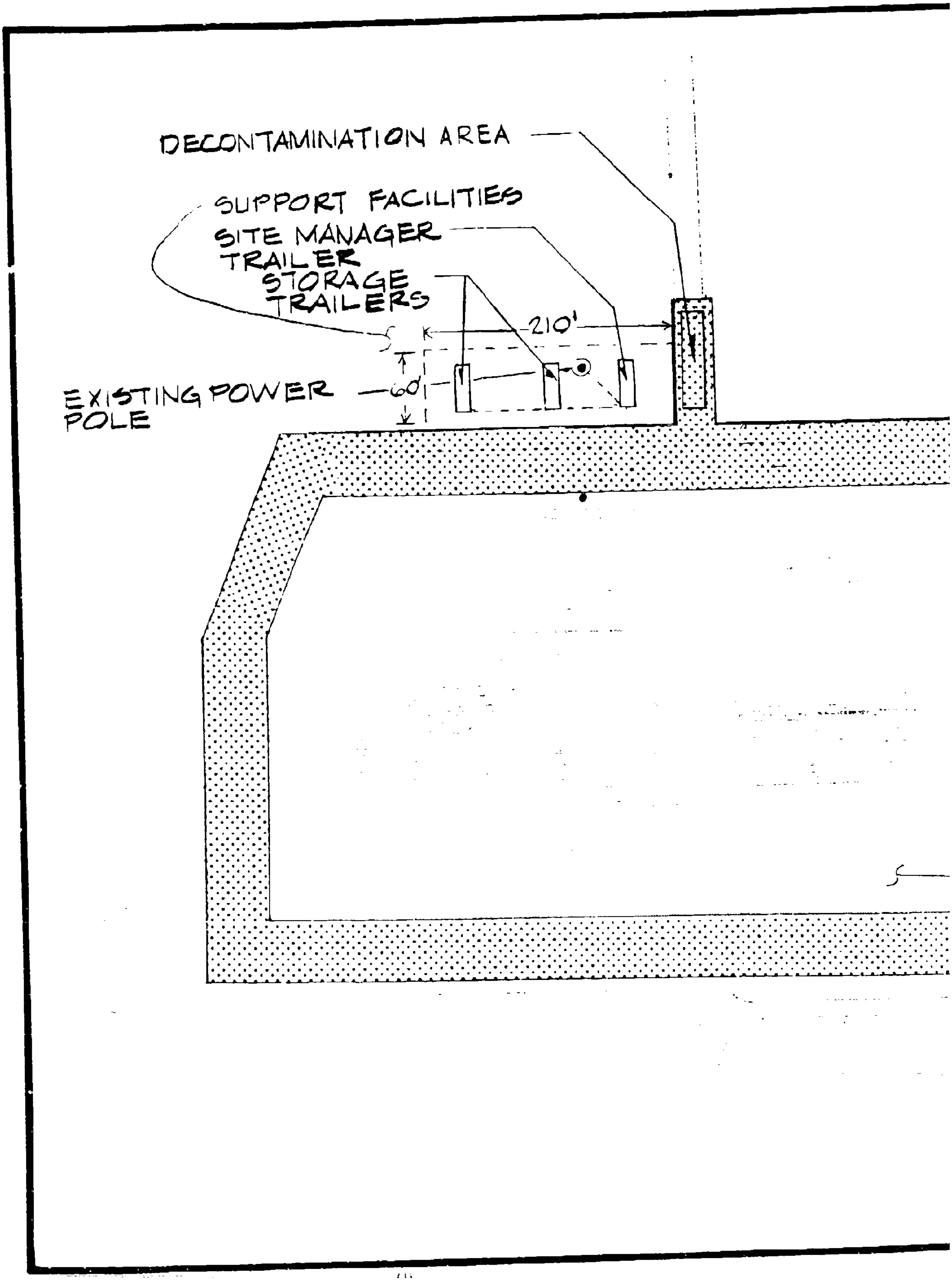
Regardless of the level of protection chosen to perform the various phases of work, the HBSF would be divided into three work zones: exclusion, contamination reduction, and support. The exclusion area is the contaminated area and may require level B personal protective equipment. This zone includes the inner HBSF fenced areas and about 20 feet on either side of the west to east overhead pipeline as shown in Figure 3-7. The contamination reduction zone is the transition between the exclusion and support zones.

During site mobilization, the utilities systems and support facilities would be built up in the support and contamination reduction zones. Required utilities include water, power, heat, telephone, sanitary, and decontamination wastewater disposal. The support facilities are as follows:

- Temporary utilities
- Field office, decontamination, and storage facilities
- Wastewater disposal facilities
- Other liquid waste disposal facilities

The temporary utilities assignment to the west and east ends of HBSF is important to the location of the support facilities. The main support and decontamination facilities would be located in the west end on the north side near the existing support trailers. This site has the advantage of power access, as it is tied into an existing support trailer. The telephone lines, fire protection water, and potable water are within 500 feet of the proposed site of support and decontamination facilities. A primary roadway runs next to the existing support facilities.

A decontamination area would also be located at the east end of the HBSF at the south entrance to the fenced area to facilitate operations


DECONTAMINATION AREA
SUPPORT FACILITIES
SITE MANAGER TRAILER
STORAGE TRAILERS
210'
EXISTING POWER POLE
60'

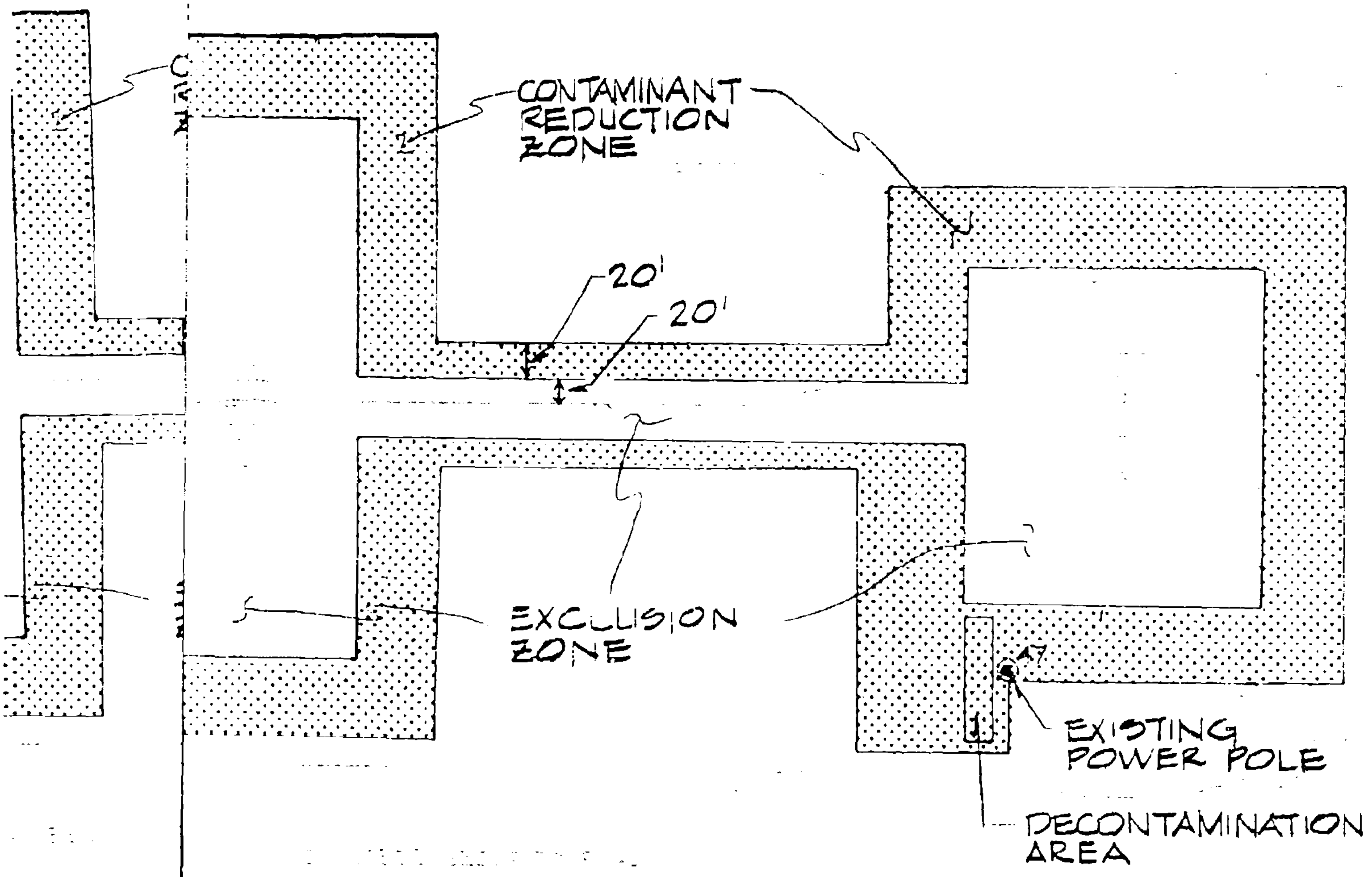


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Figure 3-7.
SUPPORT FACILITIES AN
WORK ZONES

ROCKY MOUNTAIN ARSENAL, TAS
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in this area. This location is near potable water and fire protection water systems, power, a tertiary roadway, and wastewater drainage lines with cleanouts. The drainage lines could be used to drain decontamination waters to the in-ground concrete tank for temporary holding.

Other utilities useful to the HBSF area are described in the Master Plan Basic Development Maps Sheets 35 to 46, Drawing Number 18-02-01 (COE 1984):

- General Site Area Sheet Map 35
- General Road and Recreation Sheet Map 36
- General Railroad Map 37
- General Water Map 38
- General Sanitary Sewer Map 39
- General Contaminated Waste Map 40
- General Heating Map 41
- General Gas Map 42
- General Compressed Air Map 43
- General Electrical Map 44
- General Telephone Map 45
- General Storm Drainage and Tree Cover Map 46

The field office, main decontamination area, and maintenance and storage areas would be located on the north side of the west end of the HBSF as shown in Figure 3-7.

The field office and storage trailers would require at least a 60 feet by 210 feet area for as many as three trailers. The three trailers would include the field office for site management and two trailers for equipment, supplies, and sample storage. The field office would have electric power supplied from the existing power lines, air conditioning and heat, telephone, potable water supply, and sanitary wastewater facilities. The additional trailers would have power to operate the lights, air conditioning and heat, and refrigeration equipment for sample storage. The decontamination facilities would include a trailer with contaminated side dressing room, shower and hand washing room, and clean dressing room. These facilities would be provided with water, power, heat, phone, and wastewater utilities. There would also be equipment and personnel decontamination areas as shown in Figure 3-7. Plastic liners would be placed in the decontamination area to collect rinse water and drain to the evaporation pond for disposal. The west to east end overhead pipeline demolition/dismantling operation would use either the west or east end decontamination facilities.

Support facilities at the east end of the site would be limited to vehicle, equipment, and personnel decontamination equipment. Decontamination water generated at this area would be collected in basins using plastic tarps, and may be drained to the inground concrete tank.

During the demobilization phase, the support facilities would be removed. This would be accomplished by a seven step process:

- Decontamination and removal of equipment from the HBSF east end;
- Removal of the HBSF east end decontamination area;
- Disc and seed the backfilled areas of the HBSF east end area;
- Decontamination and removal of equipment from the HBSF west end;
- Disc and seed the backfilled areas and demolished roadway areas of HBSF west end and west to east overhead pipeline areas;
- Removal of nonessential support trailer and utilities;
- Removal of the last support trailer and utilities.

The removal of the east end and west end decontamination area would be as follows:

- The decontamination area would be allowed to evaporate to dryness.
- The east end decontamination area would be removed near the end of the dismantling/demolition plan followed by west end area at the end of the solid waste handling/disposal for this area.
- The decontamination area liner would be rolled up and disposed of off-site.
- The decontamination area would be backfilled, graded, and seeded.

Upon completion of the seven-step process of demobilization, the HBSF equipment, facilities and piping removal, and site cleanup would be considered complete.

3.5 DECOMMISSIONING PLAN PERSONNEL

To operate and handle the wastes generated during the decommissioning plan, both skilled supervisory staff and laborers would be required. These personnel would be trained in all applicable hazardous waste site health and safety procedures.

The personnel would be managed to support the seven basic work plans for decommissioning the HBSF. These plans are concerned with:

- Hazard reduction
- Liquid waste handling/disposal
- Dismantling/demolition
- Solid waste handling/disposal

- Site restoration
- Health and safety
- Quality assurance/quality control

A suggested organization chart for site personnel is presented in Figure 3-8. The project would require up to about 30 persons to execute the work plans. Sections 3.5.1 to 3.5.6 describe the qualifications of the personnel required for each of the seven work plans.

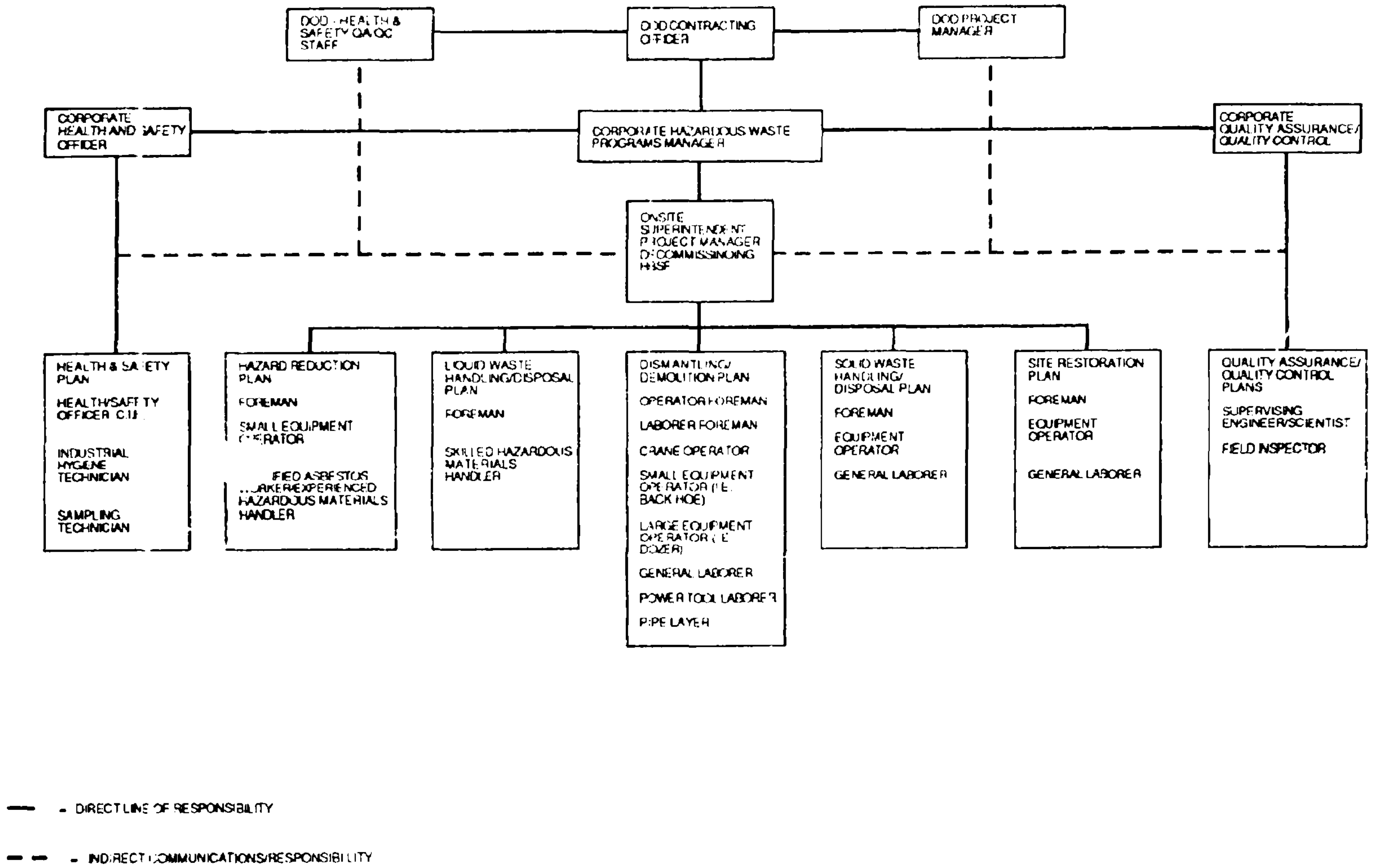
3.5.1 Hazard Reduction Plan Personnel

Hazard reduction activities would require a foreman, small equipment operator and two to four certified asbestos workers and experienced hazardous material handlers. These personnel would reduce hazards from NDMA, asbestos, miscellaneous organic liquids, and PCB filled electrical equipment, as well as remove polyurethane insulation. The personnel would work to reduce personnel protective equipment and clothing requirements. Hazard reduction personnel could be used for both hazard reduction and liquid waste disposal tasks.

3.5.2 Liquid Waste Handling/Disposal Plan Personnel

Hazard reduction personnel would handle and dispose of liquid wastes including NDMA-contaminated wastewater, miscellaneous organic liquids and PCB contaminated electrical equipment. This work would require a foreman and 2 to 4 trained hazardous material handlers to operate pumps, wastewater treatment works, liquid transfer and drumming operations.

Miscellaneous liquids would be reused, where possible. Laboratory packed drums would be used for the disposal of the materials not reused or evaporated. The removal of PCB contaminated fluids would occur later in the project to better utilize the existing on-site power



Prepared for:

Program Manager's Office For
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Figure 3-8.

ORGANIZATION CHART FOR DECOMMISSIONING WORK PLANS

ROCKY MOUNTAIN ARSENAL, TASK 34
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supply. The involvement of these personnel in the decommissioning plan would conclude with the completion of liquid handling and treatment efforts.

3.5.3 Dismantling/Demolition Plan Personnel

Performance of demolition activities would require an operator foreman and a labor foreman, as well as at least three equipment operators for a crane, dozer, and back hoe. Additionally, two or three general laborers and a pipe layer would be needed to complete the work.

3.5.4 Solid Waste Handling/Disposal Plan Personnel

The solid waste handling/disposal plan personnel would include a foreman, equipment operators, and a general laborer. These personnel would come from the dismantling/demolition work crews to load transport vehicles with solid wastes and cover these vehicles with tarpaulin.

Site restoration efforts would begin upon completion of loading and disposing of solid wastes from the dismantling/demolition work.

3.5.5 Site Restoration Plan Personnel

Preliminary site restoration would include grading and filling of site depressions or excavations created by the dismantling/demolition work and solid waste removal. Clean fill would be used to fill depression such as the decontamination areas and HBSF underground utilities removal. Final site restoration activities would include disking and seeding the backfill areas of the demolished HBSF and restoration of the decontamination areas and evaporation pond. It is expected that these activities can be accomplished by a foreman, equipment operator, and general laborer.

These activities would be done with standard equipment and the lowest level of personal protective clothing justified by the health and safety monitoring.

3.5.6 Miscellaneous Administrative, Quality Assurance/Quality Control Plan and Health and Safety Plan Personnel

As shown in Figure 3-8, the contractor's corporate hazardous waste program manager, health and safety officer and quality assurance/quality control officer would participate in decommissioning the HBSF. The government's HBSF decommissioning administrative staff would include part-time participation of DOD contracting officers from the U.S. Army and U.S. Air Force. The contracting officers would be supported by a project manager with a full-time on-site inspector as well as health/safety and QA/QC technical support staff. The function of both the contractor's and government's administrative personnel is to assure the safe decommissioning of the HBSF and the proper treatment and disposal of solid waste which had potential contact with NDMA or hydrazine fuel wastes.

The corporate health and safety officer would be supported by a full-time site health and safety officer, and a certified industrial hygienist. The site health and safety officer may use an industrial hygiene technician or sampling technician to assist in personnel monitoring, and site surveys for asbestos and NDMA.

3.6 QUALITY ASSURANCE/QUALITY CONTROL PLAN

The QA/QC plan is a generic description of what would be included in the project specific quality assurance/quality control plan for the HBSF decommissioning plan. The quality assurance/quality control function is primarily a check and audit on field and laboratory work to ensure proper hazardous material and waste sampling, chemical analysis, handling, treatment, and disposal practices. Also included in the QA/QC plan would be inspections and audits of dismantling, demolition, transport, and other decommissioning activities. The QA/QC plan would be directed by compliance with the RMA Project Quality Assurance Plan and a project specific plan for HBSF decommissioning.

3.6.1 QA/QC Plan for Sampling and Analysis

3.6.1.1 Compliance with RMA Project Quality Assurance Plan (PQAP)

Decommissioning personnel would adhere to and comply with the established QA/QC requirements of the Rocky Mountain Arsenal Project Quality Assurance Plan, presented as Volume II of the Procedures Manual to the Technical Plan (Ebasco 1985b). This plan presents generic QA/QC requirements for all RMA tasks and describes the application of PMO procedures to monitor and control field and analytical efforts, data acquisition and design at RMA.

3.6.1.2 Project Specific Contractor Quality Control Plan (CQCP) for Sampling and Analysis

The HBSF decommissioning prime contractor (contractor) would prepare a CQCP according to the following detailed instructions. The CQCP would describe in detail exactly how the contractor would collect and analyze samples during the decommissioning according to the sixteen (16) basic components listed below (USEPA 1983, Ebasco 1985b).

1. Title Page - with provision for approval signatures
2. Table of Contents
3. Project Description
4. Project Organization and Responsibility
5. Quality Assurance Objectives for Measurement Data
6. Sampling Procedures
7. Sample Custody
8. Calibration Procedures and Frequency
9. Analytical Procedures
10. Data Analysis and Reporting
11. Internal Quality Control Checks
12. Performance and Systems Audits
13. Preventative Maintenance

14. Procedures for Assessing Data Revision, Accuracy, Completeness, Representativeness, and Comparability
15. Corrective Action
16. Reports

Each of the above sixteen components must be included in the CQCP. The CQCP must be approved by the Contracting Officer, with technical staff review, before the Contracting Officer authorizes the contractor to work on the HBSF decommissioning. The CQCP must be approved in accordance with the requirements of this section. Additional analytical testing, if deemed necessary for safety reasons by the Contracting Officer or contractor's site Health and Safety Officer, may be required. All analytical results must be reviewed and approved by the Contracting Officer or his technical support staff before contaminated inventory, soil and wastewaters are removed from the site. Details of the 16 components of the sampling and analysis QA/QC plan are presented in Appendix D.

3.6.2 QA/QC Plan for Decommissioning Activities

The prime contractor would be responsible for preparing a QC/QC plan for the decommissioning activities. The plan would include provisions for ensuring that the evaporation pond is constructed according to the design specifications and inspected according to operation procedures; the treatment and removal of wastewater and other hazardous liquids are consistent with the hazard reduction plan; asbestos and PCB-containing materials are removed and disposed according to safe handling practices and regulations; above-ground structures and equipment are removed; underground piping and other non-severable equipment are removed; proper health and safety procedures are followed throughout the decommissioning; decontamination of vehicles, equipment, and protective gear is adequate; manifests are completed for shipments of hazardous waste; and the site is closed and restored.

The format for the QA/QC plan for decommissioning would be similar to that used for the sampling and analysis QA/QC plan. Components 5 through 14 listed for the sampling and analysis plan in Section 3.6.1.2 would be replaced by the corresponding operations for the specific decommissioning activity. The Contracting Officer must approve the plan and may require changes to the plan if it is deficient.

3.7 HEALTH AND SAFETY PLAN

3.7.1 Purpose

The purpose of this section is to describe the requirements for a Health and Safety Plan (HASP) covering the hazards associated with the decommissioning plans. The need for a HASP is dictated by the contamination of the site with its hazardous chemicals; the presence of asbestos containing materials in the structures; the hazard associated with the construction and demolition activities of the decommissioning plan; and the monitoring of hazard reduction and site restoration work.

Previous cleanup activities discussed in Section 1.3.6 have reduced the hazards associated with the process chemicals and byproducts used at the HBSF. It is believed that the continued presence of NDMA in groundwater, in wastewater and as a product of the oxidation of sources of UDMH remains a potential hazard. The demolition of friable and to a much lesser extent nonfriable asbestos containing material would also pose a potential health hazard. Typical construction activities also have inherent risks which must be minimized. These activities include heavy equipment operation, welding, cutting, and materials handling. They may be more hazardous than usual since most of the operations may be conducted in level B protection.

3.7.2 General Requirements

The contractor would be responsible for developing a HASP which would ensure the protection of the health and safety of employees, visitors, RMA officials and other contractors on the site. The HASP would also ensure compliance with all state, federal and U.S Army occupational health and safety regulations. The HASP must be developed incorporating the guidance provided by EPA's standard operating safety guides for hazardous waste site activities (USEPA 1984d). The format for the HASP must follow the format of Health and Safety Plan for Rocky Mountain Arsenal (Ebasco 1985c; Ebasco 1986).

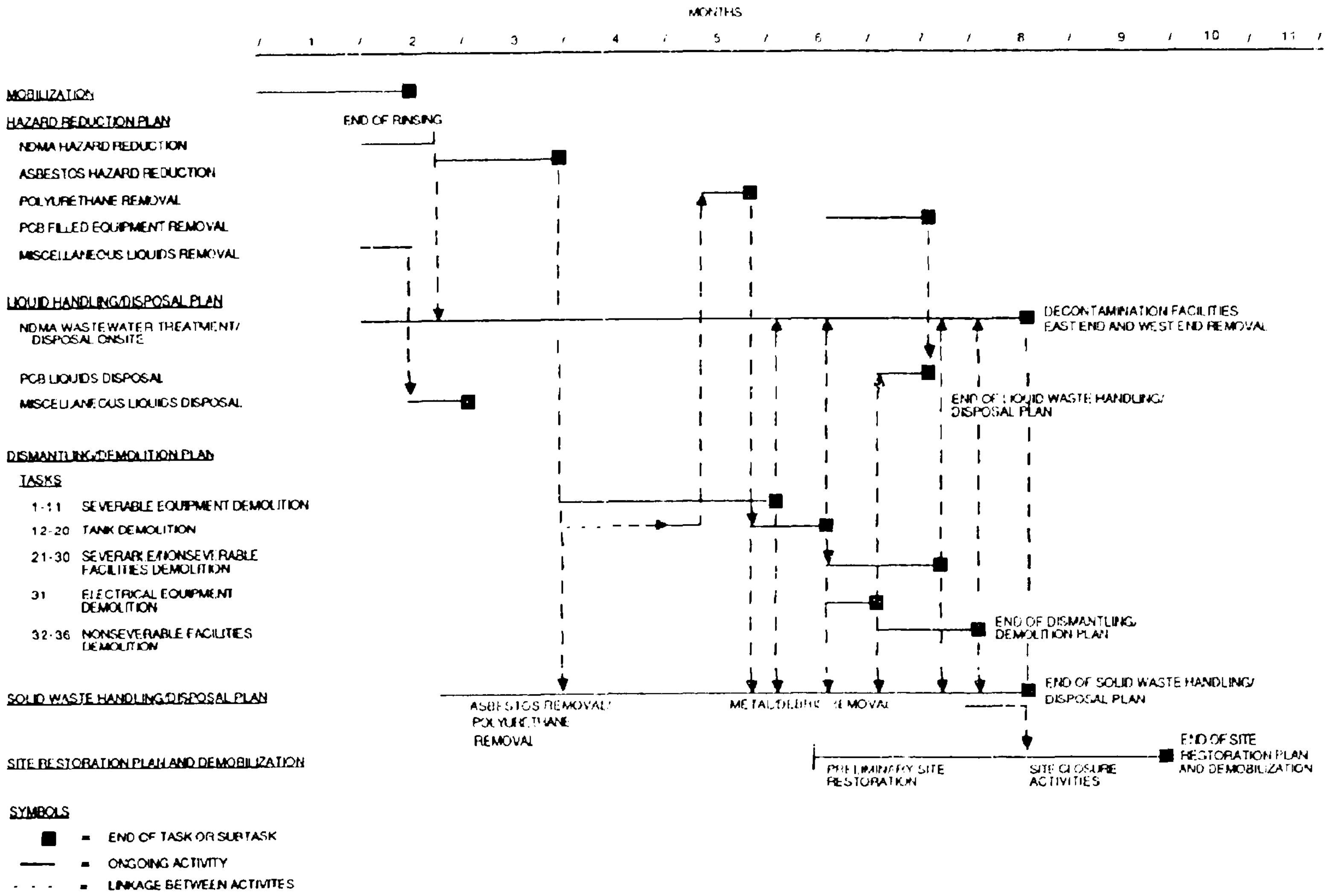
The HASP would require an assessment of the hazards posed by the conditions of the site and the activities of the decommissioning plan. These hazards should be addressed in a manner which allows for the efficient implementation of the decommissioning and at the same time protects the health of those people involved. The contractor should anticipate that many of the activities would require level B protection. In fact, all activities within the exclusion zone would require at least level B protection until it is clearly demonstrated that another level of protection is acceptable. Samples from the air and other media may be analyzed after the hazard reduction activities are complete to determine if the level B protection requirement may be downgraded. Samples would also be analyzed after decommissioning and restoration to determine if risks remain from NDMA or other hazardous material exposures.

Specific requirements of the HASP are discussed in Appendix E.

3.8 SCHEDULE

A preliminary schedule for the decommissioning plan, initiated at mobilization of construction activities, is presented in Figure 3-9. This schedule does not show time required for detailed engineering, specification preparation, or contractor procurement.

A mobilization period of a montn and half is used to install the wastewater treatment system, set up support facilities and obtain the proper supplies and equipment. This period of time is followed by the



Prepared for:
PROGRAM MANAGERS OFFICE FOR
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FIGURE 3-9.
SCHEDULE - DECOMMISSIONING PLAN
ROCKY MOUNTAIN ARSENAL, TASK 34
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implementation of the hazard reduction plan and NDMA wastewater treatment with tasks interspersed over a 3 to 4 month period. The assumption of Level B personal protective equipment has been used in the scheduling. As a result, scheduling reflects slower progress than would occur with standard demolition practices. The hazard reduction and liquid handling and disposal activities generally occur before the dismantling/demolition activities. The solid waste handling work begins with asbestos abatement and polyurethane insulation waste handling. This work concludes about six months later with the roll up of the west and east end decontamination area at the end of the preliminary site restoration period.

The west end decontamination facilities would be dismantled once all wastewater from the decommissioning efforts has been treated. The remaining site closure activities of grading, disking and seeding the HBSF area would begin as final demobilization of the remaining project equipment proceeds. The site closure activities are projected to end in the ninth month of the project. Any unforeseen delays or significant increases to the wastewater inventory volumes could delay the completion of site restoration until the next construction season.

3.9 PRELIMINARY COST ESTIMATE

A preliminary cost estimate was developed for each of the five decommissioning plans, project expenses, and overhead costs. The estimate reflects an order of magnitude estimate of -30 to +50 percent. The assumptions used in developing the cost estimate are listed in Table 3-11 and the estimate is summarized in Table 3-12. Each major cost item has its own separate contingency factor to reflect the uncertainty associated with the estimate. A preliminary estimate of the potential distribution of these items between the Army and Air Force is provided. This potential distribution was based on the quantity of material handled and the nature of the expense (refer to Section 3.2).

TABLE 3-11

COST ESTIMATING ASSUMPTIONS

1. The hazard reduction, liquid handling/disposal, dismantling/demolition, solid waste handling/disposal plans, and the preliminary site restoration labor costs are based on the need for workers to be in Level B personnel protective equipment. The use of Level B equipment yields a 0.3 production rate compared with standard nonhazardous demolition work.

2. Liquid disposal is based on treatment of the NDMA wastewater with UV oxidation using either ozone or hydrogen peroxide.

3. Other miscellaneous liquids are estimated at about 4,700 gallons of ethylene glycol, PCB liquids and lab packed paint, lacquer and other miscellaneous liquid wastes. These liquid wastes would be incinerated offsite at $0.22/pound. The waste would be transported to Chicago from Denver in two truck loads at $3,750/load.

4. Solid waste transportation and disposal cost estimates are based on delivery to the Grassy Mountain, Utah, hazardous waste landfill at $100/ton transportation cost and $140/ton or $140/cubic yard disposal costs. The solid waste inventory is estimated at approximately 235 tons metal and 2,500 tons debris at approximately one ton per cubic yard.

5. No NDMA contaminated soil was detected based on the RMA Task 11 contamination assessment report. For purposes of the RMA Task 34 cost estimate, only potentially contaminated soils under tank US-4 are included in this estimate.

6. Costs are based on 1987 dollars.

TABLE 3-12

PRELIMINARY COST ESTIMATE FOR THE DECOMMISSIONING OF THE HBSF[1/]

Hazard reduction		$29,000
- Contingency and other indirect expense (30 percent)		9,000
	Subtotal	$38,000
Army (0)	Air Force (100 percent) $ 38,000	
Liquid waste handling and disposal		$270,000
- Contingency and other indirect expense (20 percent)		54,000
	Subtotal	$324,000
Army (10 percent) $32,000	Air Force (90 percent) $292,000	
Dismantling/demolition		$240,000
- Contingency and other indirect expenses (30 percent)		72,000
	Subtotal	$312,000
Army (33 percent) $103,000	Air Force (67 percent) $209,000	
Solid waste handling and disposal		$675,000
- Contingency and other indirect expenses (30 percent)		203,000
	Subtotal	$878,000
Army (89 percent) $781,000	Air Force (11 percent) $97,000	
Site restoration		$20,000
- Contingency (20 percent)		$4,000
	Subtotal	$24,000
Army (50 percent) $12,000	Air Force (50 percent) $12,000	
Project expenses		$145,000
- Contingency (20 percent)		29,000
	Subtotal	$174,000
Army (50 percent) $87,000	Air Force (50 percent) $87,000	

TABLE 3-12 (Continued)

PRELIMINARY COST ESTIMATE FOR THE DECOMMISSIONING OF THE HBSF[1]

Overhead expense		$650,000
- Contingency (20 percent)		$130,000
	Subtotal	$780,000

Army (50 percent) $390,000 Air Force (50 percent) $390,000

Estimated manhours for decommissioning HBSF: 12,000

	Project total	$2,530,000
	Army	$1,405,000
	Air Force	$1,125,000

1/ Cost estimates are based on 1987 dollars.

The hazard reduction estimate includes the costs of rinsing and washing of tanks and piping, approximately 14 cy of asbestos waste removal, polyurethane insulation removal from both vertical and horizontal tanks, ethylene glycol removal from the HBSF west end horizontal tank jackets, heat traced piping and ethylene glycol heat exchangers; 100 gallons of PCB fluid from electrical transformers and four drums worth of lab packed miscellaneous liquids. The cost of implementing the hazard reduction plan was assigned to the Air Force because the large majority of liquids that require treatment are associated with severable equipment, which is the responsibility of the Air Force.

The liquid waste handling and disposal estimate was based on the treatment of approximately 325,000 gallons of NDMA wastewater and decommissioning rinse waters, and approximately 4,700 gallons of miscellaneous liquids. The liquid waste handling/disposal plan cost was distributed 10 percent to the Army and 90 percent to the Air Force since nearly all of the wastewater is contained in severable equipment.

The dismantling and demolition plan cost estimate was based on the 36 tasks (described in Section 3.3) that generated approximately 235 tons of metal and 2,500 loose cubic yards of debris. The distribution of costs used is 33 percent to the Army and 67 percent to the Air Force. A 30 percent contingency was applied to reflect the uncertainty associated with hazardous waste demolition work.

The solid waste handling and disposal costs are the most expensive elements of the decommissioning plan. This cost is based primarily on the shipment and disposal of approximately 235 tons of metal and 2,500 loose cubic yards of debris as hazardous waste. For cost estimating purposes, the waste was assumed to be taken from Denver, Colorado, to the Grassy Mountain, Utah, hazardous waste landfill. The cost for solid waste handling/disposal was estimated at $878,000 with the Army's share at 89 percent and the Air Force's share at 11 percent. This distribution is due to large volume of nonseverable debris that is the Army's responsibility. A 30 percent contingency was applied to solid waste handling/disposal to cover the uncertainty associated with estimating the final volume of demolition debris and the potential for modest additional amounts of contaminated soil that may have to be landfilled.

The HBSF site restoration plan cost estimate includes backfilling, disking, seeding, and other site restoration exclusive of evaporation pond area restoration. A distribution of 50/50 Army and Air Force was assigned because the site restoration is an overall project task.

Project expenses are associated with project supplies, mobilization and demobilization expenses and hazardous material/waste site training. This cost would be distributed 50/50 to the Army and Air Force because these expense items will apply to all project activities.

Overhead expenses are associated with general expenses, project supervision, and job office expense. Project supervision would include the onsite project manager, health and safety officer and quality assurance engineer or scientist. General expenses include utilities, insurance, home office overhead, bonds, and contractor profit. A distribution of 50/50 between the Army and Air Force is shown because these expenses are common to the entire project.

The total estimated cost for the HBSF decommissioning plans, project expenses and overhead expenses is $2,530,000. The Army's portion of this cost is estimated to be $1,405,000 with the Air Force's portion at $1,125,000. This cost is an order of magnitude estimate considered to be within -30 percent and +50 percent of the actual costs that would be incurred. A preliminary manhour estimate for this decommissioning work is approximately 12,000 hours exclusive of liquid waste and solid waste transport and disposal labor requirements.

The cost estimates were based on the assumption that level B protection would be required for all activities. If the protection level were to be downgraded, costs would be reduced primarily for the dismantling/ demolition, solid waste handling, and the preliminary site restoration activities. However, the major cost items such as solid waste transport and disposal and project overhead would not be significantly affected. The impact of downgrading the level of personnel protection would be relatively small because the effected costs only amount to about 25 percent of the total project cost.

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APPENDIX A

MEMORANDUM OF UNDERSTANDING
BETWEEN
THE PROGRAM MANAGER FOR ROCKY MOUNTAIN ARSENAL CONTAMINATION CLEANUP
AND
HEADQUARTERS, AIR FORCE LOGISTICS COMMAND

RMA 34
Corres In

DEPARTMENT OF THE ARMY
PROGRAM MANAGER, ROCKY MOUNTAIN ARSENAL CONTAMINATION CLEANUP
ABERDEEN PROVING GROUND, MARYLAND 21010-5401

REPLY TO
ATTENTION OF

25 JUN 1986

AMXRM-PM-P

SUBJECT: Status of Hydrazine Facility Dismantlement at RMA

Department of the Air Force
Headquarters Air Force Logistics Command
ATTN: DEPV
Wright-Patterson Air Force Base, OH 45433-5001

1. The attached Memorandum of Understanding (MOU) delineates the management, technical, and financial responsibilities for the Air Force and Army with respect to the decommissioning and closure of the Hydrazine Blending and Storage Facility (HBSF) at Rocky Mountain Arsenal. This MOU, prepared by my staff, reflects comments provided by your staff on the draft document.

2. The Office of the Program Manager for Rocky Mountain Arsenal Contamination Cleanup is continuing to proceed with HBSF closure actions; a contract to provide a decontamination plan, a scope of work (SOW) for final closure work, and an associated cost estimate has been recently awarded with a completion date of four months. Results of this action will be provided to you as soon as available. It is currently projected that funding for final closure action will be required at the beginning of the third quarter FY87.

3. Request your review and approval of the attached document in order to provide a coordinated Air Force/Army planning basis for future actions.

FOR THE PROGRAM MANAGER:

Encl

WALLACE N. QUINTRELL
Colonel, OrdC
Deputy Program Manager,
Rocky Mountain Arsenal

Memorandum of Understanding

Between

Program Manager for Rocky Mountain Arsenal Contamination Cleanup

and

Headquarters, Air Force Logistics Command

Subject: Hydrazine Blending and Storage Facility Decommissioning and Closure

1. PURPOSE:

The purpose of this Memorandum of Understanding is to delineate the management, technical, and financial responsibilities for the decommissioning and closure of the Hydrazine Blending and Storage Facility (HBSF) at Rocky Mountain Arsenal.

2. REFERENCES:

a. InterService Support Agreement, No. W51 QP5-81290-003, between RMA and the Directorate for Energy Management, San Antonio Air Logistics Center, Kelly AFB.

b. Meeting at Rocky Mountain Arsenal - 10 December 1985, Subject: Hydrazine Blending and Storage Facility Closure Plan.

3. GENERAL:

a. Rocky Mountain Arsenal has operated the Hydrazine Blending and Storage Facility under the InterService Support Agreement's (ISSA's), with Director of Energy Management, San Antonio Air Logistics Center, Kelly AFB, since 1960. In September 1982, RMA was advised by Director of Energy Management, AFLC, of their plan to phase out the HBSF at RMA. Subsequent actions by RMA and the Air Force have been directed towards this goal.

b. On 8 July 1985, the concept plan establishing the Program Manager for RMA Contamination Cleanup as the central manager of all RMA contamination cleanup activities to include the HBSF closure, was approved by Department of the Army.

c. The reference b meeting was held to review and discuss the HQs, AFLC Plan of Action for Severable Equipment Dismantlement at the HBSF and to develop a coordinated DA/AF plan for the preparation of the closure plan. At this meeting it was agreed by both HQs AFLC and the PM for RMA cleanup representatives that, in order to delineate the management, technical, and financial responsibilities of each party, a Memorandum of Understanding should be established between the parties.

4. APPLICABILITY:

This Memorandum of Understanding applies to all work efforts required for the decommissioning and closure of the HBSF at Rocky Mountain Arsenal. This MOU does not apply to any current or future remedial investigations or remedial actions conducted at RMA by the Program Manager for RMA cleanup which are outside the HBSF area, to include such areas as:

a. The rail storage siding north of the HBSF.

b. The furnace in B-538 previously used to dispose of off-specification hydrazine.

c. The underground piping from the HBSF to the chemical sewer north of B-538.

d. Ground water contamination assessment and remedial action, if required, within the HBSF area.

5. RESPONSIBILITIES:

a. Program Manager for RMA Contamination Cleanup will:

(1) Act as Project Manager providing overall project guidance, coordination and direction for the decommissioning and closure of the HBSF.

(2) Coordinate with the Air Force all Scope of Works, technical work plans, and other technical/project documentation for Air Force funded work efforts.

(3) Provide overall technical direction for the remedial action work effort, incorporating technical guidance provided by the Air Force for the Air Force funded work efforts.

(4) Prepare Scope of Work and contract for both Army and Air Force contractual work efforts required for closure.

(5) Administer all contractual efforts involved in closure and provide technical expertise and assistance to contractors as required.

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(6) Approve all technical plans prepared and submitted by contractors for all closure work efforts, incorporating Air Force technical guidance concerning Air Force funded work efforts.

(7) Provide justification and obtain funding for the Army portion of the closure work effort as delineated under Financial Responsibilities.

(8) Monitor the Environmental program for the HBSF and prepare and submit all required Environmental documentation.

b. Headquarters, Air Force Logistics Command will:

(1) Provide project guidance, coordination, and technical direction to all Air Force elements involved in the decommissioning and closure of the HBSF.

(2) Act as technical consultant and represent the Air Force for all coordination, review, and concurrence of project/technical documentation submitted to the Air Force by the Program Manager for RMA Contamination Cleanup for Air Force funded work efforts.

(3) Provide technical expertise and assistance to the Program Manager for RMA Contamination Cleanup, if requested, concerning remedial action closure efforts involving Air Force funded work efforts.

(4) Review and approve technical plans prepared and submitted to the Program Manager for RMA Contamination Cleanup for Air Force funded work efforts.

(5) Provide justification and obtain funding for the Air Force portion of the closure work efforts as delineated under Financial responsibilities.

(6) Provide technical procedures for the removal of remaining fuel at RMA and the initial decontamination of the fuel distribution and storage system.

(7) Monitor closure plans and work efforts insuring that all applicable Air Force policies, procedures, and regulations are complied with.

6. FINANCIAL PLAN:

a. The Air Force shall be responsible for providing funds required to implement the Air Force designated decommissioning and closure work efforts as described in the appendix.

b. The Program Manager for RMA Contamination Cleanup shall be responsible for providing funds required to implement the Army designated decommissioning and closure work efforts as described in the appendix.

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c. The Program Manager for RMA Contamination Cleanup will provide initial funding for the preparation of a decontamination plan and associated Scope of Work for the contractual effort required to decommission and close the HBSF.

d. The Air Force will reimburse the Program Manager for RMA cleanup for their share of the cost to develop the decontamination plan and SOW required for the contractual effort to decommission and close the HBSF based on the relative cost of each parties work effort to decommission and close the HBSF.

e. The Program Manager for RMA Contamination Cleanup will provide to the Air Force the cost to develop the decontamintion plan and SOW and a cost estimate for each party's work effort to decommission and close the HBSF when the decontamination plan and the SOW have been completed.

7. INTERSERVICE SUPPORT AGREEMENT:

The current ISSA (reference a) between RMA and the Directorate for Energy Management, Kelly AFB provides for RMA support to operate and maintain the HBSF. This agreement shall remain in effect during the decommisioning and closure work effort until RMA support is no longer required. Modifications to the ISSA may be negotiated during this timeframe. Any modifications to the ISSA shall be approved by the Program Manager for RMA Contamination Cleanup.

8. TERM: This Memorandum of Understanding is effective as of the date of the last signature and will remain in effect until all decommissioning and closure actions have been completed and the area certified closed in accordance with applicable regulations or until it is terminated by mutual consent of both parties.

Wallace N Quintrell

WALLACE N. QUINTRELL
Colonel, OrdC
Deputy, Program Manager,
Rocky Mountain Arsenal
Contamination Cleanup

25 JUN 19[illegible]
DATE

David M Cornell

DAVID M. CORNELL
Brigadier General, USAF
DCS/Engineering and Services

03 JUL 1986
DATE

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APPENDIX

Hydrazine Blending & Storage Facility
Decommissioning and Closure
Financial Responsibility

1. Headquarters, Air Force Logistic Command will have financial responsibility for the following work efforts required in the decommissioning and final closure of the HBSF at RMA.

a. The dismantlement, decontamination and final disposal of all severable equipment to include the following:

(1) All propellant storage tanks and associated platforms, catwalls.

(2) All propellant pumps, piping, and pipe support, to include piping and piping supports connecting main plant with east storage area.

(3) Propellant blender and scrubber equipment, associated piping, controls, weather cover.

(4) All waste water storage tanks and associated platforms, at east end of facility including scrubber, piping, pumps, and piping supports.

(5) Nitrogen pressurization system except supply tank which is leased equipment.

(6) Propellant heating system (heating equipment and piping, controls).

(7) All unload/loading equipment (truck, railcar, drums).

(8) All above ground electrical distribution system within HBSF (conduit, junction boxes, poles, wire, transformers, controls), including electrical distribution system at east storage tank area.

(9) Waste sump pump, piping and metal fencing around sump.

(10) All above ground fire protection system and fire inground vault equipment, piping, and electrical controls.

b. The treatment (if required) and final disposal of all hyrazine/UDMH/NDMA contaminated waste water generated during dismantlement, decontamination and disposal of above severable equipment.

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e. The treatment (if required) and final disposal of all hydrazine/UDMH/NDMA contaminated waste water currently in storage at the HBSF (estimated at 254,000 gallons).

2. Program Manager for Rocky Mountain Arsenal Contamination Cleanup will have financial responsibility for the following work efforts required in the decommissioning and final closure of the HBSF at RMA.

a. All below ground piping, electrical conduits, equipment/piping foundations, sumps, vaults, concrete/asphalts pads, etc. to include the following:

(1) All propellant and waste water tank concrete foundations, pads, and dikes.

(2) All concrete foundations for equipment and pipe supports.

(3) All concrete and asphalts pads throughout facility to include drum storage area.

(4) All underground piping to include potable water supply, fire protection water supply, and waste water piping and connections throughout main plant and east storage area.

(5) All underground electrical conduits.

(6) Above ground electrical supply to primary transformers located at B-755 and to the primary transformer in the east area.

(7) The railroad track and associated foundation within the facility to include replacement of track if required.

(8) All support buildings to include B-755 change house, B-759 drum cleaning, B-T-868C storage shed, and B-760 Fork lift storage.

(9) Double fencing around main plant and east storage areas.

(10) Above ground steam supply piping and piping supports to B-755.

(11) Perimeter earthen security roads between fences around hydrazine main plant and east area.

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APPENDIX B

HBSF DEMOLITION VOLUME
AND
METAL WEIGHT CALCULATIONS
AND
DRAWING LIST FOR QUANTITY TAKEOFFS

EBASCO SERVICES INCORPORATED

SHEET 1 OF 16

CLIENT USAT
PROJECT GMA TASK 34
SUBJECT [illegible] – Buildings & Debris [illegible] HBSF

OFS NO. 4157.411 DEPT NO. 942
BY MSH DATE 2/5/86
CHECKED BY JEM DATE 11/3/86

REFERENCE NO.	ITEM			Volume (CY)	Σ vol cy	Metal lbs	Expansion coeff	Loose Vol cy
	[illegible]							
	[illegible]	[illegible]	20' x 24' = 480 ft²	15 cy				
	4" [illegible] walls	768 ft²	[illegible] (4/) [illegible]	[illegible] cy ✓				
	[illegible] wall	382 ft²	[illegible] (1)(38)(1/27)	[illegible] cy ✓				
	[illegible]	[illegible]	[illegible]	9 1 cy ✓				
	[illegible]	see calc [illegible]	[illegible] /27	[illegible] cy ✓				
	Interior [illegible]	[illegible]	vol = [illegible] 4.6/27	[illegible] cy ✓				
	[illegible]	[illegible]	vol = 512 (1/12) [illegible] /27	1.5 cy ✓				
	[illegible]	[illegible]	vol = 720 (1/324)	[illegible] ✓				
	debris	8/1/86 memo		[illegible] ✓				
	[illegible] or [illegible]				✓ 22.3		1.5	59.7 ✓
					1.0		1.0	1.0
	[illegible]							
	[illegible] slab	25 [illegible]	20' x 40' = 800 ft²	✓ 26				
	[illegible]	[illegible]	[illegible]	✓ .31				
	[illegible]	[illegible]	[illegible]	✓ .34				
	[illegible]	[illegible]	v = π(.233)² (1/4) [illegible]	✓ [illegible]				
	[illegible]	8/1/86	memo	✓ 5.0				
					✓ 31.7		1.5	47.7 ✓
	[illegible]							
	[illegible] slab	[illegible]	21 x 10 = 210 ft²	✓ 4.3				
	[illegible]	120 ft²	[illegible] 120 (.0104) [illegible]	✓ [illegible]				
	[illegible]	120 ft²	[illegible]	✓ [illegible]				
	debris			[illegible]				
	[illegible]				✓ [illegible]		1.5	14.9 ✓
	Concrete slab	5.1 [illegible]	20' x 10' = 200 ft²	✓ 6.9				
	4" Columns	40 '	v = π(2)² (25) .361 (1/27)	✓ [illegible] 9				
	debris			[illegible]				
	Bldg 2680 Debris	8/7/86 memo		✓ [illegible]	✓ 9.2		1.5	13.8 ✓
	Concrete slab	93 [illegible]		✓ 1.3				
	Vol walls	98 [illegible]		✓ 1.9				
	[illegible]	346 ft²	v = [illegible]	✓ 1.37			1.5	36.6 ✓
	[illegible]	312 ft²	[illegible]	✓ [illegible]	✓ [illegible]			

SC10/3-74

SHEET 2 OF 16

EBASCO SERVICES INCORPORATED

CLIENT [illegible]
PROJECT [illegible] TASK 34
SUBJECT [illegible] — Buildings Debris

OPS NO. [illegible]
DEPT NO. [illegible]
BY MJH DATE 8/5/86
CHECKED BY JEM DATE 11/6/86

NO			[illegible]	[illegible]	Metal Weight	Expansion Coefficient	Loose Vol CY	
	Stanchions S71 - S76 (Exterior Fence to Change House)							
	R.R-Rails (Rails set in concrete) [illegible] in (60 lb/ft)	= 35'	.[illegible]		554	1.5	0.6	✓
	Footing	= .42 cy	.92					
	WF 16×20 (Fence Rail Stanchion) [illegible] in² (20 lb/ft)	= 42.5'	.[illegible]		850			
	Footing (Rebar Rail Stanchion)	= 1.96 cy	.36			1.5	2.94	
				4.5	[illegible],354		23.54	
	Stanchions S76-S91 (Change House to Elevator)							
	R.R.-Rails (Rails set in concrete) [illegible] in² (20 lb/ft)	= 304'	.404		6138 ✓	1.5	2.77	✓
	Footing	= 1.35 cy	.35					
				2.3	[illegible]		2 2.77	
	Stanchion Change House to Grain Cleaner S1-S8							
	Pipe 4" ø [illegible]	= 80'	.45		843			
	Support Cable × 1/4 [illegible]	= 111	.21		19			
	Footing	= 5.2 cy	[illegible]			1.5	7.8	
	Stanchions Main Run (S-7 to S-29)			[illegible]	2002		Σ 7.8	
	Stanchions S-7, S-8 & S-9 (West to East)							
	WF 6×15.5 A = 4.[illegible] in² (15.5 lb/ft)	= 26' ✓	.[illegible]		553			
	Footing	= .86 cy ✓	.50			1.5	1.3	✓
				.[illegible]	2553			
	Stanchion S-10 & S-11							
	WF 6×15.5 A = 4.[illegible] (15.5 lb/ft)	= 82'	.[illegible]		1,271 ✓			
	WF 12×27 A = 7.65 (27 lb/ft)	= 50'	.[illegible]		1350 ✓			
	Footing	= .[illegible] cy ✓	.[illegible]			1.5	0.8	✓
				.70	Σ 2,621			
	Stanchions S-12 thru S-13							
	WF 6×15.5 A = 4.[illegible] (15.5 lb/ft)	= 175'	.80		2,712 ✓			
	[illegible] 8 × 11.5 A = 3.38 (11.5 lb/ft)	= 175'	.5		[illegible] ✓			
	Footing	= 3.6 cy ✓	[illegible]			1.5	5.4	✓
				4.[illegible]	Σ 4,7[illegible]			

B-2

EBASCO SERVICES INCORPORATED

SHEET 3 OF 16

CLIENT [illegible]
PROJECT Pm A TASK 34
SUBJECT [illegible] Buildings & Beams

OFS NO. [illegible] DEPT. NO. [illegible]
BY MJH DATE 8/5/86
CHECKED BY JEM DATE 11/6/86

NO					Volume (cy)	Σ Vol	Metal Weight	Expansion Coefficient	Loose Vol cy	
	Main Run (West to E) S-19 & 20									
	WF 6 x 15.5	= 32'	= 4.43 in²		[illegible]		496			
	WF 16 x 26	= 68'	[illegible] in²		.1354		2,448			
	Tee 4 x 15.5	= 32'	A = 4.56 in²		[illegible]		996			
	L 3x3x1/4	= 36'	A = 1.44 in²	w 4.9 lb/ft	.133		176			
	WF 8 x 24	= 55.6'	A = 7.08 in²		.512		1,334			
	Footing	= 1.12 cy			1.12	.37	Σ 4,150	1.5	1.68	Footing Left in place
	Main Run (West to East) S21									
	WF 6 x 15.5	= 6'	A = 4.43		[illegible]		[illegible]			
	Tee 4 x 5	= 8'	A = 4.56		[illegible]		40			
	L 3x3x1/4	= 18'	A = 1.44	w = 4.9 lb/ft	[illegible]		26			
	WF 6 x 15.5	= 35.9'	A = 4.43		[illegible]		555			
	Footing	.26 cy			.26	.064	Σ 714	1.5	0.39	Footing Left in place
	Main Run (North to South) S22, S23 & S24									
	C 8 x 11.5	= 124'	A = 3.38		.078		1,426			
	WF 6 x 15.5	= 107'	A = 4.43		[illegible]		1,659			
	Footing	= 1.50 cy			[illegible]			1.5	2.3	✓ Footing left in place
						1.79	Σ 3,085 ✓			
	Main Run (North to South) S25									
	C 8 x 11.5	= 18.5'	A = 3.38		.01		213			
	C 6 x 8.2	= 20'	A = 2.40		.0123		164			
	WF 6 x 15.5	= 62'	A = 4.43		.0027		[illegible]			
	Footing	= .52			[illegible] ✓			1.5	0.8	✓ Footing left in place
						.62	1,380 ✓			
	Main Run (North to South) S26									
	WF 6 x 15.5	= 35.3'	A = 4.43		[illegible]		555			
	Footing	= .52			.52			1.5	0.8	✓ Footing left in place
						.56	555			

9610/5-74

CLIENT ICAT
PROJECT EMA TASK 34
SUBJECT Inventory – Buildings & Debris

OFS NO. [illegible]
DEPT. NO. [illegible]
BY MJH DATE 8/5/86
CHECKED BY JFM DATE 11/6/86

	Vol (cy)	Σ Vol (cy)	Metal weight	Expansion coefficient	Loose Vol cy
Stanchions S-27 thru S-34 (Next to East)					
[6 x 8.2 A = 2.4 = 400' ✓	.2469		3,250	✓	
WF 6 x 15.5 A = 4.43 = 391' ✓	.2377		5410	✓	
No Footings		.65	8,690	✓	
Miscellaneous Metal Attached to Support Stanchions		[illegible]	227,275	1.5	214.5
Loading/Unloading Platforms (3 total: 2 - RR Loading, 1 - Truck Loading)					
WF 6 x 15.5 (3 x 75') A = 4.43 in² = 225	.2564		3,485	✓	
L 6 x 4 x 3/8 w = 12.3 lb/ft A = 3.61 = 39'	.0262		480	✓	
Handrails 1½ ø pipe w = 2.72 A = .0133 ft² = 400 ✓	.1822		1088	✓	
C 6 x 8.2 A = 2.4 in² = 84	.0519		689	✓	
Grating 1½ Bearing bars w = (.28)(6)(4) [illegible] 159 ft² ✓	.7361		813	✓	
Stairs 2'-6" x 10" high x 51 long (4.0 lb/ft)(2.5)(51)	3.9		510	✓	
		5.16	7,068	✓	
Metal Grating S-26 thru S-34					
1" x 3/16 .12 lb/(ft/in²) A.S. 6 = 26 lb/ft² = 212 ft² ✓	.6342	.654	764	✓	
Stairs S-27					
Handrail 1½ ø w = 2.72 lb/ft A = .0123 ft² = 62' ✓	.0287		171		
Stairs 2'-6" x 9" High x 22' long (4.0 lb/ft)(2.5)(22)	1.52		220		
9 – 13.4 42'		1.55	391	✓	
		227.3			

5810/5-74

SHEET 5 OF 16

CLIENT [illegible]
PROJECT RMA – TASK 34
SUBJECT Inventory Buildings & Debris

OFS NO. [illegible] DEPT. NO [illegible]
BY [illegible] DATE 8/5/86
CHECKED BY JEM DATE 11/6/86

No			Vol cy	Σ Vol cy	Metal weight lb	Expansion coefficient	Loose Vol cy
	Fire Protection Deluge Support Stanchions						
	RR Unloading Area S1 thru S12						
	Pipe 4" Ø w= 10.79 #/ft A=.0332 ft²	= 612'	.2186		6,602	✓	
	Pipe 3" Ø w= 7.58 #/ft A=.0211 ft²	= 84'	.1527		637	✓	
	L 2½ x 2½ x ¼ w= 4.1 #/ft A 1.19 in²	= 120'	.0367		492	✓	
	L 2 x 2 x ¼ w= 3.19 #/ft A .938 in²	= 203'	.0204	(.32)	648	✓	
	Breaker Area S 12) S 19						
	Pipe 2" Ø w.=59 A [illegible] ft²	= 45'	.0067	.07	260 Σ 8,639	✓	
	Truck Loading Area 6-stanchions						
	Pipe 4" Ø w=10.79 A .0833 ft²	= 282'	.9118		3,043	✓	
	L 2½ x 2½ x ¼ w= 4.1 A 1.19 in²	= 50'	.0152		205	✓	
	L 2 x 2 x ¼ w= 3.19 A .938 in²	= 132'	.0318	(.96)	421	✓	
	Lighting Supports on Stanchions						
	C 4 x 5.4 A 1.59 in²	= 24'	.0098		130	✓	
	L 2 x 2 x ¼ w= 3.19 #/ft A .938 in²	= 21'	.0064	([illegible])	67 Σ 3,866	✓	
	Page subtotal			(2.157)	12,505	✓	

SHEET 5 OF 15

EBASCO SERVICES INCORPORATED

CLIENT USAT
PROJECT RMA TFC 34
SUBJECT Inventory [illegible]

OPS NO. 4157 411 DEPT. NO. 942
BY MJH DATE 8/5/86
CHECKED BY JEW DATE 11/6/86

	Vol CY	Σ Vol	Metal Weight	[illegible]	Loose Vol cy
Piping Above Ground Vst Area					
Asbestos Insulation (see calculations) = 4157'	13.1	Σ 13.1		10	13.1 ✓ (Summary of Piping)
Steam Line 2" ø w = 3.65 lb/ft A = 0.0218 ft²					
571-576 Exterior Fence to Change House (Outside area) = 98'	[illegible]		292		
563-565 Change House to Drum Cleaner = 111'	[illegible]	215	325 617 ✓		
Hot Water Lines Change House to Photo Area 577-521					
3" ø Hot-1" Asbestos Insulation A = 0.042 w = 7.58 = 150					
2" ø Hot-2" Asbestos Insulation A = 0.021 w = 7.58 = 152 302	[illegible]		7,726 ✓		
1½" ø Elevated [illegible] w/ 45° [illegible] pipe A = w = 2.72 = 211					
1½" ø [illegible] w/ 45° [illegible] A w = 2.72 211 422	[illegible]		1,148 ✓		
½" ø Potable A = w = 0.85 211	[illegible]		179 ✓		
Piping on [illegible] Stanchion Run S 7 thru S 24					
3" ø Hot-1,2 A = [illegible] w = 7.58 550 + 558 = 1108			8,399 ✓		
2½" ø A = 0.0241 ft² w = 5.79 HA-4 = 225'					
C-1, C-5, C-3 = 404'					
A2, A1 = 476'					
H-2, H-1 = 462'					
4-1, 9-2 = 495' Σ 2066	2.69		11,962 ✓		
1" ø A = 0.0055 w = 1.68 % Vol, N-1 = 623 + 393 = 1,027	0.259		1,725 ✓		
½" ø A = 0.0014 w = 0.85 N2, Trans Plan = 187 + 3,74 = 3,361	[illegible]		2,857		

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SHEET 7 OF 16

CLIENT [illegible]
PROJECT RMA TASK 34
SUBJECT Inventory [illegible]

OFS NO [illegible] DEPT NO [illegible]
BY MJH DATE [illegible]
CHECKED BY JEM DATE [illegible]

	[illegible]	Σ Vol y	Metal lb	Expansion Coefficient	Usage Vol cy
FIRE PROTECTION PIPING (WEST AREA)					
Hydrazine Area					
2" ø A = 0.0[illegible] ft² = 384' ✓ w= 3.65	[illegible]		1,402	✓	
6" ø A = .1[illegible] ft² = 228' ✓ w= 18.97	[illegible]		4,325	✓	
3" ø A = [illegible] = 60' ✓ w= 7.58	[illegible]	[illegible]	455	✓	
Σ [illegible]			Σ 6,182	✓	
Tank Storage Area					
2" ø A = .023 = 504' ✓ w= 3.65	[illegible]		1,840	✓	
4" ø A = .0872 = 363' w= 10.79	[illegible]		3,917	✓	
Σ 867'		[illegible]	Σ 5,757	✓	
Fire Protection Deluge Structure over Horizontal tanks		Σ 0.08			
(HAC 1,2 & 3 [illegible])					
L 2½ x 2½ x ¼ A = 1.19 in² = 576' w= 4.1	[illegible]		2,362	✓	
L 3 x 2 x ¼ A = 1.19 in² = 1,256' w= 4.1	[illegible]		5,150	✓	
WF 6 x 12 A = 3.55 = 324'	[illegible]		3,888	✓	
WF 6 x 8.5 A = 2.63 = 98'	[illegible]		833	✓	
		92	Σ 12,233	✓	
(HS-1 & HS-2)					
L 2½ x 2½ x ¼ A = 1.19 in² = 426' w= 4.1	[illegible]		1,747	✓	
L 3 x 2 x ¼ A = 1.19 in² = 312' w= 4.1	[illegible]		1,279	✓	
WF 6 x 12 A = 3.55 = 108	[illegible]		1,296	✓	
WF 6 x 8.5 A = 2.63 = 264'	[illegible]		2,244	✓	
		64	Σ 6,566	✓	

Fire Protection Pipe Summary

2" = 1402 + 1840 = 3242 ✓
3" = 455 ✓
4" = 3917 ✓
6" = 4325 ✓

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SHEET 2 OF 16

CLIENT USAF
PROJECT EMA Task [illegible]
SUBJECT Inventory [illegible]

OPS NO 415 411
DEPT NO 923
BY MJH
DATE 9/5/86
CHECKED BY JEW
DATE 11/6/86

	Vol (cy)	Σ Vol cy	Metal	Expansion coefficient	Waste Volume
Electrical Items above Ground					
4 x Transformer 25 kva 2' dia x 3' vol = 9.42 x 4 = 37.7 ft³	1.6			1.5	2.4 ✓
1 x Transformer 10 kva 1.5' dia x 3' 5.30 Power Poles Area = π(1)/4 = [illegible] ft² x 40 long x 14 poles / 27	20.2	Σ 21.8		1.5	20.3 ✓
Cables (2 #6) Area = 0.0055 ft² = 1,642 ft	3.33			1.0	3.3 ✓
Junction Boxes 3' x 1' = 4	[illegible]				
~1 hp Transformer Pump 2 hp 2 [illegible] x 3' vol 9.42 = 2	.69				
Sump Pump assumed Area vol 9.42 = 5	1.74	2.85		2.0	5.81 ✓ 9.1 ✓
Fencing					
Interior + post = 1,812	[illegible] cy				
Interior Gates 30' x 5' high thick = 2" = 8	.39	Σ 32.5		2.0	65.0 ✓
Exterior Gates 30' wide x 4' high thick = 2" = 8	[illegible] cy				
Exterior Post = 2,262	2.4 cy	Σ 9.3		2.0	18.6 ✓

EBASCO SERVICES INCORPORATED

CLIENT USAT
PROJECT RMA TASK 34
SUBJECT Inventory Debris

OPS NO. 4157-[illegible] DEPT NO 326
BY mjit DATE 8/5/86
CHECKED BY JEW DATE 11/6/86

	Yd	Σ Vol	Metal Weight	[illegible]	Expanded Vol cy
Horizontal Tanks Dismantled Volumes					
Storage Tanks Material Weight ([illegible])					
CS1 10 dia x 40 long 23,541 lb	= 58 cy		23,541		
HAS1 10 dia x 40 long 23,541 lbs	= 58		23,541		
HAS2 10 dia x 40 long 23,541 lbs	= 58		23,541		
HAS3 10 dia x 40 long 23,541 lbs	= 58	Σ232	23,541	1.0	232.0
Tank insulation 8.7 cy/Tank x 4 (see calculations)	= 34.8			1.5	52.2
			Σ94,364		
US1 10 dia x 30' long 17,426 lbs	= 44 cy		17,426		
US2 10 dia x 30' long 17,426 lbs	= 44 cy	Σ88	17,426	1.0	88.0
Tank Insulation 6.7 cy/Tank x 2 (see calcs)	= 13.4 cy			1.5	20.1
			Σ34,852		
Miscellaneous Items					
(Not enough information to estimate weight)					
Blender (see calculation 2 dismantled)	= 3.9			1.5	5.9
Scrubber Near Blender	= 0.18			1.5	0.3
Handrail Waste Sump					
3" φ Pipe A = .0491 = 62' w = 7.58#/ft	.1145		477.5		
1.5" Pipe A = .0123 266' w = 2.72#/ft	.1204		723.5		
Sump Pump 2'x2'x2' = 1 [illegible]	.30	Σ.30	1201.0	1.5	0.5
[illegible]					
Chiller	= .18			1.5	0.3
Debris (Outside of Bldgs.) SEE Calcs	= 24				
Visual Estimate West Area 22 cy		Σ245.4		1.0	Σ29.0
Visual Estimate East Area 2 cy				1.0	2.0

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EBASCO SERVICES INCORPORATED

SHEET 10 OF 16

CLIENT USAT
PROJECT CMA TASK 31
SUBJECT Inventory Detail

OFS NO 4157 411 DEPT NO 947
BY MJH DATE 3/5/86
CHECKED BY JEM DATE 11/6/86

NO			Vol cy	Σ Vol	Metal	Expansion Coeff.	Loose Volume	
	Non Salvageable Equipment							
	WASTE Sump							
	SLAB	= 51.6 cy	51.6					
	WALLS	= 25 cy	25.0					
				76.6 ✓		1.5	114.9	✓
	Compacted Backfill	= 413 cy	←					Site Restoration Item
	Fire Protection Valve Pit							
	SLABS	= 3.5 cy	3.5					
	walls	= 6.7 cy	6.7	10.2 ✓		1.5	15.3	✓
	Compacted Back Fill	= 33.7 cy	33.7 ←					Site Restoration Item
	Steam Storage Pit							
	Concrete Slab	= 79.3 cy	79.3 ✓	79.3		1.5	119.0	✓
	Nitrogen Pit							
	Concrete Slab	= 1.1 cy	1.1 ✓	1.1		1.5	1.7	✓
	Railroad Tracks							
	Opt No 1 Remove 120' of Track							
	R.R Ties	= 2,520 BF	7.8			1.5	11.7	✓
	R.R A= 5.92 in² (20 lb/ft)	240'	0.37		4,200			
	Opt No 2 Remove 622 of Southern Track							
	R R Ties	= 13,482 BF						
	R R Track A=5.95 in²	= 1244 LF						
	Un/Loading Zone							
	Concrete Slab	= 134 cy	134 ✓	134 ✓		1.5	201.0	✓

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SHEET 11 OF 6

EBASCO SERVICES INCORPORATED

CLIENT US AT
PROJECT RMA TASK 36
SUBJECT Building & Debris

OFS NO 4157 411 DEPT. NO. 94
BY MJH DATE 8/5/86
CHECKED BY JEM DATE 11/1/86

NO		Vol cy	Σ Vol	Metal lb	Expansion coefficient	Loose vol cy	
	Tank Storage Berm (Hol 2, 2 [illegible])						
	Slab = 255 cy ✓	255					
	Walls = 117.5 cy ✓	117.5					
			372.5		1.5	5588 ✓	
	Compacted Backfill 1304 cy	1304 ←					Site Restoration Item
	Storage tank berms ([illegible])						
	Slab = 83.4 cy ✓	83.4					
	Walls = 35 cy ✓	35					
			118.4		1.5	177.6 ✓	
	Compacted Backfill = 429 cy	429 ←					Site Restoration Item
	UNDERGROUND PIPING						
	2"φ - B-I (FROM Waste Sump to East Area) SEE East Area Calc.	–	–				
	Contaminant line (Mixing Facility to West Fence) 2½ φ - C.I. A = .0291 ft² = 570' ✓ w = 5.74 #/ft	.40		2,142 ✓			
	FCI From Waste Sump to [illegible] line 2"φ - C.I. A = .0218 ft² = 210 ✓ w = 3.65 #/ft	.17		766.5 ✓			
	Iron Pipe from Holding Tank to Waste Sump 6"φ - C.I. A = .196 = 110' ✓ w = 18.97 #/ft	.80		2,086.8 ✓			
	[illegible] Sump 2"φ - C.I. A = .0218 = 185' ✓ w = 3.65 #/ft (Note 30 + 155 = 185')	.15		675.2 ✓			
	Drain from [illegible] 3"φ - C.I. A = .0491 = 460' ✓ w = 7.58 #/ft	.84		3,486.8 ✓			
	Cast Iron line from Drain lines in Bldgs. 751, 760 To Sump 4"φ A = .0873 w = 10.79 = 262' ✓ 21,597	.[illegible]	2.324	2,827 ✓ 11,994			

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EBASCO SERVICES INCORPORATED

SHEET 12 OF 16

CLIENT USAF
PROJECT RCRA TAC 34
SUBJECT Inventory Buildings & Others

OFS NO. 4157.411 DEPT NO. 94
BY MJH DATE 8/5/86
CHECKED BY JFM DATE 8/6/86

No.		Vol (cy)	Σ Vol	Add lbs	Expansion coefficient	Loose Vol
	[illegible] Water Lines					
	2 ø PVC Potable (Fence to Charge H.) A: .0218 = 105	.0848			1.5	0.1 ✓
	2½ ø PVC Potable (Charge H. to Ere Area) = A: .0341 = 825 ✓	1.04			1.5	1.5 ✓
	6" ø Cement Asbestos (Tee From S' to H Area) A: .1963 = 86'	.675			1.5	0.9 ✓
	8" ø Cement Asbestos (West Area) A: .349 = 1618	20.31			1.5	31.4 ✓
			22.6			
	SEPTIC TANK Field					
	4" ø Cast Iron (Charge H. to Sept. Tank) A: .0873 = 10 ✓	0.35		1,167 ✓	1.5	0.9 ✓
	4" ø Clay Tile (Leach Field) A: .0873 = 195 ✓	[illegible]				
			0.98			
			Σ 23.5			
	BURIED Electrical CABLES					
	1¼" cable waste Pit to Storage Tanks = 195 ✓ A = .0123	.0386				
	1½" cable Transformer to C. House = 40 A: .0123	.0182				
	1½" cable C. House to Blender = 200 ✓ A: .0123	.0311				
	1½" cable C. House to Waste Pit = 140 ✓ A: .0123	.0636				
	1¼" cable C. House to Drum Cleaner = 170 ✓ A = .0085	.0537				
	745 ✓ (spool = 0.1764)	Σ 0.33	Σ .5		3.0	1.50 ✓
	1" cable C. House to Value Pit = 360 ✓ A = .00557	0.24			3.0	0.73 ✓
	#1 cable waste Pit to Storage Tanks = 195 ✓ A .00557 +.17	0.21			3.0	0.63 ✓
	#4 cable Junction Box Around Tanks = 330 ✓ A .00557 +.17	0.25			3.0	0.75 ✓
	Pavement (see calc. sheets 19,802 ft² from gate to vehicle Washdown) = 184 cy ✓	184	Σ [illegible]		2.0	368 ✓
	Perimeter Security Road 10' wide (Dirt Road) = 2008 LF ✓	[illegible] ft²				
	Access Road From South Side 22' wide (Dirt/Gravel Road) = 215 LF ✓	[illegible] ft²				

SHEET 12 OF 16

EBASCO SERVICES INCORPORATED

CLIENT USAT
PROJECT RMA TASK 34
SUBJECT Inventory Pebr.

OPS NO 9157 41 DEPT. NO 94
BY mill DATE 8/5/86
CHECKED BY JEM DATE 11/6/86

	Vol cy	Σ Vol (cy)	Metal (lb)	[illegible]	Lower Vol (cy)	
SEVERABLE EQUIPMENT EAST AREA						
STANCIONS FROM 3512 TO STORAGE TANKS (35-55)						
12 Ø columns A: .78 ft² w = 49.6 = 361'	0.5		17,905 ✓			
W 10 x 29 A = 8.53 in² = 755'	1.2		21,895 ✓			
MC 12 x 10.6 A = 3.1 in² = 755'	.052		8,003 ✓			
Footing = 0.6 cy	.6			1.5	9.9 ✓	Footing left in place
		Σ 17.3	47,803 ✓			
Fire Deluge Support Structure						
50,000 gal Tank						
4" Ø pipe - columns A: .0873 ft² w = 10.8 = 140' ✓	.453		1,512 ✓			
L 3x3x¼ A: 1.44 in² w = 4.9 = 776' ✓	.29		3,802 ✓			
		Σ .743	Σ 5,319 ✓			
200,000 gal Tank						
4" Ø pipe - columns A = .0873 ft² w = 10.8 = 476'	1.6		5,257 ✓			
L 3x3 x ¼ A = 1.44 in² w = 4.9 = 1,308' ✓	.434		6,409 ✓			
		Σ 1.544	Σ 11,766 ✓			
STRUCTURE OVER TRANFER PIT						
W 10 x 15 A = 4.41 in² = 19'	.0216		285 ✓			
Pipe 3" Ø A = .0491 ft² w = 7.6 = 32'	.0582		243 ✓			
L 3x3x¼ A = 1.44 in² w = 4.9 = 72.7'	.0269		356 ✓			
		Σ 0.11	Σ 336 ✓			

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EBASCO SERVICES INCORPORATED

CLIENT USAT
PROJECT RMA TASK 3
SUBJECT Inventory Debris

OPS NO. 4157411
DEPT. NO. 94
BY MJH
DATE 9/6/86
CHECKED BY JEM
DATE 11/6/86

	Vol cy	Σ Vol	Wght lbs	Expansion Coefficient	Loose Vol cy
PIPING ABOVE GROUND					
1"φ Nitrogen Vst 2 to East Tanks w=1.7 A = .0055 ft² = 854'	.1725		1,452	✓	
3"φ UDMH w=7.6 A = .0491 ft² = 838'	1.52		6,369	✓	
2"φ Vent w=3.65 A = .0218 ft² = 844'	0.68		3,081	✓	
		Σ 2.4	10,902	✓	
Fire Deluge Piping					
4"φ 200,000 gal Tank w=10.79 A .0873 ft² = 391' ✓	1.26		4,219		
4"φ 50,000 gal Tank w=10.79 A .0873 ft² = 196' ✓	0.63		2,115	✓	
587'		Σ 1.9	6,334	✓	
Storage Tanks Vertical					
200,000 dismantle weight = 50,916 lbs	22.6		50,916	✓	
50,000 dismantle weight = 27,736 lbs	11.1		21,106	✓	
Insulation 200,000 see calculations	24.1 ✓				
Insulation 50,000 see calculations	10.2 ✓				
		Σ 68	Σ 108,622		
Electrical Above Ground					
Cables (2-#'s) For lighting Spool=.17 cy A=0.055 ft = 760	0.32			3.0	1.0 ✓
25 KVA					
Cable From Hydrazine Area to East Area (2-#6) = 710' ×.17	0.31			3.0	0.9 ✓
Poles to East Area AL-20-43 thru 56 = 5 > ⑭					
Poles In EAST Area poles = .759 ft² × 40 lng = 1	15.72			1.5	23.6 ✓
Distribution Panel 6' × 1 = 1	0.222			1.5	0.3 ✓
		Σ 16.23			

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SHEET 15 OF 15

CLIENT USAT
PROJECT RMA TASK 34
SUBJECT Inventory Debris

OPS NO 4157411 DEPT NO 945
BY MJH DATE 3/6/86
CHECKED BY J EW DATE 11/6/86

No			Vol cy	Σ Vol cy	Metl #	Expansion Factor	Ebasco Vol cy	
	MISCELLANEOUS							
	Interior Fence see calculations	= 812' ✓	9.31 ✓	Σ 9.31		2.0	18.6	✓
	Exterior Fence see calculations	= 1,212'	1.48	21.48		2.0	3.0	✓
	Scrubber see calculations	= 30 ✓	3.0			1.5	4.5	✓
	Transformer and Submersible Pumps (3) - (1x1x3)/27	< 3	0.333 ✓			1.5	0.5	✓
	Non Submersible Equipment							
	Concrete Dikes							
	463D - 200,000 gal (US-4)							Suspected Potentially Contaminated Sand 8cy included with US-4
	Cover transfer pt	= 0.3 cy	0.3					
	Slab	= 121 cy ✓	121					
	Walls	= 51 cy ✓	51	172		1.5	258	✓
	Compacted backfill - Excavated Area	= 92.8 cy ✓	92.8					← Site Restoration Items
	Compacted backfill - Transfer Pt	= 33.5 cy	33.5					←
	805C - 50,000 gal (US-3)							
	Slab	= 40 cy ✓	40					
	Walls	= 26 cy ✓	26	66		1.5	99.0	✓
	Compacted backfill	= 242 cy ✓	242					← Site Restoration Item
	Fire Protection Valve Pt							
	Slab	= 3.5 cy ✓	3.5					
	Walls	= 6.7 cy	6.7	10.2		1.5	15.3	✓
	Compacted backfill	= 3.4 cy	3.4					← Site Restoration Item

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SHEET 16 OF 17

CLIENT ICAT
PROJECT RMA TASK 3d
SUBJECT Inventory Debris

OFS NO. 415741 DEPT NO. 242
BY MLH DATE 2/3/86
CHECKED BY JEM DATE 11/6/86

		Vol cy	Σ Vol	Metal (lbs)	Expansion Factor	Loose Vol cy	
Underground Piping							
3"ø Drain line From East Tank to Cleanout (A.0441)	= 795' 16	1.44		6,042	✓		
2"ø Black Iron From Transfer Pump to Waste Pump	= 1,060' A.0418	.086		3869	✓		
2½ø PVC Water line C. House to Emg. Eye	= 368 West Arm						
8" Cement Asbestos Fire Protective Water line A: 349	= 806'	10.4			2.0	20.8	✓
			12.7	9,911	✓		
Electric Conduit							
¾"ø Conduit Distribution Panel to Valve Pit	= 115' Spool	.17					
1"ø " "	= 115 / 230'	.0252	Σ 0.21		3.0	0.62	✓
Miscellaneous							
Security Road 10' wide	= 1000'						
Nitrogen Pad	= 1.06cy	1.06			1.5	1.6	✓
Shower Pad	= .46cy	.46			1.5	0.7	✓
Scrubbers Pad	= 2.5cy	2.5	Σ4		1.5	3.8	✓
Site Restoration							
Disposal of Upper Liner	= 16.5cy	16.5			1.5	24.75	✓
Remove Fencing Around Pond See Cal's .011 cy/ft	= 768'	8.8	253		2.0	17.6	✓

EBASCO SERVICES INCORPORATED

BY MJH DATE 7/20/87 SHEET 6A OF 6
CHKD. BY JSM DATE 7/20/87 OFS NO. 4157.487 DEPT. NO. 942
CLIENT USAT
PROJECT RMA TASK 34
SUBJECT DRAWING LIST USED FOR QUANTITY TAKE-OFFS

DRAWING NO.	DATE	TITLE
AW-78-14-01 Sheet 1	2/24/61	Concrete basin and plans
AW-78-14-01 Sheet 2	2/24/61	Concete basin section and details
AW-78-14-01 sheet 3	2/24/61	Pipe support plan and details
AW-78-14-01 sheet 4	2/24/61	Pipe support elevations
AW-78-14-01 sheet 5	2/24/61	Miscellaneous steel details
AW-78-14-01 Sheet 6	2/24/61	Process flow diagram
AW-78-14-01 Sheet 7	2/24/61	Utility flow diagram
AW-78-14-01 Sheet 8	2/24/61	Vessel details UDMH, US-1
AW-78-14-01 Sheet 8A	2/24/61	Vessel details UDMH, US-2
AW-78-14-01 sheet 9	2/24/61	Vessel details

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BY MJH DATE 7/20/87 SHEET 16B OF G

CHKD. BY JSM DATE 7/20/87 OFS NO. 4157.487 DEPT. NO. 942

CLIENT USAT

PROJECT RMA TASK 34

SUBJECT DRAWING LIST USED FOR QUANTITY TAKE-OFFS

DRAWING NO.	DATE	TITLE
AW-78-14-01 Sheet 10	2/24/61	Process area piping plan
AW-78-14-01 Sheet 11	2/24/61	Storage area piping plan
AW-78-14-01 Sheet 12	2/24/61	Process area piping sections
AW-78-14-01 Sheet 13	2/24/61	Storage area sections
AW-78-14-01 Sheet 14	2/24/61	Storage area deluge system
AW-78-14-01 Sheet 15	2/24/61	Underground piping plan
AW-78-14-01 Sheet 16	2/24/61	Miscellaneous details
AW-78-14-01 Sheet 17	2/24/61	Electrical plan
E2-72-2	8/2/60	Mixing facility area plan
E2-72-4	3/10/75	Building 758, storage tanks 463C and 805
E3-72-1	3/11/75	Building 758, storage tanks 462C and 805 reinforced concrete dike for tank 462C plan, elevation, section and details

BY MJH DATE 7/20/87 SHEET 16C OF G

CHKD. BY JSM DATE 7/20/87 OFS NO. 4 157 487 DEPT. NO. 942

CLIENT USAT

PROJECT RMA TASK 34

SUBJECT DRAWING LIST USED FOR QUANTITY TAKE-OFFS

DRAWING NO.	DATE	TITLE
E3-72-1A	8/6/60	Mixing facility concrete pad plan section and details
E3-72-2	3/11/75	Building 758 storage tanks 4630 and 805 reinforced concrete dike for tank 805 plan elevation and section de
E3-72-2A	8/25/60	Mixing facility unloading and loading platforms
E3-72-3A	8/31/60	Mixing facility change house building 755, plans and elevations
E3-72-4	3/11/75	Building 758 storage tanks 4630 and 805 stanchion supports and concrete pier plans, elevations and sections
E3-72-4A	8/30/60	Mixing facility steam line stanchion plan, elevation and detail
E3-72-5	3/11/75	Security improvement and building additions, reinforced concrete floor buildings 759, 760, 761 and sections
E3-72-5A	9/13/60	UDMH - Hydrazine mixing facility support structure for sprinkler system
E3-72-6	3/11/75	Security improvement and building additions, building 759 plan and elevations

BY MJH DATE 7/20/87 SHEET 16D OF G
CHKD. BY JSM DATE 7/20/87 OFS NO. 4157 487 DEPT. NO. 942
CLIENT USAT
PROJECT RMA TASK 34
SUBJECT DRAWING LIST USED FOR QUANTITY TAKE-OFFS

DRAWING NO.	DATE	TITLE
E3-72-6A	8/26/66	Mixing facility reservoir plan sections and details
E3-72-7	3/11/75	security improvements and building additions, building 762 and [illegible]
E3-72-8	3/13/75	Hydrazine plant building 753 storage tanks 463D and 505 reinforced concrete pump pit
E3-72-9	3/11/75	Hydrazine plant building 753 fire protection reinforced concrete valve pit plan, elevation and [illegible]
E3-72-10	4/18/75	Hydrazine plant building 753 fire protection sprinkler head pipe [illegible]
E3-72-12	3/11/75	Building 753 storage tanks 463D and 505 stanchions supports and concrete piers plan elevation and sections
E3-72-13 Sheet 1	4/21/75	Security improvements and building additions, stanchion supports and concrete piers.
E3-72-13 Sheet 2	4/21/75	Security improvements and building additions, stanchion supports and concrete piers.

EBASCO SERVICES INCORPORATED

BY MJH DATE 7/20/87 SHEET 16E OF G
CHKD. BY JSM DATE 7/20/87 OFS NO. 4157.487 DEPT. NO. 942
CLIENT USAT
PROJECT RMA TASK 34
SUBJECT DRAWING LIST USED FOR QUANTITY TAKE-OFFS

DRAWING NO.	DATE	TITLE
E3-72-14	8/4/75	security improvement and building addition, reinforced concrete drum storage slab
E3-72-17	3/19/76	Concrete pad for vent scrubber plans and sections
E3-72-21	1/19/77	Repair of 200,000 gallon UDMH Tank 463-D
E4-72-3	12/17/60	Building 755 change house electrical system
E4-72-5	4/11/75	13.8 kv line and security force lighting plan and details electrical system
E4-72-6	4/11/75	Building 758 security force lighting plan and sections, electrical system
E5-72-17	3/18/75	Storage tanks 463D and 605 UDMH hydrazine transfer and vent system and nitrogen piping
E5-72-1	8/9/60	UDMH-hydrazine mixing process and potable water lines
E5-72-2	8/30/60	Embedded piping details and fire protection spray system

EBASCO SERVICES INCORPORATED

BY MJH	DATE 7/20/87
CHKD. BY JSM	DATE 7/20/87
SHEET 16E OF G	
OFS NO. 4157.487	DEPT. NO. 942
CLIENT USAT	
PROJECT RMA TASK 34	
SUBJECT DRAWING LIST USED FOR QUANTITY TAKE-OFFS	

DRAWING NO.	DATE	TITLE
E5-72-5	9/30/60	Change house building 755 plumbing piping
E5-72-6	9/21/60	steam line piping, steam trap detail
E5-72-8	9/2/60	Process piping UDMH-hydrazine mixing plan and details
E5-72-9	2/28/61	UDMH - hydrazine mixing facility emergency drench showers piping details
E5-72-14	10/14/63	Storage area piping revisions details
E5-12-16	3/18/75	Building 758 fire protection deluge sprinkler system control valve pit
E5-72-18	4/11/75	Building 758 UDMH-hydrazine tank fire detection and sprinkler system general layout plan
E5-72-19	4/18/75	UDMH, nitrogen and vent system extension to new site
E5-72-20	4-19-75	steam and water for drum cleaning and inspection building 759
E5-72-21	4-18-75	Building 758 fire protection site plan and water main

981/6-81

EBASCO SERVICES INCORPORATED

BY MJH DATE 7/20/87 SHEET 16G OF G
CHKD. BY JSM DATE 7/20/87 OFS NO. 4157.487 DEPT. NO. 942
CLIENT USAT
PROJECT RMA TASK 34
SUBJECT DRAWING LIST USED FOR QUANTITY TAKE-OFFS

DRAWING NO.	DATE	TITLE
E5-72-23	4/23/76	Product, hydrazine, nitrogen and vent piping modification of drum fill station west hydrazine
E8-72-1	3/11/75	Building 758 storage tanks 463D and 885 site plan and drainage line plan and section
E10-72-10	8/23/75	Building 758 new floor for storage tank 463D plan and details
E10-72-11	5/5/76	scrubber vapor vent system

APPENDIX C

LIST OF PLATES
AND
CORRESPONDING DISMANTLING/DEMOLITION TASK NUMBERS

APPENDIX C

LIST OF PLATES AND CORRESPONDING DEMOLITION/DISMANTLE TASK NUMBERS

Plate No.	Description	Reference Task No.
1	East elevation of building 760 (Building 759 in background)	1
2	North elevation of building 759	2
3	East elevation of building 755 (Stanchions 60, 77, 78 and 79 in background)	3
4	Empty 42-gallon drums west of building 755	3
5	East elevation of building 868 (waste sump in background)	4
6	View of stanchions 71-76 from west fence (Buildings 755 and 868 in background)	5
7	Asbestos insulation on heat exchanger in building 755	6
8	Stanchions 77-91	7
9	Fire deluge support stanchions over railroad loading facilities and miscellaneous debris in hydrazine area	8
10	Miscellaneous debris in hydrazine area	9
11	West elevation of drum filler shed (Hydrazine blender in background)	9
12	Loading platform in the hydrazine area, 1 of 3	10
13	Stanchions 7-34 viewed from the blender looking east	11
14	Typical fire deluge structure over horizontal storage tanks	12 thru 16
15	Metal sheathing and insulation over horizontal storage tanks	12 thru 16
16	West elevation of horizontal storage tanks	12 thru 16
17	Fire deluge structure over tank US-4	17
18	Polyurethane insulation over tanks US-3 and US-4	18, 20

APPENDIX C (Continued)

LIST OF PLATES AND CORRESPONDING DEMOLITION/DISMANTLE TASK NUMBERS

Plate No.	Description	Reference Task No.
19	Northwest elevation of tanks US-3 and US-4	19
20	West elevation of steel structure over transfer pump pit	20
21	Concrete bermed area around tank US-3	21
22	Concrete bermed area around tank US-4	22
23	Eye wash and fire protection value pit	23
24	Stanchions 35-40 viewed from US-3 looking west	24
25	Connection of horizontal tanks to stanchions 34-54	24
26	Typical concrete bermed area around horizontal tanks	25
27	Hydrazine blender pad	27
28	25-kVA transformers located near building 755	31
29	25-kVA transformer near tank US-4	31
30	Truck turnaround area	32
31	Interior fence	35
32	Exterior fence	36

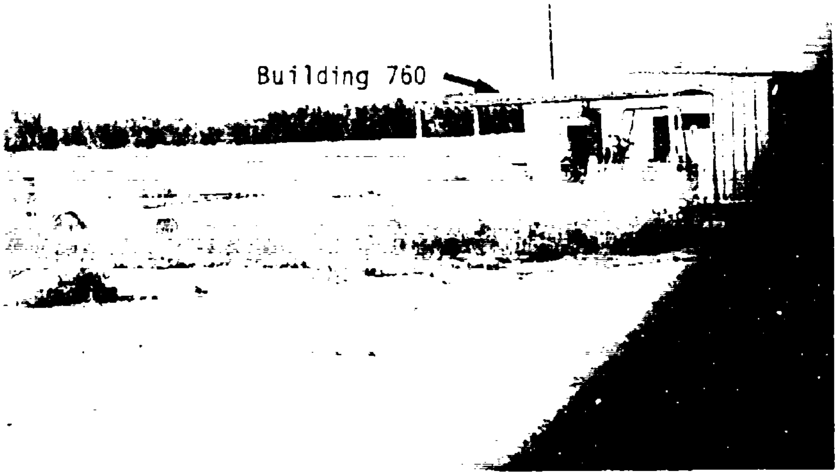


Plate No. 1

East elevation of building 760 (Building 759 in background)

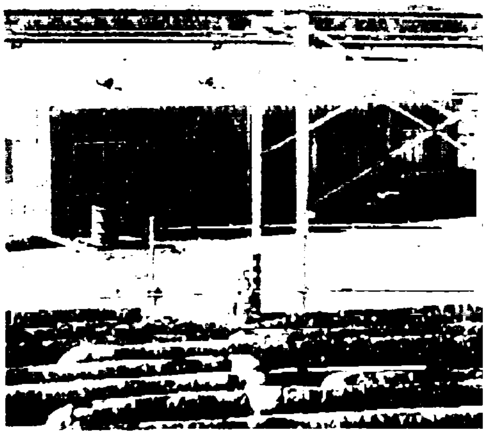


Plate No. 2 North elevation of

Plate No. 4 Empty 42-gallon drums west of building 755

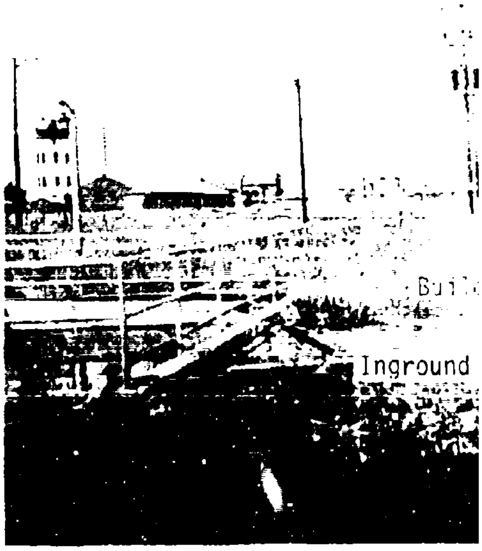
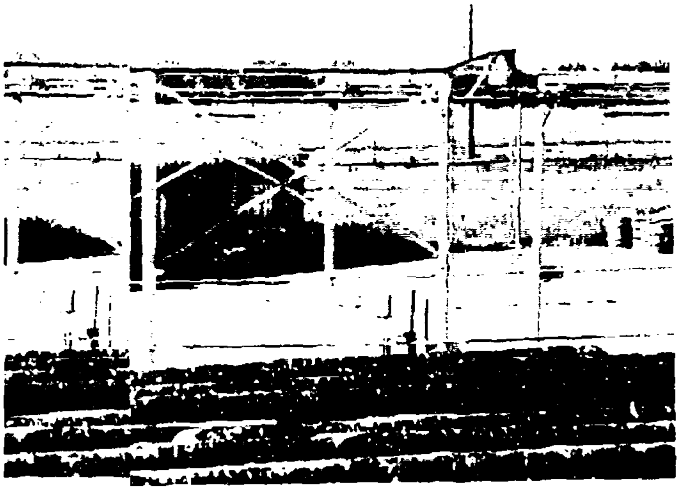


Plate No. 5

East elevation of building 868 (ir
tank in foreground)



buildin elevation of building 759

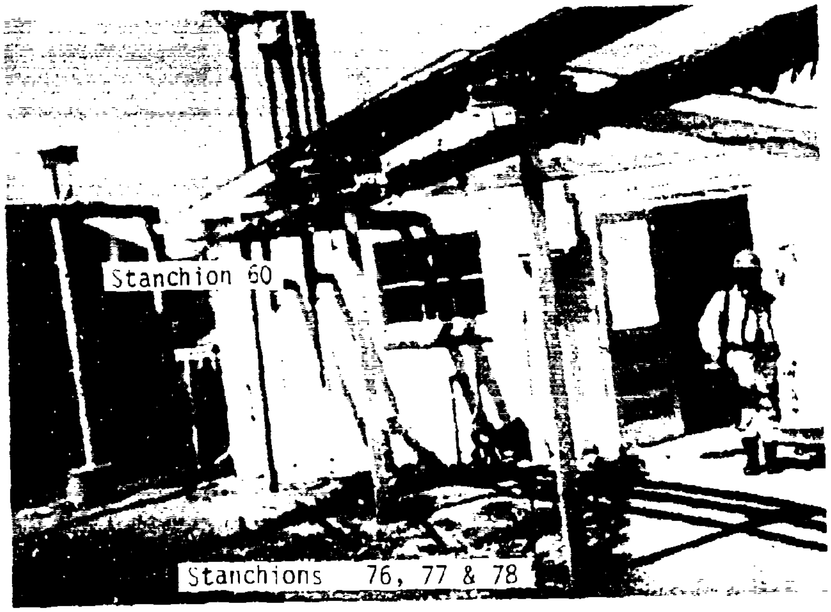
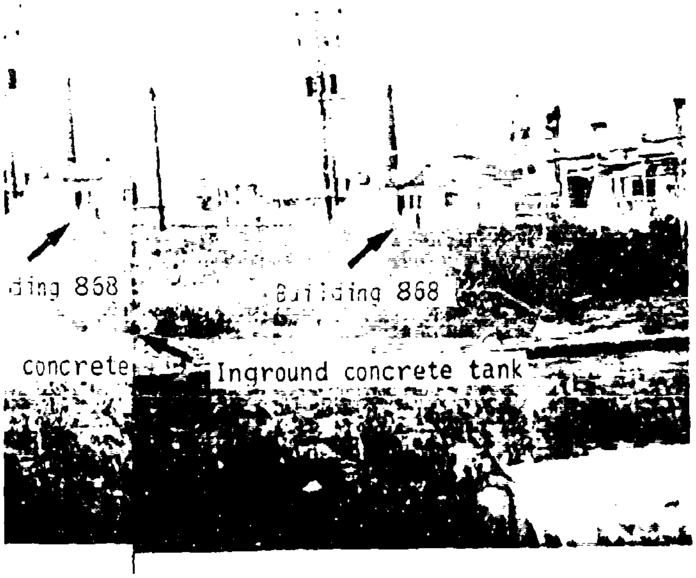


Plate No. 3
East elevation of building 755
(Stanchions 60, 76, 77 and 78 in background)



nground c uilding 868 (inground concrete

Plate No. 6
View of stanchions 71-75 from west fence
(Buildings 755 and 868 in background)

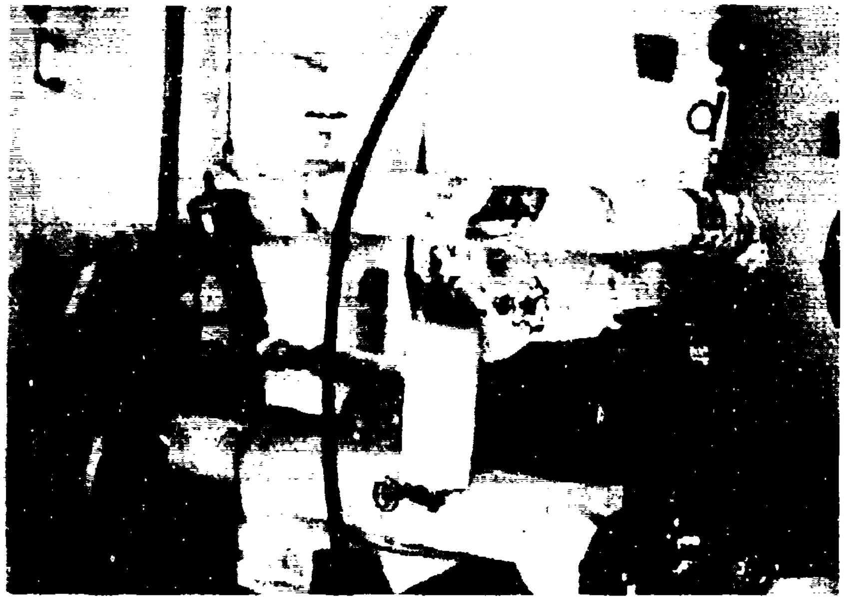


Plate No. 7
Asbestos insulation on heat exchanger in building 755

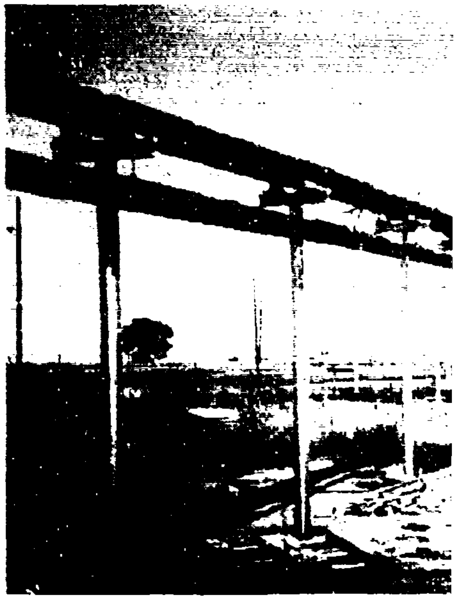


Plate No. 8 Stanchions 76-91

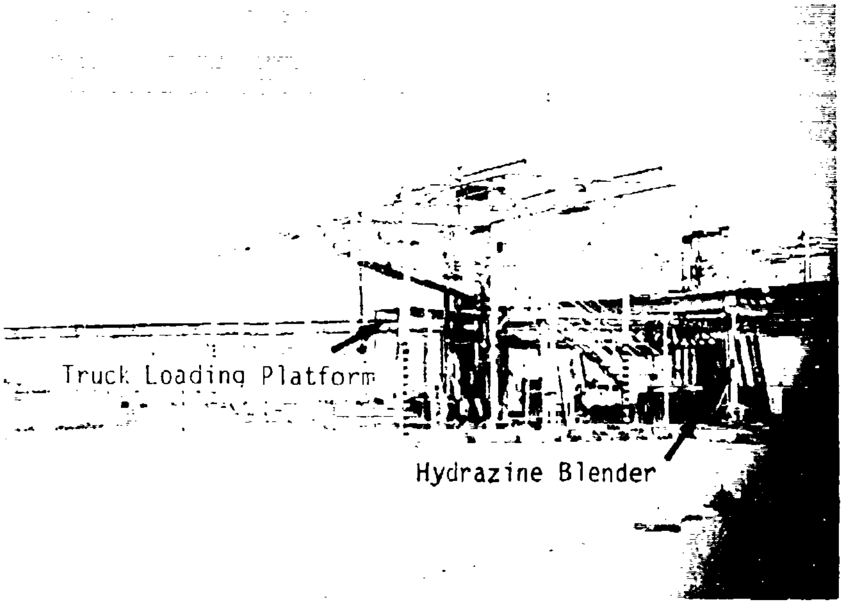


Plate No. 10 Miscellaneous debris in hydrazine area

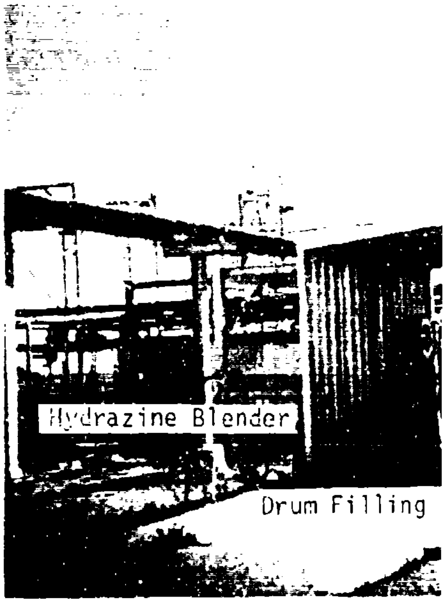
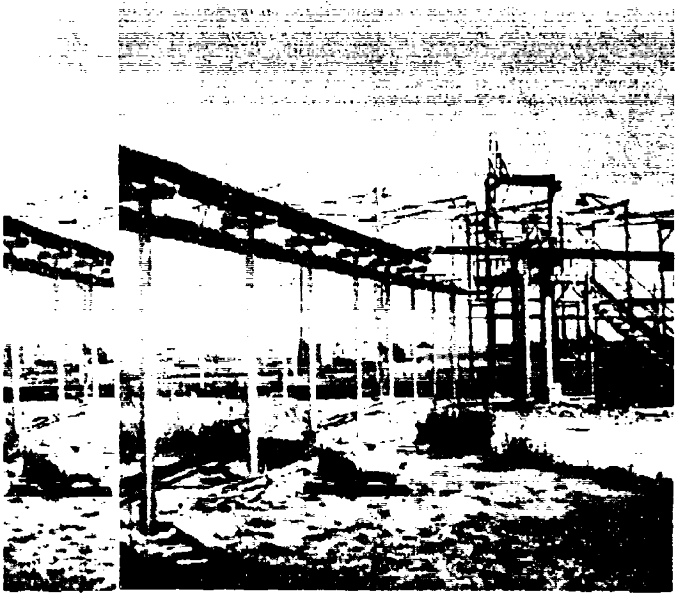


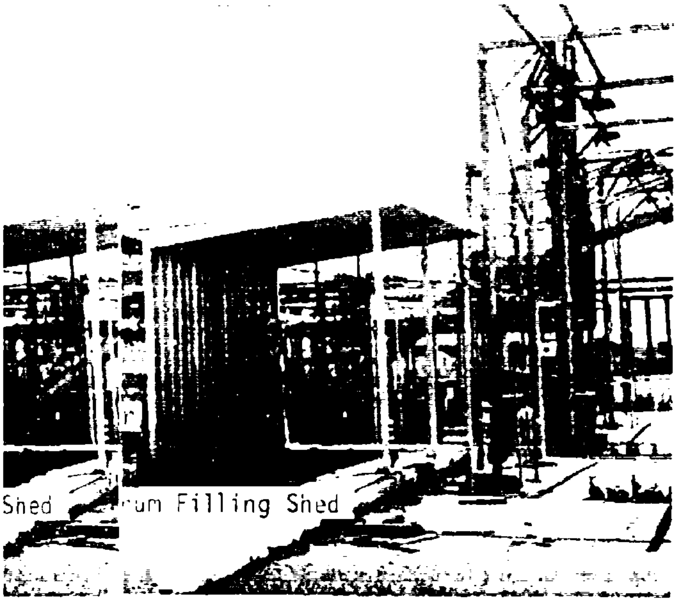
Plate No. 11
West elevation of drum filler s
(Hydrazine blender in backgroun



ions 76-91

Plate No. 9

Fire deluge support stanchions over railroad loading facilities and miscellaneous debris in hydrazine area



ned um filler shed
d) n background)

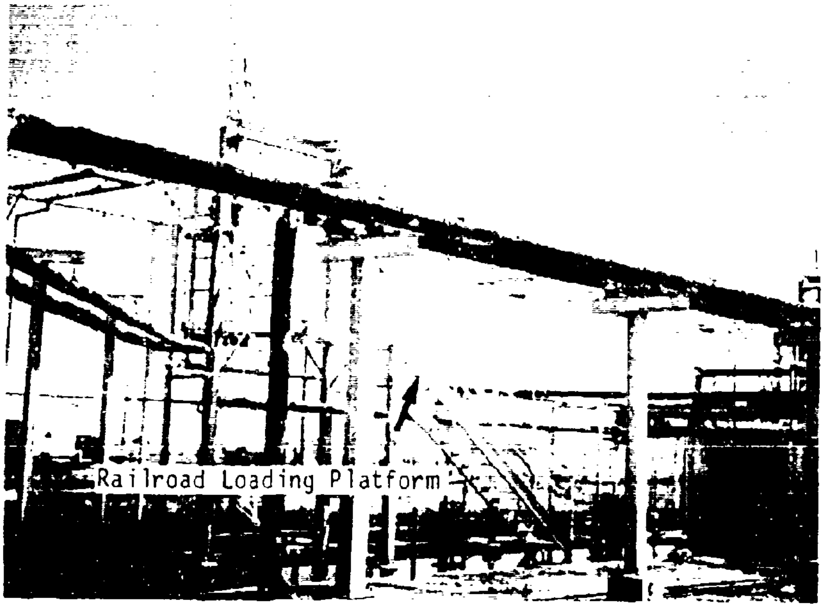


Plate No. 12

Loading platform in the hydrazine area, 1 of 3

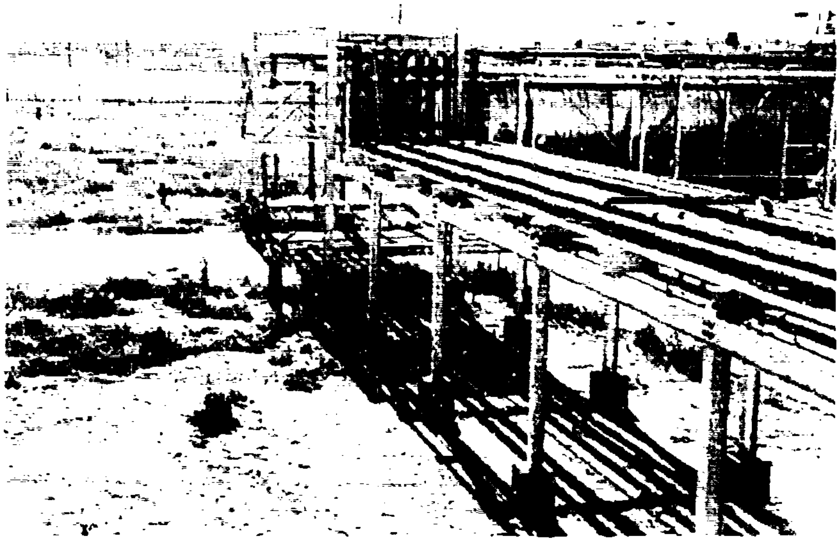


Plate No. 13

Stanchions 7-34 viewed from the blender looking east

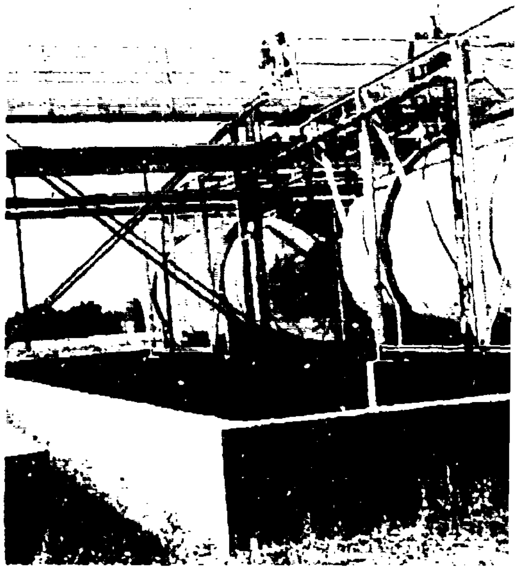


Plate No. 14

Typical fire deluge structure over horizontal storage tanks

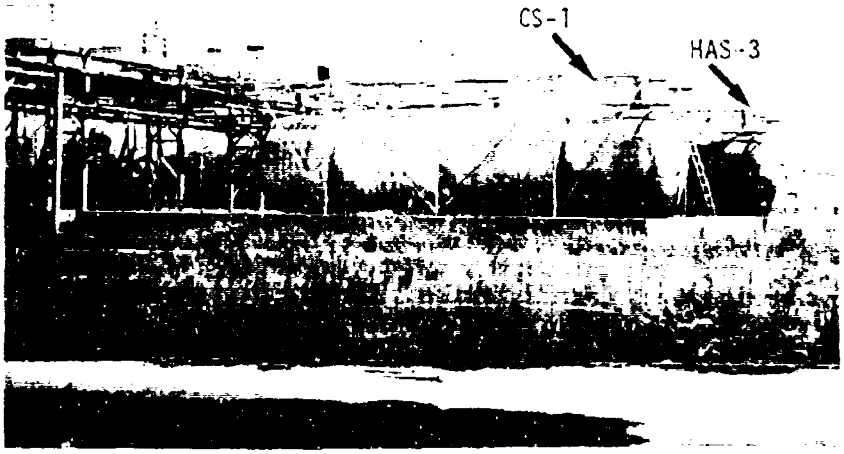


Plate No. 16 West elevation of horizontal storage tanks

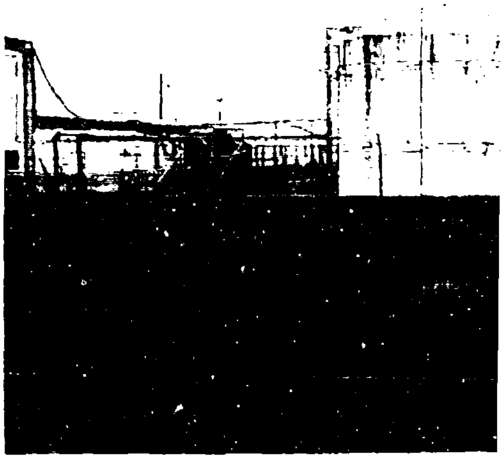
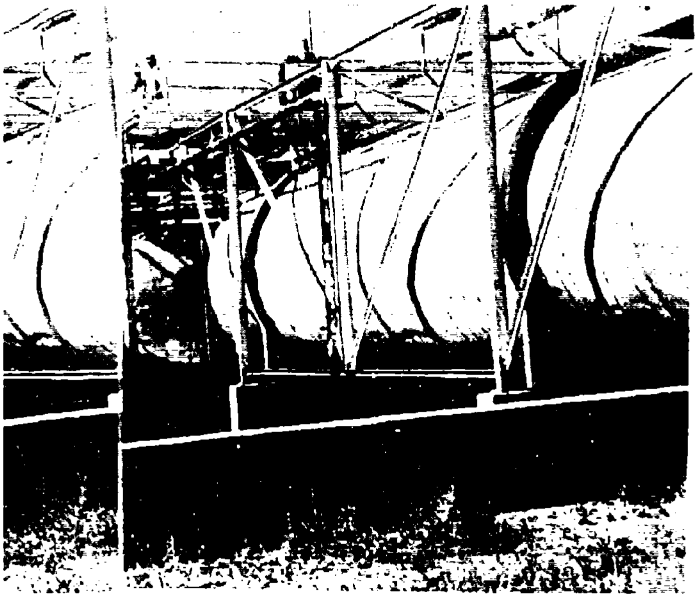


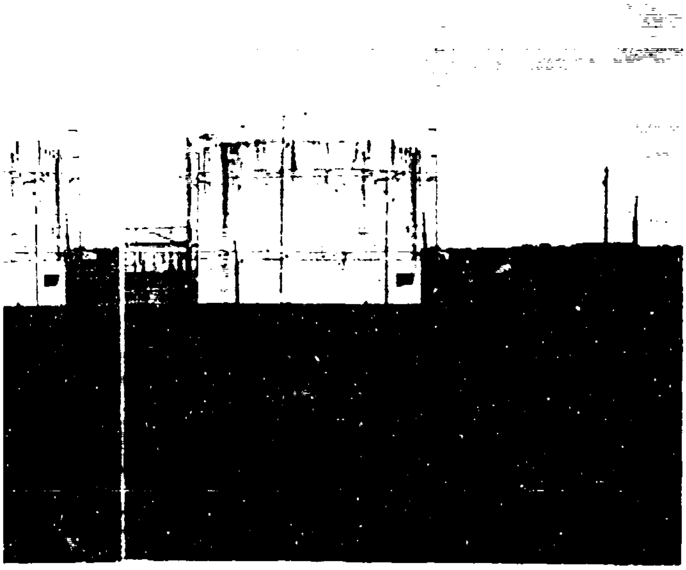
Plate No. 17 Fire deluge structur



structure over
tanks

Plate No. 15

Metal sheathing and insulation over horizontal storage tanks



e over t deluge structure over tank US-4

Plate No. 18

Polyurethane
insulation over
tanks US-3
and US-4

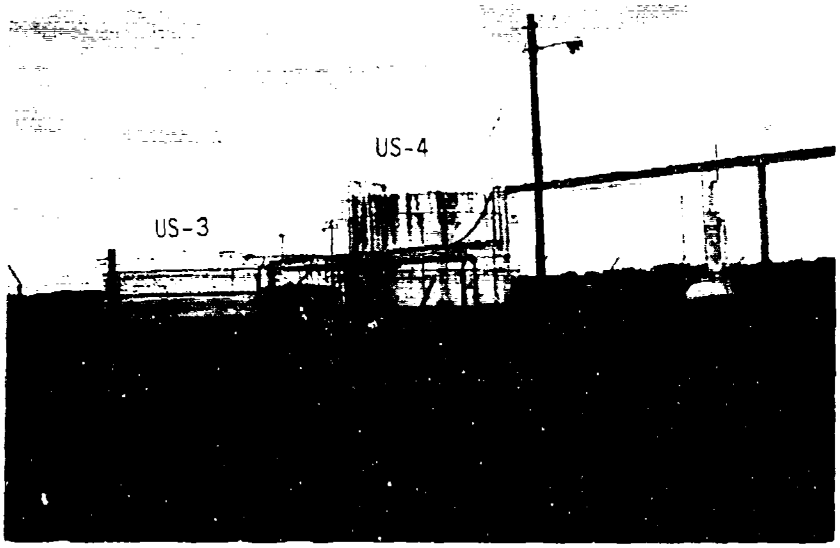


Plate No. 19
Northwest elevation of tanks US-3 and US-4

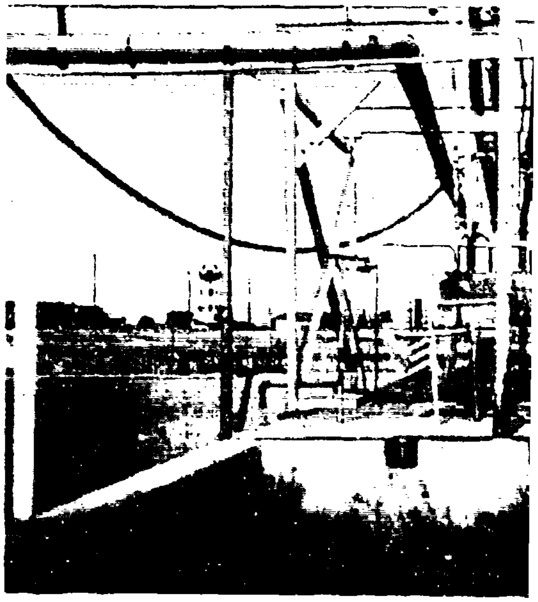


Plate No. 20
West elevation of steel structure over
pump pit

Plate No. 22
Concrete bermed
area around
tank US-4

Plate No. 23 Eye wash and fire prot

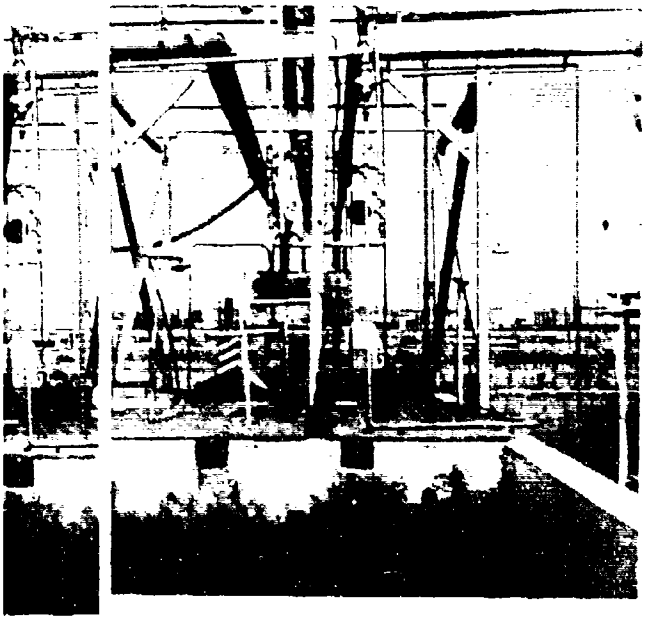


Plate No. 21 Concrete bermed area around tank US-3

structure over transfer

trans

ection

and fire protection valve pit

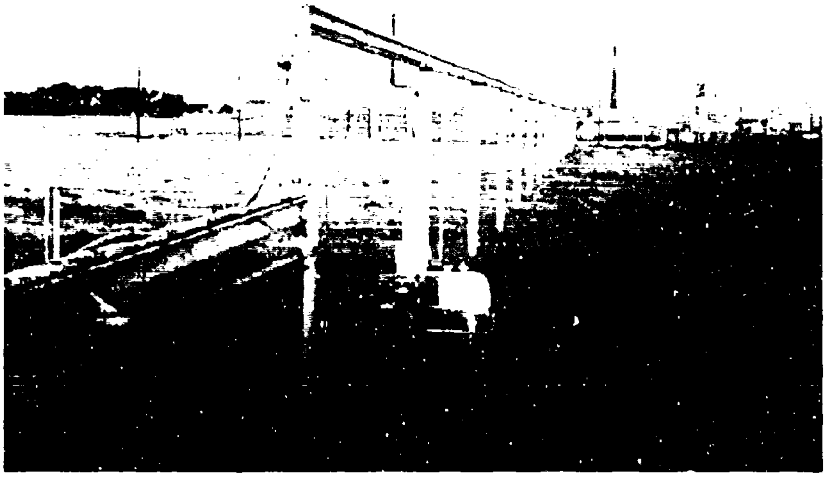


Plate No. 24

Stanchions 35-40 viewed from US-3 looking west

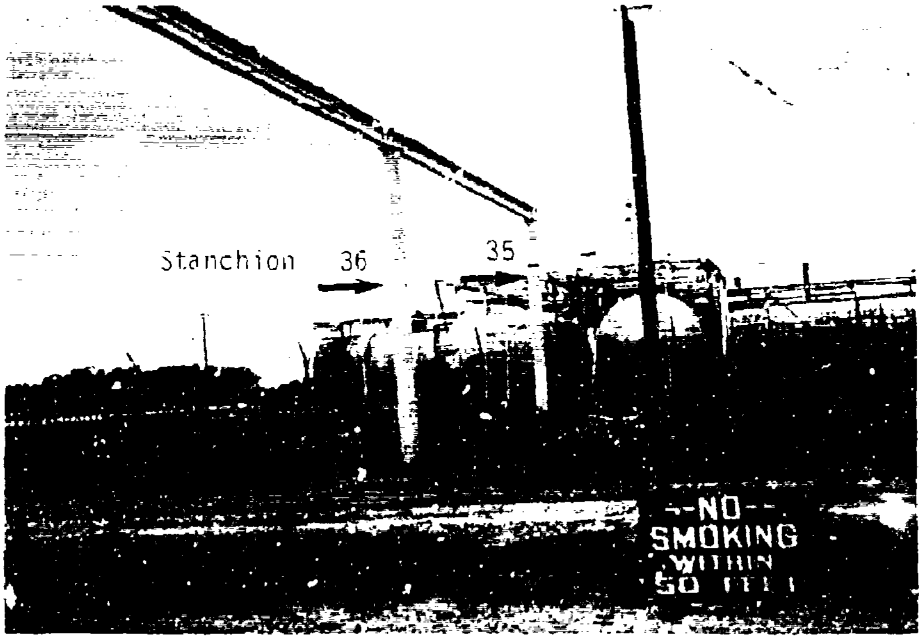
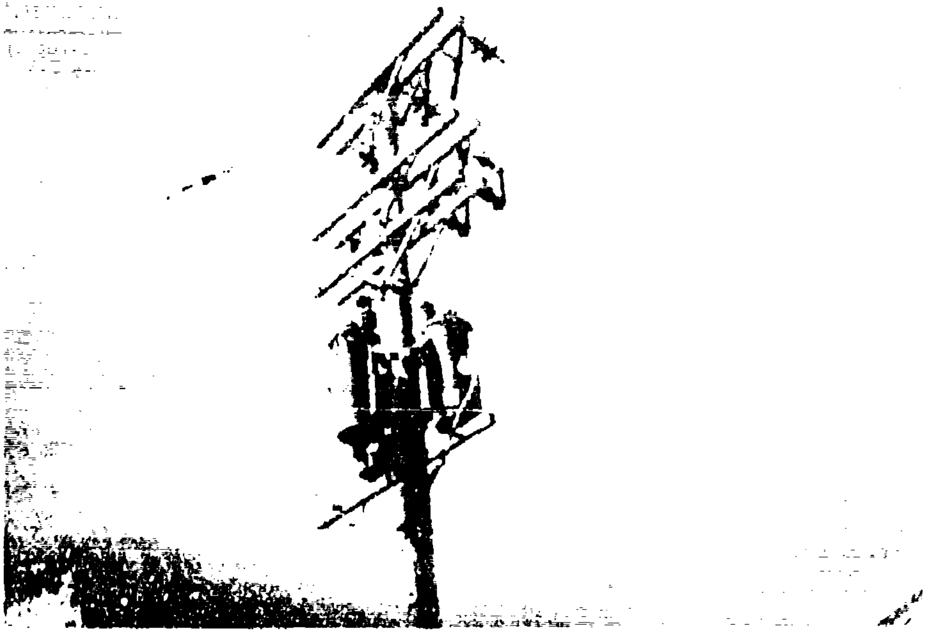
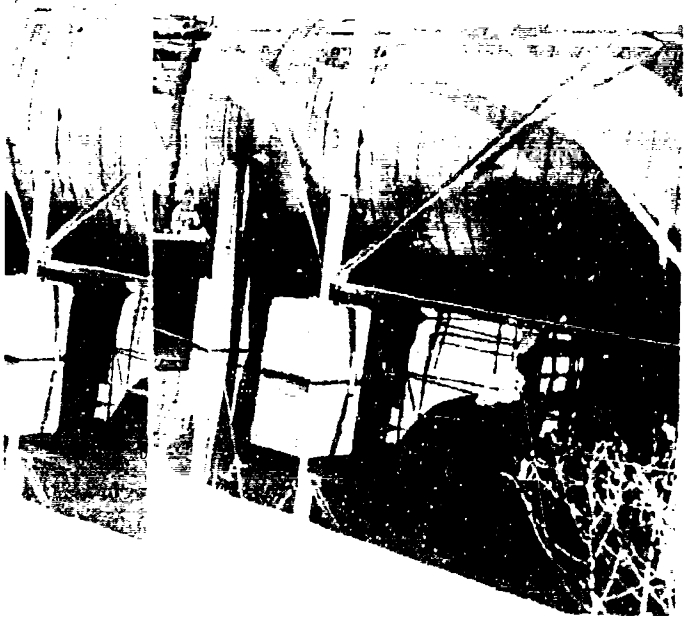


Plate No. 25
Connection of horizontal tanks to stanchions 35-53

Plate No. 15
Typical concrete be



e No. 23
kVA transformers located near building 755



[illegible] area around horizontal tanks

Plate No. 27 Hydrazine blender pad

Plate No. 29

25-KVA transformer near tank US-4

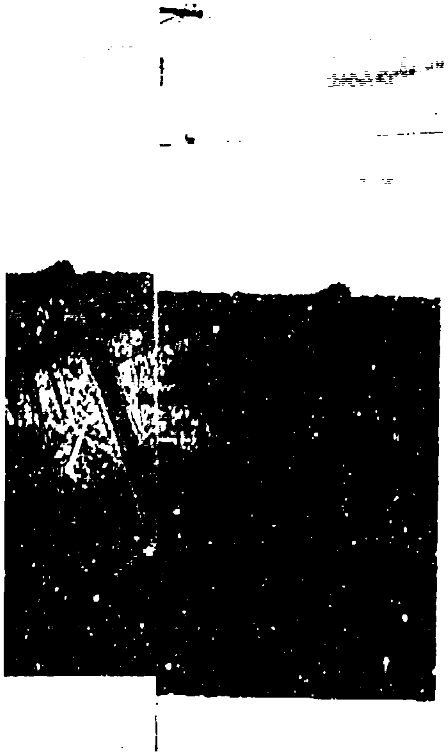


Plate No. 30 Truck turnaround area

Plate No. 31 Interior fence

Plate No. 32 Exterior fence

APPENDIX D

REQUIREMENTS OF THE CONTRACTOR QUALITY CONTROL PLAN (CQCP) FOR SAMPLING AND ANALYSIS ACTIVITIES

1.0

The following subsections provide specific guidance pertinent to each of the sixteen components which must be included in the Contractor Quality Control Plan (CQCP). The CQCP shall be prepared using a document control format consisting of information placed in the upper right hand corner of each document page as follows:

- Section Number
- Revision Number
- Date (of Revision)
- Page (___ of ___)

All CQCPs shall be controlled documents. A list shall be kept of personnel receiving copies of each CQCP and any subsequent revisions.

1.1 TITLE PAGE

Provisions shall be made at the bottom of the title page for the signatures of approving personnel and the dates of approval.

1.2 TABLE OF CONTENTS

The CQCP table of contents will address each of the following items:

- Introduction
- A serial listing of each of the 16 components
- A list of any appendices which are required to augment the CQCP

1.3 PROJECT DESCRIPTION

The contractor will provide a general description of the HBSF decommissioning work covered by the CQCP. This description may be brief but must have sufficient detail to allow reviewers of the CQCP to perform their task. Reference to the decommissioning plan may be made for additional information as appropriate.

1.4 PROJECT ORGANIZATION AND RESPONSIBILITY

The contractor will include an organization chart showing the project organization and line authority of all key personnel. The contractor shall also include a list of all key personnel and a description of the project responsibilities of each. The project organization for the prime contractor and any subcontractors will be clearly defined with QA/QC responsibilities for each delineated. The contractor QC officer must report to a responsible senior officer of the company (i.e., the QC chain of command must be separate from that of project management).

Resumes of all key contractor personnel will be included as an appendix to the CQCP . The project-related qualifications of the contractor's analytical laboratory in terms of equipment and facilities and its' personnel including names and resumes shall also be included as an appendix to the CQCP.

1.5 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

This section presents the contractor's objectives to assure that environmental monitoring data of known and acceptable quality will be provided for each work task. The contractor shall present these quality objectives for each work task, subtask, or measurement parameter as applicable in terms of precision, accuracy, completeness, representativeness, and comparability. The contractor may choose to present much of the information contained herein in tabular form. The contractor shall describe in detail how these objectives are determined under Component 14, Procedures for Determining Precision, Accuracy, Completeness, Representativeness and Comparability.

1.6 SAMPLING PROCEDURES

The contractor will include a description of the sampling procedures to be used for each task and subtask as appropriate. Procedures shall reflect the contractor's knowledge of the health and safety considerations of the tasks involved. It is imperative that the contractor employ procedures and equipment that will protect contractor personnel, minimize risk of exposure and allow quick and efficient sampling. Sampling procedures shall include the following, where applicable, for each task and subtask or measurement parameter:

- o Description of techniques and guidelines used to select sampling sites (random, stratified etc.)

- o Sampling program organization. Include charts, flow diagrams, or tables delineating sampling program operations.

- o Specific sampling procedures shall be included. Sampling procedures shall be consistent with EPA guidelines and the government QA laboratory unless otherwise specified. In some cases, special Corps procedures or, if EPA has not developed specific procedures, ASTM, NIOSH, or USATHAMA certified procedures recommended by the EPA are to be used (Ebasco 1985a). For nonstandard sampling methods or modified sampling methods, detailed method write-ups with appropriate references are required. Specific reference descriptions should be given as needed including sample sizes, samplers to be used, etc.

- o A description of containers and cleaning procedures used for sample collection, preservatives, transport and storage following EPA and equivalent guidelines (USEPA 1983; Ebasco 1985a; Ebasco 1985d)

- o Special conditions for the preparation of sampling equipment and containers to avoid sample contamination.
- o Sample preservation methods (e.g., cooling to 4°C, preserving with chemicals, etc.) and sample holding times (follow EPA and equivalent guidelines).

- o Sample transportation requirements following DOT Hazardous Material Transportation regulations (49 CFR 170-179) if taken off-site. Contractor shall specify time considerations for shipping samples promptly to the laboratory.

1.7 SAMPLE CUSTODY

Chain of custody procedures following EPA, RMA Sampling Plan and the QA laboratory guidelines will be followed by the contractor (USEPA 1983, Ebasco 1985a). The contractor will describe in step-by-step detail the chain of custody procedures used to include the following:

Field Sampling Operations

- Permanently bound notebooks shall be used. These notebooks shall contain sample descriptions, field data and observations. These may be used in conjunction with electronic data management, if applicable.
- Documentation of procedures for preparation of reagents or supplies which become an integral part of the sample (e.g., filters, and absorbing reagents),
- Procedures and forms for recording the exact location and specific considerations associated with sample acquisition.
- Documentation of specific sample preservation methods.
- Pre-prepared sample labels containing all information necessary for effective sample tracking.
- Standardized field tracking reporting forms to establish sample custody in the field prior to shipment.

Laboratory Operations

- Identification of responsible party to act as sample custodian at the laboratory facility authorized to sign for incoming field samples, obtain documents of shipment (e.g., bill of lading number or mail receipt), and verify the data entered onto the sample custody records.

- Provision for a laboratory sample custody log consisting of serially numbered standard lab-tracking report sheets.

- Specification of laboratory sample custody procedures for sample handling, storage and dispersement for analysis.

1.8 CALIBRATION PROCEDURES AND FREQUENCY

The contractor shall include calibration procedures and frequency information as follows:

- For each major measurement parameter, including all pollutant measurement systems, reference the applicable standard operating procedure or provide a written description of the calibration procedure(s) to be used.

- List the frequency planned for recalibration.

- List the calibration standards to be used and their source(s), including traceability procedures.

A list of field and laboratory instrumentation (manufacturer, model, accessories, etc.) shall be required. The instrumentation and calibration shall be consistent with the requirements of the contract and with EPA approved analytical method requirements.

1.9 ANALYTICAL PROCEDURES

The analytical procedures to be used shall be USATHAMA-certified, if necessary. USEPA or NIOSH standard methods will otherwise be used whenever practical. When not practical, other properly validated and standardized methods such as ASTM or state-of-the-art methods for which appropriate precision, accuracy and inter-laboratory comparison data have been generated may be substituted with the approval of the Contracting Officer and concurrence from Corps of Engineers Missouri

River Division Engineering Department Laboratory (MRDED-L). In some cases the exact methods to be used may be specified in the contract. Where alternate standard methods are available, the contractor may have some latitude but should normally use the most cost-effective method provided that it possesses satisfactory accuracy, specificity and sensitivity for the data requirements. If an alternate standard method is used, it must be approved by the laboratory QA Officer.

The CQCP shall specifically state the analytical procedures (exact references and descriptions are required). At a minimum, the following requirements are to be included (if a standard USATHAMA, EPA, or NIOSH method is involved, some of these details may be omitted only if stated unambiguously in the method).

- o Application of the method - specific chemicals or classes of chemicals and appropriate concentration ranges and matrices to which it is applicable.
- o Sensitivity and detection limit of the method, which must be sufficient for the purpose of the analyses and the toxicity of the chemicals involved (normally ppb to ppm).
- o Interferences - interferences anticipated based on the method of analysis, matrix involved, other chemicals known to be present.
- o Apparatus to include instrumentation, parameters, and chemicals.
- o Standards to include calibration standards.
- o Procedure - describe in detail the step-by-step procedures for analyzing samples, as well as instrument calibration procedures (to the extent not specified in standard EPA or NIOSH if modifications are involved).

- o Calibrations - describe in detail the methods by which the concentrations in the original matrix are calculated from the responses obtained in the analysis.

- o List references used as a source for the procedures.

- o Procedures to be used to validate the methods for the matrices in question (i.e., method blanks, calibration checks, recoveries, reference standards, replicate analyses, split or spike samples, standard additions, etc.).

- o The methods of extraction (if needed) and analyses must be appropriate to the matrices and chemicals required.

1.10 DATA ANALYSIS AND REPORTING

For each analytical method and major measurement parameter, the contractor shall provide the following information:

- o The data analysis scheme including units and equations required to calculate concentrations or the value of the measured parameter.

- o The principal criteria that will be used to assure data integrity during collection and reporting.

- o Plans for treating outliers.

- o Description of the data management systems, including but not limited to the collection of raw data, data storage and data quality assurance documentation.

- o Identification of raw data, and data quality control and assurance documentation, with appropriate units; i.e., mg/g; mg/l; mg/m^3.

- o Identification of individuals to be involved in the reporting sequence.

1.11 INTERNAL QUALITY CONTROL CHECKS

Internal quality control (QC) checks are made to periodically evaluate the terms of performance reliability for each measurement parameter. Examples of internal QC checks are the analysis of blank, duplicate or split samples followed by appropriate corrective measures if values are outside established control limits. These QC checks will be used when control limits are applicable. If not, additional replicates or other corrective action may be required. The types and percentages devoted to internal contractor QC checks will be specified in the CQCP. If the contractor wishes adjustments of the number of types of these checks, approval must be obtained by the Contracting Officer.

1.12 PERFORMANCE AND SYSTEM AUDITS

Each CQCP must describe the internal and external performance and systems audits which will be required to monitor the performance of the total measurement systems and the proper hazardous material recordkeeping and hazard reduction plan performance.

The systems audit consists of evaluation of all components of the measurements systems to determine their proper selection and use. This audit includes a careful evaluation of both field and laboratory quality control procedures. Systems audits are normally performed prior to or shortly after systems are operational; however, such audits should be performed on a regularly scheduled basis during the lifetime of the project or continuing operation. Schedules for systems audits shall be presented.

After systems are operational and generating data, performance audits are conducted periodically to determine the accuracy of the total measurement system(s) or component parts thereof. The CQCP should include a schedule for conducting performance audits for each measurement parameter, including a performance audit for all measurement systems. As part of the performance audit process, laboratories may be required to participate in analysis of performance evaluation samples related to specific projects. The CQCP should also indicate, where applicable, scheduled participation in all other inter-laboratory performance evaluation studies.

For an independent assessment of the quantitative data, approximately 5 to 10 percent of the samples (e.g., 1 from each lot containing 10 to 20 samples, 2 from lots containing 20 to 40 samples, but at least 1 for each type of chemical residue) shall be split for QA analysis. The Contracting Officer shall provide precleaned sample containers and sample handling protocol for any QA samples to be delivered to the Contracting Officer. Performance audit sample results must be approved by the Government QA laboratory prior to start of work. The contractor's laboratory(ies) must be inspected and approved by the Government QA laboratory prior to any sampling. They must include in the CQCP resumes of supervisors and chemists listing education and experience as well as lists of instrumentation with manufacturers and model numbers, description of laboratory facilities, and a written site-specific quality assurance plan following guidelines as listed in this section. Depending on analyses requested, turnaround time should be rapid, within 48 hours for air samples or 1 week for solid and liquid samples.

In addition to the measurement systems, proper hazardous material recordkeeping and hazard reduction plan performance will be audited to ensure appropriate hazardous materials/wastes handling. Where improper recordkeeping and materials handling is taking place, the on-site project manager will be alerted of the need for corrective action with a report to the corporate level QA/QC officer. Decommissioning work will be stopped if necessary, where improper hazardous material handling and hazardous waste disposal exists.

1.13 PREVENTIVE MAINTENANCE

A system of preventive maintenance for facilities and instrumentation shall be described. Preventive maintenance shall be performed by qualified personnel; records shall be maintained and shall be available for inspection by the contracting officer's representative. Subsequent repairs, adjustments, and calibrations shall be recorded. The following types of preventive maintenance items should be considered and addressed in the CQCP:

- o A schedule of important preventive maintenance tasks that must be carried out to minimize downtime of the measurement systems.

- o A list of any critical spare parts that should be on hand to minimize downtime.

1.14 PROCEDURES FOR ASSESSING DATA PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

The CQCP shall describe procedures to assess the precision, accuracy, completeness, representativeness and comparability of all measurement parameters. The contractor's objectives for these terms for each task, subtask or measurement parameter are presented under Component 5, Quality Assurance Objectives for Measurement Data. Procedures in this section shall include the equations to calculate precision, accuracy and completeness and the methods used to gather data for the precision and accuracy calculations.

The contractor shall describe:

- o How the accuracy is determined for each analytical method and the degree of accuracy required by the certified laboratory for each method and class of chemicals analyzed. This requires discussion of instrumentation, reference standards or spike samples, documentation (sample collection, management and data analysis), analytical methodology/procedures, calibration procedures and performance audits.

- The sensitivity for each analytical method required by the certified laboratory for each chemical or class of chemicals and type of sample (e.g., matrix) analyzed.

- How the precision of each analysis is determined (including a discussion of duplicate or replicate samples, instrumentation checks, etc.). The contractor shall report precision based on standards and known additions.

- The number and types of samples (e.g., composites, blanks, replicates) or estimates and bases for estimates (this is subject to the approval of the Contracting Officer). The percentage and types of internal QC checks and samples (e.g., blanks, duplicates, splits, spikes and reference standards, if applicable) should be summarized; and appropriate analytical methods should be listed. The percentage of samples (blanks, duplicates and splits) required for external QA should be listed. Analytical results obtained by the contractor's laboratory on duplicate or split samples corresponding to external QA samples shall be reported to the Contracting Officer within 2 working days, and forwarded to the Corps QA laboratory or equivalent laboratory for comparison with the external QA laboratory's results. Any serious discrepancies between the two sets of analytical results should be reported, within 2 working days, by the external QA laboratory to the Contracting Officer, or the specified DOD QA/QC technical support staff.

- How is it determined that samples are representative (of the matrix being analyzed or of the site location).

- How data are to be made comparable (list equations, units, standardized data format, if any grounds for confusion). Specific units; i.e., mg, mg/l, etc. must be used.

- List of blind performance audits (reference or spiked samples to be analyzed to satisfy Corps requirements to be provided by the COE QA laboratory or MRDED-L to contractor).

Statistical procedures may be required such as:

- Number of observers, arithmetic mean, range, standard deviation, geometric mean, used to assess the dispersion of data.

- Accuracy, bias, precision, representativeness, comparability and completeness to assess data quality.

1.15 CORRECTIVE ACTION

The CQCP shall include a protocol describing corrective actions to be taken by the contractor with specifically defined feedback systems. Limits of data acceptability shall be included with the corrective action to be taken when these limits are exceeded. When limits are exceeded, information justifying the poor recovery or precision shall be documented. The external QA laboratory then will decide what further corrective action, if any, need be taken. Personnel responsible for initiating and carrying out corrective action shall be indicated in the protocol. Those individuals responsible for the corrective actions shall [illegible] the bound laboratory log books and all documentation citing the corrective action.

1.16 REPORTS

The contractor shall provide the following reports. The format for each report shall be listed in the CQCP.

- Daily Contractor Quality Control (DCQC) Report. A daily report shall be submitted to the Contracting Officer's Representative during period of contract. The daily report shall contain at a minimum the following: (1) location of work; (2) weather information; (3) work performed; (4) specific inspections performed and results; (5) problems identified; (6) corrective actions, if any; (7) verbal or written instructions from government personnel for retesting; (8) type of tests performed, samples collected, personnel involved, and results of tests; (9) general remarks; (10) calibration procedures and recordings; and (11) Contractor's certification.

- Contractor Quality Control (CQCP) Project Summary. At the end of a contract period, the Contractor shall prepare for the Contracting Officer a summary of DCQC documents prepared during the period. The report shall be a consolidation and summary of individual DCQC reports.

- In addition to the QC reports already mentioned, provisions shall be made for periodic reporting of QA results to the Contracting Officer to include the results of duplicates and spikes, standard reference materials, audit results, etc. Reports are required if problems are encountered with the analytical data calibration of instruments or with the QC checks. Significant problems, corrective action and by whom taken, and solutions shall be included. Significant problems and results outside limits should be reported, in writing within 2 working days, or sooner if safety problems are suspected or if requested by the Contracting Officer. Individuals responsible for preparing the periodic reports should be identified.

APPENDIX E

SPECIFIC REQUIREMENTS FOR THE HEALTH AND SAFETY PLAN

1.0 SPECIFIC REQUIREMENTS FOR THE HASP

Each item described below shall be addressed in the HASP.

1.1 GENERAL

This section should include emergency phone numbers and a statement that the HASP has addressed all relevant hazards and requirements.

1.2 HEALTH AND SAFETY PERSONNEL

Within this section, the qualifications, responsibilities and authority of health and safety personnel shall be described. It shall also describe the management relationship they will have with other personnel on the site.

1.3 SITE HISTORY AND PHYSICAL DESCRIPTION

A detailed history of the site shall be included, discussing the use of the site, the processes involved and major events in the history of the facility.

The physical, biological, chemical, and geological characteristics of the site which may influence the conduct of the work and therefore health and safety procedures should be described. Detailed maps of the area shall be included.

Much of this information is described in Sections 1.3, 1.4, and 3.2 of this document. Additional information is contained in RMA HASP (Ebasco 1985c; Ebasco 1986).

1.4 SITE-RELATED INCIDENTS

This section shall describe incidents involving chemical releases, accidents and near accidents which occurred on the site. This information is presented in Section 1.3.3 of this report.

1.5 WASTE DESCRIPTION/CHARACTERIZATION

The types of wastes that may be encountered shall be described as well as their physical and chemical characteristics. How the wastes are contained on the site shall be described.

1.6 HAZARD ASSESSMENT

The hazards posed by waste materials on-site must be assessed and described with particular attention paid to the wastes described in Section 3.3.1. The hazards of the operational aspects of decommissioning such as materials handling, motor vehicle operation, noise and power tool handling should also be addressed. The hazards of extreme weather conditions shall be addressed.

1.7 TRAINING REQUIREMENTS

All employees entering the site must have had training fulfilling the requirements of OSHA Interim Final Standard to Protect Workers in Hazardous Waste Operations. Training shall include the proper use of a self-contained breathing apparatus (SCBA), airline respirators, and level B protection. A training program should be developed addressing the specific hazards of the decommissioning and the procedure for minimizing those hazards. An outline of the training fulfilling the above requirements should be appended to the HASP.

At least two people on-site will have Red Cross advanced first aid training and cardiopulmonary resuscitation training (CPR). Evidence that this training is current shall be appended to the HASP.

A format should be developed for daily safety briefing to present new information on hazards and procedures and review topics covered in previous training courses.

1.8 ZONES, PROTECTION, AND COMMUNICATIONS

Zones

The zones used to delineate the site including a support zone, contamination reduction zone, and exclusion zone shall be described and diagrammed. The criteria used to establish each zone and the activities permitted in each zone should be explained.

Personal Protective Equipment (PPE)

In this section, the personal protective equipment to be used in decommissioning activities should be described in detail. The information provided must include a description of the levels of protection to be provided, the different tasks to be conducted and associated PPE, and the rationale used for assigning a given level of protection to a given task. Level B protection will be used at the beginning of the project. Level B protection for RMA is described in the Project Health and Safety Plan for RMA (Ebasco, 1985; Ebasco, 1986).

Any special protective equipment shall be described. The personnel responsible for establishing levels of protection shall be noted.

Safety and first aid equipment such as fire extinguishers, eyewash fountains, deluge showers, and first aid kits should be described. The manner in which this equipment will be deployed should be explained. The procedures and equipment used for routine and emergency communications should be identified.

1.9 MONITORING

The monitoring procedures for each phase of the decommissioning plan need to be described. At a minimum, monitoring programs need to be established for NDMA, UDMH, and asbestos. Each description should specify the method for sample collection; the personnel authorized to conduct sampling; the type of equipment to be used; the calibration procedures to be used; the analytical method and laboratories to be used; and the methods for collecting and organizing the data. A mechanism for informing employees of their exposure levels and the significance of this information should be described. Action levels will be established for each contaminant monitored and each level of protection. A plan shall be developed to respond to situations where the exposure level exceeds the level of protection provided by PPE worn at the time of monitoring. The frequency of monitoring for each contaminant for each task must be established. An estimate of the total number of samples and blanks to be analyzed should be included. Some of these items will be included as part of the QA/QC plan as well (see Appendix D).

All activities within the exclusion zone shall initially be conducted in level B protection since NDMA may be present. After the hazard reduction activities are complete (Section 3.3.1), it may be possible to downgrade the level of protection. Should this approach be pursued, it must be preceded by a sampling plan which will provide representative data from which to make a decision. The monitoring program should establish that NDMA exposure levels will remain below detectable limits (Ebasco 1985d) during the completion of the activities for which a lower level of protection is proposed. This plan and any decision to downgrade the level of protection will be reviewed and approved by appropriate contract representatives (technical support) prior to implementation.

A monitoring program should be developed for confined space entry, if necessary. It should designate what chemicals will be sampled, what levels of contaminants are acceptable for continued operation, and what procedure will be followed if contaminant levels are exceeded.

1.10 SAFETY CONSIDERATIONS FOR SITE OPERATION

Any operations requiring particular safety considerations such as confined space entry, trenching, welding and cutting, and working at heights shall be described as well as the procedures for minimizing the associated hazards.

1.11 DECONTAMINATION PROCEDURES

Detailed descriptions of the procedures, equipment, supplies and water volumes used for decontamination will be provided. Separate descriptions shall be provided for each type of decontamination, such as personnel, heavy equipment, tools, and instruments. Diagrams showing these processes should be included in the HASP.

1.12 ADDITIONAL SAFE WORK PRACTICES

Section XII of the RMA HASP will be used as a guide in preparing this section (Ebasco 1985c).

1.13 DISPOSAL PROCEDURES

All items such as protective clothing, sampling supplies, decontamination supplies, and decontamination water must be listed with a description of the disposal procedure.

1.14 EMERGENCY/CONTINGENCY PLANS

The types of emergencies possible should be anticipated and briefly described. Detailed responses to each type of emergency should be included with the HASP. The decision-making authority for responding to emergencies shall be delineated in this section.

1.15 AUTHORIZATION

A list of personnel and the activities they are trained and authorized to perform should be provided.

1.16 MEDICAL DATA SHEET

The HASP shall require that a medical data sheet be filled out by all site personnel. A sample medical data sheet can be found in Ebasco's Health and Safety Plan for work at RMA (Ebasco 1985c; Ebasco 1986).

1.17 FIELD TEAM REVIEW

All field personnel must be familiar with the HASP. Documentation establishing this fact will be required before personnel would be allowed to enter the exclusion zone.

1.18 APPROVALS

This section should contain the signatures of the people responsible for the preparation and implementation of the HASP as well as the senior corporate official ultimately responsible for the health and safety of employees on the site.

1.19 APPENDICES TO THE HASP

Information supporting statements and conclusions made in the HASP should be included in the appendices. Items which would be expected include:

- sample collection forms
- lists of trained workers
- sample forms (medical qualification for respirator use, accident investigation, etc.)
- respiratory protection programs
- confined space entry procedures
- lockout/tag out procedures
- sample collection logs
- referenced literature

1.20 MEDICAL SURVEILLANCE PROGRAM

The medical surveillance program for field personnel is described in Ebasco's Health and Safety Plan for work at RMA (Ebasco 1985c; Ebasco 1986).

APPENDIX F

RESPONSE TO COMMENTS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
999 18th STREET - SUITE 500
DENVER, COLORADO 80202-2405

MAY 13 1988

Ref: 8HWM-SR

Colonel W. N. Quintrell
Program Manager
AMXRM-EE Department of the Army
U.S. Army Toxic and Hazardous Materials Agency
Building 4460
Aberdeen Proving Ground, Maryland 21010-5401

Re: Rocky Mountain Arsenal, (RMA), Task 34, Hydrazine Blending and Storage Facility, Wastewater Treatment and Decommissioning Assessment, Draft Final Report, April, 1988.

Dear Colonel Quintrell:

We have reviewed the above referenced report and have the enclosed comments from our contractor and staff. Our contact on this matter is Mr. Connally Mears at (303) 293-1528.

Sincerely yours,

Robert L. Duprey, Director
Hazardous Waste Management Division

Enclosure

cc: Thomas P. Looby, CDH
David Shelton, CDH
Lt. Col. Scott P. Isaacson
Chris Hahn, Shell Oil Company
R. D. Lundahl, Shell Oil Company
Thomas Bick, Department of Justice
David Anderson, Department of Justice
Preston Chiaro, EBASCO

COMMENTS REGARDING HANDLING OF ASBESTOS

The procedures for handling of asbestos described in the Assessment appear acceptable. However, some clarification may be necessary.

1) A key requirement for the management of the asbestos (40CFR 61.147 and 61.152) is to have no visible emissions. The suggested practices during removal should be demonstrated to meet that requirement; if unsuccessful, the possibility of use of other procedures should be reviewed.

2) Breaking of the material should be avoided. If it becomes necessary, it should be done in an enclosed space.

3) 40CFR 61.152 allows disposal of dry asbestos, and, given the other contaminants which might occur in the material, such dry disposal appears appropriate in this situation. However, it will be important to ensure that the container(s) have sufficient strength to avoid being crushed during placement and coverage operations in the landfill.

REVIEW COMMENTS

SUBJECT DOCUMENT: Hydrazine Blending and Storage Facility
Wastewater Treatment and Decommissioning Assessment
Task 34
Draft Final Report
Version 2.2
April 1988
Prepared by Ebasco Team

1. Page 1-33 (Table 1-8) and Page 1-35. The method detection limits (MDLs) employed by the USAF and presented on Table 1-8, along with the analytical results of the wastewater characterization studies, are higher than the action levels presented on page 1-35. These action levels are described as being "set at their respective MDLs". The MDLs used for any future monitoring of treatability studies and wastewater treatment effectiveness must be as low as the chosen action levels if analytical results with meaning relevant to the levels are to be produced.

2. Page 2-37 and 2-38. Part of Treatability Study No. 4 was analysis for compounds on the HSL before and after treatment. The EPA recommends that a GC/MS scan for tentatively identified compounds also be performed during any future treatability studies, especially for those studies used to monitor the effectiveness of the chosen treatment technology (page 2-53, last paragraph).

3. Page 2-42, First Full Paragraph. A statement is made that, as the results of the treatability studies indicate, Ozone/UV treatment destroys NDMA to its action level of 0.35 ppb in 24 hours or less. Some clarification is required concerning this statement since

   a. The action level for NDMA given on page 1-35 is 0.2 ppb (or 200 ppt) not 0.35 ppb.

   b. None of the treatability studies show destruction of NDMA to 0.35 ppb (or 0.2 ppb) within a 24 hour period.

   This clarification is requested because:

   a. It is important that the action levels are definitely selected and will not be subject to variance during phases of operation such as implementation of the chosen treatment technology.

   b. Implementation of the chosen treatment technology may take place according to rates provided by the treatability studies. Therefore, these rates must be accurately documented for this possible use.

4. Page 2-46. The proposed size of the evaporation pond (140 ft by 140 ft) gives a surface area for evaporation of 19,600 ft^2. Given the approximate 300,000 gallon volume of wastewater to be treated, a

25-inch depth of water will require evaporation. Evaporation/precipitation data for the Denver area released by NOAA suggest that five months could be a significant underestimate of time for the total volume to evaporate. Carryover of the evaporation process into more than one summer could result in liner damage from freeze/thaw effects, thereby potentially adding contamination to the ground water. In addition, schedules for decommissioning would not be met due to delays in evaporation. The EPA, therefore, suggests that a larger pond be planned according to the average climatic data modified by worst case weather scenarios for the region.

5. Page 2-71. Projected liquid transport costs appear to be closer to the high end of the price range quoted. According to page 3-70, estimates are made that 4,700 gallons can be transported in one load and one load's cost will be $3,750. Transporting the minimum of 300,000 gallons of wastewater indicates at least 63 loads will be necessary. Therefore, costs will be over $235,000. If the safety factor of +50 percent (page 2-67) is added to this price estimate, the cost of incineration could be prohibitive. The EPA recommends that the figures employed in these cost estimates be reviewed and revised accordingly.

6. Page 3-48, last paragraph. The use of a double liner (3 to 10 mil polyethylene) is not practical for most of the solid waste that is to be disposed (i.e., piping, tanks, demolished structures) because it is thin enough to tear and puncture easily. Polyethylene in the 10 to 20 mil range is typically recommended by vendors for soils with sharp and irregular grained constituents to ensure durability during loading and on loading procedures.

RESPONSES TO U.S. ENVIRONMENTAL PROTECTION AGENCY LETTER (DATED MAY 13, 1988) ON THE HBSF WASTEWATER TREATMENT AND DECOMMISSIONING ASSESSMENT

1. COMMENT:

The procedures for handling of asbestos described in the Assessment appear acceptable. However, some clarification may be necessary.

1) A key requirement for the management of the asbestos (40 CFR 61.147 and 61.152) is to have no visible emissions. The suggested practices during removal should be demonstrated to meet that requirement; if unsuccessful, the possibility of use of other procedures should be reviewed.

2) Breaking of the material should be avoided. If it becomes necessary, it should be done in an enclosed space.

3) 40 CFR 61.152 allows disposal of dry asbestos, and, given the other contaminants which might occur in the material, such dry disposal appears appropriate in this situation. However, it will be important to ensure that the container(s) have sufficient strength to avoid being crushed during placement and coverage operations in the landfill.

RESPONSE:

The three points of clarification made by EPA will be incorporated in their entirety into the revised assessment.

2. COMMENT:

Page 1-33 (Table 1-8) and Page 1-35. The method detection limits (MDLs) employed by the USAF and presented on Table 1-8, along with the analytical results of the wastewater characterization studies, are higher than the action levels presented on page 1-35. These action levels are described as being "set at their respective MDLs." The MDLs used for any future monitoring of treatability studies and wastewater treatment effectiveness must be as low as the chosen action levels if analytical results with meaning relevant to the levels are to be produced.

RESPONSE:

The method detection levels presented on Table 1-8 were from an earlier study and are not the current certified reporting limits that will be used to verify treatment effectiveness.

3. COMMENT:

Page 2-37 and 2-38. Part of Treatability Study No. 4 was analysis for compounds on the HSL before and after treatment. The EPA recommends that a GC/MS scan for tentatively identified compounds also be performed during any future treatability studies, especially for those studies used to monitor the effectiveness of the chosen treatment technology (page 2-53, last paragraph).

RESPONSE:

No further laboratory treatment studies are planned. However, the EPA recommendation of a GC/MS scan for tentatively identified compounds will be incorporated into pilot/start-up tests prior to the HBSF response action treatment operations.

4. COMMENTS:

Page 2-42, first full paragraph. A statement is made that, as the results of the treatability studies indicate, Ozone/UV treatment destroys NDMA to its action level of 0.35 ppb in 24 hours or less. Some clarification is required concerning this statement since:

a. The action level for NDMA given on page 1-35 is 0.2 ppb (or 200 ppt) not 0.35 ppb.

b. None of the treatability studies show destruction of NDMA to 0.35 ppb (or 0.2 ppb) within a 24-hour period.

This clarification is requested because:

a. It is important that the action levels are definitely selected and will not be subject to variance during phases of operation such as implementation of the chosen treatment technology.

b. Implementation of the chosen treatment technology may take place according to rates provided by the treatability studies. Therefore, these rates must be accurately documented for this possible use.

RESPONSE:

Comments noted and text revised.

5. COMMENT:

Page 2-46. The proposed size of the evaporation pond (140 ft by 140 ft) gives a surface area for evaporation of 19,600 ft^2. Given the approximate 300,000-gallon volume of wastewater to be treated, a 25-inch depth of water will require evaporation. Evaporation/precipitation data for the Denver area released by NOAA suggest that five months could be a significant underestimate of time for the total volume to evaporate. Carryover of the evaporation process into more than one summer could result in liner damage from freeze/thaw effects, thereby potentially adding contamination to the ground water. In addition, schedules for decommissioning would not be met due to delays in evaporation. The EPA, therefore, suggests that a larger pond be planned according to the average climatic data modified by worst case weather scenarios for the region.

RESPONSE:

Comment noted and text revised.

6. COMMENT:

Page 2-71. Projected liquid transport costs appear to be closer to the high end of the price range quoted. According to page 3-70, estimates are made that 4,700 gallons can be transported in one load and one load's cost will be $3,750. Transporting the minimum of 300,000 gallons of wastewater indicates at least 63 loads will be necessary. Therefore, costs will be over $235,000. If the safety factor of +50 percent (page 2-67) is added to this price estimate, the cost of incineration could be prohibitive. The EPA recommends that the figure employed in these cost estimates be reviewed and revised accordingly.

RESPONSE:

Table 3-11 (p. 3-70) refers to the transport of ethylene glycol, PCB liquids, and other organic waste such as paint and lacquer. The transport costs for these materials is higher per load than for the HBSF wastewater because additional effort is required to pack them in transportable containers (i.e., drums). In addition, a smaller volume of these miscellaneous wastes can be transported per load as compared to a tanker truck used for the wastewater.

7. COMMENT:

Page 3-48, last paragraph. The use of a double liner (3 to 10 mil polyethylene) is not practical for most of the solid waste that is to be disposed (i.e., piping, tanks, demolished structures) because it is thin enough to tear and puncture easily. Polyethylene in the 10 to 20 mil range is typically recommended by vendors for soils with sharp and irregular grained constituents to ensure durability during loading and unloading procedures.

RESPONSE:

Comment noted and text revised.

STATE OF COLORADO

COLORADO DEPARTMENT OF HEALTH
4210 East 11th Avenue
Denver, Colorado 80220
Phone (303) 320-8333

1876

Roy Romer
Governor

Thomas M. Vernon, M.D.
Executive Director

RECEIVED
MAY 24 1988
ENVIROSPHERE COMPANY

May 17, 1988

Mr. Donald Campbell
Office of the Program Manager
RMA Contamination Cleanup
AMXRM-EE, Building E4460
Department of the Army
Aberdeen Proving Ground, MD 21010-5401

Re: The Hydrazine Blending and Storage Facility, Wastewater Treatment and Decommissioning Assessment

Dear Mr. Campbell:

Enclosed are the State's comments on the Hydrazine Blending and Storage Facility, Wastewater Treatment and Decommissioning Assessment.

While the State believes that the Army has made an effort to identify the contamination in and around the Hydrazine facility, the State has two principal concerns regarding this report. The first concern is that the Hydrazine Blending and Storage Facility (HBSF) is a RCRA regulated facility and, therefore, must be closed in accordance with the Colorado Hazardous Waste Management Act.

The State's second major concern is that the action levels are orders of magnitude higher than health based criteria. Therefore, technologies selected for the treatment must assure complete destruction of the waste to the greatest extent possible. In this case, we believe incineration should be the preferred treatment alternative.

If you have any questions, please contact Mr. Jeff Edson with this Division.

Sincerely,

David C. Shelton
Director
Hazardous Materials and
Waste Management

DCS/PB/rw

enclosure

pc: Michael R. Hope, Attorney General's Office
Chris Hahn, Shell Oil Company
Connally Mears, U.S. Environmental Protection Agency
David Anderson, Department of Justice
Edward McGrath, Holme Roberts & Owen
Mike Gaydosh, U.S. Environmental Protection Agency

BW\PBCAMPBL.LTR

STATE COMMENTS ON HYDRAZINE BLENDING AND STORAGE FACILITY WASTEWATER TREATMENT AND DECOMMISSIONING ASSESSMENT

General Comments:

1. The Hydrazine Blending and Storage Facility (HBSF) is a RCRA regulated facility and, therefore, must be closed in accordance with the Colorado Hazardous Waste Management Act (CHWMA). Specifically, the facility must be closed in accordance with 6 CCR 1007-3, Subpart G, Sections 265.110 et seq. Furthermore, any new treatment, storage or disposal facility constructed onsite to manage hazardous wastes presently stored at the HBSF, including surface impoundments, ozone/UV or hydrogen peroxide/UV, must be permitted under the CHWMA by the Colorado Department of Health (CDH).

2. The report identifies two treatment technologies (Hydrogen Peroxide/UV and Ozone/UV) preferred for the management of hazardous wastewater at the HBSF. However, the assessment for both technologies were not shown to be capable of reducing the concentration of NDMA to below the Army proposed action levels. In addition, these proposed actions levels were based on minimum detection levels rather than health based criteria because the standards for health based action levels are 2-3 orders of magnitude lower than the detection limits. These two technologies have not been demonstrated to be appropriate for treatment of

HBSF wastes and therefore cannot be selected as the preferred alternatives. The report should reflect that the only technology demonstrated to destroy the hazardous wastes to below the proposed action levels is incineration.

3. Offsite facilities for the treatment of the HBSF waste cannot be eliminated as a final waste management alternative. The HBSF is a RCRA/CHWMA facility. Pursuant to RCRA, cost is not one of the criterion for eliminating waste management alternatives.

4. The State has not received responses to its comments concerning the Contamination Assessment Report for the HBSF. Those comments identified deficiencies in the characterization of the nature and extent of contamination at the HBSF. Many of the conclusions and assumptions used to conduct the treatment and decommissioning assessment were drawn from the inadequate and potentially erroneous characterization of contamination discussed in the Task 11, Site 1-7, Hydrazine Blending and Storage Facility, Contamination Assessment Report. Therefore, the decommissioning assessment is flawed in that it utilizes the inadequate and potentially erroneous data from the CAR. The failure to demonstrate that all soil and groundwater contamination have been removed from the site will necessitate closure of the site as a hazardous waste landfill, including a post-closure permit

and implementation of a 30-year groundwater monitoring program for the waste management unit.

5. Any new onsite treatment/storage facility that is a land management unit, (such as a surface impoundment) must include implementation of a groundwater monitoring system. Additionally, costs and scheduling associated with permitting new onsite units should be included in the assessment of onsite alternatives.

6. The report fails to fully define the contamination in the hydrazine wastewater. A full suite analysis (qualitative and quantitative) is necessary, and should be included in this report, before all technologies can be evaluated.

7. Please provide copies of all reports describing the various technologies screened.

8. A complete investigation to define the source of the hydrazine compounds detected in groundwater monitoring wells surrounding the HBSF must be conducted.

Specific Comments

1. Page 1-13. The report states that an unreported quantity of hydrazine sludges was collected, drummed and transported to pits in Sections 30 and 36. What future plans, and under what task, will the investigation of these pits be conducted? What is the approximate quantity of these wastes?

2. Page 1-14. Lowry Air Force Base received approximately 10,000 gallons of hydrazine contaminated wastewater according to this report. A complete explanation of the transfer of these wastes, including dates, manifests and treatment and disposal methods, must be provided.

3. Page 1-14. The Spill History excludes spills described in the HBSF CAR. These should be included in this report.

4. Page 1-14. The inground concrete tank used to store UDMH and other hazardous waste must be closed as a surface impoundment and must include monitoring beneath the structure to define the extent of contamination.

5. Page 1-27. As described in the State's comments to the HBSF CAR, the Phase II investigation must include the use of an extraction procedure which assures that hydrazine contamination

is detected. The United States Air Force and Martin Marietta have determined that the extraction of hydrazine from soils cannot be done using standard laboratory extraction procedures. To accurately determine whether or not hydrazine is present, a mildly acidic extractant must be used, according to the U.S.A.F. and Martin Marietta studies. Therefore, the Phase II investigations should resample and reanalyze the Phase I borings using methods proven to extract hydrazine.

6. Page 1-28. What is meant by the statement, "Other transformers are believed to contain less than 50 ppm of PCBs?" Have these transformers been analyzed? If so, why is it only believed that they are less than 50 ppm, and therefore, unregulated?

7. Page 1-31. Methyl Isobutyl Ketone was detected in one soil boring and determined to be a laboratory contaminant. Did the blank also detect MIBK? If not, the sample cannot be considered a laboratory contaminant and must be further investigated.

8. Page 1-31. The CRL for NDMA is too high. A lower detection level is necessary for this compound based on its toxicity.

9. Page 1-31. As stated in the State's comments on the HBSF CAR, an inadequate soils investigation was conducted. For example, the investigation failed to include hydrazine compounds as target analytes and an unacceptable analytical methodology was used. Soil contamination must be further investigated prior to making the assumption that the remediation of HBSF soils is not warranted.

10. Page 1-31. Various compounds such as dimethylcyanamide, N,N-dimethylformamide, tetrachloroethane, and 1-ethyl-1H-1,2,4,-triazole were detected, but because of their low levels, were not "quantified." Please explain what is meant by "quantified?" At what levels are compounds placed in this category?

11. Page 1-33, Table 1-8. The detection levels for hydrazine, MMH, UDMH, and NDMA are several orders of magnitude above recommended health based risk levels. A more recent analysis is needed, using the lowest available detection levels.

12. Page 1-34. Given that the health based criteria for MMH, UDMH, and NDMA are substantially lower than the detection limits, the State strongly recommends that complete destruction (i.e., incineration) be utilized to finally manage the hazardous wastes.

13. Page 2-24. Three of the four final candidate technologies will require a RCRA/CHWMA permit if implemented. The costs and time factors associated with the permitting process were not considered in the overall evaluations of potential technologies.

14. The report does not include TICs or unidentified organic compounds detected by the GC/MS. These should be included in the report, as it is presented in all other RMA reports. As stated on page 2-29, these "unknown constituents in the wastewater could interfere with the treatment."

15. Page 2-32. The ozone/UV treatment study could only be demonstrated to reduce the concentration of NDMA to 1.4 ppb after approximately 50 hours of treatment. This level is 7 times the proposed action level (.2 ppb). From these data, it cannot be concluded that ozone/UV treatment will satisfactorily reduce NDMA concentrations to below the proposed action level. This technology cannot be selected for implementation before making such a demonstration.

16. Page 2-34. The hydrogen peroxide/UV study did not demonstrate that the concentration of NDMA can be reduced to

below the proposed action level. This technology cannot be selected for implementation before making such a demonstration.

17. Pages 1-34 and 2-42. There appears to be some confusion as to the proposed action levels for NDMA. On page 1-34, the action level is proposed as .2 ppb. On page 2-42, the action level is stated to be .35 ppb. Please clarify.

18. Page 2-48. The first full paragraph states that the liner system will comply with 40 CCR 264.221 and the 1984 HSWA regulations. These regulations also require the implementation of sufficient monitoring wells, both upgradient and downgradient of the surface impoundment, to detect any possible groundwater contamination from the regulated unit. The report fails to include a description of where the wells are proposed to be placed.

19. Page 2-80. The most viable treatment of the hydrazine wastewaters is off-site incineration due to its high reliability of destruction and the shorter amount of time for disposal. The report should also evaluate use of off-site treatment facilities other than incineration.

20. Page 3-14. Isolation or decontamination of contaminated soils and groundwater must be conducted as part of the closure of the HBSF and should not be conducted under a separate

task. A post-closure permit requiring long-term monitoring and reporting will otherwise be necessary.

21. Page 3-21. All solid waste materials generated in the closure of the HBSF must be tested to demonstrate that they are free from contamination or managed as RCRA/CHWMA hazardous wastes.

22. Page 3-32. See Comment No. 6. The results from "earlier testing" of PCBs should be included in the report.

23. Page 3-33. Open air evaporation or release of waste flammable and non-flammable solvents and paints is not a legal waste management technique. These materials must be collected and disposed as hazardous waste.

24. Pages 3-38 to 3-40. Demolition and removal of underground piping, sumps and tanks must be followed by soil sampling and/or excavation of adjacent contaminated soils. Failure to do so will require the area to be permitted for closure as a hazardous waste landfill.

25. Page 3-52. The reports provided to the State do not include a Section 2.9 wherein construction of an evaporation pond is discussed. Please clarify Section 3.3.5 which discusses the

disposal of wastewater generated during site restoration in an evaporation pond.

BW\HBSFWTDA.CMT

RESPONSES TO COLORADO DEPARTMENT OF HEALTH LETTER (Dated May 17, 1988) ON THE HBSF WASTEWATER TREATMENT AND DECOMMISSIONING ASSESSMENT

General Comments

1. COMMENT:

The Hydrazine Blending and Storage Facility (HBSF) is a RCRA regulated facility and, therefore, must be closed in accordance with the Colorado Hazardous Waste Management Act (CHWMA). Specifically, the facility must be closed in accordance with 6 CCR 1007-3, Subpart G, Sections 265.110 et seq. Furthermore, any new treatment, storage, or disposal facility constructed on-site to manage hazardous wastes presently stored at the HBSF, including surface impoundments, ozone/UV, or hydrogen peroxide/UV must be permitted under the CHWMA by the Colorado Department of Health (CDH).

RESPONSE:

The United States, as it has made clear in the past, will conduct the cleanup at the Rocky Mountain Arsenal pursuant to CERCLA. The comprehensive cleanup program includes the HBSF interim action. The substantive requirements of the CHWMA may apply through ARAR process. CERCLA specifically excludes any requirements permits for actions conducted pursuant to the statute.

2. COMMENT:

The report identifies two treatment technologies (hydrogen peroxide/UV and ozone/UV) preferred for the management of hazardous wastewater at the HBSF. However, the assessment for both technologies were not shown to be capable of reducing the concentration of NDMA to below the Army proposed action levels. In addition, these proposed actions levels were based on minimum detection levels rather than health-based criteria because the standards for health-based action levels are 2-3 orders of magnitude lower than the detection limits. These two technologies have not been demonstrated to be appropriate for treatment of HBSF wastes and therefore cannot be selected as the preferred alternatives. The report should reflect that the only technology demonstrated to destroy the hazardous wastes to below the proposed action levels is incineration.

RESPONSE:

During the period the treatability studies were being conducted the anticipated action level for NDMA was higher than the present 0.20 ug/l. Consequently, most experiments were suspended after achieving the anticipated action level. Treatability study no. 4, utilizing ozone/UV, demonstrated destruction of NDMA to 0.20 ug/l. Due to the detection limit for NDMA, no technology can be demonstrated to destroy NDMA below 0.20 ug/l.

Additionally, the UV dosage utilized during the treatability studies ranged from 0.8-6 Watts/l. Typical commercial reactors provide a UV dosage of about 200 Watts/l, so a marked improvement in both the rate and extent of destruction is anticipated during the actual treatment process, achieving cleanup to the action levels.

3. COMMENT:

Off-site facilities for the treatment of the HBSF waste cannot be eliminated as a final waste management alternative. The HBSF is a RCRA/CHWA facility. Pursuant to RCRA, cost is not one of the criterion for eliminating waste management alternatives.

RESPONSE:

Off-site incineration of HBSF wastewater is included in the HBSF Treatment and Decommissioning Assessment report. CERCLA requires treatment technologies be evaluated for their cost effectiveness.

4. COMMENT:

The State has not received responses to its comments concerning the Contamination Assessment Report for the HBSF. Those comments identified deficiencies in the characterization of the nature and extent of contamination at the HBSF. Many of the conclusions and assumptions used to conduct the treatment and decommissioning assessment were drawn from the inadequate and potentially erroneous characterization of contamination discussed in the Task 11, Site 1-7, Hydrazine Blending and Storage Facility, Contamination Assessment Report. Therefore, the decommissioning assessment is flawed in that it utilizes the inadequate and potentially erroneous data from the CAR. The failure to demonstrate that all soil and groundwater contamination have been removed from the site will necessitate closure of the site as a hazardous waste landfill, including a post-closure permit and implementation of a 30-year groundwater program for the waste management unit.

RESPONSE:

The comment addresses matters beyond the scope of the HBSF IRA. Enough data is available to proceed with the interim action as described. The State fails to recognize that the HBSF IRA will be followed by other actions included within the final cleanup of the Arsenal.

5. COMMENT:

Any new on-site treatment/storage facility that is a land management unit (such as a surface impoundment), must include implementation of a groundwater monitoring system. Additionally, costs and scheduling associated with permitting new on-site units should be included in the assessment of on-site alternatives.

RESPONSE:

The Arsenal has an extensive groundwater monitoring system consisting of hundreds of wells. CERCLA specifically exempts cleanup actions from permitting requirements, the increased costs and scheduling delays associated with permitting not being considered as appropriate for the CERCLA cleanup process.

6. COMMENT:

The report fails to fully define the contamination in the hydrazine wastewater. A full suite analysis (qualitative and quantitative) is necessary, and should be included in this report before all technologies can be evaluated.

RESPONSE:

This report adequately defines the levels of contaminants of concern in the HBSF wastewater.

7. COMMENT:

Please provide copies of all reports describing the various technologies screened.

RESPONSE:

The reports referenced by this assessment are in the public domain. The State has adequate resources to obtain these reports.

8. COMMENT:

A complete investigation to define the source of the hydrazine compounds detected in groundwater monitoring wells surrounding the HBSF must be conducted.

RESPONSE:

This action is beyond the scope of the HBSF IRA, but was investigated under Task 11.

Specific Comments

1. COMMENT:

Page 1-13. The report states that an unreported quantity of hydrazine sludges was collected, drummed, and transported to pits in Sections 30 and 36. What future plans, and under what task, will the investigation of these pits be conducted? What is the approximate quantity of these wastes?

RESPONSE:

The subject information was provided for historical reference only. The investigation of pits in Section 30 and 36 is in the scope of Tasks 14/21 and Tasks 1/47, respectively.

2. COMMENT:

Page 1-14. Lowry Air Force Base received approximately 10,000 gallons of hydrazine-contaminated wastewater according to this report. A complete explanation of the transfer of these wastes, including dates, manifests, and treatment and disposal methods must be reported.

RESPONSE:

The requested information is not within the scope of the interim action. However, the Program Manager's Office will attempt to work with the State to retrieve this information, if it exists, through avenues other than the HBSF IRA.

3. COMMENT:

Page 1-14. The spill history excludes spills described in the HBSF CAR. These should be included in this report.

RESPONSE:

The spill history section of the HBSF assessment is provided as a summary for historical purposes only. A reference to the Task 11 CAR for more detail will be added.

4. COMMENT:

Page 1-14. The inground concrete tank used to store UDMH and other hazardous waste must be closed as a surface impoundment and must include monitoring beneath the structure to define the extent of contamination.

RESPONSE:

The HBSF interim action will be conducted pursuant to CERCLA. Specific requirements are developed through the ARAR process.

5. COMMENT:

Page 1-27. As described in the State's comments to the HBSF CAR, the Phase II investigation must include the use of an extraction procedure which assures that hydrazine contamination is detected. The United States Air Force and Martin Marietta have determined that the extraction of hydrazine from soils cannot be done using standard laboratory extraction procedures. To accurately determine whether or not hydrazine is present, a mildly acidic extractant must be used, according to the USAF and Martin Marietta studies. Therefore, the Phase II investigations should resample and reanalyze the Phase I borings using methods to extract hydrazine.

RESPONSE:

The page in question summarized the results of an Air Force decommissioning study and is provided for historical purposes only. The Phase II HBSF soils and groundwater investigation is separate from the HBSF IRA.

6. COMMENT:

Page 1-28. What is meant by the statement, "Other transformers are believed to contain less than 50 ppm of PCBs?" Have these transformers been analyzed? If so, why is it only believed that they are less than 50 ppm, and therefore, unregulated?

RESPONSE:

The paragraph in question is summarizing the results of an Air Force Decommissioning Study. In that study, all four transformers were reportedly analyzed for PCBs. Although only one transformer contained PCB-contaminated oil, oil from all the transformers will be treated as if PCB-contaminated. Hopefully this alleviates the State's concerns.

7. COMMENT:

Page 1-31. Methyl isobutyl ketone was detected in one soil boring and determined to be a laboratory contaminant. Did the blank also detect MIBK? If not, the sample cannot be considered a laboratory contaminant and must be further investigated.

RESPONSE:

Further investigation of the MIBK detected in one soil boring is not within the scope of the HBSF IRA, but is within the scope of the HBSF Phase II soils and groundwater investigation.

8. COMMENT:

Page 1-31. The CRL for NDMA is too high. A lower detection level is necessary for this compound based on its toxicity.

RESPONSE:

The reported CRL of 200 ppt for NDMA is for the most sophisticated analytical method known by the Program Manager's Office. It is also the method recommended by EPA. The Program Manager's Office would appreciate any information regarding a more sophisticated method.

9. COMMENT:

Page 1-31. As stated in the State's comments on the HBSF CAR, an inadequate soils investigation was conducted. For example, the investigation failed to include hydrazine compounds as target analytes and an unacceptable analytical methodology was used. Soil contamination must be further investigated prior to making the assumption that the remediation of HBSF soils is not warranted.

RESPONSE:

The conclusions of the Task 11 CAR about the HBSF soils is reported for background information only. Further soils investigation is not within the scope of the HBSF IRA.

10. COMMENT:

Page 1-31. Various compounds such as dimethylcyanamide, N,N-dimethylformamide, tetrachloroethane, and 1-ethyl-1H-1,2,4-triazole were detected, but because of their low levels, were not "quantified." Please explain what is meant by "quantified?" At what levels are compounds placed in this category?

RESPONSE:

The section in question is a summary of an earlier arsenal study. It is not within the scope of the HBSF IRA to determine why an earlier study could not or did not quantify organic compounds present at less than 0.2 ug/l.

11. COMMENT:

Page 1-33, Table 1-8. The detection levels for hydrazine, MMH, UDMH, and NDMA are several orders of magnitude above recommended health-based risk levels. A more recent analysis is needed, using the lowest available detection levels.

RESPONSE:

The detection limits in question were the lowest available detection levels at the time of analysis. Likewise, the lowest available detection levels will be used during the HBSF IRA. Technical information the State may have in this area would be welcomed.

12. COMMENT:

Page 1-34. Given that the health-based criteria for MMH, UDMH, and NDMA are substantially lower than the detection limits, the State strongly recommends that complete destruction (i.e., incineration) be utilized to finally manage the hazardous wastes.

RESPONSE:

Destruction by incineration is no different from other treatments in that destruction can only be certified by monitoring for the contaminants in the off gases. Incineration, as a treatment method, does not of itself guarantee complete destruction, although 99.99 percent destruction of organic compounds can generally be attained. However, wastewater treatment with UV catalyzed chemical oxidation (ozone or hydrogen peroxide) down to detection limits achieves greater than 99.99 percent destruction.

13 COMMENT:

Page 2-24. Three of the four final candidate technologies will require a RCRA/CHWMA permit if implemented. The costs and time factors associated with the permitting process were not considered in the overall evaluations of potential technologies.

RESPONSE:

CERCLA specifically excludes permitting requirements, considering the costs and delays inappropriate to the cleanup process.

14. COMMENT:

The report does not include TICs or unidentified organic compounds detected by the GC/MS. These should be included in the report, as it is presented in all other RMA reports. As stated on page 2-29, these "unknown constituents in the wastewater could interfere with the treatment."

RESPONSE:

This document is a HBSF IRA assessment and, as such, follows the format for assessment documents as defined by the consent decree. The other reports mentioned are assumed to be RI/FS CARs, which do present a listing of tentatively identified compounds (TICs). Treatability studies were performed to document treatment effectiveness on actual HBSF wastewater samples.

15. COMMENT:

Page 2-32. The ozone/UV treatment study could only be demonstrated to reduce the concentration of NDMA to 1.4 ppb after approximately 50 hrs of treatment. This level is seven times the proposed action level (0.2 ppb). From these data, it cannot be concluded that ozone/UV treatment will satisfactorily reduce NDMA concentrations to below the proposed action level. This technology cannot be selected for implementation before making such a demonstration.

RESPONSE:

In treatability study no. 4 UV/ozone treatment was demonstrated to treat NDMA contamination to the 200 ppt detection limit in about 83 hr. Commercial reactors will provide a UV dosage 30-40 times higher than in the treatability studies, markedly decreasing the time required to achieve the action level.

16. COMMENT:

Page 2-34. The hydrogen peroxide/UV study did not demonstrate that the concentration of NDMA can be reduced to below the proposed action level. This technology cannot be selected for implementation before making such a demonstration.

RESPONSE:

While UV/peroxide treatment of NDMA was not demonstrated to the 200 ppt detection limit, it is nearly identical as a treatment method to UV/ozone from a technical standpoint. UV/peroxide treatability study no. 2 was discontinued after 77 hr at the 2 ppb level, although the data indicated that further NDMA destruction would result from additional treatment time. For this treatability study the UV dosage was only 0.8 Watts/l, whereas commercially available reactors provide a dosage of approximately 200 Watts/l. The time required to achieve the NDMA action level should be greatly reduced with the commercial reactor.

17. COMMENT:

Pages 1-34 and 2-42. There appears to be some confusion as to the proposed action levels for NDMA. On page 1-34, the action level is proposed as 0.2 ppb. On page 2-42, the action is level is stated to be 0.35 ppb. Please clarify.

RESPONSE:

The action level stated on page 2-42 is in error. The text has been revised.

18. COMMENT:

Page 2-48. The first full paragraph states that the liner system will comply with 40 CFR 264.221 and the 1984 HSWA regulations. These regulations also require the implementation of sufficient monitoring wells, both upgradient and downgradient of the surface impoundment, to detect any possible groundwater contamination from the regulated unit. The report fails to include a description of where the wells are proposed to be placed.

RESPONSE:

The Arsenal has an extensive groundwater monitoring system consisting of hundreds of wells which are regularly monitored. Additional wells are not necessary.

19. COMMENT:

Page 2-80. The most viable treatment of the hydrazine wastewaters is off-site incineration due to its high reliability of destruction and the shorter amount of time for disposal. The report should also evaluate use of off-site treatment facilities other than incineration.

RESPONSE:

The State's assumptions that incineration can achieve a measurably greater destruction of NDMA and can be arranged and implemented more quickly are not supported by available data. If the hydrazine compounds and NDMA are reduced to below their detection limits (2.5 ug/l for hydrazine, 20 ug/l for MMH, 25 ug/l for UDMH, and 0.20 ug/l for NDMA) by UV catalyzed chemical oxidation, greater than 99.998 percent destruction of these contaminants would be achieved. From the results of the treatability studies it is clear that this level of cleanup is achievable, especially since commercial reactors are equipped with higher intensity UV lamps than those used in the treatability studies. Commercial reactors typically provide a UV dosage of about 200 Watts/l, while the dosage utilized in the treatability studies ranged from 0.8-6 Watts/l. Therefore, much faster reaction kinetics and more complete destruction may be expected from the commercial reactors. The degree of destruction by UV catalyzed chemical oxidation is equivalent to the expected, but undemonstrated, destruction by incineration.

20. RESPONSE:

Page 3-14. Isolation or decontamination of contaminated soils and groundwater must be conducted as part of the closure of the HBSF and should not be conducted under a separate task. A post-closure permit requiring long-term monitoring and reporting will otherwise be necessary.

RESPONSE:

Isolation or treatment of contaminated soils and groundwater are not within the scope of the HBSF IRA. These subjects can be addressed in future cleanup actions. There is no need to delay the HBSF IRA until these actions occur.

21. COMMENT:

All solid waste materials generated in the closure of the HBSF must be tested to demonstrate that they are free from contamination or managed as RCRA/CHWMA hazardous wastes.

RESPONSE:

It is the intention of the Program Manager's Office, clearly stated in the assessment, to dispose of all solid wastes generated by this interim action as designated hazardous wastes.

22. COMMENT:

Page 3-32. See Comment No. 6. The results from "earlier testing" of PCBs should be included in the report.

RESPONSE:

See the response to Comment No. 6.

COMMENT:

Page 3-33. Open air evaporation or release of waste flammable and nonflammable solvents and paints is not a legal waste management technique. These materials must be collected and disposed as hazardous waste.

RESPONSE:

The Army is not aware of the basis for this comment, as no citation is provided.

24. COMMENT:

Pages 3-38 to 3-40. Demolition and removal of underground piping, sumps, and tanks must be followed by soil sampling and/or excavation of adjacent contaminated soils. Failure to do so will require the area to be permitted for closure as a hazardous waste landfill.

RESPONSE:

Neither soil investigations nor isolation or treatment of contaminated soils are within the scope of the HBSF IRA.

25. COMMENT:

Page 3-52. The reports provided to the State do not include a Section 2.9 wherein construction of an evaporation pond is discussed. Please clarify Section 3.3.5 which discusses the disposal of wastewater generated during site restoration in an evaporation pond.

RESPONSE:

The reference to Section 2.9 is a typographical error. The correct reference is Section 2.7.

Shell Oil Company

c/o Holme Roberts & Owen
Suite 1800
1700 Broadway
Denver CO 80290

May 11, 1988

RECEIVED
JUN 1 - 1988
ENVIROSPHERE COMPANY
SEATTLE

Office of the Program Manager
for Rocky Mountain Arsenal
ATTN: AMXRM-PM: Mr. Donald L. Campbell
Building E-4460
Aberdeen Proving Ground, Maryland 21010-5401

Dear Mr. Campbell:

Enclosed herewith are Shell Oil's comments on Draft Final Report, Hydrazine Blending and Storage Facility Wastewater Treatment and Decommissioning Assessment, Task 34, April, 1988.

Sincerely,

C. K. Hahn
Manager
Denver Site Project

RDL:ajg

Enclosure

cc: (w/enclosure) ✓
Office of the Program Manager for Rocky Mountain Arsenal
ATTN: AMXRM-RP: Mr. Kevin T. Blose, Acting Chief
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Office of the Program Manager for Rocky Mountain Arsenal
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SHELL OIL COMMENTS ON DRAFT FINAL REPORT HYDRAZINE BLENDING AND STORAGE FACILITY WASTEWATER TREATMENT AND DECOMMISSIONG ASSESSMENT, TASK 34, APRIL, 1988

1. Page 1-30, second full paragraph.

   Shell is not aware of any regulation that requires treatment or destruction of materials injected in a deep well.

2. Page 1-35, third full sentence.

   As Shell has stated previously, Cancer Assessment Group (CAG) methodology is premised on invalid assumptions.

3. Page 2-1, first paragraph.

   Current regulatory policy favors the reduction of toxicity, mobility or volume.

4. Page 2-4, first full sentence.

   The text should probably state "...so that major experimentation would not be required...."

5. Page 2-51, first paragraph.

   Useful life is more a design objective (a choice) than it is an intrinsic quality of a technology, therefore it should not be a criteria.

   In the second sentence, the meaning of "the permanence of the remediation " is not clear.

6. Page 2-51, second paragraph.

   Reliability relates to consistency of performance. Less operations and maintenance does not necessarily equate to reliability.

7. Page 2-51, third paragraph.

   Timing which prevents a schedule being met is undesirable. Otherwise, timing is of secondary importance to other criteria.

8. Page 2-72, third paragraph.

   While in this case destruction is an appropriate rating basis, more generally the elimination of exposure is the goal

RESPONSES TO SHELL OIL COMPANY
LETTER (DATED MAY 11, 1988)
ON THE HBSF WASTEWATER TREATMENT
AND DECOMMISSIONING ASSESSMENT

1. COMMENT:

   Page 1-30, second full paragraph. Shell is not aware of any regulation the requires treatment or destruction of materials injected in a deep well.

   RESPONSE:

   Deep well injection would not result in the reduction of toxicity, mobility, or volume of the HBSF wastewater. Therefore, this option was rejected, in keeping with current regulatory policy.

2. COMMENT:

   Page 1-35, third full sentence. As Shell has stated previously, the Cancer Assessment Group (CAG) methodology is premised on invalid assumptions.

   RESPONSE:

   Comment noted. No text revision necessary.

3. COMMENT:

   Page 2-1, first paragraph. Current regulatory policy favors the reduction of toxicity, mobility, or volume.

   RESPONSE:

   Comment noted and text revised.

4. COMMENT:

   Page 2-4, first full sentence. The text should probably state ". . . so that major experimentation would not be required . . . ."

   RESPONSE:

   This inadvertent omission in the text has been corrected.

5. COMMENT:

Page 2-51, first paragraph. Useful life is more a design objective (a choice) than it is an intrinsic quality of a technology, therefore, it should not be a criteria. In the second sentence, the meaning of "the permanence of the remediation" is not clear.

RESPONSE:

Comments noted and text revised.

6. COMMENT:

Page 2-51, second paragraph. Reliability relates to consistency of performance. Less operations and maintenance does not necessarily equate to reliability.

RESPONSE:

Comment noted.

7. COMMENT:

Page 2-51, third paragraph. Timing which prevents a schedule being met is undesirable. Otherwise, timing is of secondary importance to other criteria.

RESPONSE:

As noted in the paragraph in question, the technologies which would be more easily and quickly implemented and require less time to complete are favored only if all other implementability factors are equal.

8. COMMENT:

Page 2-72, third paragraph. While in this case, destruction is an appropriate rating basis, more generally the elimination of exposure is the goal.

RESPONSE:

Comment noted.