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TASK 34 INVOLVES THE DEVELOPMENT OF METHODS FOR THE DECOMMISSIONING AND FINAL REMEDIATION OF THE HYDRAZINE BLENDING AND STORAGE FACILITY. PART OF THE HBSF STUDY WILL BE AN EVALUATION OF OPTIONS FOR THE TREATMENT/REMOVAL OF ASSOCIATED WASTEWATER. THE SPECIFIC OBJECTIVES OF THE STUDY ARE TO:
1. INVESTIGATE ALTERNATIVE APPROACHES FOR TREATMENT/REMOVAL OF WASTE WATER CONTAMINATED WITH LOW LEVELS OF HYDRAZINE AND HYDRAZINE RELATED COMPOUNDS
2. CONDUCT SUFFICIENT TREATABILITY STUDIES WITH THE MOST PROMISING CANDIDATE TECHNOLOGIES TO VERIFY TREATMENT LEVELS AND IDENTIFY KEY DESIGN VARIABLES
3. DEVELOP A COMPREHENSIVE DECOMMISSIONING ASSESSMENT.

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— COMMITTED TO PROTECTION OF THE ENVIRONMENT —

TECHNICAL PLAN

VERSION 3.2

April 1988

TASK NO. 34

HYDRAZINE BLENDING AND STORAGE FACILITY
WASTEWATER TREATMENT AND DECOMMISSIONING ASSE

Contract No. DAAK11-84-D-0017

EBASCO SERVICES INCORPORATED

R. L. Stollar and Associates
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DataChem, Inc. Geraghty & Miller, Inc.

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FOR THE ROCKY MOUNTAIN ARSENAL CONTAMINATION CLEANUP,
AMXRM ABERDEEN PROVING GROUND, MARYLAND

TECHNICAL PLAN

VERSION 3.2

April 1988

TASK NO. 34

HYDRAZINE BLENDING AND STORAGE FACILITY
WASTEWATER TREATMENT AND DECOMMISSIONING ASSESSMENT

Contract No. DAAK11-84-D-0017

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1.0 INTRODUCTION

1.1 STUDY OBJECTIVES

Task Order No. 34 involves the development of methods for the decommissioning and final remediation of the Hydrazine Blending and Storage Facility (HBSF). Part of the HBSF study will be an evaluation of options for the treatment/removal of associated wastewater. The specific objectives of the study are:

- o To investigate alternative approaches for treatment/removal of wastewater contaminated with low levels of hydrazine and hydrazine related compounds. Technologies will include those listed in Table 1-1 and shall be compared to the present baseline treatment approach of off-site incineration.
- o To conduct sufficient treatability studies with the most promising candidate technology(s) to verify treatment levels and identify key design variables. The design information will support an Interim Action for the HBSF wastewater.
- o To develop a comprehensive decommissioning assessment. The decommissioning assessment will support and be incorporated into the Arsenal wide Feasibility Study Alternative Assessment, i.e., Task 28.

1.2 PROCESS DESCRIPTION AND PHYSICAL FACILITY

The Rocky Mountain Arsenal (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

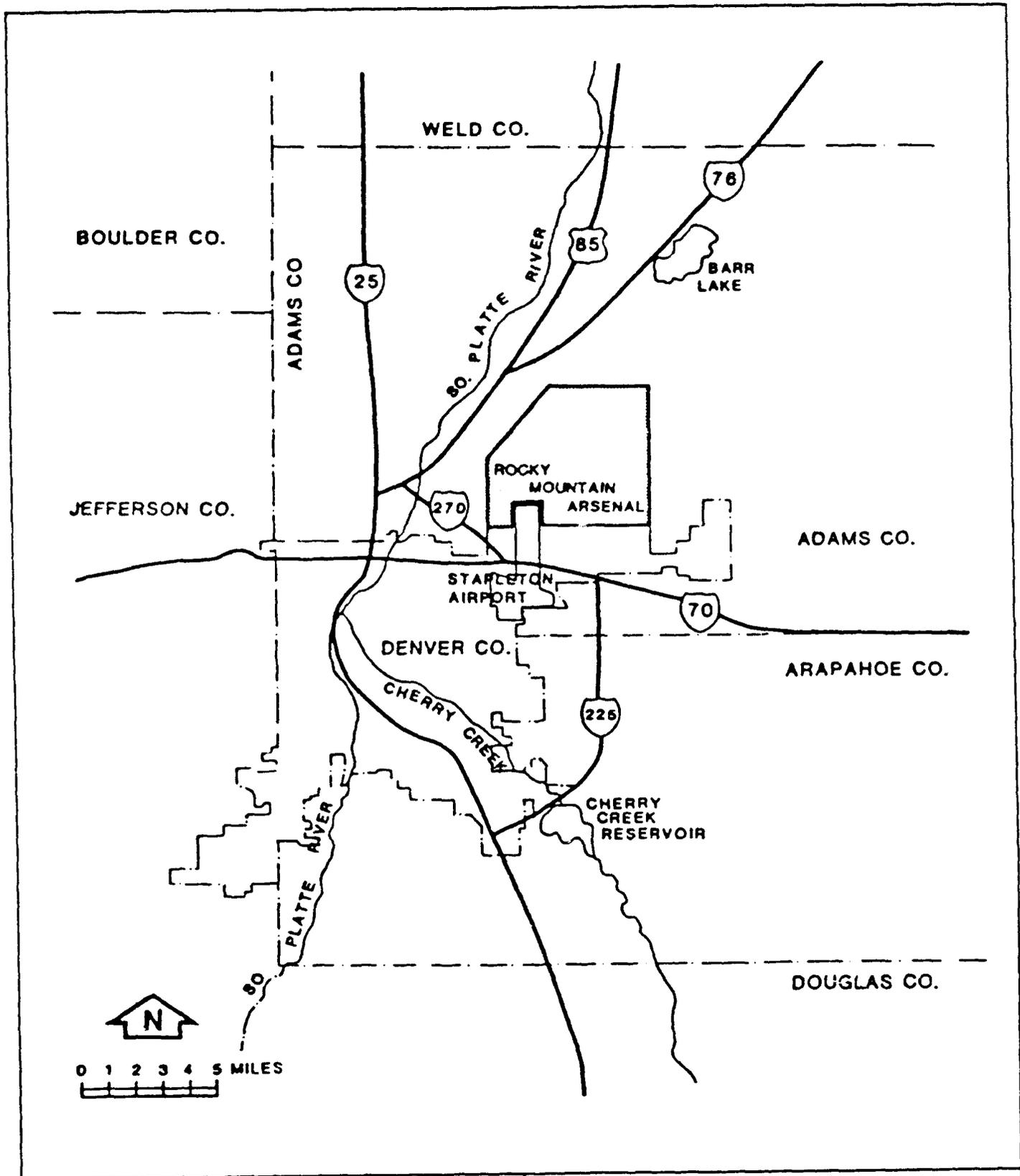
POTENTIAL TREATMENT TECHNOLOGIES

- o BIOLOGICAL TREATMENT
 - CONVENTIONAL TECHNOLOGIES
 - DISCHARGE TO PUBLICLY OWNED TREATMENT WORKS (POTW)

- o CHEMICAL TREATMENT
 - CHLORINE (VARIOUS FORMS) AND CHLORINE/ULTRAVIOLET LIGHT (UV)
 - OZONE AND OZONE/UV
 - PERMANGANATE
 - HYDROGEN PEROXIDE AND HYDROGEN PEROXIDE/UV
 - REDUCTION PROCESSES

- o PHYSICAL TREATMENT
 - ACTIVATED CARBON ADSORPTION
 - METAL OXIDE ADSORPTION/CATALYSIS
 - EVAPORATION POND
 - AIR STRIPPING
 - STEAM STRIPPING
 - SPRAY IRRIGATION

- o THERMAL TREATMENT
 - OFF-SITE INCINERATION
 - ON-SITE INCINERATION
 - NORTH PLANTS INCINERATOR
 - OTHER



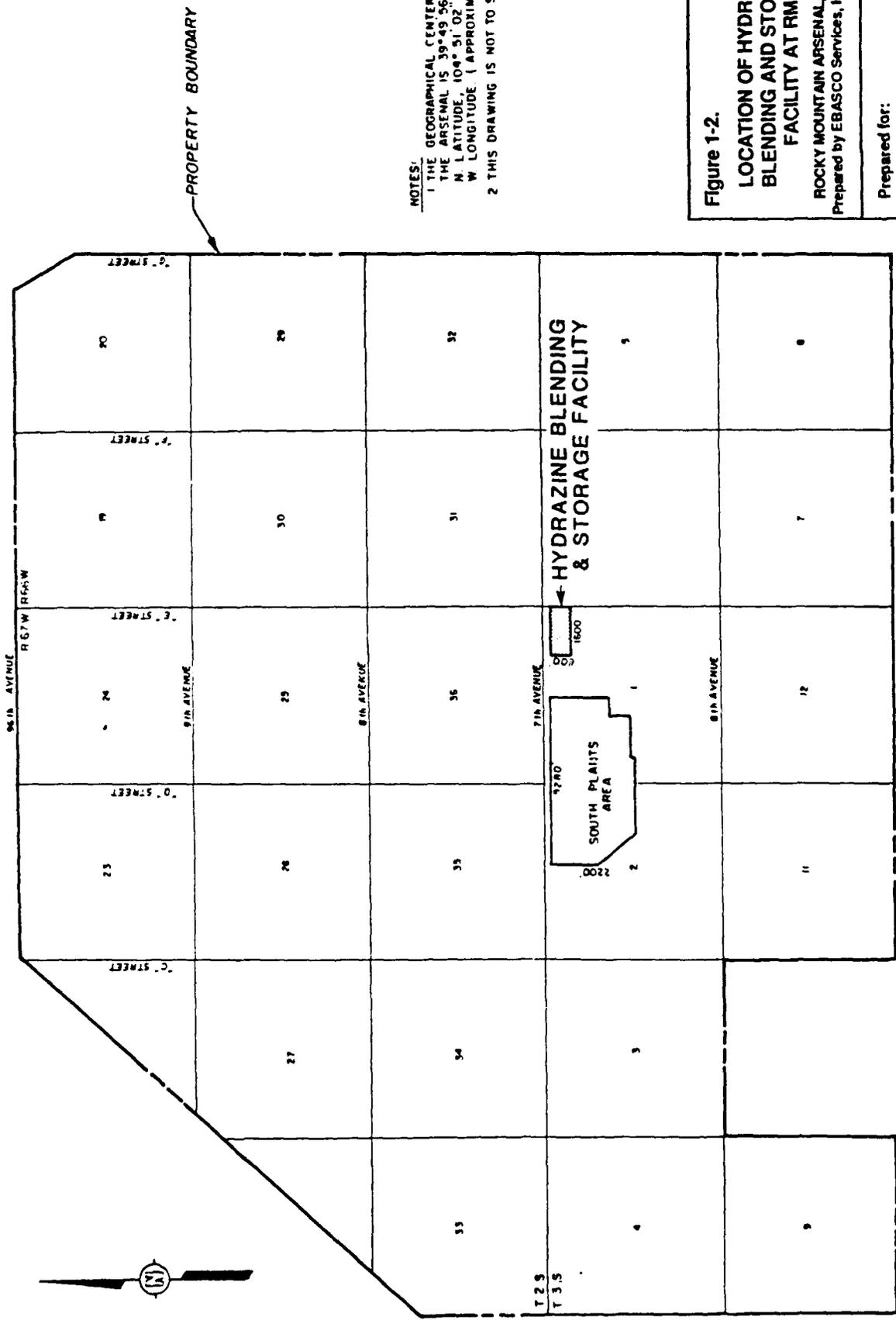
Prepared for:

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
 Prepared by EBASCO Services, Incorporated



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
 Prepared by EBASCO Services, Incorporated

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 Aberdeen Proving Ground, Maryland

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 (Hazard Abatement Plan, 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 (Hazard Abatement Plan, 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 x 600 ft). It is completely enclosed by two concentric security fences.

The facility consists of four carbon steel tanks (one of 50,000, one of 200,000, and two of 19,000-gallon capacity) that are compatible with UDMH and water only; four stainless steel tanks (each of 24,900-gallon capacity) 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/offloading station; concrete pads and dikes; a drum storage pad; a storage shed; a tool shed; an office shed and associated piping. The two carbon steel storage tanks (one of 50,000 and one of

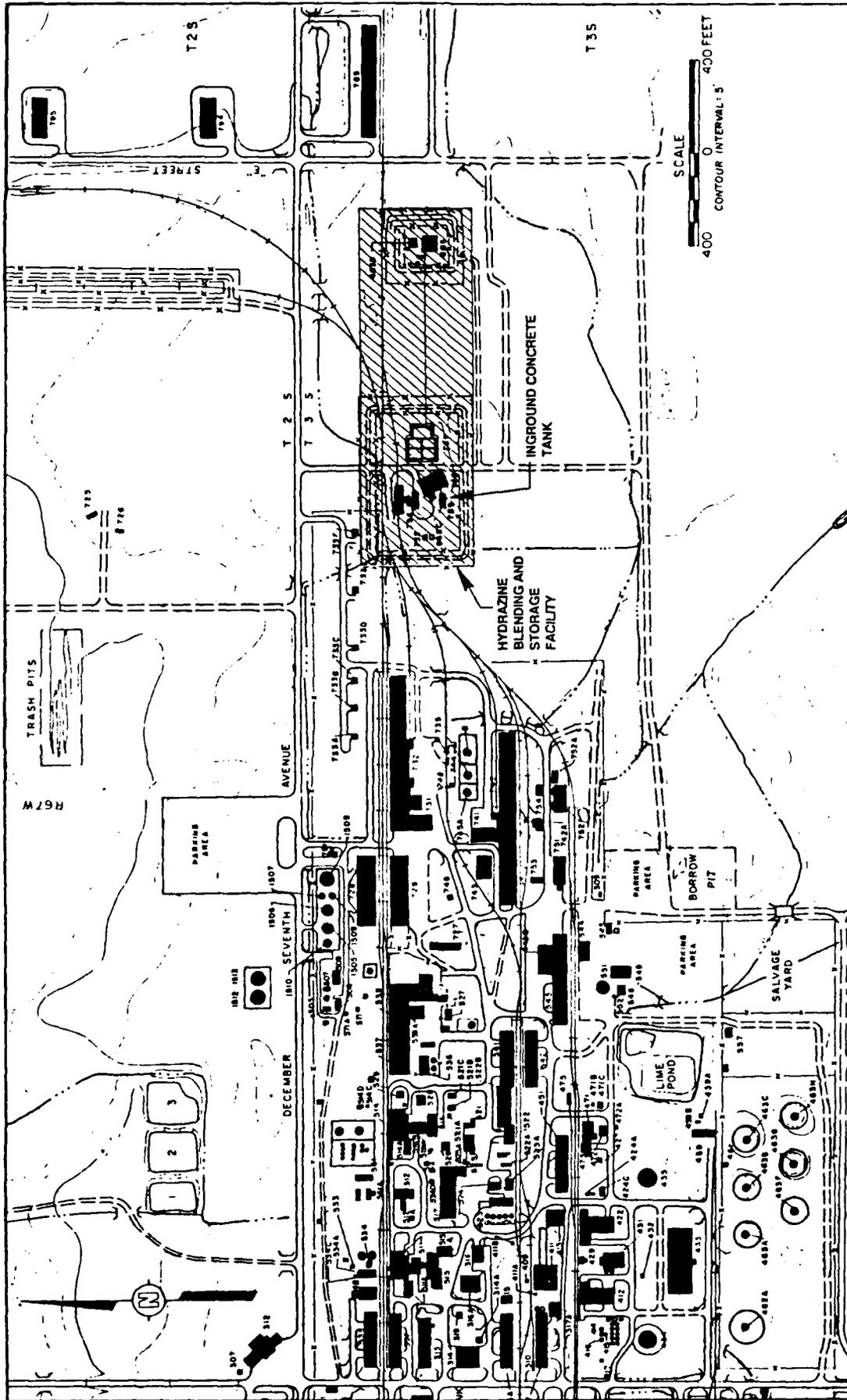


Figure 1-3.
 HYDRAZINE BLENDING AND STORAGE FACILITY
 ROCKY MOUNTAIN ARSENAL, TASK 34
 Prepared by EBASCO Services, Incorporated

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

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'

200,000-gallon capacities), 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 gal). 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 area. 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 type 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: 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 has 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 has been 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.

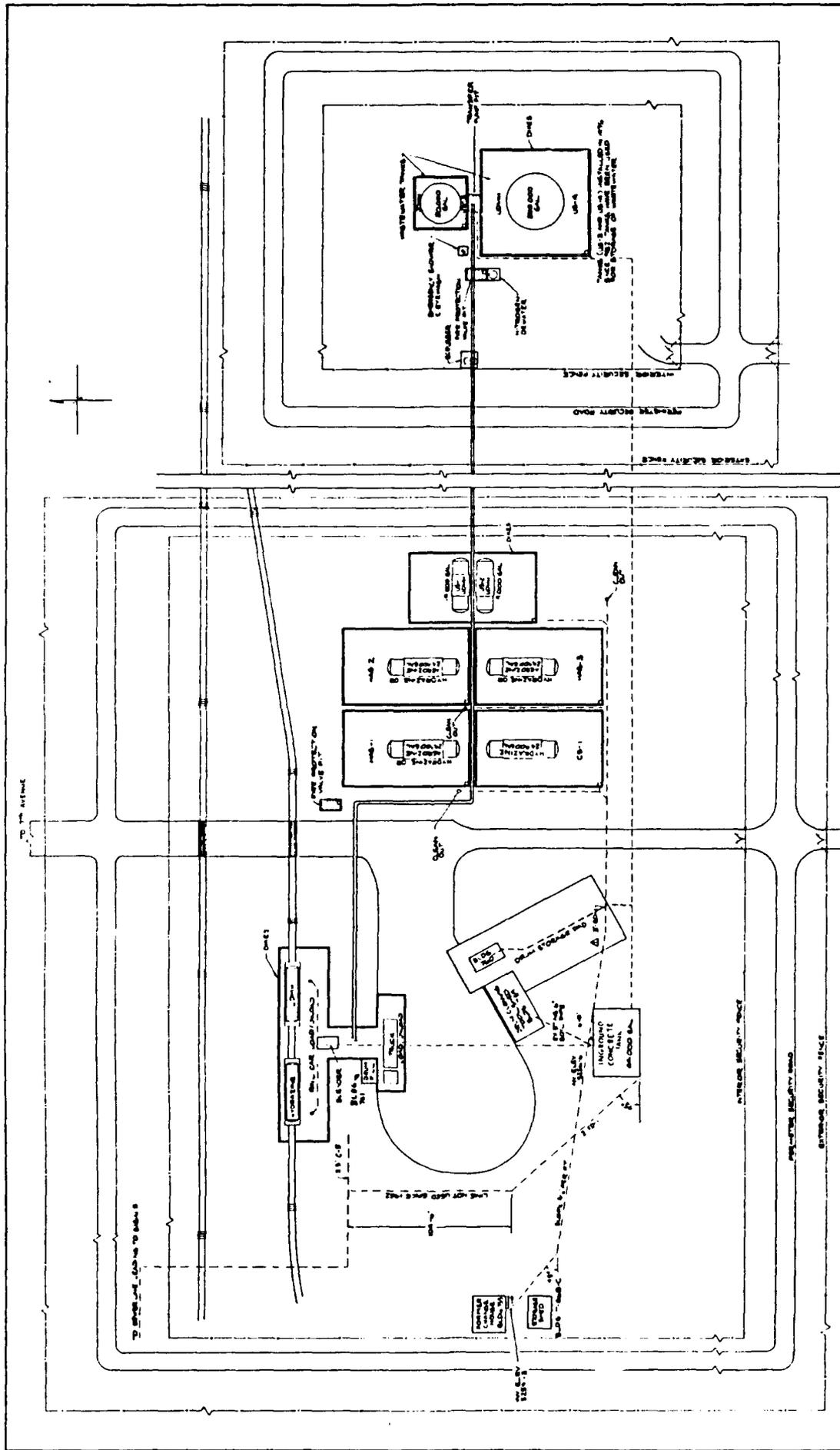


Figure 1-4.
 SCHEMATIC LAYOUT, HYDRAZINE BLENDING
 AND STORAGE FACILITY
 ROCKY MOUNTAIN ARSENAL, TASK 34
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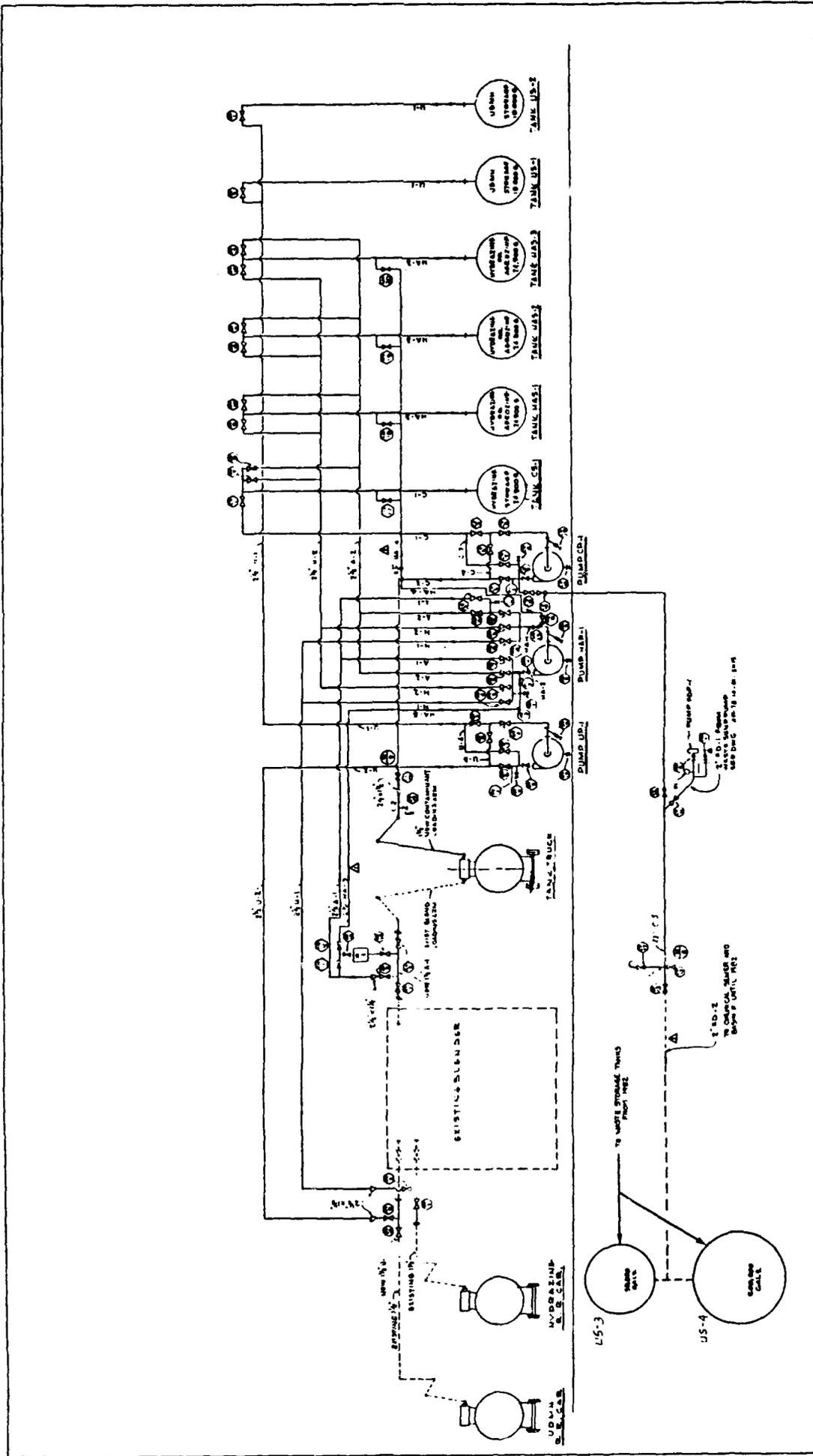


Figure 1-5.
**PROCESS FLOW DIAGRAM, HYDRAZINE
 BLENDING AND STORAGE FACILITY**
 ROCKY MOUNTAIN ARSENAL, TASK 34
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 Aberdeen Proving Ground, Maryland

TABLE 1-2

MAJOR EQUIPMENT AND STRUCTURES OF THE HYDRAZINE
BLENDING AND STORAGE FACILITY

| Item | Description |
|--|---|
| 1. Railroad Tank Car Facility Enclosed Area Function Construction Material | 120'-0" x 30'-0" Unloading of anhydrous hydrazine and UDMH from railroad tanker cars Reinforced concrete. Metal sheets. |
| 2. Blender Function Construction Material | Blend Hydrazine and UDMH to produce Aerozine 50 Reinforced concrete. Metal sheets |
| 3. Drum Loading Station (Bldg 761) Area Function Construction Material | 22' - 0" x 10'0" Loading of Aerozine 50 Reinforced concrete |
| 4. Truck Loading Station Area Function | 60'-0" x 18'-0" Loading of Aerozine 50 into tanker trucks |
| 5. Office Shed/Change House (Bldg 755) Size Function Construction Material | 20'-0" x 24'-0" x 9'-0" Clothing change and showers (until late 1970's). Glycol recircu- lating pump and heat exchanger housing. 8" masonry (concrete block) |
| 6. Inground Concrete Tank Area Volume Function Construction Material | 40'-0" x 26'-0" 44,000 gallons Receive wastewater and stormwater runoff Concrete |
| 7. Building 759 Size Function Construction Material | 40'-0" x 20'-0" x 10'-0" Drum cleaning Metal siding/metal roofing |

TABLE 1-2 (Continued)
 MAJOR EQUIPMENT AND STRUCTURES OF THE HYDRAZINE
 BLENDING AND STORAGE FACILITY

| Item | Description |
|---|---|
| 8. Shelter (Bldg. 760) Location Function Size | In drum storage area Forklift storage 20' x 0" x 10'-10" |
| 9. Storage Shed (Bldg. T-868-C) Size Function Construction Material | 13'-6" x 22'-0" (estm.) Storage of miscellaneous building materials Wood |
| 10. Drum Storage Pad Size Function | 70'-0" x 45'-0" x 6" Storage of drums |
| 11. Aerozine Storage Tanks Number of Tanks Geometric Shape Volume Construction Material Location Size of Dike | 3 (HAS 1, HAS 2, HAS 3) Cylindrical, Horizontal 24,900 gallons Stainless steel Inside concrete dikes 53'-6" x 47'-0" x 5'-0" |
| 12. Anhydrous Hydrazine Storage Tank Number of Tanks Geometric Shape Volume Construction Material Prior use Location Size of Dike | 1 (CS 1) Cylindrical, Horizontal 24,900 gallons Stainless steel Wastewater storage Inside concrete dike 53'-6" x 47'-0" x 5'-0" |
| 13. UDMH Storage Tanks Number of Tanks Geometric Shape Volume Construction Material Location Size of Dike | 2 (US-1, US-2) Cylindrical, Horizontal 19,000 gallons Carbon steel Inside concrete dike 43'-0" x 77'-0" x 5'-0" |

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, aeroxine, contaminants |
| 16. Pipes* (Above Ground) | |
| Diameter | 2.5" |
| 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" |
| Number | 2 (HWR-1, HWS-2) |
| Diameter | 4.5" |
| 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/aeroxine 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

It was estimated that a maximum of approximately 300,000 gallons of wastewater had been generated annually from the HBSF (USATHAMA, 1979). 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 more active years of facility production, a hydrazine drum filling operation was also conducted. 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 to 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) via 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 time, 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

In November 1975, the fire protection system at the hydrazine facility malfunctioned due to 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 within the surrounding dike area. The UDMH was pumped to the inground concrete tank and was neutralized for disposal into Basin F (Trautmann, undated).

1.3.4 U.S. Occupational Safety and Health Agency Survey

During January, February, and March 1982, the U.S. Occupational Safety and Health Agency'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 (Hazard Abatement Plan, 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 Sump (north side) Office | 50 | Dimethyl Amine | N.D. | -- | | | |
| | RMA 2 and 4 | Area | | | 50 | Dimethyl Amine | N.D. | -- | | | |
| | RMA 11 | Area | | | 200 | Hydrazine | N.D. | -- | | | |
| | RMA 17 | Area | | Office | 51 | UDMH | N.D. | -- | | | |
| | RMA 12 | Area | | Sump (north side) | 200 | UDMH | N.D. | -- | | | |
| | RMA 18 | Area | | Sump (north side) | 43 | UDMH | N.D. | -- | | | |
| | RMA 13 | Area | | Support beam near office | 200 | UDMH | N.D. | -- | | | |
| | RMA 19 | Area | | Support beam near office | 41 | UDMH | N.D. | -- | | | |
| | RMA 23 | Area | | Office | 252 | UDMH | N.D. | -- | | | |
| | RMA 24 | Area | | Sump (north side) | 242 | NDMA | 10.0 ug/m ³ | 5.25 ug/m ³ | | | |
| | RMA 25 | Area | | Support beam near office | 240 | NDMA | 4.1 ug/m ³ | 2.1 ug/m ³ | | | |
| | 02/25/82 | RMA 40 | Area | Background levels | Northwest corner tank farm Office Sump (north side) Support beam near office | 276 | NDMA | 0.58 ug/m ³ | 0.33 ug/m ³ | | |
| | | RMA 41 | Area | | | 274 | NDMA | 2.7 ug/m ³ | 1.54 ug/m ³ | | |
| | | RMA 42 | Area | | | 274 | NDMA | 2.7 ug/m ³ | 1.54 ug/m ³ | | |
| | | RMA 43 | Area | | | 274 | NDMA | 1.8 ug/m ³ | 1.03 ug/m ³ | | |
| | | RMA 44 | Area | | | 270 | NDMA | 0.37 ug/m ³ | -- | | |
| | | RMA 45 | Area | | | 269 | NDMA | 2.6 ug/m ³ | 1.46 ug/m ³ | | |
| | | RMA 46 | Area | | | 268 | NDMA | 1.5 ug/m ³ | 0.84 ug/m ³ | | |
| | | RMA 47 | Area | | | 267 | NDMA | 2.6 ug/m ³ | 1.45 ug/m ³ | | |
| RMA 48 | | Area | 266 | | | NDMA | 0.43 ug/m ³ | 0.74 ug/m ³ | | | |
| RMA 49 | | Area | 265 | | | NDMA | 2.3 ug/m ³ | 1.3 ug/m ³ | | | |
| RMA 50 | | Area | 263 | | | NDMA | 1.0 ug/m ³ | 0.55 ug/m ³ | | | |
| RMA 51 | | Area | 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 Northeast side Basin "F" South side building 831 East side building 1710 (Clinic) | 252 | NDMA | N.D. | -- |
| | | RMA 56 | Area | | | | | 198 | NDMA | N.D. | -- |
| | | RMA 58 | Area | | | | | 193 | NDMA | N.D. | -- |
| | | RMA 60 | Area | | | | | 191 | NDMA | N.D. | -- |
| | | RMA 62 | Area | | | | | 172 | NDMA | N.D. | -- |
| RMA 64 | Area | 171 | NDMA | N.D. | -- | | | | | | |
| RMA 57 | Area | 193 | Hydrazine | 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 UDMH | N.D. N.D. | -- |
| | RMA 61 | Area | | East side building 1710 (clinic) | 190 | Hydrazine UDMH | N.D. N.D. | -- |
| | RMA 63 | Area | | South of building 538 | 172 | Hydrazine UDMH | N.D. N.D. | -- |
| | RMA 65 | | | Building 314 in lunch room | 170 | Hydrazine UDMH | N.D. N.D. | -- |
| | RMA 69 | Area | Draining sump | On retaining wall of storage tank east of hydrazine facility | 60 | Hydrazine UDMH | N.D. N.D. | -- |
| | RMA 68 | Area | | On retaining wall of storage tank east of hydrazine facility | 60 | Hydrazine UDMH | N.D. N.D. | -- |
| | RMA 93 | Area | Transfer UDMH from rail car to storage tank | Near scrubber vent | 183 | Hydrazine UDMH | N.D. N.D. | -- |
| | RMA 94 | Area | | Near scrubber vent | 120 | Hydrazine UDMH | N.D. N.D. | -- |
| | RMA 95 | Area | | Near scrubber vent | 186 | UDMH | 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 UDMH | N.D. N.D. | -- |
| | RMA 99 | Area | | In office | 66 | Hydrazine UDMH | N.D. 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 UDMH | 16.0 ug/m ³ 56.0 ug/m ³ | 9.9 ug/m ³ 43.01 ug/m ³ |
| | RMA 103 | Area | | At control panel | 67 | Hydrazine UDMH | N.D. 116.0 ug/m ³ | -- |
| | RMA 104 | Area | | At control panel | 298 | NDMA | 30.0 ug/m ³ | 16.63 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 UDMH | N.D. N.D. | -- -- |
| 03/17/82 | RMA 107 | Area | Transfer UDMH from rail car to storage tank | On top tank CS 1 | 66 | Hydrazine UDMH | N.D. N.D. | -- -- |
| | RMA 108 | Area | | On top tank CS 1 | 294 | NDMA | N.D. | -- |
| | RMA 112 | Wipe | | Abe Padilla's apron | N/A | NDMA Hydrazine UDMH | N.D. N.D. N.D. | -- -- -- |
| | RMA 113 | Wipe | | Rudy Martinez's apron | N/A | NDMA Hydrazine UDMH | N.D. 5.7 ug/m ³ N.D. | -- -- -- |
| | RMA 114 | Wipe | | Dip sticks used to gauge tanks | N/A | NDMA Hydrazine UDMH | N.D. N.D. N.D. | -- -- -- |
| | RMA 115 | Wipe | | Desk in office | N/A | NDMA Hydrazine UDMH | N.D. N.D. 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. Figure 1-6 presents sampling locations used by AEHA. 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 detectable limits were 0.05 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 atmosphere 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. There were no sources of detectable quantities of hydrazine or UDMH contamination 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/UDMH contact exposure.

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 | | |
|----------------|--------------------------------------|--|---|--------|--------------|
| | Hyd/UDMH Sample No. | NDMA Sample No. | Hydrazine (in micrograms/cubic meter-ug/m ³) | 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/m³.

ND - None Detected, value < .05 ug/m³.

TABLE 1-4 (Continued)

| Sampling Point | Simultaneous Samples | | Sample Results | | |
|----------------|-----------------------------------|------------------------------------|--|--------|-------------|
| | Hyd/UDMH Sample No. | NDMA Sample No. | Hydrazine (in micrograms/cubic meter-ug/m ³) | UDMH | NDMA |
| SP-12 | FB-04, FB-15 | AO 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/m³.
 ND - None Detected, value < .05 ug/m³.

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 of 1985 (U.S. Air Force, 1985). PM-RMA also initiated a soil and groundwater study, which is currently ongoing. RMA personnel have completed a rinsing of 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 are 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, the U.S. Occupational Safety and Health Agency (OSHA) and the U.S. Army Environmental Hygiene Agency (AEHA) conducted surveys to quantify exposures of hydrazine related compounds. The findings of these surveys which led to the cessation of operations at the HBSF 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 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 include:

- o 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

Sampling activities were performed for the USAF at the HBSF on June 11-13, 1985. 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 (i.e., inside surfaces of fuel storage tank) 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 method detection limit (U.S. Air Force, 1985).

Wipe Samples

The purpose of a wipe sample was to provide an indication of contaminant presence on material surfaces, not a quantitative measure of its concentration. Each wipe sample consisted of wiping a 100 cm² area (10 by 10 cm) with a dry Whatman No. 41 filter paper. Two adjacent 100 cm² area were sampled at each sample location. Due to 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; office building; glycol building; storage shed; blending skid; railroad rails; liquid nitrogen tank; concrete containment dikes; inground wastewater tank; chain link fence supports; drum storage pad; and east scrubber.

With the exception of two samples (Samples 42B and 43B) all of the wipe samples analyzed were below the detection 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.

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

Bulk Samples

The collection of bulk samples was very limited due to 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, since 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.

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 (equivalent to ppm), respectively. NDMA was below the detection limit for this sample.

Contaminant levels in Bulk Sample 1, a piece of loose concrete 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).

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 due to the limited amount of accessible, visible insulation.

The only insulation sample that had reported levels 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; however, the gray material was determined to contain 5 to 10 percent Chrysolite, a common form of asbestos. Split samples of ASB-1 both resulted in 5 to 10 percent asbestos.

Wastewater Treatment

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

- o Discharge via natural drainage to a surface water
- o Transport to a POTW
- o Discharge through an NPDES permitted outfall
- o Transport to an off-site treatment/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 report for treatment and disposal of the wastewater:

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

On-site and off-site implementation of these options were 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 type 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 were noted. The availability of portable chlorination units was discussed, and it was anticipated that chlorination would treat contaminants to sub-detection levels.

Several chemical oxidation processes were included. Ozonation was determined to be a feasible treatment option. Combined ozone and ultraviolet light exposure was reported to degrade hydrazine compounds and also undesirable reaction products by the IIT Research Institute (IITRI). 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 due to the absence of treatment or destruction of the wastes.

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 any contamination. Soil and groundwater chemical analyses were conducted. Following data analysis, the following issues were addressed:

- o Local Geologic and Hydrologic Conditions;
- o Extent of Contamination;
- o Future Monitoring Requirements; and
- o 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 NBSF 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. 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 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 analyses were performed by the RMA laboratory. The 1985 analytical results were performed for the USAF (U.S. Air Force, 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 due to 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

TABLE 1-7

RESULTS OF ANALYSES OF EXTRACTS FROM EP TESTS
INGROUND CONCRETE TANK WASTEWATER^{1/}

| Parameters | Units | Substantive | |
|------------------------|-------|---|---|
| | | RCRA Concentration Limits <u>2/</u> | Inground Concrete Tank Wastewater |
| pH | s.u. | -- <u>3/</u> | -- |
| 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.

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 | * | 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 | * | 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 |

* Below detection limit. Detection limits for 5/85 analyses are:

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

Sources: PM-RMA 1983 and U.S. Air Force 1985

receptors. The determination of action levels for cleanup relies first on potential human and environmental risks associated with the contaminant. In addition, practical constraints exist 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.

Of the contaminants in the wastewater, NDMA is the most toxic and often the most resistant to treatment. Accordingly, action levels are initially defined for NDMA. Generally, destruction of NDMA to desired levels ensures that hydrazine, MMH, and UDMH are destroyed virtually completely. Even so, action levels will be determined for other contaminants of concern in a manner similar to the process used for NDMA.

Precedent for NDMA action levels has been set in the issuance of the NPDES permit for Aerojet-General Corporation in Sacramento, CA. There, 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 permit limit of 1000 ppt was designated (CA. Wat. Qual. Ctrl. Bd., 1985). A similar rationale balancing health-based treatment levels, analytical limits of detection, and the uncertainty of analytical values is used here 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 a 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 NDMA treatment action level is proposed.

The action levels for hydrazine, MMH, 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 detection limits, it is anticipated that since NDMA is generally the compound most resistant to destruction, the remaining hydrazine compounds will be destroyed well below detection limits.

1.6 SUMMARY OF TECHNICAL APPROACH

The plans for disposal of wastewater at the HBSF and decommissioning of the facility will be developed according to the following technical approach:

- o Wastewater treatment assessment, in which applicable treatment methods will be ranked. Treatability studies to support the ranking and to identify key design criteria may be performed.
- o Decommissioning plan development.
- o Final detailed decommissioning report preparation.

1.7 TASK SCHEDULE

The projected schedule for the HBSF wastewater treatment and decommissioning assessment is depicted in Figure 1-7.

FIGURE 1-7

TASK 34 - HYDRAZINE BLENDING AND STORAGE FACILITY WASTEWATER TREATMENT AND DECOMMISSIONING ASSESSMENT SCHEDULE.

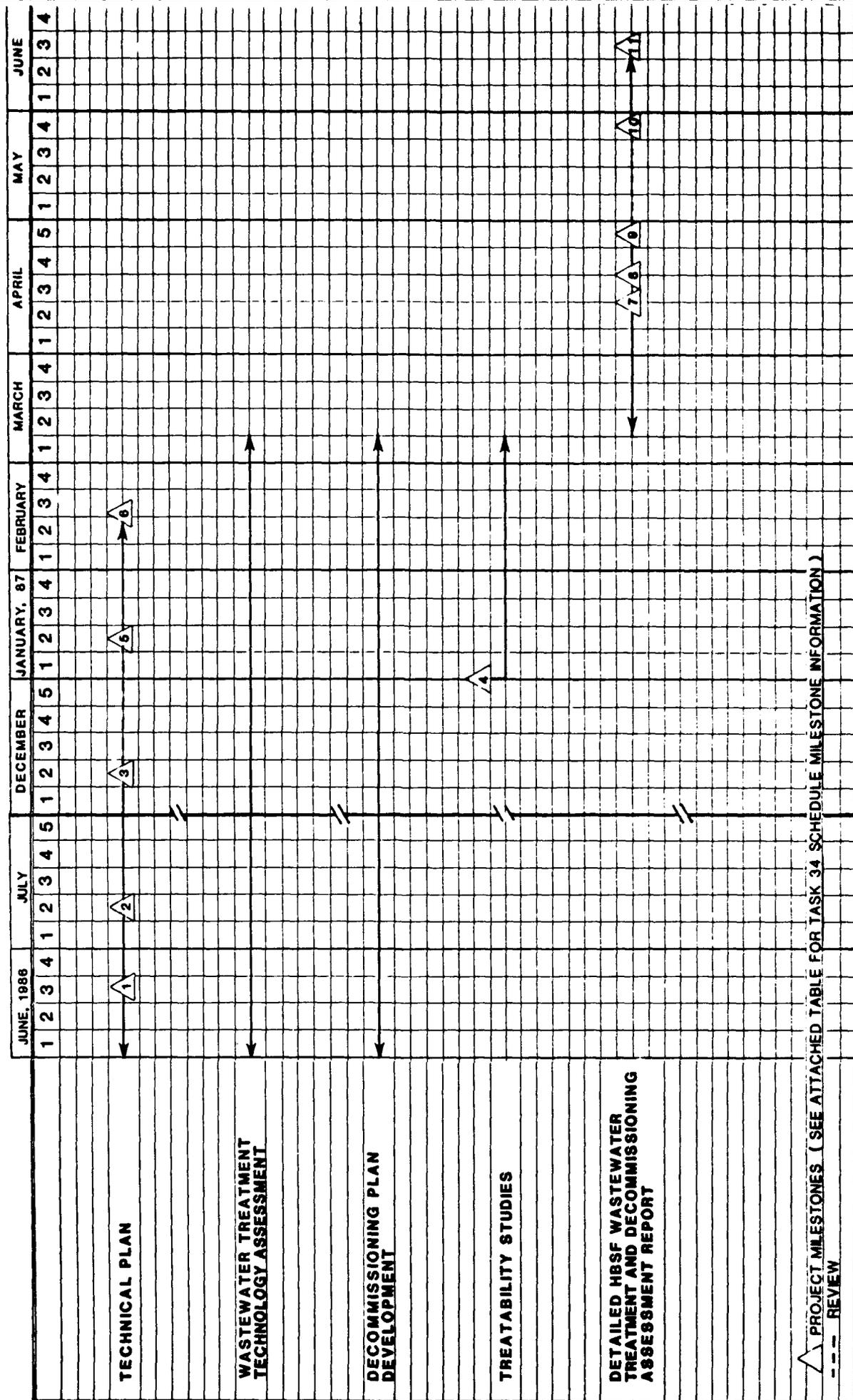


FIGURE 1-7 (Continued)

TASK 34 PROJECT MILESTONES

- 1 June 20 - Submittal of Blue Cover Technical Plan without technology screening and action levels.
- 2 July 8 - Presentation of Technical Plan to PMO and submittal of technology screening and action level sections.
- 3 December 10 - Submittal of Brown Cover Technical Plan.
- 4 January 5 - PMO approval of Treatability Studies.
- 5 January 14 - Receipt of MOA comments.
- 6 February 17 - Submittal of White Cover Technical Plan.
- 7 April 20 - Submittal of Blue Cover HBSF Wastewater Treatment and Decommissioning Assessment Report.
- 8 April 24 - Receipt of PMO comments.
- 9 April 29 - Submittal of Brown Cover HBSF Wastewater Treatment and Decommissioning Assessment Report.
- 10 May 27 - Receipt of MOA comments.
- 11 June 17 - Submittal of White Cover HBSF Wastewater Treatment and Decommissioning Assessment Report.

2.0 WASTEWATER TREATMENT ASSESSMENT

2.1 PURPOSE

Wastewater generated from operations at the Hydrazine Blending and Storage Facility will be addressed as an interim action under CERCLA. The purpose of the Wastewater Treatment Assessment is to identify the most favorable treatment alternative to be used in the interim action. The Assessment process begins with a statement of specific treatment objectives. All candidate technologies are identified. Those technologies which clearly cannot meet the treatment objectives are eliminated from further consideration. The remaining treatment technologies are then described in more detail. A second screening is conducted to eliminate less favorable technologies, which leads to identification of the final candidate technologies. These final technologies are then the subject of a detailed analysis which focuses on the permanency of the remedy (i.e., reduction of toxicity, mobility, and volume of waste), cost, ease of implementation, and treatment effectiveness as well as on the performance of treatability studies for certain technologies. Based on this analysis, a ranking of technologies will be presented.

2.2 TREATMENT OBJECTIVES

Past activities at the HBSF produced wastewaters from container rinsing and air scrubbing. The quantities of wastewater and concentrations of hydrazine contaminants are listed in Tables 1-7 and 1-8 of the previous chapter. Various chlorinated compounds may also be present in the wastewater from past practices of decontamination using chlorination. More wastewater may 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. Among other hazards, human carcinogenesis is a 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 defined in Section 1.6, for example 200 ppt NDMA, without producing equally hazardous end-products. As well as meeting treatment objectives, rapid implementation as an interim action is required. Thus, processes which have been demonstrated as effective are favored while processes which require considerable development are eliminated. Cost is an important factor insofar as the lowest cost technologies which meet the treatment and implementation objectives are 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). In the following section, a review of these technologies is presented. The review is restricted to a discussion of major process reactions and operations and is intended only as a means to identify which options clearly cannot meet the treatment and implementation requirements. If the process does not remove the hydrazine and related compounds efficiently or reliably without producing hazardous by-products, or if much development would be required to evaluate treatment efficiency and implement the process, the technology is eliminated from further consideration. Specifically, the technology or the reactions comprising the technology must have been demonstrated in the laboratory or in practice as effective in destroying hydrazine, MMH, UDMH, and NDMA to detection limits so that major experimentation is not required to prove process feasibility.

TABLE 2-1
CANDIDATE TREATMENT TECHNOLOGIES

- o BIOLOGICAL TREATMENT
 - ON-SITE BIOLOGICAL TREATMENT
 - DISCHARGE TO A PUBLICLY OWNED TREATMENT WORKS (POTW)

 - o CHEMICAL TREATMENT
 - CHLORINATION AND CHLORINATION/ULTRAVIOLET LIGHT (UV)
 - OZONATION AND OZONE/UV
 - PERMANGANATE
 - HYDROGEN PEROXIDE AND HYDROGEN PEROXIDE/UV
 - REDUCTION PROCESSES

 - o PHYSICAL TREATMENT
 - ACTIVATED CARBON ADSORPTION
 - METAL OXIDE ADSORPTION/CATALYSIS
 - EVAPORATION POND
 - AIR STRIPPING
 - STEAM STRIPPING
 - SPRAY IRRIGATION

 - o THERMAL TREATMENT
 - OFF-SITE INCINERATION
 - ON-SITE INCINERATION
 - NORTH PLANTS INCINERATOR
 - OTHER
-

Also, technologies which generate hazardous by-products in quantities requiring supplemental treatment are rejected. Those technologies which can attain the desired level of treatment and which can be rapidly implemented are carried forward for a more detailed analysis.

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) performed 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

| <u>Bacteria</u> | Concentration Causing 50 Percent Reduction in Metabolism (mg/l) | | |
|-----------------------|--|------------|-------------|
| | <u>Hydrazine</u> | <u>MMH</u> | <u>UDMH</u> |
| 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) indicate 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 is eliminated from further consideration, although it may be utilized as a disposal option for treated wastewater.

2.3.2 Discharge to a Publicly Owned Treatment Works (POTW)

Discharge to a publicly owned treatment works (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 is considered unacceptable as a complete treatment option.

2.3.3 Chlorination and Chlorination/UV

Chlorination of hydrazine compounds is a commonly suggested hydrazine decontamination 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 both incomplete and produced chloroform, various hydrazones, 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 part per million concentration range. NDMA may also be oxidized by chlorination, as has been demonstrated by Neumann and Jody (1986), who removed NDMA to below 20 parts per trillion (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 utilized 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 by-products may hold for hydrazine related wastewater, but this has yet to be confirmed.

Although chlorination may destroy the hydrazine related compounds, the resulting chlorinated side-products would be present in concentrations such that additional treatment would be required. Thus, chlorination alone produces an unacceptable end-product and is excluded 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 chloroform (less than 0.3 ppm), carbon tetrachloride (less than 0.3 ppm), and chlorinated amines (less than 0.1 ppm), while chlorinolysis minus UV did generate part per million 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 by-products. Therefore, chlorination/UV will be 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 by-products. There is formation of miscellaneous side-products following ozonolysis 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 side products. In one experiment, a solution of MMH and hydrazine in the 1,000 ppm range with trace quantities of UDMH was oxidized with ozone. The hydrazine, MMH, and UDMH were destroyed to concentrations below detection limits of 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, ozonolysis will be further investigated as a treatment alternative.

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

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 IIT Research Institute (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 by-products of ozonolysis are readily destroyed by ultraviolet light. Gas chromatography/mass spectrophotometry (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, CA, for wastewater containing hydrazine and NDMA. Discharge limits 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 will be 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 was present in the former case. Permanganate treatment may be capable of destroying the contaminants of concern, but this has not been confirmed entirely. 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 are judged to be constraints which dismiss this alternative as a promising 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 with trichloroethylene and dichloromethane (1983). Hydrogen peroxide/UV successfully destroyed 100 ppm hydrazine in wastewater to below detection limits (Hager and Smith, 1985). One potential drawback is that few, if any, experiments have been conducted using hydrogen peroxide/UV on MMH, UDMH, and NDMA. Nevertheless, the mechanism of action of hydrogen peroxide/UV is suspected to be similar to ozone/UV, with the primary difference being that ozone is 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 will be 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 evolved 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 is 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 (USEPA, 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 is eliminated based on 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., 1983). In addition, the metal oxide surface may also 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 is eliminated from further consideration since 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 the main contributions occurring during 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). 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 is 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. With the HBSF wastewater, the hydrazine and related compounds must partition favorably 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. Along with the difficulty of stripping is the problem of lack of destruction of the contaminants. Stripping, for the most part, transfers the contaminants from one media (water) to a second (air). Thus, inefficient separation and lack of contaminant destruction exclude 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 (Bradbeer, 1986), suggesting that spray irrigation would be effective. Despite the strong likelihood of success, the consequences should the method fail 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 is eliminated as a viable 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). Utilization of a mobile incinerator or construction of a new on-site incinerator would be accompanied by a test burn, and mobilization or construction time delays. Thus, on-site incineration cannot meet the need for rapid implementation. Off-site incineration is an acceptable treatment process. Two facilities contacted (SCA, Chicago and Rollins, Deer Park, TX) 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 an alternative which will be further investigated.

2.3.14 Summary of Initial Screening

Of the preliminary candidate technologies listed in Table 2-1, only six are judged to be capable of achieving the desired level of destruction of hydrazine, MMH, UDMH, and NDMA without generating hazardous by-products and can 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.

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

TABLE 2-3
SUMMARY OF INITIAL TECHNOLOGY SCREENING

| Technology | Effective De- struction of Hydrazine-Re- lated Compounds | Rapid and Simple Implementation | Non-hazardous By-Products 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 |

technologies which consist of similar operations are compared for treatment effectiveness, as indicated by reaction rate and destruction of by-products. Those technologies found to be inferior to similar processes are eliminated. Technologies which are distinctly different or which have similar treatment effectiveness are retained. The remaining "final candidate" technologies will subsequently will be reviewed in detail to provide a basis for ranking.

2.4.1 Descriptions of Technologies

Six technologies, chlorination/UV, ozonation, ozone/UV, hydrogen peroxide/UV, evaporation pond, and off-site incineration, can 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. First, 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 to an evaporation pond. The specific disposal method is not determined at this stage; rather, the need for disposal or lack thereof is mentioned. Then, each technology is 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 consists of a recirculating or batch wastewater system incorporating chlorine contact followed by ultraviolet light exposure. Treatment may be performed by contacting and recirculating the wastewater using the existing piping and tanks, or a mobile treatment system operating in a batch mode may be utilized. If the recirculating system is used, a chlorine contact

chamber and a UV light chamber may be installed on existing piping or may require new piping. A pH-monitoring and control system is necessary and a sulfite system may be required to eliminate residual chlorine prior to discharge to a waterway, although chlorine will dissipate if the water is retained. Gas vents and possibly scrubbing units are necessary for release of reaction gases. Treatment is continued until an acceptable product is generated, after which the treated wastewater is discharged. Use of a mobile treatment system involves the same process operations as does the recirculating system, but may 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 by-products are produced which may require subsequent treatment. UV light exposure aids in the destruction of the contaminants and by-products, but additional treatment of the chlorinated by-products may still be required. Treatability studies are required to determine the identity of the chlorinated by-products and the effect of UV exposure on degradation. MOA approval is required if discharge of the treated water to a sanitary treatment facility or waterway occurs, as is the case with all water discharge during hazardous waste cleanup operations. There are no significant hazards associated with implementing this system, as the reaction is contained, the reactants are easily handled, and contaminant releases are unlikely. Implementation of chlorination/UV requires 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 may be required to install the equipment assuming personal protection is required. Alternatively, the use of a mobile treatment unit only requires hookup to the existing piping or tanks.

2.4.1.2 Ozonation

The ozonation option consists of generation of ozone on-site with its introduction either into a recirculating flow of the wastewater through existing piping or directly into the tanks and sump. It is also possible to treat the wastewater internally within a mobile treatment system. Venting, scrubbing, and possibly recycling of off-gases is necessary to release reaction products and recover oxygen. A pH monitoring and control system may be necessary. Treatment is continued until the wastewater meets concentration requirements, after which the water is 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 will also be destroyed to some extent. If ozonation is successful, no further treatment is necessary and the treated water can be discharged either to a sanitary treatment plant following MOA approval or to an evaporation pond. Only minor treatability studies must be performed to determine the effectiveness of ozonation on the actual wastewater as ozonation has already been performed 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 impacts would result. Hazards associated with ozone are avoidable with proper generation, dispensing, and degeneration of unreacted ozone. Installation complexity and time requirements are minor due to the utilization of existing tanks and piping and the simplicity of the operation. A mobile treatment system would be even simpler and less time consuming to implement.

2.4.1.3 Ozone/UV

This technology is virtually identical to the preceding ozonation alternative except for the addition of an ultraviolet light contact chamber. The operation is comprised of recirculating water with initial ozone contact, pH control, and venting of off-gases. UV light exposure follows the ozonation step and may be performed in the same chamber. Recirculation of water and treatment continues until the desired removal is achieved, after which the treated water is discharged. Again, mobile treatment systems are available to perform these same operations.

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

2.4.1.4 Hydrogen Peroxide/UV

This alternative is similar to the ozone/UV process, differing primarily in that hydrogen peroxide solution is substituted for gaseous ozone. A single chamber is used for the UV exposure and for addition and mixing of hydrogen peroxide. This chamber and the necessary reaction monitoring appurtenances may be hooked up to existing piping

and used to treat the wastewater in a recirculation mode. Also, the treatment equipment may be brought on-site in a mobile unit and the wastewater treated in a batch mode. Treatment is conducted until the action levels are attained, after which the water is 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 for ozone. The hydroxyl radicals formed from the hydrogen peroxide/UV oxidize the contaminants, and continuation of the treatment likely destroys by-products and chlorinated compounds which may be present. It is expected that the treated water will require no additional treatment. MOA approval is then necessary if the water is discharged to a sanitary treatment plant. The hazards associated with this alternative are very low, as the wastewater treatment is conducted within the equipment, accidental releases are unlikely, and the hydrogen peroxide and UV light present little hazard. Treatability studies are necessary to verify the treatment effectiveness of hydrogen peroxide/UV on MMH, UDMH, and NDMA, as well as other contaminants which may be present. Implementation of this process involves either installation of the UV contact equipment, hydrogen peroxide dispensing system, and the necessary monitoring devices to existing piping or use of a mobile treatment system. In the former case, time requirements will be modest while in the latter, minimal set-up is required.

2.4.1.5 Evaporation Pond

In this alternative, a lined pond is constructed according to RCRA guidelines into which the HBSF wastewater is pumped. Alternatively, existing containment structures at the HBSF may be modified to create a pond. Access control devices such as fencing and air guns to frighten birds may be necessary. A pump is available to return the water to the tanks to avoid accidental overflowing should adverse meteorological conditions warrant. Natural degradation processes destroy the

hydrazine compounds while the water evaporates. Air monitoring devices may be placed around the pond to measure fugitive contaminant releases. Treatment continues until all the water is evaporated, after which residues are disposed along 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 possible chlorinated compounds can be assured. The exposure of the wastewater to air should provide sufficient oxidation. Releases of the compounds into the atmosphere actually facilitates destruction by increasing the contact with oxygen and the ultraviolet fraction of sunlight. Potential fugitive emissions can be monitored and if found to be excessive, the water can be returned to the tanks. Since no water discharges occur, there are no associated impacts and MOA approval requirements for discharges. Implementation of this treatment option involves only excavation of a shallow pond, placement of an impermeable liner, fencing, pumping of the wastewater, and possibly air monitoring. One possible advantage of this option is that much of the implementation can be conducted outside of the restricted HBSF area, so little personal protection equipment will be required. On the other hand, it may 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. If existing containment structures are utilized, these will have to be inspected and sealed prior to use.

2.4.1.6 Off-Site Incineration

Off-site incineration is a means to quickly and reliably destroy all contaminants present. Wastewater is pumped into tanker trucks which transport the contaminated water to a RCRA approved incineration facility. Tanker trucks of 3000 to 5000 gallon capacity would transport the wastewater to the Rollins incinerator in Deer Park,

Texas, or the SCA facility in Chicago. 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 is guaranteed with incineration. A very small possibility for health hazards exist due to the handling and transport of the wastewater in the event of a spill or a motor vehicle accident. Otherwise, risk of exposure is permanently eliminated. Other than a test burn and chemical analysis of the wastewater, no treatability studies are required. If the incineration is not sufficiently complete, which is highly unlikely, burn conditions would have to be modified or an alternate treatment utilized, which may involve further transport of the water. No monitoring of discharges is required beyond that required by the incineration facility. Implementation of the process involves pumping of 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 are all capable of destroying the hydrazine compounds to the defined action levels (Section 1.5). In some cases, undesirable intermediates are generated but these substances can be treated as well. Despite the capacity of each technology to produce an acceptable product, clearly some technologies are more advantageous than others from a standpoint of overall treatment efficiency.

Ozonation combined with UV differs from ozonation alone only in 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 destruction of reaction by-products (Neuman and Jody 1986). Thus ozonation is excluded in favor of ozone/UV.

Combined chlorination and UV is also a reliable method, yet it has complications which are not inherent in the ozone/UV process. For example, there is generation of undesirable chlorinated compounds which does not occur with ozone/UV. The amount of chlorinated compounds generated may be small in comparison to the quantities already present due to past chlorination activities; nonetheless, while chlorination contributes undesirable chlorinated compounds, ozonation destroys them. Although the UV light destroys some of these chlorinated products, the time required to do so may be extensive. Additionally, a sulfite contact dechlorination system or extended time for residual chlorine dissipation may be required but is unnecessary with ozone/UV. Thus, ozone/UV is preferred over UV/chlorination because it does not require extended treatment to destroy refractory chlorinated compounds generated during the initial reaction.

Hydrogen peroxide/UV has similar advantages to ozone/UV, 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 may be nearly as effective as ozone/UV. In addition, peroxide is generally easier to handle than ozone, and has fewer potential safety complications. Therefore, hydrogen peroxide/UV will be studied in more detail as a treatment method.

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

Off-site incineration is another acceptable cleanup method. It offers ease and rapidity of implementation, requires no monitoring of releases beyond that required of the incineration facility, and assures

destruction. Only minor hazards associated with handling and transport exist. Because of its treatment effectiveness, off-site incineration will also be 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 can provide adequate destruction of hydrazine, MMH, UDMH, and NDMA and be implemented in a few months time. Of these six, four are found superior because of simplicity, treatment efficiency without the need for subsequent treatment, and rapid implementation. These four final candidate technologies are:

- o Ozone/UV
- o Hydrogen Peroxide/UV
- o Evaporation Pond
- o Off-Site Incineration

The first two of these require treatability studies to verify treatment effectiveness with the actual wastewater, and to identify key design parameters. These four technologies will be discussed in more detail in order to assess each and weigh their relative merits.

2.6 DETAILED EVALUATION OF TECHNOLOGIES

The four final candidate technologies, ozonation/UV, hydrogen peroxide/UV, evaporation pond, and off-site incineration, will be evaluated in detail. Components of the evaluation will include:

- o Conceptual Engineering

TABLE 2-4

SUMMARY OF SECONDARY TECHNOLOGY SCREENING

| Technology | Criteria |
|-----------------------|--|
| | Treatment Efficiency - Rate of Destruction, Destruction of Undesirable Intermediates, Process Simplicity |
| 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. |

- o Human and Environmental Health Assessment
- o Cost Evaluation

2.6.1 Conceptual Engineering

Each final candidate alternative will be the subject of a conceptual engineering analysis. The level of detail will be such that all process components and a basic understanding of the operation will be known. This task will entail compilation of the following information:

- o Major Equipment Components
- o Accessory Equipment Required to Produce an Acceptable End-product
- o Preliminary Process Layout
- o Implementation Schedule
- o Monitoring Requirements

2.6.2 Human and Environmental Health Assessment

Based on the conceptual engineering analysis, a qualitative assessment of human and environmental health impacts will be provided. The cleanup operations may adversely impact cleanup workers, and the treated wastewater, if it is discharged, must not contain contaminants at concentrations which could adversely impact the environment or potential users of the water. The following issues have been considered in the initial screening and will be expanded as necessary in the detailed evaluation:

- o Permanency of the Remedy (Reduction of Toxicity/Mobility)
- o Efficiency and Reliability of Treatment

- o Production of Harmful Chemical Intermediates
- o Potential Releases and Short-term Exposure During Cleanup
- o Potential Hazard Should The Technology Fail
- o Acceptability and Long-term Health Impacts of the Final Products

2.6.3 Cost Evaluation

The conceptual engineering analysis will also provide the basis for the estimate of costs. The accuracy of estimates will be approximately +30% in order to compare the final candidate technologies and to provide an indication of the actual cost. Costs will include capital and operation and maintenance expenditures. Most costs will be based on quotations from established, reputable suppliers, while the remaining costs will be derived from recent studies. Future expenditures will be discounted at 10 percent as recommended by OMB (USEPA 1985). Cost elements which will be included are:

- o Capital Equipment
- o Operation and Maintenance
- o Transport
- o Disposal
- o Chemical Supply
- o Engineering, Supervision
- o Contractor's Fees
- o Contingencies

2.7 CHEMICAL ANALYSIS AND TREATABILITY STUDIES

To assure that the most appropriate treatment technologies are investigated, it is necessary to perform chemical analyses on the wastewater. Previous analyses focused on the hydrazine compounds and

NDMA. However, these analyses may not be representative of the wastewater, as the contaminants may be stratified in the tanks and inground concrete tank. Furthermore, continued use of the water to rinse the fuel tanks and lines may have altered the composition. Because of the practice of decontamination using chlorination, the presence of chlorinated compounds is suspected. Thus, sampling and chemical analyses will be performed. Sampling will be conducted such that a sample representative of a container's entire contents is obtained or samples from different heights will be taken. Chemical analyses will include hydrazine, MMH, UDMH, NDMA, and representative chlorine compounds resulting from the chlorination of hydrazine compounds, such as chloroform and methylene chloride.

Concurrent with the wastewater treatment assessment study, treatability studies will be conducted to assess the destruction of the contaminants identified in the chemical analyses. The primary purpose of the treatability studies is to verify the effectiveness of ozone/UV and hydrogen peroxide/UV in oxidizing not only hydrazine compounds and NDMA, but also chlorinated contaminants, if present. Ozone/UV has been demonstrated as effective on simulated hydrazine, MMH, UDMH, and NDMA wastewaters (Neuman and Jody, 1986); however, the presence of other compounds may affect the treatment, so studies conducted on samples of the actual wastewater are required. Hydrogen peroxide/UV destroyed hydrazine to below detection levels in a simulated wastewater (Hager and Smith 1985); similar destruction of MMH, UDMH, and NDMA is likely achievable by this process, but this possibility must be confirmed in the laboratory, particularly with the actual wastewater.

Following determination of the general treatment effectiveness, additional batch studies will be conducted to identify key process variables. Contact time, UV dosage and lamp spacing, ozone or hydrogen peroxide dosage, and concurrent use of ozone or hydrogen peroxide and UV will be examined. These process variables are easily adjusted within any given treatment system by controlling flow rates, reactor

size, dosing, and detention time and may be scaled to virtually any size operation. Additionally, results are applicable not only to batch operations but also to continuous flow systems. Therefore, results from a lab scale, batch process will be useful for the configurations envisioned for the actual wastewater treatment operations.

2.8 RANKING OF TREATMENT TECHNOLOGIES

The detailed evaluation of technologies supplemented by the treatability study results will provide the information necessary to rank the technologies. The criteria to be used in the ranking will be:

- o Treatment Performance, including contaminant destruction efficiency and rate, process reliability, and permanence of treatment.
- o Implementation, including ease of mobilization, health and safety, compatability with overall site decommissioning, and operation and maintenance requirements.
- o Cost, including capital expenditures, lease costs, operation and maintenance costs, and associated labor and fees to estimate the present worth.

The pertinent criteria will be established and weighted, and a composite score will be generated in order to rank the final candidate technologies.

3.0 DECOMMISSIONING ASSESSMENT

3.1 PURPOSE

The decommissioning assessment will provide input for the Arsenal-wide Feasibility Study. Eight major items must be addressed, as listed below:

- o Develop a current waste and operable equipment inventory
- o Specify a decontamination procedure
- o Identify equipment and support facilities
- o Identify residuals disposal options
- o Develop quality assurance and quality control procedures
- o Develop health and safety plan requirements
- o Establish a project schedule
- o Develop a preliminary cost estimate

These items are discussed in more detail in the following sections.

3.2 WASTE INVENTORY

3.2.1 Facilities and Equipment

A facilities and equipment inventory will be developed based upon a review of existing HBSF drawings and an on-site inventory of useful existing equipment. During the development of this inventory, equipment, structures, and facilities will be classified according to waste types or forms, and the division of financial responsibility between the Air Force Logistic Command and the PMO will be further refined based upon the existing division of responsibilities as described in Appendix A. An example of such an inventory form is presented in Table 3-1. The review of the drawings will provide the basis for preliminary waste material estimates and will also provide information on wastewater tank capacities, as well as connections between the tankage and the above and below ground piping and equipment.

TABLE 3-1
EXAMPLE OF A WASTE CLASSIFICATION CHECKLIST

| Items | Condition | Responsibility |
|---|-----------|----------------|
| I. Buildings and Debris | | |
| A. Building 755 Change House | | |
| B. Building 759 Drum Cleaning | | |
| C. Building 760 Fork Lift Storage | | |
| D. Building 868 Storage Shed | | |
| II. Equipment | | |
| A. Mechanical and Civil | | |
| 1. Piping and Fittings | | |
| i. Process Equipment | | |
| ii. Fire Protection | | |
| iii. Other Utilities | | |
| a) Severable | | |
| b) Nonseverable | | |
| 2. Piping Supports | | |
| 3. Pumps | | |
| 4. Tanks and Platforms | | |
| i. Waste Water | | |
| ii. Equipment | | |
| 5. Propellant Blending and Scrubbing System | | |
| i. Waste Water | | |
| ii. Equipment | | |
| 6. Nitrogen Inerting System | | |
| i. Compressed Gases | | |
| ii. Equipment | | |
| 7. Heat Transfer System | | |
| i. Ethylene Glycol | | |
| ii. Equipment | | |
| 8. Unloading/Loading Station | | |

TABLE 3-1 (Continued)
EXAMPLE OF A WASTE CLASSIFICATION CHECKLIST

| Items | Condition | Responsibility |
|--|-----------|----------------|
| 9. Insulation i. Piping ii. Tanks iii. Buildings | | |
| 10. Foundations, Containment Areas, Vaults, Sumps and Roadways | | |
| 11. Railroad Track | | |
| 12. Fencing | | |
| 13. Miscellaneous Chemical Storage | | |
| 14. Decontamination Support Equipment and Facilities | | |
| B. Electrical | | |
| 1. Telephone i. Poles ii. Lines iii. Miscellaneous Equipment | | |
| 2. Electric Power i. Transformer a) PCB Items b) Non-PCB Items ii. Miscellaneous Equipment a) Mercury Vapor Lamps b) Fluorescent Light Ballast c) Oil Filled Capacitors, Electrical Switch Gear, Etc. iii. Poles iv. Lines | | |

3.2.2 Soil

Soil samples analyzed as part of the Task 11 soil investigation contain no detectable hydrazine, MMH, UDMH, or NDMA (Bradbeer, 1986).

Therefore, soil excavation will not be included as part of the facility decommissioning.

3.2.3 Wastewater

Wastewater removal, treatment, and disposal can be divided into three phases during the decommissioning of the HBSF. The first phase consists of handling wastewater that is presently in the hydrazine wastewater tanks and inground concrete tank. The second phase includes management of wastewater that may be generated from additional HBSF equipment cleansing and flushing. The third phase includes management of wastewater from the decontamination of workers, equipment and facilities used in the decommissioning of the HBSF. Current wastewater volumes can readily be defined from tank level readings and estimates of wastewater volumes in the process piping. Volumes of phase two and three wastewaters will be estimated based upon the decontamination methods specified in the decommissioning plan. Waste characteristics will be defined for the existing wastewaters by sample collection and analysis. For the phase two and three wastewaters, it will only be possible to estimate waste characteristics based upon an evaluation of flushing and decontamination procedures.

3.2.4 Additional Sampling

It is anticipated that the waste inventory may reveal the need for additional sampling at the HBSF. This sampling is expected to be required for the following items and reasons:

- o Unsampld transformers to determine whether or not PCB fluids are present;

- o Ethylene glycol in the heating system due to regulatory restrictions placed on the disposal of liquid hazardous waste in landfills; and
- o Asbestos in piping, tank, and building insulation to determine the need for personnel monitoring and handling and disposal requirements during demolition.

Although this sampling is not crucial to the development of a detailed decommissioning plan for the HBSF facility, it can help to define the extent of problems that may be associated with these materials.

3.3 DECOMMISSIONING PLAN DEVELOPMENT

3.3.1 Hazard Reduction Plan

The initial goal of the HBSF decommissioning effort is to reduce the hazards associated with the HBSF chemical contaminants. This plan is envisioned as a four step process of equipment cleaning, asbestos removal, other organic liquid removal, and wastewater treatment and disposal. These steps would comprise individual components of the overall cleanup. These steps are consistent with plans for reducing the personnel protective clothing from level B requirements to a level C or modified level D. Chemical hazards will be defined and evaluated so that decontamination plans can be developed to clear the site of hazardous materials prior to dismantling and demolition. RMA activities to date have cleared HBSF of known hydrazine fuel. The interior of fuel tanks and piping has been flushed with existing wastewater, and the horizontal tanks, loading arms, and connecting piping have been flushed again with a hypochlorite solution.

The disposal of hydrazine wastewater is an important step in the decommissioning process. This activity will establish the wastewater treatment and disposal needs for the overall decommissioning plan. The wastewater will be treated by processes identified during the wastewater treatment assessment. The recommended choices for wastewater treatment and disposal will be incorporated into the decommissioning plan.

3.3.2 Severable Facilities and Equipment (Above Ground)

This activity will establish the need for additional cleaning and flushing of equipment, tank and piping interiors. Work zones will be established for exclusion, contaminant reduction, and support activities. In addition to work zones, the site may be divided into sectors to facilitate the sequencing of the demolition work. Acceptable dismantling and demolition methods will be developed, but every effort will be made to give the demolition contractor maximum flexibility in approaching this project. In general terms, the demolition process will include pretreatment of contaminated residues; dismantling and removal of structures; demolition; debris collection; and waste treatment and/or disposal. Having developed acceptable dismantling and demolition methods, a sequence will be established for the demolition process for both hazardous material handling and, perhaps, a sector by sector decommissioning of equipment and structures. With the methods established for severable equipment decommissioning, the storage and transportation requirements will be determined for the decontaminated waste. All severable decontaminated equipment is assumed to be disposed of at a hazardous waste landfill.

3.3.3 Nonseverable Facilities (Surface and Below Ground)

This activity will evaluate decontamination methods for nonseverable facilities. The nonseverable facilities include roadways, railway, foundations, and below ground utilities. Methods of demolition and removal will be established again with an effort to permit maximum flexibility in the choice of demolition methods by the contractor. The sequence of removal will be coordinated with the removal of severable equipment. Storage and transportation requirements for the wastes will be determined and the wastes will be disposed of as if they were hazardous materials.

3.3.4 Site Restoration

Having decontaminated and demolished the HBSF, site restoration will begin. The first step in this activity is for the off-site piping, electrical and telephone lines and poles to be secured. The removal of fences and decontamination of decommissioning equipment is another step in site restoration. In addition to these steps, revegetation and grading/fill plan criteria will be developed for the site. Post cleanup care and monitoring efforts will also be established.

3.4 EQUIPMENT AND SUPPORT FACILITIES

This activity will identify equipment and support facilities needed to perform the HBSF decommissioning. It is anticipated that both heavy equipment, cranes, front end loaders, back hoes and steam cleaners will be used for the demolition and excavation work. Along with the equipment, there are personnel support requirements such as trailers, decontamination showers and staging areas, and air and water supplies.

3.5 RESIDUAL DISPOSAL

This task will investigate the acceptable methods for disposal of wastewater and solid waste. It is anticipated that the wastewater treatment assessment will describe the disposal needs for the chemical wastewater.

3.6 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Quality assurance/quality control procedures will be developed during this task. These procedures will involve sampling and analysis and construction supervision as well as allocation of costs to the Air Force Logistic Command and PMO-RMA. These procedures will be based upon existing RMA quality assurance and quality control procedures to ensure adherence to safe working practices and proper demolition and disposal of hazardous wastes.

3.7 HEALTH AND SAFETY PLAN REQUIREMENTS

A health and safety plan will be developed under the direction of a Certified Industrial Hygienist; however, RMA specific guidelines will be followed in relation to the particular hazards and site safety concerns of the HBSF. This activity will use the RMA Health and Safety Plan (HASP) to develop a sample HASP for contractor guidance. The HASP will cover personnel training, medical surveillance, personnel protective equipment, and site safety issues.

3.8 SCHEDULE

A schedule will be developed for the decommissioning activities, which will consist of hazard reduction (including wastewater treatment), dismantling and demolition of equipment, waste transportation and disposal, and site restoration. Details of the schedule will depend on the specific decommissioning operations developed.

3.9 PRELIMINARY COST ESTIMATE

A preliminary cost estimate for HBSF decommissioning will be developed based on demolition calculations, decontamination takeoffs from existing HBSF plans, and unit costs. This effort will assist in the development of plans for the HBSF decommissioning. As much as possible, the existing RMA drawings and aerial photographs will be used to accomplish the cost estimation work.

4.0 FINAL REPORT

The results of the wastewater treatment assessment, decommissioning plan development, and the treatability study(s), will be incorporated in discrete sections into the detailed HBSF Wastewater Treatment and Decommissioning Assessment Report. Each assumption, criteria, approach, information source, basis for decision, and conclusion will be clearly documented to allow questions and/or comments to be directed toward specific portions of the study rather than the study in general. This report will be reviewed by PM-RMA and other agencies as appropriate.

The HBSF Wastewater Treatment and Decommissioning Assessment Report will generally follow the outline of this technical plan. The wastewater treatment assessment and decommissioning plan sections will be expanded to accommodate the information generated during this effort.

5.0 FIELD SAMPLING PROGRAM AND CHEMICAL ANALYSIS PROGRAM

5.1 FIELD SAMPLING PROGRAM

The recent flushing of the HBSF tanks and piping with stored wastewaters followed by flushing with a sodium hypochlorite solution (James 1986) may result in a wastewater with different characteristics from those identified in previous studies (See Section 1.4). To ensure meaningful results from the wastewater treatment assessment, duplicate samples from each of the wastewater tanks will be obtained and analyzed after completion of the flushing and cleansing operation.

Should wastewater treatability studies be required, additional samples (large volume) will be collected and transported to the designated laboratory.

5.2 CHEMICAL ANALYSIS PROGRAM

Wastewater samples from the two wastewater storage tanks, and treatability study samples (if necessary) will be analyzed for the hydrazine-related parameters identified below. Additional parameters may be recommended following the results of the wastewater treatment screening process.

Hydrazine

1,1-Dimethylhydrazine (UDMH)

Methylhydrazine (MMH)

N-Nitrosodimethylamine (NDMA)

Table 5-1 identifies the analytical method, detection limit, high range concentration, sample holding time, level of certification, reference method and method principal for the parameters of interest.

TABLE 5-1
ANALYTICAL METHODS/LIQUID MATRIX FOR TASK 34

| Analysis/Matrix/Analytes | Detection Limit ^a | High Range Concentrations ^b | Hold Time | Level of Certification | Reference Methods | Principle of Method ^b |
|--|------------------------------|--|------------|------------------------|--------------------------------------|--|
| Hydrazines/Water Hydrazine | 5 µg/l | 100 µg/l | 7 days | Quantitative | Developed by UBTL for USATHAMA | A 25 ml of sample is pipetted into a 50 ml volumetric flask. Add 15 ml acetonitrile to the volumetric flask, shake and allow sit until bubbles disappear. Bring mixture to 50 ml volume with acetonitrile and assay by HPLC. |
| 1,1-Dimethylhydrazine | 5 µg/l | 100 µg/l | See (1) | | | |
| Methylhydrazine | 5 µg/l | 100 µg/l | | | certification | |
| Nitrosamines/Water N-Nitrosodimethylamine | 0.2 µg/l | 50 µg/l | 7 days (2) | Quantitative | EPA 607(2) | Approximately 1 liter of water is extracted 3x with 60 ml methylene chloride by shaking for 30 seconds in a separatory funnel. The combined extract is washed with HCl (1:1) to remove free amines, dried and concentrated. Concentrate is cleaned on a florisil column and assayed by GC/MPD on a chromosorb W-AW (80/100 mesh) 10 percent carbowax column. |

^aActual detection limits for certified methods are identified in Volume IV of the RMA Procedures Manual (Project Specific Analytical Methods Manual) for each laboratory. Detection limits for uncertified methods and methods to be certified are desired detection limits.

^b Reflects an estimate of the linear range of the method and is proposed to minimize dilutions.
To be developed during USATHAMA Phase II certification.

References:

- (1) ESC-AMP.2-UD-H₂O.1, July 22, 1982.
- (2) EPA SW-946, 2nd ed., "Test Methods for Evaluating Solid Waste".

Sample shipping and holding temperatures are indicated in the QA/QC plan (see Volume II of the RMA Procedures Manual). Analytical methods for worker exposure (e.g., volatile organics in air) will not be USATHAMA Certified. Data from these samples will be used as an initial assessment to identify the potential for worker exposure to organic vapors.

All liquid matrix methods will be USATHAMA Certified at the quantitative level. Referenced methods have been prepared in a specific USATHAMA format as per the instructions of the PMO by the program contractor laboratories.

Hydrazine, MMH, and UDMH by Colorimetric Analysis

The colorimetric technique for hydrazine analysis is based on the ASTM method D1385 for hydrazine in industrial waters. In this method, the color reagent paradimethylaminobenzaldehyde is added to 10 ml of liquid sample. The resulting colored complex is analyzed in a spectrophotometer utilizing 458 nm wavelength light. The USATHAMA certified detection limit is 2.5 ppb.

The MMH liquid analysis technique is derived from NIOSH method S-149 for MMH in air. Phosphomolybdic acid is added to 15 ml of an acidified water sample. Spectrophotometric readings are taken at 730 nm wavelength. The USATHAMA certified detection limit is 20 ppb.

The USAFSAM report TR-82-89, Field Sampling and Analysis of Hydrazine and UDMH Vapors in Air: The Firebrick Method, provides the basis for the analysis of UDMH in water. A 15 ml sample is acidified and buffered with citric acid phosphate buffer prior to addition of trisodium pentacyanoaminoferrate. The resulting solution is analyzed at 500 nm wavelength using spectrophotometry. The certified detection limit is 25 ppb.

Nitrosamines in Liquid Samples by Gas Chromatography (GC)

This gas chromatography (GC) method was developed from EPA method 607 (EPA 600/4-82-057) and will be USATHAMA certified at the quantitative level.

In the method one liter of the sample will be obtained with a minimum of handling and shaken for 30 seconds with 60 ml methylene chloride. The organic layer is allowed to separate from the water phase for ten minutes, then filtered through glass wool into a 250 ml Erlenmeyer flask. The extraction/filtration procedure is repeated for a second and third time. All three extracts are combined in an Erlenmeyer flask. These combined extracts are washed with 10 ml dilute HCl (1:1) to remove free amines, dried with anhydrous sodium sulfate and concentrated in a Kuderna-Danish (K-D) apparatus to a volume of 10 ml or less for storage.

Prior to analyses the extract is concentrated to 2 ml in a K-D apparatus. Concentrated extract is cleaned on a florisil column and assayed by gas chromatography on a chromosorb W-AW (80/100 mesh) coated with 10 percent carbowax column using a nitrogen phosphorous detector.

6.0 QUALITY ASSURANCE PROGRAM/DATA MANAGEMENT PROGRAM

6.1 PROJECT QA/QC PLAN

An integral part of the Technical Plan is the project specific Quality Assurance/Quality Control (QA/QC) Plan describing the application of PMO procedures to monitor and control field and analytical efforts, and monitor and control data acquisition and design efforts at RMA. For Task 34, personnel will adhere to and comply with the established QA/QC requirements. The plan is presented in the RMA Procedures Manual. The specific objectives of the Quality Assurance Program for RMA are to:

- o Ensure adherence to established PMO/USATHAMA QA Program guidelines and standards;
- o Ensure precision and accuracy for measurement data;
- o Ensure validity of procedures and systems used to achieve project goals;
- o Ensure that documentation is verified and complete;
- o Ensure that deficiencies affecting quality of data are quickly determined;
- o Perform corrective actions that are approved and properly documented;
- o Ensure that the data acquired will be sufficiently documented to be legally defensible;
- o Ensure that the precision and accuracy levels attained during the PMO/USATHAMA analytical certification program are maintained during the project.

The overall project QA/QC responsibility rests with the Project QA/QC Coordinator, who will be assisted by the Field and Laboratory QA/QC Coordinators. The Field QA/QC Coordinator will assure that all quality control procedures are implemented for sampling, field blanks, duplicate samples, chain-of-custody and documentation.

6.2 SPECIFIC PROJECT REQUIREMENTS

6.2.1 Field Sampling

The management of samples, up through the point of shipment from the field to the laboratory, will be under the supervision of the Field QA/QC Coordinators (FQA/QC). Samples must be collected in properly cleaned containers, properly labeled, preserved and transported according to the prescribed methods. Section 8.0 of the Project QA/QC Plan describes the procedures to monitor adherence to approved sampling protocol. If the FQA/QC determines that deviations from the sampling protocol have occurred, resulting in a compromise of the sample integrity, all samples taken prior to the inspection will be discarded and fresh samples will be taken. The FQA/QC is responsible for field chain-of-custody documentation and transfer and will supervise the strict adherence to chain-of-custody procedures.

6.2.2 Laboratory Quality Assurance Procedures

Section 10 of the Project QA/QC Plan describes the Laboratory Quality Assurance Procedures. The laboratories along with their internal quality assurance programs will adhere to the Project QA/QC Program.

The samples must be analyzed within the prescribed holding time by the approved analytical methods. Analytical methods are described in Section 5.0 of the Technical Plan.

6.2.3 Laboratory Analytical Controls

Daily quality control of the analytical systems ensures accurate and reproducible results. Careful calibration and the introduction of the control samples are prerequisites for obtaining accurate and reliable results. Procedures for instrument calibration and analytical controls are described in Section 12 of the Project QA/QC Plan.

6.2.4 Laboratory Data Management, Data Review and Validation and Reporting Procedures

Sections 13 to 16 of the Project QA/QC Plan detail the procedures for laboratory data review, validation and reporting procedures. The laboratories utilize a highly automated system for analytical data collection and reduction. The analytical supervisor along with the Laboratory QA/QC Coordinator review all analytical data after data reduction and prior to the transfer of the data report to Ebasco. The laboratory data reporting procedure is described in Section 15 of the Project QA/QC Plan which is based on the established PMO reporting procedures for analyses performed at quantitative and semi-quantitative levels. Target compounds will be reported by formatting analytical data onto USATHAMA standardized coding forms. The laboratories will adhere to these reporting procedures.

6.3 DATA MANAGEMENT PROGRAM

The data management aspects of this task will generally be limited to the wastewater analyses and other sampling which may be required, such as for PCB and asbestos. Data from laboratory analyses will undergo a sequence of collection, validation, and storage QA/QC checks. Any data transfer or reduction will be accompanied by validation of the transfer or computations and will include statistical analysis when appropriate. In addition, the representativeness, completeness, and comparability of sample data will be assessed.

7.0 HEALTH AND SAFETY PROGRAM

A draft of the project Health and Safety Plan (HASP), prepared according to the Ebasco Corporate Health and Safety Program, is included in the RMA Procedures Manual. The purpose of this section is to provide an overview of the safety program that Ebasco will employ to ensure the safety of its employees and that of subcontractors engaged in wastewater sample collection activities during Task 34. All personnel working at RMA are or will be familiar with this document and they are and/or will be indoctrinated in all aspects of the safety program, which complies with OSHA guidelines and criteria.

In particular, the following specifics of this document are especially important to Task 34 sample collection activities. These are:

- o Safety organization, administration and responsibilities;
- o Initial assessment and procedures for hazard assessment;
- o Safety training;
- o Safety operations procedures;
- o Monitoring procedures;
- o Safety considerations for sampling; and
- o Emergency procedures.

Overall responsibility for safety during the site investigation activities rests with the Project Health and Safety Officer. He is responsible for developing the site-specific HASP at RMA and through the on-site Health and Safety Coordinator assumes its implementation responsibility. Specifically, he and his staff are responsible for:

- o Characterizing the potential specific chemical and physical hazards to be encountered;
- o Developing all safety procedures and operation on-site;

- o Assuring that adequate and appropriate safety training and equipment are available for project personnel;
- o Arranging for medical examinations for specified project personnel;
- o Arranging for the availability of on-site emergency medical care and first aid, as necessary;
- o Determining and posting locations and routes to site work zones;
- o Notifying installation emergency officers (i.e., police and fire departments) of the nature of the team's operations and making emergency telephone numbers available to all team members; and
- o Indoctrinating all team members in safety procedures.

In implementing this safety program, the Project Health and Safety Officer will be assisted by a Field Health and Safety Coordinator, whose function is to oversee that the established health and safety procedures are properly followed. The details of the safety organization, administration and responsibilities are described in Section I of the HASP.

Based on the evaluation of past activities, incidents, accidents and investigations, the presence of chemicals and wastes may be found in the area surrounding the wastewater storage tanks, and definitely in the wastewater itself. The characteristics of these wastes are known to be toxic and hazardous to human health. The conclusion of the site hazard assessment based on historical evidence is that the overall site hazard assessment is extremely variable and is entirely location and operation dependent. Section V of the HASP describes the procedures to

be employed to determine the hazard of a specific building or a sampling location for the identification of the preliminary level of protection requirement.

Section VI of the HASP explains the training program that is planned for the RMA project. Basically, the training will focus on the general health and safety consideration and provide site specific safety instructions.

Section VII describes in detail the safety operations procedures. The important aspects of the safety operations procedures are:

- o Zone approach for field work;
- o Personal protection; and
- o Communications.

A three zone approach (Support Zone, Contamination Reduction Zone and Exclusion Zone), where possible, will be utilized for field work at RMA. The Support Zone will contain the Command Post with appropriate facilities such as communications, first aid, safety equipment, support personnel, hygiene facilities, etc. This zone will be manned at all times when field teams are operating downrange. Adjacent to the Support Zone will be the Contamination Reduction Zone (CRZ) which will contain the contamination reduction corridor for the decontamination of equipment and personnel (the actual decontamination procedures are discussed in Section X of the HASP). A hotline for operations within the HBSF will be established as the fence line of the HBSF. All areas beyond the CRZ will be considered the Exclusion Zone. For wastewater sampling the Exclusion Zone will be established as a 30 foot radius from the tanks. These support facilities are discussed and illustrated in Section III.

The level of protection to be worn by field personnel will be defined and controlled by the on-site Health and Safety Coordinator and will be specifically defined for each operation in the Facility Information

Sheet (FIS). The preliminary FIS will be developed based upon historical information and data. This will be upgraded and utilized for future operations based upon the results of the Health and Safety portion of the Soil Sampling programs. All operations targeted within the HBSF will be conducted in level "B" protective equipment. Level "B" protection requirement is based on several factors including: previous data for the area indicating the need for level "B"; an extremely low Threshold Limit Value (TLV) of 0.1 ppm for hydrazine (ACGIH 1985); and the absence of a non-SCBA type respirator for hydrazine. In the case of all but the geophysical survey operations, the level "B" protection will employ the use of dual purpose SCBA used mainly in the airline mode. This will include the technician assigned the responsibility of tending the breathing air cascade manifold system. Dual purpose SCBA will provide the necessary mobility to the field team in order to stage equipment down range and deploy the cascade manifold system. It should be noted that the breathing air tender will have his own breathing air cylinder separate from the cascade system due to equipment limitations. The geophysical survey within the confines of the HBSF will be conducted at level "B" using SCBA because of the necessary mobility associated with the task. If determined necessary, changing to Level C or A protection can be easily achieved in the field in a matter of hours. Basic level of protection (i.e., Levels A, B, C or D) for general operations are defined in Section VII.

Maintaining proper communications among team members (sample collection team and Health and Safety team members) during sample collection work is of utmost importance for the protection of team members. The methods of communication that will be employed are:

- o Walkie Talkies;
- o Air Horns;
- o Hand Signal; and
- o Voice Amplification System.

For external communication telephones and sirens will be utilized.

Section VIII of the HASP explains the health and safety monitoring procedures. A continuous monitoring of the working environment will be performed to ensure the adequacy of the level of personnel protection. Depending on the history of the sampling location, the presence of the following parameters will be monitored:

- o Army Agents;
- o Oxygen Level;
- o Explosive Conditions;
- o Organic Vapors Level;
- o Inorganic Gases Level; and
- o Dust Analyses.

The type of on-site monitoring instruments to be utilized includes but is not limited to the following and will be based on the potential for the instrument specific contaminants to be present:

- o M18A2 Chemical Agent Kit for Army Agents;
- o MB Alarm for nerve agents;
- o Oxygen meter for oxygen level;
- o Combustible gas indicator for explosive condition;
- o PID and FID meters for organic vapors; and
- o For inorganic gases, a gold film mercury monitor, a chlorine monitor, a carbon monoxide monitor and a hydrogen sulfide monitor.

Air monitoring will be conducted using both direct reading instrumentation (the HNu and OVA predominately) and portable sampling pumps with Tenax and acid washed fire brick sampling media. Samples collected with the portable sampling pumps will be submitted for lab analysis when: 1) direct reading instruments indicate the presence of airborne contaminants greater than the background level established outside of the HBSF; 2) operations involve fluids that employees may contact; 3) any employee experiences respirator leakage; and/or 4) any employee experiences symptoms of exposure.

Based on the monitoring results (real time and field or laboratory analyses of the health and safety samples) the on-site Health and Safety Coordinator can stop field investigation work or upgrade and or downgrade the level of personal protection.

Section IX of the HASP explains the safety considerations during actual sampling events. It describes the safety procedures to be followed for drilling operations, soil, surface water and liquid waste sampling, building sampling, and sampling in a confined space.

The wastewater survey to be conducted for the HBSF area will be similar to that which has been conducted for other RMA tasks, with the exception that these will be conducted under level "B" protection. Because of the need to change SCBA bottles, or use air lines, this operation will require significant logistical support. In addition, it should be noted that the advanced training requirements apply in this situation.

An investigation of useful equipment for the HBSF area will be performed. Precautions similar to those employed for sampling will be employed.

In addition to the wastewater sampling and treatability studies, additional sampling described in Section 3.2.4 may be considered to fast track the program. As in the case of wastewater sampling, all fluids and solids produced must be collected for subsequent disposal and the employees must be protected from making contact with those same fluids and solids. Monitoring of each tank will precede this operation and personnel sampling will be performed.

The mobile decon trailer will be stationed in the CRZ, outside and upwind of the HBSF during the course of all operations conducted within that area. While hydrazine and its products are not considered "Army Agents" the same decon solutions that have been used to neutralized

potential agent contamination will be used for the hydrazine group. The H&S Supervisor will assure that those decon solutions are placed at both the gross boot and glove wash stations of the decon line.

The emergency procedures are described in Section XII to XIV of the HASP. Section XII explains the basic emergency scenarios and activities to be undertaken during each of these emergency situations; Section XIII describes how to get emergency services (i.e. medical, fire protection, ambulance, etc.) and Section XIV outlines the evacuation procedures in case of emergency such as fire, explosion, and/or a significant release of toxic gases.

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APPENDIX A

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

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 the 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 the 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.
- (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 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 required, 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.
- c. The Program Manager the 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 decontamination 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 decommissioning 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.

APPENDIX A

HYDRAZINE BLENDING AND 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.
 - (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 stations (truck, railcar, drums).

- (8) All above ground electrical distribution systems 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 hydrazine/UDMH/NDMA contaminated waste water generated during dismantlement, decontamination and disposal of above severable equipment.
 - c. 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 concreted 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 supports to B-755.
- (11) Perimeter earthen security roads between fences around hydrazine main plant and east area.

APPENDIX B

RESPONSE TO COMMENTS

8963a

STATE OF COLORADO

COLORADO DEPARTMENT OF HEALTH

4210 East 11th Avenue
Denver, Colorado 80220
Phone (303) 320-8333

April 14, 1987



Roy Romer
Governor

Thomas M. Vernon, M.D.
Executive Director

Mr. Don Campbell
Office of the Program Manager
RMA Contamination Cleanup
Department of the Army
AMXRM-EE, Bldg 4585
Aberdeen Proving Grounds, MD 21010-5401

Re: Tasks 17 and 34

Dear Don:

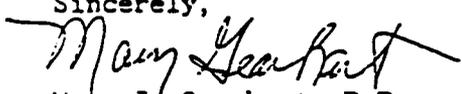
The State has determined that providing detailed comments on the Draft Technical Plan for Task 34, Hydrazine Blending and Storage Facility Wastewater Treatment and Decommissioning Assessment, and the Draft Report on the Selection of Incineration Technology for Basin F Wastes at Rocky Mountain Arsenal, Task 17, is inappropriate at this time. As you know, Basin F and the Hydrazine Blending and Storage Facility (HBSF) are Colorado Hazardous Waste Management Act/Resource Conservation and Recovery Act (CHWMA/RCRA) facilities as defined in 6 CCR 1007-3, Section 250. Therefore, Basin F and the HBSF must be closed in accordance with CHWMA/RCRA.

As you also know, the State is currently involved in a lawsuit with the Army regarding the Army's groundwater monitoring at Basin F. At issue in that suit is the scope of the State's CHWMA authority at RMA. The State reserves the right to comment on technical plans and reports relating to CHWMA facilities until the court rules on the scope of the States' CHWMA authority at RMA.

Despite the decision not to provide detailed comments on Tasks 17 and 34 at this time, we encourage the Army to mitigate the immediate threat to public health and the environment caused by the continued storage of hydrazine wastewater at the HBSF. Therefore, we support all efforts by the Army to treat and/or dispose of the hydrazine wastewater stored at the HBSF as soon as possible.

If you have any questions, please feel free to contact us.

Sincerely,


Mary J. Gearhart, P.E.
Section Chief, Permits
Hazardous Materials and Waste Management Division

MJG/CS/ddw

xc: Howard Kenison, Attorney General's Office
Robert Duprey, USEPA, Region VIII
Chris Hahn, Shell Oil Company
Edward McGrath, Esq.
Thomas Bick, U.S. Department of Justice

Response to Colorado Department
of Health Letter (Dated April 14, 1987)
on Task 34 Technical Plan

No response required at this time.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII

999 18th STREET—SUITE 500
DENVER, COLORADO 80202-2405

RECEIVED
JUN 9 1987

REF: 8HWM-SR

MAY 14 1987

ENVIROSPHERE COMPANY
SEATTLE

Colonel W. N. Quintrell
Deputy Program Manager
AMXRM-EE Department of the Army
U.S. Army Toxic and Hazardous Materials Agency
Building 4585
Aberdeen Proving Ground, MD 21010-5401

Re: Rocky Mountain Arsenal (RMA),
Comments on Task 34 Technical Plan
for Treatment of Hydrazine Blending
and Storage Facility (HBSF) Wastewater

Dear Colonel Quintrell:

We are pleased that the Army is investigating options for an interim response action to treat wastewater from the HBSF through Task 34. EPA places high priority on this response action as well as several other interim actions which can be undertaken at RMA before completion of the final RI/FS reports. Several issues must be resolved before a full evaluation of the treatment options can be made. Our concerns are presented in the enclosed comments on the subject technical plan.

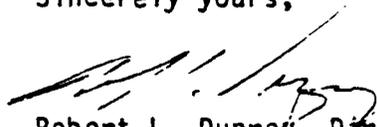
We note that the Task 34 Technical Plan for treatment of Hydrazine Blending and Storage Facility Wastewater is characterized as a CERCLA removal action. Since EPA currently is developing its policy on CERCLA and RCRA jurisdiction at Federal facilities, we do not take any position at this time on the appropriateness of characterizing this cleanup as a CERCLA removal action. Regardless of whether cleanup of the facility is under the jurisdiction of RCRA or CERCLA, the substantive requirements of RCRA must be addressed in the response action.

If the site is characterized as a CERCLA response action, the Army should carefully review the appropriateness of conducting the response action as a remedial action operable unit pursuant to 40 CFR section 300.68(c) of the National Contingency Plan ("NCP"), rather than as a removal action. Given the actual or potential exposure to hazardous substances by nearby populations, the nature and extent of contamination, and the anticipated response actions (as EPA now understands those factors), we initially believe that it may be more appropriate to characterize the response action as a remedial action rather than a removal action. See sections 101(23) and 101(24) of CERCLA (definitions of the terms removal and remedial); see also 40 CFR sections 300.65 and 300.68.

If conducted as a remedial action operable unit, the HBSF wastewater treatment effort should address the preference for treatment technologies and permanent solutions under section 121(b) of CERCLA, and the cleanup standards under section 121(d) of SARA, including, but not limited to, pertinent substantive requirements of RCRA. Also, development, screening, and analysis of alternatives should be conducted in a manner consistent with the NCP and SARA.

The Region looks forward to the scheduled discussions with all the MOA parties on the appropriate process for conducting interim response actions, including the above approaches or other alternatives. We understand that other Tasks will address remedies for contaminated soils, groundwater and equipment from the HBSF. If you have any questions regarding these comments, please contact Mr. Connally Mears at FTS 564-1528 or Mr. Robert Lawrence at FTS 564-1463.

Sincerely yours,



Robert L. Duprey, Director
Waste Management Division

enclosure

cc: Thomas P. Looby, CDH
Joan Sowinski, CDH
Chris Hahn, Shell Oil Company
R. D. Lundahl, Shell Oil Company
Thomas Bick, Department of Justice
Elliott Laws, Department of Justice

COMMENTS

A. Screening of Remedial Alternatives

1. General

EPA supports the general objectives of Task 34. We encourage the Army to implement this task as expeditiously and effectively as possible. If appropriate characterization of the site as a remedial action operable unit should not result in any significant delays in implementation so long as coordination with all parties is maintained throughout the process.

2. Consideration of Innovative Technologies

Innovative technologies should be considered among the remedial alternatives evaluated for this Task. Specifically, EPA recommends that the Pyroplasma System, developed by Westinghouse Electric and a technology associated with EPA's SITE (Superfund Innovative Technology Evaluation) program, be reviewed as an alternative for the treatment of the HBSF wastewater.

3. Consideration of Wet Air Oxidation

Wet Air Oxidation should be evaluated as a remedial alternative for treatment of the HBSF wastewater. Documentation for this evaluation should be provided for review.

4. Permanency of Remedy

The analysis and screening of remedial alternatives must take into consideration the permanency of the remediation. Remedies that provide the reduction of toxicity, mobility and volume of waste should be preferred over other alternatives.

5. Consideration of Publically Owned Treatment Works (POTW) as a Treatment Alternative

If discharge of the effluent to a POTW is to be considered as a viable option, the pretreatment criteria for NDMA should be specified.

6. Use of Air Scrubbers For Remediation

For all technologies that require the use of scrubbers for remediation, the treatment or disposal of the remanent waste from scrubber operations must be specified.

B. Action Levels

1. Action levels must be established in accordance with section 121(d) of CERCLA to assure protection of human health and the environment and to attain legally applicable or relevant and appropriate requirements. Practical constraints such as treatment technologies, analytical detection limits, and the uncertainty of analytical values are not relevant to the selection of action levels specifying a degree of cleanup under section 121(d)(ii)(A) of CERCLA. Moreover, action levels should not be set at levels which pose a "significant risk". Rather, the action level must assure adequate protection of public health, and be set at levels below those which pose a significant risk.

Acceptable ranges of risk in accordance with current EPA policy are from 10^{-4} to 10^{-7} . EPA's risk goal is 10^{-6} . Action levels should be set within the acceptable range of risk. If the action level is below detection limits, the action level should be the goal to be achieved by the remediation, recognizing that detection limits preclude measurement to the goal. If analytical instrumentation and techniques become more sophisticated, the action level goal will remain the same, and the detection limit may be lowered.

2. N-nitrosodimethylamine (NDMA) Action Level

Since the CAG 10^{-6} level for NDMA in water is 1.4 ppt, which is well below the detection limits, the action level for NDMA should be based on the detection limit of the most sensitive analytical technique for its quantification. Currently, the detection limit specified by EPA Method 607 for NDMA is 150 ppt. If the Army prefers another analytical technique, the equivalency of this technique to EPA Method 607 should be documented and demonstrated. If analytical instrumentation and techniques become more sophisticated and the detection limits are lowered, the action level should be revised.

3. Unsymmetrical Dimethylhydrazine (UDMH) and Monomethyl Hydrazine (MMH) Action Levels

EPA supports the specific determination of action levels for MMH and UDMH. The Army should consult with the other MOA parties over the determination and formulation of these action levels.

C. Analysis For Hydrazine in Phase I Soil Program

Full consideration should be given to including hydrazine in the analyte list for Phase I of the soil program of other Tasks. EPA recommends that the Army examine analytical methods used for the detection of hydrazine currently being implemented at the Martin Marietta Superfund site in EPA Region VIII.

RESPONSE TO U.S. ENVIRONMENTAL PROTECTION AGENCY COMMENTS
(DATED MAY 14, 1987) ON TASK 34 TECHNICAL PLAN

A. Screening of Remedial Alternatives

1. General

Comment:

EPA supports the general objectives of Task 34. We encourage the Army to implement this task as expeditiously and effectively as possible. If appropriate characterization of the site as a remedial action operable unit should not result in any significant delays in implementation so long as coordination with all parties is maintained throughout the process.

Response:

The MOA parties recognize the need to proceed with an expeditious and effective remedial action.

2. Consideration of Innovative Technologies

Comment:

Innovative technologies should be considered among the remedial alternatives evaluated for this Task. Specifically, EPA recommends that the Pyroplasma System, developed by Westinghouse Electric and a technology associated with EPA's SITE (Superfund Innovative Technology Evaluation) program, be reviewed as an alternative for the treatment of the HBSF wastewater.

Response:

The primary focus of the Task 34 Study was to rapidly implement treatment of Hydrazine contaminated waste water and demolition of above ground equipment. As such, Task 34 was limited to identifying and evaluating only those technologies with documented effectiveness for treating the Hydrazine and NDMA contaminated wastewater. In this manner, proven technologies were favored over those still being developed, such as the Westinghouse Electric Pyroplasma System. For the above reasons, it was dropped from further consideration.

3. Consideration of Wet Air Oxidation

Comment:

Wet air oxidation should be evaluated as a remedial alternative for treatment of the HBSF wastewater. Documentation for this evaluation should be provided for review.

Response:

Wet air oxidation was considered. However, published literature indicates that wet air oxidation is effective in treating wastewater with NDMA concentrations of 500-5,000 ppm down to effluent levels of 1-20 ppm. NDMA concentrations at RMA are 20-100 ppb and require treatment to 0.20 ppb. The use of wet air oxidation to treat these low levels was rejected because it was judged to be uneconomical under these conditions.

4. Permanency of Remedy

Comment:

The analysis and screening of remedial alternatives must take into consideration the permanency of the remediation. Remedies

that provide the reduction of toxicity, mobility and volume of waste should be preferred over other alternatives.

Response:

Permanence was used to screen the alternatives. In fact, the final candidate technologies all essentially provide permanent remedies since the hydrazines and NDMA would be destroyed to below detectable levels.

5. Consideration of Publicly Owned Treatment Works (POTW) as a Treatment Alternative

Comment:

If discharge of the effluent to a POTW is to be considered as a viable option, the pretreatment criteria for NDMA should be specified.

Response:

Discharge of untreated HBSF wastewater to a POTW did not meet the criteria established for the remediation, and thus was not considered a viable treatment alternative. Therefore, specifying pretreatment criteria was not necessary.

6. Use of Air Scrubbers for Remediation

Comment:

For all technologies that require the use of scrubbers for remediation, the treatment or disposal of the remanent waste from scrubber operations must be specified.

Response:

Technologies requiring the use of scrubbers also did not meet criteria for the remediation. These alternatives were not considered viable and were eliminated from further analysis.

B. Action Levels

1. General

Comment:

Action levels must be established in accordance with section 121(d) of CERCLA to assure protection of human health and the environment and to attain legally applicable or relevant and appropriate requirements. Practical constraints such as treatment technologies, analytical detection limits, and the uncertainty of analytical values are not relevant to the selection of action levels specifying a degree of cleanup under section 121(d)(ii)(A) of CERCLA. Moreover, action levels should not be set at levels which pose a "significant risk." Rather, the action level must assure adequate protection of public health, and be set at levels below those which pose a significant risk.

Acceptable ranges of risk in accordance with current EPA policy are from 10^{-4} to 10^{-7} . EPA's risk goal is 10^{-6} . Action levels should be set within the acceptable range of risk. If the action level is below detection limits, the action level should be the goal to be achieved by the remediation, recognizing that detection limits preclude measurement to the goal. If analytical instrumentation and techniques become more sophisticated, the action level goal will remain the same, and the detection limit may be lowered.

Response:

In accordance with CERCLA, the wastewater treatment/disposal system will be chosen to assure adequate protection of public health. If a chemical oxidation system is recommended, it will be based on treatability studies which demonstrate the effective destruction of the compounds of concern. The verification of compound destruction, a critical point with any treatment system, can only be accomplished at concentrations where the precision and accuracy of the analytical method is known within appropriate limits; a concentration above the detection limit. As the detection limit is approached the precision and accuracy of the analytical method become more uncertain and, therefore, the results are more questionable. It should be noted that if chemical treatment is recommended, the treated effluent will be discharged to either a surface drainage system near the facility or to the existing RMA treatment plant. Both disposal options should result in further degradation and dilution. In light of these potential discharge modes and the increased uncertainty of the analytical results at low concentrations, it is felt that treatment to "below detectable levels" should be achieved.

2. N-nitrosodimethylamine (NDMA) Action Level

Comment:

Since the CAG 10^{-6} level for NDMA in water is 1.4 ppt, which is well below the detection limits, the action level for NDMA should be based on the detection limit of the most sensitive analytical technique for its quantification. Currently, the detection limit specified by the EPA Method 607 for NDMA is 150 ppt. If the Army prefers another analytical technique, the equivalency of this technique to EPA Method 607 should be

documented and demonstrated. If analytical instrumentation and techniques become more sophisticated and the detection limits are lowered, the action level should be revised.

Response:

The method used to determine NDMA is EPA Method 607 and has been certified at a detection level of 200 ppt (2×10^{-10} g/l). No analytical technique can maximize accuracy of results while achieving the lowest possible detection limits. USTHAMA certification procedures emphasize accuracy over achieving "state-of-the-art" detection limits. Program "detection limits" are not actually instrument detection limits, but are USATHAMA Certified Reporting Limits (CRLs). CRLs are calculated following laboratory analysis of certification performance samples which have been spiked with known concentrations of target contaminants. A least squares linear regression is then performed on the paired data (x,y), where x is the target concentration in the certification performance sample and y is the reported concentration for that sample. This includes calculation of the equations for the upper and lower 90 percent confidence limit curves for the reported concentrations. To find the CRL, y_u , the upper confidence limit level for y corresponding to $x=0$, is calculated x_{CRL} , the value of x corresponding to a lower confidence limit level equal to y_u , is calculated. x_{CRL} is the CRL unless it is greater than all concentrations in the certification performance samples, in which case the lowest target concentration is the CRL. In general, the CRL will be higher than the instrument detection limit.

It is also considered more prudent to document destruction efficiency at a level above detection than to experience increased costs and analytical uncertainty at concentrations equal to or below the detection limit. PM-RMA does, however,

agree with EPA that the destruction of NDMA should be as complete as possible. In light of this, PM-RMA agrees to reduce the treatment level from 500 ppt to 200 ppt. It is felt that at this concentration NDMA destruction can still be effectively demonstrated despite the numerous chemical analyses that will be performed during treatment. The text of the Task 34 Technical Plan will be revised to reflect this level.

3. UDMH and MMH Action Levels

Comment:

EPA supports the specific determination of action levels for MMH and UDMH. The Army should consult with the other MOA parties over the determination and formulation of these action levels.

Response:

Based upon treatability studies performed on HBSF wastewater samples (described in the HBSF Technical Plan with results to be presented in the HBSF Wastewater Treatment and Decommissioning Assessment), NDMA is the most difficult compound to destroy and determines the time of treatment. Destruction of NDMA to below its action level effectively ensures that the hydrazine compounds will be destroyed to below their detection limits. It is therefore felt that the treatment levels proposed are appropriate to assure adequate protection of public health.

C. Analysis for Hydrazine in Phase I Soil Program

Comment:

Full consideration should be given to including hydrazine in the analyte list for Phase I of the soil program of other Tasks.

EPA recommends that the Army examine analytical methods used for the detection of hydrazine currently being implemented at the Martin Marietta Superfund site in EPA Region VIII.

Response:

The Phase I Soil and Groundwater Program for the HBSF is being conducted under Task 11 at RMA and is not within the scope of Task 34. Analyses of hydrazine, MMH, UDMH, and NDMA is included within the scope of Task 11. A preliminary draft of the Task 11 Phase I Report was issued in April 1987 and is undergoing review and revision.

Shell Oil Company



c/o Holme Roberts & Owen
Suite 1800
1700 Broadway
Denver, CO 80290

February 20, 1987

FEDERAL EXPRESS

Mr. Don Campbell
Department of the Army
Program Managers Office for Rocky Mountain Arsenal
Building E4585
Dbl. Trailer
Aberdeen Proving Grounds, Maryland 21010-5401

Re: United States v. Shell Oil

Dear Mr. Campbell:

Enclosed herewith are Shell's comments on Task 34, Hydrazine Blending and Storage Facilities Wastewater Treatment and Decommissioning Assessment, January 1987.

We are unable to determine a technical, scientific or legal basis for treating the matter as an emergent situation requiring a removal action. Creating an aura of emergency where none appears to exist, can result in an inadequate technical and scientific fact finding analysis and comparison of alternatives.

In addition, Shell is concerned the Army has already made critical decisions concerning an expedited action plan. For example, the selection of offsite incineration as the baseline technology in the reported interest of timing. Also, it appears that non-hazardous wastes will be disposed of as if they were a hazardous waste. Shell concerns are that uneconomic decisions are being made without realizing the potential impact on other remedial action plans at the RMA. Shell recommends that these decisions be reconsidered. Such potential precedent setting decisions will be for the Army's account.

Very truly yours,

A handwritten signature in black ink, appearing to read "C.K. Hahn".

C. K. Hahn
Manager, Denver Site Project

CKH/jy/13505

Enc.

cc: (w/enclosure)
USATHAMA
Office of the Program Manager
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-EE: Mr. Kevin T. Blose
Bldg. E4585, Trailer
Aberdeen Proving Ground, MD 21010-5401

Mr. Thomas Bick
Environmental Enforcement Section
Land & Natural Resources Division
U.S. Department of Justice
P.O. Box 23896
Benjamin Franklin Station
Washington, DC 20026

Major Robert J. Boonstoppel
Headquarters - Department of the Army
ATTN: DAJA-LTS
Washington, DC 20310-2210

Ms. Patricia Bohm
Office of Attorney General
CERCLA Litigation Section
1560 Broadway, Suite 250
Denver, CO 80202

Mr. Chris Sutton
Colorado Department of Health
4210 East 11th Avenue
Denver, CO 80220

Mr. Robert L. Duprey
Director, Air & Waste Management Division
U.S. Environmental Protection Agency, Region VIII
One Denver Place
999 18th Street, Suite 1300
Denver, CO 80202-2413

Mr. Connally Mears
U.S. Environmental Protection Agency, Region VIII
One Denver Place
999 18th Street, Suite 1300
Denver, CO 80202-2413

bc: (w/enclosure)

Shell

W. E. Adcock

A. D. Bowers

C. L. Oubre

E. W. Swift

D. M. Walton

HRO

A. E. Benton

E. J. McGrath

MKE

C. S. Allred

A. L. Notary

G. A. Rasmussen

ATTACHMENT I
COMMENTS ON TASK 34 - HYDRAZINE FACILITIES

1. Page 1-1, paragraph 1.1 - Why and how was off site incineration selected as the baseline technology?
2. Page 1.2, Table 1-1 - Was wet air oxidation overlooked, or rejected?
3. Figure 1-4 - No drain lines are shown from the drum storage pad to the in ground concrete storage tank. Are there any facilities to catch spills, or drum wash water?
4. Page 1-12, Table 1-2 - Why are the above ground pipes listed and not the below ground pipes?
5. Page 1-13, first paragraph - Was the 44,000 gallon in ground storage tank part of the original facility installation, or added at a later date?
6. Page 1-13, third paragraph - The text mentions the disposal of sludges from the in ground concrete tank being disposed of in pits in Sections 30 and 36. Was the material placed in containers? Where are these pits located?
7. Page 1-14, paragraph 1.3.3, first paragraph - Did RMA personnel sample and analyze the water prior to spreading it on the adjacent fields?
8. Page 1-14, second paragraph - Assuming a 30 foot tank diameter, 4 inches is equivalent to a 1760 gallon loss of UDMH. Was this pure UDMH or diluted? After neutralization, was the procedure to analyze the sump contents prior to discharging to Basin F, or only check pH? Recognizing the potential health problems associated with UDMH and NDMA, why was no sampling conducted for these parameters in the groundwater north and west of Basin F?
9. Page 1-23, paragraph 1.3.6 - The results of the completed RMA soils and groundwater studies have not been transmitted to the MOA parties.
10. Page 1-25, paragraph 1.4.3 - The discussion of PCB samples can not be found in the text as described except as the bottom sentence on page 3-4. Was this portion deleted?
11. Page 1-27 - Analyses of samples notes the following detection limits:

| | |
|-----------|---------|
| Hydrazine | 50 ppm |
| NDMA | 0.1 ppm |
| UDMH | 50 ppm |
| MMH | 50 ppm |

Is this level of detection consistent with the potential

ATTACHMENT I
COMMENTS ON TASK 34 - HYDRAZINE FACILITIES

health hazards posed by these compounds?

In the NPDES permit application for the RMA, the suggested water level for NDMA at a ten to the minus 5 exponent risk level is 14 ug/l, not 0.1 mg/l. Why the difference? The 1981 NPDES permit renewal application (Permit #CO-0021202) provides an analyses of wastewater treatment for hydrazine wastewater. This should be reviewed for consistency with Task 34.

Natural resource damage by hydrazine has been found by the Air Force to result in a 75 percent inhibition of nitrite oxidation at 48 ug/l. Why was an analytical level of 50 ug/l established?

MMH in static bioassay test demonstrates a LD50 for fish from 2.58 to 6.69 mg/l. Why was an analytical detection level established at 50 mg/l?

12. Page 1-29, last sentence - Why is treatment or destruction of wastes necessary in conjunction with deep well disposal?
13. Page 1-30, first paragraph - What were the results of the soil and groundwater chemical analyses developed in this program? If analytical methods for hydrazine and related compounds are available in soil, why weren't these compounds included in the analyte list for Phase I of the soil programs?
14. Page 1-30, paragraph 1.4.5 - Has a risk assessment been completed to justify not quantifying concentrations of organic compounds in the in ground concrete tank wastewater samples below 20 ug/l?
15. Page 1-30, last sentence - Have these compounds been analyzed for in the environment (soil/groundwater) in the vicinity of the hydrazine blending facility?
16. Page 1-31, Table 1-7 - What would be the likely source of the 2, 4-D?
17. Page 1-34, second paragraph - If an action level is established for a particular compound which is less than the certified analytical detection level, then it is inappropriate to arbitrarily increase the action level by a factor of 2.5 as is being suggested for NDMA. The analytical method for NDMA in water is certified for use at RMA at a detection limit of 200 ppt. Levels as low as 16-20 ppt are reported on pages 2-6 and 2-9. Why isn't this method being used at RMA?
18. Page 1-34, last paragraph - There is no logic presented for the MDLs proposed for hydrazine, MMH and UDMH. In

ATTACHMENT I
COMMENTS ON TASK 34 - HYDRAZINE FACILITIES

- addition, why are action levels needed for the remaining compounds if the NDMA is truly the hardest to destroy? Wouldn't it be appropriate to set action levels for the indicator compounds and thereby reduce the analytical effort involved? Alternately, action levels could be set for those critical compounds once the technology were selected, rather than set them now.
19. Page 2-1, paragraph 2.2, second sentence - There are no quantities of wastewater given in either Table 1-7 or 1-8.
 20. Page 2-12, paragraph 2.3.10 - An evaporation pond as a primary treatment system has potentially the same drawback as air stripping. Paragraph 2.3.11, next to last sentence, "the contaminants could be transferred from one median (water) to a second (air)." If the half-life of NDMA is 30 minutes in sunlight and NDMA is the major compound of concern (Ref. 1st paragraph, page 1-34), then accepting evaporation pond and rejecting air stripping as viable alternatives seems basically inconsistent.
 21. Page 2-14, paragraph 2.3.14 - It is suggested that wet air oxidation be considered as one of the potential processes. We believe that small scale pilot units are available for rent which might prove effective.
 22. Page 2-17, last paragraph - In this and other descriptions which follow it states that the MOA parties must approve if a discharge is made to the sanitary sewage facility or a waterway. This is not true of all the MOA parties.
 23. Page 2-18, first paragraph, third sentence - It is recognized a scrubber will be necessary to reduce the potential of emitting components such as NDMA to the air. If a scrubber is used it will possibly result in contamination of more water with the various contaminants. Scrubber water is the source of the problem which is being addressed in Task 34, in the first place.
 24. Page 2-24, paragraph 2.5 - The inclusion of rapid implementation as a major criteria in the selection process can lead to uneconomic decisions, particularly as relates to the off site incineration. In addition, the selection of off site incineration as the base line process for comparison of the alternatives, may result in establishing precedents for off site removal of other wastes which could easily be treated and disposed of on site. The material is supposedly stored safely in the tanks and not an threat to the public safety or environment. Therefore there is no justification for

ATTACHMENT I
COMMENTS ON TASK 34 - HYDRAZINE FACILITIES

rapid implementation being a driving force in the selection of the preferred strategy.

25. Page 3-6, paragraph 3.3.3 - Removal of the rail facilities prior to the selection of the overall RMA remedial plan may not be economic in the long term.
26. Page 3-6, last sentence - The disposal of wastes as if they were hazardous materials may possibly assist in establishing uneconomic practices inconsistent with CERCLA and the NCP in other areas of the RMA. It is recommended that only hazardous wastes be handled and disposed of as a hazardous waste. If it is deemed necessary to dispose of non-hazardous wastes as a hazardous waste, the foundation of the decision needs to be documented.
27. Page 5-4 - As noted in Section 1.5 - Action Levels, NDMA is the most toxic of all the hydrazine related compounds and is the one of the most concern. The GC method using a nitrogen phosphorous detector (NPD) is not specific to identify NDMA. The analysis is subject to both false negative and positive results. Decisions based on this method for discarding treated wastewater could defeat one of the major objectives of the program, i.e., endangerment of the environment and human health. The same comment is also applicable to UDMH and MMH. Both are listed as suspected carcinogens, and the color spectrophotometric analytical procedures are not specific methods for identification of these compounds.

RESPONSES TO SHELL COMMENTS (DATED 2/20/87)
ON TASK 34 TECHNICAL PLAN

1. COMMENT:

Page 1-1, paragraph 1.1--Why and how was offsite incineration selected as the baseline technology?

RESPONSE:

Incineration was selected as the baseline treatment technology because it assures complete destruction of the wastewater's contaminants, can be readily implemented, and is commercially available. Such selection does not indicate it will be the recommended treatment method, merely a benchmark with which to compare other methods.

2. COMMENT:

Page 1.2, Table 1-1--Was wet air oxidation overlooked, or rejected?

RESPONSE:

Wet air oxidation was considered. However, published literature indicates that wet air oxidation is effective at treating wastewater with NDMA concentrations of 500-5,000 ppm down to effluent levels of 1-20 ppm. NDMA concentrations at RMA are 20-100 ppb and require treatment to 0.20 ppb. The use of wet air oxidation to treat to these levels was rejected because it was judged to be uneconomical at these conditions.

3. COMMENT:

Figure 1-4--No drain lines are shown from the drum storage pad to the inground concrete storage tank. Are there any facilities to catch spills, or drum wash water?

RESPONSE:

Yes, there are drains from the pad which discharge to the inground concrete tank. Appropriate figures will be included in the Task 34 report.

4. COMMENT:

Page 1-12, Table 1-2--Why are the aboveground pipes listed and not the belowground pipes?

RESPONSE:

This information was not available at the time of Technical Plan writing; it will be included in the Task 34 report.

5. COMMENT:

Page 1-13, first paragraph--Was the 44,000-gallon inground storage tank part of the original facility installation, or added at a later date?

RESPONSE:

Pages 1-13 and 1-14 were included to provide a brief history and some general background. Ebasco does not have information available regarding the detailed history of these events and cannot answer these questions. Developing such a detailed history was not in the scope of Task 34.

6. COMMENT:

Page 1-13, third paragraph--The text mentions the disposal of sludges from the inground concrete tank being disposed of in pits in Sections 30 and 36. Was the material placed in containers? Where are these pits located?

RESPONSE:

See Response to Comment 5.

7. COMMENT:

Page 1-14, paragraph 1.3.3, first sentence--Did RMA personnel sample and analyze the water prior to spreading it on the adjacent fields?

RESPONSE:

See Response to Comment 5.

8. COMMENT:

Page 1-14, second paragraph--Assuming a 30-foot tank diameter, four inches is equivalent to a 1,760-gallon loss of UDMH. Was this pure UDMH or diluted? After neutralization, was the procedure to analyze the sump contents prior to discharging to Basin F, or only check pH? Recognizing the potential health problems associated with UDMH and NDMA, why was no sampling conducted for these parameters in the groundwater north and west of Basin F?

RESPONSE:

See Response to Comment 5.

9. COMMENT:

Page 1-23, paragraph 1.3.6--The results of the completed RMA soils and groundwater studies have not been transmitted to the MOA parties.

RESPONSE:

This study, Task 11, has not yet been completed. It will be transmitted to all MOA parties when available. A preliminary draft of the Phase I Report was issued in April 1987 and is undergoing review and revision. Note wording will be changed in the Final Technical Plan.

10. COMMENT:

Page 1-25, paragraph 1.4.3--The discussion of PCB samples can not be found in the text as described except as the bottom sentence on page 3-4. Was this portion deleted?

RESPONSE:

The PCB discussion was inadvertently omitted and will be included in the Final Technical Plan.

11. COMMENT:

Page 1-27--Analyses of samples notes the following detection limits:

| | |
|-----------|---------|
| Hydrazine | 50 ppm |
| NDMA | 0.1 ppm |
| UDMH | 50 ppm |
| MMH | 50 ppm |

Is this level of detection consistent with the potential health hazards posed by these compounds?

In the NPDES permit application for the RMA, the suggested water level for NDMA at a ten to the minus five exponent risk level is 14 ug/l, not 0.1 mg/l. Why the difference? The 1981 NPDES permit renewal application (Permit No. CO-0021202) provides an analysis of wastewater treatment for hydrazine wastewater. This should be reviewed for consistency with Task 34.

Natural resource damage by hydrazine has been found by the Air Force to result in a 75 percent inhibition of nitrite oxidation at 48 ug/l. Why was an analytical level of 50 ug/l established?

RESPONSE:

This comment asks several questions about why two previous independent studies that were provided for background information used different NDMA detection limits. These questions are entirely outside the scope of Task 34. However, to somewhat clarify your concern, note that the two detection limits in question are for soil (0.1 mg/l) and for water (0.014 mg/l), and are, therefore, not comparable.

12. COMMENT:

Page 1-29, last sentence--Why is treatment or destruction of wastes necessary in conjunction with deep well disposal?

RESPONSE:

Section 1.4.3 simply summarizes the U.S. Air Force study.

13. COMMENT:

Page 1-30, first paragraph--What were the results of the soil and groundwater chemical analyses developed in this program? If analytical methods for hydrazine related compounds are available in soil, why weren't these compounds included in the analyte list for Phase I of the soil programs?

RESPONSE:

This study, Task 11, has not yet been completed. It will be transmitted to all MOA parties when available. A preliminary draft of the Phase I Report was issued in April 1987 and is undergoing review and revision. Note wording will be changed in the Final Technical Plan.

14. COMMENT:

Page 1-30, paragraph 1.4.5--Has a risk assessment been completed to justify not quantifying concentrations of organic compounds in the inground concrete tank wastewater samples below 20 ug/l?

RESPONSE:

Section 1.4.5 reports on previous work done by the Analytical Systems Branch Laboratory. Historical data is presented for information purposes only.

15. COMMENT:

Page 1-30, last sentence--Have these compounds been analyzed for in the environment (soil/groundwater) in the vicinity of the hydrazine blending facility?

RESPONSE:

Analyses of these compounds are not in the scope of Task 34.

16. COMMENT:

Page 1-31, Table 1-7--What would be the likely source of the 2,4-D?

RESPONSE:

Identification of the source is not within the scope of Task 34.

17. COMMENT:

Page 1-34, second paragraph--If an action level is established for a particular compound which is less than the certified analytical detection level, then it is inappropriate to arbitrarily increase the action level by a factor of 2.5 as is being suggested for NDMA. The analytical method for NDMA in water is certified for use at RMA at a detection limit of 200 ppt. Levels as low as 16-20 ppt are reported on pages 2-6 and 2-9. Why isn't this method being used at RMA?

RESPONSE:

The rationale for determining the action level is presented on page 1-34. Often, equipment limitations constrain the selection of an action level; therefore, the use of a lower level may be of no practical significance because both precision and accuracy are reduced as the detection limit is lowered. The method used to achieve the 16-20 ppt detection is the same as is currently certified for use at RMA. The low number reported on pages 2-6 and 2-9 were achieved in a

research mode and have unknown precision and accuracy. Routine environmental samples analyzed by this method will have a much higher detection limit.

PM-RMA does, however, agree that the destruction of NDMA be as complete as possible. In light of this, PM-RMA agrees to reduce the treatment level from 500 ppt to 200 ppt. It is felt that at this concentration NDMA destruction can still be effectively demonstrated despite the numerous chemical analyses that will be performed during treatment. The text of the Technical Plan will be revised to reflect this level. (See also Responses to EPA Comments B1, B2, and B3).

18. COMMENT:

Page 1-34, last paragraph--There is no logic presented for the MDLs proposed for hydrazine, MMH, and UDMH. In addition, why are action levels needed for the remaining compounds if the NDMA is truly the hardest to destroy? Wouldn't it be appropriate to set action levels for the indicator compounds and thereby reduce the analytical effort involved? Alternately, action levels could be set for those critical compounds once the technology were selected, rather than set them now.

RESPONSE:

The action levels for hydrazine, MMH and UDMH were selected based on their analytical detection limits (i.e., MDL) using USATHAMA certified methods. Action levels are necessary for the hydrazine compounds in cases where they may be present and NDMA absent. Action levels, which represent treatment goals, are used to determine the appropriate treatment technologies, not the reverse.

19. COMMENT:

Page 2-1, paragraph 2.2, second sentence--There are no quantities of wastewater given in either Tables 1-7 or 1-8.

RESPONSE:

Comment noted. The Task 34 report will include the wastewater quantities.

20. COMMENT:

Page 2-12, paragraph 2.3.10--An evaporation pond as a primary treatment system has potentially the same drawback as air stripping. Paragraph 2.3.11, next to last sentence, "the contaminants could be transferred from one medium (water) to second (air)." If the half-life of NDMA is 30 minutes in sunlight and NDMA is the major compound of concern (Ref. first paragraph, page 1-34), then accepting evaporation pond and rejecting air stripping as viable alternatives seems basically inconsistent.

RESPONSE:

Air stripping would not be effective in removing the relatively nonvolatile NDMA from the wastewater and was therefore rejected. An evaporation pond would expose NDMA to ultraviolet light, which would destroy the compound. Please note the last sentence of Section 2.3.11.

21. COMMENT:

Page 2-14, paragraph 2.3.14--It is suggested that wet air oxidation be considered as one of the potential processes. We believe that small-scale pilot units are available for rent which might prove effective.

RESPONSE:

See response to Question 2.

22. COMMENT:

Page 2-17, last paragraph--In this and other descriptions which follow, it states that the MOA parties must approve if a discharge is made to the sanitary sewage facility or a waterway. This is not true of all the MOA parties.

RESPONSE:

Comment noted and text will be changed.

23. COMMENT:

Page 2-18, first paragraph, third sentence--It is recognized that a scrubber will be necessary to reduce the potential of emitting components such as NDMA to the air. If a scrubber is used, it will possibly result in contamination of more water with the various contaminants. Scrubber water is the source of the problem which is being addressed in Task 34 in the first place.

RESPONSE:

The potential problem is recognized and will be investigated.

24. COMMENT:

Page 2-24, paragraph 2.5--The inclusion of rapid implementation as a major criterion in the selection process can lead to uneconomic decisions, particularly as relates to the offsite incineration. In addition, the selection of offsite

incineration as the baseline process for comparison of the alternatives may result in establishing precedent for offsite removal of other wastes which could easily be treated and disposed of on-site. The material is supposedly stored safely in the tanks and not a threat to the public safety or environment. Therefore, there is no justification for rapid implementation being a driving force in the selection of the preferred strategy.

RESPONSE:

Rapid implementation is not the driving factor for selection of the preferred treatment technology. Nonetheless, it is an important consideration inasmuch as the wastewater must be treated early in the decommissioning process in order that equipment may be dismantled. Please see the response to Question 1 regarding incineration.

25. COMMENT:

Page 3-6, paragraph 3.3.3--Removal of the rail facilities prior to the selection of the overall RMA remedial plan may not be economical in the long term.

RESPONSE:

This will be addressed in the Task 34 report.

26. COMMENT:

Page 3-6, last sentence--The disposal of wastes as if they were hazardous materials may possibly assist in establishing uneconomic practices inconsistent with CERCLA and the NCP in

other areas of the RMA. It is recommended that only hazardous wastes be handled and disposed of as a hazardous waste. If it is deemed necessary to dispose of nonhazardous wastes as a hazardous waste, the foundation of the decision needs to be documented.

RESPONSE:

Pursuant to the MOU between the PM-RMA and the Air Force Logistics Command (Attachment A), both parties agreed that all materials should be handled as if they were a hazardous waste.

27. COMMENT:

Page 5-4--As noted in Section 1.5 (Action Levels), NDMA is the most toxic of all the hydrazine-related compounds and is the one of the most concern. The GC method using a nitrogen phosphorus detector (NPD) is not specific to identify NDMA. The analysis is subject to both false negative and false positive results. Decision based on this method for discarding treated wastewater could defeat one of the major objectives of the program, i.e., endangerment of the environment and human health. The same comment is also applicable to UDMH and MMH. Both are listed as suspected carcinogens, and the color spectrophotometric analytical procedures are not specific methods for identification of these compounds.

RESPONSE:

Analyses will be performed by laboratories that employ USATHAMA certified procedures.