GJPO–MWTP–19

Grand Junction Projects Office
Mixed-Waste Treatment Program

VAC*TRAX Mobile Treatment Unit Process Hazards Analysis

April 1996

U.S. Department of Energy
Grand Junction Projects Office

MASTER

Work Performed Under DOE Contract No. DE–AC04–94AL96907 for the U.S. Department of Energy

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

GJPO–MWTP–19
Copy No. 21

Grand Junction Projects Office
Mixed-Waste Treatment Program

VAC*TRAX Mobile Treatment Unit Process Hazards Analysis

April 1996

Prepared for
U.S. Department of Energy
Albuquerque Operations Office
Grand Junction Projects Office

Prepared by
Rust Geotech
Grand Junction, Colorado

Engineering Project Number ENG–430–0002–06–000
Engineering Document Number E0350600

Work Performed Under DOE Contract No. DE–AC04–94AL96907

This page intentionally blank

Signature Page

Prepared by ___________________________________ 4/3/96
Robert R. Bloom Date
Project Manager

Reviewed by ___________________________________ 4/3/96
Robert L. Morris Date
Health Physicist

Approved for release by ___________________________________ 4/3/96
Keith R. Rademacher Date
Quality Assurance Manager

This page intentionally blank

Contents

Appendices

Tables

Tables (continued)

Figures

This page intentionally blank

Executive Summary

In response to the need for increased mixed-waste treatment capability, the Department of Energy (DOE) Albuquerque Operations Office (AL) organized a Treatment Selection Team to match mixed wastes with treatment options and develop a strategy for treatment of its mixed waste. The strategy developed by the Treatment Selection Team was to use available off-site commercial treatment facilities and develop mobile treatment capability to treat wastes at the DOE–AL sites where wastes are generated. One of the technologies assigned to the DOE Grand Junction Projects Office (GJPO) for development was thermal desorption (TD).

Rust Geotech, contractor to DOE–GJPO, conducted pilot-scale TD treatability testing with the Rust-patented VAC*TRAX process. Information gained from the treatability testing was used to design a full-scale VAC*TRAX mobile treatment unit (MTU). The VAC*TRAX MTU uses an indirectly heated, batch vacuum dryer to thermally desorb organic compounds.

A Process Hazards Analysis (PHA) is required for each MTU being developed. The objective of the PHA and this report is to demonstrate that a thorough assessment of the risks associated with the operation of the VAC*TRAX MTU has been performed and documented. This report has been prepared according to the methodology and report format guidelines provided in the DOE–AL Guidance for the Preparation of MWT Process Hazards Analysis (DOE 1995).

On the basis of this PHA, the overall risk to any population group from operation of the VAC*TRAX MTU has been determined to be very low. The MTU is classified as a Radiological Facility (i.e., less than a Hazard Category 3 facility), with low hazards (i.e., minor on-site and negligible off-site impacts to people and the environment).

Of the 102 potential hazards identified, only three were considered significant in that they could result in a fire or explosion. All three of the significant hazards involved the inclusion of oxygen in a process that included the other two requirements for fire; an ignition source and fuel. The three significant hazards identified during this PHA were that the VAC*TRAX MTU design: (1) allowed inclusion of oxygen in the off-gas condenser system; (2) did not provide sufficient control of the oxygen content in the shredder portion of the feed preparation glovebox; and (3) allowed oxygen inclusion in the process dryer. The remaining hazards were evaluated for potential design improvements to further lessen their severity and/or their frequency. No further action is required to reduce risks associated with these and the other identified hazards because changes to the design of the VAC*TRAX MTU were made concurrent with the hazard identification and analysis. Recommended actions have already resulted in design changes to reduce the risks to acceptable levels, take advantage of cost effective features, and improve design operability. All hazards with initial risk rankings of 1 or 2 have been reduced to acceptable risk rankings of 3 or 4.

Some of the principal preventive and mitigative features of the VAC*TRAX MTU include: the use of gloveboxes for containment of the waste where the worker could be exposed to materials at risk; a processing system which has been designed to minimize, or essentially preclude, the possibility of oxygen inclusion; redundant oxygen analyzers are used to monitor the oxygen in the dryer and condensate systems; and a programmable logic control system with all critical instrumentation alarmed, including the capability for automatic shut-down of the MTU should critical operating parameters be exceeded.

This PHA is considered adequate as the only safety basis documentation (supplemental safety analysis and/or a full scope SAR) for supporting DOE authorization to operate the VAC*TRAX MTU at all user sites. No additional safety basis documentation is recommended.

This page intentionally blank

Abbreviations, Acronyms, and Initialisms

AL	Albuquerque Operations Office
CFR	U.S. Code of Federal Regulations
Ci	curie
DBA	design basis accident
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EBSC	evaluation basis site characteristics
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
ESF	engineered safety features
FFCA	Federal Facilities Compliance Act
ft	foot (feet)
°F	degrees Fahrenheit
ft^2	square foot (feet)
ft^3	cubic foot (feet)
gal	gallon(s)
GJPO	Grand Junction Projects Office
HASP	health and safety plan
HAZOP	hazards and operability analysis
HEPA	high-efficiency particulate air
IDLH	immediately dangerous to life or health
IH	Industrial Hygienist
KAFB	Kirtland Air Force Base
kg	kilogram(s)
km	kilometer(s)
k/h	kilometer(s) per hour
LANL	Los Alamos National Laboratory
lb	pound(s)
lb/ft^3	pounds per cubic foot
LDR	land disposal restriction
LEL	lower explosive limit
m	meter(s)
MAR	materials at risk
mb	millibar
mi	mile(s)
m^3	cubic meter(s)
m^3/h	cubic meter(s) per hour
mrem	milliroentgen(s)
mrem/h	milliroentgen(s) per hour
m/s	meter(s) per second
MTU	mobile treatment unit
MWTP	Mixed-Waste Treatment Program
nCi/g	nanocuries per gram
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocuries per gram
psia	pounds per square inch absolute

Abbreviations, Acronyms, and Initialisms (continued)

PTX	Pantex
PHA	process hazards analysis
P&ID	piping and instrumentation diagram
PPE	personal protective equipment
ppm	parts per million
Pu	plutonium
RCRA	Resource Conservation and Recovery Act
RMWMF	Radioactive and Mixed Waste Management Facility
RMMA	radioactive material management area
RQ	reportable quantity
SAR	safety analysis report
SNL/NM	Sandia National Laboratories/New Mexico
SOP	standard operating procedure
SSCs	structures, systems, or components
TA–3	Technical Area 3
TD	thermal desorption
U	uranium
UEL	upper explosive limit
UBC	Uniform Building Code
VOC	volatile organic compound(s)

1.0 Introduction

1.1 Scope

In 1992, Congress passed the Federal Facilities Compliance Act (FFCA) that requires the U.S. Department of Energy (DOE) to treat and dispose of its mixed waste in accordance with the Resource Conservation and Recovery Act (RCRA) land disposal restrictions (LDRs). Adequate treatment capability does not currently exist to treat the mixed wastes that are generated and stored at the nine sites the DOE Albuquerque Operations Office (AL) oversees. In response to the need for increased mixed-waste treatment capability, DOE–AL organized a Treatment Selection Team to match mixed wastes with treatment options and develop a strategy for treatment of its mixed waste.

The strategy developed by the Treatment Selection Team, as described in the *AL Mixed-Waste Treatment Plan* (DOE 1994), was to use available off-site commercial treatment facilities and develop mobile treatment capability to treat wastes at the DOE–AL sites where wastes are generated. Treatment processes used for mixed waste must not only address the hazardous component to comply with LDRs, but must also contain the radioactive component in a form that allows final disposal while protecting workers, the public, and the environment.

On the basis of recommendations of the Treatment Selection Team, DOE–AL assigned projects to various DOE–AL sites to bring mixed-waste treatment on line. One of the technologies assigned to the DOE Grand Junction Projects Office (GJPO) for development was thermal desorption (TD). Rust Geotech, contractor to DOE–GJPO, conducted pilot-scale TD treatability testing with the Rust-patented VAC*TRAX process. Information gained from the treatability testing was used to design a full-scale VAC*TRAX mobile treatment unit (MTU).

The overall scope of this *VAC*TRAX MTU Process Hazards Analysis* (PHA) report is to document the hazards analysis performed by GJPO on the VAC*TRAX MTU. To date, the DOE–AL sites that plan to use the VAC*TRAX MTU for treating their mixed waste inventories are Los Alamos National Laboratory (LANL), Sandia National Laboratories/New Mexico (SNL/NM), and Pantex (PTX). The VAC*TRAX MTU is scheduled for deployment in 1997..

The VAC*TRAX MTU uses an indirectly heated, batch vacuum dryer to thermally desorb organic compounds. The organics, including RCRA-listed wastes with waste codes F001 through F005, water, a small amount of sweep nitrogen, and other volatile compounds exit the dryer as a vapor along with some fine particulates. The nitrogen is added both as a "sweep" gas to enhance removal of volatilized compounds and to suppress combustion. The entrained solids are removed from the gas stream with a high-efficiency particulate air (HEPA) filter located on the dryer. Filtered process vapors are cooled in a vacuum condenser and the condensate is removed prior to passing through a vacuum pump. The discharge vapor from the vacuum pump is further cooled in a second condenser and the noncondensable stream is vented to the atmosphere after passing through carbon canisters for removal of residual organics.

Following removal of the bulk of the volatile compounds, the solids, which contain the nonvolatile radionuclides and metals from the original feed, are held at full vacuum for a period of 15 minutes to several hours, depending on the type and quantity of contaminants, as well as on the properties of the solid matrix. The solids are then cooled and discharged from the dryer, completing the treatment cycle.

The major components of the VAC*TRAX MTU are a shredder, thermal desorption dryer, nitrogen preheater, high-temperature process HEPA filter, primary vacuum condenser, vacuum pump, secondary condenser, feed preparation and loading and unloading gloveboxes, demisters after the primary and secondary condensers, and carbon adsorption canisters.

1.2 Objectives

The overall TD project objective is to bring the VAC*TRAX MTU on line for treating mixed-waste inventories, therefore enabling specific DOE–AL sites to meet their FFCA commitments.

The objective of this PHA report is to demonstrate that a thorough assessment of the risks associated with the operation of the VAC*TRAX MTU has been performed and documented. This report has been prepared according to the methodology and report format guidelines provided in the DOE–AL *Guidance for the Preparation of MWT* Process Hazards Analysis (DOE 1995).

2.0 Site Description

2.1 Site Information

The VAC*TRAX MTU is scheduled to be delivered to three DOE–AL sites. The MTU is designed to be housed in a climate-controlled environment and is not suitable for outdoor use. However, barometric pressures, seismic zones, and maximum temperatures were taken into account during the design. Locations, elevations above sea level in feet (ft) and meters (m), barometric pressures in millibars (mb) and pounds per square inch absolute (psia), seismic zone designations, and reasonable maximum temperature in degrees Fahrenheit (°F) of the three sites the MTU is currently slated for treatment operations are

LANL

- Location — Los Alamos, New Mexico
- Elevation — 7,300 ft (2,225 m)
- Average barometric pressure — 779 mb (11.3 psia)
- Seismic zone: 2B
- Reasonable maximum temperature — 88 °F

SNL/NM

- Location — Albuquerque, New Mexico
- Elevation — 4,958 ft (1,511 m)
- Average barometric pressure — 841 mb (12.2 psia)
- Seismic zone: 2B
- Reasonable maximum temperature — 98 °F

PTX

- Location — Amarillo, Texas
- Elevation — 3,600 ft (1098 m)
- Average barometric pressure — 889 mb (12.9 psia)
- Seismic zone: 1
- Reasonable maximum temperature — 101 °F

Because SNL/NM has provided more site-specific information and has proposed a specific building to house the VAC*TRAX MTU for treating its mixed-waste inventories, SNL/NM was chosen for the site-specific risk assessment. Because LANL and PTX have not determined where the MTU will be located on site, analyses were conducted in a very conservative manner to ensure all sites could apply the results to their facilities. Appendix A presents the site characteristics used for the evaluation basis of the risk assessment. Site-specific risk assessment evaluations of each MTU user site will be required during permitting activities and before transporting the MTU to the user site.

2.1.1 SNL/NM Site Description

The VAC*TRAX MTU will be located within the SNL/NM Radioactive and Mixed Waste Management Facility (RMWMF) in Technical Area 3 (TA–3). The RMWMF is in the southeast corner of TA–3 and consists of Buildings 6920 and 6921; two skid-mounted storage buildings for reactive and ignitable/flammable waste; a 4,000-square foot prefabricated waste storage building; a 7,000 gallon (gal) fuel-storage tank; an office trailer; and a rubber-lined retention basin. The location of these facilities are shown in Figure 2–1.

Mixed-Waste Treatment Location

Building 6920 is the principal structure in the RMWMF. Treatment of mixed waste with the VAC*TRAX MTU is planned to be performed in the north bay of Building 6920. No ignitable, flammable, or reactive waste will be stored in Building 6920. Two skid-mounted storage buildings, for storage of reactive and ignitable/flammable waste, are located approximately 100 feet to the northeast and northwest of Building 6920, respectively.

The primary radiological buffer area for Building 6920 has been engineered to minimize the generation of airborne contamination and the spread of contamination. Pressure zones are maintained throughout the building to cause air to flow from areas of no airborne contamination to areas of progressively greater potential for airborne contamination. The north bay is exhausted through one stage of prefilters and HEPA filters.

Geography

SNL/NM is on Kirtland Air Force Base (KAFB), which is located in Bernalillo County, New Mexico. KAFB is bordered on the north and west by densely populated residential areas of Albuquerque. To the east of KAFB is the Four Hills residential area of Albuquerque. To the south of KAFB is the Isleta Indian Reservation and Valencia County. Valencia County is a rural, sparsely populated area. Surrounding populations, as of 1990, were as follows:

Bernalillo County:	480,577
Albuquerque:	384,736
Isleta Reservation:	2,915
Valencia County:	45,235
KAFB:	5,761

The metropolitan population center closest to SNL/NM is Albuquerque, located along the northern boundary of the site (Figure 2–2). Distances from the RMWMF to the nearest KAFB housing and the nearest Albuquerque residential housing are approximately 9.2 kilometers (km) or 5.7 miles (mi) and 8.5

km (5.3 mi), respectively. The nearest on-site individual is located about 300 m northeast of the RMWMF. The nearest boundary to public land is approximately 2.8 km (1.7 mi) to the south. The main east-west runway of the Albuquerque/KAFB airport lies 8.5 km (5.3 mi) north-northwest of the RMWMF.

Meteorology

SNL/NM and KAFB is located in the Albuquerque-Belen Basin which is characterized by low precipitation; wide temperature extremes; frequent, dry winds; and occasional heavy rain showers. Strong winds usually occur in late winter and early spring. Wind speeds reach a velocity of 50 kilometers per hour (km/hr) on an average of 46 days per year. Every 2 years, a 1-minute duration gust of 97-km/hr wind is expected. Prevailing surface winds on KAFB are from the east.

Surface Hydrology

The major surface hydrologic feature in central New Mexico is the Rio Grande River, which flows north to south through Albuquerque and lies approximately 10 km (6.2 mi) west of KAFB. Water from the Rio Grande River is used primarily for irrigation of agricultural crops. There are no continuously running streams on SNL/NM property.

Subsurface Hydrology

A fault complex (including a normal fault and an inferred fault) separates the regional aquifer system into a deeper zone west of the faults and a relatively shallower zone east of the faults. The depth to groundwater underlying SNL/NM facilities varies from approximately 15 to 30 m east of the faults and from approximately 116 to 153 m west of the faults.

2.2 RCRA Site Permitting

The sites currently targeted to receive the VAC*TRAX MTU for treatment of mixed wastes all possess a RCRA permit for some form of treatment, storage, or disposal. As a result, it is expected that permitting of the MTU can be accomplished through a modification to the existing RCRA permits. VAC*TRAX MTU technical information required for modifying the RCRA permits is provided in the *VAC*TRAX Mobile Treatment Unit Design Report* (DOE 1996b). The Mixed-Waste Treatment Program Manager will provide the technical information to DOE–AL, and DOE–AL will make the information available to the user sites to assist the sites in preparing the required permit modifications.

The VAC*TRAX MTU user sites must obtain a RCRA permit modification for operation of the unit. RCRA Section 3005(a), as amended by the Hazardous and Solid Waste Amendments of 1984, requires owners and operators of all hazardous waste treatment, storage, and disposal facilities to obtain a RCRA permit prior to installing the MTU at a RCRA facility. The MTU may be prefabricated and transported to the proposed treatment site; however, construction on the site itself, such as pouring concrete foundations and connecting the MTU to physical structures on site, cannot occur until the RCRA operation permit is issued (RCRA Section 1004[2]).

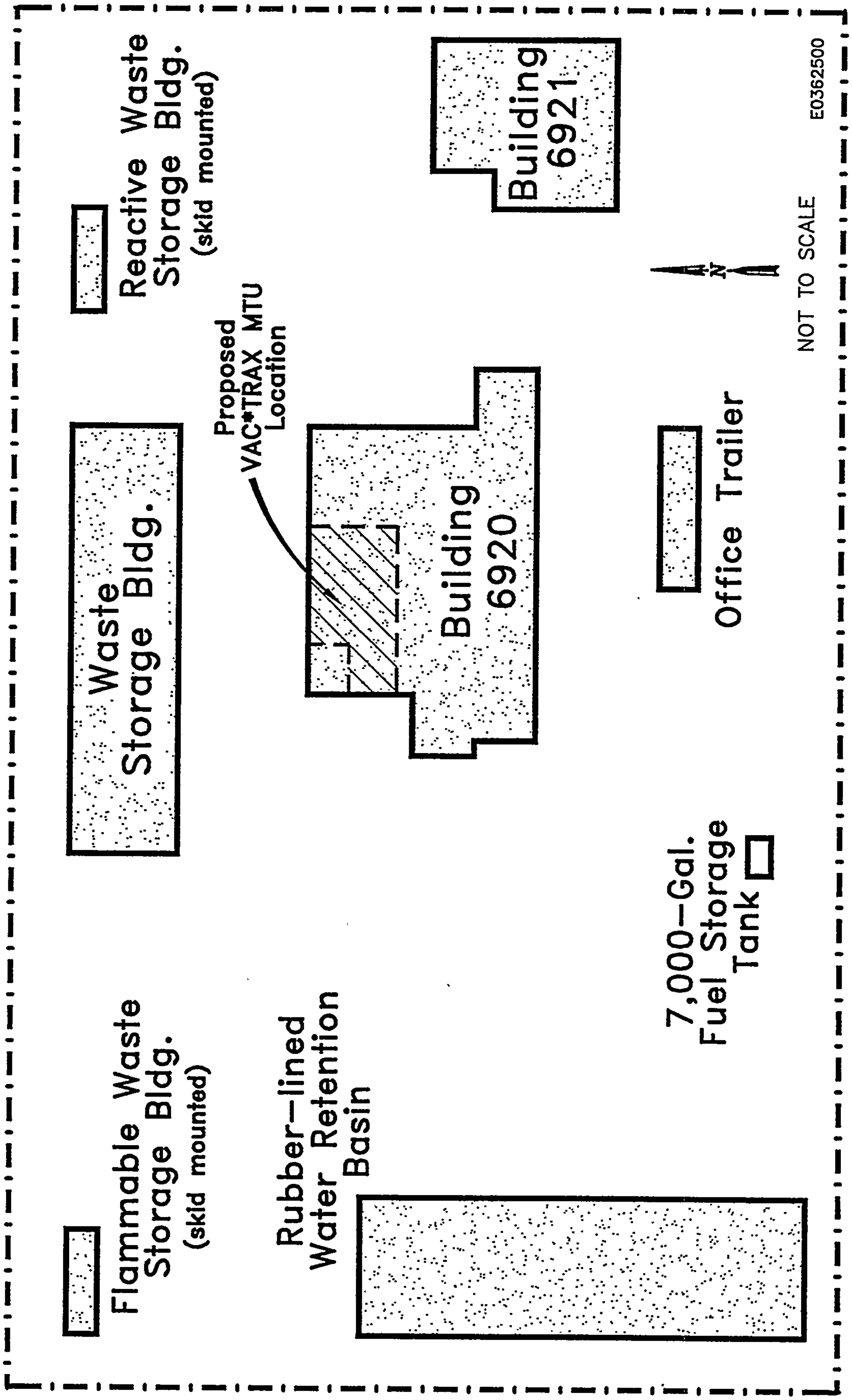


*Figure 2–1. SNL/NM — RMWMF Location Map of Proposed VAC*TRAX MTU Location*

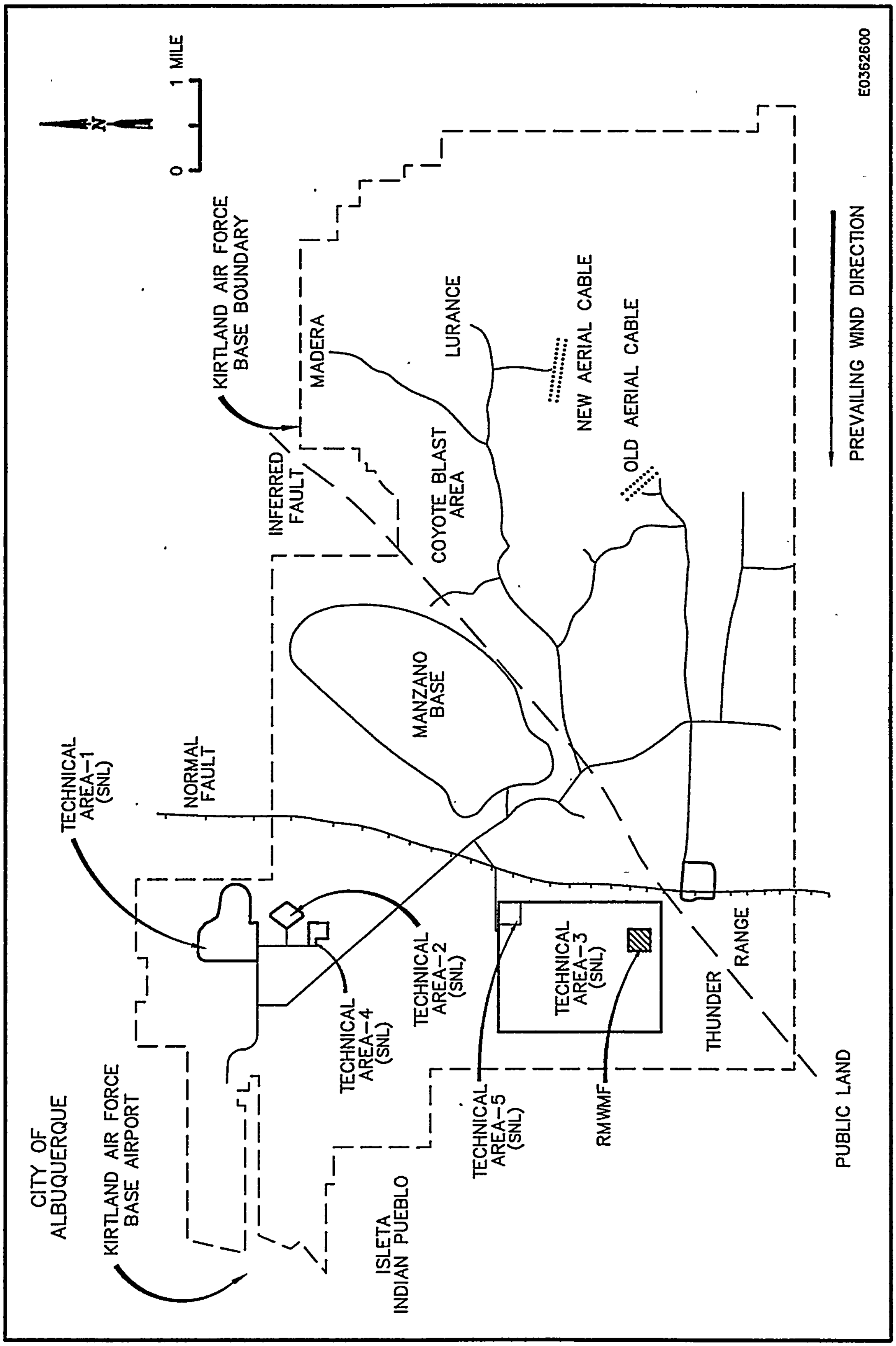


Figure 2–2. Sandia National Laboratories, New Mexico, Location Map

This page intentionally blank

3.0 Process Description

3.1 TD Mixed Waste Treatment Process

The VAC*TRAX MTU uses the Rust-patented TD process to treat radiologically contaminated solids that contain hazardous volatile and semivolatile organic and inorganic constituents. The process uses an indirectly heated, horizontal batch rotary dryer to thermally desorb hazardous compounds. The dryer is operated under vacuum to reduce the boiling points of the hazardous compounds, which minimizes the required operating temperature. A small amount of nitrogen is added as a sweep gas to enhance the removal of volatilized compounds, and also to suppress the potential for combustion by reducing the oxygen concentration in the dryer and off gas below the range where combustion is possible.

The volatile and semivolatile hazardous compounds, water, other volatile compounds, and the sweep nitrogen exit the dryer as a gas stream, which may carry a small amount of entrained fine particulates. The entrained particulates, which may include radionuclides, are removed from the gas stream by passing the off gas through a HEPA filter located in a cupola mounted directly on the dryer. The filtered process vapors are then cooled in a primary condenser that is operated under vacuum. The condensate formed in the primary condenser is separated and collected in the primary receiver. The uncondensed gases are drawn through a vacuum pump and then pass to a secondary condenser, operated at a slight positive pressure, which condenses the remaining volatiles. Condensate from this condenser is separated and collected in a secondary receiver, while noncondensable gases pass through a second HEPA filter, and then through a carbon canister that removes trace residual organics before the gases are exhausted to the atmosphere. The recovered condensate from both receivers is discharged into drums for disposal as hazardous liquid waste.

The mixed waste to be treated in the VAC*TRAX MTU is received in U.S. Department of Transportation (DOT) approved, Type B, 55- or 30-gal drums, 85-gal overpacks, or special containers, and is unloaded from the containers in a sealed glovebox. The contents of the containers are sorted, and materials unsuitable for treatment in the MTU are removed and drummed out separately. The solids to be treated in the MTU are shredded for ease of treatment in the dryer. The shredded material is charged to the dryer by way of a loading glovebox, which is mounted directly on the dryer. After a treatment run is complete, the treated solids are discharged through an unloading glovebox into drums for disposal as radioactive waste.

TD is a batch process in which process conditions such as temperatures, pressures, and flow rates vary widely over the course of a run. The waste streams to be treated by the VAC*TRAX MTU potentially range from sludges containing as much as 40 percent liquid by weight, to debris and used personal protective equipment containing parts-per-million levels of volatiles. The 40 percent by weight is based on an organic with a high molecular weight resulting in the higher weight percent liquid. For the design basis accident analysis, acetone was used as the primary volatile organic. The maximum weight percent to maintain no free standing liquids was taken as 24 percent. Unlike a continuous process with a homogeneous feed, there is no single feed stream, nor any single set of operating conditions, that constitute a design point for the MTU.

Available waste stream data will be reviewed by chemistry and health physics personnel to verify that feed composition meets the acceptance criteria. However, the characterization of the waste streams slated for treatment by the MTU is neither complete nor necessarily accurate. It is not possible to envelope the design of the MTU for the range of contaminants and concentrations that may be encountered in waste treatment. The MTU therefore must be designed for maximum flexibility.

3.1.1 Batch Size

The approximate current and expected future maximum inventory of wastes chosen for treatment by the VAC*TRAX MTU is presented in Table 3–1.

*Table 3–1. Inventory of DOE–AL Mixed Wastes To Be Treated With VAC*TRAX MTU*

Site	Stream ID	Current (ft^3)	Future (ft^3)	Total Drums
LANL	TG–21	1,000	250	170
LANL	TG–22	276	280	76
SNL/NM	TG–8	989	35	139
PTX	TG–4.2	792	0	108
PTX	TG–5.1	4.24	6,700	914

The designed batch capacity of the VAC*TRAX MTU is two 55-gal drums or 14.7 cubic feet (ft^3). At a rate of one batch per day, 5 days per week, the MTU will be able to process the LANL waste in approximately 6 months, and the SNL/NM waste in about 3 months. Treatment of the total current and planned future inventory of waste at PTX with a two-drum MTU would take about 2 years. The treatment schedule at PTX allows enough time for treatment of all PTX mixed waste based on this design capacity. The MTU dryer is designed for a total volume per batch of 30 ft^3, so when a full charge of 14.7 ft^3 is added, the dryer will be approximately half full. This dryer volume will allow enough void space to promote good mixing while minimizing the chance of pushing radiologically contaminated solids into the off-gas line.

3.1.2 Waste Characteristics

As demonstrated by pilot-scale VAC*TRAX treatability testing documented in the *Thermal Desorption Treatability Test Conducted With VAC*TRAX Unit* report (DOE 1996b), a wide variety of feed types and a wide range of volatile and semivolatile contaminants can be treated by the VAC*TRAX MTU. The only solids unsuitable for treatment are those that are too large or dense to be shredded, such as tools and large pieces of scrap metal, and those with a level of radiological contamination above the regulatory threshold for low-level waste. Because of the vacuum capability of the dryer, the process can remove any contaminant with a normal boiling point of less than about 750 °F. The MTU has been designed to treat solids having a maximum liquid content of 40 percent by weight; it has not been designed to handle or treat free-flowing liquids.

3.1.3 Operating Cycle

Because TD is a batch process, the VAC*TRAX MTU can be operated on any shift schedule. According to the current mixed-waste treatment program schedule, the TD treatment schedule is based on operation by a single-shift crew, with an operating cycle of 8 hours per day, 5 days per week. With the time required for prestartup checkout of the MTU, startup of utilities, and for cool down at the end of a run, the actual treatment time for the design basis case must be 4 hours or less to permit a complete operating cycle in 8 hours. Operation of the MTU will be performed according to the operation and maintenance (O&M) procedures to be prepared prior to use of the MTU at user sites. Hereafter in this PHA the O&M

Procedures are referred to as the standard operating procedure (SOP). The planned daily operating procedure is as follows.

1. Discharge wastes treated the previous day from the dryer using the dryer discharge glovebox to ensure containment. This treated material will be radioactive but will not be hazardous, and it will be sealed into drums and removed from the containment (glovebox) area.

2. Load the waste charge, which was prepared and loaded into transport hoppers the previous day, into the dryer using the dryer loading glovebox to ensure containment.

3. Start the dryer operation and treatment cycle following the standard operating procedure (SOP).

4. After the dryer operation stabilizes to the extent where it requires a minimum amount of attention, bring a new drum of waste into the feed preparation area and bag it into the feed preparation glovebox. Open the drum, inspect and sort the contents as necessary, and shred the material, as required, into the transport hopper.

5. When Step 4 is complete and the waste drum is empty, disconnect the full transport hopper and bag out the empty waste drum.

6. Repeat Steps 4 and 5 with a second drum of waste. Set the full transport hoppers aside for the next day's operation, and take the empty drums out of the feed preparation area.

7. When the dryer treatment cycle is complete, shut down the dryer following the SOP. Leave the treated material in the dryer to cool for discharge the next day.

The condensate tanks will be emptied into drums, and the drums will be sealed and removed from the containment area, as needed. Because the vast majority of wastes are expected to have a liquid content much lower than 40 percent, the condensate tanks will typically hold the condensate from several runs, and emptying the condensate tanks will not be required after every run.

3.1.4 Oxygen Concentrations

An explosive potential exists whenever the concentration of an explosive compound is above its lower explosive limit (LEL), and below its upper explosive limit (UEL). LEL and UEL are normally measured in air, which contains 21 percent oxygen, at ambient temperature. As the oxygen concentration drops, the LEL increases and the UEL decreases. Eventually, when the oxygen concentration is sufficiently low, the LEL and UEL will become equal. Below this oxygen concentration, no explosive potential exists. A review of LEL data for a number of explosive fluids showed that none of them will detonate at ambient temperature when the oxygen concentration is below 9 percent. The only exception is hydrogen, but the wastes to be treated with VAC*TRAX will not contain significant concentrations of molecular hydrogen.

An additional consideration is that the VAC*TRAX MTU operates at up to 600 °F. At this temperature the LELs for several compounds are 1 to 2 percent lower than at ambient temperature. Applying this general LEL correction for temperature indicates that the compounds to be treated with the MTU will not explode at operating temperature if the oxygen concentration in the dryer is kept below 9 percent. To be conservative, the SOP for the MTU will specify that the oxygen concentration must be maintained at no higher than 5 percent.

3.2 Treatment of Radioactive Waste Byproducts

The VAC*TRAX MTU is designed to contain the nonvolatile radioactive constituents in the dryer. The dryer will be emptied when the volatile constituents, normally the hydrocarbons and water, have been removed. The solids will contain the radionuclides, with the exception of tritium, and metals that were in the initial feed. Tritium will volatilize and enter the off-gas system similar to water vapor, unless the tritium is attached to a semivolatile organic that does not volatilize at the VAC*TRAX MTU operating conditions.

If metals are present in the waste feed that are RCRA-regulated, the treated waste byproduct will be considered a mixed waste. If the waste originally contained RCRA F-listed constituents, it would remain an F-listed hazardous waste. If the waste does not contain RCRA-regulated metals or other F-listed hazardous waste, the treated waste byproducts can be disposed as low-level radiologically contaminated waste.

If tritium contaminated waste is treated, the majority of the tritium will be condensed along with the volatile hydrocarbons and water. The resultant condensate can be disposed at a commercial mixed-waste treatment facility. Treatment at such a facility is outside the scope of this PHA, as is further treatment of byproducts by technologies such as macro encapsulation, or the ultimate disposal of the waste.

The VAC*TRAX MTU waste acceptance criteria allows for treatment of low-level radioactivity mixed waste. It is possible that, if the waste to be treated contains transuranic elements with activities close to 100 nanocuries per gram (nCi/g) and has a high loss-of-weight on drying, the residual solids may be transuranic. The drying process will have a minimal effect on the volume, but it may have a significant effect on the waste weight when the volatile material is removed. Therefore, for a given activity, the activity-per-unit weight will increase as the volatile material is removed. If generation of waste that exceeds 100 nCi/g of transuranic material is undesirable, the waste acceptance criteria can be modified to preclude treatment of these waste streams. Operation of the VAC*TRAX MTU is not affected by the presence of transuranic wastes.

Residual rinse solutions may be generated between treatment of dissimilar waste streams or during the final decontamination of the VAC*TRAX MTU. The rinse solution could be recycled solvent obtained during treatment or a mild wash solution such as Alconox. The solution either will be concentrated, if the wastewater evaporator* is available, or added to the volume of condensate produced. Treatment with wastewater evaporation is outside the scope of this PHA.

3.3 Decontamination and Decommissioning Prior to Shipment to Next Host Site

The exterior and interior surfaces of the VAC*TRAX MTU equipment is designed for decontamination between runs of dissimilar wastes and before shipping the MTU to the next user site. The MTU is designed to withstand frequent decontamination and decommissioning (D&D) without damage to the equipment surfaces or functions. Decontamination will be accomplished mechanically or by draining, flushing, or chemically treating the equipment to meet health and safety, permitting, and transportation requirements.

*Wastewater evaporation is another mobile treatment unit mixed-waste treatment technology being developed by the DOE–GJPO.

Ancillary equipment that does not contact mixed waste, including the chiller system, hot-oil system, nitrogen generator, and transformers will be located outside the area of contamination. This equipment will not require decontamination prior to shipment to the next user site.

Contaminated equipment will be completely drained or emptied of loose material. Initially, the dryer can be operated with hot clean sand to mechanically remove radioactivity that may have become imbedded in the pores or welds in the metal of the dryer. Operating with hot sand also will ensure that volatile hazardous materials are removed. The sand will became a low-level radioactive waste. Following operation with the sand, the VAC*TRAX MTU can be operated at ambient temperature with polypropylene pellets. The pellets will further scour the metal surfaces to remove the remaining contamination. The dryer can then be dismantled to decontaminate the dryer paddle.

The HEPA filters will be removed from the cupola. Both the filters and cupola will be mechanically cleaned. Cleaning the filters will require heating the filters and brushing them to remove any smearable contamination. The filter housing also will be mechanically cleaned. The filters and filter housings will not be free released; instead they will be shipped in a strong, tight, DOT-approved package. The package cannot exceed 0.5 milliroentgen per hour (mrem/h) exposure rate at any point on its surface.

The primary HEPA filter and carbon canister will contain capture media. Even if the carbon canisters are not spent, the canisters will require disposal by the host site. The primary HEPA filter should be dismantled and the filter media removed for disposal. The secondary HEPA filter will be surveyed, and if not contaminated can be reused. New HEPA filter media and carbon canisters will be required for each host site.

Off-gas piping can be flushed in place with an appropriate solvent and/or a commercial cleaner. If tritium existed in the original feed of the last run, the piping will be purged with heated nitrogen for several hours to volatilize the tritium. The external surfaces of the dryer will be decontaminated to the limits given in Title 49, Part 173 of the *U. S. Code of Federal Regulations* (49 CFR 173). Following decontamination, the piping will be empty according to RCRA criteria and nonradioactive. The piping then will be sealed on all open ends and palletized for shipment.

Condensers will be flushed in place and decontaminated in a manner similar to the piping. The condenser heads can be removed to verify the effectiveness of the flushing, and then resealed. Condenser pipe openings will be sealed for shipment.

The external surfaces of the vacuum pump will be decontaminated to the extent possible and the inlet and outlet openings will be sealed. The pump will be sealed in place and left on its skid for transportation. All piping on the skids that contacted contamination while in service will have openings sealed for shipment.

The feed preparation and loading and unloading gloveboxes will be mechanically cleaned and stiffened as necessary for transport, with all openings sealed. The external surfaces of the gloveboxes will be decontaminated.

The internal surfaces of the shredder will be decontaminated and the external surfaces will be cleaned and openings will be sealed. The sand used for the dryer decontamination can be run through the shredder to remove the internal surface contamination. Two separate batches of sand may be necessary to clean the shredder to acceptable shipping criteria. The internal components of the shredder can be accessed to determine if the decontamination has been successful, if not, additional sand batches will be run through the shredder.

There are no known unique hazards expected to arise as a result of the decontamination effort. Portable local ventilation will be provided, as necessary, to prevent either hazardous or radioactive material from becoming airborne. All D&D work that could result in exposure to hazardous or radioactive material will be done inside a radioactive material management area (RMMA).

The D&D performance criteria will be the DOT requirements for shipping the VAC*TRAX MTU equipment as nonhazardous and radioactive, low-specific-activity material as defined by 49 CFR 173. If the material is shown to have a specific activity of less than 2,000 picocuries per gram (pCi/g), it is not considered radioactive and may not need to meet special DOT shipping requirements. In general, the equipment will be sealed and secured to facilitate shipment to the next user site.

3.4 End of Service Life Decontamination and Decommissioning

Final decommissioning of the MTU is beyond the scope of this PHA. However, it should be noted that several parts of the system are not expected, by design, to contact any mixed waste and, therefore, final decommissioning of these parts should be simplified. This equipment includes the chiller system, hot-oil system, nitrogen generator, and transformer.

4.0 Facility Description

This section covers both primary and secondary containment. The primary containment includes gloveboxes and sumps that are part of the design on the VAC*TRAX MTU. It is assumed that secondary containment will be provided by the host sites and is not a part of the MTU design.

4.1 Mixed Waste Treatment Skids

The VAC*TRAX MTU skids are designed to be structurally stable to withstand the design basis earthquake which is based on the SNL/NM and LANL seismic zone designations of 2B, and rigid to avoid damage during transit. The equipment either is installed in gloveboxes, or is itself the primary containment. Secondary containment will be a building large enough to house the skids. The building will be a RCRA-permitted building and in compliance with DOE Standard DOE–STD–1020–92, "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities," particularly for the flood and wind design basis accidents (DBAs).

The VAC*TRAX MTU is comprised of three primary skids: (1) the feed preparation glovebox skid, which includes the segregation area and the shredder; (2) the dryer skid; and (3) the process condensate system skid. The footprint for the skids include an 8- by 10-ft feed preparation glovebox skid, an 8- by 12-ft dryer skid, and an 8- by 10-ft condensate system skid. The footprint of the VAC*TRAX MTU is 370 square feet (ft^2), of which 176 ft^2 is the treatment process unit and 194 ft^2 is the feed preparation unit. These units can, if necessary, be arranged to fit a smaller area. However, the operability of the MTU will be much enhanced if the two units are arranged to allow more space between equipment, as shown in Figure 4–1. The dryer skid will be shipped in three pieces to be stacked and assembled at the site. The total height of the assembled dryer skid is 21 ft 7 inches above grade. The condensate system skid is designed with a sump to contain any spilled materials.

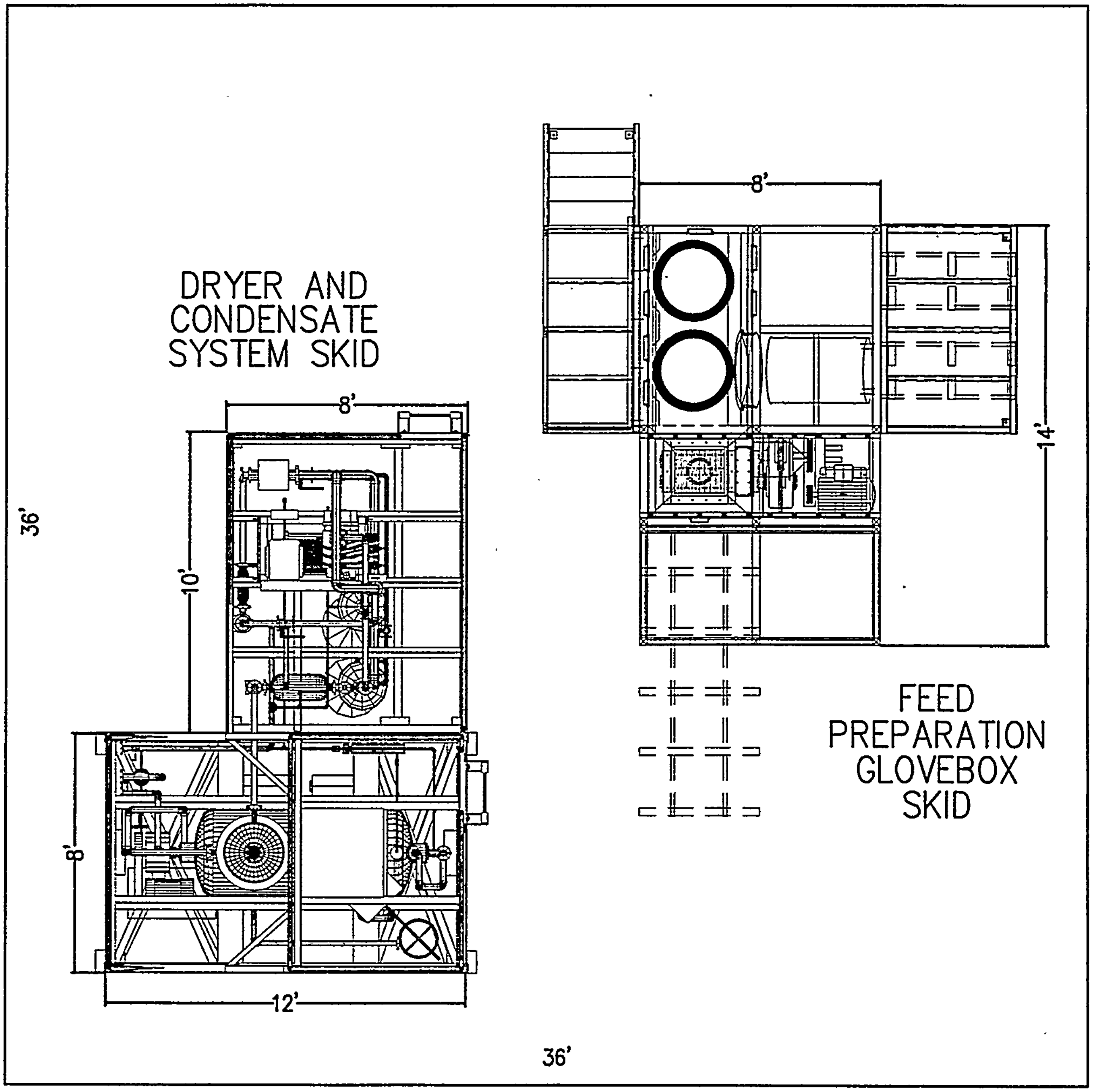
The treatment process, including the feed preparation, can be discontinued or interrupted instantly without loss of containment or damage to the equipment. The feed preparation and treatment process are batch operations designed to maintain containment of the hazardous and radioactive contaminants. The condensate system skid is designed to contain the maximum liquid that can be stored in the condensate equipment.

The VAC*TRAX MTU skids were designed by a registered structural engineer, with at least 5 years experience, and were reviewed by a civil engineer knowledgeable in structural design, also with at least 5 years experience. The MTU skid design structural sketches, drawings, and calculations demonstrate centers of gravity, connection details, points of load application, and stresses in the structural members restraining the assemblies.

4.2 Secondary Containment

The VAC*TRAX MTU design does not include the design or specifications for secondary containment, because the host sites will provide climate-controlled secondary containment, compliant with RCRA (40 CFR 264) storage requirements, and will be able to meet the requirements for a radiological area. The materials at risk (MAR) and hazard classification analyses indicate no special structure is required. The structure will be designed to comply with DOE–STD–1020–92 for a Category I or II structure for the naturally occurring phenomena accidents for the particular site. Appendix A contains additional information on the requirements for the host-site structure and rationale for the structure specifications.

The existing structures at SNL/NM and LANL are designed to withstand the design basis seismic zone 2B earthquake, the worst case for sites hosting this MTU, through compliance with building codes such as the Uniform Building Code (UBC). A static force analysis was performed during the MTU design using methods described in the UBC. A performance category of either I or II, as defined by DOE–STD–1020–92, is appropriate for the building and the MTU because (1) there will be a low quantity of MAR, as indicated in Appendix B; (2) the batch operation can be instantly shut down and the MARs contained; and (3) the two levels of containment are not likely to be breached when the contaminants of concern are being processed. Even if containment is breached, based on the unmitigated accident analysis, as presented in Appendix C.4 it is improbable that a life threatening event would result.



E0362700

*Figure 4–1. VAC*TRAX MTU Primary Skid Layout*

5.0 Process Hazards Analysis Summary

5.1 Purpose

The purpose of this PHA report is to provide a formal determination of facility class and hazard category for the VAC*TRAX MTU operation, identify the hazards of the operation, estimate the bounding unmitigated accident consequences, and evaluate the adequacy of safeguards and mitigating controls.

The VAC*TRAX MTU will be used to treat mixed wastes at LANL, SNL/NM, and PTX. This document will provide a basis for the user sites to perform an unreviewed safety question analysis, as described in DOE Order 5480.21. This PHA will determine whether additional site-specific safety analysis and/or a full scope safety analysis report (SAR) will be required prior to DOE authorization to operate the MTU. This PHA also provides the basis for changes to site-specific health and safety plans, process safety management programs, full scope SARs, or environmental assessments as needed.

The scope of this PHA is the operation of the VAC*TRAX MTU, including routine startup and shutdown. Commissioning, decommissioning, and transportation hazards associated with the MTU are outside the scope of this PHA. Commissioning hazards will be analyzed during the readiness review processes (DOE Order 5480.31). Hazards specific to decommissioning the MTU will be handled through a task-specific decommissioning plan. Transportation hazard analysis will be controlled through a safety review of the MTU SOP and DOT requirements. There will be no MAR in the MTU during these analyses.

5.2 Methodology

The general PHA process entails data evaluation to determine material at risk; hazards identification, evaluation, and resolution; accident scenario analysis; and consequence analysis. These steps build on one-another to arrive at a determination of the degree of hazard involved in the process being studied.

The hazards identification, evaluation, and resolution portion of this PHA chose the hazards and operability analysis (HAZOP) tool for its investigation of the hazards in a methodical, meticulous manner.

The VAC*TRAX MTU PHA was performed according to the DOE–AL *Guidance for the Preparation of MWT Process Hazards Analysis* (DOE 1995). DOE Standards 1027, 5502, and 3009 were also used to ensure the PHA met all requirements. The quantities of hazardous and radioactive substances for the MTU do not require compliance with 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals," but the intent of this regulation was met as well.

This PHA was developed by a team with expertise in operations, engineering, health physics, industrial hygiene, industrial safety, and quality assurance.

The HAZOP portion of this PHA used LEADER3 software to prompt the team and document their results. The software has built in prompts for the majority of the equipment selected that asked questions about what happens if high pressure, low pressure, high flow, low flow, etc. exists. The team analyzed by node the consequences (severity) of the condition, assessed the potential frequency of each occurrence, and categorized issues such as safety, environmental, financial, or general. Nodes were selected from the Piping and Instrument Drawings (P&IDs). A node is a specific piece of equipment or section of piping that normally only has one function. For instance, the chiller node does not include the condenser but does include the supply piping to the condenser. The attached P&ID's in Appendix C.1.2 show the node selection. The hazard evaluation consequence and frequency criteria are shown in Appendix C.1.1 in

Tables C.1.1–1 and C.1.1–2. Each event (deviation), cause, consequence, safeguard, and recommendation made by the review team was analyzed and documented.

The first node studied, the nitrogen preheater, is shown on the P&IDs in Figure C.1.2–1. Nitrogen preheater hazards are identified and evaluated in Table C.1.3–1, pages 1 and 2. Six potential deviations were identified with a total of twelve causes, seven consequences with severity ratings, 15 mitigating safeguards, and ten recommended actions. One shortcoming of the software is that consequences, safeguards and recommendations do not always line up horizontally with the causes, consequently, the table is difficult to use. The frequency for Deviation 1.1, HIGH PROCESS FLOW, could be caused by a control valve sticking open, which was assessed to have a frequency of IV (once in the lifetime of the unit) and a consequence severity of D (negligible). It was assessed by the team to be a general (G) consequence. The computer then calculated the risk as GR 4. Tables C.1.1–3 and C.1.1–4 show the Risk Rank Matrix and Risk Decision Criteria. All safety risks of 1 or 2 were mitigated to reduce the risk to 3 or below. Safety risks of 3 were reduced whenever analysis showed it to be cost effective. Environmental, financial, and general risks were all evaluated and reduced if possible. All risks were reduced to 3 or below.

The guidance for doing a HAZOP is not to perform redesign during the review, but assign a recommendation and responsible party for resolution of the deviation. Because the HAZOP defined some significant deviations, it was decided to temporarily discontinue the HAZOP/PHA pending resolution of the primary concerns. Engineering resolved the concerns and the team reconvened. At that time, the concerns that showed undesirable risk were reevaluated. Following resolution of the issues, a list of design basis accidents was developed as shown in Appendix C.1.4. Four accidents were reviewed. A fault tree analysis was done for each of the scenarios. The fault trees are shown in Tables C.1.4–1 through C.1.4–4. Appendix C.1.5 shows the tracking, resolution, and reevaluated risks identified in the HAZOP.

The following assumptions and variations to the DOE–AL PHA guidance document were used in the development of this PHA, reflecting the purpose and intent of the guidance document.

- This PHA was prepared late in the design stage, which effected the content of this report. For example, recommended design changes were made concurrent with the production of this report, following hazard identification and analysis. Therefore, this report does not recommend actions to reduce risks. Recommended actions have already resulted in design changes to reduce the risks to acceptable levels, take advantage of cost effective features, and improve design operability. The evaluation of the frequency or consequence of risks and the mitigative features implemented in the VAC*TRAX MTU design are documented in Appendix C and summarized in Section 5.3.

- Hazards classification was based on conservative estimates, using available data for MARs and results of quantitative results of the unmitigated accident scenarios. Hazard classification is required by DOE Order 5480.23. DOE–STD–1027–92 and DOE–STD–5502–94 were used as guidance.

- Operational hazards were identified using the HAZOP analysis method. LEADER3 software, customized with the risk matrix shown in Table C.1.1–3, was used to analyze and document operational events. The evaluation criteria are shown in Appendix C.1.1.

- Potential hazards were identified and classified for their frequency, consequence severity, and resulting estimated risk. Engineered safeguards and administrative controls that mitigate these potential hazards were identified and evaluated during the VAC*TRAX MTU HAZOP review. Table C.1.3–1, lists the potential hazards identified.

- The PHA team identified action items to reduce risks and assigned responsibilities for resolution. These items were tracked to completion using the LEADER3 software. Table C.3–1 lists the resolution and closure of each action item.

- A fault-tree analysis was performed based on the identified hazards that showed a HIGH safety risk during the HAZOP process. Appendix C.2 contains the fault trees for the DBAs and the accident scenarios are described in Section 5.3. The fault-tree analysis documents risks while the VAC*TRAX MTU is in operation. The MTU will be in operation approximately 10 percent of the time it is on site (4 hours per day, 5 days a week), which reduces the frequency of an accident occurring.

- Chemical doses, radiological doses for workers, collocated workers, and the general public at the site boundary were calculated for the unmitigated accident scenarios. Appendix C.1.6 describes the calculations and use of EPIcode and HOTSPOT software. A summary is presented in Section 5.6.

No secondary containment building credit was taken into account in the unmitigated accident analysis, thus maximizing the radiological doses and contaminant concentrations. However, for the MTU user sites, this PHA assumes a RCRA-permitted building will be provided for the MTU operation.

5.3 Hazard Identification

Hazards were identified during the HAZOP using LEADER3 software to perform a detailed review. Table C.1–1 contains the detailed hazards identification worksheets. A total of 102 hazards were identified and resolved. Many of hazards identified were minor, nonsafety related issues. The analysis revealed 20 hazards with a safety risk of either 1 or 2, which required resolution. These 20 hazards tied to three primary design concerns. The primary design concerns were: (1) oxygen was allowed into the off-gas condenser system; (2) there was insufficient control of the oxygen content in the shredder portion of the feed preparation glovebox; and (3) oxygen inclusion was possible in the process dryer.

Resolution of the first major concern, oxygen in the off-gas condenser system, was to redesign the condenser system to reduce the risk of oxygen inclusion in the system. The condenser system was originally designed with automatic controls to permit discharge of both the primary and secondary condensers into a common receiver tank. The original system design could have allowed air inclusion into the off-gas, resulting in a potential oxygen inclusion above the LEL for the expected organics. The condenser system was redesigned to separate the primary and secondary condensers and to provide for manual discharge of the condensate from both condensers.

Resolution of the second major concern, insufficient control of the oxygen content in the shredder portion of the feed preparation glovebox, was to introduce the nitrogen purge for the feed preparation glovebox through the shredder area, ensuring that the nitrogen does not bypass the location with the highest probability of having an ignition source.

Resolution of the third major concern, oxygen in the process dryer, resulted in the addition of a second rupture disk, in series, to eliminate the possibility of a single point failure permitting oxygen to enter the dryer if the initial disk ruptures.

The Hazards Identification Sheets (Table C.1.1–1.) show the action taken to mitigate the identified concerns. In most cases the actions were relatively minor, and in some cases the action was simply verifying that the design incorporates the requirement.

5.4 Hazard Classification

DOE–STD–1027–92 and DOE–EM–STD–5502–94 were used as guidance for the preliminary and final hazard classification of the VAC*TRAX MTU. Both the preliminary and final hazard classifications are based on a segmented system, as shown in Figure 5–1. The concept is allowed by DOE Order 5480.23 when MAR from one segment cannot interact with MAR from another segment. A detailed analysis of hazard classification is presented in Appendix B.

Preliminary Hazard Classification

The preliminary VAC*TRAX MTU hazard classification is "Radiological Facility," based on the total inventory considered MAR in the process. The MARs are described in detail in Appendix B.

Final Hazard Classification

The final hazard classification is based on the results of the unmitigated accident consequences presented in Appendix C.4. The results of the selected DBAs, based on the quantitative results of the unmitigated accident scenarios, indicate that the preliminary hazard classification was appropriate. Therefore, the VAC*TRAX MTU is classified as a "Radiological Facility" according to the classification scheme presented in DOE–EM–STD–5502–94. The unmitigated accident consequences presented in Appendix C indicate that the DBA results are several orders of magnitude less than the guidelines, at the site boundary, indicating that the MTU is a low-hazard facility.

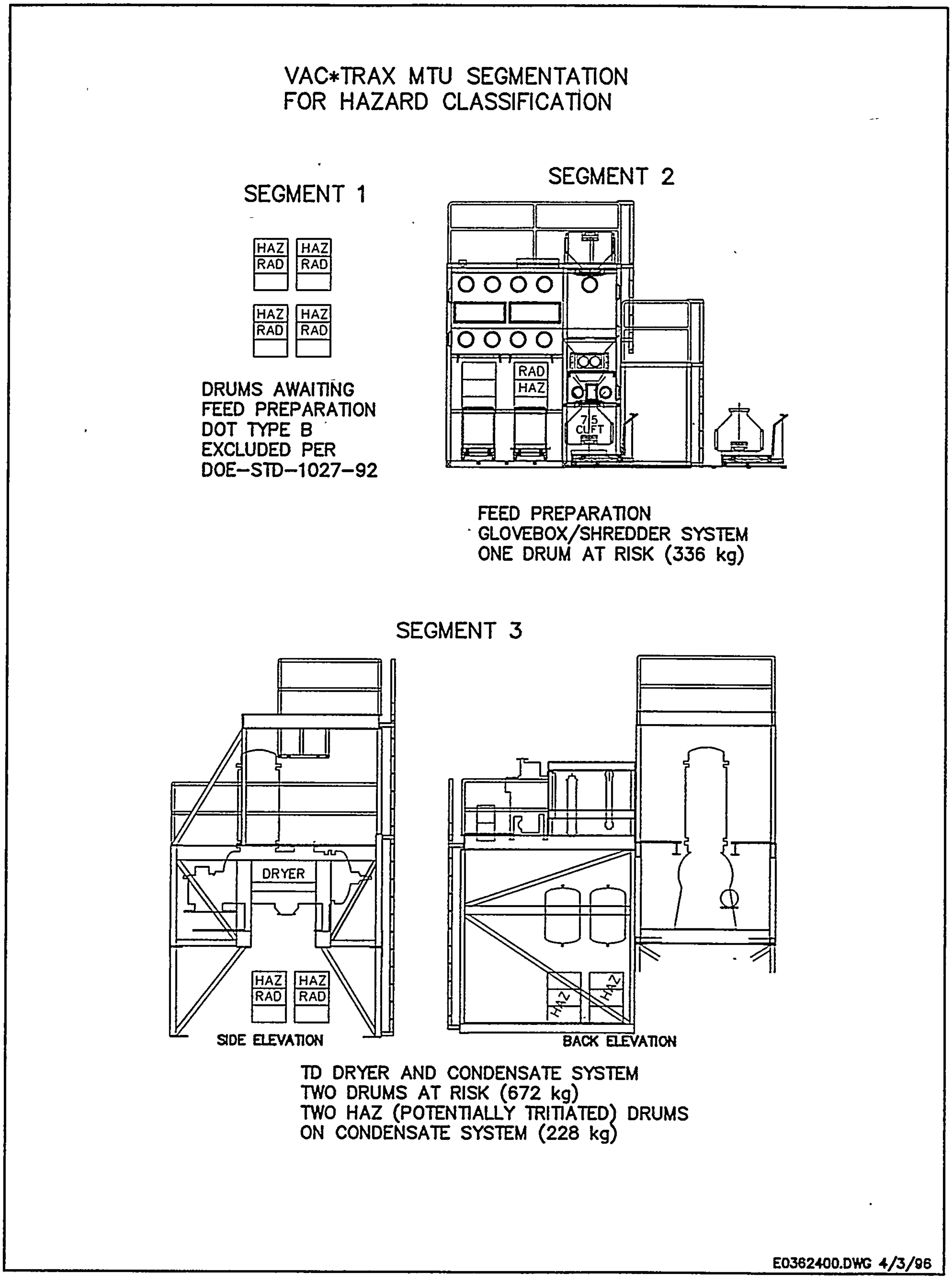


*Figure 5–1. VAC*TRAX MTU Segmentation for Hazard Classification*

5.5 Accident Scenarios

Accident analysis entails the formal quantification of a limited subset of accidents (i.e., DBAs). These accidents represent, as noted in DOE Order 5480.23, "a complete set of bounding conditions." The identification of DBAs for the VAC*TRAX MTU was based on the hazard evaluation ranking of the complete spectrum of facility accidents described in Appendix C.

Four accident scenarios were chosen for possible DBAs as a result of the HAZOP analysis. These DBAs were: (1) failures due to natural phenomena; (2) waste acceptance criteria failure; (3) a feed preparation glovebox failure resulting in either a fire or explosion and a catastrophic release of contaminants; and (4) dryer failure resulting in a fire or explosion and a catastrophic release of contaminants. A fault tree. analysis was done for each of these scenarios to evaluate the probability of the occurrences. The fault tree analyses are shown in Appendix C.1.4. The fault tree analyses detail the following probabilities of occurrence of the accidents.

1. On the basis of an earthquake scenario, failure due to natural phenomena has a calculated probability of 10^{-6} (Figure C.2–1). The principal mitigator is the seismic analysis that was done as part of the MTU equipment and structural design. Other natural phenomena are outside the scope of this study because the design of the structure to house the MTU will be by others. It is assumed that an adequate secondary containment will be constructed by the host site as part of the RCRA-permitted building.

2. Because of the possibility that waste could be received that was not properly characterized, or the information provided was not properly reviewed, failure of waste to be in compliance with the waste acceptance criteria is evaluated to be a probability of 10^{-7}. The consequences of this failure are not likely to be severe. See fault tree shown in Figure C.2–2.

3. The probability of feed preparation glovebox failure is 10^{-8}, because a fire or explosion accident can happen only if sufficient oxygen, an ignition source, and a fuel source are present simultaneously. Autoignition is not possible. The scenario takes into account the instrumentation, containment, and other design features that mitigate the accident. The analysis assumes there is always sufficient fuel. The primary mitigator is the nitrogen purge that reduces the oxygen, therefore eliminating the potential for explosion or fire. See fault tree shown in Figure C.2–3.

4. Dryer failure with catastrophic release occurs when of oxygen is introduced into the process equipment and is assessed to be a probability of 10^{-7}. The major mitigator (nitrogen environment) is much the same as the oxygen inclusion in the feed preparation glovebox. See fault tree shown in Figure C.2–4.

Due to the significance of nitrogen as a mitigator for feed preparation glovebox and dryer failure, precautions should be taken to limit any single mode failure of the nitrogen system and its backup (e.g., protection of pipe runs).

5.5.1 Design Basis Accident for the VAC*TRAX MTU

The VAC*TRAX MTU DBA, which is considered bounding for all potential accidents, is the glovebox fire or explosion scenario. The TD process has the potential for ignition of acetone or methanol contained in the waste, either in the feed preparation shredder or in the dryer unit. A rapidly expanding fire is assumed. The glass on the feed preparation glovebox could be blown out during a rapid fire and the dryer could release material through a blown seal. Therefore, the fire scenario was chosen as the bounding DBA for the MTU. However, an explosion of components is not considered possible.

The fire scenario involves the worker in the building containing the MTU, the nearest non-MTU worker on the site, and the off-site public. It is assumed that oxygen is introduced into the feed preparation glovebox, or into the MTU process system, and that sufficient fuel and ignition is available for initiating a fire.

The MTU worker is assumed to reside in the building during the fire for 30 minutes, thus allowing time for rescue if the worker is not capable of self rescue. The nearest non-MTU worker and the offsite public member is assumed to reside at their location for the duration of the atmospheric plume passage.

5.5.2 Design Basis Accident Scenarios

Three scenarios were assessed for their potential impacts on the worker and the public from unmitigated accidents involving the MTU process and are described in detail in Appendix B. Each scenario for the DBA is described in the following cases.

Worst Case: The waste acceptance criteria is assumed to be violated, which results in flammable levels of material that initiate a fire in the feed preparation system or in the dryer. Plutonium in the waste is assumed to be available at levels up to 100 nCi/g and acetone levels at up to 24 weight percent of the waste.

Worst Likely Case: On the basis of data from the treatability testing with the pilot-scale VAC*TRAX unit, flammable material is again assumed present in the waste, which initiates a fire in the feed preparation system or in the dryer. Plutonium is assumed to be available at levels up to 3,300 pCi/g, methanol at up to 41,000 parts per million (ppm), and methylene chloride at up to 29,000 ppm.

Likely Low-Activity and Low-Hazardous Concentrations Case: This case represents debris waste material primarily from clean-up of spills that occurred in a RMMA. The majority of wastes identified for treatment with the VAC*TRAX MTU is debris. Plutonium and uranium are assumed to be present in a 50/50 mixture, at a radioactivity level of 100 pCi/g, and methanol at 100 ppm.

The maximum level of waste was assumed to be two 55-gal drums, which is the maximum MAR for the VAC*TRAX MTU, and occurs for the dryer unit (i.e., 672 kg waste). It was assumed that a fire in either the feed preparation system or the dryer would not involve the other component, due to process separation and location of the components.

5.6 Accident Consequences

Fire DBA consequences were assessed for each source-term scenario for the VAC*TRAX MTU, as described in Section 5.5. Concentrations and doses of hazardous constituents are presented in Appendix A and summarized in Table 5–2 for the distances determined from the evaluation basis site characteristics. Additional consequences at several other distances are given in Appendix C.

Table 5–2. Radiological Dose and Hazardous Concentrations for the Fire DBA

Fire DBA Event	Source Term	Thermal Desorption Worker*	Onsite Nearest Worker (0.3 km)	Site Boundary (2.8 km)
Worst Case	100 nCi/g Pu	78 rem	31 mrem	0.77 mrem
	24 wt. % Acetone	5E7 ppm	10,000 ppm	65 ppm
Worst Likely Case	3.3 nCi/g Pu	2.6 rem	1 mrem	0.025 mrem
	41,000 ppm Methanol	35 ppm	2.5 ppm	0.016 ppm
	29,000 ppm Methylene Chloride	270 ppm	5.9 ppm	0.038 ppm
Likely Low-Activity, Low-Hazardous Concentration	0.1 nCi/g 50/50 U and Pu	39.4 mrem Pu 9.2 mrem U	0.016 mrem Pu 0.006 mrem U	0.0004 mrem Pu 0.0001 mrem U
	100 ppm Methanol	0.086 ppm	0.006 ppm	0.00004 ppm

*Unprotected worker - no credit is given for mitigators, such as respirators or other emergency equipment available in the work area.

Key: Pu = Plutonium
U = Uranium
km = kilometer(s)
nCi/g = nanocuries per gram
wt. % = weight percent
ppm = parts per million
mrem = miilliroentgen(s)

6.0 Defense-In-Depth

This section summarizes the defense-in-depth (i.e., prevention of uncontrolled hazardous or radioactive material releases) provided by the passive design features, engineered safety features (ESFs), and administrative controls for each type of hazard identified in the VAC*TRAX MTU PHA. ESFs and administrative controls that mitigate potential hazards were identified and evaluated during the HAZOP analysis. Table C.1.3–1 contains a list of all potential hazards identified and their respective safeguards. Sections 3.0 and 4.0 also describe some of the major safety design features of the MTU.

Of the 102 potential hazards identified, only three were considered significant and are addressed in this section. The remaining hazards were evaluated for potential design improvements to lessen their severity and/or their frequency.

As presented in Section 5.3, the three significant hazards identified during this PHA were that the VAC*TRAX MTU design: (1) allowed inclusion of oxygen in the off-gas condenser system; (2) did not provide sufficient control of the oxygen content in the shredder portion of the feed preparation glovebox; and (3) allowed oxygen inclusion in the process dryer. The condenser system was redesigned to separate the primary and secondary condensers and to provide for manual discharge of the condensate from both condensers. Resolution of the second hazard was to introduce the nitrogen purge for the feed preparation glovebox through the shredder area, ensuring that the nitrogen does not bypass the location with the highest probability of having an ignition source. Resolution of the third hazard resulted in the addition of a second rupture disk, in series, to eliminate the possibility of oxygen entering the dryer if the initial disk ruptures.

The design for the VAC*TRAX MTU has various design features to mitigate the DBA. The need for containment of the MAR is addressed as part of the MTU design. Where the worker could be exposed to MAR, gloveboxes will be used for containment of the waste. Four gloveboxes are used: (1) for feed preparation; (2) for shredder discharge; (3) for dryer loading; and (4) for dryer discharge. The gloveboxes employ either a bagged transfer station or a bagless transfer station. The feed preparation glovebox is nitrogen purged to inert the atmosphere because although the waste normally has enough fuel to combust it requires oxygen concentrations above the lower explosive limit (LEL) and an ignition source. Two independent monitors provide alarms if the oxygen concentration rises above the SOP five percent level. One analyzer is an oxygen analyzer. The second is a percent LEL analyzer. The design recognizes the shredder as the most likely ignition source, consequently, the glovebox nitrogen flow is introduced through the shredder to assure that the most likely place for an explosion is inert.

The processing system has been designed to minimize, or essentially preclude, the possibility of oxygen inclusion. Redundant oxygen analyzers are used to monitor the oxygen in the dryer and condensate systems. The dryer seals are the most likely location for oxygen to be allowed into the system. The seals are purged with nitrogen and even if they become worn the likelihood of excessive oxygen is remote.

The design employs a proven programmable logic control system with all critical instrumentation alarmed, including the capability for automatic shut-down of the MTU should critical operating parameters be exceeded. The SOP for the MTU will ensure the safe operation of the MTU. The instrumentation assures the information is available to the operator to safely operate the unit.

On the basis of the PHA, there are no structures, systems, or components (SSCs) of the VAC*TRAX MTU that are considered safety class SSCs. In accordance with the guidance provided in DOE–STD–3009, safety class SSCs are those which accident analyses indicates are needed to prevent accident consequences to the public from exceeding the evaluation guidelines. As presented in Appendix C.4, the unmitigated accident consequence results for the MTU are several orders of magnitude less than the guidelines at the site boundary;* therefore, no SSCs are considered safety class SSCs. This identification of no safety class SSCs is consistent with DOE–STD–3009, which indicates that safety class SSCs normally will not be associated with Hazard Category 2 and 3 facilities due to their limited potential for off-site impact.

Safety significant SSCs are those SSCs not designated as safety class SSCs, but their preventive or mitigative function is a major contributor to defense-in-depth and/or worker safety as determined from the hazard analysis. According to the guidance provided in DOE–STD–3009, safety significant SSC designations based on worker safety are limited to those SSCs whose failure is estimated to result in a worker fatality or serious injuries to workers. The guidance also indicates that the distribution of the hazardous material inventory is a key consideration in designating safety significant SSCs (e.g., if the total hazardous material inventory is distributed over a hundred containers, the failure of any one container does not constitute a major uncontrolled hazardous material release). As presented in Section 5.4 and Appendix C.4, the VAC*TRAX MTU is a low-hazard Radiological Facility, which is a facility that does not meet or exceed the Hazard Category 3 threshold criteria of the potential for only significant localized consequences, and has hazards that present minor on-site and negligible off-site impacts to people and the environment. The risk of any injury to an MTU worker is low, and the risk of serious injury or death from operation of the MTU is considered nonexistent. Therefore, based on the guidance and the design of the MTU, no SSCs are considered safety significant SSCs.

* Per telephone conversation between R. L. Morris, Rust Geotech, and Vince Wahler, DOE–AL Nuclear Safety Division on March 8, 1996 (Wahler 1996), the applicable guideline indicates a fence line dose to a member of the public in excess of 25 rem committed effective dose equivalent (CEDE).

7.0 Conclusions and Recommendations

On the basis of this PHA, the overall risk to any population group from operation of the VAC*TRAX MTU has been determined to be very low. The MTU is classified as a Radiological Facility (i.e., less than a Hazard Category 3 facility), with low hazards (i.e., minor on-site and negligible off-site impacts to people and the environment).

The unmitigated accident consequence results for the MTU are several orders of magnitude less than the guidelines at the site boundary; therefore, no SSCs are considered safety class SSCs. The risk of any injury to an MTU worker is low, and the risk of serious injury or death from operation of the MTU is considered nonexistent. Therefore, no SSCs are considered safety significant SSCs.

The PHA did not consider a secondary containment system in the unmitigated accident analysis, thereby maximizing the radiological doses and contaminant concentrations. However, for site use, this PHA assumes a RCRA-permitted building will be provided for the MTU operation.

No further action is required to reduce risks because changes to the design of the VAC*TRAX MTU were made concurrent with the hazard identification and analysis. Recommended actions have already resulted in design changes to reduce the risks to acceptable levels, take advantage of cost effective features, and improve design operability. The evaluation of the frequency or consequence of the risks and the mitigative features implemented in the VAC*TRAX MTU design are documented in Table C.1.3–1 and summarized in Section 5.3. All hazards with initial risk rankings of 1 or 2 have been reduced to acceptable risk rankings of 3 or 4.

Based on the final hazard classification as a Radiological Facility and the guidance given for facilities with a final radiological classification (Section 6.3 of the *Guidance for The Preparation of MWT* Process Hazards Analysis [DOE 1950]), this PHA is adequate as the only safety basis documentation for supporting DOE authorization to operate the VAC*TRAX MTU at all user sites. No additional safety basis documentation (supplemental safety analysis and/or a full scope SAR) is recommended.

This page intentionally blank

8.0 References

Homann, S.G., 1994. *HOTSPOT: Health Physics Codes for the PC*, Hazards Control Department, Lawrence Livermore National Laboratory, University of California, Livermore, California.

________, 1988. *EPIcode: Emergency Prediction Information*, Homann Associates, Inc., Fremont, California.

Lange, N.A., Ph.D., 1961. *Handbook of Chemistry*, Tenth Addition, McGraw-Hill Book Company, Inc., New York, New York..

Liquid Air Corporation. "FLOAL Nitrogen Systems for the Chemical Process Industry," *Tech Specs*, Liquid Air Corporation, Walnut Creek, California.

U.S. Code of Federal Regulations:
- Title 29, "Labor."
- Title 40, "Protection of Environment."
- Title 49, "Transportation."

U.S. Department of Energy, 1996a. *Thermal Desorption Treatability Test Conducted With VAC*TRAX Unit*, GJPO–MWTP–5, prepared by Rust Geotech for the U.S. Department of Energy Grand Junction Projects Office Grand Junction, Colorado, January.

________, 1996b. *VAC*TRAX Mobile Treatment Unit Design Report*, GJPO–MWTP–20, prepared by Rust Geotech for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, April.

________, 1995. *Guidance for the Preparation of MWT Process Hazards Analysis,* prepared by the Treatment Selection Team for the Waste Management Division, U.S. Department of Energy Albuquerque Operations Office, Albuquerque, New Mexico, March.

________, 1994. *AL Mixed-Waste Treatment Plan,* prepared by the Treatment Selection Team for the Waste Management Division, U.S. Department of Energy Albuquerque Operations Office, Albuquerque, New Mexico, March.

U.S. Department of Energy Orders
- DOE Order 5480.21, *Unreviewed Safety Questions*, 1991.
- DOE Order 5480.23, *Nuclear Safety Analysis Reports*, 1994.
- DOE Order 5480.31, *Startup and Restart of Nuclear Facilities*, 1993.

U.S. Department of Energy Standards
- DOE–STD–1020–92, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, 1992.
- DOE–STD–1027–92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* 1992.
- DOE–STD–3009–94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* 1994.
- DOE–EM–STD–5502–94, *Hazard Baseline Documentation* 1994.

U.S. Department of Health and Human Services, 1990. *NIOSH Pocket Guide to Chemical Hazards*, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute of Safety and Health, Washington, D.C., June.

Wahler, Vince, 1996. Personal communication between Vince Wahler, Nuclear Safety Division, U.S. Department of Energy Albuquerque Operations Office, Albuquerque, New Mexico, and R. L. Morris, Rust Geotech, Grand Junction, Colorado, March 8.

Appendix A

Evaluation Basis Site Characteristics

A.1 Assumed Generic Site Characteristics

A.2 Assumed Attributes of Generic Secondary Containment

A.3 MTU Accidents as Initiators of External Accidents

This page intentionally blank

Appendix A. Evaluation Basis Site Characteristics

This appendix provides information on the methodology and assumptions used to develop the site characteristics. These characteristics are referred to as the evaluation basis site characteristics (EBSC). The EBSC were considered during the VAC*TRAX mobile treatment unit (MTU) Process Hazards Analysis (PHA). Because the unmitigated accident analysis is based on a generic set of site characteristics, simplified assumptions were used in the development of the characteristics to ensure conservatism. The design basis accident (DBA) selected as bounding for all potential VAC*TRAX MTU accidents was a fire in the feed preparation glovebox.

A.1 Assumed Generic Site Characteristics

The unmitigated accident analyses were conducted in a generic fashion to ensure that the consequences would be bounding for each site using the VAC*TRAX MTU. The distances to the nearest on-site facility and site boundary where determined based on information from Sandia National Laboratories, New Mexico (SNL/NM). SNL/NM has proposed a location for the MTU. Los Alamos National Laboratory (LANL) and Pantex (PTX) have not determined where the MTU will be located on site. Therefore, the analyses were conducted in a conservative manner to ensure that all sites could apply the results to their facilities. Table A.1–1 presents a summary of the EBSC considered during the unmitigated accident analyses.

Table A.1–1. Evaluation Basis Site Characteristics Summary

Site Attribute	SNL/NM	EBSC
Closest distance to site boundary	2.8 km (1.736 mi)	2.8 km
Distance to nearest occupied building or area	0.3 km (0.186 mi)	0.3 km
Distance from MTU to MTU-exclusion-area boundary	Unknown	To be determined
Pertinent meteorology	Worst case	Worst case

Note: EBSC distances are assumed, based on SNL/NM facility information. The worst case meteorology was used for the unmitigated accident analyses, which included a ground-level release with Category-F stability and a 1-m/s windspeed.

Generic, conservative meteorology was assumed for the unmitigated accident analyses. Ground-level releases were assumed along with a Category-F stability and 1 meter per second (m/s) windspeed. These worst-case assumptions ensure that the maximum dose and concentration location is not missed in the analysis. The consequences for the analyses are over predicted, because the contaminant plume would have some effective height of release due to the heat of the fire, thus allowing for additional dilution of the plume and this effect was not considered in the analyses.

The VAC*TRAX MTU is not expected to be significantly impacted by external events. Reactive and ignitable/flammable waste will be stored SNL/NM in skid-mounted storage buildings located approximately 100 feet to the northeast and to the northwest of Building 6920, the proposed location of the VAC*TRAX MTU.

A.2 Assumed Attributes of Generic Secondary Containment

The unmitigated accident analyses do not take into account secondary containment. Therefore, radiological doses and hazardous contaminant concentrations are maximized in the analyses.

Treatment, storage, and disposal facility regulations (40 CFR 264) include requirements for secondary containment for tanks and containers. These standards, or equivalent standards administered by a State, will be incorporated into a Resource Conservation and Recovery Act (RCRA) Part B permit for each facility. Thus, the Part B permit will interpret these standards and state the specific requirements. At a minimum, Part B permit requirements are likely to include secondary containment for vessels and containers containing free liquids. This secondary containment could either be constructed into the skid or it could be incorporated into the construction of the facility housing the VAC*TRAX MTU.

To be independent of the design of host facilities, the VAC*TRAX MTU condenser and condensate collection tank skid has been designed to incorporate secondary containment. Secondary containment for spill control, in the form of a sump built into the bottom of the condensate system skid, is included in the VAC*TRAX MTU design. The floor of the skid will be constructed with grated material to allow spilled materials to fall through to the sump, where they will be contained.

It is considered the responsibility of the host site to ensure that the VAC*TRAX MTU is located in an area where external events would not impact the unit.

A.3 MTU Accidents as Initiators of External Accidents

The potential unmitigated accidents, developed from Appendix C, are not considered to be potential initiators of external accidents. The fire DBA would result in a rapidly expanding fire; however, it would not have enough force to create events at other facilities at the site. In addition, the mitigators for the fire DBA would likely stop a fire before it spread to other areas of the building where the VAC*TRAX MTU is located.

This generic analysis is not considered an appropriate avenue for analysis of VAC*TRAX MTU accidents as initiators of external accidents. Because the MTU will be located at multiple sites, it would be prudent for site personnel to ensure that the MTU is not located next to areas containing highly reactive or flammable material and that an adequate fire suppression system be installed.

Appendix B

Materials at Risk

B.1 Assumed Materials at Risk

B.2 Evaluation Basis Waste Characteristics

B.3 Assumed Cases for Process Hazards Analysis

This page intentionally blank

Appendix B. Materials at Risk

B.1 Assumed Materials at Risk

Characterization data for the mixed-waste streams proposed for treatment in the VAC*TRAX MTU is inadequate. To determine a maximum worst-case scenario for a Process Hazards Analysis of the MTU, available information, including data from characterization of the waste samples fed to the pilot-scale VAC*TRAX unit during treatability testing at the U.S. Department of Energy, Grand Junction Projects Office (DOE–GJPO), was reviewed. Also, a realistic approach was used to determine the amount of liquid that could be present without resulting in free liquids. Data collected from the VAC*TRAX treatability test feed preparation analytical results for Sandia National Laboratories/New Mexico (SNL/NM), Las Alamos National Laboratory (LANL), and Pantex (PTX) waste feed samples were used to determine the expected maximum worst-case scenario and a generic list of materials at risk (MAR).

It is assumed that the waste acceptance criteria for the VAC*TRAX MTU will be met by the host sites. The primary factors effecting MAR acceptability for VAC*TRAX MTU treatment are packaging and content characteristics.

B.1.1 Packaging

Waste shall be received in containers approved by the U.S. Department of Transportation (DOT) (i.e., authorized for the waste contained and chemically compatible with the wastes). The containers shall be 85-gallon (gal) overpack, 55-gal drums, or 30-gal drums that are free of surface defects, bulges, dents, or similar physical evidence of degradation, ice, snow, or mud. The containers shall have visible, legibly printed, stenciled, or hand-written markings. The markings shall include all of the following:

- Name and address of the generator.
- Gross package weight.
- Waste-stream identification number.
- Major radionuclides present.
- Maximum radiation level on contact and at 1 meter in air.
- Proper DOT labels and markings.
- Resource Conservation and Recovery Act (RCRA) hazardous waste markings.
- No extraneous markings.

B.1.2 Content Characteristics (Waste Acceptance Criteria)

The waste shall contain none of the following:

- Reactive metals.
- Pressurized containers.

- Etiological agents.
- Incompatible wastes within the same container.
- Explosives.
- Pyrophoric or shock-sensitive materials.
- Free liquids (greater than 40 percent).
- Asbestos.
- Beryllium from beryllium sources as defined by 40 CFR 61.
- Large nonpliable items such as lead shielding or steel shapes.
- Radioactivity levels greater than 100 nanocuries per gram (nCi/g).

B.1.3 Waste Processing Limitations

The VAC*TRAX MTU process is not intended for treatment of solids containing RCRA-regulated heavy metals. However, the process can be used to treat volatile organic compounds (VOCs) containing radionuclides and heavy metals. Treatment of VOCs containing radionuclides and heavy metals will include a preprocessing step and solidification/stabilization of the resulting solids, which will contain both radionuclides and heavy, nonvolatilizable metals. Tritiated organics with a high boiling point will remain with the solid matrix. Other volatile radioactive materials, such as tritium, will end up dispersed through the off-gas system.

Normal operating conditions of the VAC*TRAX MTU is up to 600 °F, at nearly full vacuum, when treating nontemperature-degradable solids such as vermiculite, soils, and sludges. Temperature-sensitive materials, such as plastics and personal protective equipment that soften or melt when heated, are limited to treatment below their melting point and nearly full vacuum. Processing different concentrations of volatile materials may result in varying run durations. The VAC*TRAX MTU process is flexible in accommodating a wide variety of concentrations of volatiles and multiple volatiles in the same waste stream.

Each waste stream treated will have an individual run plan that addresses the contaminants of concern, physical properties such as boiling points at various pressures, radioactive constituents, and the operating conditions for the particular waste. Industrial hygiene and health physics issues also will be addressed in the run plan, and specific precautions will become mandatory operating conditions.

B.1.4 Quantity of MARs

For the basis of this analysis, it is assumed that the VAC*TRAX MTU will be installed in a RCRA-permitted building at the host site. Installing the MTU inside a building constitutes the secondary containment for the MAR. If a large building is chosen, it can be partitioned off to minimize the size of the process area. The minimum square footage required for the operation of the VAC*TRAX MTU is 1,296 square feet (ft^2), of which 870 ft^2, based on the primary skid layout as shown on Figure 4–1, needs to be in a radioactive material management area (RMMA). Support equipment and utilities that will not be in contact with the contaminants of concern will be located outside the RMMA. These systems include closed-loop chiller systems, transformers, a hot-oil system, and a nitrogen-generation system.

Table B.1.4–1 presents a summary of the maximum quantities of MAR allowed, or estimated, at each stage of the VAC*TRAX MTU process.

Table B.1.4–1. Summary of Volume and Weight of Materials at Risk

Stream	Volume (ft^3)	Pounds (kg)	Containment
Feed	22.1	2200 (1,000)	Sealed Drums[a]
Glovebox	7.35	735 (333)	Sealed Glovebox
Dryer/Intermediate Bins	14.7	1470 (672)	Dryer or Sealed Bin
Solid Residual	14.7	1400 (636)	Dryer or Sealed Bin
Condensate	7.35	460 (208)	Sealed Drum
Total	66.2	6,265 (2,849)	All Normally Sealed

[a] 85-gal overpack, 55-gal drums, or 30-gal drums.
Key: ft^3 = cubic feet
kg = kilograms

The maximum quantity of MAR allowed in the feed preparation staging area at one time is limited to the amount of material required to efficiently process the waste, which is two 55-gal drums of solids. The maximum quantity of MAR allowed in the processing area at one time is limited to the equivalent volume of three sealed 55-gal drums awaiting feed preparation. Considering a worst case of three 55-gal drums in the processing area, the maximum quantity of MAR will be 22.1 cubic feet (ft^3) with a maximum weight of 2,200 pounds (lb) or 1,000 kilograms (kg). Each 55-gal drum contains 7.35 ft^3 volume. The material in a filled drum is assumed to be soils and sludges and the weight is based on 100 pounds per cubic foot (lb/ft^3). The weight of each drum is 739 lb or 336 Kg.

The feed preparation glovebox can contain one trash drum for rejected materials and one waste drum for waste to be treated. For this analysis, the trash drum is assumed either to be empty or to contain some rejected material from the drum being filled during feed preparation. Both drums are bagged out to the feed preparation glovebox, providing a sealed barrier between the open drums and the room. The glovebox is nitrogen purged and has a ventilation system separate from the main VAC*TRAX MTU off-gas system. The glovebox has automatic overpressure relief. The feed preparation glovebox can be, and normally will be, operated independent of the MTU processing equipment. The maximum MAR in the glovebox is 7.35 ft^3 at up to 739 lb or 336 kg.

The feed preparation operation warrants special design considerations because this is when the containers will be opened first. Feed preparation involves sorting materials that are appropriate for treatment in the VAC*TRAX MTU. The trash drum is used to contain unsuitable materials. The materials will be spread out on a sort table where they can be visually inspected through the windows and manually segregated through the glovebox. The environment inside the glovebox will be controlled by nitrogen addition to maintain acceptable oxygen concentrations and to keep the atmosphere below the lower explosive limit (LEL) of the expected volatiles. The oxygen and LEL concentration will be continuously monitored and alarmed. The monitoring instruments will be recalibrated as required and recommended by the manufacturer, or user site requirements, but no less than weekly or whenever waste streams are changed.

Material determined suitable for TD treatment will be shredded and discharged to a transfer hopper. The shredder is an integral part of the feed preparation glovebox. The transfer hopper is equipped with a commercially available bagless transfer door. At various times in the operation there could be less MAR in the staging area and more MAR in the transfer hopper. The total MAR remains the same and it is always in sealed containers. No additional MAR need be accounted for.

The dryer is designed to contain the solid material. Volatilizable material is collected in an off-gas system. The batch-operated dryer will normally contain a 1-day-operation volume of material, or the equivalent of two 55-gal drums of material, at various states of processing. The worst-case scenario is when the dryer is first filled. The dryer is equipped with a feed glovebox where the sealed bagless transfer bins discharge into the feed glovebox and flow to the dryer. The operation is sealed from the room and nitrogen purged. Any unexpected or unacceptable materials found would have been discovered and removed during feed preparation and should not be found in the dryer feed. Containment and maintenance of the dryers controlled atmosphere are the primary safeguards. When the dryer is filled, the inlet valve is closed and the MAR is sealed in the dryer. The main off-gas filters will contain the solid residuals. The maximum volume of material in the dryer is 14.7 ft^3, 1,478 lb or 672 kg of soils, or 400 lb or 182 kg of debris.

Residuals from the process include treated solids, condensate, and spent carbon. The solids residual from the dryer will be nearly the same volume as the feed material but lighter by the weight of material volatilized. The volume of solids residual will be a maximum of 14.7 ft^3, weighing less than 1,400 lb or 636 kg. The solids residual will be dustier than the feed but will not constitute a potential dust explosion problem. Solids residuals will be sealed in 55-gal drums for disposal as low-level radiological waste. Generally, the solids residuals will contain all the radioactive material and none of the hazardous components of the original feed material. The exception is when RCRA-regulated heavy metals were present in the feed.

The amount of condensate collected will be administratively limited to two 30-gal drums. Two 30-gal drums, with a total volume of 8.4 ft^3 and a total weight of 502 lb or 228 kg, will be the maximum condensate residual permitted to accumulate during any processing campaign. The drums will contain condensate from multiple waste runs. The hazardous waste, nonradioactive condensate containers will be sealed between runs. The quantity of organics contained in the spent carbon drums is not significant enough to be considered in this analysis.

B.1.5 Hazard Classification

Hazard classification as required by DOE Order 5480.23, *Nuclear Safety Analysis Reports*, is a two-fold system. The first element involves the initial, or preliminary assessment of the inventory of hazardous MAR and the estimate of the hazard classification. Once a hazards analysis has been performed the hazard classification can be finalized. The final classification is based on an "unmitigated release" of available material. For the purposes of hazard classification, "unmitigated" is meant to consider material quantity, form, location, dispersability, and interaction with available energy sources, but does not consider safety features (e.g., ventilation system, fire suppression, etc.) which will prevent or mitigate a release. Figure B.1.5–1 presents a flow chart of the hazard classification process.

DOE Standards (DOE–STD–1027–92 and DOE–EM–STD–5502–94) were used as guidance for the preliminary and final hazard classification of the VAC*TRAX MTU. DOE–STD–1027–92 provides guidance on the requirements for the development of a safety analysis report (SAR) based upon the hazard classification for nuclear facilities with Category 1 through Category 3 hazards.

DOE–EM–STD–5502–94 provides additional guidance for further classification of facilities that are below the nuclear facility Category 3 hazard classification, and contains criteria for grouping environmental management facilities into nuclear, radiological, non-nuclear, or industrial categories. Only facilities that fall below the Category 3 classification threshold are exempt from the requirements of DOE Order 5480.23.

DOE–STD–1027–92 identifies a threshold for the total segmented inventory of a Category 3 nuclear facility. The quantity limits in Attachment 1 of DOE–STD–1027–92 were developed by taking the product of the airborne release fraction and effective dose equivalents from different pathways or sources (e.g., inhalation, ground contamination, and cloud shine).

To establish a hazard classification system based on inventories in DOE–STD–1027–92 DOE modified the U.S. Environmental Protection Agency (EPA) reportable quantities (RQs) for radionuclides defined in 40 CFR 302.4, Appendix B. The values for radionuclides represent levels of material which, if released, would produce less than 10-rem doses at 30 meters (m) based on a 24-hour exposure. For the period of exposure, the DOE hazard classification models assume that persons are exposed for one day for inhalation and direct exposure, but that persons are exposed for longer periods through the ingestion pathway in order to account for the slow movement of radionuclides in groundwater. Radioactive decay is not taken into account for the sake of conservatism and simplicity.

DOE–STD–1027–92 also modifies the hazardous release fractions used by the U.S. Nuclear Regulatory Commission (NRC) in NUREG–1140 and assumed a value of 10^{-3} for solids, powder, and liquid. DOE believes that the 10^{-3} value is a reasonably conservative approximation because it will be applied to an entire building without scenario-specific considerations. DOE recognizes that some accidents, particularly those involving powders and liquids, can produce much higher values, whereas accidents involving metals would normally produce slightly smaller release fractions. However, it is unlikely that any event will affect all material in a building, and high release phenomena such as explosions, pressurization, etc., will affect only a localized fraction of the material. Therefore, the 10^{-3} is a reasonable average for hazard categorization purposes and was considered acceptable for hazard classification of the VAC*TRAX MTU.

The radionuclide of interest for the MTU is plutonium 239 (Pu-239) because it is the most likely radionuclide to be in the nontransuranic waste streams to be treated. Pu-239 also is among the most limiting radionuclides in regard to concentration and inventory limits. Acetone was chosen as the worst case hazardous chemical because of past processing knowledge. Most chemical concentrations slated for the waste treatment with the VAC*TRAX MTU are in the parts-per-million range. See Table B.2.2–1 for the evaluation basis waste characteristics.

Preliminary Hazard Classification

The preliminary hazard classification of the VAC*TRAX MTU required identification of the MAR. The quantity of MAR for the MTU are described in detail in Appendix B.1.4 and provide the basis for the preliminary hazard classification. A preliminary hazard classification does not require assessment of specific accident scenarios; rather, it is based upon the total inventory considered at risk in the process.

DOE Order 5480.23 states that an analysis and categorization is to be performed on "processes, operations, or activities" and not necessarily whole facilities. For the purpose of hazard categorizing and estimating the MAR inventory for the VAC*TRAX MTU, the objective was to understand the available hazards that could interact and cause harm to individuals or the environment. It is not desirable to estimate the potential consequences from an inventory of hazardous materials when facility features would preclude bringing this material together. Therefore, the DOE Order 5480.23 allows the concept of facility segmentation, provided the MAR in one segment could not interact with MAR in other segments. The concept of independent facility segments was applied to the MTU where facility features preclude bringing MAR together or causing harmful MAR interaction from a common severe phenomenon.

Segmentation of the VAC*TRAX MTU

The VAC*TRAX MTU was divided into three primary segments: (1) three drums awaiting feed preparation; (2) the feed preparation glovebox and shredder; and (3) the dryer unit and condensate system. The three segments for the MTU are independent systems, thus ensuring that an accident in one segment would not precipitate a release in the other segments of the MTU. The skids represent primary segments of the facility. The feed preparation skid will be separated physically from the dryer and condensate skids which are bolted together. (See Figure 5–1). This ensures that an accident involving feed preparation will not result in a similar involvement of the dryer and condensate systems. See Figure 5–1 for VAC*TRAX MTU segmentation for hazard classification.

Segment 1: The three drums awaiting feed preparation, are not required to be included in the MAR inventory for the hazard classification. DOE–STD–1027–92 states that material contained in DOT, Type B shipping containers, with or without overpack, may be excluded from assessment of a facility's radioactive inventory.

Segment 2: The feed preparation glovebox and shredder are included in the total MAR inventory for the hazard classification. The feed preparation glovebox can contain one waste reject drum and one waste feed drum. However, the reject drum is either empty or contains partial contents of the drum being processed. The reject drum is used to contain materials unsuitable for the VAC*TRAX MTU. Suitable feed material will be shredded and discharged to a bagless transfer station. The total maximum MAR for Segment 2 will be one drum, weighing a total of 739 lb or 336 kg, based on soils.

Segment 3: The VAC*TRAX MTU dryer and condensate system are included in the inventory for the hazard classification. The dryer is designed to contain the solid material. Volatile material is collected in the off-gas system. The batch-operated dryer will normally contain a 1-day accumulation (two drums) of material, at various states of processing. The dryer is equipped with a feed glovebox. When the dryer is filled, the inlet valve is closed and the MAR is sealed in the dryer. The maximum volume of material in the dryer is 14.7 ft^3, weighing a total of 1,478 lb or 672 kg, based on soils.

The residuals from TD processing include treated solids, condensate, and spent carbon. The solid residuals from the dryer will be nearly the same volume as the feed material but lighter by the weight of material volatilized. The maximum volume of solid residue will be 14.7 ft^3, weighing less than 1,400 lb or 635 kg. The solids residuals will be dustier than the feed but will not constitute a potential dust explosion problem. The residue will be sealed in 55-gal drums for disposal as a low-level radioactive waste. Generally, the solids residuals will contain all the radioactive material and none of the hazardous components for the original feed material. The exception is when RCRA-regulated metals were present in the feed.

The amount of condensate collected will be administratively limited to two 30-gal drums. Two 30-gal drums, weighing 502 lb or 228 kg, is expected to be the maximum condensate residual accumulated during any processing campaign and would include condensate from multiple waste runs. Unless tritium is present in the feed, the condensate residual will be nonradioactive, hazardous waste. The condensate containers will be sealed between runs.

The spent carbon drums also will be sealed between runs. The carbon used in the drums will be the noncombustible grade. The quantity of organics contained in the spent carbon is not significant enough to be considered in this analysis.

Facility Classification

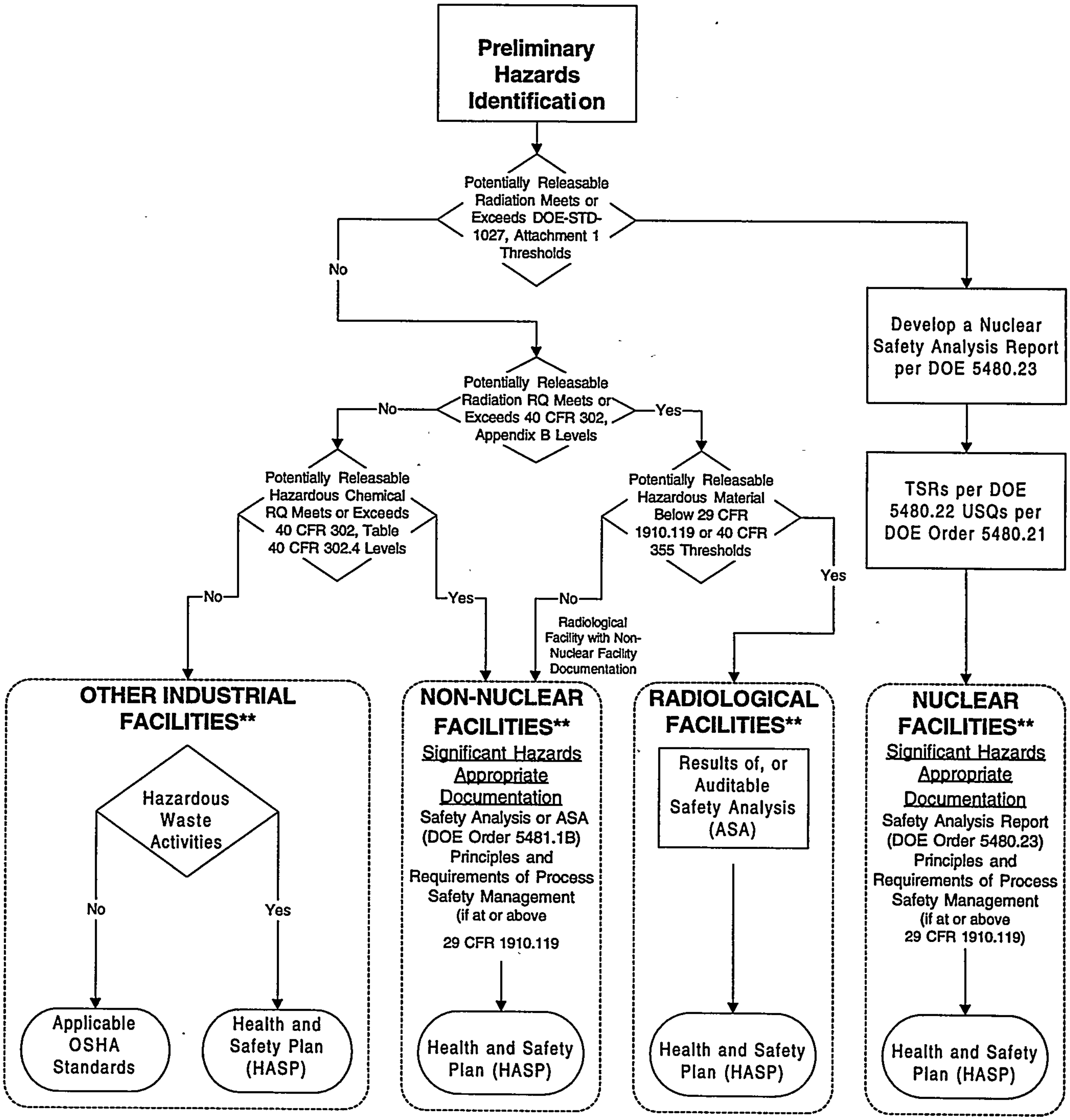
The most conservative estimate of MAR for the VAC*TRAX MTU hazard classification include MAR from the dryer and condensate system, consisting of a maximum two drums of mixed waste, weighing a total of 1,478 lb or 672 kg, and two 30-gal drums of non-radioactive condensate, unless tritium was present in the feed, weighing 502 lb or 228 kg potentially at risk. The worst-case concentration of contaminants assumed from the waste acceptance criteria, is plutonium (Pu-239) is at 100 nCi/g. This assumption results in a MAR of 0.067 curie (Ci) for Segment 3. Table A.1 of DOE–STD–1027–92 states that the Category 3 threshold of radionuclides is 0.52 Ci for Pu-239. Therefore, the MAR estimates for the VAC*TRAX MTU result in a hazard classification of less than a Category 3 facility. Tritium may be present in some waste forms and will be in the off-gas system and concentrated in the condensate. However, the tritium limit in DOE–STD–1027–92 is 1000 Ci of releasable material, and in 40 CFR 300, Appendix B, the RQ for tritium is 100 Ci. This level of tritium is not expected to be processed in the MTU.

DOE–EM–STD–5502–94 provides additional requirements for determining the hazard classification based on comparison of the MAR estimates to Table 302.4 of 40 CFR 302. The RQ for Pu-239 in Table 302.4 is 0.01 Ci. The VAC*TRAX MTU exceeds the RQ value therefore, it is classified as either a "Radiological Facility" or a "Radiological Facility with Non-Nuclear Documentation."

The determination of whether the VAC*TRAX MTU is a "Radiological Facility" or a "Radiological Facility with Non-Nuclear Documentation" is accomplished by comparing the estimates of the hazardous MAR to the RQ thresholds in 29 CFR 1910.119 and 40 CFR 355. The MAR estimates indicate that the chemicals listed in 29 CFR 1910.119 and 40 CFR 355 are not anticipated to be in the waste treated with the MTU. Therefore, the MTU is classified as a "Radiological Facility."

Although not part of the hazard classification for "Radiological Facilities," the RQs for the hazardous substances in the waste are included in Table 302.4 of 40 CFR 302 and a list of RQs of MAR from Table 302.4 of 40 CFR 302 are provided in Table B.1–2.

The worst-case hazardous substance in the wastes slated for treatment with the VAC*TRAX MTU is acetone, at 24 percent weight, resulting in a MAR for Segment 3 of 356 lb or 161 kg. The hazardous chemical components of the wastes expected for treatment with the MTU are well below the RQs in Table 302.4 of 40 CFR 302. The hazardous substances are all expected to be in the range of 10 to 41,200 parts per million (ppm), which results in each hazardous substance being far less than the minimum 1-lb each of MAR for the MTU.



** Other types of safety and health hazard identification and control documentation such as construction safety requirements, Chemical Hygiene Plans, and Hazcomm, may be necessary. All facilities with hazardous waste activities require a HASP as defined in 29 CFR 1910.120(a).

Figure B.1.5–1. Hazard Classification Process

Final Hazard Classification

The final hazard classification of the VAC*TRAX MTU is based on the results of the unmitigated accident consequences presented in Appendix C.4. The results of the selected DBAs, based on the quantitative results of the unmitigated accident scenarios, indicate that the preliminary hazard classification was appropriate. The unmitigated consequences result in localized hazards without significant consequences for surrounding facilities or the off-site public. Therefore, the facility is classified as a "Radiological Facility" according the classification scheme presented in DOE–EM–STD–5502–94. The unmitigated accident consequences, as presented in Appendix C, indicate that the results are several orders of magnitude less than the guidelines, at the site boundary, indicating that the MTU is a low-hazard facility.

Table B.1.5–2. Reportable Quantities for Hazardous Substances from 40 CFR 302

Hazardous Substance	Regulatory synonyms	RQ (lbs)	RQ (Kg)
Acetone	2-Propanone	5,000	2,270
Benzene	none	10	4.54
2-Butanone	Methyl ethyl ketone	5,000	2,270
Carbon tetrachloride	Tetrachloromethane	10	4.54
Dichloromethane	Methylene chloride	1,000	454
2,4-Dinitrotoluene	1-Methyl-2,4-dinitrobenzene	10	4.54
Hexachlorobenzene	Hexachlorobenzene	10	4.54
Hexachlorobutadiene	1,3-Butadiene	1	0.454
Hexachloroethane	Hexachloroethane	100	45.4
Methanol	Methyl alcohol	5,000	2,270
Nitrobenzene	Nitrobenzene	1,000	454
Toluene	Methyl benzene	1,000	454
Trichloroethene	Trichloroethylene	100	45.4
Trichloromonofluoromethane	Trichlorofluoromethane	5,000	2,270
Vinyl Chloride	Chloroethene	1	0.454
Xylene	Dimethylbenzene	100	45.4

B.2 Evaluation Basis Waste Characteristics

The concentration of the contaminants of concern has not been completely characterized for most of the wastes selected for treatment with the VAC*TRAX MTU. However, as a result of treatability testing with the pilot-scale VAC*TRAX unit, some waste characterization data exist. Initially, the VAC*TRAX MTU will be deployed to LANL, SNL/NM, or PTX. Characterization data from treatability tests performed with waste-stream samples from these three sites was used to set the limits for the hazardous and radioactive MAR which constitute the EBWCs.

B.2.1 Primary Constituents Expected

LANL

Data obtained from pilot-scale VAC*TRAX treatability testing of LANL waste-stream samples indicate the primary hazardous wastes, excluding RCRA heavy metals, are methanol, acetone, and dichloromethane. The *AL Mixed Waste Treatment Plan* (DOE 1994) and data sheets provided by LANL indicate that small quantities of trichloroethane, trichloroethylene, benzene, methyl ethyl ketone, toluene, and xylene may be present. Trace amounts of vinyl chloride, 2,4-dinitrotoluene, nitrobenzene, trichlorofluoromethane, hexachlorobenzene, hexachlorobutadiene, and hexachloroethane may be present.

SNL/NM

Data obtained from pilot-scale VAC*TRAX treatability testing of SNL/NM waste-stream samples indicate the primary hazardous wastes, excluding RCRA heavy metals, are 2-butanone, methanol, acetone, and dichloromethane. The waste-stream sample was primarily debris. Test samples were collected by selecting materials that appeared to be the most contaminated; consequently, the actual contaminant concentrations in the waste streams are subject to some uncertainty. Analytical results from the debris samples tested generally indicate the lower characterization limit for the primary hazardous wastes, suggesting that only trace amounts of the primary hazardous wastes are present. The *AL Mixed-Waste Treatment Plan* (DOE 1994) indicates that an indeterminant amount of various alcohols and paint thinners containing toluene and xylene may be found in the SNL/NM waste stream.

PTX

Little information is available on the PTX waste stream. The medium tested during the pilot-scale VAC*TRAX treatability tests was vermiculite used as packing for scintillation cocktails. The contaminants of concern found during treatability testing were toluene and xylene. The primary organic present was RCRA-nonregulated pseudocumene (trimethylbenzene). The large concentration of pseudocumene made it difficult to analyze for the toluene and xylene. The concentration of toluene was in the hundreds of parts-per-million (ppm) range, xylene was under 100 ppm, and pseudocumene was in the 16,000- to 47,000-ppm range.

The *AL Mixed Waste Treatment Plan* (DOE 1994) indicates that the PTX soils, which were not included in the pilot-scale VAC*TRAX treatability testing, may contain various solvents in trace amounts.

Table B.2.2–1 presents a summary of the properties of the hazardous constituents known to exist in the LANL and SNL/NM waste streams. Because the maximum operating temperature of the VAC*TRAX MTU is 600 °F, the autoignition temperature value for the hazardous constituents in Table B.2.1–1 will not be reached. However, some of the LELs for these hazardous constituents are very low in air. Nitrogen is used as a diluent, which effectively raises the LEL value for the contaminants of concern. For the major contaminants of concern actual LEL in a controlled oxygen environment of less than 5 percent oxygen is in the order of 7 to 10 percent. At a reduced oxygen content, a normally flammable mixture will be nonflammable. The maximum percent oxygen for nonflamability shown in Table B.2.1–1 is below the volume percent of oxygen at which the mixtures will be nonflammable. This information is from the *Air Liquid Tech Specs* brochure on "FLOAL Nitrogen Systems for the Chemical Process Industry." The maximum oxygen content for nonflamability will vary with temperature; when the temperature increases the values for nonflamability go down. The values given in the Table B.2.1–1 are for ambient air temperatures.

Table B.2.1–1. Summary of Hazardous Waste Properties

Chemical	MW	BP (°F)	LEL[a] (%)	AIT (°F)	TWA (ppm[b])	STEL (ppm[b])	IDLH (ppm[b])	VP (mm)	FP (°F)	Maximum O_2 for Nonflammability (%)
(%) Methanol	32	147	6	878	200	250	25,000	330	54	9.7
Acetone	58	133	2.2	1,118	250	1,000	20,000	180	0.00	11.6
Dichloromethane	85	104	14	1,224	50	LFC	5,000	350		c
Carbon Tetrachloride	154	170	NA	NA	LFC	2	300	1 atm	NA	c
Toluene	92	232	1.2	1,026	100	150	2,000	20	40	9.1
Xylene	106	281	1.1	924	100	150	1,000	9	81	8
Benzene	78	176	1.3	1,076	0.1	1	3,000	.75	12	11.2
Trichloroethylene	131	189	8	NA	25	200	1,000	58	90	c

[a] All LEL values are in air.
[b] The ppm values can be converted to mg/m^3 by multiplying ppm x MW/24.45 at 760 torr and 77 °F.
[c] Constituent is nearly nonflammable or nonflammable.

Key:

AIT = autoignition temperature
atm = atmosphere
BP = boiling point
FP = flash point
IDLH = immediately dangerous to life or health
LEL = lower explosive limit
LFC = lowest feasible concentration
mm = millimeters
MW = molecular weight
NA = not applicable
ppm = parts per million
STEL = short term exposure limit
TWA = time weighted average
VP = vapor pressure

References: *Handbook of Chemistry,* Tenth Addition (Lange 1961), and *NIOSH Pocket Guide to Chemical Hazards* (U.S. Department of Health and Human Services 1990).

On the basis of the reduced oxygen data, it is unlikely that flammable gaseous products of the VAC*TRAX process will combust even when the concentration of flammable gases exceeds the LEL in air (a worst-case scenario). The control is the addition of nitrogen to maintain the oxygen concentration below 5 percent. Two oxygen analyzers are provided in the design of the VAC*TRAX MTU and are interlocked to the appropriate process controls to ensure maintenance of the oxygen dilution. Both oxygen analysis and LEL analysis are continuously monitored in the feed preparation glovebox. The use of two independent oxygen and LEL analyzers further reduces the risk of loss of control. The VAC*TRAX MTU HAZOP and this process hazards analysis (PHA) addressed the risk of oxygen intrusion in the feed preparation and VAC*TRAX operation.

B.2.2 Concentrations of Major Hazardous Constituents

Limited data exist on the actual concentrations of hazardous constituents in the waste streams slated for treatment with the VAC*TRAX MTU. In general, the majority of the waste is debris or a heterogeneous mixture of solids. The fact that the material is heterogeneous does not effect the overall performance of the VAC*TRAX process. The dryer heating capacity is limited to the available heat transfer area and the heat transfer coefficient. The Mixed-Waste Treatment Program test report, *Thermal Desorption Treatability Test Conducted With VAC*TRAX Unit* (DOE 1996a), documents the design considerations. The conclusion from the treatability testing is that the VAC*TRAX system is very adaptable to variations in volatile or radioactive concentrations in wastes. The limitation is the amount of heat that can be transferred to the solids and, consequently, the rate or duration of vaporization of the volatile constituents. With the exception of tritium, radionuclides have little effect on the operation.

Data from the pilot scale VAC*TRAX treatability testing of LANL and SNL/NM waste samples indicate the maximum and minimum concentrations of the hazardous components as shown in Table B.2.2–1. The contaminant concentrations for most of the material is in the parts-per-million range. The majority of the material was generated during clean-up operations in radiologically contaminated areas.

Table B.2.2–1. Evaluation Basis Waste Characteristics

Chemical	LANL	SNL/NM
Methanol	41,200 to < 10 ppm	< 10 ppm
Acetone	150 to 88 ppm	< 10 ppm
Dichloromethane	29,000 to < 10 ppm	< 10 ppm
Chloroform	< 10 ppm	< 10 ppm
Carbon Tetrachloride	< 10 ppm	< 10 ppm
Benzene	< 10 ppm	< 10 ppm

Note: The data indicate the range of values found.
Key: ppm = parts per million

PTX waste also is expected to contain only parts per million of halogenated and nonhalogenated solvents. VAC*TRAX treatability testing of the PTX vermiculite waste samples contaminated with xylene, toluene, and pseudocumene demonstrated the flexibility of the process to safely treat higher concentrations of organics.

B.2.3 Radioactive Contaminants

The VAC*TRAX MTU will treat mixed waste with a radioactivity level less than 100 nCi/g. However, the VAC*TRAX process does not technically limit the radioactivity to less than 100 nCi/g. The radioactivity is contained in the dryer and consequently has little effect on the process. Tritium is the primary exception.

The gross alpha beta data for the composite waste-stream samples from LANL indicate a maximum of 3,300 picocuries per gram (pCi/g) alpha and up to 720 pCi/g beta. One sample received from LANL comprised approximately 160 individual sample bottles. A composite sample for treatability testing was selected from the individual sample bottles. Analysis of the radioactivity level from this composite was not considered typical or a good indicator of the actual level of radioactivity of the entire waste stream.

The SNL/NM waste-stream sample varied significantly from a high of 14,100 pCi/g alpha and 3,200 pCi/g beta to near background for both alpha and beta. This significant variation is expected because of the heterogeneous nature of the waste.

B.3 Assumed Cases for Process Hazards Analysis

For this process hazards analysis, three scenarios were selected on the basis of available site information, the TD treatability testing analytical data, and the VAC*TRAX MTU design waste acceptance criteria.

B.3.1 Waste Acceptance Criteria Case

The first case depicts a worst case where the concentration of contaminants of concern are bounded primarily by the waste acceptance criteria. On the basis of available information and recent testing, it is highly unlikely this scenario would ever be experienced. The basis is

Radioactivity: Plutonium-239 at 100 nCi/g.

Hazardous Constituents: Acetone at 24 weight percent.

It is unlikely that the radioactive constituents would only be plutonium. It is more likely that the radioactivity will be significantly less. The 24 weight percent acetone case depicts a sludge with a highly volatile hazardous-waste component. With the exception of the sludge tested from the GJPO, which was consumed during pilot-scale VAC*TRAX treatability testing, there is no evidence that any of the waste streams identified for treatment with the VAC*TRAX MTU contain this level of organics.

B.3.2 Likely Worst Case

Based on the data from treatability testing, the most likely worst case would be

Radioactivity: Plutonium-239 at 3,300 pCi/g.

Hazardous Constituents: Methanol at 41,000 ppm.
Methylene chloride at 29,000 ppm.

This case more realistically depicts the expected worst case.

B.3.3 Likely Low-Activity and Low-Hazardous Concentrations

This case represents debris primarily from cleanup of spills that occurred in a contaminated area. Presently, this case represents the majority of the waste identified to be treated with the VAC*TRAX MTU. The basis is

Radioactivity: A 50/50 percent mix of plutonium and uranium at background to less than 100 pCi/g .

Hazardous Constituents: Solvents (assume methanol) at less than 100 ppm.

This page intentionally blank

Appendix C

Process Hazards Analysis

This page intentionally blank

Appendix C. Process Hazards Analysis

C.1 Hazards Identification and Evaluation

The general PHA process entails data evaluation to determine material at risk; hazards identification, evaluation, and resolution; accident scenario analysis; and consequence analysis. These steps build on one-another to arrive at a determination of the degree of hazards involved in the process being studied. This PHA followed the roadmap presented in *Guidance for the Preparation of MWT Process Hazards Analysis* (DOE 1995).

The hazards identification, evaluation, and resolution portion of this PHA chose the hazards and operability analysis (HAZOP) tool for its investigation of the hazards in a methodical meticulous manner. This appendix provides the basis of evaluation, figures locating the components which were analyzed, and detailed hazards identification and evaluation worksheets.

C.1.1 Hazard Evaluation Criteria

The overall risk ranking of hazards were evaluated using the consequence, frequency, and risk categories defined in Tables C.1.1–1, C.1.1–2, and C.1.1–3. Risks were identified in the areas of safety, environmental, financial, and general. This PHA formally addresses only the safety risks, although action items from all risk categories were resolved. Table C.1.1–4 identifies the decision criteria followed in action item resolution.

Table C.1.1–1. Consequence Categories

Consequences Severity Categories				
	Safety	**Environment**	**Financial**	**General**
A High	Significant public exposure with significant health effects	Significant onsite and offsite contamination	Significant costs	Production shutdown for extended time
	High collocated worker exposure with major health effects			
	Potentially lethal worker exposure, loss of life from energy release			
B Moderate	Moderate public exposure with minor health effects	Significant onsite and minor offsite contamination	Moderate costs	Short-term production shutdown
	Significant collocated worker exposure with significant health effects			
	High worker exposure with major health effects, severe injury with disability			
C Low	Low public exposure with negligible health effects	Significant facility contamination	Low costs	Loss of production efficiency
	Moderate collocated worker exposure with minor health effects			
	Significant worker exposure with significant health effects, severe injury by no disability			
D Negligible	Negligible public exposure with no health effects	Minor facility contamination	Negligible costs	Minor production delay for repair
	Low collocated worker exposure with negligible heath effects			
	Moderate worker exposure with minor health effects, minor injury			

Table C.1.1–2. Frequency Categories

Frequency (Likelihood) Categories	
I (>0.1)	Normal operations; Once per month
II (0.1 to 0.01)	Anticipated Events; Once per waste stream
III (10^{-2} to 10^{-4})	Unlikely; Once per site visit
IV (10^{-4} to 10^{-6})	Very likely; Once in the life of the mobile treatment unit
V	Improbable; Impossible

Note: Frequencies determined specifically for the MTU, based on equipment life.

Table C.1.1–3. Risk Rank Matrix

Risk Rank Matrix					
Consequence Category	**Frequency Category**				
	I	**II**	**III**	**IV**	**V**
A	1	1	1	2	3
B	1	1	2	3	4
C	1	2	3	4	4
D	2	3	4	4	4

Table C.1.1–4. Risk Decision Criteria

Risk Decision Criteria	
Risk Number	**Accepted Action**
1	Unacceptable Risk – Must be mitigated to risk number 3 or lower
2	Undesirable Risk – Should be reduced to risk rank 3 or lower with cost enhancements.
3	Acceptable With Controls – Should evaluate cost effective enhancements.
4	Acceptable As Is – No action necessary.

Accident Selection

Examination of all Safety risks of 1, 2, and 3 revealed three major areas of concern that are discussed in the following 3 accident scenarios and a natural phenomenon scenario (Scenario 1) in Appendix C.2.

Scenario (2) Failure of waste acceptance criteria.

Scenario (3) Possible fire or explosion in the feed preparation glovebox.

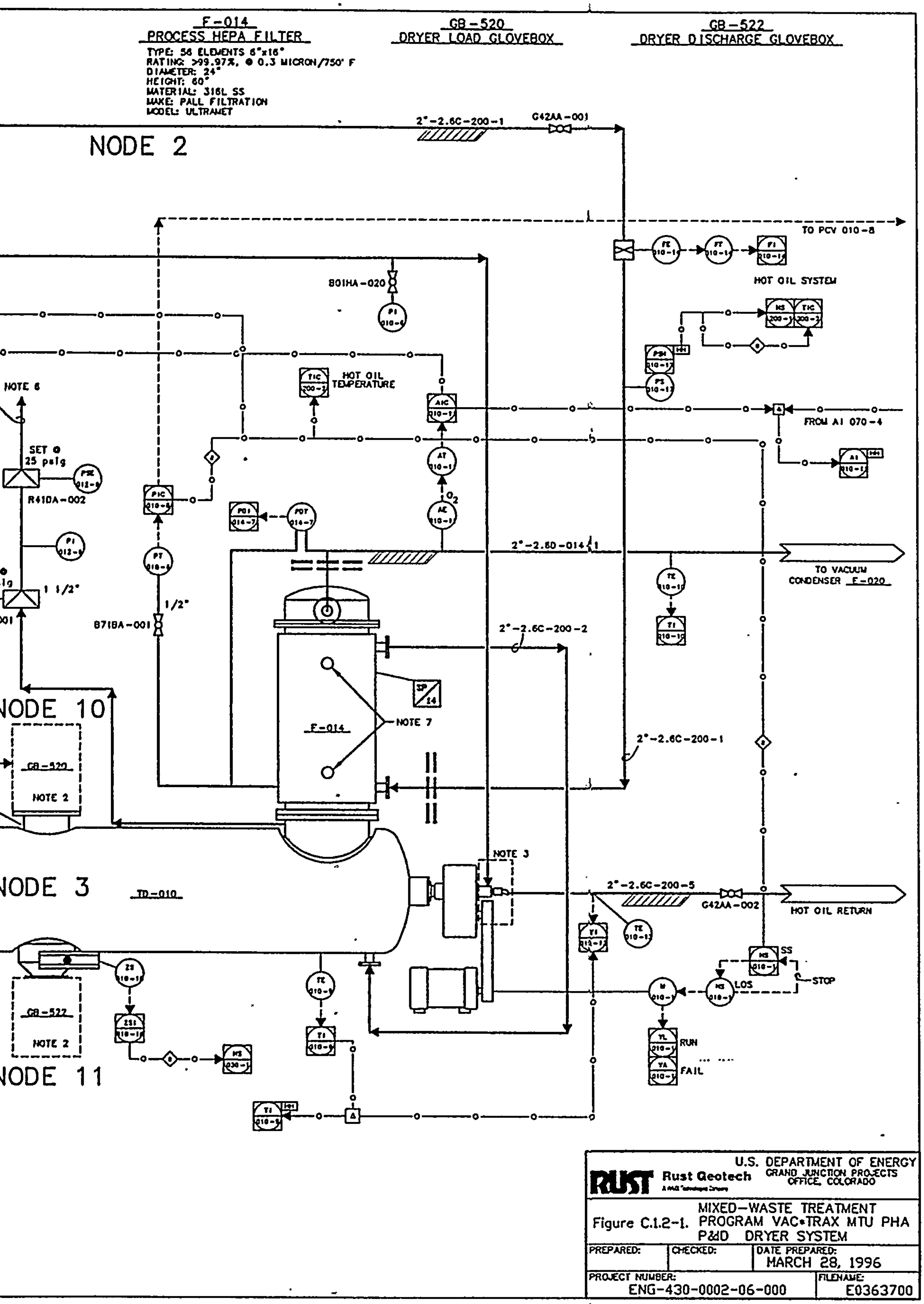
Scenario (4) Oxygen contamination in the dryer.

C.1.2 Piping and Instrumentation Diagrams (P&IDs)

Figures C.1.2–1 through C.1.2–6 illustrate the nodes (single function components) identified for analysis during the HAZOP. These figures are from the *VAC*TRAX Mobile Treatment Unit Design Report* (DOE 1996b). The nodes commonly included piping attached to components if the piping did not serve additional functions. Some components were combined into one node when they contributed to the same function.

These figures can be cross-referenced to the hazard identification worksheets in Appendix C.1.3 by reference to the figure and node numbers.

This page intentionally blank



yer System P&ID

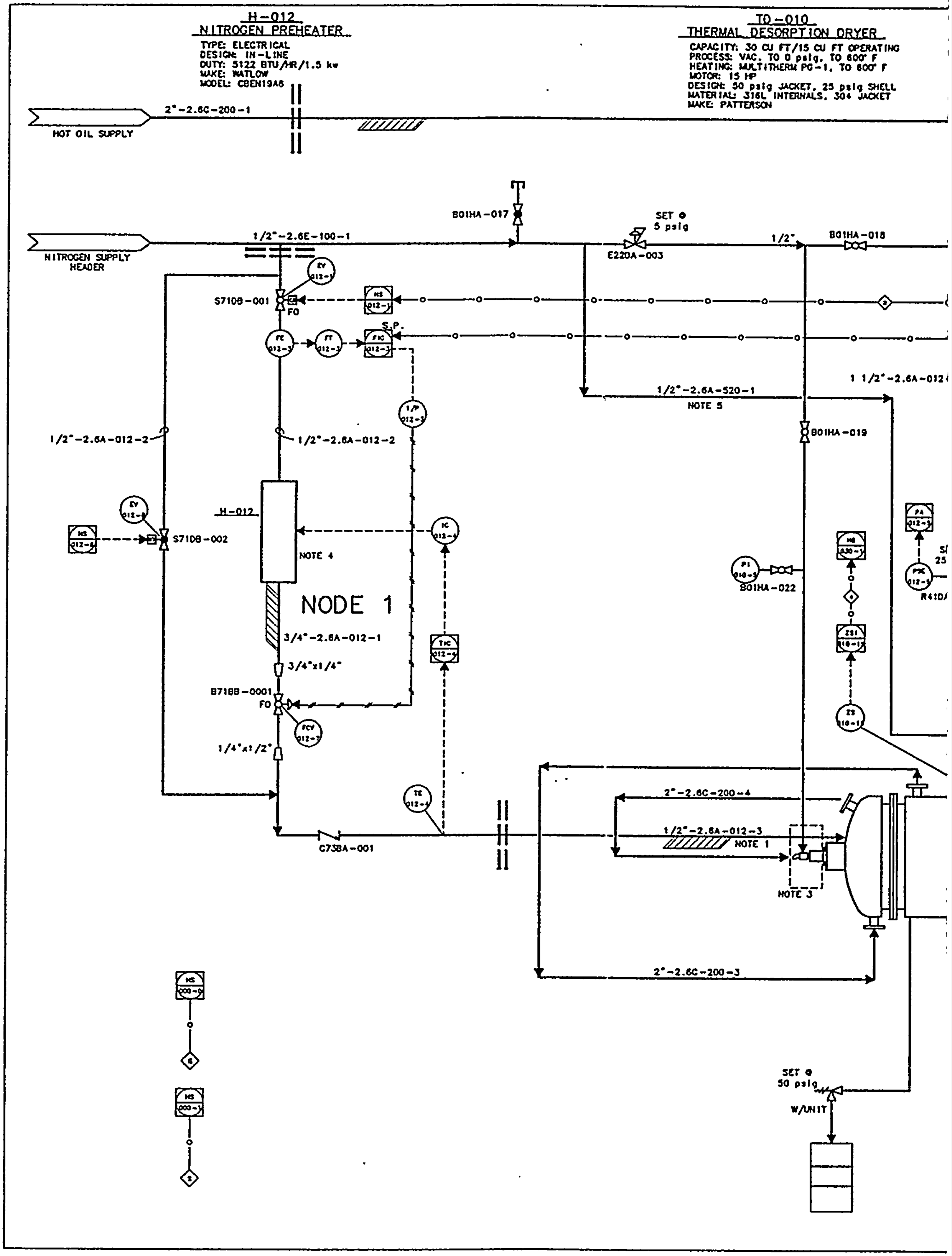
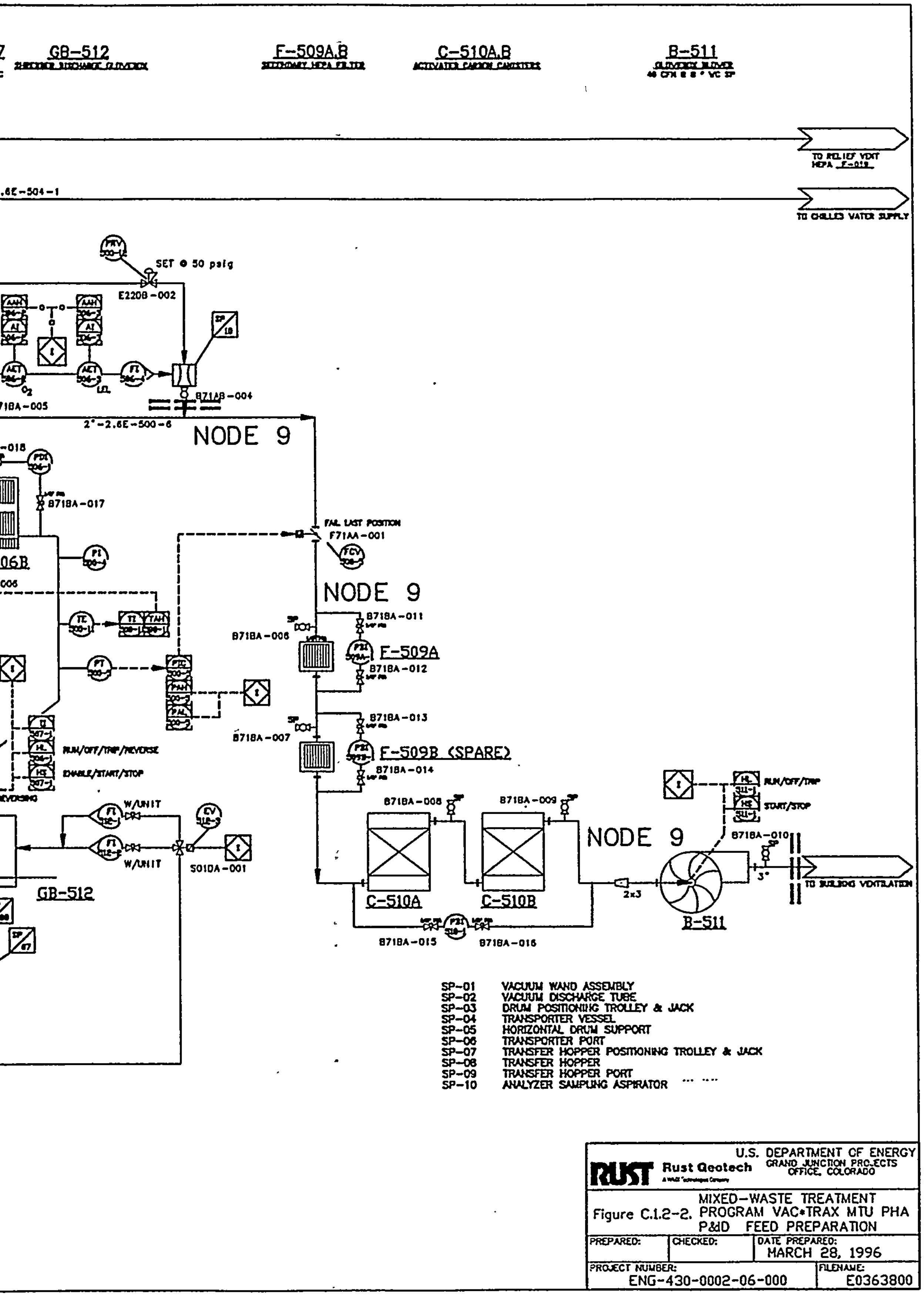

H-012
NITROGEN PREHEATER
TYPE: ELECTRICAL
DESIGN: IN-LINE
DUTY: 5122 BTU/HR/1.5 kw
MAKE: WATLOW
MODEL: CBEN19A6
TD-010
THERMAL DESORPTION DRYER
CAPACITY: 30 CU FT/15 CU FT OPERATING
PROCESS: VAC. TO 0 psig, TO 600° F
HEATING: MULTITHERM PG-1, TO 600° F
MOTOR: 15 HP
DESIGN: 50 psig JACKET, 25 psig SHELL
MATERIAL: 316L INTERNALS, 304 JACKET
MAKE: PATTERSON
HOT OIL SUPPLY
2"-2.6C-200-1
NITROGEN SUPPLY HEADER
1/2"-2.6E-100-1
B01HA-017
SET @ 5 psig
E220A-003
B01HA-018
S710B-001
FO
S.P.
1/2"-2.6A-520-1
NOTE 5
B01HA-019
1/2"-2.6A-012-2
H-012
S710B-002
NOTE 4
NODE 1
3/4"-2.6A-012-1
3/4"x1/4"
B718B-0001
1/4"x1/2"
B01HA-022
C738A-001
2"-2.6C-200-4
1/2"-2.6A-012-3
NOTE 1
NOTE 3
2"-2.6C-200-3
SET @ 50 psig
W/UNIT

Figure C.1.2–1.



d Preparation P&ID

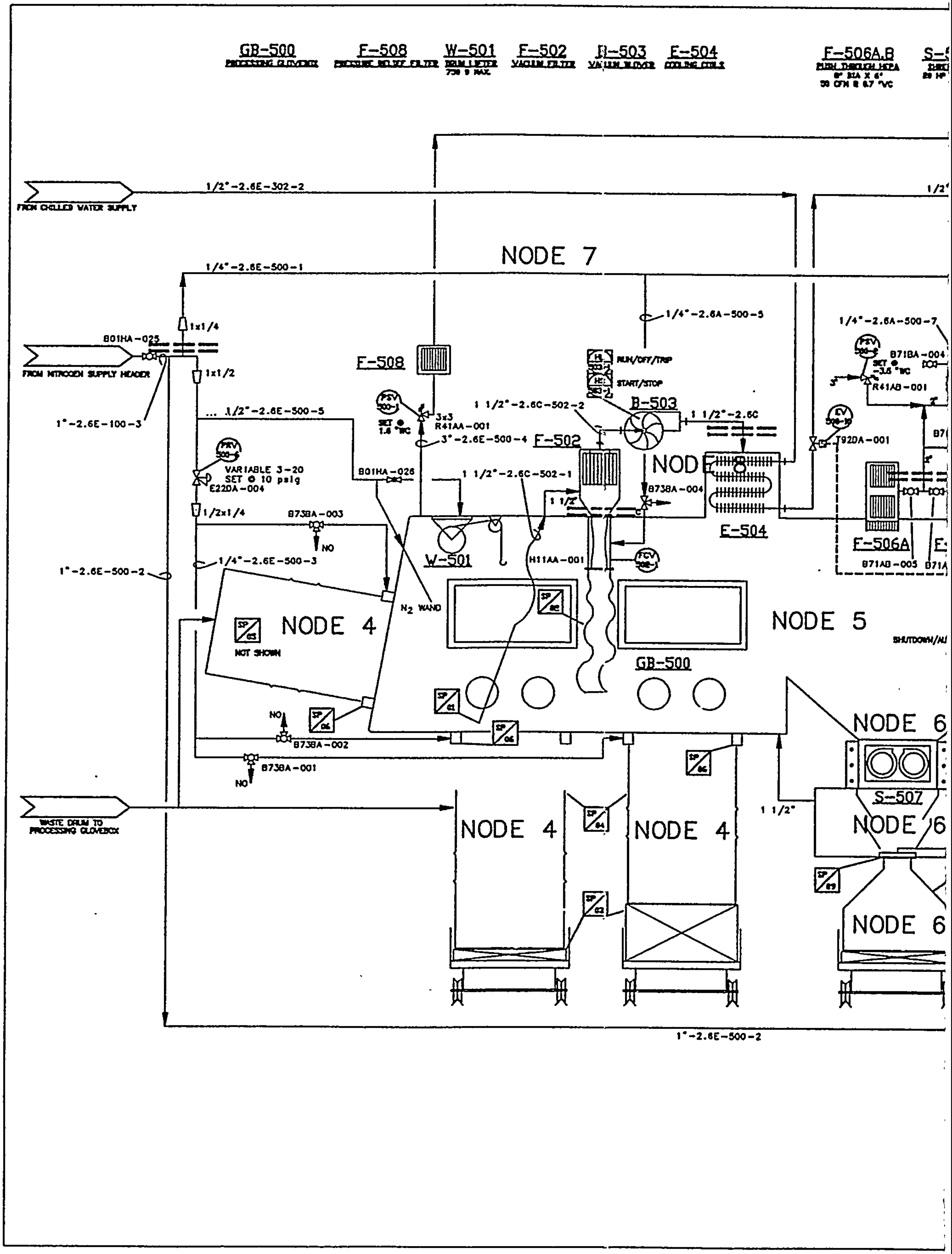
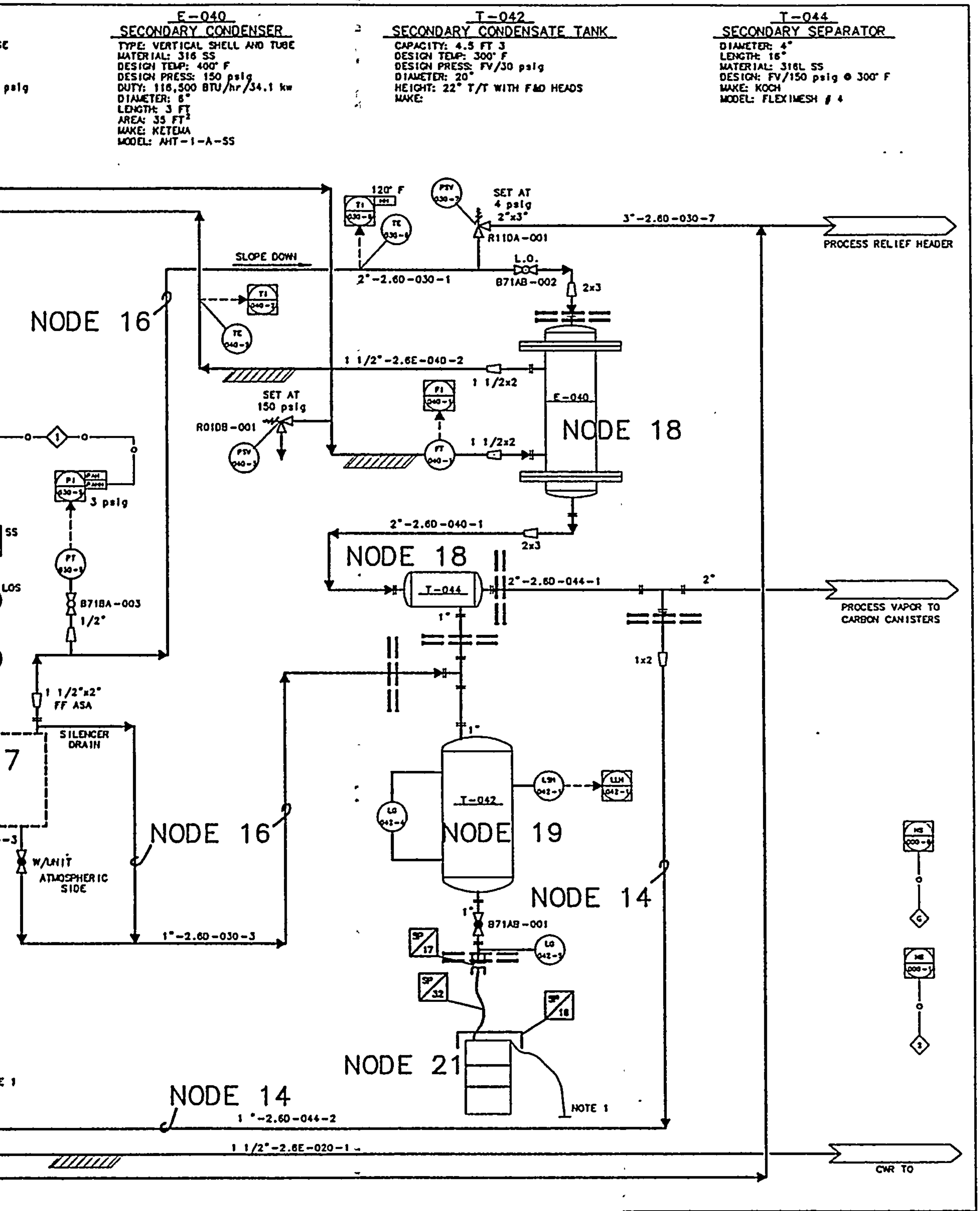


Figure C.1.2–2. Fe



U.S. DEPARTMENT OF ENERGY GRAND JUNCTION PROJECTS OFFICE, COLORADO	
RUST Rust Geotech	
Figure C.1.2-3. MIXED-WASTE TREATMENT PROGRAM VAC*TRAX MTU PHA P&ID CONDENSER SYSTEM	
PREPARED: / CHECKED:	DATE PREPARED: MARCH 28, 1996
PROJECT NUMBER: ENG-430-0002-06-000	FILENAME: E0363900

NOTE:
1. ELECTRICAL GROUND FOR DRUM.

denser System P&ID

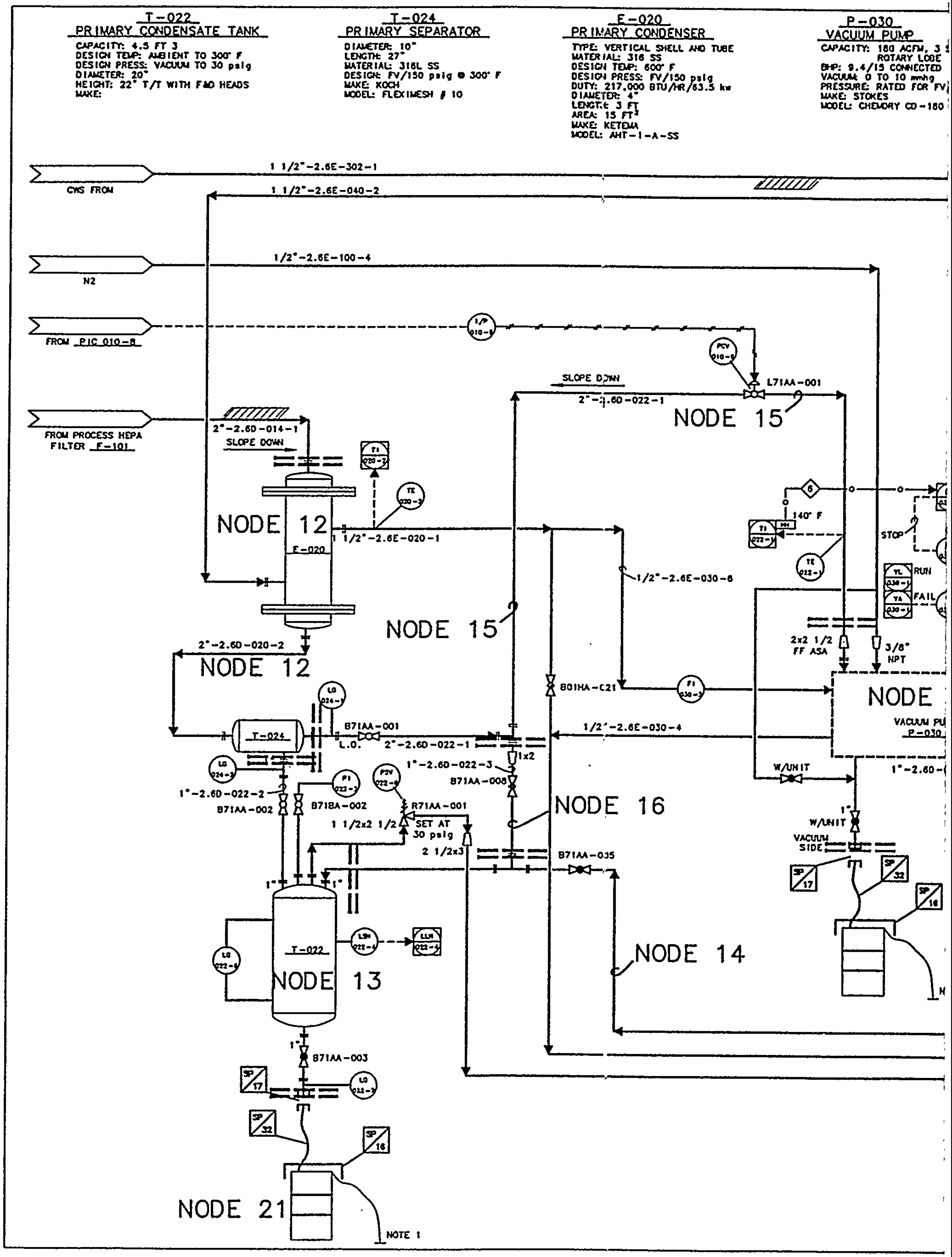
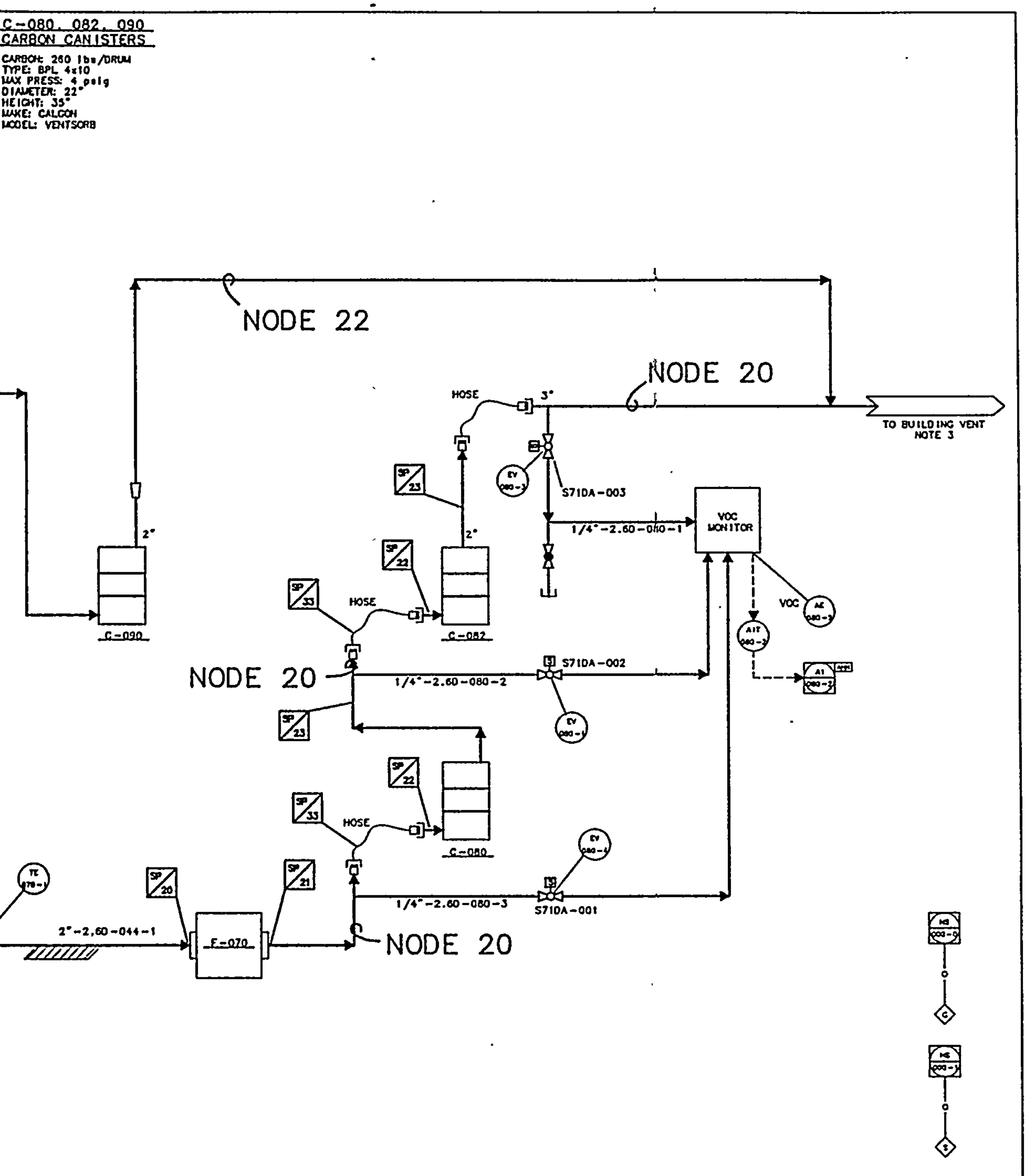


Figure C.1.2-3. Co



NOTE
1. SELF-LIMITING HEATTAPE.
2. ROOM LEFT FOR A POSSIBLE SECOND HEPA FILTER.
3. CANNOT BE DIRECTLY ATTACHED TO A HIGH-FLOW VENTILATION SYSTEM.

RUST Rust Geotech	U.S. DEPARTMENT OF ENERGY GRAND JUNCTION PROJECTS OFFICE, COLORADO
Figure C.1.2-4. MIXED-WASTE TREATMENT PROGRAM VAC*TRAX MTU PHA P&ID CARBON SYSTEM	
PREPARED: / CHECKED:	DATE PREPARED: MARCH 28, 1996
PROJECT NUMBER: ENG-430-0002-06-000	FILENAME: E0364000

rbon System P&ID

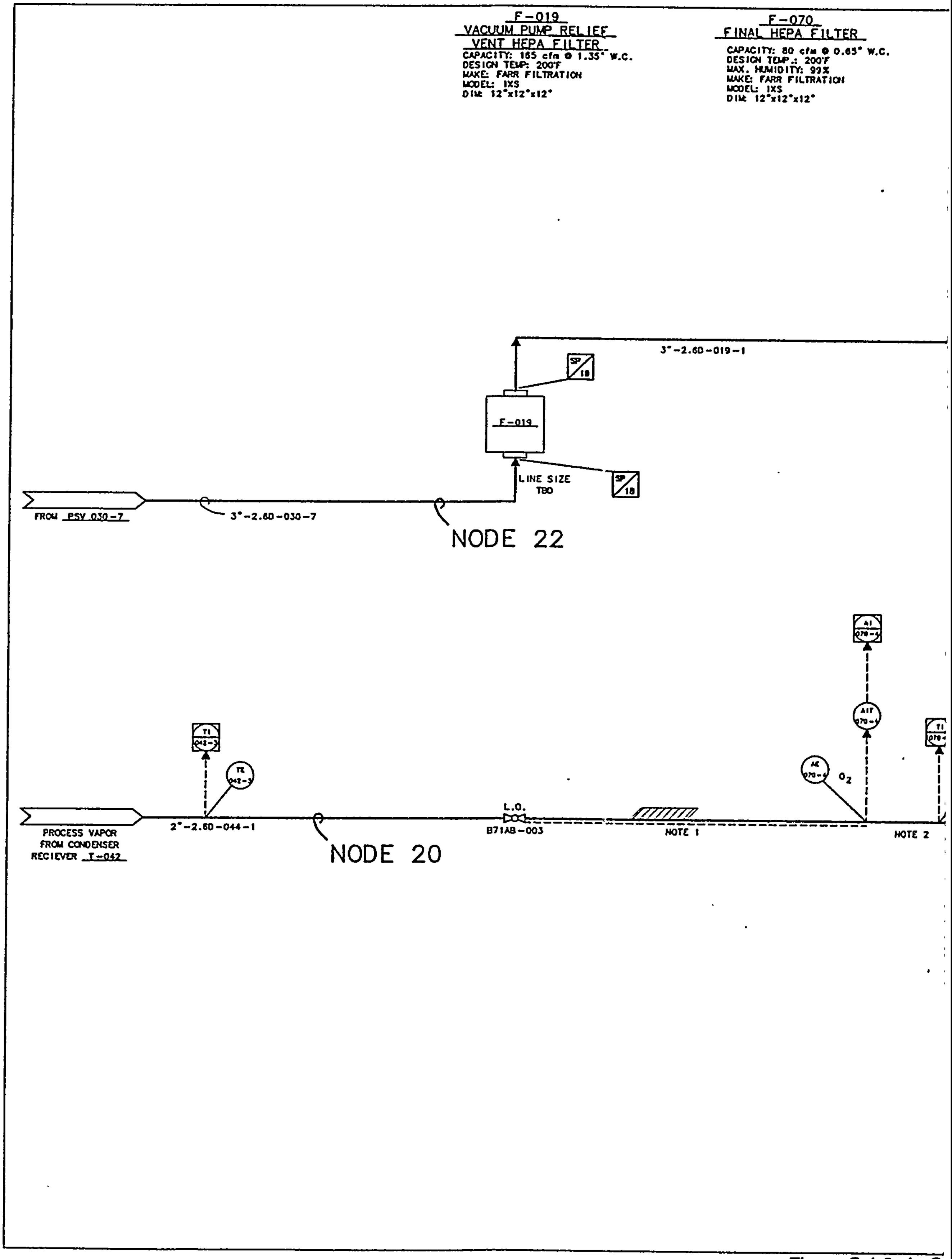
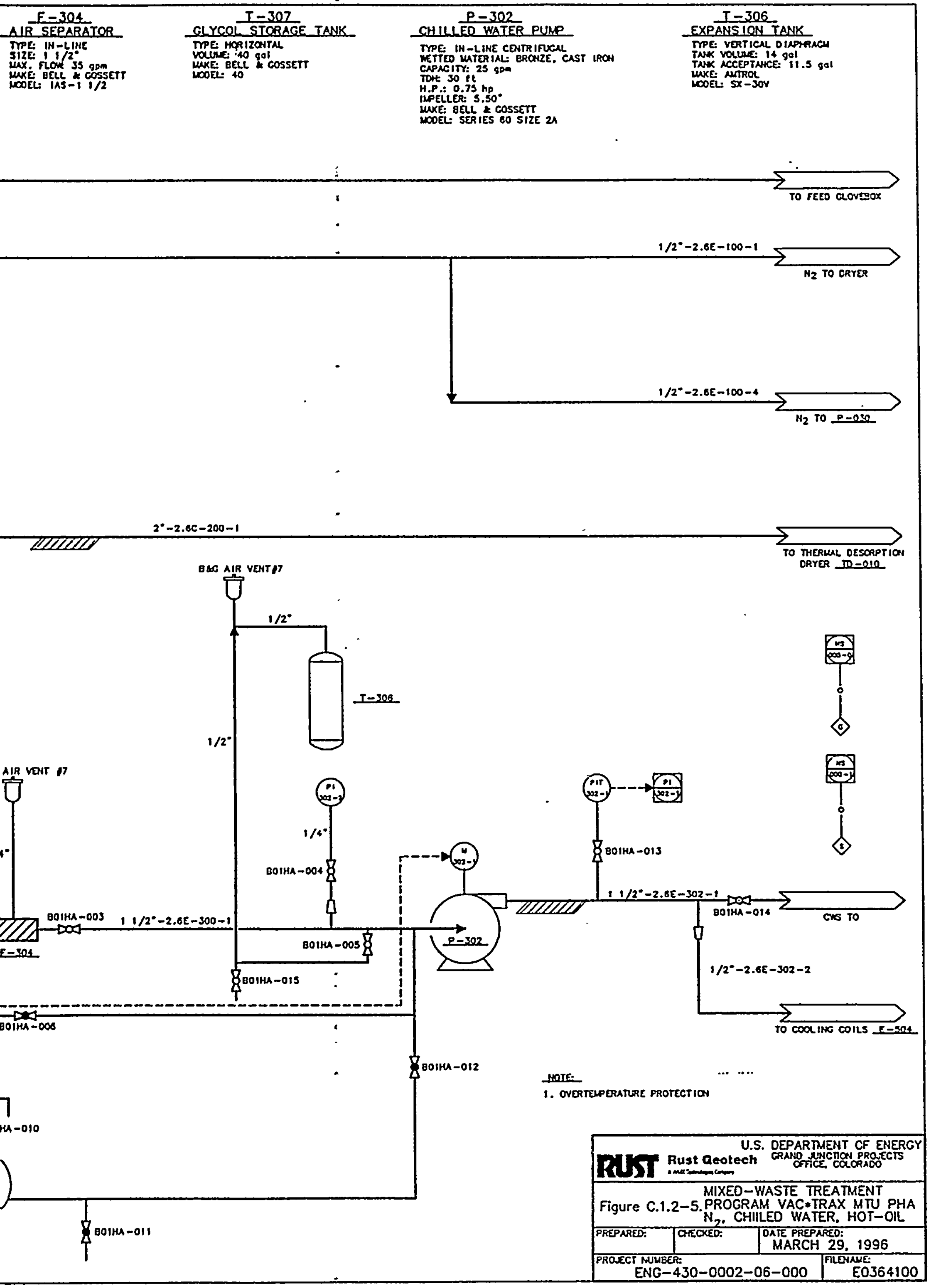


Figure C.1.2–4. C



Water, and Hot Oil Systems P&ID

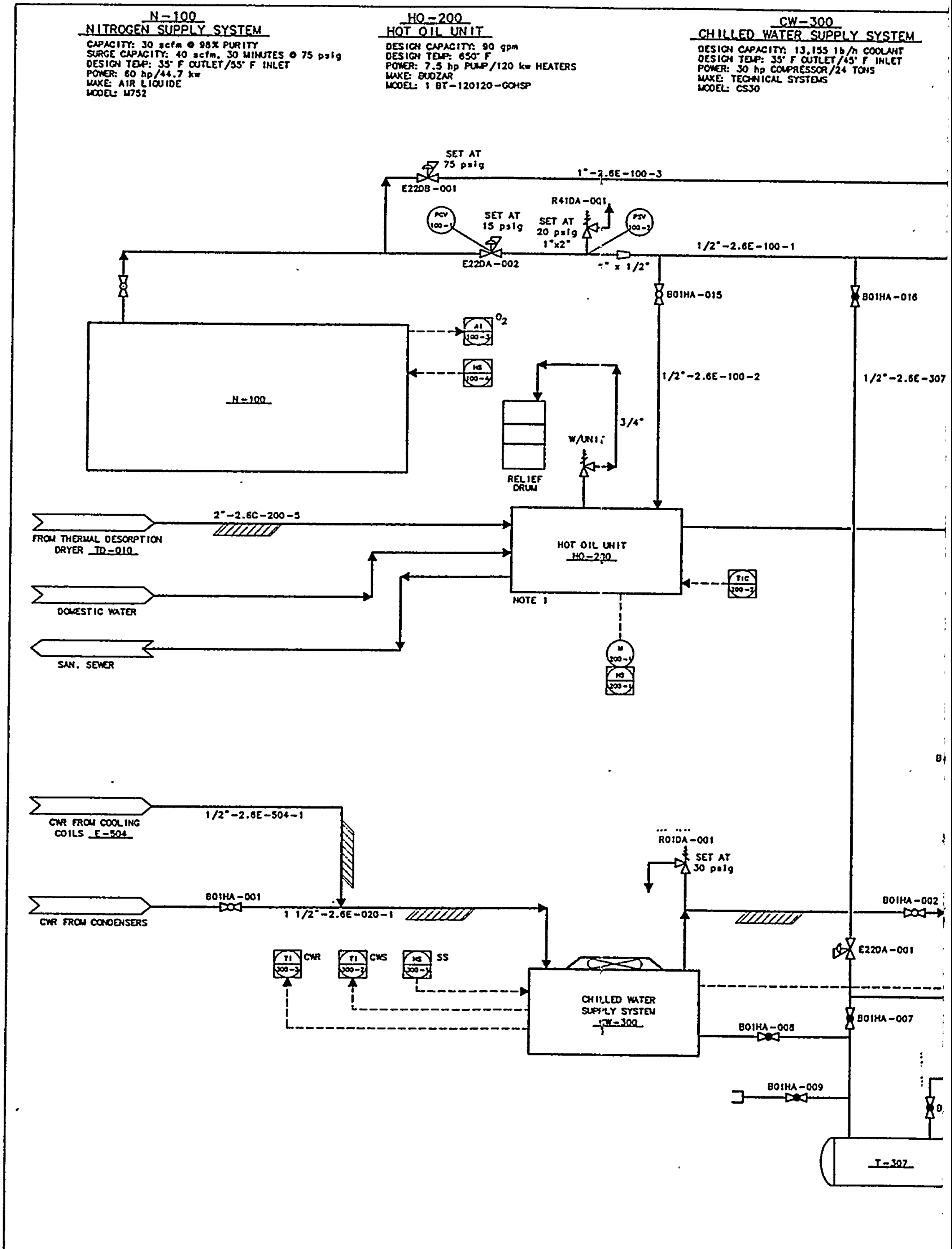
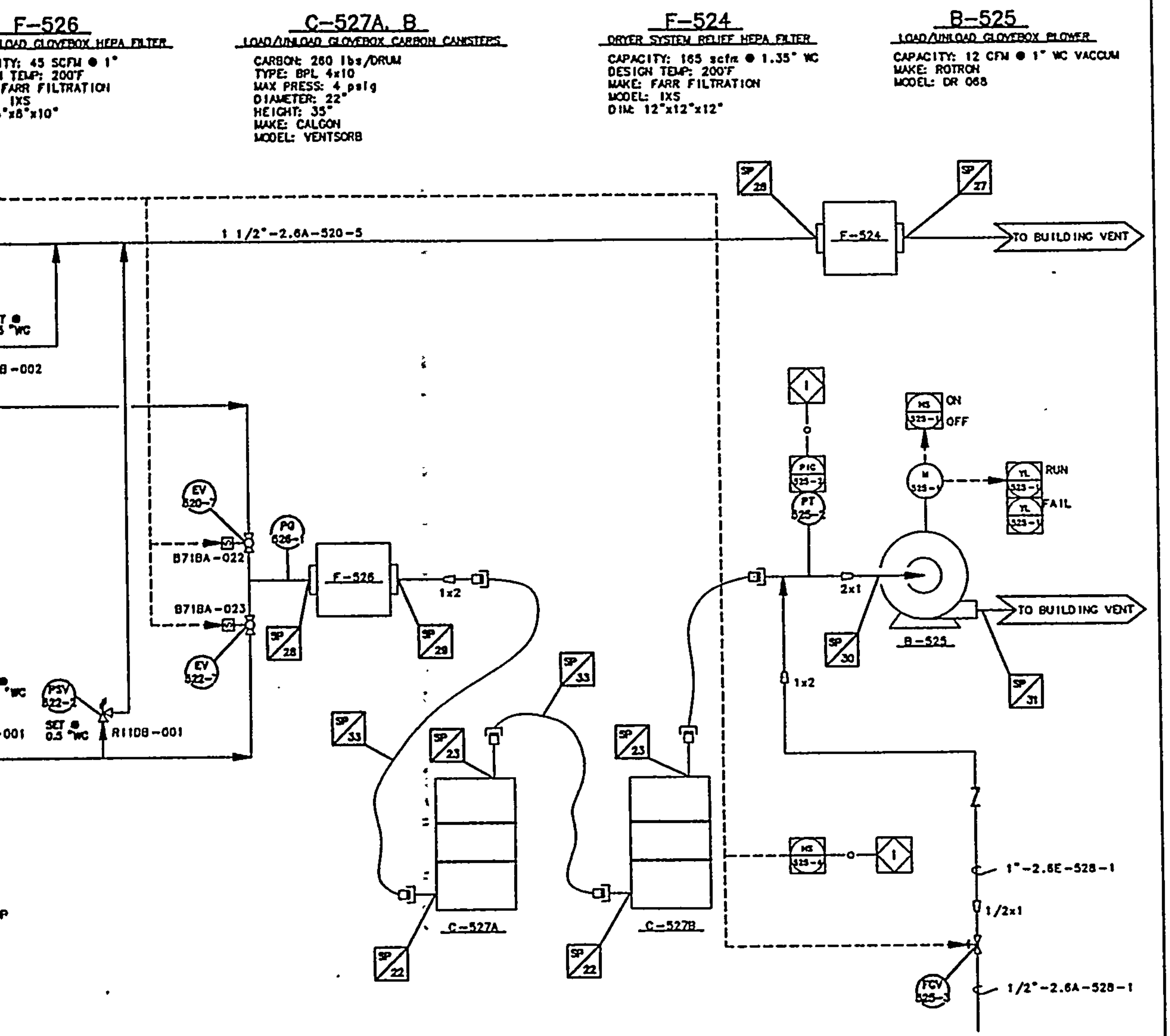


Figure C.1.2–5. Nitrogen, Chilled



RUST Rust Geotech	U.S. DEPARTMENT OF ENERGY GRAND JUNCTION PROJECTS OFFICE, COLORADO	
Figure C.1.2-6. MIXED-WASTE TREATMENT PROGRAM VAC*TRAX MTU PHA LOAD & DISCHARGE GLOVBOXES		
PREPARED:	CHECKED:	DATE PREPARED: MARCH 29, 1996
PROJECT NUMBER: ENG-430-0002-06-000		FILENAME: E0364200

Discharge Gloveboxes P&ID

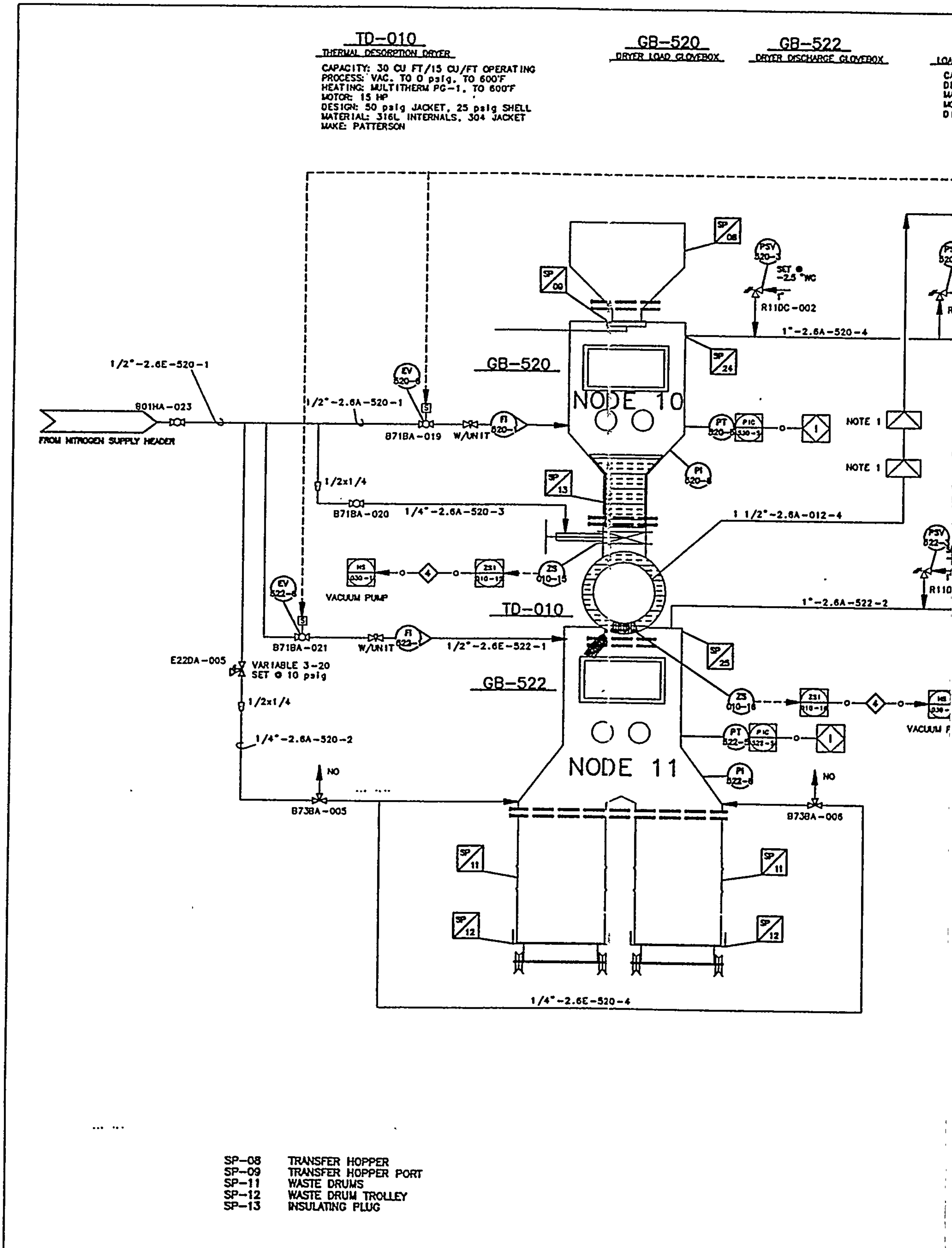


Figure C.1.2–6. Load and

C.1.3 Hazard Identification and Evaluation

The VAC*TRAX MTU hazard identification was performed with LEADER3 software using HAZOP methodology. Customized risk assessment tables were based on the criteria in Appendix C.1.1. The software uses key process variables (e.g., flow or pressure) and guide words (e.g., high or reversed) to identify possible deviations for each component of the process studied. All major components of the VAC*TRAX process were studied. Causes, consequences, safeguards, and recommended actions were developed by input from all members of the PHA team.

Table C.1.3–1 lists each component and the deviations identified. The frequency, ranging from I to IV, is listed under the cause column. The consequence, from A to D, is coded S (safety), E (environmental), F (financial), and G (general). The resulting risk rank (1 to 4) is also listed under the consequence column and coded for safety, environmental, financial, and general. For example S:A in the consequence column and Frequency:II in the cause column identifies a resulting safety risk rank of S:1 listed in the consequence column. Each action item was assigned to an engineer for resolution and tracked to closure as documented in Table C.3–1.

This page intentionally blank

Table C.1.3-1 Hazard Identification and Evaluation

1 Nitrogen Preheater
Drawings: P&ID Figure C.1.2-1 Node 1

Page 1

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
1.1	**High process flow**	Control valve stuck open [Frequency = IV] Electrical Failure [Frequency = III]	Poor process performance, wasted carbon and nitrogen G: D GR: 4 Operating under pressure, overpowering vacuum system and exhausting into glove box (which isn't meant to maintain pressure) S: D SR: 4 PSE012-5 may pop High pressure - N5 Thermal Desorption Dryer (see 3.4)	Flow indication Relief valve on discharge glove box set at .5 inches Rupture Disk PSE012-5	Size line and valve (012-7) to avoid excess flow Specify as a fail open valve (012-7) Consider changing nitrogen supply pressure to below 25 (PCV 100-1)
1.2	**Low/no process flow**	Control valve stuck closed [Frequency = IV] Nitrogen generator fails [Frequency = V] Plug in the Line (012-1) [Frequency = III] Check valve could fail [Frequency = III] Low process pressure (see 1.5)	High oxygen concentration S: B SR: 2 Burning up the heater High process temperature (see 1.3)	Flow indication Low flow alarm Oxygen analyzer	Confirm whether nitrogen gen. has oxygen detector that alarms on main panel Add backup nitrogen bottles Calculate detonation scenario Add 2nd oxygen analyzer tied in

Table C.1.3-1 Hazard Identification and Evaluation

1 Nitrogen Preheater
Drawings: P&ID Figure C.1.2-1 Node 1

Page 2

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
1.3	**High process temperature**	Low/no process flow (see 1.2) [Frequency = II] Runaway heater [Frequency = IV]	Seal damage - possible oxygen contamination S: A SR: 1	High temperature alarm Temperature indication (TIC 012-4)	Verify high temp seals Verify high temp shutoff Show insulation on P&ID
1.4	**Low process temperature**	Heater failure [Frequency = III]	Plugged filters, operational problems G: D GR: 4	Low temperature alarm Temperature indication	
1.5	**Low process pressure**	Control valve sticking open [Frequency = IV]	Low/no process flow (see 1.2) Heater failure F: D FR: 4	Low pressure alarm Pressure indication	
1.6	**Leak or rupture**	Leak or rupture (bump, crack, etc) [Frequency = IV]	Down time G: D GR: 4	Insulation prevents direct hot nitrogen streams Minimize distance between heater and dryer Flow measurement	

Table C.1.3-1 Hazard Identification and Evaluation

2 Hot Oil Supply to Dryer
The hot oil supply is a short line from the hot oil unit (H0-200) to the dryer (TD-010)
Drawings: P&ID Figure C.1.2-1 Node 2

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
2.1	High Flow	None	None	Pump sized correctly	
2.2	Low/no flow	Open bypass valve [Frequency = III] Mechanical pump problems [Frequency = IV]	Operational down time G: D GR: 4	Flow meter Standard operational procedures (SOP)	
2.3	Reverse flow	Not possible, operational tests show pump flows forward	None	Electrical leads properly hooked up	
2.4	High temperature	Runaway heater [Frequency = IV]	Exceed melting point of dryer contents G: B GR: 3 Exceed design temperature of dryer, seals and joints fail S: A SR: 2 High temperature - N5 Thermal Desorption Dryer (see 3.1)	Softening point tests for each waste stream Dryer Temperature T010-9 Hot oil temperature shutdown Rotary joint rated 100 psi, relief valve at 50 psi	Put a shroud around rotary joint Interlock control system to oil heater (high temp shutoff on hot oil) Add insulation to PID Direct temp control from PLC
2.5	Low temperature	None , system not working if temperature is too low	No production		

Table C.1.3-1 Hazard Identification and Evaluation

Page 4

2 Hot Oil Supply to Dryer
The hot oil supply is a short line from the hot oil unit (H0-200) to the dryer (TD-010)
Drawings: P&ID Figure C.1.2-1 Node 2

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
2.6	High pressure	Extreme Cold [Frequency = III] Block valve closed [Frequency = III]	Potential release through the relief valve G: D GR: 4 Potential release through rotary joint failure S: B SR: 2	Relief valve rated at 50 psi Rotary joint rated 100 psi	Add block valve to PID Fire suppression system (Halon substitute) Consider high pressure alarm
2.7	Low pressure	Pump malfunction [Frequency = IV] Bypass fully open [Frequency = III]	None	Operator surveillance System checkout	
2.8	Rupture	Rotary joint failure [Frequency = V] High pressure [Frequency = IV]	Personnel burns S: B SR: 3 Potential fire S: A SR: 2	Pressure relief valve, 50 psi Rotary joint rated for 100 psi, higher than relief valve	Fire suppression system Shroud around rotary joint Consider relief valve rotary joint
2.9	High concentration of contaminants	Degradation of oil [Frequency = IV]	Poor heat transfer F: D FR: 4	Nitrogen blanket SOP - Sample oil and examine visually for degradation	
2.10	Leaks	Gasket, packing, or seal failure [Frequency = IV]	Operations delayed F: D FR: 4	Nondestructive inspection to verify joints	SOP includes having absorbent material available

Table C.1.3-1 Hazard Identification and Evaluation

2 Hot Oil Supply to Dryer
The hot oil supply is a short line from the hot oil unit (H0-200) to the dryer (TD-010)
Drawings: P&ID Figure C.1.2-1 Node 2

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
		Instrument or instrument line failure [Frequency = IV]	Personnel slips/trips S: D SR: 4	Operation/maintenance response as required, including isolation if needed	
		Material defect [Frequency = IV]		Relief valve	
		Sample station valve leaking [Frequency = IV]			
		Thermal expansion with equipment blocked in [Frequency = IV]			
		Vent or drain valve leaking [Frequency = IV]			
		Forklift or physical damage to pipe [Frequency = III]			
2.11	Startup	Extreme Cold [Frequency = IV]	Low viscosity oil heated too quickly G: D GR: 4	Outdoor design of hot oil supply unit or move unit inside	Determine minimum daily startup temp
2.12	Shutdown	None			

Table C.1.3-1 Hazard Identification and Evaluation

3 Thermal Desorption Dryer
Drawings: P&ID Figure C.1.2-1 Node 3

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
3.1	**High temperature**	Operator error inappropriate set point on hot oil [Frequency = IV] High temperature - N3 Hot oil Supply to Dryer (see 2.4) Potential internal combustion [Frequency = IV] Indicated temp reading low [Frequency = IV]	Melted plastics G: C GR: 4 Delayed operation G: C GR: 4 Exceed design temp of dryer S: D SR: 4	SOPs Waste acceptance criteria Multiple temperature indication	Consider interlock TIs on hot oil system Program high deviation alarm comparing dryer to hot oil temp Consider interlocking deviation between dryer and hot oil
3.2	**Low temperature**	Filter blow back during run [Frequency = II]	Longer running time G: D GR: 3 Possible filter clogging due to low temp condensation G: C GR: 2	None	Tie the blow down into the correct place on the cupola Remove blow down system or heat blow back nitrogen
3.3	**High vaporization rate**	Too high temperature ramp up [Frequency = II] Vacuum ramp up too high [Frequency = II]	Overload HEPA filters F-O14 G: D GR: 3 Overload vacuum pump G: D GR: 3	SOPs Characterize loss of weight on heating	
3.4	**High pressure**	Blocked filters [Frequency = III] Plugged line/knockout pot/condenser	Blown rupture disk G: D GR: 4 Worker/building contamination S: C SR: 3	Rupture disk Continuous air monitor	Suggest that EV-22-2 be a latching 3-way valve High-High pressure interlock of dryer to hot oil

Table C.1.3-1 Hazard Identification and Evaluation

3 Thermal Desorption Dryer
Drawings: P&ID Figure C.1.2-1 Node 3

Page 7

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
		[Frequency = IV]			
		Vacuum pump failure [Frequency = IV]	Worker injury S: A SR: 1		Investigate with vendor possibility of seal/valve leakage below design pressure of 25 psig
		High process flow - N1: Nitro Preheater (see 1.1)	High Pressure - Node 19: Dryer Discharge Glove box (see 11.4)		
		Explosion [Frequency = V]	High Pressure (Tube Side) - Node 21: Primary Condenser (see 12.1)		Investigate how much vapor at what concentration to have explosion exterior of vessel (slight pressurization <25)
		External Fire [Frequency = V]	No flow - Node 23: Vacuum Pump Suction Line (see 15.2)		Possibility of adding 2 rupture disks in series
		High pressure - Node 22: Primary Knockout Pot (see 13.3)	High pressure - Node 23: Vacuum Pump Suction Line (see 15.5)		
3.5	**Low pressure**	None	None		
3.6	**Reverse sequence**	Turning on agitator before turning on oil flow [Frequency = IV]	Possible damage to rotary joint F: C FR: 4	SOP will specify step sequence	
3.7	**High concentration of contaminants**	Rupture disk leak (oxygen leaks into dryer) [Frequency = V]	Possible fire or explosion S: A SR: 1	Dual O2 analyzers	Off gas flow meter to double check oxygen analyzer
			High Nitrogen usage G: D GR: 3	Nitrogen purge	Investigate a second relief system (capped with N2)
		Leaks through feed/discharge valves [Frequency = II]		O2 analyzers calibration	
				Waste Acceptance Criteria	

Table C.1.3-1 Hazard Identification and Evaluation

3 Thermal Desorption Dryer
Drawings: P&ID Figure C.1.2-1 Node 3

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
		Chemical oxidizers in waste [Frequency = V] Reverse flow - Node 23: Vacuum Pump Suction Line (see 15.3)			
3.8	Filter leak	Improperly installed filter [Frequency = IV]	Particulate breakthrough F: B FR: 3 G: C GR: 4	SOPs	Possible installation of nozzle for interior swipe of cupola Possible installation of DOP test sample ports
3.9	Loss of containment	See: High pressure			
3.10	Maintenance/sampling	Pulling paddle after soil type matrix [Frequency = II]	Personnel exposure S: D SR: 3 G: D GR: 3	Air monitoring guides PPE	
3.11	Shutdown	Turn off nitrogen too early [Frequency = V]	Possible recondensing of organics in system (filter clog) F: C FR: 4	SOP will specify sequence and importance	

Table C.1.3-1 Hazard Identification and Evaluation

4 Waste Drums/Transport (Transporter vessel, Drum Positioning Trolley, Horizontal Drum Support)
Drawings: P&ID Figure C.1.2-2 Node 4

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
4.1	**Damage to Glove box**	Improper seating of drum when raising [Frequency = III]	Damage to glove box F: D FR: 4	Foot-powered manual lift (non-motorized) SOPs Operator training Spotter and lifter (two man operation)	Chock or wheel brake on scissors jack Mark outside of drum (positioning index mark)
4.2	**Loss of containment**	Loss of control during movement of drum from vertical to horizontal position [Frequency = II] Failure of lifting device [Frequency = IV] Seismic event [Frequency = V] Bag puncture [Frequency = II]	Personnel exposure S: D SR: 3 Possible fire S: B SR: 1	SOPs specify no working under raised barrels Design of lifting cradle Crane load tests and inspection	Rethink of side mount waste drum lifting operation

Table C.1.3-1 Hazard Identification and Evaluation

Page 10

5 Feed Prep and Loading Glove box
Drawings: P&ID Figure C.1.2-2 Node 5

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
5.1	High temperature	Chilled water failure and continuous operation of B-503 [Frequency = IV] Internal or external fire [Frequency = V]	More organic evolution G: D GR: 4 Possible seal failure S: D SR: 4		Possible addition of temperature indication
5.2	Low temperature	Stuck chilled water valve [Frequency = IV]	None - discomfort issue G: D GR: 4	None	
5.3	High pressure	Blocked discharge line [Frequency = IV] Blower failure [Frequency = IV] Excessive nitrogen flow [Frequency = IV] Pressure control failure PI 500-5 [Frequency = IV]	Loss of containment S: C SR: 3 Possible fire or explosion S: B SR: 2	SOPs pids Blower status indication 511-1 Nitrogen flow controlled by size of rota meter Pressure relief system on glove box PSV 500-2	Verify pressure relief sizing
5.4	Low pressure	Loss of nitrogen flow [Frequency = IV] Malfunction of pressure control system PSL 500-5 [Frequency = IV]	Contamination of glove box (oxygen) S: D SR: 4	Vacuum breaker PSV 500-3	Possibly remove or modify vacuum breaker PSV 500-3 (Blower not capable collapsing glove box)

Table C.1.3-1 Hazard Identification and Evaluation

5 Feed Prep and Loading Glove box
Drawings: P&ID Figure C.1.2-2 Node 5

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
5.5	**High concentration of contaminants (oxygen)**	Seal leakage [Frequency = III]	Operational delay F: D FR: 3	O2 analyzer 506-2	Consider making hard wire interlock
		Inadequate nitrogen flow [Frequency = II]	Possible fire or explosion S: B SR: 1	LEL analyzer 506-3	Check for pinch points
		Pressure control failure [Frequency = IV]	Personnel contamination S: D SR: 3	Nitrogen supply	Mockup of main feed prep glove box is desirable
		Vacuum breaker failure [Frequency = IV]		Shredder interlock	
		O2 and LEL analyzer failure [Frequency = IV]		Run plan or RWP, Glove selection	
		Glove failure (chemical degradation) [Frequency = III]			
5.6	**Internal coil leak or rupture**			Sub critical mass (plutonium) is no problem	

Table C.1.3-1 Hazard Identification and Evaluation

6 Shredder/Glove Box/Transport Hopper/Trolley/Jack | Page 12
Drawings: P&ID Figure C.1.2-2 Node 6

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
6.1	**High level**	Overfilling [Frequency = III]	Time delay F: D FR: 4	SOPs	Consider view port
6.2	**Oxygen contamination**	Short circuit nitrogen flow [Frequency = II]	Stagnant zone in shredder glove box S: B SR: 1	None	Add nitrogen purge nozzle to shredder/glove box
				Mechanical and lockout/tag out	Analyze design of shredder access from glove port
		Glove caught in shredder [Frequency = IV]	Personnel injury S: B SR: 1		Chock or wheel stop on IBC

Table C.1.3-1 Hazard Identification and Evaluation

7 Glove Box / Aspirator Nitrogen Supply
Drawings: P&ID Figure C.1.2-2 Node 7

Page 13

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
7.1	**High flow**	No high flow			
7.2	**Low/no flow (O2 aspiration line only)**	Closed header value [Frequency = IV] Nitrogen generator failure [Frequency = IV] Aspirator contamination from LEL coking [Frequency = V]	Faulty O2 reading (slow response) G: D GR: 4	SOP address operation without an O2 analyzer	Portable oxygen analyzer and pump to double check
7.3	**Reverse flow**	Close main header (diffusion) [Frequency = IV] Back pressure [Frequency = IV]	Decontamination of line F: D FR: 4	None	In-Line HEPA

Table C.1.3-1 Hazard Identification and Evaluation

8 Vacuum System (Glove Box)
Drawings: P&ID Figure C.1.2-2 Node 8

Page 14

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
8.1	**Loss of containment**	Seal failure [Frequency = III]	Possible particulate and/or hazardous emission S: C SR: 3	None	Consider putting the blower inside a containment
8.2	**High Temperature**	Blower in containment			

Table C.1.3-1 Hazard Identification and Evaluation

9 Glove Box Off Gas, Filters and Blower
Drawings: P&ID Figure C.1.2-2 Node 9

Page . 15

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
9.1	Low/no flow (to the O2 and LEL analyzers)	No aspiration flow in node 12 [Frequency = IV] Blocked line	False O2 and LEL readings G: D GR: 4	FI 506-4 flow indicator SOP	Calibration system Isolation valves
9.2	High temperature	Carbon drum fire [Frequency = V]	Delay G: B GR: 4		Make sure carbon selection is noncombustible Provide room for F 509B in series
9.3	High pressure				Verify pressure rating of components

Table C.1.3-1 Hazard Identification and Evaluation

10 Dryer Loading Glove Box
Drawings: P&ID Figure C.1.2-6 Node 10

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
10.1	High level				Justify existing design or change it (evaluate whether side or top mount is better design) Justify existing location of transport hopper
10.2	High temperature	Conduction from dryer [Frequency = I]	Possible damage to dryer loading glove box F: C FR: 1 High temperature - Node 19: Dryer Discharge Glove box (see 11.3)	Nitrogen purge and insulation plug	Design calculations for high temp in glove box
10.3	High pressure	Bottom valve closed and nitrogen purge is on [Frequency = III]	Loss of containment on dryer loading glovebox or release through the relief valve S: D SR: 4 F: C FR: 3	Relief valve PSV 520-2	Consider interlock on dryer loading valve and N2 supply
10.4	Low pressure	Leaking valve on the dryer loading glovebox [Frequency = IV] No pressure control feature to glovebox [Frequency = I]	Possible rigid gloves, difficult to work with G: D GR: 3 Failure (?) of dryer loading glovebox S: C SR: 1 F: C FR: 1	Vacuum breaker PSV 520-3	Develop pressure control system Interlock dryer loading valve to vacuum pump P-030

Table C.1.3-1 Hazard Identification and Evaluation

10 Dryer Loading Glove Box
Drawings: P&ID Figure C.1.2-6 Node 10

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
10.5	High concentration of contaminants (Oxygen)	No nitrogen flow [Frequency = IV] Leak [Frequency = IV]	Possible fire or explosion in the dryer loading glovebox S: A SR: 2	Flow meter of nitrogen FI 520-1	

Table C.1.3-1 Hazard Identification and Evaluation

11 Dryer Discharge Glove Box
Drawings: P&ID Figure C.1.2-6 Node 11

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
11.1	High level	Operator overfilling drum [Frequency = IV]	Possible delay G: D GR: 4	Control feed charge volume Meter discharge with agitator	Considering trying to fill drums completely
11.2	Low level	Hang up in dryer [Frequency = I] Bridging in valve port [Frequency = II]	Personnel exposure (dryer hang up) G: C GR: 1 Time delay (Bridging) G: D GR: 3	Shred finer next run	Review design with vendor (for hang ups in the dryer)
11.3	High temperature	High temperature - Node 18: Dryer Loading Glove box (see 10.2) [Frequency = V]	Loss of containment due to glove melting S: D SR: 4	SOPs	
11.4	High Pressure	High pressure - N5 Thermal Desorption Dryer (see 3.4)		PSV 522-2	
11.5	Low pressure	Leaky discharge valve on dryer [Frequency = IV]	Glove box failure F: D FR: 4	PSV 522-3	Chock wheels or wheel stops on waste drum trolley SP-12 Confirm discharge valve won't open under vac.

Table C.1.3-1 Hazard Identification and Evaluation

12 Primary Condenser
Drawings: P&ID Figure C.1.2-3 Node 12

Page 19

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
12.1	**High Pressure (Tube Side)**	High pressure - N5 Thermal Desorption Dryer (see 3.4)			
12.2	**Tube Leak**	Corrosion [Frequency = V] Thermal stress [Frequency = V]	Maintenance G: D GR: 4 Cooling water in condensate F: D FR: 4 G: D GR: 4	SOPs Hydrotest	Slope line (2"-2.6D-014-1) to primary condenser
12.3	**Reverse Flow**	Diffusion in cooling the dryer [Frequency = V]	Possible condensation on filter G: D GR: 4 Possible recontamination of treated material G: D GR: 4	SOP	
12.4	**Low or No Flow (Shell Side)**	Chill water system failure [Frequency = IV]	Overheating on the shell side G: D GR: 4 System Shutdown F: D FR: 4	SOP Flow meter FI 040-1	Put a relief valve on the shell side Remove all block valves on shell side

Table C.1.3-1 Hazard Identification and Evaluation

13 Primary Condensate Tank
Drawings: P&ID Figure C.1.2-3 Node 13

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
13.1	High level	Failure of the LSH 022-4 [Frequency = IV]	Line blocked with liquid backup G: D GR: 4	Sight glass	Use quick disconnect from drum instead of valve
		Plugged drain line [Frequency = IV]	High pressure in dryer G: D GR: 4		
		Operator error [Frequency = III]			
13.2	Low level	Reverse flow - Node 14A, Pressure Bleed (see 16.1)	Shutdown G: C GR: 4	Follow SOP sequence for disconnecting drum before bleeding T022	
		Bottom valve left open and vent on drum open [Frequency = IV]			
13.3	High pressure	Pressure control valve failure [Frequency = IV]	High pressure - N3 Thermal Desorption Dryer (see 3.4) G: D GR: 4	TI 022-1 temperature indicator	
		Vacuum pump failure [Frequency = IV]		Pressure indicator PIC 010-8 on the dryer	
		Demister plug [Frequency = IV]			
13.4	Low Flow	Plugged Line [Frequency = IV]	System shutdown G: D GR: 4		Install sight glass on T024 drain line or on 2" Line
		Closed Valve [Frequency = III]	Flood vacuum pump F: B FR: 2		

Table C.1.3-1 Hazard Identification and Evaluation

13 Primary Condensate Tank
Drawings: P&ID Figure C.1.2-3 Node 13

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
13.5	Reverse Flow	Pressure bleed procedure ignored - valve positions [Frequency = III]	Vacuum pump damage F: C FR: 3	SOP directing valve positioning	

Table C.1.3-1 Hazard Identification and Evaluation

14 T022 Pressurization Line
Drawings: P&ID Figure C.1.2-3 Node 14

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
14.1	Low/no flow	Plugged line [Frequency = IV] Operator error [Frequency = III]	System shutdown G: C GR: 3	SOP	
14.2	Misdirected flow	Operator error (wrong valves open/closed) [Frequency = III]	Loss of pressure control to dryer G: C GR: 3	SOP	Move high temp (TI022-1) to vacuum pump suction

Table C.1.3-1 Hazard Identification and Evaluation

15 Vacuum Pump Suction Line
Drawings: P&ID Figure C.1.2-3 Node 15

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
15.1	High flow	High temperature [Frequency = III] Control Valve (PCV 010-8) stuck open [Frequency = IV]	Shutdown G: D GR: 4		Put a time delay or filter on the high temp interlock for vacuum inlet TI 022-1
15.2	No flow	High pressure - N3 Thermal Desorption Dryer (see 3.4) [Frequency = IV]			
15.3	Reverse flow	EV 022-2 in wrong position while running [Frequency = III]	High concentration of contaminants - N3 Thermal Desorption Dryer (see 3.7) S: A SR: 1 High concentration of contaminants (see 15.6) Reverse flow - Node 21: Process Vapor to Carbon Canister (see 20.2)	Interlock #7 on EV-022-2 Check valve in bypass line	
15.4	Low temperature			Lockout block valve	
15.5	High pressure	High pressure - N3 Thermal Desorption Dryer (see 3.4)			

Table C.1.3-1 Hazard Identification and Evaluation

15 Vacuum Pump Suction Line
Drawings: P&ID Figure C.1.2-3 Node 15

Page 24

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
15.6	**High concentration of contaminants**	Reverse flow (see 15.3)			

Table C.1.3-1 Hazard Identification and Evaluation

16 Pressure (Vacuum) Bleed
Drawings: P&ID Figure C.1.2-3 Node 16

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
16.1	Reverse flow	Bottom discharge valve left open and 55 gallon drum still connected [Frequency = III]	Oxygen in system S: B SR: 2 Low level - Node 13: Primary Knockout Pot (see 13.2)	SOP - disconnect drum first Oxygen alarms	Revisit condensate drainage

Table C.1.3-1 Hazard Identification and Evaluation

17 Vacuum Pump and the Interstage Cooler
Drawings: P&ID Figure C.1.2-3 Node 17

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
17.1	High Pressure	High back pressure in the line or blocked discharge [Frequency = IV]	Pressure relief valve PSV 030-7 pops G: D GR: 4	Pressure safety interlock #1	Number pressure safety interlock PI 030-5
		Low/no flow - Node 21: Process Vapor to Carbon Canister (see 20.1)	High pressure - Node 16: Secondary Condenser (see 18.1)		
17.2	High temperature	Chilled water valving incorrect [Frequency = III]	Possible vacuum pump failure F: C FR: 3	None	Consider high-high alarm on TI 030-6 Consider RO instead of unnumbered bypass globe valve Consider closed loop for vacuum system with fin fan
17.3	Low Temperature	Cooling water too cold [Frequency = IV]	Possible pump damage F: C FR: 4	Low level alarm	Check with manufacturer if pump can actually operate at 35F. SOP to startup at 40F then cool down to 35F

Comments:

Table C.1.3-1 Hazard Identification and Evaluation

17 Vacuum Pump and the Interstage Cooler
Drawings: P&ID Figure C.1.2-3 Node 17

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
17.4	High Level of Condensate				Design condensate drain and return system Consider sloping vacuum pump discharge line (030-1) down to the exchanger E 040 Consider sloping line 022-1 away from vacuum pump

Table C.1.3-1 Hazard Identification and Evaluation

18 Secondary Condenser - E-040
Drawings: P&ID Figure C.1.2-3 Node 18

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
18.1	High pressure	High Pressure - Node 15: Vacuum Pump (see 17.1)		This is rated for 150psig	

Table C.1.3-1 Hazard Identification and Evaluation

19 Secondary Condensate Tank T-042
Drawings: P&ID Figure C.1.2-3 Node 19

Page 29

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
19.1	**High level**	Level Indicator Failure [Frequency = IV] Plugged Discharge Line [Frequency = IV]	System Shutdown G: D GR: 4	SOP	Consider vent system Determine means of knowing tanks are empty

Table C.1.3-1 Hazard Identification and Evaluation

20 Process Vapor/Carbon Canister/HEPA/Blower.
Drawings: P&ID Figure C.1.2-4 Node 20

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
20.1	**Low/no flow**	Block valve closed downstream or upstream [Frequency = IV] Plugged hepa filter F 070 or restricted carbon canisters C 080, etc (heat tape failure) [Frequency = IV]	High pressure - Node 15: Vacuum Pump (see 17.1) High pressure (see 20.4)	Pressure interlock PI 030-5 Pressure relief valve PSV 030-7 Pressure indicator PI 030-5	Consider roughing filter Install gas sample ports Install a flow meter on line 042-1
20.2	**Reverse flow**	Reverse flow - Node 14: Vacuum Pump Suction Line (see 15.3)			
20.3	**Low temperature**	Heat tape failure [Frequency = III]	False O2 reading or no O2 reading on 070-4 S: C SR: 3 Condensation on hepa F 070 G: C GR: 3	O2 analyzer reads "error"	Move TI 042-3 downstream of heat tape or add another one downstream of heat tape
20.4	**High pressure**	Low/no flow (see 20.1)			Take isolation valves off carbon drums
20.5	**Low pressure**	Blower B 524 running while process is running [Frequency = IV]	Poor condenser performance G: D GR: 4		Draw on the PID the on,off,start status of blower Leave room for a second hepa filter

Table C.1.3-1 Hazard Identification and Evaluation

20 Process Vapor/Carbon Canister/HEPA/Blower.
Drawings: P&ID Figure C.1.2-4 Node 20

Page 31

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
20.6	High Temperature	Heat Tape Controller Fails [Frequency = III]	Possible hepa seal damage G: D GR: 4 Carbon drum reduced efficiency G: D GR: 4	No	

Table C.1.3-1 Hazard Identification and Evaluation

21 Condensate Disposal Drums
Drawings: P&ID Figure C.1.2-3 Node 21

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
21.1	Loss of containment	Knock Drum Over (Uncontrolled release of organic vapors) [Frequency = IV] Liquid overflow [Frequency = IV]	Personnel exposure S: C SR: 4 Fire S: B SR: 3	Drums will be grounded Local Ventilation Containment for liquids Use of sampling sleeve for colowasa Fire suppression system	Install local exhaust Consider condensate redesign Look at overflow of 55 gallon drum or fill mechanism Look at drum fill mechanism level indicator
21.2	Sampling	Loss of containment of vapors while sampling [Frequency = I]	Personnel protection S: C SR: 1	None	Need a means to sample and determine phases. Provide a local ventilation system for sampling the liquid in the drum.

Table C.1.3-1 Hazard Identification and Evaluation

22 Relief System
Drawings: P&ID Figure C.1.2-4 Node 22

No.	Deviation	Causes	Consequences	Safeguards	Recommendations
22.1	**High pressure**				Investigate direct tie-ins
22.2	**Low pressure**	Direct ventilation tie-in (very strong ventilation) [Frequency = I]			Assure no direct tie-in to ventilation system
22.3	**High concentration of contaminants**	Relief valve popping	Potential oxygen or organics		Consider nitrogen sweep

This page intentionally blank

C.2 Design Basis Accident Analysis Scenarios for Selected Accidents (Fault Trees)

Scenario 1 - Natural Phenomenon (Figure C.2–1)

Failures due to natural phenomenon were limited to earthquake. High wind, flooding, temperature extremes, etc. were not considered because it is assumed that the MTU will be housed in a RCRA-permitted building which would be designed for these considerations. Tornados and cyclones are not expected at the sites this MTU is serving.

Scenario 2 - Waste Acceptance Criteria Failure (Figure C.2–2)

Lack of availability and inaccuracy of waste profile data can be compounded by poor review by an Industrial hygienist (IH) or Chemists prior to acceptance. The combination of the presence of reactive material, poor data and poor review of data may result in damage to the glovebox.

Scenario 3 - Fire in the Feed Preparation Glovebox (Figure C.2–3)

The quantity and volatility of material available in the feed preparation glovebox could cause a fire or explosion. However, it would require the combination of oxygen in the glovebox, an ignition source, and volatile organics in large enough quantities to burn could create a fire in the glovebox.

Scenario 4 - Dryer Failure with Catastrophic Release (Figure C.2–4)

Oxygen in the dryer could occur if containment were breached and failure of the oxygen controls in place (e.g., percent oxygen detectors and oxygen replacement with nitrogen) occurred simultaneously. The introduction of oxygen to the dryer could result in fire or a release of contaminants, through the release valve, to the atmosphere.

This page intentionally blank

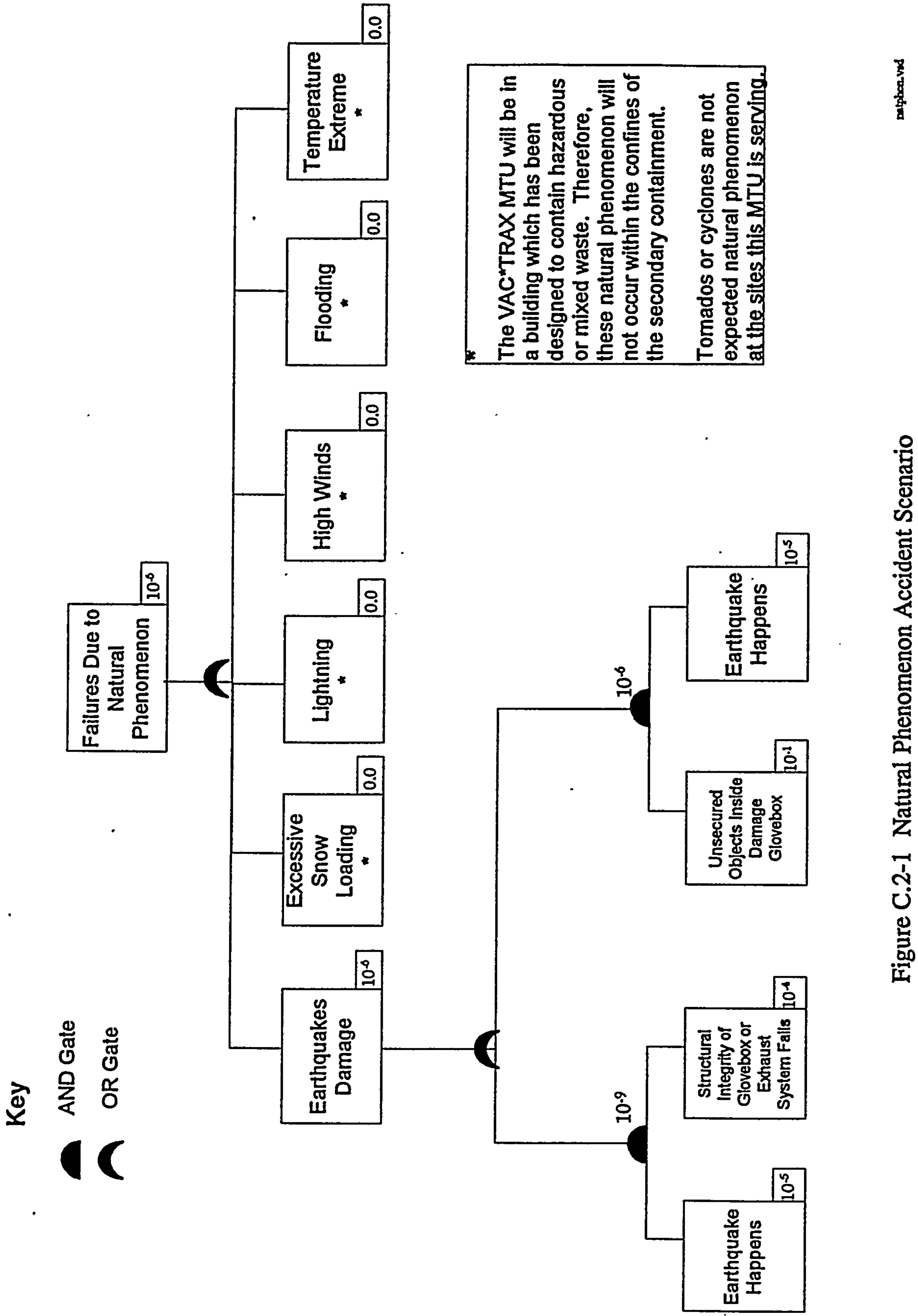


Figure C.2-1 Natural Phenomenon Accident Scenario

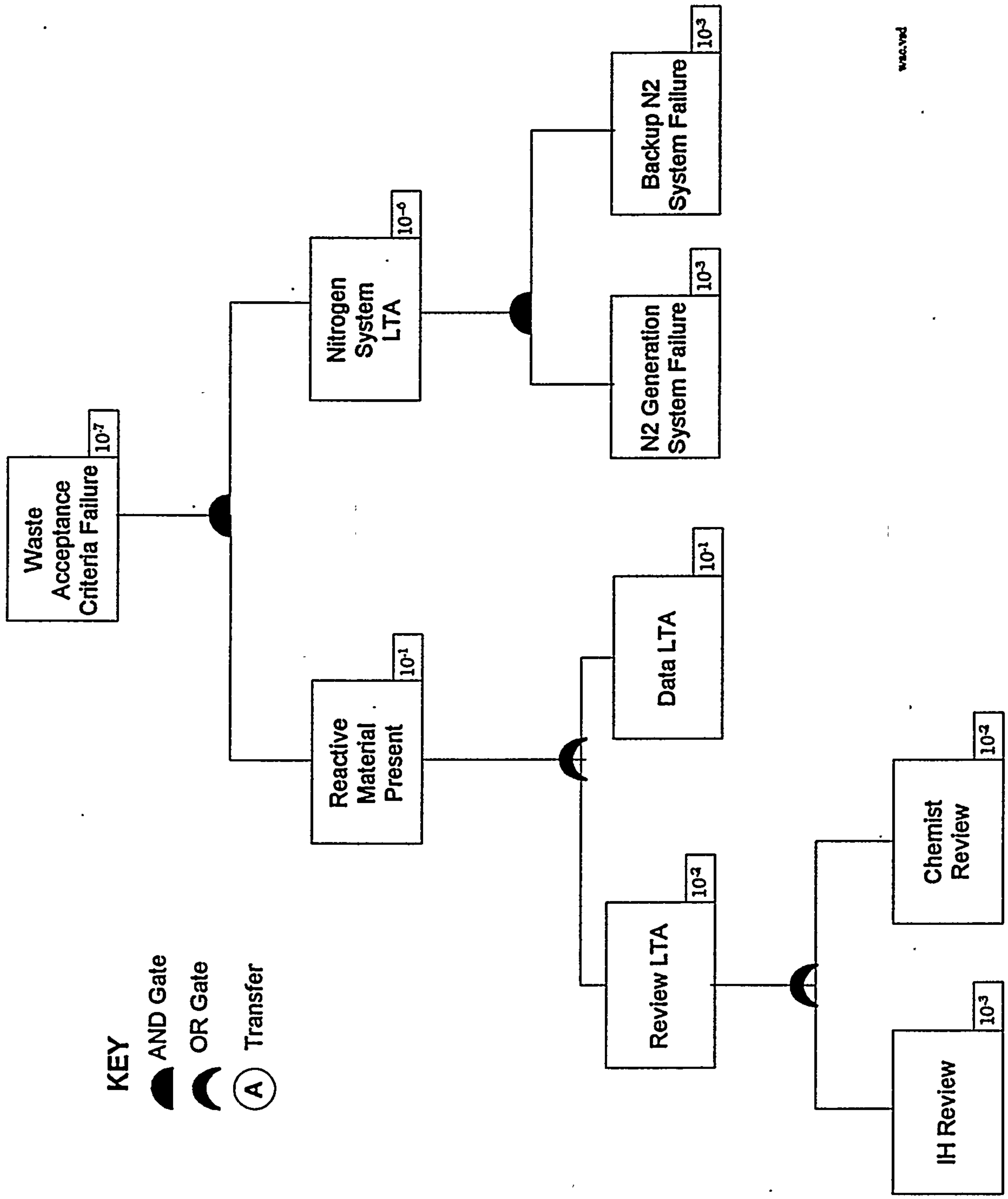


Figure C.2-2 Waste Acceptance Criteria Accident Senario

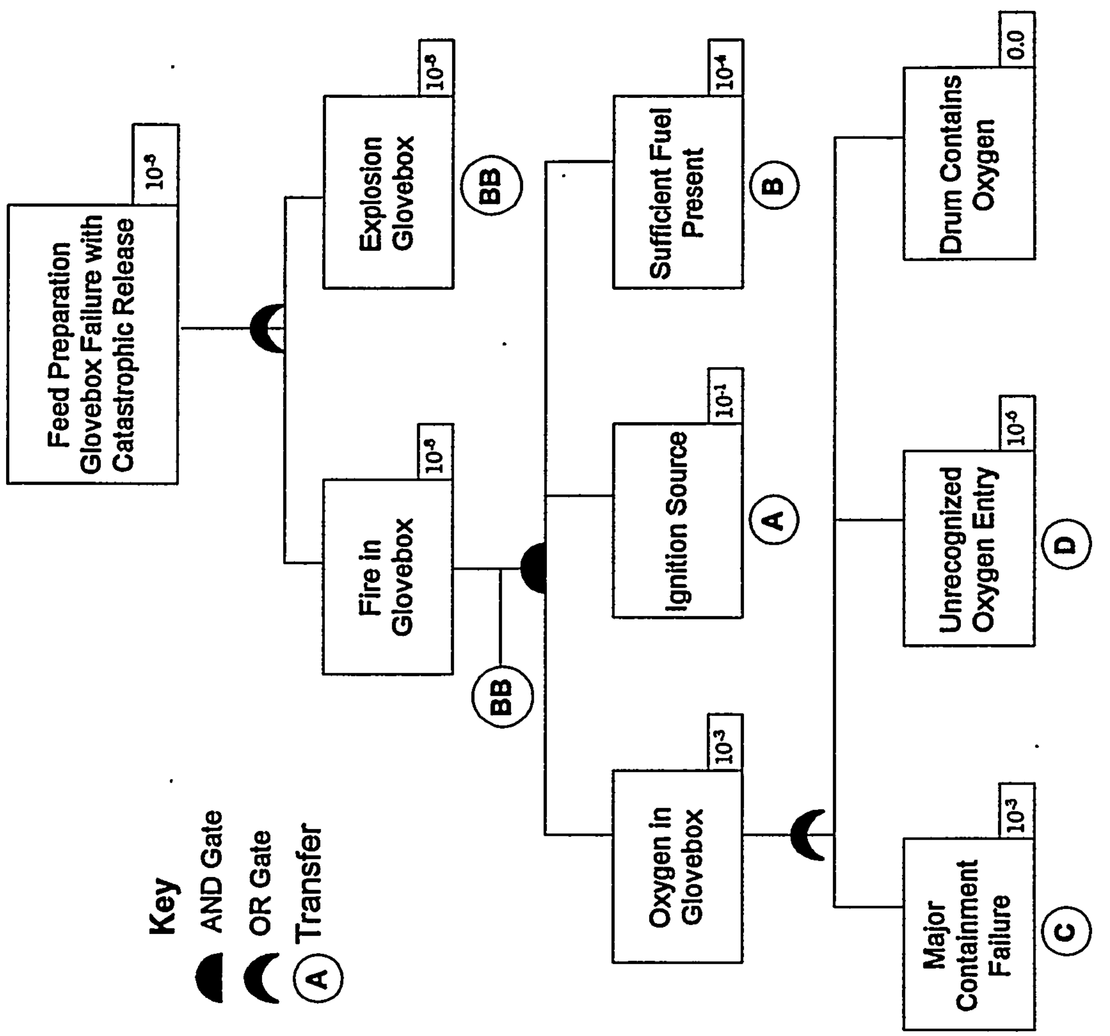


Figure C.2-3 Fire In The Feed Preparation Glovebox Accident Scenario

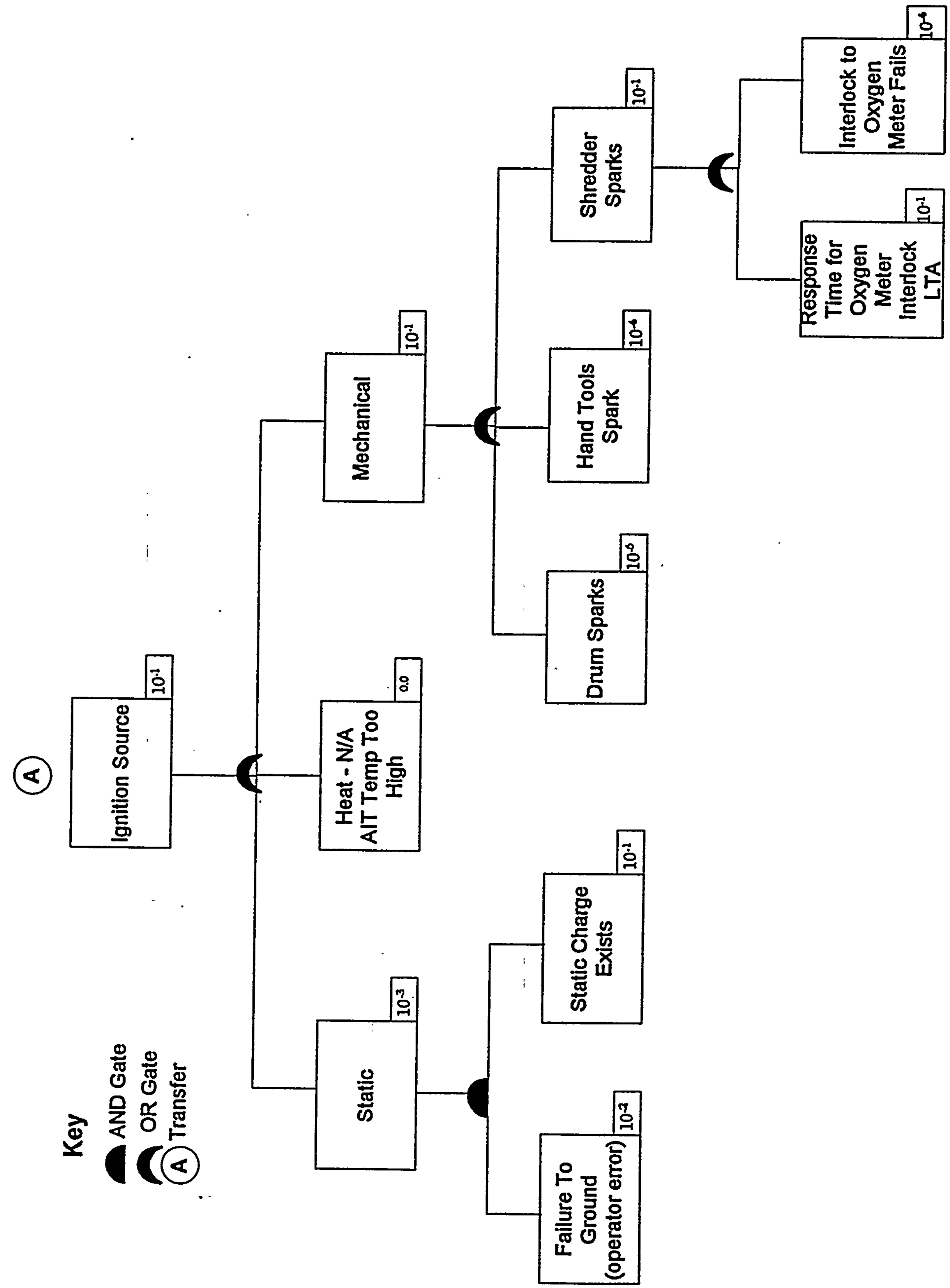


Figure C.2-3 (cont) Fire In The Feed Preparation Glovebox Accident Scenario

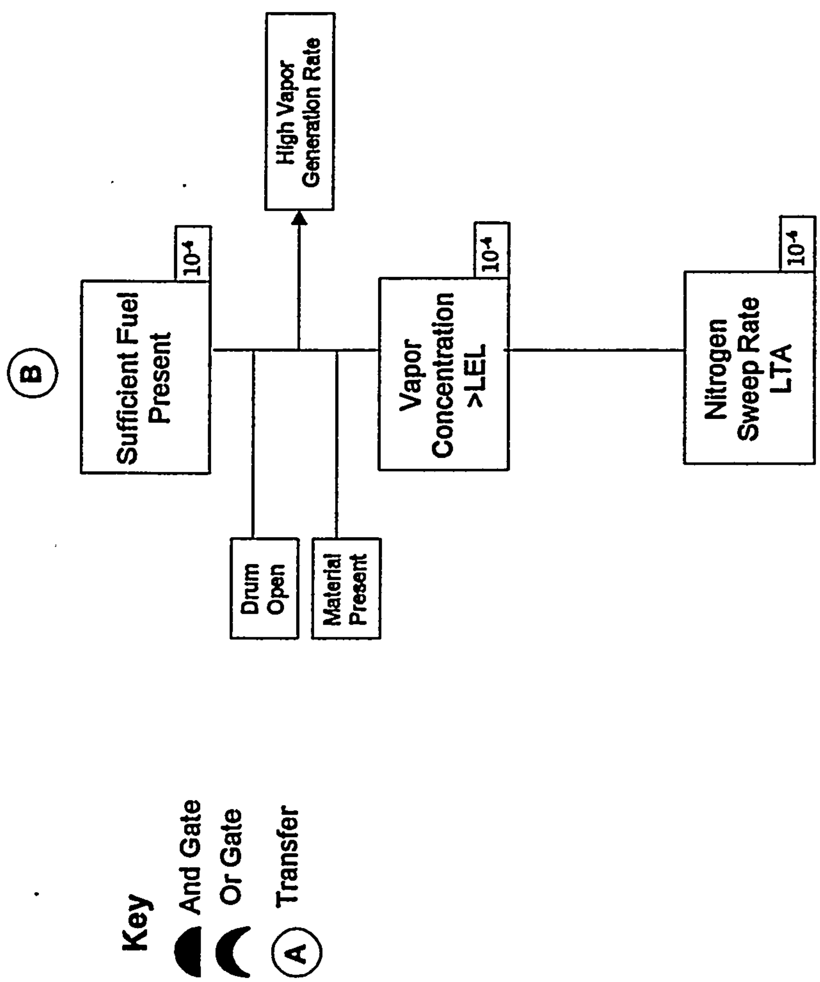


Figure C.2-3 (cont) Fire In The Feed Preparation Glovebox Accident Scenario

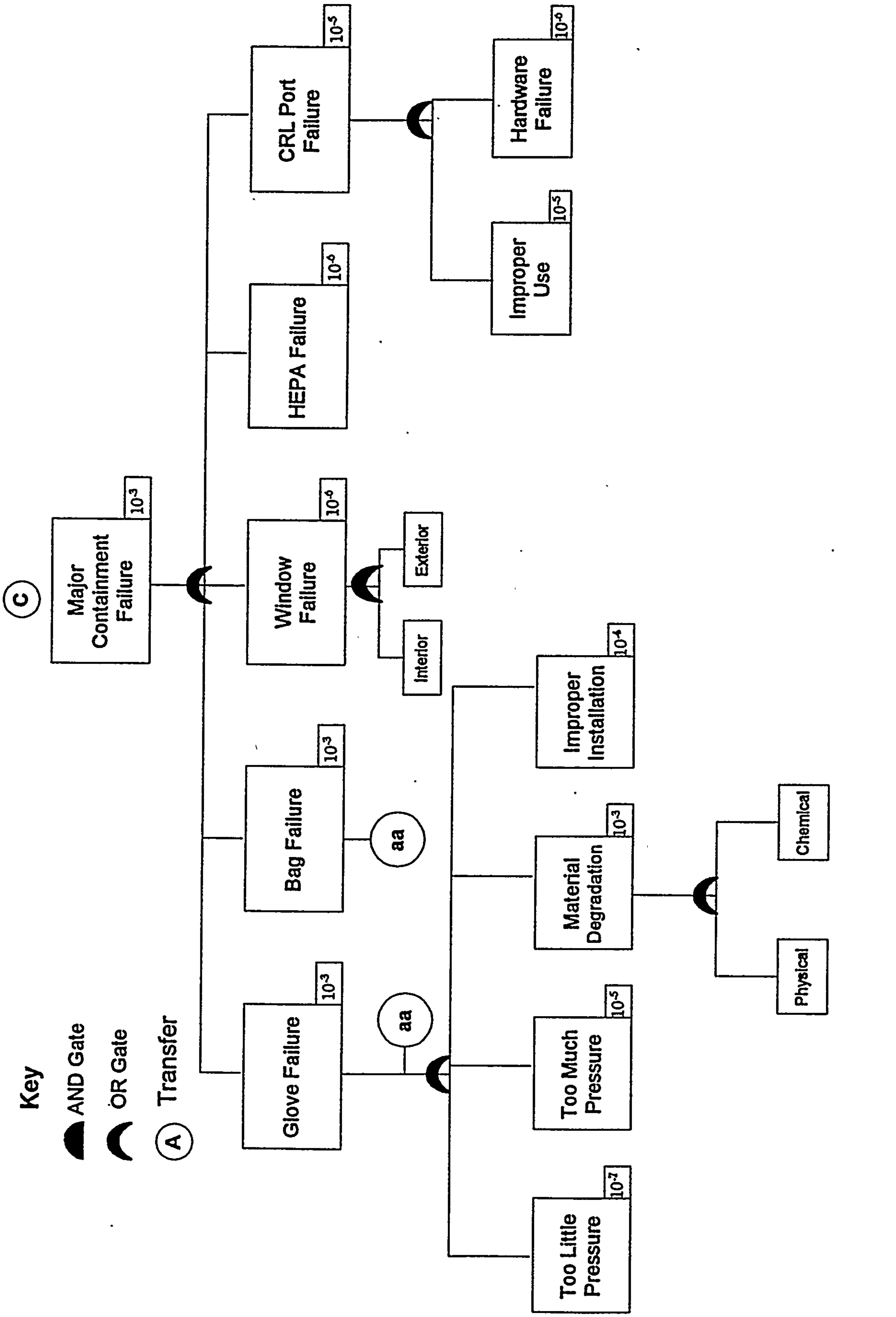


Figure C.2-3 (cont) Fire in The Feed Preparation Glovebox Accident Scenario

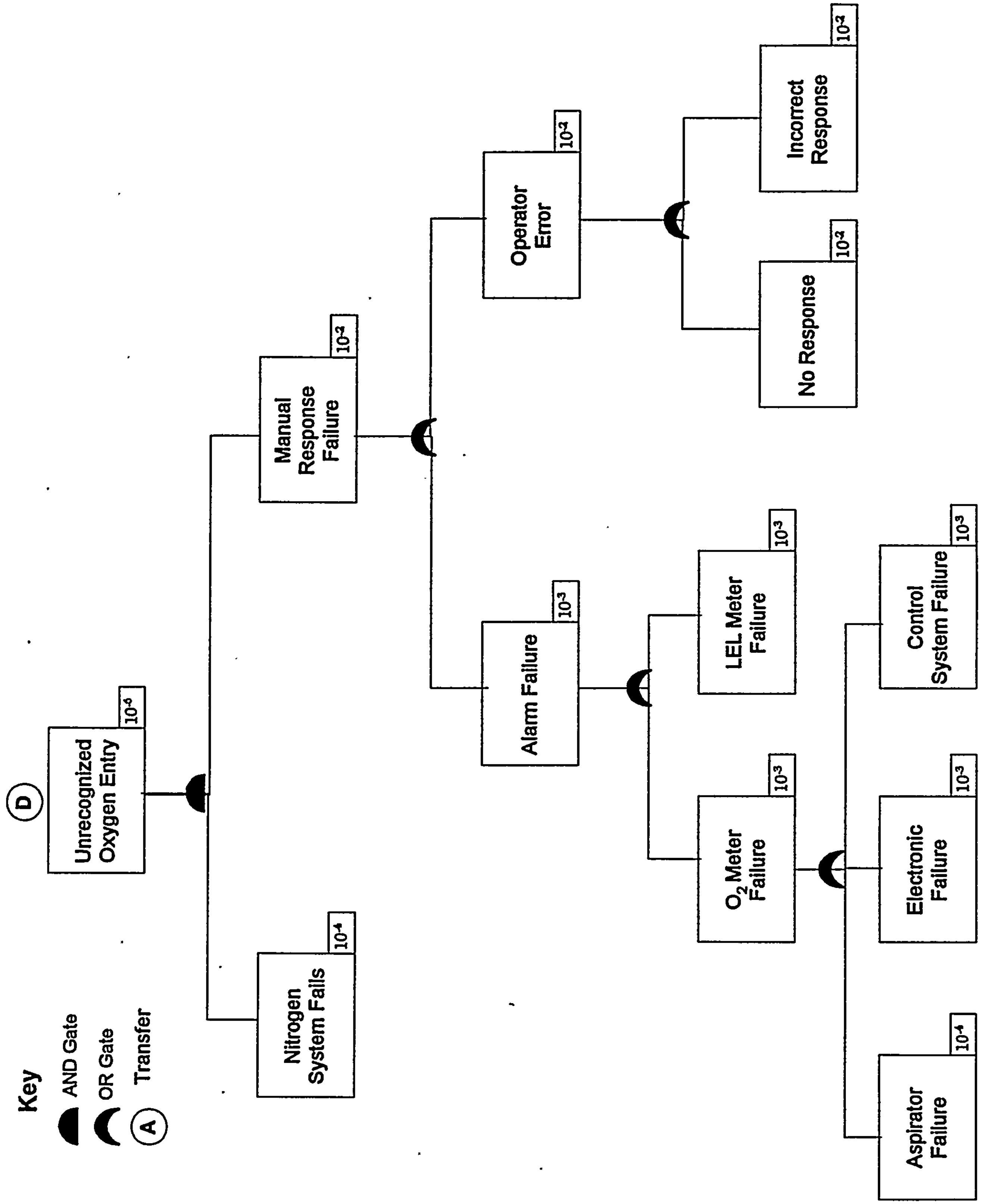
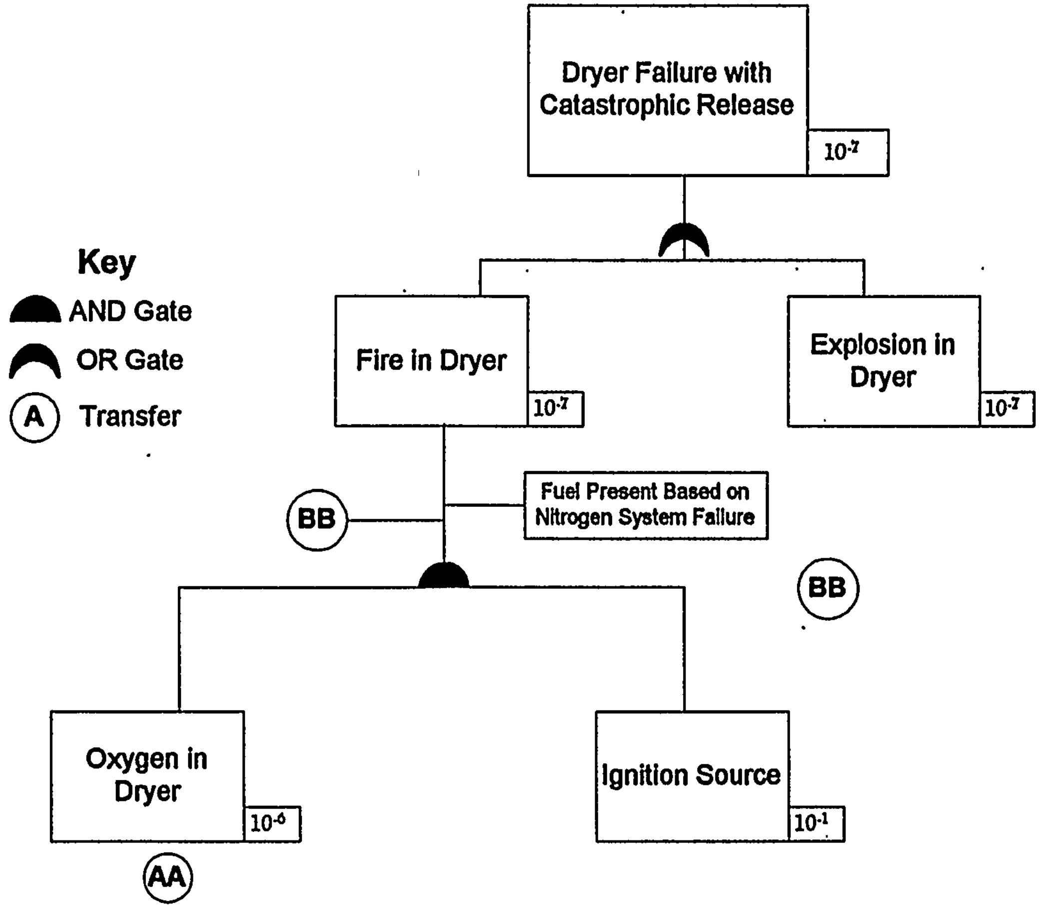


Figure C.2-3 (cont) Fire In The Feed Preparation Glovebox Accident Scenario



Note: Ignition source is similar to the risks in the feed preparation glovebox accident scenario. Refer to Figure C.2-3 for the details.

pha-gb.vsd

Figure C.2-4 Dryer Failure with Catastrophic Release

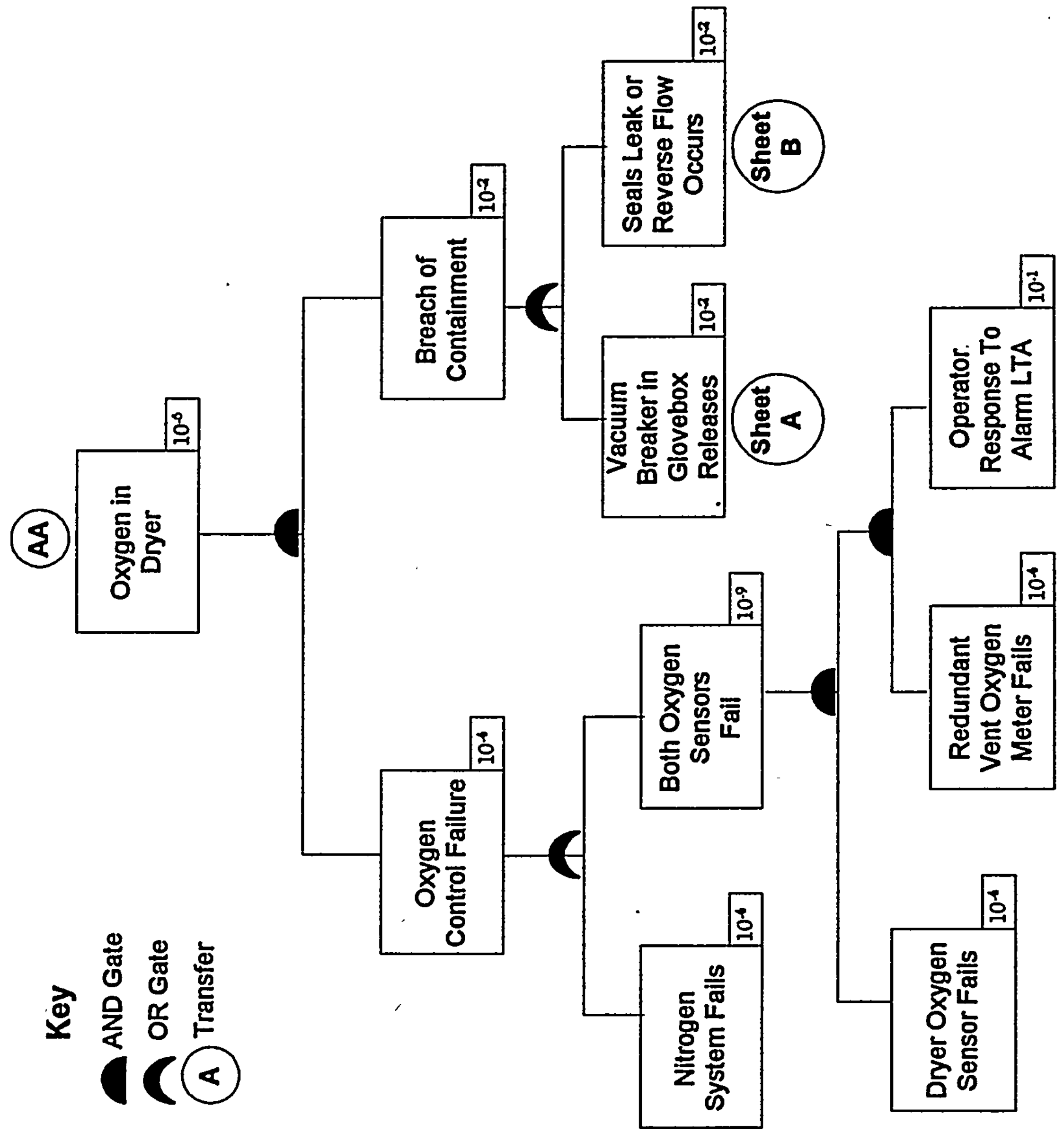


Figure C.2-4(cont) Dryer Failure with Catastrophic Release

oxydr.vsd

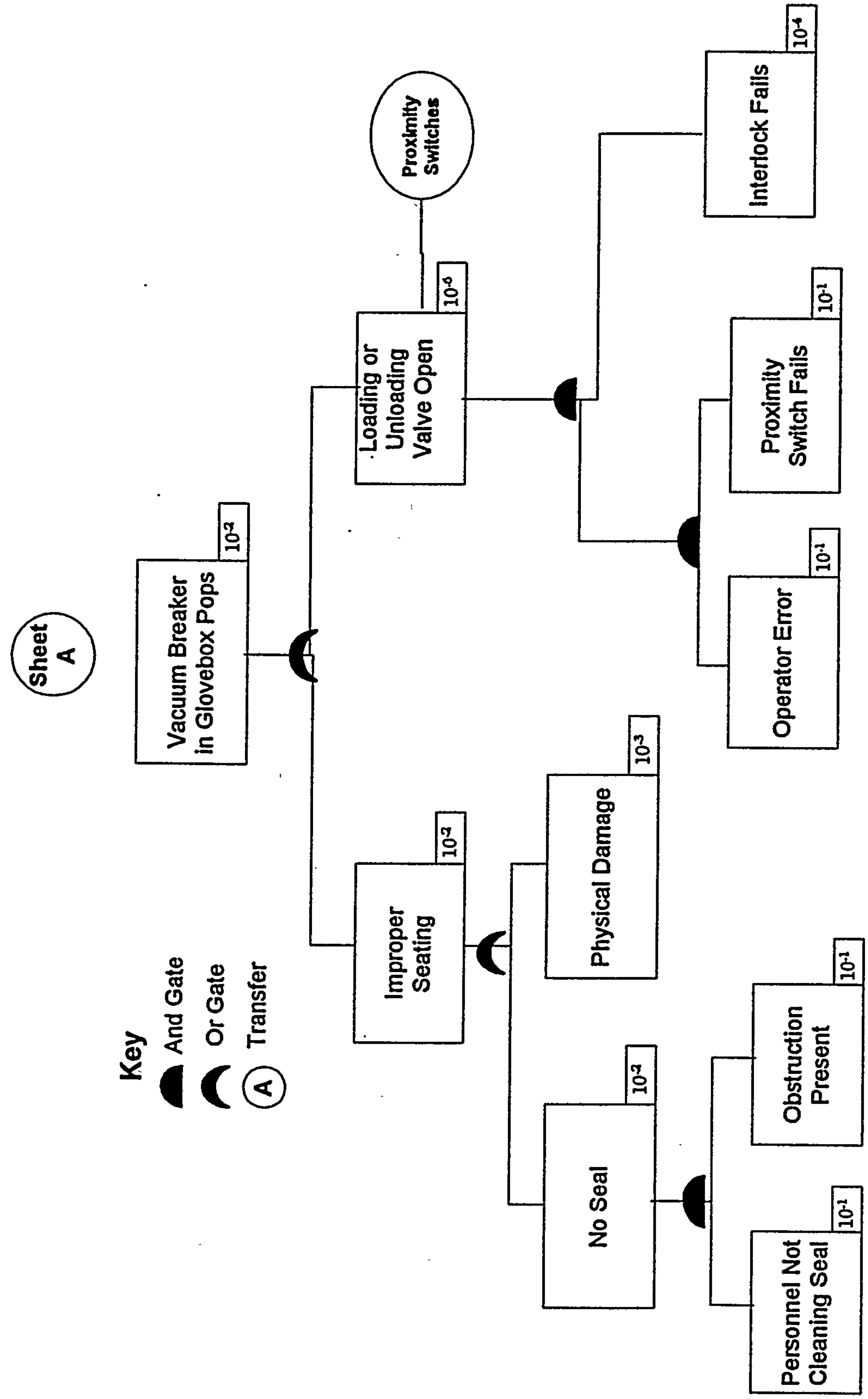


Figure C.2-4 (cont) Dryer Failure with Catastrophic Release

vacbrk.vsd

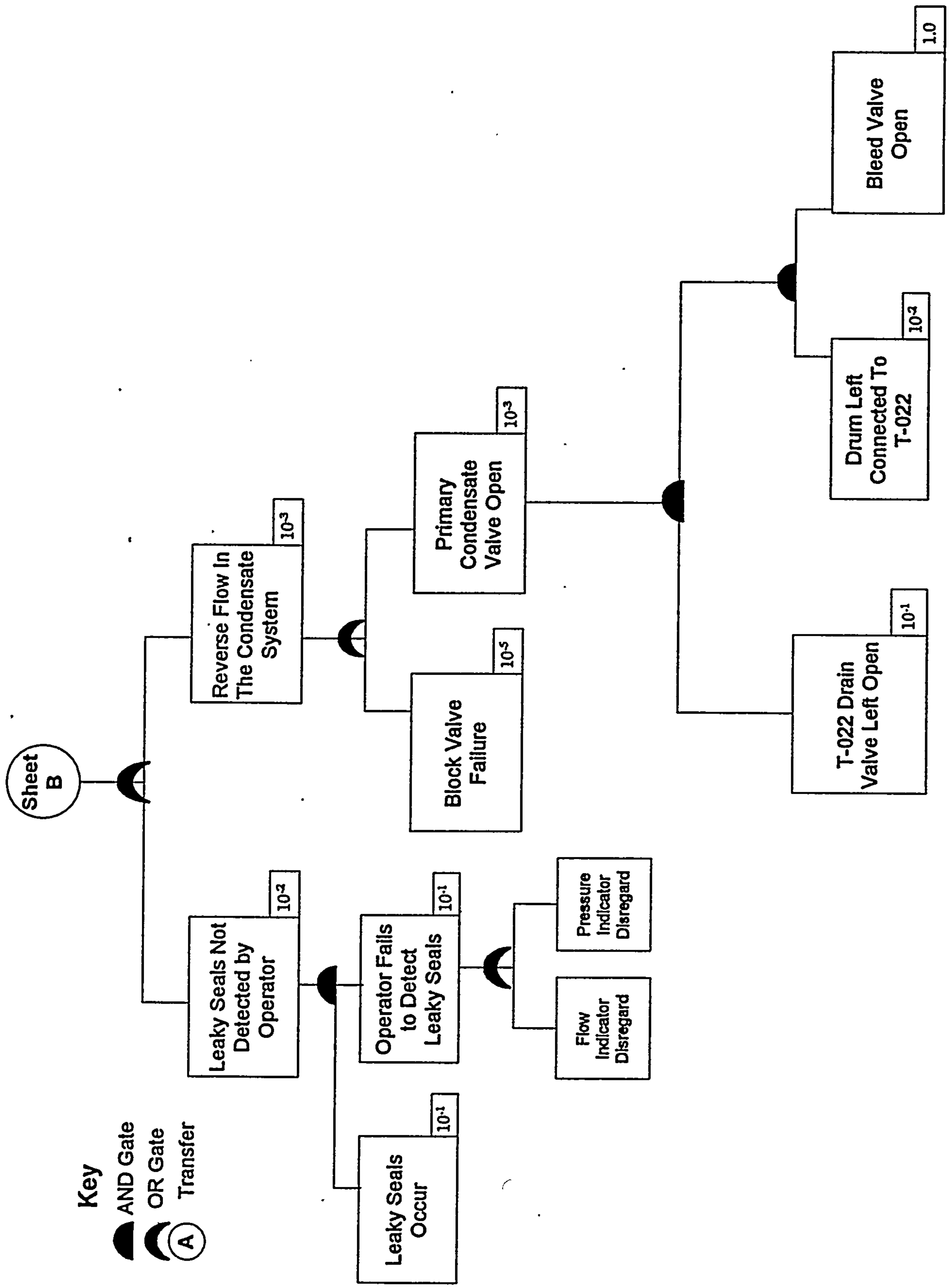


Figure C.2-4 (cont) Dryer Failure with Catastrophic Release

This page intentionally blank

C.3 Action Item Tracking and Risk Reduction

This Appendix contains a listing of all action items determined during the VAC*TRAX MTU HAZOP process and their resolution. The recommendations have all been addressed as shown by the current status of "complete."

The deviation concern and current (initial) risks are those identified during the HAZOP and documented in Table C.1.3–1. This table shows how each item was resolved and the resulting reduced risk. The risks are coded: Safety (S); environmental (E); financial (F); and general (G). The risk rating range is from 1 (high risk) to 4 (low risk). All risks have been reduced to 3 or lower.

This page intentionally blank

Table C.3-1 Action Item Resolution

Number: 1 **Description:** Size line and valve (012-7) to avoid excess flow

Worksheet: Nitrogen Preheater **Deviation:** High process flow

Concern:
Excess flow could cause high pressure in the dryer, poor process performance, and wasted nitrogen or carbon.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Line and valve sized to avoid excess flow - No change in risk.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	4			4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4			4	**Operating Cost ($/yr × 1000):**	0.00

Number: 2 **Description:** Specify as a fail open valve (012-7)

Worksheet: Nitrogen Preheater **Deviation:** High process flow

Concern:
High N2 flow could cause high pressure in dryer and blown rupture disk.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Valve specified as fail open - No change in risk.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	4			4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4			4	**Operating Cost ($/yr × 1000):**	0.00

Number: 3 **Description:** Consider changing nitrogen supply pressure to below 25 (PCV 100-1)

Worksheet: Nitrogen Preheater **Deviation:** High process flow

Concern:
High flow could result in overpowering vacuum system and glovebox seals.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Nitrogen supply pressure reduced - No change in risk.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 3 **Description:** Consider changing nitrogen supply pressure to below 25 (PCV 100-1)

Worksheet: Relief System **Deviation:** High concentration of contaminants

Concern:
High N2 flow could results in owerpowering vacuum system and glovebox seals.

Current Status:	Responsible:	Department:	Date:
Complete	R Richardson	Rust Eng	4/3/96

Current/Final Resolution:
Nitrogen supply pressure reduced - No change in risk.

	S	E	F	G
Current Risk:				4
Residual Risk:				4

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Number: 4 **Description:** Confirm whether nitrogen gen. has oxygen detector that alarms on main panel

Worksheet: Nitrogen Preheater **Deviation:** Low/no process flow

Concern:
No/low flow in N2 system could allow excess O2 in system.

Current Status:	Responsible:	Department:	Date:
Complete	R Mancik	Rust Eng	4/3/96

Current/Final Resolution:
Nitrogen generation system has O2 detector that alarms on main panel. Frequency = IV, Consequence B = 3 risk

	S	E	F	G
Current Risk:	2			
Residual Risk:	3			

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Number: 5 **Description:** Add backup nitrogen bottles

Worksheet: Nitrogen Preheater **Deviation:** Low/no process flow

Concern:
No flow in N2 generation system could allow O2 high enough for a fire to occur.

Current Status:	Responsible:	Department:	Date:
Complete	R Mancik	Rust Eng	4/3/96

Current/Final Resolution:
Design spec 15998 specifies backup N2 system Frequency V, Consequence B = 4 Risk

	S	E	F	G
Current Risk:	2			
Residual Risk:	4			

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Table C.3-1 Action Item Resolution

Number: 6 **Description:** Calculate detonation scenario

Worksheet: Nitrogen Preheater **Deviation:** Low/no process flow

Concern:
Is detonation of the system possible if valves stuck or line plugged?

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	R Richardson	Rust Eng	4/ 3/96

Current/Final Resolution:
Consultation with experts determined system is too small for detonation calculations - Frequency III, Consequence D = 4 Risk

	S	E	F	G	Drawing Numbers:	
Current Risk:	2				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4				**Operating Cost ($/yr × 1000):**	0.00

Number: 7 **Description:** Add 2nd oxygen analyzer tied in

Worksheet: Nitrogen Preheater **Deviation:** Low/no process flow

Concern:
Failure of O2 analyzer could allow high O2 concentration.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Two oxygen analyzers are tied together. New frequency (IV), Consequence B = 4 Risk

	S	E	F	G	Drawing Numbers:	
Current Risk:	2				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4				**Operating Cost ($/yr × 1000):**	0.00

Number: 8 **Description:** Verify high temp seals

Worksheet: Nitrogen Preheater **Deviation:** High process temperature

Concern:
High process temperature could cause seal damage/leakage.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	R Mancik	Rust Eng	4/ 3/96

Current/Final Resolution:
Heater design eliminates possibility of seal leakage. Frequency V, No Consequence = 0 Risk

	S	E	F	G	Drawing Numbers:	
Current Risk:	1				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	0				**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 9 **Description:** Verify high temp shutoff

Worksheet: Nitrogen Preheater **Deviation:** High process temperature

Concern:
High heat could cause seal damage resulting in oxygen intrusion.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	R Mancik	Rust Eng	4/ 3/96

Current/Final Resolution:
Unit has a sheath temperature high cutoff
Frequency V, No Consequence = No risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	1				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	0				**Operating Cost ($/yr × 1000):**	0.00

Number: 10 **Description:** Show insulation on P&ID

Worksheet: Nitrogen Preheater **Deviation:** High process temperature

Concern:
Piping drawing did not show insulation for worker protection.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Design spec 15260 describes piping insulation No risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:					**Captial Cost ($ × 1000):**	0.00
Residual Risk:					**Operating Cost ($/yr × 1000):**	0.00

Number: 11 **Description:** Put a shroud around rotary joint

Worksheet: Hot oil Supply to Dryer **Deviation:** High temperature

Concern:
If rotary joint fails, workers need protection from hot oil.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Rotary joint rated for 100 psi, relief valve will go at 50 psi
Frequency IV, No Consequence = No risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	1				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	0				**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 12 **Description:** Interlock control system to oil heater (high temp shutoff on hot oil)

Worksheet: Hot oil Supply to Dryer **Deviation:** High temperature

Concern:
Exceeding dryer temperature could cause seals and joints to fail.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	S Brill	Rust Eng	4/ 3/96

Current/Final Resolution:
Not needed, high temperature shutoff capability
Frequency IV, No Consequence = No risk

	S	E	F	G	**Drawing Numbers:**	
Current Risk:	1				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	0				**Operating Cost ($/yr × 1000):**	0.00

Number: 13 **Description:** Add insulation to PID

Worksheet: Hot oil Supply to Dryer **Deviation:** High temperature

Concern:
Piping insulation for worker protection not shown on drawing.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Design spec 15260 specifies piping insulation - No risk

	S	E	F	G	**Drawing Numbers:**	
Current Risk:					**Captial Cost ($ × 1000):**	0.00
Residual Risk:					**Operating Cost ($/yr × 1000):**	0.00

Number: 14 **Description:** Direct temp control from PLC

Worksheet: Hot oil Supply to Dryer **Deviation:** High temperature

Concern:
High temperature in hot oil system results in high temperature in dryer.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Design spec 16900 specifies PLC - Frequency V, Consequence A = 3 risk

	S	E	F	G	**Drawing Numbers:**	
Current Risk:	2			3	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	3			4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 15 **Description:** Add block valve to PID

Worksheet: Hot oil Supply to Dryer **Deviation:** High pressure

Concern:
Blocked valve could result in high pressure in dryer.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
High pressure alarm will identify blocked valve - Frequency IV, Consequence B = 3 risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	2			4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	3			4	**Operating Cost ($/yr × 1000):**	0.00

Number: 16 **Description:** Fire suppression system (Halon substitute)

Worksheet: Hot oil Supply to Dryer **Deviation:** High pressure

Concern:
High pressure could cause rotary joint failure, potential employee burns.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Rotary joint rated twice the pressure of the relief valve and second relief valve added, no longer require fire suppression. - Frequency V, Consequence B = 4 risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	2				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4				**Operating Cost ($/yr × 1000):**	0.00

Number: 17 **Description:** Consider high pressure alarm

Worksheet: Hot oil Supply to Dryer **Deviation:** High pressure

Concern:
High pressure in hot oil supply could cause high pressure in dryer.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Added a high pressure interlock - Frequency V, Consequence A = Risk 3

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	1				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	3				**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 18 **Description:** Fire suppression system

Worksheet: Hot oil Supply to Dryer **Deviation:** Rupture

Concern:
Potential fire or worker burns possible if rotary joint fails .

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Fire suppression not needed now that dual rupture disk in place and rotary joint rated twice the rupture disks.
Frequency V, Consequence B = 4 risk for personnel burns

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	3				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4				**Operating Cost ($/yr × 1000):**	0.00

Number: 19 **Description:** Shroud around rotary joint

Worksheet: Hot oil Supply to Dryer **Deviation:** Rupture

Concern:
Rotary joint failure could cause worker burns.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Joint failure (100psi) less likely than relief (50) - Frequency V, Consequence B = 4 Risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	2				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4				**Operating Cost ($/yr × 1000):**	0.00

Number: 20 **Description:** Consider relief valve rotary joint

Worksheet: Hot oil Supply to Dryer **Deviation:** Rupture

Concern:
Rupture of rotary joint could cause personnel burns.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
High pressure interlock added between dryer and hot oil - no relief valve needed - Frequency V, Consequence B = 4 risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	2				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4				**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 21 **Description:** SOP includes having absorbent material available

Worksheet: Hot oil Supply to Dryer **Deviation:** Leaks

Concern:
Leaks could cause delay in operations, slipping hazard.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
SOP includes absorbent material available - No change in risk

	S	E	F	G	Drawing Numbers:	
Current Risk:	4		4		**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4		4		**Operating Cost ($/yr × 1000):**	0.00

Number: 22 **Description:** Determine minimum daily startup temp

Worksheet: Hot oil Supply to Dryer **Deviation:** Startup

Concern:
Extreme cold (low viscosity oil can heat too quickly).

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	S Brill	Rust Eng	4/ 3/96

Current/Final Resolution:
Minimum daily startup temp 13 degrees F and included in design documentation. Hot oil pump is centrifugal, therefore not a problem - No change in risk.

	S	E	F	G	Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Number: 23 **Description:** Consider interlock TIs on hot oil system

Worksheet: Thermal Desorption Dryer **Deviation:** High temperature

Concern:
High temperature due to operator error on hot oil set point.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Not necessary, because PLC compares hot oil and dryer temperatures and alarms - No change in risk

	S	E	F	G	Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 24 **Description:** Program high deviation alarm comparing dryer to hot oil temp

Worksheet: Thermal Desorption Dryer **Deviation:** High temperature

Concern:
High temperature in dryer due to high temperature in hot oil supply.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beatonm	Rust Eng	4/ 1/96

Current/Final Resolution:
PLC compares 2 temps and alarms - No change in risk

	S	E	F	G	Drawing Numbers:	
Current Risk:	4			4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4			4	**Operating Cost ($/yr × 1000):**	0.00

Number: 25 **Description:** Consider interlocking deviation between dryer and hot oil

Worksheet: Thermal Desorption Dryer **Deviation:** High temperature

Concern:
High temperature in dryer due to high temperature in hot oil supply.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
PCL compares dryer and hot oil temp - No change in risk.

	S	E	F	G	Drawing Numbers:	
Current Risk:	4			4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4			4	**Operating Cost ($/yr × 1000):**	0.00

Number: 26 **Description:** Tie the blow down into the correct place on the cupola

Worksheet: Thermal Desorption Dryer **Deviation:** Low temperature

Concern:
At low temperature, filter could blow back during run.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Blow down removed. Frequency V, Consequence C = 4 risk

	S	E	F	G	Drawing Numbers:	
Current Risk:				3	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 27 **Description:** Remove blow down system or heat blow back nitrogen

Worksheet: Thermal Desorption Dryer **Deviation:** Low temperature

Concern:
At low temperature, filter could blow back during run.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Blow down removed - Frequency V, Consequence C = 4 risk

	S	E	F	G	**Drawing Numbers:**	
Current Risk:				3	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Number: 28 **Description:** Suggest that EV-22-2 be a latching 3-way valve

Worksheet: Thermal Desorption Dryer **Deviation:** High pressure

Concern:
Blocked filter or line could overload vacuum system.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Not needed, valve is interlocked - No change in risk.

	S	E	F	G	**Drawing Numbers:**	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Number: 29 **Description:** High-High pressure interlock of dryer to hot oil

Worksheet: Thermal Desorption Dryer **Deviation:** High pressure

Concern:
Blocked line could overload vacuum system.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
HH pressure interlock - dryer to hot oil - No change in risk.

	S	E	F	G	**Drawing Numbers:**	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 30 **Description:** Investigate with vendor possibility of seal/valve leakage below design pressure of 25 psig

Worksheet: Thermal Desorption Dryer **Deviation:** High pressure

Concern:
High pressure could result in valve leakage.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
The valve is rated for 150 psig - Frequency III, No consequence = No risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	3			4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	0			0	**Operating Cost ($/yr × 1000):**	0.00

Number: 31 **Description:** Investigate how much vapor at what concentration to have explosion exterior of vessel (slight pressurization <25)

Worksheet: Condensate Disposal Drums **Deviation:** Loss of containment

Concern:
Explosion.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	R Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Design team felt 3 independent, simultaneous failures would have to occur for explosion - not a credible concern.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:					**Captial Cost ($ × 1000):**	0.00
Residual Risk:					**Operating Cost ($/yr × 1000):**	0.00

Number: 32 **Description:** Possibility of adding 2 rupture disks in series

Worksheet: Thermal Desorption Dryer **Deviation:** High pressure

Concern:
Single rupture disk may allow oxygen into system.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	R Richardson	Rust Eng	4/ 3/96

Current/Final Resolution:
PSE/PA 012-8 has been added downstream of PSE/PA 012-5 with pressure gauge in between (same type disk) - Frequency IV, Consequence C = 4 Risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	3			4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4			4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 33 **Description:** Off gas flow meter to double check oxygen analyzer

Worksheet: Thermal Desorption Dryer **Deviation:** High concentration of contaminants

Concern:
Possiblility of fire or explosion from leaks.

Current Status: Complete
Responsible: R Richardson **Department:** Rust Eng **Date:** 4/ 3/96

Current/Final Resolution:
Two oxygen analyzers provide redundancy - Frequency II, Consequence D = 3 Risk.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	1			4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	3			4	**Operating Cost ($/yr × 1000):**	0.00

Number: 34 **Description:** Investigate a second relief system (capped with N2)

Worksheet: Thermal Desorption Dryer **Deviation:** High concentration of contaminants

Concern:
Possibility of fire due to oxygen inleakage.

Current Status: Complete
Responsible: R Richardson **Department:** Rust Eng **Date:** 4/ 3/96

Current/Final Resolution:
Addition of 2nd rupture disk will provide protection. - Frequency V, Consequence C = 4 Risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	1			3	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4			4	**Operating Cost ($/yr × 1000):**	0.00

Number: 35 **Description:** Possible installation of nozzle for interior swipe of cupola

Worksheet: Thermal Desorption Dryer **Deviation:** Filter leak

Concern:
Ease of sampling for particulate breakthrough.

Current Status: Complete
Responsible: T Beaton **Department:** Rust Eng **Date:** 4/ 3/96

Current/Final Resolution:
Dryer will be specified with these nozzles - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			3	4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:			3	4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 36 **Description:** Possible installation of DOP test sample ports

Worksheet: Thermal Desorption Dryer **Deviation:** Filter leak

Concern:
Ease in sampling.

Current Status: Complete

Responsible:	Department:	Date:
T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Two DOP sample ports on cupola (F-014) - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			3	4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:			3	4	**Operating Cost ($/yr × 1000):**	0.00

Number: 37 **Description:** Chock or wheel brake on scissors jack

Worksheet: Waste Drums/Transport **Deviation:** Damage to Glove box

Concern:
Unintended movement could damage glovebox.

Current Status: Complete

Responsible:	Department:	Date:
D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Design includes chock or brake - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Number: 38 **Description:** Mark outside of drum (positioning index mark)

Worksheet: Waste Drums/Transport **Deviation:** Damage to Glove box

Concern:
Avoid overfilling drum.

Current Status: Complete

Responsible:	Department:	Date:
D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Noted for inclusion in SOPs - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 39 **Description:** Rethink of side mount waste drum lifting operation

Worksheet: Waste Drums/Transport **Deviation:** Loss of containment

Concern:
Possible loss of control during drum movement.

Current Status:	Responsible:	Department:	Date:
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
. Morse brand commercial geared drum lifter will be used.
New frequency IV, Consequence B = 3 risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	1				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	3				**Operating Cost ($/yr × 1000):**	0.00

Number: 40 **Description:** Possible addition of temperature indication

Worksheet: Feed Prep. and Loading Glove box **Deviation:** High temperature

Concern:
Seal failure with internal fire.

Current Status:	Responsible:	Department:	Date:
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Te 500-11 added - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	4			4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4			4	**Operating Cost ($/yr × 1000):**	0.00

Number: 41 **Description:** Verify pressure relief sizing

Worksheet: Feed Prep. and Loading Glove box **Deviation:** High pressure

Concern:
Pressure relief control failure.

Current Status:	Responsible:	Department:	Date:
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Pressure relief sizing verified ok - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	3				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	3				**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 42 **Description:** Possibly remove or modify vacuum breaker PSV 500-3 (Blower not capable collapsing glove box)

Worksheet: Feed Prep. and Loading Glove box **Deviation:** Low pressure

Concern:
Glovebox contamination (oxygen) possilble if vacuum breaker fails.

Current Status:	Responsible:	Department:	Date:
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Moved to outside of the glove box, won't allow O2 into glove box - No change in risk.

	S	E	F	G	Drawing Numbers:	
Current Risk:	4				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4				**Operating Cost ($/yr × 1000):**	0.00

Number: 43 **Description:** Consider making hard wire interlock

Worksheet: Feed Prep. and Loading Glove box **Deviation:** High concentration of contaminants (oxygen)

Concern:
Possible fir or explosion or personnel contamination.

Current Status:	Responsible:	Department:	Date:
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Not needed, now the shredder is flooded with N2 when it is running to assure adequate nitrogen flow. - Frequency IV, Consequence B = 3 risk

	S	E	F	G	Drawing Numbers:	
Current Risk:	1				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	3				**Operating Cost ($/yr × 1000):**	0.00

Number: 44 **Description:** Check for pinch points

Worksheet: Feed Prep. and Loading Glove box **Deviation:** High concentration of contaminants (oxygen)

Concern:
Personnel injury.

Current Status:	Responsible:	Department:	Date:
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
None found - No change in risk

	S	E	F	G	Drawing Numbers:	
Current Risk:	3				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	3				**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 45 **Description:** Mockup of main feed prep glove box is desirable

Worksheet: Feed Prep. and Loading Glove box **Deviation:** High concentration of contaminants (oxygen)

Concern:
Detection of unseen operational problems is desirable.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Time constraint does not allow - No change in risk.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			3		**Captial Cost ($ × 1000):**	0.00
Residual Risk:			3		**Operating Cost ($/yr × 1000):**	0.00

Number: 46 **Description:** Consider view port

Worksheet: Shredder and Glove box **Deviation:** High level

Concern:
Time delay due to overfilling.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Not required, may use optical level gauge - No change in risk.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			4		**Captial Cost ($ × 1000):**	0.00
Residual Risk:			4		**Operating Cost ($/yr × 1000):**	0.00

Number: 47 **Description:** Add nitrogen purge nozzle to shredder/glove box

Worksheet: Shredder and Glove box **Deviation:** Oxygen contamination

Concern:
Stagnant zone in nitrogen flow.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
N2 purge added to shredder/glove box - New Frequency IV, Consequence B = 3 risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	1				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	3				**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 48 **Description:** Analyze design of shredder access from glove port

Worksheet: Shredder and Glove box **Deviation:** Oxygen contamination

Concern:
Glove catching in shredder.

Current Status: Complete

Responsible: D Munger **Department:** Sante Fe E **Date:** 4/ 3/96

Current/Final Resolution:
Top will use hasp and pull glove out, bottom will use tunnel and pull gloves out - New Frequency V, Consequence B = 4 Risk

	S	E	F	G
Current Risk:	1			
Residual Risk:	4			

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Number: 49 **Description:** Chock or wheel stop on IBC

Worksheet: Shredder and Glove box **Deviation:** Oxygen contamination

Concern:
Uncontrolled movement of IBC could cause personnel injury.

Current Status: Complete

Responsible: D Munger **Department:** Sante Fe E **Date:** 4/ 3/96

Current/Final Resolution:
Wheel chocks added - Frequency IV, Consequence B = 3 Risk

	S	E	F	G
Current Risk:	1			
Residual Risk:	3			

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Number: 50 **Description:** Portable oxygen analyzer and pump to double check

Worksheet: Glove Box / Aspirator Nitrogen Supply **Deviation:** Low/no flow (O2 aspiration line only)

Concern:
Faulty O2 reading.

Current Status: Complete

Responsible: D Munger **Department:** Sante Fe E **Date:** 4/ 3/96

Current/Final Resolution:
Included in SOPs - No change in risk

	S	E	F	G
Current Risk:				4
Residual Risk:				4

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Table C.3-1 Action Item Resolution

Number: 51 **Description:** In-Line HEPA

Worksheet: Glove Box / Aspirator Nitrogen Supply **Deviation:** Reverse flow

Concern:
Use HEPA filters inline to avoid contamination of piping.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
In-line HEPA will not be used in this short copper line, is not cost effective - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			4		**Captial Cost ($ × 1000):**	0.00
Residual Risk:			4		**Operating Cost ($/yr × 1000):**	0.00

Number: 52 **Description:** Consider putting the blower inside a containment

Worksheet: Vacuum System (Glove Box) **Deviation:** Loss of containment

Concern:
Possible particulate or hazardous emission if seals fail.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Will use zero-leak seals and minimize back pressure.
New Frequency IV, Consequence C = 4 risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	3				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4				**Operating Cost ($/yr × 1000):**	0.00

Number: 53 **Description:** Calibration system

Worksheet: Glove Box Off Gas, Filters and Blower **Deviation:** Low/no flow (to the O2 and LEL analyzers)

Concern:
Dependability of calibrated equipment.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Calibration handled in SOPs - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 54 **Description:** Isolation valves

Worksheet: Glove Box Off Gas, Filters and Blower **Deviation:** Low/no flow (to the O2 and LEL analyzers)

Concern:
Abillity to perform maintenance with ease.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Specify in SOPs - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Number: 55 **Description:** Make sure carbon selection is noncombustible

Worksheet: Glove Box Off Gas, Filters and Blower **Deviation:** High temperature

Concern:
Possibility of fire in carbon canister.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Noncombustible carbon selected - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Number: 56 **Description:** Provide room for F 509B in series

Worksheet: Glove Box Off Gas, Filters and Blower **Deviation:** High temperature

Concern:
If particulate breakthrough happens, need backup.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Additional HEPA added to P&ID - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 57 **Description:** Verify pressure rating of components

Worksheet: Glove Box Off Gas, Filters and Blower **Deviation:** High pressure

Concern:
Componenets subject to 25 psi.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Pressure ratings of components are ok. No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Number: 58 **Description:** Justify existing design or change it (evaluate whether side or top mount is better design)

Worksheet: Dryer Loading Glove Box **Deviation:** High level

Concern:
Possible loss of contamination or personnel injury.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Top design ok. No risk.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:					**Captial Cost ($ × 1000):**	0.00
Residual Risk:					**Operating Cost ($/yr × 1000):**	0.00

Number: 59 **Description:** Justify existing location of transport hopper

Worksheet: Dryer Loading Glove Box **Deviation:** High level

Concern:
Evaluate side and top loading designs.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Top design better location. No risk.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:					**Captial Cost ($ × 1000):**	0.00
Residual Risk:					**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 60 **Description:** Design calculations for high temp in glove box

Worksheet: Dryer Loading Glove Box **Deviation:** High temperature

Concern:
Possible glovebox damage due to conduction from the dryer.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	D Munger	Sante Fe E	4/ 3/96

Current/Final Resolution:
Calculations not done, having N2 on during operation will fix. - New Frequency III, Consequence C, = 3 Risk

	S	E	F	G	Drawing Numbers:	
Current Risk:			1		**Captial Cost ($ × 1000):**	0.00
Residual Risk:			3		**Operating Cost ($/yr × 1000):**	0.00

Number: 61 **Description:** Consider interlock on dryer loading valve and N2 supply

Worksheet: Dryer Loading Glove Box **Deviation:** High pressure

Concern:
Loss of containment if bottom valve is closed and N2 purge is on.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	DM & TB	Rust Eng	4/ 3/96

Current/Final Resolution:
High pressure switch interlocked - Frequency IV, Consequence C - 4 risk

	S	E	F	G	Drawing Numbers:	
Current Risk:	4		3		**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4		4		**Operating Cost ($/yr × 1000):**	0.00

Number: 62 **Description:** Develop pressure control system

Worksheet: Dryer Loading Glove Box **Deviation:** Low pressure

Concern:
Rigid gloves or glovebox failure due to leaks.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Manual control system developed - Frequency III, Consequence C = 3 Risk

	S	E	F	G	Drawing Numbers:	
Current Risk:	1		1	3	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	3		3	3	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 63 **Description:** Interlock dryer loading valve to vacuum pump P-030

Worksheet: Dryer Loading Glove Box **Deviation:** Low pressure

Concern:
Loading valve leaks leading to glovebox failure.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Interlocked dryer loading valve to P-030 - Frequency IV, Consequence C = 4 Risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	1		1	3	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4		4	4	**Operating Cost ($/yr × 1000):**	0.00

Number: 64 **Description:** Considering trying to fill drums completely

Worksheet: Dryer Discharge Glove Box **Deviation:** High level

Concern:
Operator overfilling drum, operational delay.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
To be determined by Site. Capability available. - No change in risk.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Number: 65 **Description:** Review design with vendor (for hang ups in the dryer)

Worksheet: Dryer Discharge Glove Box **Deviation:** Low level

Concern:
Personnel exposure when clearing hangup in dryer.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	RR/RB	Rust Eng	4/ 3/96

Current/Final Resolution:
Vendor feels debris will be discharged and sees no problem, personnel in proper ppe. - Frequency IV, Consequence D = 4 Risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				1	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 66 **Description:** Chock wheels or wheel stops on waste drum trolley SP-12

Worksheet: Dryer Discharge Glove Box **Deviation:** Low pressure

Concern:
Unintended movement of trolley could injure personnel.

Current Status: Complete
Responsible: D Munger **Department:** Sante Fe E **Date:** 4/ 3/96

Current/Final Resolution:
Wheel chocks added - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost (\$ × 1000):**	0.00
Residual Risk:				4	**Operating Cost (\$/yr × 1000):**	0.00

Number: 67 **Description:** Confirm discharge valve won't open under vac.

Worksheet: Dryer Discharge Glove Box **Deviation:** Low pressure

Concern:
Leaks in discharge valve on dryer could cause glovebox failure.

Current Status: Complete
Responsible: T Beaton **Department:** Rust Eng **Date:** 4/ 3/96

Current/Final Resolution:
Added interlock to stop vacuum pump if valve is opened
No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost (\$ × 1000):**	0.00
Residual Risk:				4	**Operating Cost (\$/yr × 1000):**	0.00

Number: 68 **Description:** Slope line (2"-2.6D-014-1) to primary condenser

Worksheet: Primary Condenser **Deviation:** Tube Leak

Concern:
Ease in maintenance.

Current Status: Complete
Responsible: T Beaton **Department:** Rust Eng **Date:** 4/ 3/96

Current/Final Resolution:
Line sloped - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			4	4	**Captial Cost (\$ × 1000):**	0.00
Residual Risk:			4	4	**Operating Cost (\$/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 69 **Description:** Put a relief valve on the shell side

Worksheet: Primary Condenser **Deviation:** Low or No Flow (Shell Side)

Concern:
Chill water failure could result in overheating on the shell side.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Relief valve added - No change in risk

	S	E	F	G	Drawing Numbers:	
Current Risk:			4	4	Captial Cost ($ × 1000):	0.00
Residual Risk:			4	4	Operating Cost ($/yr × 1000):	0.00

Number: 70 **Description:** Remove all block valves on shell side

Worksheet: Primary Condenser **Deviation:** Low or No Flow (Shell Side)

Concern:
Chill water system failure could result in system shutdown.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Valves deleted - No change in risk

	S	E	F	G	Drawing Numbers:	
Current Risk:			4	4	Captial Cost ($ × 1000):	0.00
Residual Risk:			4	4	Operating Cost ($/yr × 1000):	0.00

Number: 71 **Description:** Use quick disconnect from drum instead of valve

Worksheet: Primary Condensate Tank **Deviation:** High level

Concern:
Operator error in drum disconnect sequence.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
SOP says to disconnect drum. - No change in risk

	S	E	F	G	Drawing Numbers:	
Current Risk:				4	Captial Cost ($ × 1000):	0.00
Residual Risk:				4	Operating Cost ($/yr × 1000):	0.00

Table C.3-1 Action Item Resolution

Number: 72 **Description:** Install sight glass on T024 drain line or on 2" Line

Worksheet: Primary Condensate Tank **Deviation:** Low Flow

Concern:
Closed valve or blocked line could result in vacuum pump flood.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Sight glass on all outlets of unit - Frequency IV, Consequence B = 3 risk

	S	E	F	G	Drawing Numbers:	
Current Risk:			2	4	Captial Cost ($ × 1000):	0.00
Residual Risk:			3	4	Operating Cost ($/yr × 1000):	0.00

Number: 73 **Description:** Move high temp (TI022-1) to vacuum pump suction

Worksheet: T022 Pressurization Line **Deviation:** Misdirected flow

Concern:
Operator closes wrong valve.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Ti 022-1 moved to vac pump suction line - Frequency IV, Consequence C = 4 Risk

	S	E	F	G	Drawing Numbers:	
Current Risk:				3	Captial Cost ($ × 1000):	0.00
Residual Risk:				4	Operating Cost ($/yr × 1000):	0.00

Number: 74 **Description:** Put a time delay or filter on the high temp interlock for vacuum inlet TI 022-1

Worksheet: Vacuum Pump Suction Line **Deviation:** High flow

Concern:
High temp or control valve stuck open could cause shutdown.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Time delay and interlock added - No change in risk.

	S	E	F	G	Drawing Numbers:	
Current Risk:				4	Captial Cost ($ × 1000):	0.00
Residual Risk:				4	Operating Cost ($/yr × 1000):	0.00

Table C.3-1 Action Item Resolution

Number: 75 **Description:** Revisit condensate drainage

Worksheet: Pressure (Vacuum) Bleed **Deviation:** Reverse flow

Concern:
O2 in system could occur if bottom discharge valve were left open with 55 gal drum still connected.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
SOP specifies steps, redesign of condensate system decreased frequency of reverse flow. - New Frequency IV, Consequence B =3 risk

	S	E	F	G	Drawing Numbers:	
Current Risk:	2				Captial Cost ($ × 1000):	0.00
Residual Risk:	3				Operating Cost ($/yr × 1000):	0.00

Number: 76 **Description:** Number pressure safety interlock PI 030-5

Worksheet: Vacuum Pump and the Interstage Cooler **Deviation:** High Pressure

Concern:
Drawings did not indicate numbering - operational issue..

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Interlock numbered - No change in risk

	S	E	F	G	Drawing Numbers:	
Current Risk:				4	Captial Cost ($ × 1000):	0.00
Residual Risk:				4	Operating Cost ($/yr × 1000):	0.00

Number: 77 **Description:** Consider high-high alarm on TI 030-6

Worksheet: Vacuum Pump and the Interstage Cooler **Deviation:** High temperature

Concern:
Valving incorrect, possible pump failure.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
High-high alarm added. Frequency IV, Consequence C = 4 Risk

	S	E	F	G	Drawing Numbers:	
Current Risk:			3		Captial Cost ($ × 1000):	0.00
Residual Risk:			4		Operating Cost ($/yr × 1000):	0.00

Table C.3-1 Action Item Resolution

Number: 78 **Description:** Consider RO instead of unnumbered bypass globe valve

Worksheet: Vacuum Pump and the Interstage Cooler **Deviation:** High temperature

Concern:
Chilled water valve set incorrectly could cause vacuum pump failure.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Vacuum pump cooled with city water - Frequency IV, Consequence C = 4 Risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			3		**Captial Cost ($ × 1000):**	0.00
Residual Risk:			4		**Operating Cost ($/yr × 1000):**	0.00

Number: 79 **Description:** Consider closed loop for vacuum system with fin fan

Worksheet: Vacuum Pump and the Interstage Cooler **Deviation:** High temperature

Concern:
Chilled water valve incorrectly set.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Chilled water is used. - Frequency IV, Consequence C = 4 Risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			3		**Captial Cost ($ × 1000):**	0.00
Residual Risk:			4		**Operating Cost ($/yr × 1000):**	0.00

Number: 80 **Description:** Check with manufacturer if pump can actually operate at 35F.

Worksheet: Vacuum Pump and the Interstage Cooler **Deviation:** Low Temperature

Concern:
Chill water too cold could damage pump.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Not required, process water now used - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 81 **Description:** SOP to startup at 40F then cool down to 35F

Worksheet: Vacuum Pump and the Interstage Cooler **Deviation:** Low Temperature

Concern:
Pump damage if water too cold.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Not required, process water now used - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Number: 82 **Description:** Design condensate drain and return system

Worksheet: Vacuum Pump and the Interstage Cooler **Deviation:** High Level of Condensate

Concern:
High condensate level possible.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Redesigned - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			4		**Captial Cost ($ × 1000):**	0.00
Residual Risk:			4		**Operating Cost ($/yr × 1000):**	0.00

Number: 83 **Description:** Consider sloping vacuum pump discharge line (030-1) down to the exchanger E 040

Worksheet: Vacuum Pump and the Interstage Cooler **Deviation:** High Level of Condensate

Concern:
Ease in maintenance.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Lines sloped 1/8" per foot - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			4		**Captial Cost ($ × 1000):**	0.00
Residual Risk:			4		**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 84 **Description:** Consider sloping line 022-1 away from vacuum pump

Worksheet: Vacuum Pump and the Interstage Cooler **Deviation:** High Level of Condensate

Concern:
Avoid draining condensate into vacuum system.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Line sloped 1/8" per foot - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:			4		**Captial Cost ($ × 1000):**	0.00
Residual Risk:			4		**Operating Cost ($/yr × 1000):**	0.00

Number: 85 **Description:** Determine means of knowing tanks are empty

Worksheet: Secondary Condensate Tank T-042 **Deviation:** High level

Concern:
Level indicator failure.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Visual sight glass added below discharge valve. - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Number: 86 **Description:** Consider vent system

Worksheet: Secondary Condensate Tank T-042 **Deviation:** High level

Concern:
Plugged line could cause system shutdown.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Not Needed - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 87 **Description:** Consider roughing filter

Worksheet: Process Vapor to Carbon Canister/HEPA/Blower **Deviation:** Low/no flow

Concern:
Plugged filter or carbon canister could cause high pressure.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Decided roughing filter not needed - No risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:					**Captial Cost ($ × 1000):**	0.00
Residual Risk:					**Operating Cost ($/yr × 1000):**	0.00

Number: 88 **Description:** Install gas sample ports

Worksheet: Process Vapor to Carbon Canister/HEPA/Blower **Deviation:** Low/no flow

Concern:
Ease of sampling.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Samle gas ports installed - No risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:					**Captial Cost ($ × 1000):**	0.00
Residual Risk:					**Operating Cost ($/yr × 1000):**	0.00

Number: 89 **Description:** Install a flow meter on line 042-1

Worksheet: Process Vapor to Carbon Canister/HEPA/Blower **Deviation:** Low/no flow

Concern:
High pressure due to plugged line.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Not needed - No risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:					**Captial Cost ($ × 1000):**	0.00
Residual Risk:					**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 90 **Description:** Move TI 042-3 downstream of heat tape or add another one downstream of heat tape

Worksheet: Process Vapor to Carbon Canister/HEPA/Blower **Deviation:** Low temperature

Concern:
Heat tape failure could cause condensation in filter.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Another temperature indicator added downstream - Frequency IV Consequence C = 4 Risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	3			3	**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4			4	**Operating Cost ($/yr × 1000):**	0.00

Number: 91 **Description:** Take isolation valves off carbon drums

Worksheet: Process Vapor to Carbon Canister/HEPA/Blower **Deviation:** High pressure

Concern:
High pressure in carbon drums.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	R Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Isolation valves removed - risk reduced to 4.

	S	E	F	G		
					Drawing Numbers:	
Current Risk:	3				**Captial Cost ($ × 1000):**	0.00
Residual Risk:	4				**Operating Cost ($/yr × 1000):**	0.00

Number: 92 **Description:** Draw on the PID the on,off,start status of blower

Worksheet: Process Vapor to Carbon Canister/HEPA/Blower **Deviation:** Low pressure

Concern:
Blower running while in process can produce poor condenser performance.

Current Status:	**Responsible:**	**Department:**	**Date:**
Complete	T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Blower status indicated on P&ID - No change in risk

	S	E	F	G		
					Drawing Numbers:	
Current Risk:				4	**Captial Cost ($ × 1000):**	0.00
Residual Risk:				4	**Operating Cost ($/yr × 1000):**	0.00

Table C.3-1 Action Item Resolution

Number: 93 **Description:** Leave room for a second hepa filter

Worksheet: Process Vapor to Carbon Canister/HEPA/Blower **Deviation:** Low pressure

Concern:
If breakthrough, will need another filter added.

Current Status:
Complete

Responsible:	**Department:**	**Date:**
T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Design has room for adding a second HEPA filter - No change in risk

	S	E	F	G
Current Risk:				4
Residual Risk:				4

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Number: 94 **Description:** Install local exhaust

Worksheet: Condensate Disposal Drums **Deviation:** Loss of containment

Concern:
Uncontrolled release of organic vapors possible.

Current Status:
Complete

Responsible:	**Department:**	**Date:**
T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Local exhaust installed - No change in risk

	S	E	F	G
Current Risk:	4			
Residual Risk:	4			

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Number: 95 **Description:** Consider condensate redesign

Worksheet: Condensate Disposal Drums **Deviation:** Loss of containment

Concern:
Liquid overflow is possible.

Current Status:
Complete

Responsible:	**Department:**	**Date:**
T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
System redesign - No change in risk

	S	E	F	G
Current Risk:	3			
Residual Risk:	3			

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Table C.3-1 Action Item Resolution

Number: 96 **Description:** Look at overflow of 55 gallon drum or fill mechanism

Worksheet: Condensate Disposal Drums **Deviation:** Loss of containment

Concern:
Liquid overflow is possible.

Current Status:
Complete

Responsible:	**Department:**	**Date:**
T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Drum fill directed by SOP - No change in risk

	S	E	F	G
Current Risk:	3			
Residual Risk:	3			

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Number: 98 **Description:** Need a means to sample and determine phases.

Worksheet: Condensate Disposal Drums **Deviation:** Sampling

Concern:
Loss of containment while sampling.

Current Status:
Complete

Responsible:	**Department:**	**Date:**
T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
SOPs and local exhaust - Frequency IV, Consequence C = 4 risk

	S	E	F	G
Current Risk:	1			
Residual Risk:	4			

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Number: 99 **Description:** Provide a local ventilation system for sampling the liquid in the drum.

Worksheet: Condensate Disposal Drums **Deviation:** Sampling

Concern:
Personnel protection while sampling.

Current Status:
Complete

Responsible:	**Department:**	**Date:**
T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Local ventilation system for sampling - Frequency IV consequence C = 4 risk

	S	E	F	G
Current Risk:	1			
Residual Risk:	4			

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Table C.3-1 Action Item Resolution

Number: 100 **Description:** Investigate direct tie-ins

Worksheet: Relief System **Deviation:** High pressure

Concern:
High pressure in relief system is possible.

Current Status:
Complete

Responsible:	**Department:**	**Date:**
T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
Cannot tie directly to a high flow vent system No risk

	S	E	F	G
Current Risk:				
Residual Risk:				

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

Number: 101 **Description:** Assure no direct tie-in to ventilation system

Worksheet: Relief System **Deviation:** Low pressure

Concern:
Strong ventilation with direct tie-in would interfere with flow of process.

Current Status:
Complete

Responsible:	**Department:**	**Date:**
T Beaton	Rust Eng	4/ 3/96

Current/Final Resolution:
SOP specifies. - No risk

	S	E	F	G
Current Risk:				
Residual Risk:				

Drawing Numbers:
Captial Cost ($ × 1000): 0.00
Operating Cost ($/yr × 1000): 0.00

C.4 Unmitigated Accident Consequences

The results of the unmitigated accidents are discussed in this section. The computational methods, models, and assumptions are also presented. Input data for the calculations is provided for each model and computational method.

C.4.1 Results By DBA

The summary of the unmitigated accident consequences is provided in Table C.4.3–1 This table also provides a comparison to the evaluation criteria. *Guidance for the Preparation of MWT Process Hazards Analysis,* (DOE 1995) states to "compare the calculated exposure of the maximum exposed off-site individual against the evaluation guidelines presented in Appendix A (draft) to DOE-STD-3009." . . . However, Appendix A to DOE-STD-3009 was never published by DOE. Guidance was obtained from DOE-AL Nuclear Safety Division (i.e., Vince Wahler) regarding the evaluation criteria. DOE-AL indicated that the criteria of interest in the unpublished document was that equipment which mitigates a off-site dose at the site boundary to a member of the public in excess of 25 rem committed effective dose equivalent (CEDE) should be designated safety classification equipment. For chemicals, if the Emergency Response Planning Guidelines (ERPG) III level is not exceeded the site is a low hazard. For chemicals without ERPGs, a similar criterion may be used such as the facility is a low hazard if the immediately dangerous to life and health (IDLH) concentration is not exceeded. These criteria are for classifying equipment, and are not valid as risk acceptance guidelines.

Table C.4.3–1 shows the unmitigated accident consequences for each source term scenario of the fire DBA based on the evaluation basis site characteristic from Appendix A. As can be seen, the site boundary committed effective dose equivalent to a member of the public never exceeds the guideline value of 25 rem. The doses are several orders of magnitude below the guideline. The hazardous chemical concentrations at the site boundary are all less than the IDLH values, and are several order of magnitude less than the guideline.

Additional consequences are given in Tables C.4.3–2 through C.4.3–4 for various distance from the thermal desorption unit. These tables are provided for the sites where the nearest onsite worker and the offsite member of the public may differ in distance to those specified in Appendix A.

C.4.2 Source Term Analysis

The materials at risk (MAR) described in Appendix B was used in the unmitigated accident analyses. The maximum material at risk of 672 kg of waste was assumed for the fire DBA. One hundred percent of the radiological activity was assumed to be released in the fire with the respirable fraction of 0.05 percent taken from the HOTSPOT computer model (Homann 1994).

The hazardous component of the source term (i.e., acetone and methanol) were assumed to be partially consumed in the fire. This allowed for a conservative estimate of the airborne concentration of the hazardous materials. The fire would likely consume the majority of the acetone and methanol, thus releasing non-hazardous degradation products. However, 50 percent was assumed to be released into the air for conservatism, with 50 percent of the material burned. Methylene chloride in the waste was assumed to be unaffected by the fire and 100 percent released into the atmosphere for the purpose of conservatism.

The respirable fraction of each component of the source term was assumed to be released into the room for the worker exposure. In addition, the respirable fraction was also assumed to be available to the onsite worker and the public. This allowed for a conservative, generic analysis which avoids the uncertainty of leakpath factors for releases from the facility.

C.4.3 Description of Calculational Methods

Three calculation methods were used in the assessment of onsite and off-site radiological doses and chemical concentrations. The worker located in the building housing the thermal desorption unit was assessed using simple hand calculation methods. The nearest onsite worker and off-site member of the public were assessed using the computer models EPIcode (Homann 1988) and HOTSPOT (Homann 1994).

Thermal Desorption Unit Worker Model

This assessment consisted of simplified calculations for the determination of the contaminant concentrations in the air of the room housing the thermal desorption unit. The material at risk was adjusted for each DBA according to the fraction that was considered respirable. To be consistent with the HOTSPOT computer code used for offsite analyses, the respirable fraction for plutonium and uranium of 0.05 percent was assumed for the fire DBA. The acetone and methanol, which created the fire, were assumed to be 50 percent consumed by the fire with the other 50 percent being released into the room.

The respirable fraction was assumed to be released instantaneously into a room assumed to be the equivalent of the thermal desorption unit footprint (i.e., 132 m^3). The worker then was assumed to reside in the room for 30 minutes, considered a reasonable time for rescue of the worker by onsite personnel.

The following equation was used to calculated the committed effective dose equivalent (CEDE) from inhalation of radionuclides by the worker:

$$D = C_a * B_r * E_t * DCF$$

where:
- D = committed effective dose equivalent (rem)
- C_a = radionuclide air concentration (µCi/m^3)
- B_r = worker breathing rate (m^3/hr)
- E_t = exposure time (hr)
- DCF = dose conversion factor for inhalation (rem/µCi)

The concentration of the hazardous chemicals in the atmosphere of the room were determined as follows:

$$C_h = \frac{S_h}{A_r \, \rho_a}$$

where:
- C_h = air concentration of hazardous component (ppm)
- S_h = source term of hazardous component (mg)
- A_r = volume of the room (m^3)
- ρ_a = density of air (kg/m^3)

The input assumption for the thermal desorption worker parameters are given in Table C-4.3–5.

Onsite Worker and Off-site Public Radiological Dispersion Model

The HOTSPOT computer code (Homann 1994) was used for the calculation of radiological doses for the nearest onsite worker and the off-site public. HOTSPOT uses the well-established Gaussian plume model, widely used for safety-analysis planning of a radionuclide release. The dosimetric methods of International Commission on Radiological Protection (ICRP) Publication 30 are used in the HOTSPOT program. The HOTSPOT dose values are due solely to the inhalation of released material during passage of the plume. The ground-shine dose is not included because the committed effective dose equivalent (per hour of time in the contaminated area) due to ground shine is typically several orders of magnitude less than the committed effective dose equivalent due to plume passage. For alpha-emitting radionuclides (i.e., plutonium and uranium) the hourly ground-shine component is at least 7 orders of magnitude less than the inhalation component.

The Gaussian model has been used and accepted by the Environmental Protection Agency. The adequacy of the this model for making initial dispersion estimates or worst-case safety analyses has been tested and verified for many years.

For the fire DBA, HOTSPOT requires the estimation of the duration of the event, and the radius of the release. These values were maximized for the purpose of conservatism to be 1 minute of duration and a 1 meter radius of release. The larger the values for duration and radius of release, the lower the predicted doses. The plutonium and uranium fire senerios in HOTSPOT were used.

HOTSPOT requires the input of the release height. A ground-level release was assumed for the purposes of conservatism. The meteorological parameters were also maximized as stability category F and a 1 m/s windspeed assumed to be in the direction of the off-site public during the duration of the event.

The input parameter values used in HOTSPOT are given in Table C.4.3–5.

Onsite Worker and Off-site Public Hazardous Concentration Model

EPIcode (Homann 1988) was used for the calculation of the hazardous air concentrations for the nearest onsite worker and the off-site public. EPIcode uses the well-established Gaussian plume model, which is widely used for safety analysis planning of a chemical release. The EPIcode library contains information on over 600 toxic substances listed in the Threshold Limit Values and Biological Exposure Indices published by the American Governmental Conference of Governmental Industrial Hygienist.

For the fire DBA, EPIcode requires the estimation of the duration of the event, and the radius of the release. These values were maximized for the purpose of conservatism to be 1 minute of duration and a 1 meter radius of release. The larger the values for duration and radius of release, the lower the predicted doses.

EPIcode requires the input of the release height. A ground-level release was assumed for the purposes of conservatism. The meteorological parameters were also maximized as stability category F and a 1 m/s windspeed assumed to be in the direction of the offsite public during the duration of the event.

The input parameter values used in EPIcode are given in Table C.4.3–5.

Table C.4.3–1. Unmitigated Consequences for the Thermal Desorption Unit Fire DBAs

Fire DBA Event	Contaminant	MTU Worker	Onsite Nearest Worker (0.3 km)	Site Boundary (2.8 km)	Guideline[a]
Worst Case	Plutonium	78 rem	31 mrem	0.77 mrem	25 rem
	Acetone	5E7 ppm	10,000 ppm	65 ppm	20,000 ppm IDLH
Likely Worst Case	Plutonium	2.6 rem	1 mrem	0.025 mrem	25 rem
	Methanol	35 ppm	2.5 ppm	0.016 ppm	25,000 ppm IDLH
	Methylene Chloride	270 ppm	5.9 ppm	0.038 ppm	5,000 ppm IDLH
Likely Low-Activity, Low-Hazardous Concentration	Plutonium	39.4 mrem	0.016 mrem	0.0004 mrem	25 rem
	Uranium	9.2 mrem	0.006 mrem	0.0001 mrem	25 rem
	Methanol	0.086 ppm	0.006 ppm	0.00004 ppm	25,000 ppm IDLH

a "Guidance for the Preparation of MWT Process Hazards Analysis" references Appendix A of DOE–STD–3009–94 which was never published. Vince Wahler of DOE-AL Nuclear Safety Division indicated that the criteria of interest in the unpublished document was that equipment which mitigates a site boundary dose to a member of the public in excess of 25 rem committed effective dose equivalent should be designated safety classification equipment. For chemicals, if the ERPG III level is not exceed the site is a low hazard. For chemicals without ERPGs, a similar criteria may be used such as a facility is low hazard if the IDLH concentration is not exceeded at the site boundary.

Key: ppm = parts per million
mrem = milliroentgen(s)
IDLH = immediately dangerous to life or health

Table C.4.3–2. Unmitigated Accidents Consequences for "Worst Case" Source Term Scenario

Distance (km) from MTU	Plutonium (mrem)	Acetone (ppm)
0.1	210	73,000
0.2	64	21,000
0.5	13	4,000
1.0	3.8	1,200
2.0	1.3	270
5.0	0.35	10
10.0	0.16	1.1
20.0	0.088	0.35

Key: km = kilometer(s)
mrem = milliroentgen(s)
ppm = parts per million

Table C.4.3–3. Unmitigated Accidents Consequences for "Likely Worst Case" Source Term Scenario

Distance (km) from MTU	Plutonium (mrem)	Methanol (ppm)	Methylene Chloride (ppm)
0.1	6.7	18	43
0.2	2.1	5.3	12
0.5	0.42	1.0	2.4
1.0	0.13	0.3	0.70
2.0	0.041	0.066	0.16
5.0	0.012	0.0026	0.0062
10.0	0.0054	0.00026	0.00062
20.0	0.0029	0.000087	0.00020

Key: km = kilometer(s)
mrem = milliroentgen(s)
ppm = parts per million

Table C.4.3–4. Unmitigated Accidents Consequences for "Likely Low-Hazard Case" Source Term Scenario

Distance (km) from MTU	Plutonium (mrem)	Uranium (mrem)	Methanol (ppm)
0.1	0.1	0.038	0.045
0.2	0.032	0.012	0.013
0.5	0.0064	0.0024	0.0024
1.0	0.0019	0.00071	0.00073
2.0	0.00064	0.00023	0.00016
5.0	0.00018	0.000066	6.4E-6
10.0	0.000083	0.000030	6.5E-7
20.0	0.000045	0.000016	2.1E-7

Key: km = kilometer(s)
mrem = milliroentgen(s)
ppm = parts per million

Table C.4.3–5. Input Parameter Values used in the Unmitigated Accident Analyses

Parameter	Value	Application	Comments
Area of the room	132 m^3	MTU worker	MTU footprint
Worker breathing rate	1.2 m^3/h	All scenarios	HOTSPOT/EPIcode value
Exposure time worker	0.5 h	MTU worker	assumed rescue time
Exposure time offsite	plume passage duration	all except MTU worker	determined by codes
Air density	1.2 kg/m^3	MTU worker	
Release radius	1 m	All except MTU worker	conservative value
Release height	ground-level	All except MTU worker	conservative value
Release duration	1 minute	All except MTU worker	conservative value
Stability Class	F	All except MTU worker	conservative value
Wind speed	1 m/s	All except MTU worker	conservative value
Receptor location	plume centerline	All except MTU worker	conservative value
Specific Activity Pu	8.1E-2 Ci/g	All scenarios	weapons grade plutonium
Specific Activity U	1.55E-6 Ci/g	All scenarios	enriched uranium
Pu Activity	100 nCi/g 3,300 pCi/g 50 pCi/g	Waste Acceptance Criteria Case Likely Worst Case Likely Low Activity Case	8.296 E-4 kg 2.72 E-5 kg 4.2 E-7 kg
U Activity	50 pCi/g	Likely Low Activity Case	2.2 E-2 kg
Acetone	24 weight %	Waste Acceptance Case	21.3 gal 50% burned
Methanol	41,000 ppm 100 ppm	Likely Worst Case Likely Low Activity Case	2.94 E-3 gal 7.2 E-6 gal 50% burned
Methylene Chloride	29,000 ppm	Likely Worst Case	1.1 E-2 gal 100% released
MAR	672 km	All scenarios	See Appendix B

Key:
- Ci/g = curies per gram
- gal = gallon(s)
- h = hour(s)
- kg = kilogram
- kg/m3 = kilogram(s) per cubic meter
- km = kilometer(s)
- m = meter(s)
- m^3 = cubic meter(s)
- m^3/h = cubic meter(s) per hour
- m/s = meter(s) per second
- ppm = parts per million
- Pu = Plutonium
- U = Uranium