CS 10-16-95 QA: N/A

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

DESIGN PACKAGE 1C SYSTEM SAFETY ANALYSIS (SCPB: 1.2.1.8)

REVISION 01

CS 10-16-95

February 1995

CS 10-16-95

00146

Document Identifier: BAB000000-01717-0200-~~00146~~ REV01

Prepared for:

U.S. Department of Energy
Office of Civilian Radioactive Waste Management
1000 Independence Avenue S.W.
Washington D.C. 20585

Prepared by:

TRW Environmental Safety Systems Inc.
2650 Park Tower Drive
Suite 800
Vienna, Virginia 22180

CRWMS/M&O

Design Analysis Revision Record

Complete only applicable items.

(1.)

QA: N/A

Page: ii Of:

2. DESIGN ANALYSIS TITLE

Yucca Mountain Site Characterization Project Design Package 1C System Safety Analysis (SCPB: 1.2.1.8) AS 10-Nov-95

3. DOCUMENT IDENTIFIER (Including Rev. No.)	4. REVISION NO.
BAB000000-01717-0200-00146	01

5. Revision No.	6. Total Pages	7. Description of Revision
01	1	Table of Contents
01	10	DRR and Comment Sheets - L. R. Morrison
01	2	DRR and Comment Sheets - J. J. Keating
01	3	DRR and Comment Sheets - R. H. Leske
01	2	DRR and Comment Sheets - H. R. Montalvo
01	3	DRR and Comment Sheets - A. S. Dodd
01	1	E-Mail Message - C. Mellen
	2	DOE Transmittal Letter
01	1	Design Analysis Cover Sheet
01	48	Design Package 1C System Safety Analysis

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

WARNING

ALTHOUGH EVERY EFFORT HAS GENERALLY BEEN MADE TO INCORPORATE SAFETY FEATURES INTO DESIGN, IT IS OFTEN NECESSARY TO RELY ON PROCEDURES AND TRAINING TO MITIGATE SITUATIONS THAT CAN PRODUCE HAZARDS. SAFETY IS, THEREFORE, HEAVILY DEPENDENT ON ADEQUATE TRAINING AND PROCEDURES. INADEQUATE TRAINING OR PROCEDURES OR FAILURE TO STRICTLY ADHERE TO TRAINING AND PROCEDURES CAN LEAD TO SEVERE INJURIES OR DEATH.

1. PURPOSE

The purpose of this analysis is to systematically identify and evaluate hazards related to the Yucca Mountain Project Exploratory Studies Facility (ESF) Design Package 1C, Surface Utilities (for a list of package 1C subsystems see section 3). This process is an integral part of the systems engineering process; whereby safety is considered during planning, design, testing, and construction. A largely qualitative approach was used since a radiological System Safety Analysis is not required. The risk assessment in this analysis characterizes the accident scenarios associated with the Design Package 1C structures/systems/components in terms of relative risk and includes recommendations for mitigating all identified risks. The priority for recommending and implementing mitigation control features is: 1) Incorporate measures to reduce risks and hazards into the structure/system/component (S/S/C) design, 2) add safety devices and capabilities to the designs that reduce risk, 3) provide devices that detect and warn personnel of hazardous conditions, and 4) develop procedures and conduct training to increase worker awareness of potential hazards, on methods to reduce exposure to hazards, and on the actions required to avoid accidents or correct hazardous conditions.

The scope of this analysis is limited to the Design Package 1C structures/systems/components (S/S/Cs) during normal operations. Hazards occurring during maintenance and "off normal" operations have not been included in this analysis.

2. QUALITY ASSURANCE

A QAP-2-0 evaluation was performed to determine if the Design Package 1C System Safety Analysis is subject to QARD requirements. The results of the evaluation are presented in a "Quality Activity Evaluation Engineering Specialty", Revision 0, dated June 20, 1994.

Based on the results of the QAP-2-0 evaluation, this analysis is not considered to be important to radiological safety or waste isolation.

3. METHOD

The safety/risk assessment methodology used in this analysis is shown in Figure 1. The result of the analysis is a "risk evaluation" of the scenarios identified in this analysis in accordance with MIL-STD-882C. Three steps are required to complete the risk evaluation. The steps are hazard/scenario identification, consequence assessment, and frequency assessment. The word "accident" as used in this analysis refers to events, breakdowns, incidents, or any other occurrence that may have a negative effect on personnel safety.

In addition to the guidance provided in DOE Orders, traditional methods of the System Safety Analysis were reviewed and adopted for this analysis, including those sources listed in sections 4 and 7.

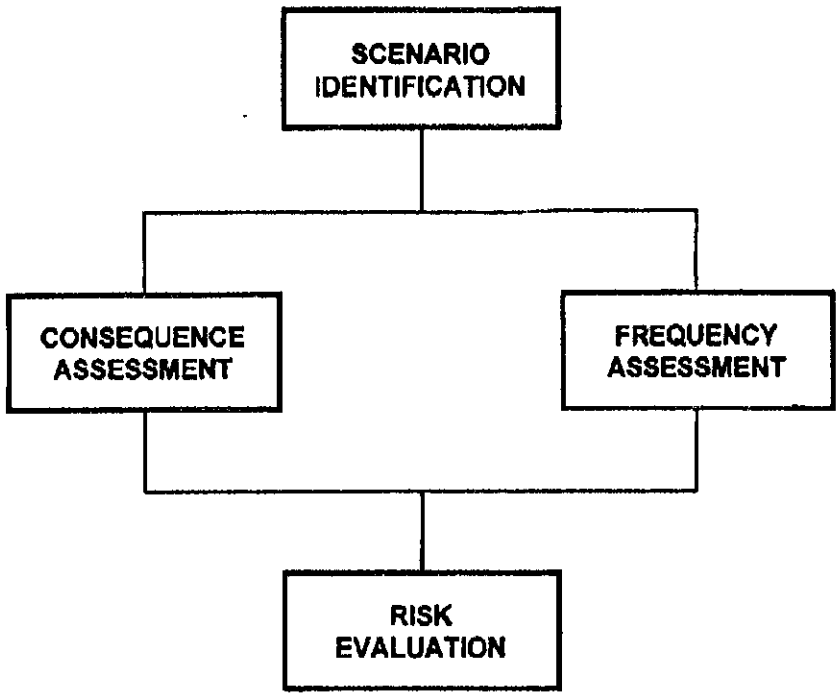


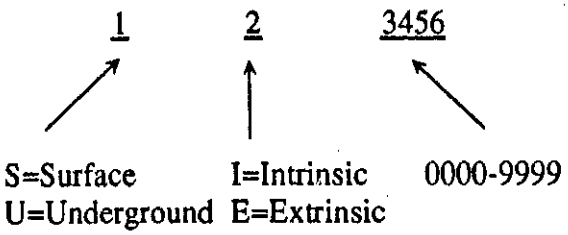
Figure 1. Risk Methodology Conceptual Overview

The S/S/C design items included in the ESF Design Package 1C safety analysis are:

- Substation w/Standby Generators
- Surface Compressed Air

The Design Package 1C System Safety Analysis consists of accidents caused by both intrinsic (e.g., human error, equipment failure) and extrinsic (e.g., act of nature, airplane crash) surface occurrences. Each of the scenarios contained in Attachment A of this System Safety Analysis has a scenario number which uniquely identifies the scenario. The scenario number not only

uniquely identifies the scenario, it also provides information concerning the type of scenario, i.e., surface or subsurface, extrinsic or intrinsic. The format of the scenario number is:



where 1 = S or U and 2 = I or E.

3.1 Scenario Identification

The first step involves the identification of possible accident scenarios that can have negative consequences for the ESF personnel or facilities. It is important to provide assurance that potentially significant scenarios have been considered and the consequences are appropriately mitigated through design selection, safety design features or devices, detection and warning devices, and/or use of procedures and training. To identify the scenarios, the Design Package 1C documentation was reviewed, i.e., design specifications, drawings, Determination of Importance Evaluations and the BFD.

A systematic procedure has been used to identify the relevant scenarios. The identification of scenarios is a relatively complex task. Analogous scenarios were grouped together to determine if there were any significant differences among them. For example, several of the accident scenarios addresses rupture of the compressed air structures/systems/components. A rupture may be caused by an act of nature (e.g., earthquake, winds), a component failure (e.g., tank leak, defective valve), or human error (e.g., puncturing the tank, opening/closing a valve at the wrong time). Each of these scenarios could be included in the System Safety Analysis as a separate scenario, a subset of the group of scenarios could be included in the analysis, or a single representative sample scenario could be included in the System Safety Analysis. The decision of whether to include one or more scenarios from a group of potential scenarios in the System Safety Analysis was based on largely qualitative factors such as the probability that the scenarios will result in a significantly different risk designation, the accident can be associated with a particular situation or piece of equipment, and the probability that the accident cause(s) or result(s) will impact the frequency or consequence rating.

The scenarios are contained in Attachment A. Refer to the "System Safety Analysis Handbook," Scenario Analysis, page 3-241, for a description of scenario analysis.

3.2 Frequency Assessment

Bounding frequency estimates were developed for the accident scenarios and system failures. The frequency rating scale contains five levels of estimated frequency. The frequency levels are shown in Table 1.

Table 1. Frequency Rating Scale

Frequency		Description
A	Frequent	Likely to occur frequently
B	Probable	Will occur several times in the life of an SSC*
C	Occasional	Likely to occur some time in the life of an SSC*
D	Remote	Unlikely but possible to occur in the life of an SSC*
E	Improbable	So unlikely, it can be assumed occurrence may not be experienced

* SSC = system/structure/component (e.g., Design Package 1B, Design Package 2C)

On September 6-8, 1994, a System Safety Working Group met to review the TBM System Safety Analysis and the Design Package 2C System Safety Analysis. During this review the working group also defined a set of frequency and consequence scales. A major objective was to define the scales so that they could be applied to other system safety analyses with little or no modifications. Also during the review, DOE stated that the following new project phases and schedule were being established:

- Technical Site Suitability
- Environmental Impact Statement
- License Application.

DOE further said that the Technical Site Suitability phase is synonymous with the ESF; and they directed System Safety to use a life expectancy of four (4) years for the Design Package 2C System Safety Analysis.

Based on the System Safety Working Group definitions and the life expectancy of the ESF, the frequency rating scale definitions used for this analysis are the same as the frequency rating scale definitions used for the TBM and Design Package 2C system safety analyses. The definitions are:

Frequent - Greater than 4.5 occurrences during the life of Design Package 1C or more than one occurrence per year.

Probable - Greater than 2.25 but not more than 4.5 occurrences during the life of Design Package 1C or one or less occurrence per year.

Occasional - Greater than 1.0 but not more than 2.25 occurrences during the life of Design Package 1C or one or two occurrences during the life of Design Package 1C.

Remote - Greater than .25 but not more than 1.0 occurrences during the life of Design Package 1C or the occurrence may happen once.

Improbable - From 0 to .25 occurrences during the life of Design Package 1C or very unlikely, probably no occurrence.

3.3 Consequence Assessment

The potential range of consequences, from minor health effects to injury and/or fatality, was determined by using a consequence rating scale. The rating scale and definitions are presented in Table 2. The consequence rating scale also addresses potential impacts to site characterization data ranging from no loss of data to an irretrievable loss of license application data. The determination of consequence for each scenario, like the frequency estimate, was based on engineering experience and judgment and historical operating data.

Table 2. Consequence Rating and Definition

Consequence Level		Maximum Consequence
I	Catastrophic	Death, system/equipment loss, or severe environmental impact
II	Critical	Severe injury or illness, major system/equipment or environmental damage
III	Marginal	Minor injury or illness, minor system/equipment damage, minor delay of data collection or loss of data
IV	Negligible	Less than minor injury, occupational illness, or system damage

The definitions for the consequence ratings are the same as the definitions established by the System Safety Working Group for the TBM and Design Package 2C system safety analyses. They are:

Catastrophic - Death
Critical - Permanent partial or complete disability. Injury does not allow worker to return to same job (e.g., loss of limb or eye).
Marginal - Nonpermanent, recoverable injury that would not preclude performing the same job (e.g., broken bones).
Negligible - First aid injury with no loss of work time.

3.4 Risk Assessment

Risk is a function of frequency and consequence. The level of risk is determined by assigning a qualitative rating - high, medium, low, extremely low - to each of the frequency and consequence combinations. By determining each scenario's frequency of occurrence and level of consequence, the scenario's risk classification is determined by using the risk matrix in Figure 2. Within each risk category there is a precedence, based on consequence and frequency. For example, a scenario with a frequency = A and a consequence = I has a higher risk than a scenario with a frequency = A and a consequence = II.

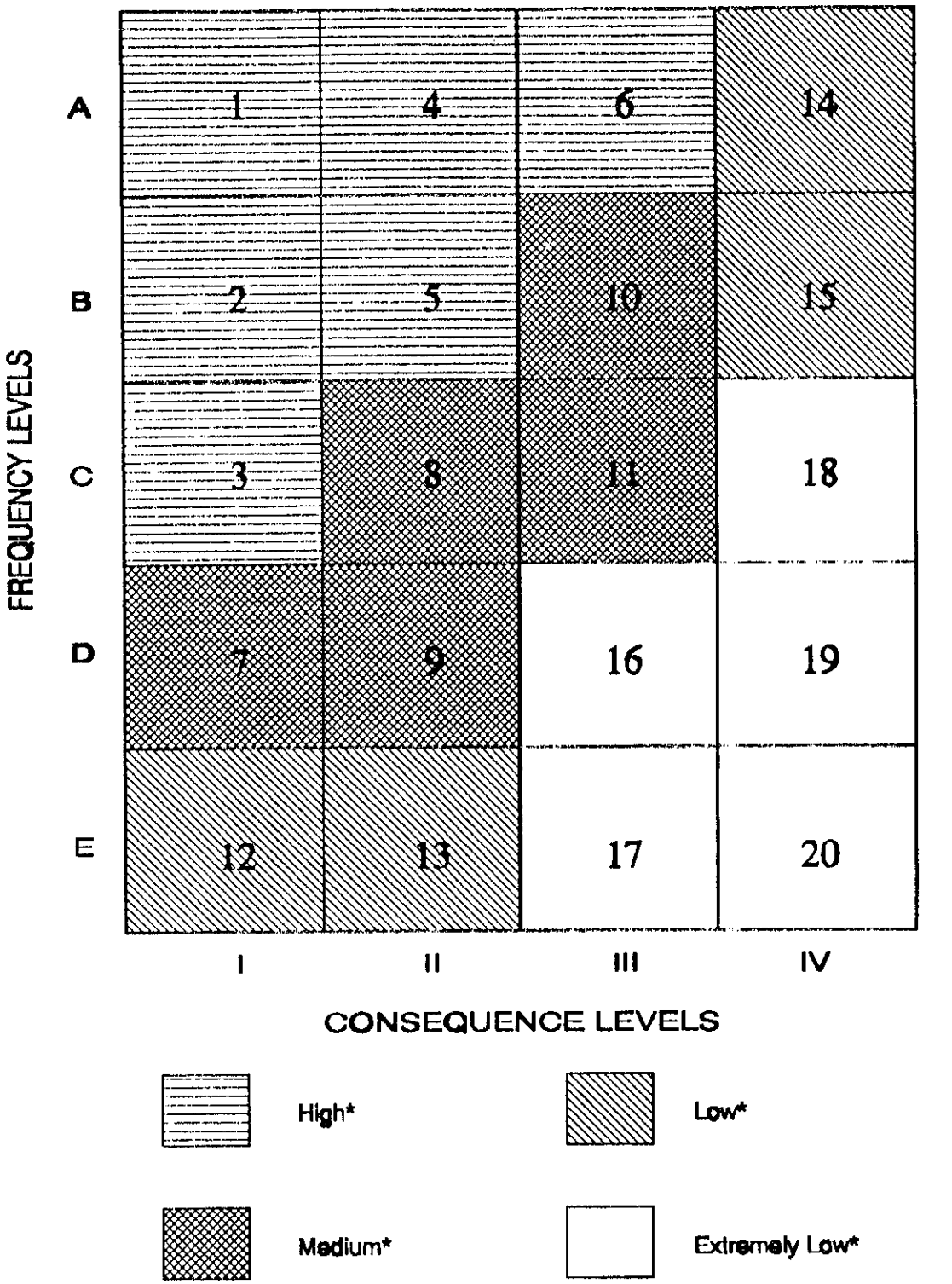
Since the levels of risk are largely subjective, the risk designations must be viewed as relative. Relative risks are useful for determining the order in which risks are addressed; they are not absolute measures. Absolute risk is used when sufficient historical operating data is available on the same design as is currently being utilized and under the same operating conditions.

None-the-less, relative risk can be used as a management tool, especially when mitigation features have not been established and/or verified.

3.5 Exclusions

The following systems, structures, and components; processes; activities; and functions were not considered in this analysis:

- Conduits and piping (except for above ground piping directly associated with the compressed air system);
- Pipe hangers and supports;
- Equipment mounting and anchors;
- Lamps and lights;
- Surface lightning protection system;
- Maintenance procedures;
- Industrial hygiene exposure; and
- Emergency response/contingencies and off-normal operations.



* DOE is responsible for defining the criteria for risk acceptability

Figure 2. Risk Rating Matrix

- Maintenance procedures;
- Industrial hygiene exposure; and
- Emergency response/contingencies and off-normal operations.

In addition, this system safety analysis does not include determining hazards associated with construction, maintenance, maintenance facilities, training, testing, and support operations.

4. CODES AND STANDARDS

4.1 MIL-STD-882C; "System Safety Program Requirements," 19 January 1993

4.2 DOE Order 5481.1B; "Safety Analysis and Review System," 23 September 1986

4.3 SYSTEM SAFETY HANDBOOK-A source book for safety practitioners, July 1993, published by the System Safety Society.

5. CRITERIA

5.1 ESFDR, 3.2.1.19 Rev. 01, ICN-1, 1-19-95

6. ASSUMPTIONS

- The DOE CMO is responsible for determining whether the identified hazards associated with Design Package 1C have been adequately mitigated to proceed with construction and operations of the S/S/Cs.
- It is the designer's, i.e., M&O's, responsibility to implement the design based mitigation features, and it is the constructor's and operator's responsibility to verify and document that the hazards identified in this report have been mitigated.
- The information, i.e., Analysis and Conclusions, contained in this System Safety Analysis is limited to only the scenarios identified.
- Future design changes will need to be evaluated for risk to personnel.
- It is the constructor's and operator's responsibility to ensure that all procedures, training, manuals, and other documentation identified as mitigation features are complete, comprehensive, and accurate.

7. REFERENCES

7.1 "Summary of Work Package 1C, Specification Section 01013"
7.2 DOE Order 6430.1A, "General Design Criteria," 6 April 1989
7.3 Minutes of the Design Package 2C System Safety Analysis Review, 8 September 1994

7.4 YMP/CM-0019, "Exploratory Studies Facility Design Requirements," 19 January 1995

7.5 YMP/91-37, "Preliminary Safety Analysis Report for the Yucca Mountain Project Exploratory Studies Facility and Site Characterization Program"

8. COMPUTER PROGRAMS

Computer programs were not used in conjunction with this analysis.

9. RESULTS

Based on the results of the analysis, existing Preliminary Safety Analysis Report scenarios were modified and the need for new scenarios was identified. Table 3 identifies the scenarios contained in Attachment A. Each scenario was assigned to a risk category based on the consequence and the frequency of occurrence, and the scenario identification number was plotted on the risk rating matrix shown in Figure 3. Table 4 lists the scenarios in rank order from high to low risk levels.

Detailed scenario descriptions for the Design Package 1C S/S/Cs are contained in Attachment A.

Based on the frequency and consequence ratings, there were no scenarios with a high or medium risk designation, nine (10) scenarios with a low risk designation, and three (3) scenarios with an extremely low risk designation.

10. CONCLUSIONS

The Design Package 1C System Safety Analysis has identified hazards related to the design of the ESF Design Package 1C; the consequences of the hazards have been analyzed; an assessment of the risk(s) has been performed; and mitigation measures to eliminate or control hazards by design or operational controls have been identified. Information concerning the design was obtained from the Design Package 1C 90% review documentation.

Table 3. List of Scenarios Evaluated

Scenario ID Number	Description
SI0033	Failure of 4160 Volt switchgear (non-emergency) for air compressors results in loss of non-emergency equipment power
SI0035	Failure of 12.47 KV cables (non-emergency) results in power loss to non-emergency system
SI0039	Failure of generator(s) causes a loss of power to facility. A potential effect of a generator failure(s) is a delay of tunneling operations due to loss of power to electric powered systems (e.g., lighting, ventilation, trolley)
SI0040	Failure of 4160 Volt switchgear (emergency) results in loss of emergency power to facility
SI0042	Failure of 4160 Volt cables (emergency) results in loss of one or more generators for emergency power
SI0078	Compressor explosion results in flying object(s)
SI0079	Fire and subsequent oil explosion at compressed air plant
SI0080	Pipe rupture caused by collision results in flying rocks, dust or object(s)
SI0086	Compressed air accident causes personnel injury
SI0088	Compressed gas tank rupture results in flying object(s)
SI0100	Compressed air line rupture at portal caused by overpressure or impact causes loss of air pressure in ramps and drifts
SI0101	Generator(s) fire and subsequent explosion
SI0121	Compressed air line rupture at portal caused by overpressure or impact causes loss of air pressure in refuge chamber(s)

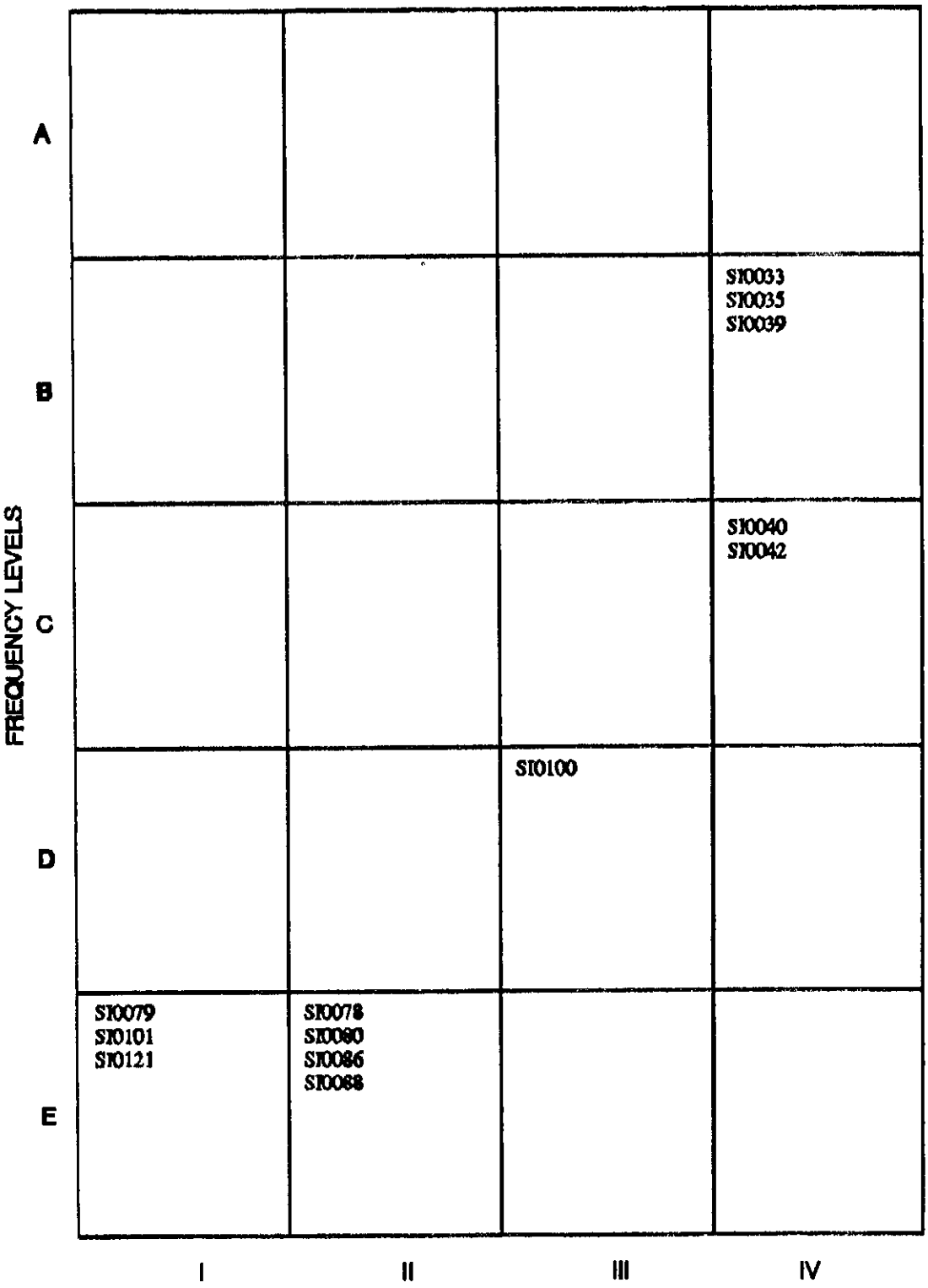


Figure 3. Scenarios Distributed Over Risk Matrix

Table 4. Highest Risk Contributors (page 1 of 2)

Risk Level	Frequency Consequence	Scenario ID Number	Scenario Description
Low	E,I	SI0079	Fire and subsequent oil explosion at compressed air plant
Low	E,I	SI0101	Generator(s) fire and subsequent explosion
Low	E,I	SI0121	Compressed air line rupture at portal caused by overpressure or impact causes loss of air pressure in refuge chamber(s)
Low	E,II	SI0078	Compressor explosion results in flying object(s)
Low	E,II	SI0080	Pipe rupture caused by collision results in flying rocks, dust or object(s)
Low	E,II	SI0086	Compressed air accident causes personnel injury
Low	E,II	SI0088	Compressed gas tank rupture results in flying object(s)
Low	B,IV	SI0033	Failure of 4160 Volt switchgear (non-emergency) for air compressors results in loss of non-emergency equipment power
Low	B,IV	SI0035	Failure of 12.47 KV cables (non-emergency) results in power loss to non-emergency system
Low	B,IV	SI0039	Failure of generator(s) causes a loss of power to facility. A potential effect of a generator failure(s) is a delay of tunneling operations due to loss of power to electric powered systems (e.g., lighting, ventilation, trolley)

Table 4. Highest Risk Contributors (page 2 of 2)

Risk Level	Frequency Consequence	Scenario ID Number	Scenario Description
Extremely Low	D,III	SI0100	Compressed air line rupture at portal caused by overpressure or impact causes loss of air pressure in ramps and drifts
Extremely Low	D,IV	SI0040	Failure of 4160 Volt switchgear (emergency) results in loss of emergency power to facility
Extremely Low	D,IV	SI0042	Failure of 4160 Volt cables (emergency) results in loss of one or more generators for emergency power

Attachment A

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0033 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

Portal Pad - Switchgear Building

SCENARIO:

Failure of 4160 Volt switchgear (non-emergency) for air compressors results in loss of non-emergency equipment power.

SYSTEM/COMPONENT FAILURE:

- Electrical overload
- Breaker trips/malfunctions
- Human error (e.g., worker throws breaker)
- Loss of power to switchgear (e.g., feeder cable malfunction - burned/cut)

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: B - Probable

Consequence Rating: IV - Negligible

Risk Designation: Low

MITIGATION/CONTROL FEATURES:

- Design switchgear in accordance with applicable codes.
- Protect breakers so that they can not be inadvertently thrown (e.g., cover on breaker box, use high resistance switches, recess breaker switches in switch box).
- Encase cables in concrete.
- Label breakers clearly.
- Post safety/warning signs.
- Provide safety training for all personnel.
- Establish regular test, inspection, and maintenance procedures and schedule. Maintain test, inspection, and maintenance records.

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER: SI0033

MITIGATION DOCUMENTATION:

- System Specifications
- Training Manuals
- Maintenance Manuals
- Safety Manuals
- Codes, Standards, and Regulations

  - DOE 6430.1, General Design Criteria Manual
  - NEC NFPA 70
  - National Electrical Safety Code, ANSI C-2
  - Underwriters' Laboratories, Inc. (UL)

- Title II Design Drawings

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0035 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

Portal Pad

SCENARIO:

Failure of 12.47 KV cables (non-emergency) results in power loss to non-emergency system.

SYSTEM/COMPONENT FAILURE:

- Loose connection(s)
- Electrical overload
- Insulation failure (e.g., cracked, frayed)
- Cable break (e.g., cut)

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: B - Probable

Consequence Rating: IV - Negligible

Risk Designation: Low

MITIGATION/CONTROL FEATURES:

- Use UL listed cables and comply with ICEA for this installation.
- Encase all medium voltage cables in concrete.
- Provide access points (e.g., covers) for inspection and repair.
- Provide backup generators for the main power system and an UPS for the critical data. (The likelihood of complete loss of all electrical facilities is estimated to be extremely low. There are standby generators and the probability of all standby generators not starting is rare.)
- Establish regular inspection and maintenance procedures and schedule. Maintain inspection and maintenance records.

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER: SI0035

MITIGATION DOCUMENTATION:

- Title II Design Drawings
- Maintenance Manuals
- Codes, Standards, and Regulations

  - DOE 6430.1, General Design Criteria Manual.
  - NEC NFPA 70
  - National Electrical Safety Code, ANSI C-2
  - Underwriters' Laboratories, Inc. (UL)

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0039 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

Portal Pad

SCENARIO:

Failure of generator(s) causes a loss of power to facility. A potential effect of a generator failure(s) is a delay of tunneling operations due to loss of power to electric powered systems (e.g., lighting, ventilation, trolley).

SYSTEM/COMPONENT FAILURE:

- Electrical overload
- Internal component failure (e.g., generator windings, brushes)
- Human error

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: B - Probable

Consequence Rating: IV - Negligible

Risk Designation: Low

MITIGATION/CONTROL FEATURES:

- Design switchgear in accordance with applicable codes.
- Establish regular inspection and maintenance procedures and schedule. Maintain inspection and maintenance records.
- Provide an UPS for the critical data and safety systems. (The likelihood of complete loss of all standby generators, all standby generators not starting, and the loss of all power at the same time is extremely low.)

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER : SI0039

MITIGATION DOCUMENTATION:

- Maintenance Manuals
- Operators Manuals (e.g., emergency backup procedures)
- Codes, Standards, and Regulations

  - DOE 6430.1, General Design Criteria Manual
  - NEC NFPA 70
  - National Electrical Safety Code, ANSI C-2
  - Underwriters' Laboratories, Inc. (UL)

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0040 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

Portal Pad - Switchgear Building

SCENARIO:

Failure of 4160 Volt switchgear (emergency) results in loss of emergency power to facility.

SYSTEM/COMPONENT FAILURE:

- Electrical overload
- Breaker trips/malfunctions
- Human error (e.g., worker throws breaker)
- Loss of power to switchgear (e.g., feeder cable malfunction - burned/cut)

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: C - Occasional

Consequence Rating: IV- Negligible

Risk Designation: Extremely Low

MITIGATION/CONTROL FEATURES:

- Design switchgear in accordance with applicable codes.
- Protect breakers so that they can not be inadvertently thrown (e.g., cover on breaker box, use high resistance switches, recess breaker switches in switch box).
- Encase cables in concrete.
- Label breakers clearly.
- Post safety/warning signs.
- Provide safety training for all personnel.
- Establish regular test, inspection, and maintenance procedures and schedule. Maintain test, inspection, and maintenance records.
- Provide an UPS for the critical data. (The likelihood of complete loss of all electrical facilities is estimated to be extremely low. There are standby generators and the probability of all standby generators not starting is rare.)

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER : SI0040

MITIGATION DOCUMENTATION:

- System Specifications
- Training Manuals
- Maintenance Manuals
- Safety Manuals
- Codes, Standards, and Regulations

  - DOE 6430.1, General Design Criteria Manual
  - NEC NFPA 70
  - National Electrical Safety Code, ANSI C-2
  - Underwriters' Laboratories, Inc. (UL)

- Title II Design Drawings

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0042 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

Portal Pad

SCENARIO:

Failure of 4160 Volt cables (emergency) results in loss of one or more generators for emergency power.

SYSTEM/COMPONENT FAILURE:

- Loose connections
- Electrical overload
- Insulation failure (e.g., cracked, frayed)
- Failure of facility main power cables
- Cable break (e.g., cut)

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: C - Occasional

Consequence Rating: IV - Negligible

Risk Designation: Extremely Low

MITIGATION/CONTROL FEATURES:

- Use UL listed cables and comply with ICEA for this installation.
- Encase all medium voltage cables in concrete.
- Provide access points (e.g., covers) for inspection and repair.
- Provide an UPS for the critical data. (The likelihood of complete loss of all standby generator cables or the probability of all standby generators not starting is extremely low.)
- Establish regular inspection and maintenance procedures and schedule. Maintain inspection and maintenance records.

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER : SI0042

MITIGATION DOCUMENTATION:

- Title II Design Drawings
- Maintenance Manuals
- Codes, Standards, and Regulations

  - DOE 6430.1, General Design Criteria Manual.
  - NEC NFPA 70
  - National Electrical Safety Code, ANSI C-2
  - Underwriters' Laboratories, Inc. (UL)

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0078 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

Portal Pad - Compressed Air Plant

SCENARIO:

Compressor explosion results in flying object(s).

SYSTEM/COMPONENT FAILURE:

- Pressure relief failure/blockage
- Electrical overload
- Internal component failure (e.g., motor, valves)
- Piping system failure (e.g., rupture)

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: E - Improbable

Consequence Rating: II - Critical

Risk Designation: Low

MITIGATION/CONTROL FEATURES:

- Use rotary screw type compressors.
- Incorporate protective measures in the compressed air system such as:
  - Air pressure relief valves
  - Air discharge check valve
  - High air temperature shutdown feature
  - High winding temperature shutdown (main motor)
  - Over current protection (motor & starter)
  - High temperature warning indicator
  - High pressure warning indicator(s).
- Post safety/warning signs.

SCENARIO NUMBER: SI0078

- Provide safety training for all personnel.
- Establish regular test, monitoring, inspection, and maintenance procedures and schedule. Maintain test, monitoring, inspection and maintenance records.

MITIGATION DOCUMENTATION:

- Training Manuals
- Maintenance Manuals
- Safety Manuals
- Title II Design Drawings

  - BABBDF000-01717-2100-29024, Mechanical Compressed Air System P&ID, Sheet 1
  - BABBDF000-01717-2100-29025, Mechanical Compressed Air System P&ID, Sheet 2
  - BABBDF000-01717-2100-29026, Mechanical Compressed Air System P&ID, Sheet 3
  - BABBDF000-01717-2100-29027, Mechanical Compressed Air System P&ID, Sheet 4
  - BABBDF000-01717-2100-29028, Mechanical Compressed Air System P&ID, Sheet 5
  - BABBDF000-01717-2100-29029, Mechanical Compressed Air System P&ID, Sheet 6

- System Specifications

  - Specifications for compressed air systems (Sections 15481, 15482, and 15483)

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0079 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

Portal Pad - Compressed Air Plant

SCENARIO:

Fire and subsequent oil explosion at compressed air plant.

SYSTEM/COMPONENT FAILURE:

- Air compressor malfunction
- Inlet air filter blockage
- Electrical overload
- Feeder cable malfunction (e.g., burned, cut)

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: E - Improbable

Consequence Rating: I - Catastrophic

Risk Designation: Low

MITIGATION/CONTROL FEATURES:

- Incorporate protective measures in air compressors such as:
  - High temperature warning indicator
  - High air temperature shutdown feature
  - Over current protection
  - Air filter pressure drop warning indicator.
- Post safety/warning signs.
- Encase cables in concrete.
- Provide safety training for all personnel.
- Remove/store flammable materials in approved containers/facilities.
- Establish regular monitoring, inspection, and maintenance procedures and schedule.
- Maintain monitoring, inspection, and maintenance records.

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER: SI0079

MITIGATION DOCUMENTATION:

- System Specifications
- Training Manuals
- Maintenance Manuals
- Safety Manuals
- Title II Design Drawings

  - BABBDF000-01717-2100-29024, Mechanical Compressed Air System P&ID, Sheet 1
  - BABBDF000-01717-2100-29025, Mechanical Compressed Air System P&ID, Sheet 2
  - BABBDF000-01717-2100-29026, Mechanical Compressed Air System P&ID, Sheet 3
  - BABBDF000-01717-2100-29027, Mechanical Compressed Air System P&ID, Sheet 4
  - BABBDF000-01717-2100-29028, Mechanical Compressed Air System P&ID, Sheet 5
  - BABBDF000-01717-2100-29029, Mechanical Compressed Air System P&ID, Sheet 6

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0080 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

Portal Pad - Compressed Air Plant

SCENARIO:

Pipe rupture caused by collision results in flying rocks, dust or object(s).

SYSTEM/COMPONENT FAILURE:

- Pipe and pipe fittings
- Vehicle failure (e.g., brakes)
- Human error (e.g., failure to obey speed limit)

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: E - Improbable

Consequence Rating: II - Critical

Risk Designation: Low

MITIGATION/CONTROL FEATURES:

- Design to ANSI piping codes.
- Locate the compressor station area away from vehicular traffic.
- Protect pipes and other exposed surfaces from contact (e.g., fences, barriers, guard rails).
- Post safety/warning signs.
- Provide safety training for all personnel.

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER: SI0080

MITIGATION DOCUMENTATION:

- Safety Manuals
- Title II Design Drawings
  - BABBDF000-01717-2100-29024, Mechanical Compressed Air System P&ID, Sheet 1
  - BABBDF000-01717-2100-29025, Mechanical Compressed Air System P&ID, Sheet 2
  - BABBDF000-01717-2100-29026, Mechanical Compressed Air System P&ID, Sheet 3
  - BABBDF000-01717-2100-29027, Mechanical Compressed Air System P&ID, Sheet 4
  - BABBDF000-01717-2100-29028, Mechanical Compressed Air System P&ID, Sheet 5
  - BABBDF000-01717-2100-29029, Mechanical Compressed Air System P&ID, Sheet 6

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0086 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

North Portal Pad - Shop Building

SCENARIO:

Compressed air accident causes personnel injury.

SYSTEM/COMPONENT FAILURE:

- Compressor component failure (e.g., fittings)
- Air hose/pipe line rupture
- Air receiver tanks leak/rupture
- Human error (e.g., failure to properly tighten connections/fittings)

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: E - Improbable

Consequence Rating: II - Critical

Risk Designation: Low

MITIGATION/CONTROL FEATURES:

- Design to ANSI piping codes.
- Use only rock drill oil specifically formulated for use in compressed air in the compressed air lines to lubricate air operated drills/tools .
- Require all persons using, or in the vicinity of, compressed air for blowing, to wear safety glasses.
- Install safety chains or cables across all hose connections in accordance with MSHA requirements.
- Bleed air from line(s) before disconnecting or repairing compressed air line(s) or tool(s) connected to compressed air line(s).
- Post safety/warning signs.

SCENARIO NUMBER : SI0086

- Provide safety training for all personnel (e.g., at no time shall compressed air be directed toward a person, use of pneumatic power tools in accordance with 29 CFR 1926.302).
- Establish regular inspection and maintenance procedures and schedule. Maintain inspection and maintenance records.

MITIGATION DOCUMENTATION:

- 29 CFR 1926, Subpart I
- 30 CFR 57
- System Specifications
- Training Manuals
- Maintenance Manuals
- Safety Manuals

Analysis: BAB000000-01717-0200-00146 REV. 01

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0088 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

North Portal Pad - Shop Building

SCENARIO:

Compressed gas tank rupture results in flying object(s).

SYSTEM/COMPONENT FAILURE:

- Shop oxygen and acetylene bottles
- Valve failure
- Human Error (e.g., failure to secure bottles, failure to cap valves)

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: E - Improbable

Consequence Rating: II - Critical

Risk Designation: Low

MITIGATION/CONTROL FEATURES:

- Remove gauge and hoses from bottles and the cap valve when transporting bottles between surface and underground.
- Chain all bottles in place, either in storage rack, cart, etc., when the valve covers are removed.
- Post safety/warning signs.
- Provide safety training for all personnel (e.g., storage, cutting, and welding operations in compliance with 29 CFR 1936.350).
- Establish regular inspection and maintenance procedures and schedule. Maintain inspection and maintenance records.

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER: SI0088

MITIGATION DOCUMENTATION:

- 29 CFR 1926, Subpart J
- Training Manuals
- Safety Manuals
- Maintenance Manuals

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0100 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

North and South Portals

SCENARIO:

Compressed air line rupture at portal caused by overpressure or impact causes loss of air pressure in ramps and drifts.

SYSTEM/COMPONENT FAILURE:

- Pipe break
- Pipe fitting failure

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: D - Remote

Consequence Rating: III - Marginal

Risk Designation: Extremely Low

MITIGATION/CONTROL FEATURES:

- Design to ANSI piping codes.
- Use the American Society of Mechanical Engineers (ASME) code stamped receivers with safety relief valves to alleviate overpressure.
- Position piping out of vehicle, equipment, and material travel envelope and path.
- Post safety/warning signs.
- Provide safety training for all personnel.
- Establish regular inspection and maintenance procedures and schedule. Maintain inspection and maintenance records.

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER: SI0100

MITIGATION DOCUMENTATION:

- Safety Manuals
- Maintenance Manuals
- Title II Design Drawings
  - Compressed Air Distribution System, Schematic Flow Diagram
- Design Analyses
  - BABBDF000-01717-0200-00023, North Portal Surface-Based Compressed Air System Analysis
  - BABFAG000-01717-0200-00161, Compressed Air Distribution Design Analysis

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0101 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

Portal Pad

SCENARIO:

Generator(s) fire and subsequent explosion.

SYSTEM/COMPONENT FAILURE:

- Internal component failure
- Fuel leak
- Fuel spill
- Human error (e.g., smoking in no smoking area)

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: E - Improbable

Consequence Rating: I - Catastrophic

Risk Designation: Low

MITIGATION/CONTROL FEATURES:

- Incorporate protective measures in generators such as:
  - High temperature warning indicator
  - High air temperature shutdown feature
  - High/low pressure warning indicators.
- Post safety/warning signs.
- Provide safety training for all personnel.
- Remove/store flammable materials in approved containers/facilities.
- Establish regular monitoring, inspection, and maintenance procedures and schedule. Maintain monitoring, inspection, and maintenance records.

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER: SI0101

MITIGATION DOCUMENTATION:

- System Specifications
- Training Manuals
- Maintenance Manuals
- Safety Manuals
- Title II Design Drawings

ACCIDENT ANALYSIS SUMMARY

SCENARIO NUMBER: SI0121 REVISION: 01 REVISION DATE: 1/19/95

LOCATION:

North and South Portals

SCENARIO:

Compressed air line rupture at portal caused by overpressure or impact causes loss of air pressure in refuge chamber(s).

SYSTEM/COMPONENT FAILURE:

- Pipe break
- Pipe fitting failure

ACCIDENT CLASSIFICATION AFTER MITIGATION:

Frequency Rating: E - Improbable

Consequence Rating: I - Catastrophic

Risk Designation: Low

MITIGATION/CONTROL FEATURES:

- Design to ANSI piping codes.
- Use the American Society of Mechanical Engineers (ASME) code stamped receivers with safety relief valves to alleviate overpressure.
- Position piping out of vehicle, equipment, and material travel envelope and path.
- Require personnel to wear self-rescuers while underground (self-rescuers do not supply oxygen).
- Establish exact location of each refuge chamber on a surface map and provide a cement pad on the surface directly above each refuge chamber. The cement pad will provide a landmark and a stable surface so that emergency drill equipment can be brought onto the pad and an emergency air hole can be drilled as quickly as possible.
- Post safety/warning signs.

Analysis: BAB000000-01717-0200-00146 REV. 01

SCENARIO NUMBER: SI0121

- Provide safety training for all personnel.
- Establish regular inspection and maintenance procedures and schedule. Maintain inspection and maintenance records.

MITIGATION DOCUMENTATION:

- Safety Manuals
- Maintenance Manuals
- Title II Design Drawings
  - Compressed Air Distribution System, Schematic Flow Diagram
- Design Analyses
  - BABBDF000-01717-0200-00023, North Portal Surface-Based Compressed Air System Analysis
  - BABFAG000-01717-0200-00161, Compressed Air Distribution Design Analysis