EGG-PREP--8883

DE91 006292

AN APPROACH TO ESTIMATING RADIOLOGICAL RISK OF OFFSITE RELEASE
FROM A DESIGN BASIS EARTHQUAKE
FOR THE PROCESS EXPERIMENTAL PILOT PLANT (PREPP)

Vickie Lucero
Babette M. Meale
Daniel A. Reny
Anthony N. Brown

Published September 1990

EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

Prepared for the
U. S. Department of Energy
Idaho Operations Office
Under DOE Contract No. DE-AC07-76ID01570

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED
ps

ABSTRACT

In compliance with Department Of Energy (DOE) Order 6430.1A, a seismic analysis was performed on DOE's Process Experimental Pilot Plant (PREPP), a facility for processing low-level and transuranic (TRU) waste. Because no hazard curves were available for the Idaho National Engineering Laboratory (INEL), DOE guidelines were used to estimate the frequency for the specified design-basis earthquake (DBE). A dynamic structural analysis of the building was performed, using the DBE parameters, followed by a probabilistic risk assessment (PRA). For the PRA, a functional organization of the facility equipment was effected so that top events for a representative event tree model could be determined. Building response spectra (calculated from the structural analysis), in conjunction with generic fragility data, were used to generate fragility curves for the PREPP equipment. Using these curves, failure probabilities for each top event were calculated. These probabilities were integrated into the event tree model, and accident sequences and respective probabilities were calculated through quantification. By combining the sequences failure probabilities with a transport analysis of the estimated airborne source term from a DBE, onsite and offsite consequences were calculated. The results of the comprehensive analysis substantiated the ability of the PREPP facility to withstand a DBE with negligible consequence (i.e., estimated release was within personnel and environmental dose guidelines).

EXECUTIVE SUMMARY

The Department of Energy is evaluating various means for preparing mixed low-level and transuranic (TRU) waste for permanent storage. The Process Experimental Pilot Plant (PREPP) facility, located at the Test Area North (TAN) site of the Idaho National Engineering Laboratory (INEL) and operated under contract by EG&G Idaho, Inc., was built as an experimental waste processing facility to test the effectiveness of an incineration/grouting process. This process, which involves shredding, incineration, off-gas treatment, and repackaging, is a proposed method for preparing waste to comply with the storage criteria at DOE's permanent storage site.

After PREPP was built, it was designated as a fully-operational processing facility and categorized as a non-reactor nuclear facility. Additionally, since PREPP's design, DOE's design criteria (DOE Order 6430.1) were also revised to recognize radioactive waste facilities as a separate category of non-reactor nuclear facilities with specific design requirements. One of the criterion involves the ability of the facility to withstand a design basis earthquake (DBE). While the revised order was not intended to apply retroactively to existing facilities, because PREPP had not yet begun to process radioactive materials, its qualification as an 'existing' facility was questionable. Therefore, management determined that PREPP should meet the DBE criterion and a seismic analysis ensued that utilized various probabilistic risk assessment (PRA) techniques to determine the potential effects of a postulated DBE. The purpose of the seismic analysis documented in this report is to substantiate design requirements and/or identify new requirements that will reduce risk associated with the facility operations.

While DBEs are generally determined through use of site-specific hazard curves, such curves for the INEL were not available when this effort began. Consequently, available DOE guidelines were used to select the DBE used for the analysis efforts. As per these guidelines, the recommended DBE for the INEL is represented by 0.14 g ground acceleration, with a return frequency of every 1000 years (1E-3/y).

Initial accident sequences were postulated based upon partitioning the facility into functional areas. The equipment within each area was then identified with respect to location, elevation, function, and susceptibility (i.e., fragility) to a DBE. The function and design characteristics of the equipment provided the basis for component fragility selection. Because specific fragility data do not exist for the PREPP components, PREPP components were equated to nuclear power plant components, for which component fragilities have been documented. Integrating the PREPP-specific equipment information/evaluation with generic component fragility data, fragility curves for each PREPP component were generated from which failure probabilities were calculated.

Seismic documentation indicates that the most common equipment failures from a DBE are support or anchor bolt failures. For actual functional or structural failure of most equipment, considerably high ground accelerations must be experienced.

Therefore, in order to postulate a release from the failed equipment, each support failure probability was multiplied by a conservative 'breach' factor to estimate a (conservative) probability of failure that could actually lead to release.

After failure probabilities were estimated, event tree models were developed to represent each functional area. The probabilities were integrated into the event tree models for quantification of the postulated accident scenarios. Because of the importance of the heating, ventilation, and air conditioning (HVAC) system in mitigating potential environmental release of source term (given an accident), the accident scenarios were quantified in two modes: success and failure of HVAC. There were twelve dominant accident sequences (6 with HVAC success; 6 with HVAC failure) selected for further analysis with a consequence analysis.

In the consequence analysis, a transport model was developed based on the environment within the PREPP facility (e.g., pressures, temperatures, heat structures, flow paths). The estimated failures and airborne source term estimated for each dominant accident sequence were entered as initial facility conditions. The consequences of each of the dominant accident sequences were then calculated from time 0-to-30 min to estimate maximum and final source term for each area within the facility as well as for the environment. In addition to evaluating each functional area, two 'worst-case' sequences were also postulated: maximum potential aerosol release of source term within the facility from simultaneous failures of all equipment, evaluated with both success and failure of HVAC.

Equipment failures from earthquakes generally involve the anchor bolts or supports of equipment. However, it is unlikely that such failures would constitute a release. Nevertheless, to reduce possible equipment damage from a DBE, it was recommended that all anchor bolts and supports be strengthened to reduce the failure probabilities. The fragility analysis, however, also indicated that the quencher vessel was also susceptible to a DBE. As a result, further evaluation of the anchoring of this piece of equipment is recommended.

Analysis of the two worst-case sequences' results indicated that the maximum aerosol source term that could potentially be released to the environment was 2 mg (which could only occur with HVAC failure). Because this quantity is insignificant, no offsite analysis was deemed necessary. Additionally, examination of all transport analysis results showed all potential releases to be inconsequential within current dose guidelines. From these results, the capability of the facility to withstand a DBE without significant environmental impact was substantiated.

TABLE OF CONTENTS

ABSTRACT	II
EXECUTIVE SUMMARY	III
1.0 INTRODUCTION	1
2.0 GENERAL METHODOLOGY	3
2.1 Structural Analysis and Response	5
2.2 Risk Assessment Methodology	5
2.2.1 Plant Familiarization	5
2.2.2 Plant Walkdowns	6
2.2.3 Accident Scenario Postulation	6
2.2.4 Systems Analysis	6
2.2.5 Component Fragility Determination	6
2.2.6 Final Accident Sequence/Event Tree Model Development	7
2.2.7 Facility Damage State Evaluation	7
2.2.8 Onsite Consequence Analysis	7
2.2.9 Offsite Consequence Analysis	8
3.0 SYSTEMS ANALYSIS	9
3.1 Introduction	9
3.2 Assumptions	14
3.3 System Equipment Analysis	18
3.3.1 Area 1 Components	28
3.3.2 Area 2 Components	34
3.3.3 Area 3 Components	34
3.3.4 Area 4 Components	43
3.3.5 Area 5 Components	45
3.3.6 Area 6 Components	45
3.3.7 Area 7 Components	50
3.3.8 Area 8 Components	50
3.3.9 Area 9 Components	50

TABLE OF CONTENTS (CONCLUDED)

4.0	EVENT TREE ANALYSIS	51
4.1	Introduction	51
4.2	Accident Scenario Development	51
4.3	Dominant Accident Sequences	51
5.0	CONSEQUENCE ANALYSIS	58
6.0	SUMMARY OF RESULTS	67
7.0	CONCLUSIONS AND RECOMMENDATIONS	75
8.0	REFERENCES	77
APPENDIX A--COMPONENT FRAGILITY DATA		A-1
APPENDIX B--AREA EVENT TREES		B-1
APPENDIX C--TRANSPORT DATA PLOTS		C-1

LIST OF FIGURES

Figure 1.	PREPP facility first floor plan.	10
Figure 2.	PREPP facility second floor plan.	11
Figure 3.	Simplified schematic of the feed conveyor.	32
Figure 4.	Simplified schematic of the rotary kiln and SCC.	33
Figure 5.	Simplified schematic of the wet quencher.	35
Figure 6.	Simplified schematic of the venturi scrubber.	36
Figure 7.	Simplified schematic of the entrainment eliminator.	37
Figure 8.	Simplified schematic of the mist eliminator.	38
Figure 9.	Simplified schematic of the surge recycle tank.	39
Figure 10.	Simplified schematic of the sludge tanks.	40
Figure 11.	Simplified schematic of the surge recycle drain tank.	41
Figure 12.	Simplified schematic of the emergency drain tank.	42
Figure 13.	Simplified schematic of the discharge conveyor.	44
Figure 14.	Simplified schematic of the trommel hopper.	46
Figure 15.	Simplified schematic of the fines hoppers and blender tanks.	47
Figure 16.	Simplified schematic of the fines weigh tank.	48
Figure 17.	Simplified schematic of the grout mixer tank.	49
Figure 18.	Consequence of postulated worst-case failure with HVAC success.	69
Figure 19.	Consequence of postulated worst-case failure with HVAC failure.	72

LIST OF TABLES

Table 1.	PREPP area designations	12
Table 2.	PREPP building spectra	19
Table 3.	PREPP component fragility summary	29
Table 4.	PREPP component fragility values	31
Table 5.	Accident scenario and release frequency summary with HVAC success	53
Table 6.	Accident scenario and release frequency summary with HVAC failure	55
Table 7.	Source term estimates	57
Table 8.	PREPP control volumes	59
Table 9.	Transport results for HVAC success Accident Scenario 1.	61
Table 10.	Transport results for HVAC success Accident Scenario 2	61
Table 11.	Transport results for HVAC success Accident Scenario 3	62
Table 12.	Transport results for HVAC success Accident Scenario 4	62
Table 13.	Transport results for HVAC success Accident Scenario 5	63
Table 14.	Transport results for HVAC success Accident Scenario 6	63
Table 15.	Transport results for HVAC failure Accident Scenario 1	64
Table 16.	Transport results for HVAC failure Accident Scenario 2	64
Table 17.	Transport results for HVAC failure Accident Scenario 3	65
Table 18.	Transport results for HVAC failure Accident Scenario 4	65
Table 19.	Transport results for HVAC failure Accident Scenario 5	66
Table 20.	Transport results for HVAC failure Accident Scenario 6	66

1.0 INTRODUCTION

The Process Experimental Pilot Plant (PREPP) facility, located at the Idaho National Engineering Laboratory (INEL), is operated under contract by EG&G Idaho, Inc. It was built as an experimental transuranic (TRU) waste processing facility to prepare TRU waste, in various solid forms, for permanent storage at the Department of Energy (DOE) permanent storage site. In order to meet the permanent storage criteria, the waste undergoes a process of incineration followed by cement grouting solidification.

The PREPP facility is built and operational, but still undergoing pre-operational testing and development. Efficiency of the incineration process design requirements and supporting functions, and recommended modifications for maintaining confinement control are being evaluated and implemented. The seismic effort documented in this report is one part of the overall probabilistic risk assessment (PRA) that is being used as a tool for substantiating the design requirements and/or identifying new requirements that will reduce risk associated with the facility operations.

The PREPP facility is housed within a previously constructed building, TAN 607. Both buildings were designed and constructed using Uniform Building Code (UBC) criteria which address seismic structural requirements. At the time of the design, DOE design criteria (DOE Order 6430.1) did not encompass radioactive waste processing facilities. Recent revision of the DOE Order 6430.1A (Ref. 1) recognizes radioactive waste facilities as a separate category of non-reactor nuclear facilities. Under this current criteria, PREPP is classified as a "Radioactive Solid Waste Facility."

The revised order is not intended to apply retroactively to existing facilities, however, since PREPP has not started processing radioactive materials its qualification as an existing facility may be questioned. Also, without performing analyses to current criteria, there would always be a question regarding the ability of the existing facilities to meet current DOE standards for safety, both to the public and the employees, in the event of a design basis seismic event. For these reasons dynamic seismic analyses were performed on the PREPP and TAN 607 building structures (Refs. 2 and 3) in accordance with DOE Order 6430.1A. This work was extended to provide dynamic spectra for use in design of the process system and facility modifications currently in progress and for performing seismic risk assessment and consequence analysis associated with PREPP radioactive operations. This report presents the methodology and results of the risk assessment and consequence analysis performed as part of the PREPP seismic analysis.

Section 2.0 presents the methodology by which the analysis was performed. Included in this section are a summary of the structural analysis of the two building structures encompassing the facility and descriptions of the different tasks accomplished in performing the risk assessment.

Systems analysis tasks are described in Section 3.0. At the first of this section, a brief overview of the facility layout and assumptions used in the analysis are presented. The remainder of the section provides detailed accounts of the analysis for each of the nine areas within the facility, including equipment descriptions, functions, and locations; schematic representations of the major equipment; spectral accelerations at various locations within the facility; and failure probabilities of the equipment as estimated from fragility curves (provided in Appendix A).

Following the Systems Analysis section is an Event Tree Analysis section (Section 4.0). Again, the section commences with an introduction of the event tree process and its specific application to the analysis. Accident scenario development and dominant accident sequence identification are also presented in this section.

Section 5.0 presents the consequence analysis, including concise descriptions of the computer model parameters and results. The results as presented in this section and the previous analysis tasks are summarized in Section 6.0. Based on the results, conclusions and recommendations were made and are presented in Section 7.0. The final section, Section 8.0, provides a reference listing as cited throughout the report.

In addition to the main report, three appendices are also provided: Appendix A, Component Fragility Data (in support of Section 3.0); Appendix B, Area Event Trees (supporting Section 4.0); and Appendix C, Transport Data Plots, supporting the Consequence Analysis (Section 5.0).

2.0 GENERAL METHODOLOGY

This report provides the results of a probabilistic assessment of the likelihood and magnitude of a radioactive material release from the PREPP facility due to a Design Basis Earthquake (DBE). The analysis was limited to an assessment of the likelihood and magnitude associated with only the single seismic level of the DBE event. However, the point estimate at the DBE level event would envelope or bound the likelihood of release consequences associated with any seismic event of lower intensity but, would not provide any risk information about seismic events of higher intensity than the DBE.

There are three particular seismic failure modes that lead to releases of material at PREPP. One, failure and collapse of the building structure that results in release of entire building inventory; two, significant overdrift of building structure that leads to failure of all confinement equipment and component mounting failures that may lead to breaches and releases; and three, independent failure of confinement equipment and components that may lead to breaches and releases. The total likelihood and magnitude of release due to the DBE event would be the sum of these three failure modes.

The first failure mode, building collapse, is a function of the building structural integrity and therefore is a function of the results of the building structural analysis. The PREPP structural analysis results showed significant overstressing of the first floor crossbracing connections which lead to probable (greater than 50% likelihood) collapse of the entire structure. Given the DBE frequency of occurrence is $1E-3$ per year, the PREPP structure as it stands would have a $5E-3$ likelihood of collapse and release of a significant amount, if not all, of the source term material confined within the PREPP structure. However, fixes for the overstressed crossbracing connections have been identified and are planned. With the fixes accomplished, all of the structural stresses would be below the allowable limits, which would then provide a high confidence (about 99.9%) that the structure would not collapse at the DBE seismic level event. Given the fixes are accomplished, then the likelihood of the structural collapse failure mode would be reduced to below $1E-5$ and could be as low as $1E-6$ per year.

The second failure mode, building overdrift and equipment and component mountings failure, can be determined by the building drift calculated in the building structural analysis. The general rule on allowable drift before component mounting failure occurs is .01 of the building height. For the PREPP building .01 of the building

height is approximately 4 inches. The building structural analysis calculated the maximum building drift at the maximum height of the building, the roof, to be 0.82 inches at the point the building structure fails and collapse occurs. Therefore, building collapse would occur prior to the overdrift component failure mode, which makes this failure mode inconsequential.

The third failure mode, individual component failures, are analyzed and results reported within this report. The analysis results identified six release sequences composed of five individual confinement equipment failures and one simultaneous failure of two components. All of the sequences lead to releases within the PREPP building. These releases within the PREPP building occur with the building structure and integrity intact and with the building confinement HVAC system either operable or failed. The sum of the likelihood of sequences leading to releases within the building with the building HVAC operable is $8.8\text{E-}5$. The amount of source term released within the building is considered to be significant however, a building transport analysis shows almost none is released from the building to the outside environment. The sum of the likelihood of sequences leading to releases within the building with the building HVAC inoperable is $8.7\text{E-}6$. The amount of source term released within the building is the same and the building transport analysis shows that even with the building HVAC failed, very little is released from the building to the outside environment.

Based on the amount of material released within the building and outside of the building, a bounding consequence assessment was performed to show the offsite consequences to the public to be within acceptable guideline limits. However, the analysis also shows there are high consequences (above guidelines) associated with personnel exposure to releases within the building and at the TAN site.

Because no formal seismic evaluation had been performed for PREPP prior to this effort, it was necessary to develop an appropriate methodology specific to the facility. This required an in-depth review of available seismic (probabilistic) analysis methodologies and design criteria (Refs. 4-15), seismic fragility data (Refs. 16-20), and various other documents and articles relevant to risk assessment and/or seismic analysis (Refs. 21-26). Identification and review of available plant-specific documentation (Refs. 27-45) was also conducted in order to tailor the developed approach to PREPP.

A seismic risk analysis generally consists of five specific tasks: (1) seismic hazard analysis, (2) plant walkdowns, (3) systems analysis, (4) equipment fragility evaluation,

and (5) release frequency evaluation. However, the uniqueness of the PREPP facility and the unavailability of site-specific hazard curves and seismic evaluation data for the PREPP equipment dictated a diversion from the typical methodology. The methodology applied to the PREPP seismic analysis effort is presented in the following sections.

As part of a seismic hazard analysis, a design basis earthquake (DBE) must be determined. While this is generally performed through use of site-specific hazard curves, such curves were not available when the PREPP seismic effort began. Consequently, the Department of Energy's (DOE's) guidelines as presented in Reference 46 were used to select a DBE. As per these guidelines, the recommended DBE is represented by 0.14 g ground acceleration, with a return frequency of every 1000 years (1E-3/yr).

2.1 Structural Analysis and Response

A dynamic structural analysis of both the PREPP and TAN 607 structures (Refs. 2 and 3) was performed. Following the guidelines provided in Reference 45, two loadings were considered: deadweight (i.e., weight forces associated with the entire mass of the structure) and earthquake. Using a 7% damped spectra, the seismic forces in the PREPP structure was evaluated in a response spectra analysis. The building structural response spectra was further expanded to create a two-dimensional stick model with an artificial acceleration time history. Response spectra for locations within the facility were generated through a direct integration procedure which provided in-structure acceleration time histories. (For more details on the in-structure response spectra, see Reference 47.)

2.2 Risk Assessment Methodology

2.2.1 Plant Familiarization

Plant familiarization consisted of several facility tours and discussions with cognizant facility personnel. Further, in-depth reviews of plant-specific documentation were conducted. Information related to design criteria, design upgrades, plant operations, and administrative guidelines were gathered during this task. Component and system functions were also researched.

2.2.2 Plant Walkdowns

The purpose of the initial plant walkdown was to familiarize the analysts with the facility layout and equipment locations. Subsequent walkdowns facilitated identification of components that were potentially susceptible to a DBE. Such susceptibility was estimated based on equipment function, location, and orientation. The walkdown process was repeated as necessary to evaluate equipment fragility and design upgrades, and to verify collected information and assumptions.

2.2.3 Accident Scenario Postulation

Combining the information collected during the walkdowns with other plant-specific data provided a basis for postulating initial accident scenarios. Because rooms within the plant have relatively unique, distinct functions, one scenario was postulated for each room. While this approach provided a strong foundation for accident sequence evaluation, it also generated more sequences than could be evaluated within the scope and timeframe of this effort--in fact, more than were necessary. Therefore, an in-depth systems analysis was initiated to appropriately reduce the number of sequences and to effectively generate final scenarios which would accurately represent the facility. A detailed description of the accident scenario development and modeling is presented in Section 4.0.

2.2.4 Systems Analysis

The systems analysis consisted of thoroughly examining system documentation, drawings, and schematics of the plant equipment. Through this in-depth review, the various functions in the PREPP process were identified and the facility was appropriately grouped into a more reasonable number of areas. In this regrouping, the primary functions of the facility were each uniquely represented in one area. A more detailed discussion of this task is presented in Section 3.0.

2.2.5 Component Fragility Determination

Component fragility is an estimate of the conditional probability of component failure given a seismic event. Determination of the component fragilities entailed gathering information concerning the size, shape, and structural support for each component. Specific fragility data do not exist for the PREPP components; and the tests required to determine such data are beyond the scope of this effort. However, component fragilities have been determined and documented for similar equipment as found in

nuclear power plants. Therefore, using the guidelines documented in Reference 18, each PREPP component was matched to a nuclear plant component with similar structural characteristics. The parameters of the power plant component from Reference 18 were then used to generate a distribution to represent probability of component failure with respect to the acceleration at the component's location. Section 3.0 provides more specific information on the methodology for determining PREPP component fragilities.

2.2.6 Final Accident Sequence/Event Tree Model Development

The next step in the analysis involved developing event tree models to represent the final accident sequences. Event tree analysis was chosen as the most appropriate PRA technique to systematically model seismic effects because of its ability to address the sequential nature that is inherent in the consequences resulting from a seismic event. A detailed discussion of the event tree modeling and analysis is presented in Section 4.0.

2.2.7 Facility Damage State Evaluation

Determination of source term quantities in each area and quantification of the event trees provide input for this task. Dominant accident sequences were obtained from the quantification effort. Source term characteristics (e.g., airborne or liquid) and the quantity of the source term within the areas identified by the dominant sequences were then confirmed. This information was integrated with other area characteristics (e.g., temperature, pressure, etc.) to determine the facility damage state for each postulated dominant accident event. The source term characteristics and quantities and the resulting damage states for the PREPP analysis are presented in Section 4.0.

2.2.8 Onsite Consequence Analysis

For this analysis, the facility was modeled as characterized by the damage states. The dominant accident sequences were analyzed individually to determine the transport and dispersion of the specified source term within the facility. Section 5.0 presents specific information and data relevant to the consequence analysis for the PREPP seismic analysis.

2.2.9 Offsite Consequence Analysis

Potential offsite radiological consequences for the postulated PREPP accident scenarios identified by the event tree analysis were calculated in this task. The calculated doses represented committed effective dose equivalents (i.e., fraction of radionuclides retained in the body for 50 years following the period of intake). The PREPP-specific results of this portion of the seismic effort are addressed in Section 5.0.

3.0 SYSTEMS ANALYSIS

3.1 Introduction

PREPP is a multi-level facility comprised of two main floors, two mezzanine floors, and a basement level or pit. Within this arrangement, some rooms are completely enclosed on one floor level, while others may encompass two or three different levels. Because of this unusual architectural design, the rooms as designated on the P&IDs (Ref. 34) and shown in Figures 1 and 2 were grouped into more practical units. The purpose of this regrouping is twofold: (1) to minimize the total number of models needed to adequately represent the facility and (2) to reflect the function of a particular area with respect to confinement and/or mitigation of a potential release. To accurately represent the distinct functions within the facility, an in-depth review of the available PREPP-specific documentation was performed. The newly-designated areas as derived from this review, including designator (number and title), room numbers included in the area, and a brief description of the overall function of the area in terms of operations is provided as Table 1.

As summarized in Table 1, the PREPP facility was divided into nine functional areas and two support areas. The nine functional areas are further described in the following subsections. The support areas (Areas 10 and 11), however, were not included in the detailed systems and event tree analyses but are described below.

Area 10 represents Zone C areas which are used only for transport of sealed containers. All containers must be transported within six inches of the floor at all times (see Assumption 10, Section 3.2). Although the seismic initiator could, feasibly, cause containers to fall from the transport equipment, at this minimal distance no damage could be effected (Ref. 48). Additionally, in small enclosed rooms within this area (e.g., lift conveyors), it was considered equally incredible for movement caused by a DBE to cause any damage to sealed containers.

Area 11 includes all areas that will not contain any waste (e.g., UPS, switchgear, corridors). While the rooms in this area may have implications as auxiliary support and possible deterrent to the spread of a release, they have no significance from a release-source perspective. The additional corridors and/or air locks have been incorporated in the transport analysis model, to determine accurate pathways for any releases modeled (See Section 5.0).

Figure 2. PREPP facility second floor plan.

TABLE 1. PREPP AREA DESIGNATIONS

<u>Area Number</u>	<u>Area Name</u>	<u>Rooms Included^a</u>	<u>Area Function and Equipment</u>
1	Feed	109 120	Waste feed and incineration. Includes feed conveyor, kiln, and secondary combustion chamber (SCC).
2	Off-Gas	217	Processing off-gas. Includes wet quencher (WQ), venturi scrubber (VS), entrainment eliminator (EE), and mist eliminator (ME).
3	Liquid	122	Processing of the liquid by-product of cleansing the off-gas. Includes Surge Recycle Tank (SRT), SRT pump, sludge tanks, sludge tank pumps, Surge Recycle Drain Tank, and Emergency Drain Tank.
4	Solid	119	Processing solid discharge from the kiln. Includes only the discharge conveyor.
5	Fines	118 119 215	Processing the fines waste for mixing with the grout. Includes trommel hopper, ash conveyor, fines hoppers, fines tanks, and fines weigh tank.
6	Filling	118 119	Filling the drums with mixture of waste and grout. Includes the drum being filled and drum enclosure.

TABLE 1. CONCLUDED.

<u>Arec Number</u>	<u>Area Name</u>	<u>Rooms Included^a</u>	<u>Area Function and Equipment</u>
7	Mixing	215	Mixing the fines with grout for drum storage. Includes only the grout mixer tank.
8	Curling	112	Storage of filled drums. Includes the stored drums only.
9	HVAC	115	HVAC provides negative pressure within the PREPP facility. Includes running HVAC blower only.
10	Access Ways	101, 104 105, 106 107, 110 111, 121 203, 204	Areas through which waste can be transported but is not processed.
11	Corridors	102, 103 108, 113 114, 116 117, 202 206, 207 208, 209 210, 211 212, 213 214, 216	Areas where waste is never present during normal operations.

^aRooms 201 and 205 have been excluded from the listing. Room 201 contains the HEPAs, exhaust fans, and facility stack-release is assumed to occur prior to these components. Room 205 contains the shredder, which will always contain unconfined waste when in operation.

Using the Table-1 regrouping, each area was evaluated to determine actual physical confinement of the waste. Each piece of equipment providing such confinement was identified and evaluated as previously described in Section 2.6. Detailed descriptions of the equipment, presented by the Table 1 area designations, are provided in Subsections 3.3.1 through 3.3.9. Included in each area description are structural attributes of the equipment contained within the area, accompanied by a simplified schematic, and the respective functions of each major component identified. The fragility for each major component (calculated from Reference 18 parameters) is also included in the descriptions.

In addition to physical confinement, the negative pressure boundary was examined. Two systems contribute to maintaining the negative pressure within the facility: (1) the off-gas treatment system, and (2) the heating, ventilation, and air conditioning (HVAC) system. The HVAC system, however, is capable of maintaining the boundary without the off-gas. Therefore, the HVAC system (Area 9) was considered to determine success or failure of the negative pressure boundary. The extent to which actual pressure boundaries within the facility fail, given failure of the HVAC, and the effect of such failures on offsite release are provided in the consequence analysis section (Section 5.0).

3.2 Assumptions

Because the PREPP facility is still undergoing design changes, facility-specific information on the process equipment as well as other process parameters was not available at the time of this analysis. Consequently, the following conservative assumptions were generated in order to provide some bounds for the analysis:

- (1) The source term considered consists of Plutonium (Pu) and Americium (Am).

Justification: References 46 and 49.

- (2) Pu is characterized by the following attributes:

Oxide in form.

Justification: In addition to being the probable form of Pu anticipated, this assumption was needed in order to bound the analysis (Ref. 49-50).

Average particle size of 20 μm .

Justification: This size is probable and presents a potential health and safety hazard (Ref. 49).

Always attached to particulate.
Justification: References 49-51.

Quantity = 70 g/ft³ ash.
Justification: References 50-52.

Negligible amount of Pu in coarse materials.
Justification: References 49-52.

- (3) Americium (Am) is characterized by the following attributes:

Amount of Am is determined to be 2.5 mg per gram of Pu generated over 25 years, plus an initial 100 µg per gram of Pu present at time container was filled.
Justification: Reference 49-52.

Am will exist in the same form and react as Pu (e.g., particle size, attached to particulate).
Justification: Reference 49.

- (4) Maximum storage for various equipment anticipated in normal operations is as follows:

Fines Blenders--25 ft³ inventory assumed.

Justification: Each fines blender has the capacity for 17 ft³. Under normal operating conditions, one blender would be used for drum filling and the other would be in receiving mode. Therefore, one could be full (17 ft³), and the other beginning to receive. Filling is expected to occur when the second hopper begins receiving (or before). Consequently, as the second hopper begins to fill, the full one is being depleted (References 49-52).

Trommel Hopper--3 ft³ inventory assumed.

Justification: The hopper has recently been redesigned so that during normal operations there is 1 ft³ in the monitoring area and < 4 ft³ in the remainder of the hopper. While not anticipated during any normal operating conditions, the hopper could feasibly hold up to 8 ft³. (This maximum quantity may be used in performing sensitivity analyses once the seismic analysis is completed.) (References 49-52.)

Grout Mixer--3.5 ft³ inventory, consisting of fines (~30%), sand/sludge solid (~31%), cement (~25%), and sludge/liquid (~14%).

Justification: References 49-52.

Sludge Tanks--40 gal (3 tanks) inventory.

Justification: Normal operating conditions could dictate that one tank was filled, being depleted for grouting; one tank is sparging, waiting to be used for grouting; and one is being filled from off-gas. In this configuration, a maximum of two tanks (at 25 gal each) could be full before one begins to empty for grouting. However, grouting depletes a tank much faster than the off-gas can fill one. Therefore, less than two full tanks is considered more realistic given the limiting operating conditions imposed by grouting requirements (References 49-52).

- (5) Offsite power is unavailable.

Justification: Reference 49.

- (6) TAN and PREPP diesels initially available.

Justification: Reference 49.

- (7) Waste is not in drum fill room for longer than 1 hour, which corresponds to one drum/h output (two grout batches).

Justification: Normal operation involves grouting simultaneously with incineration and grouting continuously. Normal operating procedure also requires layering of waste: resultant mixture is 200 lb fines, 350 lb coarse, and 350 lb grout. At this rate, solid waste will not remain in the drum fill enclosure longer than the time to fill one drum (Ref. 49). If, however, grouting is not performed simultaneously with incineration, waste could feasibly remain in enclosure between 8 and 16 hours (References 49-52). Sensitivity analyses could be performed if further analysis were warranted.

- (8) On the average, total weight of waste after incineration is 25 percent of the original weight; 15 percent of this goes to off-gas, 21 percent goes into fines, and 64 percent goes to drum fill enclosure.
Justification: References 49 and 52.
- (9) Only the off-gas and fines contain significant quantities of source term of interest. Additionally, the source term of concern is that which is not suspended in the liquids of the off-gas vessels but only that which has the potential to become airborne.
Justification: Reference 49.
- (10) Drums meet criteria of 49CFR, which states that the drums will not breach if dropped from elevation of four feet when the drums are filled with 98 percent water (i.e., ~ 500 lb). While this criteria is somewhat less rigorous than what the drums will actually be subjected to, transport equipment regulations require that drums remain within 6" of the floor. At this height, the difference in the 49CFR testing and actual stress on the drums is insignificant.
Justification: References 48 and 49.
- (11) The ducting throughout the facility is exceptionally rugged because of the extensive welding of the joints, anchors, and supports.
Justification: Reference 49.
- (12) The lines associated with the sludge tank pumps are small. Therefore, they are assumed to rupture with the pumps.
Justification: Reference 49.
- (13) The sumps are designed to hold 125 percent of total volume capacity of the liquid in the four off-gas vessels.
Justification: Reference 49.
- (14) For purposes of this analysis, the hydrocyclone separators and the sludge tanks are evaluated as one unit.
Justification: Because of their connections and supports, both the sludge tank and its associated separator would have to fail, i.e., it is highly improbable that one could fail structurally without the other also failing.

- (15) The SCC is not evaluated for failure because of the sturdiness of structure and mountings.
Justification: Reference 49.
- (16) The fragility of the kiln was based on the trapeze supports for the seals, the tie rods, and the firing hood bolting.
Justification: Reference 49.
- (17) While the feed conveyor is more rugged than tanks, it was conservatively evaluated with tank parameters.
Justification: To determine exact fragility of the conveyor would be beyond the scope of this effort; therefore a conservative estimate was used.
- (18) Drum being filled was evaluated by the supports that lock it into place.
Justification: These supports are rated to full drum (static equivalent load) capacity. The clamps, seismically rated for 0.38 horizontal and 0.25 vertical, are assumed to hold drum in place under DBE conditions (Ref. 48).
- (19) Average number of drums in short-term storage were estimated to total 60.
Justification: Reference 53.

3.3 System Equipment Analysis

The areas identified in Table 1 will be addressed in the following sections. Included in the discussions will be concise descriptions of the equipment in each area, supported with simplified schematic representations of each major component identified. A detailed equipment evaluation was performed to identify the primary function of the equipment, as well as to confirm several other key attributes: location, elevation, anchoring/bolting/supports, structure, and source term parameters. These equipment features were then organized for use in the component fragility analysis.

Component fragility was determined by integrating the information from the equipment evaluation task and References 18 and 47. From Reference 47, spectral accelerations in all three orthogonal directions (see Table 2) were integrated using square root of the sum of the squares (SRSS) methodology. Using appropriate

TABLE 2. PREPP BUILDING SPECTRA

Ground Floor Spectra--5% Damping			
Vertical		Horizontal	
(Hz)	(Gs)	(Hz)	(Gs)
0.001	0	0.001	0
0.1	0.00969	0.1	0.01428
0.242	0.05662	0.242	0.08344
0.248	0.05947	0.248	0.08764
0.253	0.06194	0.253	0.09128
0.256	0.06251	0.256	0.09212
0.263	0.06441	0.263	0.09492
0.274	0.06707	0.274	0.09884
1.542	0.37734	1.542	0.55608
1.599	0.39121	1.599	0.57652
1.643	0.40204	1.643	0.59248
1.668	0.40204	1.668	0.59248
1.732	0.40204	1.732	0.59248
1.818	0.40204	1.818	0.59248
8	0.40204	8	0.59248
10.273	0.35226	10.273	0.51912
12.545	0.31692	12.545	0.46704
14.818	0.29013	14.818	0.42756
17.091	0.26904	17.091	0.39648
19.364	0.25194	19.364	0.37128
21.636	0.2375	21.636	0.35
23.909	0.22534	23.909	0.33208
26.182	0.2147	26.182	0.3164
28.455	0.20558	28.455	0.30296
30.727	0.19722	30.727	0.29064
33	0.19	33	0.28
100	0.19	100	0.28

TABLE 2. CONTINUED.

Second Floor Spectra--5% Damping											
Horizontal X		Horizontal Y		Vertical Node 5		Vertical Node 38		Vertical Node 70		Vertical Node 178	
(Hz)	(G)	(Hz)	(G)	(Hz)	(G)	(Hz)	(G)	(Hz)	(G)	(Hz)	(G)
0.2	0.00158	0.2	0.00179	0.2	0.00063	0.2	0.00062	0.2	0.00057	0.2	0.00062
0.53	0.01167	0.53	0.01423	0.53	0.00413	0.53	0.00419	0.53	0.00441	0.53	0.00436
0.86	0.03996	0.86	0.04305	0.86	0.01363	0.86	0.0128	0.86	0.01372	0.86	0.01415
1.19	0.08157	1.19	0.1261	1.19	0.02522	1.19	0.02535	1.19	0.02677	1.19	0.02627
1.52	0.16617	1.52	0.19361	1.52	0.05148	1.52	0.04684	1.52	0.0513	1.52	0.05133
1.85	0.31824	1.85	0.43094	1.85	0.07451	1.85	0.0701	1.85	0.08217	1.85	0.08077
2.18	0.45173	2.18	0.55273	2.18	0.12033	2.18	0.11208	2.18	0.12611	2.18	0.12401
2.51	0.71668	2.51	0.89267	2.51	0.15797	2.51	0.14884	2.51	0.161	2.51	0.15965
2.84	1.0536	2.84	1.78736	2.84	0.22529	2.84	0.21314	2.84	0.23194	2.84	0.2312
3.17	1.91839	3.17	2.14884	3.17	0.27009	3.17	0.26517	3.17	0.26165	3.17	0.26821
3.5	2.10973	3.5	1.67004	3.5	0.35654	3.5	0.34783	3.5	0.36849	3.5	0.37823
3.83	1.40732	3.83	1.38725	3.83	0.54508	3.83	0.48939	3.83	0.58843	3.83	0.58693
4.16	1.3525	4.16	1.21043	4.16	0.79127	4.16	0.70127	4.16	0.77838	4.16	0.80454
4.49	1.1868	4.49	1.06968	4.49	0.9774	4.49	0.85008	4.49	1.05851	4.49	1.06104
4.82	0.98289	4.82	0.87917	4.82	1.47952	4.82	1.34905	4.82	1.68199	4.82	1.68475
5.15	0.86716	5.15	0.81514	5.15	2.30283	5.15	2.002	5.15	2.35148	5.15	2.48107
5.48	0.82591	5.48	0.70073	5.48	2.08749	5.48	2.186	5.48	1.88924	5.48	1.93467
5.81	0.81711	5.81	0.73661	5.81	1.8745	5.81	2.03955	5.81	1.37727	5.81	1.6805
6.14	0.67919	6.14	0.74003	6.14	1.65433	6.14	1.70221	6.14	1.19652	6.14	1.52662
6.47	0.66795	6.47	0.72152	6.47	1.42969	6.47	1.45511	6.47	1.07891	6.47	1.38981
6.8	0.58784	6.8	0.71535	6.8	1.16276	6.8	1.34386	6.8	1.07311	6.8	1.06393
7.13	0.5954	7.13	0.68197	7.13	1.03322	7.13	1.15515	7.13	1.20139	7.13	0.88588
7.46	0.61783	7.46	0.69655	7.46	0.98919	7.46	0.97998	7.46	1.12568	7.46	0.8277
7.79	0.70245	7.79	0.79484	7.79	0.90674	7.79	0.93344	7.79	0.94941	7.79	0.74278
8.12	0.7566	8.12	0.8636	8.12	0.80348	8.12	0.81696	8.12	0.80344	8.12	0.7911
8.45	0.75257	8.45	0.78128	8.45	0.78274	8.45	0.78052	8.45	0.74183	8.45	0.76536
8.78	0.7059	8.78	0.76618	8.78	0.73101	8.78	0.74005	8.78	0.71848	8.78	0.76924
9.11	0.79236	9.11	0.76601	9.11	0.62256	9.11	0.68268	9.11	0.67735	9.11	0.69634

TABLE 2. CONTINUED.

Second Floor Spectra--5% Damping											
Horizontal X		Horizontal Y		Vertical Node 5		Vertical Node 38		Vertical Node 70		Vertical Node 178	
(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)
9.44	0.7975	9.44	0.70205	9.44	0.57121	9.44	0.83783	9.44	0.81011	9.44	0.66074
9.77	0.80152	9.77	0.61906	9.77	0.57098	9.77	0.84606	9.77	0.6612	9.77	0.58437
10.1	0.77218	10.1	0.60752	10.1	0.562	10.1	0.84448	10.1	0.65445	10.1	0.54719
10.43	0.87599	10.43	0.62072	10.43	0.53217	10.43	0.84348	10.43	0.65844	10.43	0.55735
10.76	0.57411	10.76	0.62096	10.76	0.5293	10.76	0.5859	10.76	0.65959	10.76	0.54811
11.09	0.54973	11.09	0.58665	11.09	0.52919	11.09	0.58586	11.09	0.66266	11.09	0.53604
11.42	0.55292	11.42	0.57317	11.42	0.52514	11.42	0.59105	11.42	0.66197	11.42	0.53535
11.75	0.54444	11.75	0.57417	11.75	0.51507	11.75	0.59087	11.75	0.65637	11.75	0.55283
12.08	0.53756	12.08	0.55586	12.08	0.50306	12.08	0.57951	12.08	0.63103	12.08	0.56036
12.41	0.56251	12.41	0.55695	12.41	0.50055	12.41	0.57974	12.41	0.62554	12.41	0.54875
12.74	0.54874	12.74	0.50552	12.74	0.48308	12.74	0.57006	12.74	0.61113	12.74	0.52024
13.07	0.53717	13.07	0.5611	13.07	0.459	13.07	0.54126	13.07	0.57568	13.07	0.48094
13.4	0.53655	13.4	0.56647	13.4	0.45904	13.4	0.52157	13.4	0.54447	13.4	0.45129
13.73	0.52024	13.73	0.57409	13.73	0.46481	13.73	0.53995	13.73	0.53429	13.73	0.4501
14.06	0.51258	14.06	0.57335	14.06	0.4756	14.06	0.56424	14.06	0.53373	14.06	0.45446
14.39	0.50784	14.39	0.55625	14.39	0.47047	14.39	0.55737	14.39	0.51822	14.39	0.44848
14.72	0.48865	14.72	0.53362	14.72	0.45913	14.72	0.51762	14.72	0.48888	14.72	0.44279
15.05	0.47083	15.05	0.51512	15.05	0.43983	15.05	0.52591	15.05	0.4515	15.05	0.45798
15.38	0.46741	15.38	0.50987	15.38	0.43668	15.38	0.53185	15.38	0.42648	15.38	0.45233
15.71	0.47818	15.71	0.5173	15.71	0.42639	15.71	0.51702	15.71	0.42867	15.71	0.43909
16.04	0.49071	16.04	0.52093	16.04	0.42144	16.04	0.50374	16.04	0.43889	16.04	0.42699
16.37	0.49524	16.37	0.5155	16.37	0.41297	16.37	0.49833	16.37	0.44478	16.37	0.4151
16.7	0.49391	16.7	0.50168	16.7	0.40344	16.7	0.50253	16.7	0.44393	16.7	0.40624
17.03	0.48563	17.03	0.49043	17.03	0.39839	17.03	0.49402	17.03	0.43108	17.03	0.40538
17.36	0.47545	17.36	0.4787	17.36	0.39417	17.36	0.48092	17.36	0.42114	17.36	0.40805
17.69	0.46898	17.69	0.46897	17.69	0.39191	17.69	0.46676	17.69	0.42331	17.69	0.40634
18.02	0.46663	18.02	0.46358	18.02	0.39064	18.02	0.45706	18.02	0.42127	18.02	0.39886
18.35	0.46318	18.35	0.45788	18.35	0.38605	18.35	0.44772	18.35	0.42616	18.35	0.3908

TABLE 2. CONTINUED.

Second Floor Spectra--5% Damping											
Horizontal X		Horizontal Y		Vertical Node 5		Vertical Node 38		Vertical Node 70		Vertical Node 178	
(Hz)	(G)	(Hz)	(G)	(Hz)	(G)	(Hz)	(G)	(Hz)	(G)	(Hz)	(G)
18.68	0.45836	18.68	0.4489	18.68	0.37824	18.68	0.43821	18.68	0.43053	18.68	0.38829
19.01	0.45791	19.01	0.43781	19.01	0.37294	19.01	0.43328	19.01	0.43288	19.01	0.38673
19.34	0.46148	19.34	0.43247	19.34	0.37075	19.34	0.42889	19.34	0.43187	19.34	0.38278
19.67	0.46131	19.67	0.43698	19.67	0.37271	19.67	0.42544	19.67	0.42789	19.67	0.378
20	0.4539	20	0.44753	20	0.37604	20	0.42316	20	0.42606	20	0.3749
20.33	0.44448	20.33	0.45619	20.33	0.37749	20.33	0.42203	20.33	0.42762	20.33	0.37284
20.66	0.4325	20.66	0.46265	20.66	0.37833	20.66	0.42112	20.66	0.42856	20.66	0.36975
20.99	0.42358	20.99	0.46633	20.99	0.38065	20.99	0.41919	20.99	0.42845	20.99	0.36367
21.32	0.41989	21.32	0.46548	21.32	0.38468	21.32	0.41658	21.32	0.42426	21.32	0.35644
21.65	0.41947	21.65	0.46133	21.65	0.38765	21.65	0.41338	21.65	0.41796	21.65	0.35492
21.98	0.41874	21.98	0.45544	21.98	0.39006	21.98	0.41035	21.98	0.41208	21.98	0.35557
22.31	0.41751	22.31	0.44911	22.31	0.38882	22.31	0.41284	22.31	0.40777	22.31	0.35501
22.64	0.41647	22.64	0.44362	22.64	0.38499	22.64	0.41346	22.64	0.40517	22.64	0.35385
22.97	0.41466	22.97	0.43908	22.97	0.38019	22.97	0.41354	22.97	0.40414	22.97	0.35765
23.3	0.4113	23.3	0.43582	23.3	0.37636	23.3	0.41405	23.3	0.40436	23.3	0.36174
23.63	0.40731	23.63	0.43433	23.63	0.37115	23.63	0.41352	23.63	0.40527	23.63	0.36472
23.96	0.40433	23.96	0.43394	23.96	0.36482	23.96	0.4115	23.96	0.40615	23.96	0.36632
24.29	0.40271	24.29	0.43353	24.29	0.35859	24.29	0.40977	24.29	0.4065	24.29	0.36696
24.62	0.40229	24.62	0.43297	24.62	0.35305	24.62	0.40781	24.62	0.40635	24.62	0.36732
24.95	0.40234	24.95	0.43259	24.95	0.3482	24.95	0.40541	24.95	0.40604	24.95	0.36759
25.28	0.40294	25.28	0.43257	25.28	0.34735	25.28	0.40265	25.28	0.40578	25.28	0.36755
25.61	0.40383	25.61	0.43281	25.61	0.34802	25.61	0.39951	25.31	0.40585	25.61	0.36725
25.94	0.40498	25.94	0.433	25.94	0.34888	25.94	0.39592	25.94	0.4056	25.94	0.36687
26.27	0.40645	26.27	0.43339	26.27	0.34916	26.27	0.3925	26.27	0.40533	26.27	0.3673
26.6	0.40794	26.6	0.43441	26.6	0.34888	26.6	0.38902	26.6	0.40446	26.6	0.36737
26.93	0.40863	26.93	0.43592	26.93	0.3519	26.93	0.38558	26.93	0.40255	26.93	0.3664
27.26	0.40838	27.26	0.43754	27.26	0.35587	27.26	0.38245	27.26	0.40099	27.26	0.36422
27.59	0.40773	27.59	0.43956	27.59	0.35955	27.59	0.3814	27.59	0.39898	27.59	0.36113

TABLE 2. CONTINUED.

Second Floor Spectra--5% Damping											
Horizontal X		Horizontal Y		Vertical Node 5		Vertical Node 38		Vertical Node 70		Vertical Node 178	
(Hz)	(G)	(Hz)	(G)	(Hz)	(G)	(Hz)	(G)	(Hz)	(G)	(Hz)	(G)
27.92	0.40764	27.92	0.44111	27.92	0.36255	27.92	0.38104	27.92	0.39733	27.92	0.35771
28.25	0.40762	28.25	0.44159	28.25	0.36419	28.25	0.38078	28.25	0.39649	28.25	0.35446
28.58	0.40794	28.58	0.44037	28.58	0.36443	28.58	0.38022	28.58	0.39681	28.58	0.35181
28.91	0.40907	28.91	0.43731	28.91	0.36489	28.91	0.38046	28.91	0.39683	28.91	0.35022
29.24	0.41119	29.24	0.43428	29.24	0.36446	29.24	0.38168	29.24	0.40043	29.24	0.34989
29.57	0.41366	29.57	0.43042	29.57	0.36375	29.57	0.38254	29.57	0.40124	29.57	0.35046
29.9	0.41536	29.9	0.4267	29.9	0.3629	29.9	0.38314	29.9	0.40375	29.9	0.35138
30.23	0.41554	30.23	0.42528	30.23	0.36176	30.23	0.38356	30.23	0.4047	30.23	0.35239
30.56	0.41427	30.56	0.426	30.56	0.36016	30.56	0.38375	30.56	0.40572	30.56	0.35356
30.89	0.41232	30.89	0.42803	30.89	0.35821	30.89	0.38431	30.89	0.40694	30.89	0.355
31.22	0.41042	31.22	0.43053	31.22	0.35621	31.22	0.38507	31.22	0.40807	31.22	0.35658
31.55	0.4099	31.55	0.43284	31.55	0.35451	31.55	0.38517	31.55	0.40877	31.55	0.35805
31.88	0.4096	31.88	0.4347	31.88	0.35326	31.88	0.38447	31.88	0.40881	31.88	0.35923
32.21	0.40932	32.21	0.43621	32.21	0.35248	32.21	0.38288	32.21	0.40805	32.21	0.35994
32.54	0.40904	32.54	0.43745	32.54	0.35213	32.54	0.38033	32.54	0.4065	32.54	0.36005
32.87	0.40856	32.87	0.43834	32.87	0.35223	32.87	0.37991	32.87	0.40443	32.87	0.35959

TABLE 2. CONTINUED.

Roof Spectra--5% Damping											
Horizontal X		Horizontal Y		Vertical Node 39		Vertical Node 69		Vertical Node 96		Vertical Node 187	
(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)
0.2	0.00215	0.2	0.00248	0.2	0.00057	0.2	0.00061	0.2	0.00091	0.2	0.00081
0.53	0.01617	0.53	0.01959	0.53	0.00212	0.53	0.00451	0.53	0.0047	0.53	0.00514
0.86	0.05437	0.86	0.06014	0.86	0.00571	0.86	0.01213	0.86	0.01469	0.86	0.01598
1.19	0.11016	1.19	0.17338	1.19	0.01231	1.19	0.02822	1.19	0.02372	1.19	0.03196
1.52	0.22753	1.52	0.26878	1.52	0.02369	1.52	0.04617	1.52	0.042	1.52	0.05381
1.85	0.43969	1.85	0.59807	1.85	0.03918	1.85	0.07407	1.85	0.08736	1.85	0.08905
2.18	0.63021	2.18	0.77745	2.18	0.04588	2.18	0.11699	2.18	0.12295	2.18	0.13491
2.51	1.0002	2.51	1.24895	2.51	0.06608	2.51	0.15907	2.51	0.14628	2.51	0.18089
2.84	1.46925	2.84	2.52171	2.84	0.08799	2.84	0.2196	2.84	0.23805	2.84	0.25973
3.17	2.7002	3.17	3.0659	3.17	0.10803	3.17	0.2508	3.17	0.26277	3.17	0.29959
3.5	3.0318	3.5	2.40703	3.5	0.1451	3.5	0.35218	3.5	0.36991	3.5	0.42165
3.83	2.03098	3.83	2.00686	3.83	0.21864	3.83	0.52075	3.83	0.52696	3.83	0.64316
4.16	1.97288	4.16	1.79521	4.16	0.29308	4.16	0.81108	4.16	0.7061	4.16	0.97861
4.49	1.7875	4.49	1.6024	4.49	0.33932	4.49	1.142	4.49	0.98322	4.49	1.38095
4.82	1.46405	4.82	1.32866	4.82	0.4683	4.82	1.68928	4.82	1.62067	4.82	2.00851
5.15	1.29447	5.15	1.24991	5.15	0.52993	5.15	1.96115	5.15	2.34145	5.15	2.52961
5.48	1.36797	5.48	1.27362	5.48	0.6004	5.48	1.65	5.48	1.99208	5.48	2.0029
5.81	1.30722	5.81	1.30773	5.81	0.61407	5.81	1.69572	5.81	1.54765	5.81	1.68494
6.14	1.21059	6.14	1.29259	6.14	0.50068	6.14	1.88583	6.14	1.30927	6.14	1.59674
6.47	1.35916	6.47	1.29178	6.47	0.51343	6.47	1.8502	6.47	1.20611	6.47	1.40077
6.8	1.32676	6.8	1.31201	6.8	0.73694	6.8	2.07781	6.8	1.23111	6.8	1.23332
7.13	1.35763	7.13	1.20233	7.13	0.99531	7.13	2.09537	7.13	1.45221	7.13	1.29627
7.46	1.38061	7.46	1.20201	7.46	1.22962	7.46	2.04495	7.46	1.61583	7.46	1.22789

TABLE 2. CONTINUED.

Roof Spectra--5% Damping											
Horizontal X		Horizontal Y		Vertical Node 39		Vertical Node 69		Vertical Node 96		Vertical Node 187	
(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)
7.79	1.30807	7.79	1.0308	7.79	1.46139	7.79	1.78718	7.79	1.75195	7.79	1.01335
8.12	1.11803	8.12	0.89652	8.12	1.36844	8.12	1.39829	8.12	1.74166	8.12	0.8696
8.45	0.86822	8.45	0.81699	8.45	1.16717	8.45	1.22744	8.45	1.40341	8.45	0.78507
8.78	0.76941	8.78	0.77392	8.78	0.98783	8.78	1.09193	8.78	1.20974	8.78	0.76534
9.11	0.72394	9.11	0.75595	9.11	0.8567	9.11	0.95726	9.11	1.11655	9.11	0.76035
9.44	0.70881	9.44	0.71587	9.44	0.80302	9.44	0.89538	9.44	1.01825	9.44	0.73994
9.77	0.70539	9.77	0.70916	9.77	0.75099	9.77	0.82956	9.77	0.98516	9.77	0.78081
10.1	0.73089	10.1	0.73575	10.1	0.80747	10.1	0.7716	10.1	0.87242	10.1	0.72029
10.43	0.75077	10.43	0.73806	10.43	0.7731	10.43	0.74477	10.43	0.7816	10.43	0.65506
10.76	0.72127	10.76	0.71627	10.76	0.71293	10.76	0.72924	10.76	0.76261	10.76	0.63059
11.09	0.69047	11.09	0.70073	11.09	0.67894	11.09	0.68724	11.09	0.77699	11.09	0.62059
11.42	0.70481	11.42	0.70311	11.42	0.64463	11.42	0.65264	11.42	0.74895	11.42	0.59823
11.75	0.70088	11.75	0.70347	11.75	0.60773	11.75	0.65294	11.75	0.69933	11.75	0.58521
12.08	0.68961	12.08	0.69238	12.08	0.5694	12.08	0.65642	12.08	0.64473	12.08	0.58697
12.41	0.6625	12.41	0.6916	12.41	0.55953	12.41	0.64016	12.41	0.61206	12.41	0.5808
12.74	0.62976	12.74	0.68235	12.74	0.55948	12.74	0.63334	12.74	0.60446	12.74	0.57624
13.07	0.62903	13.07	0.67392	13.07	0.52778	13.07	0.63778	13.07	0.64283	13.07	0.57943
13.4	0.63524	13.4	0.6769	13.4	0.49396	13.4	0.63684	13.4	0.64826	13.4	0.58046
13.73	0.62704	13.73	0.66696	13.73	0.47718	13.73	0.62541	13.73	0.61477	13.73	0.57433
14.06	0.62258	14.06	0.65853	14.06	0.47692	14.06	0.59842	14.06	0.5825	14.06	0.55943
14.39	0.62162	14.39	0.66157	14.39	0.47085	14.39	0.56601	14.39	0.58544	14.39	0.53558
14.72	0.60854	14.72	0.66102	14.72	0.45356	14.72	0.55237	14.72	0.58447	14.72	0.50585
15.05	0.59271	15.05	0.66019	15.05	0.42201	15.05	0.55181	15.05	0.58836	15.05	0.48966
15.38	0.58698	15.38	0.66474	15.38	0.39127	15.38	0.55258	15.38	0.58247	15.38	0.4812
15.71	0.59575	15.71	0.66751	15.71	0.37643	15.71	0.55134	15.71	0.59523	15.71	0.49271
16.04	0.60943	16.04	0.66684	16.04	0.37603	16.04	0.54384	16.04	0.592	16.04	0.50547
16.37	0.61726	16.37	0.66365	16.37	0.37059	16.37	0.53037	16.37	0.57362	16.37	0.50191

TABLE 2. CONTINUED.

Roof Spectra--5% Damping											
Horizontal X		Horizontal Y		Vertical Node 39		Vertical Node 69		Vertical Node 96		Vertical Node 187	
(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)
16.7	0.61845	16.7	0.65352	16.7	0.37881	16.7	0.52078	16.7	0.55966	16.7	0.49638
17.03	0.61933	17.03	0.63975	17.03	0.37345	17.03	0.51657	17.03	0.54837	17.03	0.49882
17.36	0.62657	17.36	0.62518	17.36	0.36217	17.36	0.51057	17.36	0.53691	17.36	0.50617
17.69	0.62958	17.69	0.61279	17.69	0.35294	17.69	0.5117	17.69	0.51833	17.69	0.51205
18.02	0.6285	18.02	0.59844	18.02	0.34829	18.02	0.51009	18.02	0.49883	18.02	0.51557
18.35	0.62382	18.35	0.58465	18.35	0.34555	18.35	0.50613	18.35	0.48368	18.35	0.51547
18.68	0.61629	18.68	0.57892	18.68	0.34403	18.68	0.49962	18.68	0.47321	18.68	0.51348
19.01	0.60671	19.01	0.57415	19.01	0.34266	19.01	0.49156	19.01	0.46655	19.01	0.50922
19.34	0.5998	19.34	0.57357	19.34	0.33893	19.34	0.48295	19.34	0.46216	19.34	0.50282
19.67	0.5972	19.67	0.58199	19.67	0.33271	19.67	0.48711	19.67	0.4589	19.67	0.49695
20	0.59421	20	0.58714	20	0.32647	20	0.49497	20	0.45669	20	0.49413
20.33	0.58774	20.33	0.58785	20.33	0.32055	20.33	0.50024	20.33	0.4547	20.33	0.49203
20.66	0.58409	20.66	0.58636	20.66	0.3171	20.66	0.50092	20.66	0.45187	20.66	0.48696
20.99	0.57672	20.99	0.58284	20.99	0.31866	20.99	0.49775	20.99	0.44897	20.99	0.47845
21.32	0.57383	21.32	0.57821	21.32	0.32209	21.32	0.494	21.32	0.44792	21.32	0.4696
21.65	0.56864	21.65	0.57387	21.65	0.3261	21.65	0.49034	21.65	0.44749	21.65	0.46369
21.98	0.56329	21.98	0.57175	21.98	0.32696	21.98	0.48652	21.98	0.44676	21.98	0.46128
22.31	0.55965	22.31	0.57167	22.31	0.32445	22.31	0.48172	22.31	0.44567	22.31	0.4627
22.64	0.55868	22.64	0.57205	22.64	0.32051	22.64	0.47655	22.64	0.44487	22.64	0.46548
22.97	0.557	22.97	0.57222	22.97	0.31725	22.97	0.4734	22.97	0.44532	22.97	0.46894
23.3	0.5538	23.3	0.57215	23.3	0.31494	23.3	0.47604	23.3	0.4473	23.3	0.47195
23.63	0.54996	23.63	0.57163	23.63	0.31229	23.63	0.48087	23.63	0.45011	23.63	0.47367
23.96	0.54708	23.96	0.57042	23.96	0.30906	23.96	0.48539	23.96	0.45262	23.96	0.47422
24.29	0.54539	24.29	0.56883	24.29	0.30638	24.29	0.48838	24.29	0.45383	24.29	0.475
24.62	0.54423	24.62	0.56749	24.62	0.30383	24.62	0.48952	24.62	0.45348	24.62	0.47532
24.95	0.54353	24.95	0.56746	24.95	0.30194	24.95	0.49096	24.95	0.45268	24.95	0.47541
25.28	0.54348	25.28	0.56742	25.28	0.30084	25.28	0.4905	25.28	0.45133	25.28	0.4752

TABLE 2. CONTINUED.

Roof Spectra--5% Damping											
Horizontal X		Horizontal Y		Vertical Node 39		Vertical Node 69		Vertical Node 96		Vertical Node 187	
(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)	(Hz)	(Gs)
25.61	0.54389	25.61	0.56787	25.61	0.30027	25.61	0.48824	25.61	0.44883	25.61	0.47472
25.94	0.54465	25.94	0.56866	25.94	0.29976	25.94	0.48453	25.94	0.44554	25.94	0.47404
26.27	0.54598	26.27	0.56912	26.27	0.29873	26.27	0.47991	26.27	0.44201	26.27	0.47288
26.6	0.54775	26.6	0.56907	26.6	0.29698	26.6	0.47527	26.6	0.43901	26.6	0.47087
26.93	0.54919	26.93	0.56871	26.93	0.29499	26.93	0.47188	26.93	0.43707	26.93	0.46792
27.26	0.55053	27.26	0.56829	27.26	0.2932	27.26	0.47062	27.26	0.43624	27.26	0.46434
27.59	0.55288	27.59	0.56798	27.59	0.29134	27.59	0.47118	27.59	0.43614	27.59	0.46073
27.92	0.55495	27.92	0.56803	27.92	0.28872	27.92	0.47258	27.92	0.43627	27.92	0.45758
28.25	0.55747	28.25	0.56871	28.25	0.28516	28.25	0.47404	28.25	0.43639	28.25	0.45529
28.58	0.55952	28.58	0.56989	28.58	0.28123	28.58	0.47532	28.58	0.43654	28.58	0.45428
28.91	0.56097	28.91	0.57098	28.91	0.27795	28.91	0.47632	28.91	0.4369	28.91	0.4548
29.24	0.56173	29.24	0.57144	29.24	0.27598	29.24	0.47668	29.24	0.43754	29.24	0.4565
29.57	0.56185	29.57	0.57103	29.57	0.27521	29.57	0.47586	29.57	0.43832	29.57	0.45857
29.9	0.56153	29.9	0.57041	29.9	0.275	29.9	0.47375	29.9	0.43913	29.9	0.46035
30.23	0.5627	30.23	0.56888	30.23	0.2747	30.23	0.47079	30.23	0.44005	30.23	0.46176
30.56	0.56378	30.56	0.56688	30.56	0.27463	30.56	0.46766	30.56	0.44127	30.56	0.46307
30.89	0.56464	30.89	0.56603	30.89	0.27446	30.89	0.46505	30.89	0.44292	30.89	0.46433
31.22	0.56503	31.22	0.56707	31.22	0.27398	31.22	0.46349	31.22	0.4451	31.22	0.46534
31.55	0.56453	31.55	0.56953	31.55	0.27346	31.55	0.46312	31.55	0.44783	31.55	0.46583
31.88	0.56279	31.88	0.57287	31.88	0.27314	31.88	0.46381	31.88	0.45094	31.88	0.46568
32.21	0.56029	32.21	0.57639	32.21	0.27314	32.21	0.46528	32.21	0.45403	32.21	0.46482
32.54	0.55867	32.54	0.57955	32.54	0.27339	32.54	0.46719	32.54	0.45653	32.54	0.46333
32.87	0.55592	32.87	0.58199	32.87	0.27366	32.87	0.46922	32.87	0.45795	32.87	0.46146

frequency ranges for each component (from Reference 18), acceleration distributions were developed from the Table 2 data to represent an estimated mean acceleration at the required component locations.

The appropriate fragility distribution parameters were determined for each component based on Reference-18 components with similar structural properties. Table 3 summarizes the results of the component mapping, including distribution parameters and the building structural node from Reference 47 that were used in determining component fragility. The fragility curves generated from these distributions are provided in Appendix A.

By locating the acceleration value on the appropriate fragility curve, the probability of failure could be estimated. This probability, however, represented the failure mode from Reference 18, which was usually anchor bolts or support failures. To expand this estimate to include failure probability that could represent a potential release, a conservative "breach" factor of 0.1 was applied to all components where the failure mode involved supports or anchoring. The final fragility determination for each component is included in the following area discussions and presented in Table 4.

3.3.1 Area 1 Components

The function of this area is waste feed and incineration. Area 1 consists of Rooms 109 and 120. The feed enclosure, located in Room 109, contains the equipment that performs the waste feed function. The kiln and secondary combustion chamber (SCC) located in Room 120 incinerate the waste and ensure complete combustion of volatile by-products of the incineration process, respectively.

The feed enclosure consists of the feed conveyor and auger mechanism as shown in Figure 3. The feed conveyor receives waste from the shredder discharge and transfers it via the auger into the kiln. It is mounted to the second floor, a first mezzanine platform, and the wall adjacent to the kiln. The fragility for the feed conveyor is illustrated by the curve in Figure A-1 (Appendix A). As indicated in Table 4, failure probability for the feed conveyor was estimated to be 0.00353.

The incineration process is accomplished by the kiln and SCC, which are illustrated in Figure 4. The kiln burns all the combustibles and the SCC ensures that all volatile by-products are gasified. The kiln sits on a fiberglass support structure to permit some free movement. Additional support is provided by ceiling mounts. The SCC was assumed not to fail because of the sturdiness of structure and mountings (see

TABLE 3. PREPP COMPONENT FRAGILITY SUMMARY

COMPONENT	DESCRIPTION (from Reference 18)	FAILURE MODE	DISTRIBUTION PARAMETERS		NODE (from Table 2)
			MEDIAN	BETA	
FEED CONVEYOR	LARGE HORIZONTAL VESSEL--Includes large storage tanks and heat exchangers. Characterized by large volume, relatively low pressure, thin wall cylindrical tanks mounted with the cylinder axis in the horizontal position. 12-20 hz with 5% damping.	FAILURE OF ANCHOR BOLTS	3.91	0.61	70/178
KILN	LARGE HORIZONTAL VESSEL--Includes large storage tanks and heat exchangers. Characterized by large volume, relatively low pressure, thin wall cylindrical tanks mounted with the cylinder axis in the horizontal position. 12-20 hz with 5% damping.	FAILURE OF ANCHOR BOLTS	3.91	0.61	70/178
EMERGENCY DRAIN TANK	LARGE HORIZONTAL VESSEL--Includes large storage tanks and heat exchangers. Characterized by large volume, relatively low pressure, thin wall cylindrical tanks mounted with the cylinder axis in the horizontal position. 12-20 hz with 5% damping.	FAILURE OF ANCHOR BOLTS			1st Floor
GROUT MIXER	LARGE HORIZONTAL VESSEL--Includes large storage tanks and heat exchangers. Characterized by large volume, relatively low pressure, thin wall cylindrical tanks mounted with the cylinder axis in the horizontal position. 12-20 hz with 5% damping.	FAILURE OF ANCHOR BOLTS			39
FINES HOPPERS/BLENDER TANKS	LARGE VERTICAL VESSEL WITH FORMED HEAD--Includes accumulator and volume control tanks. Typically low pressure with thin wall construction supported by skirts. May have non-integrally reinforced nozzles or non-reinforced fabricated nozzles. Fluid sloshing and fluid-structure interaction are critical with respect to dynamic response. 4-10 hz.	RUPTURE OF ANCHOR BOLTS; BREAKING OF SUPPORTS	1.46	0.40	39
ENTRAINMENT ELIMINATOR	LARGE VERTICAL VESSEL WITH FORMED HEAD--Includes accumulator and volume control tanks. Typically low pressure with thin wall construction supported by skirts. May have non-integrally reinforced nozzles or non-reinforced fabricated nozzles. Fluid sloshing and fluid-structure interaction are critical with respect to dynamic response. 4-10 hz.	RUPTURE OF ANCHOR BOLTS; BREAKING OF SUPPORTS			39
VENTURI SCRUBBER	LARGE VERTICAL VESSEL WITH FORMED HEAD--Includes accumulator and volume control tanks. Typically low pressure with thin wall construction supported by skirts. May have non-integrally reinforced nozzles or non-reinforced fabricated nozzles. Fluid sloshing and fluid-structure interaction are critical with respect to dynamic response. 4-10 hz.	RUPTURE OF ANCHOR BOLTS; BREAKING OF SUPPORTS			39

TABLE 3. CONCLUDED.

COMPONENT	DESCRIPTION (from Reference 18)	FAILURE MODE	DISTRIBUTION PARAMETERS		NODE (from Table 2)
			MEDIAN	BETA	
MIST ELIMINATOR	LARGE VERTICAL VESSEL WITH FORMED HEAD—Includes accumulator and volume control tanks. Typically low pressure with thin wall construction supported by skirts. May have non-integrally reinforced nozzles or non-reinforced fabricated nozzles. Fluid sloshing and fluid-structure interaction are critical with respect to dynamic response. 4-10 hz.	RUPTURE OF ANCHOR BOLTS; BREAKING OF SUPPORTS			39
SLUDGE TANK	LARGE VERTICAL VESSEL WITH FORMED HEAD—Includes accumulator and volume control tanks. Typically low pressure with thin wall construction supported by skirts. May have non-integrally reinforced nozzles or non-reinforced fabricated nozzles. Fluid sloshing and fluid-structure interaction are critical with respect to dynamic response. 4-10 hz.	RUPTURE OF ANCHOR BOLTS; BREAKING OF SUPPORTS			38
SURGE RECYCLE TANK	LARGE VERTICAL VESSEL WITH FORMED HEAD—Includes accumulator and volume control tanks. Typically low pressure with thin wall construction supported by skirts. May have non-integrally reinforced nozzles or non-reinforced fabricated nozzles. Fluid sloshing and fluid-structure interaction are critical with respect to dynamic response. 4-10 hz.	RUPTURE OF ANCHOR BOLTS; BREAKING OF SUPPORTS			1st Floor
SURGE RECYCLE DRAIN TANK	LARGE VERTICAL VESSEL WITH FORMED HEAD—Includes accumulator and volume control tanks. Typically low pressure with thin wall construction supported by skirts. May have non-integrally reinforced nozzles or non-reinforced fabricated nozzles. Fluid sloshing and fluid-structure interaction are critical with respect to dynamic response. 4-10 hz.	RUPTURE OF ANCHOR BOLTS; BREAKING OF SUPPORTS			38
QUENCHER	LARGE VERTICAL VESSEL—Large storage tanks typically anchored to the foundation. Fluid sloshing effects are critical with respect to dynamic response. 4-10 hz.	FRACTURE OF ANCHOR BOLTS	2.01	0.38	38/187
DISCHARGE CONVEYOR	SMALL-MEDIUM VESSEL—Cylindrical or spherical in shape mounted horizontally or vertically. Supports are typically legs or saddles welded directly to the pressure boundary and bolted to the floor. 15-30 hz with 5% damping.	RUPTURE OF ANCHOR BOLTS; SUPPORT FAILURE	1.84	0.51	38/187
GROUTED DRUMS	SMALL-MEDIUM VESSEL—Cylindrical or spherical in shape mounted horizontally or vertically. Supports are typically legs or saddles welded directly to the pressure boundary and bolted to the floor. 15-30 hz with 5% damping.	RUPTURE OF ANCHOR BOLTS; SUPPORT FAILURE			178
DRUMS BEING FILLED	SMALL-MEDIUM VESSEL—Cylindrical or spherical in shape mounted horizontally or vertically. Supports are typically legs or saddles welded directly to the pressure boundary and bolted to the floor. 15-30 hz with 5% damping.	RUPTURE OF ANCHOR BOLTS; SUPPORT FAILURE			1st Floor

TABLE 4. PREPP COMPONENT FRAGILITY VALUES

PREPP Component	Fragility ^a	Total Fragility ^b
FC - Feed Conveyor	0.0353	0.00353
KL - Kiln	0.0024	0.00024
B1 - HVAC System	0.0900	0.09000
D2 - Grouted drums	0.1700	0.01700
T1 - Surge Recycle Tank (SRT)	0.1295	0.01295
S1 - Sludge tank (recr. w/SRT)	0.6110	0.06110
T2 - Surge Recycle Drain Tank	0.6110	0.06110
ET - Emergency Drain Tank	0.0024	0.00024
S2 - Sludge tank (grouting)	0.6110	0.06110
S3 - Sludge tank (sparging)	0.6110	0.06110
P2 - Sludge pump for S2	0.0087	0.00087
P3 - Sludge pump for S3	0.0087	0.00087
MX - Grout mixer	0.0071	0.00071
THE - Trommel hopper	0.1295	0.01295
T3 - Fines hopper & blender (input)	0.0004	0.00004
T4 - Fines hopper & blender (output)	0.0004	0.00004
T5 - Fines Weigh Tank	0.2000	0.02000
V4 - Discharge conveyor	0.0240	0.00240
WQ - Wet Quencher	0.6156	0.06156
OG - Off-Gas Vessels (VS,EE,ME)	0.0002	0.00002
D1 - Drums being filled	0.0001	0.00010

^aProbability of support failure at the estimated acceleration expected for the component.

^bActual probability of breach is < 1E-5; nevertheless, a conservative probability of 0.1 has been applied to all support fragilities except B1 and D1, to provide a total estimated failure probability.

Figure 3. Simplified schematic of the feed conveyor.

Figure 4. Simplified schematic of the rotary kiln and SCC.

Assumption 15). The fragility for the kiln is illustrated by the curve in Figure A-2 (Appendix A). As indicated in Table 4, failure probability for the kiln was estimated to be 0.00024.

3.3.2 Area 2 Components

The function of this area is to process the off-gas generated by the waste incineration. The off-gas components modeled were the wet quencher, venturi scrubber, entrainment eliminator, and mist eliminator (see Figures 5-8). These components are all located in Room 217.

The wet quencher and venturi scrubber cleanse the off-gas of both particulate and acidic compounds using a sodium carbonate scrubbing solution. Also, the off-gas is cooled from ~2300°F to ~180°F by the quencher. The entrainment eliminator and mist eliminator remove the free liquid in the off-gas stream. The wet quencher sits on a spring-type support mounted to a second mezzanine platform. It is also welded to a duct that extends through the adjacent corridor walls into the SCC. Because the venturi scrubber, entrainment eliminator, and mist eliminator are located relatively close to each other and secured with welded piping connections, they were considered in the analysis as one entity. The fragility for the off-gas vessels is illustrated by the curve in Figure A-3 (Appendix A).^{*} As indicated in Table 4, the failure probability for the quencher was estimated to be 0.06156; for the three grouped components, 0.0002.

3.3.3 Area 3 Components

The function of this area is to process the liquid by-product from the off-gas cleansing process. The components required for this function are the SRT and associated pump (Figure 9), and the three sludge tanks and their associated hydrocyclone separators and pumps (Figure 10). The Surge Recycle Drain Tank (SRDT) and Emergency Drain Tank (EDT) as shown in Figures 11 and 12, respectively, are also included in this area. These components are all located in Room 122.

The SRT collects liquids from the area sumps and the off-gas components. For this analysis, the SRT and its associated pump were considered as one entity, mounted to the first floor. However, the pump fragility was negligible relative to that of the SRT,

^{*} Because of the similarity in shape and elevation of the vessels, the same fragility curve represents all four vessels. However, because of limited supports, the quencher was considered more susceptible (i.e., more 'fragile' than the other three vessels, which were assumed to fail concurrently.

Figure 5. Simplified schematic of the wet quencher.

Figure 6. Simplified schematic of the venturi scrubber.

Figure 7. Simplified schematic of the entrainment eliminator.

Figure 8. Simplified schematic of the mist eliminator.

Figure 9. Simplified schematic of the surge recycle tank.

Figure 10. Simplified schematic of the sludge tanks.

Figure 11. Simplified schematic of the surge recycle drain tank.

Figure 12. Simplified schematic of the emergency drain tank.

illustrated by Figure A-4 (Appendix A). From this curve, the SRT was assigned the failure probability of 0.01294 (see Table 4).

Normal configuration of the sludge tanks and associated equipment is that one tank is being depleted for grouting; one tank is sparging, waiting to be used for grouting; and one is being filled from the off-gas cleansing process (see Assumption 4). For purposes of this analysis, the hydrocyclone separators and the sludge tanks are evaluated as one unit (see Assumption 14). The tank units are mounted to the SRT from the bottom and the off-gas vessels from the top. Additional support is provided from structures mounted to the first mezzanine (e.g., piping). The fragility for the sludge tanks is shown by the curve in Figure A-5 (Appendix A). As indicated in Table 4, the failure probability for the sludge tanks was estimated to be 0.0611. The pumps associated with the sludge tanks that are sparging and grouting were evaluated as separate entities because the pipes associated with these pumps are small and are assumed to rupture with the pumps (see Assumption 12). Therefore, the fragility associated with the pumps is shown by the curve in Figure A-6 (Appendix A) and the failure probability for each pump was estimated to be 0.00087 (see Table 4).

The SRDT and EDT are back-up tanks required for off-normal situations. Mounted to the first mezzanine, the SRDT and EDT are both illustrated by the curve in Figure A-7 (Appendix A). As indicated by the figure and listed in Table 4, the failure probability for both the SRDT and EDT is 0.0611.

3.3.4 Area 4 Components

The function of this area is to process the solid discharge from the kiln. The only component required for this function is the discharge conveyor (Figure 13), which is located in Room 119.

The discharge conveyor receives waste discharged from the SCC and transfers it to the trommel hopper (Area 5). The discharge conveyor cooling system cools the waste from a maximum entrance temperature of 1800°F to less than 180°F before discharging it to the trommel hopper. On the sides, the discharge conveyor is mounted to the wall adjacent to the SCC and the drum fill enclosure via the trommel hopper. It also is supported from the first and second floors. The fragility for the discharge conveyor is illustrated by the curve in Figure A-8 (Appendix A). As indicated in Table 4, the failure probability estimated for the discharge conveyor was 0.0024.

Figure 13. Simplified schematic of the discharge conveyor.

3.3.5 Area 5 Components

The function of this area is to process the fines waste for mixing with the grout. The components modeled for this function are the trommel hopper, fines hoppers and blender tanks, and fines weigh tank (Figures 14 through 16, respectively). This equipment is located in Rooms 118, 119, and 215.

Course waste is separated from the fine ash in the trommel hopper. Waste material $<1/4$ " diameter and 1" long are processed as fines; and the larger pieces move through the trommel and into the drum fill enclosure. The fine ash is removed from the trommel hopper by a pneumatic ash conveyor and sent to one of two fines filter hoppers. The fines are dumped from the fines filter hoppers into the fines blender tanks. Each blender tank contains a mixer to thoroughly blend the fines before being included in the grout recipe. The trommel hopper has supports to the discharge conveyor, drum fill enclosure, first floor, and basement. The fines filter hoppers and blender tanks are mounted from the second mezzanine, the second floor, and a first mezzanine platform. The fines weigh tank is welded to piping that is supported by both the second mezzanine and second floor. The fragilities for the trommel hopper and the fines hoppers/blender tanks are shown by the curves presented in Figures A-9 and A-10 (Appendix A), respectively. The fragility for the fines weight tank was calculated from the fragility data represented by piping and tank failures. As indicated in Table 4, the failure probabilities estimated for these components are 0.01295 (trommel hopper), 0.00004 (fines hoppers/blender tanks, including the ash conveyor), and 0.02 (fines weigh tank).

3.3.6 Area 6 Components

The function of this area is filling the drums with a mixture of waste and grout. This area encompasses the drum enclosure and the drum being filled. The filling process takes place in Rooms 118 and 119. The drum enclosure contains only course waste; and it has been assumed that a negligible amount of plutonium is in the coarse materials (see Assumption 2). Therefore, only the drums being filled have been modeled. The failure probability estimated for these drums was 0.0001 (see Table 4) based upon Assumption 18.

Figure 14. Simplified schematic of the trommel hopper.

Figure 15. Simplified schematic of the fines hoppers and blender tanks.

Figure 16. Simplified schematic of the fines weigh tank.

3.3.7 Area 7 Components

The function of this area is mixing the fines with grout for drum filling. Only the grout mixer tank is required for this function (see Figure 17). This tank is located in Room 215. The grout mixer tank takes sand, cement, water, sludge, and plasticizer to produce grout for filling the waste drums. The grout mixer supports are mounted to the second floor. The fragility for the grout mixer tank is represented by the curve in Figure A-11 (Appendix A). As indicated in Table 4, the failure probability estimated for the grout mixer tank was 0.00071.

3.3.8 Area 8 Components

The function of this area is curing the grout-filled drums. Once the drums have been filled, they are moved to Room 112 to cure. The only source of release in the curing process is breach of the drums; and this failure probability has been estimated, calculated from the maximum number and locations of drums expected in this room (see Assumption 19), to be 0.017.

3.3.9 Area 9 Components

The function of this area is to provide negative pressure boundaries within the facility. This is accomplished using one HVAC blower. The failure probability for this blower was estimated to be 0.09 based upon the estimated availability of electric power during the seismic event (Assumptions 5 and 6).

Figure 17. Simplified schematic of the grout mixer tank.

4.0 EVENT TREE ANALYSIS

4.1 Introduction

Event tree analysis is a PRA technique for systematically modeling and evaluating accident scenarios. It possesses a unique ability to address the sequential nature that is inherent in consequences resulting from a seismic event. The overall process involved development of accident scenarios and entering the scenarios into the computerized event tree modeling code, Riskman (Ref. 54). Once a complete model was developed, the fragility curves provided the probability data needed for quantification of the event tree model. The quantification process provided insight into the dominant accident scenarios, i.e., the ones with the highest frequencies. The source term, environmental conditions, and failures for the areas represented by the dominant accident scenarios were then evaluated to determine the condition of the facility following such events, i.e., facility damage state.

4.2 Accident Scenario Development

Initially, scenarios were postulated for each room in the facility. A precursory look at the resultant scenarios, however, indicated numerous scenarios with negligible contribution to any potential release. The facility was then divided into functional areas, including all applicable equipment. The areas correspond to those discussed in the systems analysis section, Section 3.3. These functional areas were evaluated and reduced in order to obtain realistic scenarios that represented potential risk to the facility personnel or to the environment (and, subsequently, the public). Event trees for each of these areas are illustrated in Appendix B, Figures B-1 through B-9.

4.3 Dominant Accident Sequences

The event tree models illustrated in Appendix B were quantified using probabilities from the systems analysis fragility data (see Section 3.0). For PREPP, the models were separated into two categories: (1) only liquid release (Areas 3) and (2) potential airborne release (Areas 1, 2, 4, and 5). Because the Category (1) releases would have not apparent environmental impact, dominant accident sequences* were selected from the Category (2) scenarios. Details of these dominant accident sequences,

*Dominant accident sequences were identified as those with probabilities greater than $1E-6$ when HVAC succeeded and greater than $1E-7$ when HVAC failed.

evaluated with and without the HVAC system, are presented in Tables 5 and 6, respectively. Dominant sequences involve the multiplication (indicated by the asterisks, '**') of the failure probabilities of particular components and the success probabilities of other components. In Tables 5 and 6, failures are indicated with a slash preceding the component acronym (e.g., /WQ).

In characterizing these 12 dominant sequences with respect to source term quantities, the estimates in Table 7 were used. The numbers in Table 7 were derived from Reference 55. These source term estimates were then integrated with equipment failures and environmental conditions for determining total facility damage state conditions for each dominant accident sequence. These facility damage states were further integrated in the consequence model described in Section 5.0.

TABLE 5. ACCIDENT SCENARIO AND RELEASE FREQUENCY SUMMARY WITH HVAC SUCCESS

<u>SEQUENCE NAME</u>	<u>ACCIDENT SEQUENCE</u>	<u>FREQUENCY</u>
QUENCHER FAILS	FC*KL*V4*/WQ*OG*THE*T3*T4*T5*B1	5.3837E-05
	<u>Sequence Breakdown</u>	<u>Probability</u>
	FC = Success of feed conveyor	9.9647E-01
	KL = Success of kiln & SCC	9.9976E-01
	V4 = Success of discharge conveyor	9.9760E-01
	/WQ = Failure of wet quencher	6.1560E-02
	OG = Success of off-gas vessels	9.9977E-01
	THE = Success of trommel hopper	9.8705E-01
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	T5 = Success of fines weigh tank	9.8000E-01
	B1 = Success of HVAC	9.1000E-01
FINES WEIGH TANK FAILS	FC*KL*V4*WQ*OG*THE*T3*T4*/T5*B1	1.6749E-05
	<u>Sequence Breakdown</u>	<u>Probability</u>
	FC = Success of feed conveyor	9.9647E-01
	KL = Success of kiln & SCC	9.9976E-01
	V4 = Success of discharge conveyor	9.9760E-01
	WQ = Success of wet quencher	9.3844E-01
	OG = Success of off-gas vessels	9.9977E-01
	THE = Success of trommel hopper	9.8705E-01
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	/T5 = Failure of fines weigh tank	2.0000E-02
	B1 = Success of HVAC	9.1000E-01
TROMMEL HOPPER FAILS	FC*KL*V4*WQ*OG*/THE*T3*T4*T5*B1	1.0768E-05
	<u>Sequence Breakdown</u>	<u>Probability</u>
	FC = Success of feed conveyor	9.9647E-01
	KL = Success of kiln & SCC	9.9976E-01
	V4 = Success of discharge conveyor	9.9760E-01
	WQ = Success of wet quencher	9.3844E-01
	OG = Success of off-gas vessels	9.9977E-01
	/THE = Failure of trommel hopper	1.2950E-02
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	T5 = Success of fines weigh tank	9.8000E-01
	B1 = Success of HVAC	9.1000E-01

TABLE 5. CONCLUDED.

<u>SEQUENCE NAME</u>	<u>ACCIDENT SEQUENCE</u>	<u>FREQUENCY</u>
FEED ENCLOSURE FAILS	/FC*KL*V4*WQ*OG*THE*T3*T4*T5*B1	2.9074E-06
	<u>Sequence Breakdown</u>	<u>Probability</u>
	/FC = Failure of feed conveyor	3.5300E-03
	KL = Success of kiln & SCC	9.9976E-01
	V4 = Success of discharge conveyor	9.9760E-01
	WQ = Success of wet quencher	9.3844E-01
	OG = Success of off-gas vessels	9.9977E-01
	THE = Success of trommel hopper	9.8705E-01
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	T5 = Success of fines weigh tank	9.8000E-01
	B1 = Success of HVAC	9.1000E-01
DISCHARGE CONVEYOR FAILS	FC*KL*/V4*WQ*OG*THE*T3*T4*T5*B1	1.9744E-06
	<u>Sequence Breakdown</u>	<u>Probability</u>
	FC = Success of feed conveyor	9.9647E-01
	KL = Success of kiln & SCC	9.9976E-01
	/V4 = Failure of discharge conveyor	2.4000E-03
	WQ = Success of wet quencher	9.3844E-01
	OG = Success of off-gas vessels	9.9977E-01
	THE = Success of trommel hopper	9.8705E-01
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	T5 = Success of fines weigh tank	9.8000E-01
	B1 = Success of HVAC	9.1000E-01
QUENCHER & WEIGH TANK FAIL	FC*KL*V4*/WQ*OG*THE*T3*T4*/T5*B1	1.0987E-06
	<u>Sequence Breakdown</u>	<u>Probability</u>
	FC = Success of feed conveyor	9.9647E-01
	KL = Success of kiln & SCC	9.9976E-01
	V4 = Success of discharge conveyor	9.9760E-01
	/WQ = Failure of wet quencher	6.1560E-02
	OG = Success of off-gas vessels	9.9977E-01
	THE = Success of trommel hopper	9.8705E-01
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	/T5 = Failure of fines weigh tank	2.0000E-02
	B1 = Success of HVAC	9.1000E-01

TABLE 6. ACCIDENT SCENARIO AND RELEASE FREQUENCY SUMMARY WITH HVAC FAILURE

<u>SEQUENCE NAME</u>	<u>ACCIDENT SEQUENCE</u>	<u>FREQUENCY</u>
QUENCHER FAILS	FC*KL*V4*/WQ*OG*THE*T3*T4*T5*/B1	5.3246E-06
	<u>Sequence Breakdown</u>	<u>Probability</u>
	FC = Success of feed conveyor	9.9647E-01
	KL = Success of kiln & SCC	9.9976E-01
	V4 = Success of discharge conveyor	9.9760E-01
	/WQ = Failure of wet quencher	6.1560E-02
	OG = Success of off-gas vessels	9.9977E-01
	THE = Success of trommel hopper	9.8705E-01
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	T5 = Success of fines weigh tank	9.8000E-01
	/B1 = Failure of HVAC	9.0000E-02
FINES WEIGH TANK FAILS	FC*KL*V4*WQ*OG*THE*T3*T4*/T5*/B1	1.6565E-06
	<u>Sequence Breakdown</u>	<u>Probability</u>
	FC = Success of feed conveyor	9.9647E-01
	KL = Success of kiln & SCC	9.9976E-01
	V4 = Success of discharge conveyor	9.9760E-01
	WQ = Success of wet quencher	9.3844E-01
	OG = Success of off-gas vessels	9.9977E-01
	THE = Success of trommel hopper	9.8705E-01
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	/T5 = Failure of fines weigh tank	2.0000E-02
	/B1 = Failure of HVAC	9.0000E-02
TROMMEL HOPPER FAILS	FC*KL*V4*WQ*OG*/THE*T3*T4*T5*/B1	1.0649E-06
	<u>Sequence Breakdown</u>	<u>Probability</u>
	FC = Success of feed conveyor	9.9647E-01
	KL = Success of kiln & SCC	9.9976E-01
	V4 = Success of discharge conveyor	9.9760E-01
	WQ = Success of wet quencher	9.3844E-01
	OG = Success of off-gas vessels	9.9977E-01
	/THE = Failure of trommel hopper	1.2950E-02
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	T5 = Success of fines weigh tank	9.8000E-01
	/B1 = Failure of HVAC	9.0000E-02

TABLE 6. CONCLUDED.

<u>SEQUENCE NAME</u>	<u>ACCIDENT SEQUENCE</u>	<u>FREQUENCY</u>
FEED ENCLOSURE FAILS	/FC*KL*V4*WQ*OG*THE*T3*T4*T5*/B1	2.8754E-07
	<u>Sequence Breakdown</u>	<u>Probability</u>
	/FC = Failure of feed conveyor	3.5300E-03
	KL = Success of kiln & SCC	9.9976E-01
	V4 = Success of discharge conveyor	9.9760E-01
	WQ = Success of wet quencher	9.3844E-01
	OG = Success of off-gas vessels	9.9977E-01
	THE = Success of trommel hopper	9.8705E-01
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	T5 = Success of fines weigh tank	9.8000E-01
	/B1 = Failure of HVAC	9.0000E-02
DISCHARGE CONVEYOR FAILS	FC*KL*/V4*WQ*OG*THE*T3*T4*T5*/B1	1.9527E-07
	<u>Sequence Breakdown</u>	<u>Probability</u>
	FC = Success of feed conveyor	9.9647E-01
	KL = Success of kiln & SCC	9.9976E-01
	/V4 = Failure of discharge conveyor	2.4000E-03
	WQ = Success of wet quencher	9.3844E-01
	OG = Success of off-gas vessels	9.9977E-01
	THE = Success of trommel hopper	9.8705E-01
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	T5 = Success of fines weigh tank	9.8000E-01
	/B1 = Failure of HVAC	9.0000E-02
QUENCHER & WEIGH TANK FAIL	FC*KL*V4*/WQ*OG*THE*T3*T4*/T5*/B1	1.0866E-07
	<u>Sequence Breakdown</u>	<u>Probability</u>
	FC = Success of feed conveyor	9.9647E-01
	KL = Success of kiln & SCC	9.9976E-01
	V4 = Success of discharge conveyor	9.9760E-01
	/WQ = Failure of wet quencher	6.1560E-02
	OG = Success of off-gas vessels	9.9977E-01
	THE = Success of trommel hopper	9.8705E-01
	T3 = Success of fines blender (input)	9.9996E-01
	T4 = Success of fines blender (output)	9.9996E-01
	/T5 = Failure of fines weigh tank	2.0000E-02
	/B1 = Failure of HVAC	9.0000E-02

TABLE 7. SOURCE TERM ESTIMATES

<u>PREPP Area</u>	<u>Total Grams</u>	<u>Release Fraction</u>	<u>Airborne Grams</u>
Feed	592.0	5E-4	0.30
Off-Gas	500.0	5E-4	0.25
Liquid	3837.0	0.00	0.00
Solid	64.5	5E-4	0.03
Fines	2240.0	5E-4	1.12
Filling	21.5	0.00	0.00
Mixing	63.0	0.00	0.00
Curling	860.0	0.00	0.00

5.0 CONSEQUENCE ANALYSIS

In this analysis, the characteristics of each accident scenario (i.e., facility damage state) were consolidated with facility internal environmental conditions to model dispersion of the estimated airborne source term within the facility and the amount that could potentially be released to the environment. In a preliminary analysis effort, potential radiological consequences for the postulated PREPP accidents were calculated based on the RSAC-4 computer code (Ref. 56). The calculated doses included inhalation and air immersion pathways, representing committed effective dose equivalents (i.e., fraction of radionuclides retained in the body for 50 years following the period of intake). Following these preliminary results, a more in-depth analysis was performed to obtain more realistic quantities than the original conservative estimates of source term. A complex transport computer modeling code was used in the final consequence analysis. A presentation of the details and results of the consequence analysis follows.

Various considerations were included in developing the computer model used in this analysis (MELCOR, Ref. 57). Particularly close attention was paid to the modeling of temperatures, pressures, and heat structures (i.e., floors, ceilings, and walls). No credit was taken for the TAN structure which houses the PREPP facility, i.e., any releases from PREPP were assumed to be to the environment.

In creating the model for this analysis, the PREPP facility was divided into 12 areas called control volumes: 11 representing the 39 rooms in the facility, and 1 representing the environment. Table 8 provides the designation for the 12 control volumes and the rooms represented by each.

Because of the unique differences implied by the success or failure of HVAC, two models were developed—one to represent the sequences with HVAC success (see Table 5); the other to represent the sequences with HVAC failure (see Table 6). For HVAC success, 44 flow paths throughout the facility were modeled; for HVAC failure, 28 flow paths. These flow paths were modeled to represent the small gap around closed doors, assumed to have a size corresponding to the full circumference of the door (2 mm), creating an opening of 0.012 m^2 per door. Flow path length was assumed to be 0.1 m (approximate thickness of the door). A conservative assumption that no flow restrictions exist in any control volume is also included in the model. With

TABLE 8. PREPP CONTROL VOLUMES

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>DESIGNATION</u>
1	none	Environment
2	104,109,110	Feed Conveyor
3	105,106,107,203	Overpack Area
4	108,117,118,119,M-102	Drum Fill Area
5	111,112,115,116	Drum Curing
6	120	Kiln/SCC
7	121,122,M-103,201,217,S3	Off-Gas Equipment
8	202,206,218,S1,S11	Gallery
9	204,205,210,218,M-201	Shredder Rooms
10	207,208,209,M-202,S2	Personnel Decon.
11	211	Control Room
12	213,214,215	Fines Storage/ Handling

^a'M' indicates a mezzanine; 'S' indicates stairs.

the exception of Control Volume 11 (Control Room), each control volume contains at least two flow paths.

Each control volume also has numerous associated heat structures. All floors, walls, and ceilings were included in this parameter, to create a total of 109 heat structures. Eight different structure types are represented, dependent on material composition, thickness, and communication. Most walls interior to the confinement were modeled as adiabatic, i.e., no heat conduction. All perimeter walls and the walls of the kiln were modeled to allow one-dimensional conduction between control volumes, with convection on both sides of the walls.

Each of the 12 accident scenarios were modeled, with associated source term and failures, to determine dispersion/transport of the source term. Tables 9 through 20 present the results of the 12 accident scenarios. In the six models representing HVAC success (Tables 9 - 14), the 12 control volumes were connected by velocity controlled flow paths. A uniform size of 1 m² and a constant velocity in concert with the HVAC system flow rates was chosen for each of the 44 flow paths in this model. No consideration was included, however, for the removal efficiency of the HEPA filters through which the aerosol would pass before being released to the environment. Therefore, a HEPA filter efficiency factor of 99.97% should be applied to the source term indicated in these tables (Tables 9-14) to obtain the actual source term potentially released to the environment.

The remaining six tables, Tables 15 through 20, represent the scenarios from Table 6 (i.e., HVAC failure). In these scenarios, the release was not through the HEPAs; aerosols were assumed to be released to the environment through seal openings around doors. Therefore, no additional credit or reductions can be applied to the source term quantities presented in these tables (Tables 15 - 20).

TABLE 9. TRANSPORT RESULTS FOR HVAC SUCCESS ACCIDENT SCENARIO 1.

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000010	0.000010
2	104,109,110	0.000000	0.000000
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000013	0.000000
5	111,112,115,116	0.000000	0.000000
6	120	0.000000	0.000000
7	121,122,M-103,201,217,S3	0.000000	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 10. TRANSPORT RESULTS FOR HVAC SUCCESS ACCIDENT SCENARIO 2

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1			
2	none	0.000035	0.000035
3	104,109,110	0.000000	0.000000
4	105,106,107,203	0.000000	0.000000
5	108,117,118,119,M-102	0.000047	0.000047
6	111,112,115,116	0.000001	0.000001
7	120	0.000000	0.000000
8	121,122,M-103,201,217,S3	0.000000	0.000000
9	202,206,218,S1,S11	0.000000	0.000000
10	204,205,210,218,M-201	0.000000	0.000000
11	207,208,209,M-202,S2	0.000000	0.000000
12	211	0.000000	0.000000
	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 11. TRANSPORT RESULTS FOR HVAC SUCCESS ACCIDENT SCENARIO 3

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000045	0.000045
2	104,109,110	0.000000	0.000000
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000060	0.000000
5	111,112,115,116	0.000001	0.000001
6	120	0.000000	0.000000
7	121,122,M-103,201,217,S3	0.000000	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 12. TRANSPORT RESULTS FOR HVAC SUCCESS ACCIDENT SCENARIO 4

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000018	0.000018
2	104,109,110	0.000000	0.000000
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000001	0.000000
5	111,112,115,116	0.000000	0.000000
6	120	0.000004	0.000004
7	121,122,M-103,201,217,S3	0.000061	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 13. TRANSPORT RESULTS FOR HVAC SUCCESS ACCIDENT SCENARIO 5

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000053	0.000053
2	104,109,110	0.000000	0.000000
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000047	0.000000
5	111,112,115,116	0.000001	0.000000
6	120	0.000004	0.000000
7	121,122,M-103,201,217,S3	0.000061	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 14. TRANSPORT RESULTS FOR HVAC SUCCESS ACCIDENT SCENARIO 6

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000031	0.000031
2	104,109,110	0.000069	0.000000
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000004	0.000047
5	111,112,115,116	0.000004	0.000001
6	120	0.000005	0.000000
7	121,122,M-103,201,217,S3	0.000000	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 15. TRANSPORT RESULTS FOR HVAC FAILURE ACCIDENT SCENARIO 1

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000000	0.000000
2	104,109,110	0.000000	0.000000
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000014	0.000000
5	111,112,115,116	0.000000	0.000000
6	120	0.000000	0.000000
7	121,122,M-103,201,217,S3	0.000000	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 16. TRANSPORT RESULTS FOR HVAC FAILURE ACCIDENT SCENARIO 2

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000000	0.000000
2	104,109,110	0.000000	0.000000
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000052	0.000000
5	111,112,115,116	0.000000	0.000000
6	120	0.000000	0.000000
7	121,122,M-103,201,217,S3	0.000000	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 17. TRANSPORT RESULTS FOR HVAC FAILURE ACCIDENT SCENARIO 3

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000000	0.000000
2	104,109,110	0.000000	0.000000
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000066	0.000000
5	111,112,115,116	0.000000	0.000000
6	120	0.000000	0.000000
7	121,122,M-103,201,217,S3	0.000000	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 18. TRANSPORT RESULTS FOR HVAC FAILURE ACCIDENT SCENARIO 4

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000000	0.000000
2	104,109,110	0.000000	0.000000
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000000	0.000000
5	111,112,115,116	0.000000	0.000000
6	120	0.000000	0.000000
7	121,122,M-103,201,217,S3	0.000062	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 19. TRANSPORT RESULTS FOR HVAC FAILURE ACCIDENT SCENARIO 5

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000000	0.000000
2	104,109,110	0.000000	0.000000
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000052	0.000000
5	111,112,115,116	0.000000	0.000000
6	120	0.000000	0.000000
7	121,122,M-103,201,217,S3	0.000062	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

TABLE 20. TRANSPORT RESULTS FOR HVAC FAILURE ACCIDENT SCENARIO 6

<u>CONTROL VOLUME</u>	<u>ROOMS INCLUDED^a</u>	<u>PEAK QUANTITY</u> <u>OF Pu (kg)^b</u>	<u>FINAL QUANTITY</u> <u>OF Pu (kg)^b</u>
1	none	0.000000	0.000000
2	104,109,110	0.000072	0.000001
3	105,106,107,203	0.000000	0.000000
4	108,117,118,119,M-102	0.000000	0.000000
5	111,112,115,116	0.000000	0.000000
6	120	0.000000	0.000000
7	121,122,M-103,201,217,S3	0.000000	0.000000
8	202,206,218,S1,S11	0.000000	0.000000
9	204,205,210,218,M-201	0.000000	0.000000
10	207,208,209,M-202,S2	0.000000	0.000000
11	211	0.000000	0.000000
12	213,214,215	0.000000	0.000000

^a'M' indicates a mezzanine; 'S' indicates stairs.

^bMeasured from time 0-to-30 min.

6.0 SUMMARY OF RESULTS

This analysis was characterized by four key subtasks: methodology development, systems analysis, event tree or accident scenario analysis, and consequence analysis. The methodology, described in Section 2.0, provided the structure around which the actual analyses were performed.

The first efforts in the systems analysis task involved the regrouping of the rooms within the facility into appropriate functional areas. These areas include waste feed, off-gas, liquid waste, solid waste, fines handling and storage, grout mixing, filling of new drums, drum curing, and mechanical equipment (HVAC). The equipment in each of these nine areas was identified and evaluated with respect to its location, elevation, and susceptibility (i.e., fragility) to a DBE. The results from the systems analysis task were consolidated as failure probabilities (given a DBE) associated with each component evaluated within the facility. These probabilities were provided in Table 4, Section 3.0.

In the event tree analysis task, accident scenarios were postulated. Event tree models were developed for each area; and the failure probabilities for the system analysis task were integrated into the appropriate model. Because the models represented included both liquid and aerosol releases, only the event tree models representing potential aerosol release were further quantified (see Appendix B). However, for possible clean-up implications from liquid releases, these models were also quantified and included in Appendix B.

Quantification of the models of concern (i.e., aerosol) generated failure probabilities for all sequences represented. Both success and failure of HVAC were represented in the calculations (see Tables 5 and 6, respectively). As shown in Tables 5 and 6, the probabilities for release with HVAC failure are $\leq 2.8754\text{E-}07$; and with HVAC success, $\leq 5.3837\text{E-}05$. Source term estimates were also calculated during this task (see Table 7). These estimates were incorporated as initial conditions in the consequence analysis computer model.

The environment within the PREPP facility (e.g., pressures, temperatures, heat structures, and flow paths) was established in a transport model. The estimated releases and failures of each postulated accident sequence were incorporated as initial conditions of the facility. The transport model calculated the consequences or effects of each postulated accident sequence, for time 0 to 30 min.

In addition to the 12 required scenarios, two 'worst-case' models were also generated to reflect simultaneous failures within all areas--again, with HVAC success and failure. The results of these two models are provided as Figures 18 and 19. As illustrated in these two figures, the maximum source term that could reach the environment is 2 mg (see Figure 19). Because of this incredibly low amount, no offsite analysis was considered necessary. However, the data in these two figures and Appendix C provide valuable insight to potential onsite hazards that could be encountered with clean-up activities.

Figure 18. Consequence of postulated worst-case failure with HVAC success. (page 1 of 3)

Figure 18. Continued. (page 2 of 3)

Figure 18. Concluded. (page 3 of 3)

Figure 19. Consequence of postulated worst-case failure with HVAC failure. (page 1 of 3)

Figure 19. Continued. (page 2 of 3)

Figure 19. Concluded. (page 3 of 3)

7.0 CONCLUSIONS AND RECOMMENDATIONS

The results of this entire analysis effort were thoroughly examined for apparent and/or subtle safety/risk implications. One major assumption of this entire analysis effort was that the problem areas identified in the structural analyses (Refs. 2 and 3) would be corrected (i.e., the building would remain intact). Therefore, results from both structural and equipment/facility analyses are included in the following conclusions and (where appropriate) recommendations:

- (1) **TAN 607 Structure**—In the TAN 607 analysis, two areas were identified as presenting potential risk (see Section 3.2.1). The scope of the current modifications will be expanded to include design and implementation of solutions to these two areas of primary concern. One of two solutions could satisfy the east wall concern: add additional diagonal bracing to the upper portions of the wall or remove the bridge crane, whichever is most cost-beneficial. The solution to the concern with the truss in the north wall was the addition of diagonal bracing. Additional analysis of local areas of lesser concern will also be performed to ensure there will be no structural failures of the TAN 607 building which would be detrimental to the integrity of the PREPP structure housed within the building.
- (2) **PREPP Structure**—As mentioned above in Section 1.0, the PREPP structural analysis indicated that the PREPP building structure meets current design criteria with the exception of end connections on the lower level diagonal cross bracing between the support columns of the multilevel building walls. About seventy percent of these connections are directly accessible for rework and the remaining locations may be reworked with relatively little structural modifications. Accordingly, the scope of the current modifications will be expanded to adequately strengthen the indicated cross bracing end connections to make the building structure comply with current DOE design criteria.

- (3) **Confinement (equipment structures)**--The most common failure identified for the equipment within the PREPP facility involved the bolts and/or anchors supporting the equipment. Therefore, it is recommended that adequate and proper anchoring of all equipment be verified to ensure structural ruggedness of each of the confinements.

8.0 REFERENCES

1. General Design Criteria, DOE Order 6430.1A, Department of Energy, Washington, DC, April 1989.
2. Singh, J. N., Seismic Evaluation of Two Bays of TAN-607, EDF-PREPP-408, EG&G Idaho, Inc., Idaho Falls, ID, November 14, 1989.
3. Russell, M. J., Dynamic Seismic Analysis of the PREPP Building, EDF-PREPP-400, EG&G Idaho, Inc., Idaho Falls, ID, November 15, 1989.
4. Approach to the Quantification of Seismic Margins in Nuclear Power Plants, NUREG/CR-4334, Lawrence Livermore National Laboratory, Livermore, CA, August 1985.
5. "Seismic and Dynamic Analysis Methods," PVP-Vol. 81, presented at The 1984 Pressure Vessels and Piping Conference and Exhibition in San Antonio, TX, American Society of Mechanical Engineers, New York, NY, 1984.
6. Shieh, L. C., et al., Simplified Seismic Probabilistic Risk Assessment: Procedures and Limitations, NUREG/CR-4331, UCID-20468, Lawrence Livermore National Laboratory, Livermore, CA, August 1985.
7. Prassinis, P. G., M. K. Ravindra, and J. B. Savy, Recommendations to the Nuclear Regulatory Commission on Trial Guidelines for Seismic Margin Reviews of Nuclear Power Plants, DRAFT, NUREG/CR-4482, UCID-20579, Lawrence Livermore National Laboratory, Livermore, CA, March 1986.
9. Kimura, C. Y., and R. J. Budnitz, Evaluation of External Hazards to Nuclear Power Plants in the United States, NUREG/CR-5042, UCID-21223, Lawrence Livermore National Laboratory, Livermore, CA, December 1987.
10. Proceedings on Probabilistic Methods in Seismic Risk Assessment of Nuclear Power Plants, from Second CSNI Specialist Meeting held in Livermore, CA, USA, 16-18 May 1983, CSNI Report No. 76, Committee on the Safety of Nuclear Installations, Paris, France, 1983.
11. Budnitz, R. J., et al., An Approach to the Quantification of Seismic Margins in Nuclear Power Plants, NUREG/CR-4334, UCID-20444, Lawrence Livermore National Laboratory, Livermore, CA, August 1985.
12. Newmark, N. M. and W. J. Hall, Development of Criteria for Seismic Review of Selected Nuclear Power Plants, NUREG/CR-0098, N. M. Newmark Consulting Engineering Services, Urbana, IL, May 1978.

13. Coats, D. W., Recommended Revisions to Nuclear Regulatory Commission Seismic Design Criteria, NUREG/CR-1161, Lawrence Livermore Laboratory, Livermore, CA, May 1980.
14. A Methodology for Assessment of Nuclear Power Plant Seismic Margin, EPRI-NP-6041, Electric Power Research Institute, Palo Alto, CA, October 1988.
15. Garrick, B. John, Karl N. Fleming, and Alfred Torri, Seabrook Station Probabilistic Safety Assessment Technical Summary Report, PLG-0365, Pickard, Lowe and Garrick, Inc., Newport Beach, CA, June 1984.
16. Campbell, R. D., et al., Compilation of Fragility Information from Available Probabilistic Risk Assessments, UCID-20571, Lawrence Livermore National Laboratory, CA, September 1985.
17. Kennedy, R. P., et al., Subsystem Fragility, Seismic Safety Margins Research Program, Phase I, NUREG/CR-2405, UCRL-15407, Lawrence Livermore National Laboratory, Livermore, CA, February 1982.
18. Cover, L. E., et al., Handbook of Nuclear Power Plant Seismic Fragilities, Seismic Safety Margins Research Program, NUREG/CR-3558, UCRL-53455, Lawrence Livermore National Laboratory, Livermore, CA, June 1985.
19. Bandyopadhyay, K. K., et al., Seismic Fragility of Nuclear Power Plant Components, Phase II, NUREG/CR-3549, Vol. 2, Brookhaven National Laboratory, Long Island, NY, December 1987.
20. Smith, C. B. and K. L. Merz, Generic Seismic Ruggedness of Power Plant Equipment, NP-5223, ANCO Engineers, Inc., Culver City, CA, May 1987.
21. Probabilistic Risk Assessment (PRA) Reference Document, NUREG-1050, U.S. Nuclear Regulatory Commission, Washington, D.C., September 1984.
22. PRA Procedures Guide, NUREG/CR-2300, Vols. 1 and 2, U. S. Nuclear Regulatory Commission, Washington, D.C., January 1983.
23. Budnitz, Robert J., "Seismic PRA: Recent Developments in Methodology and Applications," Future Resources Associates, Inc., Berkeley, CA, 1989.
24. Shibata, H. and K. Abe, "Discussion of Seismic Risk Analysis Issues in Japan Raised by Recent Research at Jaeri," University of Tokyo and Japan Atomic Energy Research Institute, Japan, 1989.
25. Chen, J. T. and W. D. Beckher, "Severe Accident Policy Implementation External Events," U.S. Nuclear Regulatory Commission, Washington, D.C., 1989.
26. Wells, J. E., Reliability Data Required for a Seismic Risk Assessment, Lawrence Livermore National Laboratory, Livermore, CA.

27. Singh, Jag N., Seismic Evaluation of Process Experimental Pilot Plant, EG&G Idaho, Inc., Idaho Falls, ID, January 1989.
28. Preliminary PREPP Facility Probabilistic Safety (Risk) Assessment, Phase I Report, Rev. 0, EG&G Idaho, Inc., Idaho Falls, ID, January 1989.
29. "PREPP Phase I PRA Review Presentation," EG&G Idaho, Inc., Idaho Falls, ID, April 18, 1988.
30. Wilkins, D. E., Criticality Control Plan for the Process Experimental Pilot Plant (PREPP), Draft, EG&G Idaho, Inc., Idaho Falls, ID, January 15, 1986.
31. PREPP Operating Manual, Vol. I, EG&G Idaho, Inc., Idaho Falls, ID, 1988.
32. PREPP Operating Manual, Vol. II, EG&G Idaho, Inc., Idaho Falls, ID, 1988.
33. PREPP Operating Manual, Vol. III, EG&G Idaho, Inc., Idaho Falls, ID, 1988.
34. PREPP Operating Manual, Vol. IV, EG&G Idaho, Inc., Idaho Falls, ID, 1988.
35. Woods, W. D., Correspondence re: Job 5943--Process Experimental Pilot Plant Off-Gas Piping Analysis, HALS-52-84, The Ralph M. Parsons Company, Pasadena, CA, May 10, 1984.
36. Morton, D. K., PREPP Off-Gas System Stress Reanalysis, EDF-PREPP-149, EG&G Idaho, Inc., Idaho Falls, ID, December 20, 1984.
37. Miller, G. K., Stress Effects of Misalignment of the Quencher Vessel, EDF-PREPP-230, EG&G Idaho, Inc., Idaho Falls, ID, December 1, 1986.
38. Rahl, R. G., Feed System Stress Analysis on Lexan Window, EDF-PREPP-155, EG&G Idaho, Inc., Idaho Falls, ID, January 17, 1985.
39. Uldrich, E. D., Stress Analysis of PREPP Incinerator Discharge Conveyor, EDF-PREPP-116, EG&G Idaho, Inc., Idaho Falls, ID, September 11, 1984.
40. Gale, L., Report on Test Results for ATP's 19006 (poly), 19007 (PVC), 19008 (mixtures), 19015 (fiberglass & wood), and 19016 (paper), EDF-PREPP-348, EG&G Idaho, Inc., Idaho Falls, ID, January 10, 1989.
41. Langford, J. E., "Review of Feed System Operating System - JEL-9-89," Interoffice Correspondence, EG&G Idaho, Inc., Idaho Falls, ID, November 13, 1989.
42. Gale, L., Evaluation of the Off-Gas System Capacity, EDF-PREPP-383, EG&G Idaho, Inc., Idaho Falls, ID, August 30, 1989.

43. Stermer, D. and L. Gale, Report Documenting Results and Conclusions from the Quencher Droplet Test - ATP9312, EDF-PREPP-374, EG&G Idaho, Idaho Falls, ID, August 30, 1989.
44. Stermer, D. L., Report on the Off-Gas System Components Performance Test Results During ATP-9307, ATP-9310, ATP-9311, ATP-19013, and ATP-19018, EDF-PREPP-349, EG&G Idaho, Inc., Idaho Falls, ID, April 20, 1989.
45. Franz, W. A., "Process Experimental Pilot Plant (PREPP) NESHAP Application - WAF-71-89," Correspondence, EG&G Idaho, Inc., Idaho Falls, ID, September 28, 1989.
46. Kennedy, Robert P., et al., Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards, UCRL-15910, Draft, Lawrence Livermore National Laboratory, Livermore, CA, April 1988.
47. Miller, G. V., Floor Acceleration Response Spectra Generation for the PREPP Building, EDF-PREPP-406, EG&G Idaho, Inc., Idaho Falls, ID, January 15, 1990.
48. 49 CFR, Ch. 1, 178.109-11, 10-1-86.
49. Meeting with L. Gale, J. Langford, L. Ball, B. Meale, V. Lucero for determining assumptions, equipment characterization, and other deterministic information necessary for completing the analysis, held on 19 December 1989.
50. Notegram from L. J. Ball to Vickie Lucero, re: "Information Requested for PREPP seismic Consequence Analysis," December 14, 1989.
51. Gale, L., Informal written communication re: "Reasonable Estimate of Pu Content of the Scrub Solution," December 21, 1989.
52. Gale, L., Informal communication, December 1989.
53. Ball, L., Informal communication, January 15, 1990.
54. RISKMAN, PRA Workstation Software, developed by Pickard, Lowe, and Garrick, Inc., October 1989.
55. Draft Environmental Assessment for The Process Experimental Pilot Plant Idaho National Engineering Laboratory, Predecisional (DOE/EA), U.S. Department of Energy, Idaho Falls, ID, February 1990.
56. Wenzel, D. R., Radiological Safety Analysis Computer (RSAC) Program, Version 4.0, 1990.
57. MELCOR, computer modeling code, developed by Sandia National Laboratories, Albuquerque, NM, 1988.

APPENDIX A
COMPONENT FRAGILITY CURVES

Figure A-1. Feed conveyor fragility curve.

Figure A-2. Kiln fragility curve.

Figure A-3. Off-gas vessels fragility curve.

Figure A-4. Surge Recycle Tank fragility curve.

Figure A-5. Sludge tank fragility curve.

Figure A-6. Sludge tank pump fragility curve.

Figure A-7. Surge recycle and emergency drain tanks fragility curve.

Figure A-8. Discharge conveyor fragility curve.

Figure A-9. Trommel hopper fragility curve.

Figure A-10. Fines hoppers and blenders fragility curve.

Figure A-11. Grout mixer fragility curve.

APPENDIX B
AREA EVENT TREES

SEISMIC INITIATING EVENT	FEED CONVEYOR ENCLOSURE	KILN & SECONDARY COMBUSTION CHAMBER	SEQUENCE PROBABILITY
IE	FC	KL	
1.0E-3		9.9976E-1	9.9623E-4
		9.9647E-1	
		2.4E-4	2.3915E-7
		9.9976E-1	3.5292E-6
		3.53E-3	
		2.4E-4	8.472E-10

Figure B-1. Area 1 (feed) event tree.

SEISMIC INITIATING EVENT	WET QUENCHER	OFF-GAS VESSELS	SEQUENCE PROBABILITY
IE	WQ	OG	
1.0E-3		9.9977E-1	9.3822E-4
		2.33E-4	2.1866E-7
		9.9977E-1	6.1546E-5
		2.33E-4	1.4343E-8

Figure B-2. Area 2 (off-gas) event tree.

Figure B-3. Area 3 (liquid) event tree. (page 1 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	7.6552E-4
			9.389E-1		
				8.7E-4	6.6658E-7
		9.9913E-1		9.9913E-1	4.9817E-5
			6.11E-2		
				8.7E-4	4.3379E-8
	9.389E-1			9.9913E-1	6.6658E-7
			9.389E-1		
				8.7E-4	5.8043E-10
		8.7E-4		9.9913E-1	4.3379E-8
			6.11E-2		
				8.7E-4	3.7772E-11
				9.9913E-1	4.9817E-5
			9.389E-1		
				8.7E-4	4.3379E-8
		9.9913E-1		9.9913E-1	3.2419E-6
			6.11E-2		
				8.7E-4	2.8229E-9
	6.11E-2			9.9913E-1	4.3379E-8
			9.389E-1		
				8.7E-4	3.7772E-11
		8.7E-4		9.9913E-1	2.8229E-9
			6.11E-2		
				8.7E-4	2.4581E-12

Figure B-3. Continued. (page 2 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	1.8377E-7
			9.389E-1		
				8.7E-4	1.6002E-10
		9.9913E-1		9.9913E-1	1.1959E-8
			6.11E-2		
				8.7E-4	1.0413E-11
	9.389E-1			9.9913E-1	1.6002E-10
			9.389E-1		
				8.7E-4	1.3934E-13
		8.7E-4		9.9913E-1	1.0413E-11
			6.11E-2		
				8.7E-4	9.0675E-15
				9.9913E-1	1.1959E-8
			9.389E-1		
				8.7E-4	1.0413E-11
		9.9913E-1		9.9913E-1	7.7824E-10
			6.11E-2		
				8.7E-4	6.7766E-13
	6.11E-2			9.9913E-1	1.0413E-11
			9.389E-1		
				8.7E-4	9.0675E-15
		8.7E-4		9.9913E-1	6.7766E-13
			6.11E-2		
				8.7E-4	5.9008E-16

Figure B-3. Continued. (page 3 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GRDUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	4.9817E-5
			9.389E-1		
				8.7E-4	4.3379E-8
		9.9913E-1		9.9913E-1	3.2419E-6
			6.11E-2		
				8.7E-4	2.8229E-9
	9.389E-1			9.9913E-1	4.3379E-8
			9.389E-1		
				8.7E-4	3.7772E-11
		8.7E-4		9.9913E-1	2.8229E-9
			6.11E-2		
				8.7E-4	2.4581E-12
				9.9913E-1	3.2419E-6
			9.389E-1		
				8.7E-4	2.8229E-9
		9.9913E-1		9.9913E-1	2.1097E-7
			6.11E-2		
				8.7E-4	1.8370E-10
	6.11E-2			9.9913E-1	2.8229E-9
			9.389E-1		
				8.7E-4	2.4581E-12
		8.7E-4		9.9913E-1	1.8370E-10
			6.11E-2		
				8.7E-4	1.5996E-13

Figure B-3. Continued. (page 4 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	1.1959E-8
			9.389E-1	8.7E-4	1.0413E-11
		9.9913E-1	6.11E-2	9.9913E-1	7.7824E-10
				8.7E-4	6.7766E-13
	9.389E-1			9.9913E-1	1.0413E-11
			9.389E-1	8.7E-4	9.0675E-15
		8.7E-4	6.11E-2	9.9913E-1	6.7766E-13
				8.7E-4	5.9008E-16
				9.9913E-1	7.7824E-10
			9.389E-1	8.7E-4	6.7766E-13
		9.9913E-1	6.11E-2	9.9913E-1	5.0645E-11
				8.7E-4	4.4100E-14
	6.11E-2			9.9913E-1	6.7766E-13
			9.389E-1	8.7E-4	5.9008E-16
		8.7E-4	6.11E-2	9.9913E-1	4.4100E-14
				8.7E-4	3.8400E-17

Figure B-3. Continued. (page 5 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	4.9817E-5
			9.389E-1		
				8.7E-4	4.3379E-8
		9.9913E-1		9.9913E-1	3.2419E-6
			6.11E-2		
				8.7E-4	2.8229E-9
	9.389E-1			9.9913E-1	4.3379E-8
			9.389E-1		
				8.7E-4	3.7772E-11
		8.7E-4		9.9913E-1	2.8229E-9
			6.11E-2		
				8.7E-4	2.4581E-12
				9.9913E-1	3.2419E-6
			9.389E-1		
				8.7E-4	2.8229E-9
		9.9913E-1		9.9913E-1	2.1037E-7
			6.11E-2		
	6.11E-2			8.7E-4	1.8370E-10
				9.9913E-1	2.8229E-9
			9.389E-1		
				8.7E-4	2.4581E-12
		8.7E-4		9.9913E-1	1.8370E-10
			6.11E-2		
				8.7E-4	1.5996E-13

Figure B-3. Continued. (page 6 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	1.1959E-8
			9.389E-1		
				8.7E-4	1.0413E-11
		9.9913E-1		9.9913E-1	7.7824E-10
			6.11E-2		
				8.7E-4	6.7766E-13
	9.389E-1			9.9913E-1	1.0413E-11
			9.389E-1		
				8.7E-4	9.0675E-15
		8.7E-4		9.9913E-1	6.7766E-13
			6.11E-2		
				8.7E-4	5.9008E-16
				9.9913E-1	7.7824E-10
			9.389E-1		
				8.7E-4	6.7766E-13
		9.9913E-1		9.9913E-1	5.0645E-11
			6.11E-2		
				8.7E-4	4.4100E-14
	6.11E-2			9.9913E-1	6.7766E-13
			9.389E-1		
				8.7E-4	5.9008E-16
		8.7E-4		9.9913E-1	4.4100E-14
			6.11E-2		
				8.7E-4	3.8400E-17

Figure B-3. Continued. (page 7 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	3.2419E-6
			9.389E-1		
				8.7E-4	2.8229E-9
		9.9913E-1		9.9913E-1	2.1097E-7
			6.11E-2		
				8.7E-4	1.8370E-10
	9.389E-1			9.9913E-1	2.8229E-9
			9.389E-1		
				8.7E-4	2.4581E-12
		8.7E-4		9.9913E-1	1.8370E-10
			6.11E-2		
				8.7E-4	1.5996E-13
				9.9913E-1	2.1097E-7
			9.389E-1		
				8.7E-4	1.8370E-10
		9.9913E-1		9.9913E-1	1.3729E-8
			6.11E-2		
				8.7E-4	1.1955E-11
	6.11E-2			9.9913E-1	1.8370E-10
			9.389E-1		
				8.7E-4	1.5996E-13
		8.7E-4		9.9913E-1	1.1955E-11
			6.11E-2		
				8.7E-4	1.0410E-14

Figure B-3. Continued. (page 8 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	7.7824E-10
			9.389E-1		
				8.7E-4	6.7766E-13
		9.9913E-1		9.9913E-1	5.0645E-11
			6.11E-2		
				8.7E-4	4.4100E-14
	9.389E-1			9.9913E-1	6.7766E-13
			9.389E-1		
				8.7E-4	5.9008E-16
		8.7E-4		9.9913E-1	4.4100E-14
			6.11E-2		
				8.7E-4	3.8400E-17
				9.9913E-1	5.0645E-11
			9.389E-1		
				8.7E-4	4.4100E-14
		9.9913E-1		9.9913E-1	3.2958E-12
			6.11E-2		
				8.7E-4	2.8698E-15
	6.11E-2			9.9913E-1	4.4100E-14
			9.389E-1		
				8.7E-4	3.8400E-17
		8.7E-4		9.9913E-1	2.8698E-15
			6.11E-2		
				8.7E-4	2.4989E-18

Figure B-3. Continued. (page 9 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	1.0044E-5
			9.389E-1		
				8.7E-4	8.7455E-9
		9.9913E-1		9.9913E-1	6.5360E-7
			6.11E-2		
				8.7E-4	5.6912E-10
	9.389E-1			9.9913E-1	8.7455E-9
			9.389E-1		
				8.7E-4	7.6152E-12
		8.7E-4		9.9913E-1	5.6912E-10
			6.11E-2		
				8.7E-4	4.9557E-13
				9.9913E-1	6.5360E-7
			9.389E-1		
				8.7E-4	5.6912E-10
		9.9913E-1		9.9913E-1	4.2533E-8
			6.11E-2		
				8.7E-4	3.7036E-11
	6.11E-2			9.9913E-1	5.6912E-10
			9.389E-1		
				8.7E-4	4.9557E-13
		8.7E-4		9.9913E-1	3.7036E-11
			6.11E-2		
				8.7E-4	3.2250E-14

Figure B-3. Continued. (page 10 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROIJT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	2.4110E-9
			9.389E-1		
				8.7E-4	2.0994E-12
		9.9913E-1		9.9913E-1	1.5690E-10
			6.11E-2		
				8.7E-4	1.3662E-13
				9.9913E-1	2.0994E-12
	9.389E-1		9.389E-1		
				8.7E-4	1.8281E-15
		8.7E-4		9.9913E-1	1.3662E-13
			6.11E-2		
				8.7E-4	1.1896E-16
				9.9913E-1	1.5690E-10
			9.389E-1		
				8.7E-4	1.3662E-13
		9.9913E-1		9.9913E-1	1.0210E-11
			6.11E-2		
				8.7E-4	8.8909E-15
				9.9913E-1	1.3662E-13
	6.11E-2		9.389E-1		
				8.7E-4	1.1896E-16
		8.7E-4		9.9913E-1	8.8909E-15
			6.11E-2		
				8.7E-4	7.7418E-18

Figure B-3. Continued. (page 11 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	6.5360E-7
			9.389E-1		
				8.7E-4	5.6912E-10
		9.9913E-1		9.9913E-1	4.2533E-8
			6.11E-2		
				8.7E-4	3.7036E-11
				9.9913E-1	5.6912E-10
	9.389E-1		9.389E-1		
				8.7E-4	4.9557E-13
		8.7E-4		9.9913E-1	3.7036E-11
			6.11E-2		
				8.7E-4	3.2250E-14
				9.9913E-1	4.2533E-8
			9.389E-1		
				8.7E-4	3.7036E-11
		9.9913E-1		9.9913E-1	2.7679E-9
			6.11E-2		
				8.7E-4	2.4102E-12
	6.11E-2			9.9913E-1	3.7036E-11
			9.389E-1		
				8.7E-4	3.2250E-14
		8.7E-4		9.9913E-1	2.4102E-12
			6.11E-2		
				8.7E-4	2.0987E-15

Figure B-3. Continued. (page 12 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	1.5690E-10
			9.389E-1		
				8.7E-4	1.3662E-13
		9.9913E-1		9.9913E-1	1.0210E-11
			6.11E-2		
				8.7E-4	8.8909E-15
	9.389E-1			9.9913E-1	1.3662E-13
			9.389E-1		
				8.7E-4	1.1896E-16
		8.7E-4		9.9913E-1	8.8909E-15
			6.11E-2		
				8.7E-4	7.7418E-18
				9.9913E-1	1.0210E-11
			9.389E-1		
				8.7E-4	8.8909E-15
		9.9913E-1		9.9913E-1	6.6446E-13
			6.11E-2		
				8.7E-4	5.7858E-16
	6.11E-2			9.9913E-1	8.8909E-15
			9.389E-1		
				8.7E-4	7.7418E-18
		8.7E-4		9.9913E-1	5.7858E-16
			6.11E-2		
				8.7E-4	5.0381E-19

Figure B-3. Continued. (page 13 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	6.5360E-7
			9.389E-1		
				8.7E-4	5.6912E-10
		9.9913E-1		9.9913E-1	4.2533E-8
			6.11E-2		
				8.7E-4	3.7036E-11
	9.389E-1			9.9913E-1	5.6912E-10
			9.389E-1		
				8.7E-4	4.9557E-13
		8.7E-4		9.9913E-1	3.7036E-11
			6.11E-2		
				8.7E-4	3.2250E-14
				9.9913E-1	4.2533E-8
			9.389E-1		
				8.7E-4	3.7036E-11
		9.9913E-1		9.9913E-1	2.7679E-9
			6.11E-2		
				8.7E-4	2.4102E-12
	6.11E-2			9.9913E-1	3.7036E-11
			9.389E-1		
				8.7E-4	3.2250E-14
		8.7E-4		9.9913E-1	2.4102E-12
			6.11E-2		
				8.7E-4	2.0987E-15

Figure B-3. Continued. (page 14 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	1.5690E-10
			9.389E-1		
				8.7E-4	1.3662E-13
		9.9913E-1		9.9913E-1	1.0210E-11
			6.11E-2		
				8.7E-4	8.8909E-15
	9.389E-1			9.9913E-1	1.3662E-13
			9.389E-1		
				8.7E-4	1.1896E-16
		8.7E-4		9.9913E-1	8.8909E-15
			6.11E-2		
				8.7E-4	7.7418E-18
				9.9913E-1	1.0210E-11
			9.389E-1		
				8.7E-4	8.8909E-15
		9.9913E-1		9.9913E-1	6.6446E-13
			6.11E-2		
				8.7E-4	5.7858E-16
	6.11E-2			9.9913E-1	8.8909E-15
			9.389E-1		
				8.7E-4	7.7418E-18
		8.7E-4		9.9913E-1	5.7858E-16
			6.11E-2		
				8.7E-4	5.0381E-19

Figure B-3. Continued. (page 15 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	4.2533E-8
			9.389E-1		
				8.7E-4	3.7036E-11
		9.9913E-1		9.9913E-1	2.7679E-9
			6.11E-2		
				8.7E-4	2.4102E-12
				9.9913E-1	3.7036E-11
	9.389E-1		9.389E-1		
		8.7E-4		8.7E-4	3.2250E-14
				9.9913E-1	2.4102E-12
			6.11E-2		
				8.7E-4	2.0987E-15
				9.9913E-1	2.7679E-9
			9.389E-1		
		9.9913E-1		8.7E-4	2.4102E-12
				9.9913E-1	1.8013E-10
			6.11E-2		
				8.7E-4	1.5685E-13
	6.11E-2			9.9913E-1	2.4102E-12
			9.389E-1		
		8.7E-4		8.7E-4	2.0987E-15
				9.9913E-1	1.5683E-13
			6.11E-2		
				8.7E-4	1.3657E-16

Figure B-3. Continued. (page 16 of 17)

TRANSFERRED FROM PAGE B-4	SLUDGE TANK IN SPARGING STATE	SLUDGE PUMP FOR S2	SLUDGE TANK SUPPLYING LIQUID FOR GROUT	SLUDGE PUMP FOR S3	SEQUENCE PROBABILITY
	S2	P2	S3	P3	
				9.9913E-1	1.0210E-11
			9.389E-1		
				8.7E-4	8.8909E-15
		9.9913E-1		9.9913E-1	6.6446E-13
			6.11E-2		
				8.7E-4	5.7858E-16
	9.389E-1			9.9913E-1	8.8909E-15
			9.389E-1		
				8.7E-4	7.7418E-18
		8.7E-4		9.9913E-1	5.7858E-16
			6.11E-2		
				8.7E-4	5.0381E-19
				9.9913E-1	6.6446E-13
			9.389E-1		
				8.7E-4	5.7858E-16
		9.9913E-1		9.9913E-1	4.3240E-14
			6.11E-2		
	6.11E-2			8.7E-4	3.7652E-17
				9.9913E-1	5.7858E-16
			9.389E-1		
				8.7E-4	5.0381E-19
		8.7E-4		9.9913E-1	3.7652E-17
			6.11E-2		
				8.7E-4	3.2786E-20

Figure B-3. Continued. (page 17 of 17)

SEISMIC INITIATING EVENT	DISCHARGE CONVEYOR	SEQUENCE PROBABILITY
IE	V4	
	9.976E-1	9.976E-4
1.0E-3		
	2.4E-3	2.4E-6

Figure B-4. Area 4 (solid) event tree.

SEISMIC INITIATING EVENT	TROMMEL HOPPER	FINES BLENDER TANK (INPUT)	FINES BLENDER TANK (OUTPUT)	FINES WEIGH TANK	SEQUENCE PROBABILITY
IE	TH	T3	T4	T5	
1.0E-3	9.8705E-1	9.9996E-1	9.9996E-1	9.8E-1	9.6723E-4
				2.0E-2	1.9739E-5
			4.34E-5	9.8E-1	4.1979E-8
				2.0E-2	8.5672E-10
		4.34E-5	9.9996E-1	9.8E-1	4.1979E-8
				2.0E-2	8.5672E-10
			4.34E-5	9.8E-1	1.8220E-12
				2.0E-2	3.7183E-14
	1.295E-2	9.9996E-1	9.9996E-1	9.8E-1	1.2690E-5
				2.0E-2	2.5898E-7
			4.34E-5	9.8E-1	5.5077E-10
				2.0E-2	1.1240E-11
		4.34E-5	9.9996E-1	9.8E-1	5.5077E-10
				2.0E-2	1.1240E-11
			4.34E-5	9.8E-1	2.3904E-14
				2.0E-2	4.8784E-16

Figure B-5. Area 5 (fines) event tree.

SEISMIC INITIATING EVENT	DRUM BEING FILLED	SEQUENCE PROBABILITY
IE	D1	
	9.999E-1	9.999E-4
1.0E-3		
	1.0E-4	1.0E-7

Figure B-6. Area 6 (filling) event tree.

SEISMIC INITIATING EVENT	GROUT MIXER	SEQUENCE PROBABILITY
IE	MX	
1.0E-3	9.9929E-1	9.9929E-4
	7.1E-4	7.1E-7

Figure B-7. Area 7 (mixing) event tree.

SEISMIC INITIATING EVENT	GROUTED DRUM	SEQUENCE PROBABILITY
IE	D2	
	9.83E-1	9.83E-4
1.0E-3		
	1.7E-2	1.7E-5

Figure B-8. Area 8 (curing) event tree.

SEISMIC INITIATING EVENT	HVAC SYSTEM	SEQUENCE PROBABILITY
IE	B1	
	9.1E-1	9.1E-4
1.0E-3		
	9.0E-2	9.0E-5

Figure B-9. Area 9 (HVAC) event tree.

APPENDIX C
TRANSPORT DATA PLOTS

Figure C-1. Consequences of quencher failure with HVAC success. (page 1 of 3)

Figure C-1. Continued. (page 2 of 3)

Figure C-1. Concluded. (page 3 of 3)

Figure C-2. Consequences of weigh tank failure with HVAC success. (page 1 of 3)

Figure C-2. Continued. (page 2 of 3)

Figure C-2. Concluded. (page 3 of 3)

Figure C-3. Consequences of trommel hopper failure with HVAC success. (page 1 of 3)

Figure C-3. Continued. (page 2 of 3)

Figure C-3. Concluded. (page 3 of 3)

Figure C-4. Consequences of feed enclosure failure with HVAC success. (page 1 of 3)

Figure C-4. Continued. (page 2 of 3)

Figure C-4. Concluded. (page 3 of 3)

Figure C-5. Consequences of discharge conveyor failure with HVAC success. (page 1 of 3)

Figure C-5. Continued. (page 2 of 3)

Figure C-5. Concluded. (page 3 of 3)

Figure C-6. Consequences of quencher and weigh tank failure with HVAC success. (page 1 of 3)

Figure C-6. Continued. (page 2 of 3)

Figure C-6. Concluded. (page 3 of 3)

Figure C-7. Consequences of quencher failure with HVAC failure. (page 1 of 3)

Figure C-7. Continued. (page 2 of 3)

Figure C-7. Concluded. (page 3 of 3)

Figure C-8. Consequences of welgh tank failure with HVAC failure. (page 1 of 3)

Figure C-8. Continued. (page 2 of 3)

Figure C-8. Concluded. (page 3 of 3)

Figure C-9. Consequences of trommel hopper failure with HVAC failure. (page 1 of 3)

Figure C-9. Continued. (page 2 of 3)

Figure C-9. Concluded. (page 3 of 3)

Figure C-10. Consequences of feed enclosure failure with HVAC failure. (page 1 of 3)

Figure C-10. Continued. (page 2 of 3)

Figure C-10. Concluded. (page 3 of 3)

Figure C-11. Consequences of discharge conveyor failure with HVAC failure. (page 1 of 3)

Figure C-11. Continued. (page 2 of 3)

Figure C-11. Concluded. (page 3 of 3)

Figure C-12. Consequences of quencher and weigh tank failure with HVAC failure. (page 1 of 3)

Figure C-12. Continued. (page 2 of 3)

Figure C-12. Concluded. (page 3 of 3)

END

DATE FILMED

02 / 26 / 91