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FAULT TREE ANALYSIS OF PROJECT S-4404, UPGRADE CANYON EXHAUST SYSTEM (U)

by E. V. Brown^e

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

Other Authors:

J. M. Low
(WSRC)
C. R. Lux
(WSRC)

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Westinghouse
Savannah River Company

P.O. Box 616
Aiken, SC 29802

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TO: H.S. Chaudhry
Program Control & Integration
704-F

FROM: E.V. Browne, *ab smd.* J.M. Low, C.R. Lux
Nuclear Processes Safety Research
992W-1, Centennial Corporate Center

Fault Tree Analysis of Project S-4404,
Upgrade Canyon Exhaust Systems(U)

INTRODUCTION:

Project S-4404, Upgrade Canyon Exhaust Systems, is a \$177 million project with the purpose of upgrading the Exhaust Systems for both F and H Canyon Facilities. This upgrade will replace major portions of the F and H-Canyon exhaust systems, downstream of their respective sand filters with higher capacity and more reliable systems. Because of the high cost, DOE requested Program Control & Integration (PC&I) to examine specific deletions to the project. PC&I requested Nuclear Processes Safety Research (NPSR) to perform an analysis to compare failure rates for the existing F & H Canyon exhaust systems with the proposed exhaust system and specific proposed exhaust system alternatives.

SUMMARY:

Fault tree analysis was used to determine and compare the failure rates (frequency) of the existing F & H Area exhaust systems with the proposed exhaust system and specific proposed exhaust system alternatives. The failure rate for each existing canyon exhaust system is about 2.7×10^{-6} per hour, or once every 42 years. The dominant failure mode for this scenario is failure of the [REDACTED] at a 0.04 g earthquake and pluggage of the [REDACTED] exhaust system. The failure rate for each proposed canyon exhaust system is 2.7×10^{-8} per hour, or once every 4200 years. The dominant failure mode in this scenario is failure of both [REDACTED] and [REDACTED]. This scenario assumes that the system is designed to withstand a [REDACTED]

Design Basis Earthquake (0.2 g). The fault tree does not consider a beyond design basis earthquake. One of the alternatives that NPSR was requested to evaluate was deletion of the decontamination and decommissioning (D&D) activities. NPSR demonstrated through fault tree analysis that D&D activities could be eliminated from the project with no significant decrease to overall system safety and result in a project cost savings of about \$29 million.

DISCUSSION:

Background:

Project S-4404, Upgrade Canyon Exhaust Systems, is a \$177 million project with the purpose of upgrading the F and H Canyon Exhaust Systems. The project will replace major portions of the F and H Canyon Exhaust Systems, downstream of their respective sand filters with higher capability and more reliable systems. The exhaust systems will be designed and constructed to withstand all Design Basis Accidents (DBAs). Because of the high cost, DOE identified project alternatives and requested Programs Control and Integration (PC&I) of the Separations Department to prepare a cost benefit analysis. The list of project alternatives identified by PC&I is shown in Table 1. PC&I requested NPSR to evaluate alternatives 1 and 5 using fault tree analysis to determine the effect of each alternative on overall system safety.

In the existing exhaust system, exhaust air leaves the canyon through [REDACTED]. This [REDACTED] leads to the underground sand filters. The exhaust air is pulled through the sand filters by four fans in Buildings 292- F & H. Three of these units are normally in operation and the remaining unit is on stand-by. The stand-by unit comes on if the vacuum drops below a preset level. The filtered exhaust air is discharged to Buildings 291- F & H exhaust stacks. Stand-by power from a 600 kW diesel generator in Building 292- F & H is available to three of the canyon exhaust fans. In addition, two of the fans are served by dedicated diesel generators. The project will replace the existing exhaust system with a new safety class exhaust system.

Methodology:

This work was performed using fault tree analysis techniques and the Computer Aided Fault Tree Analysis (CAFTA) Program. Fault tree analysis provides a structured method for evaluation of failure modes and sequences in a system through the use of a logic model describing system operation. System failure modes are identified by a deductive reasoning process which uses process and operations information to formulate possible failure scenarios leading to the occurrence of the undesired top event. Credible failure modes are logically incorporated into the fault tree for qualitative and quantitative evaluation. System failure requires the occurrence of initiating and enabling events, and these constitute the basic elements of the fault tree model. An

[REDACTED]

initiating event must occur in order to begin the failure sequence. Enabling events are those events which allow the failure sequence to continue to the top event.

In this analysis, some of the operating systems, such as fans 1, 2, and 4, are considered operating redundant systems. These systems are treated as initiator/enablers because any individual fan can initiate or enable the accident. For example, one accident scenario could be failure of fan 1 with subsequent failure of fans 2, 3, and 4. A similar scenario could be failure of fan 2 with subsequent failure of fans 1, 3, and 4. The CAFTA cutset editor, "CSRAM", allows the fans to be treated as initiators/enablers and adequately quantifies these scenarios.

The fault tree logic model for this study was developed by reviewing the H-Canyon exhaust system fault tree in the H-Canyon Systems Analysis and through discussions with Hafeez Chaudhry of PC&I. The top event for the analysis was identified as "Exhaust System Failure". Exhaust system failure is defined as the failure or loss of all four exhaust fans. Initiating events for the fault tree included 1) stack collapse by earthquake, 2) stack collapse by tornado, 3) [REDACTED] collapse, and 4) electrical or mechanical failures which cause the first exhaust fan to fail. The first three initiating events are common cause failure events, i.e. the occurrence of any one of these events could cause failure of the entire exhaust system. The fourth set of initiating events includes loss of utility power, loss of transformer, tie-breaker fails open, fan bearing failure, etc.

Enabling events for the fault tree include those basic events which would allow a second, third, and fourth fan to fail. These events are similar to the fourth set of initiating events. The difference is that initiating events are reported in terms of frequency (rate of failure) and enabling events are reported in terms probability (unavailability, unreliability, and/or undependability). Therefore, enabling events report the probability that a fan will fail to start or fail to continue running.

Analysis:

This analysis assumes that the existing canyon exhaust systems are similar in design and construction. The failure rates for an existing canyon exhaust system, the proposed canyon exhaust system, and the project alternatives 1 and 5 are summarized in Table 2. The failure rate for an existing canyon exhaust system is estimated to be about 2.7×10^{-6} per hour, or once every 42 years.¹ The dominant failure mode for this scenario is failure of the [REDACTED] at a 0.04 g earthquake and plugage of the [REDACTED] exhaust system. The failure rate for each proposed canyon exhaust system is 2.7×10^{-8} per hour, or once every 4200 years. The dominant failure mode in this scenario is failure of both [REDACTED] and [REDACTED]. This scenario assumes that the system is

[REDACTED]

designed to withstand a Design Basis Earthquake (0.2 g). The fault tree does not consider a beyond design basis earthquake. This fault tree is shown in Appendix A.

The first alternative that NPSR was requested to evaluate was deletion of the decontamination and decommissioning (D&D) activities. (Case 1, Table 1). D & D activities include removal of the existing fan building and stack. Failure of the fan building would not be expected to impact the proposed facilities. However, failure of the stack could have a significant impact. The failure rate for each proposed canyon exhaust system, including the deletion of D & D activities, is also estimated to be 2.7×10^{-8} per hour. Beyond design basis earthquakes are not considered as part of this analysis. Failure of the existing stack does not appear as a failure mode in the fault tree because 1) it is assumed that the existing stack withstands a 0.2g earthquake and 2) the location of the existing stack relative to the proposed facilities minimizes any interaction. Based on this fault tree, D & D activities could be eliminated from the project with no significant decrease to exhaust system safety. Deletion of D & D activities would result in a cost savings of \$29 million. Therefore, the fault tree in Appendix A can also be used for this alternative.

The second alternative NPSR was requested to evaluate was deletion of DOE Order 6430.1A requirements regarding Design Basis Accidents (Case 5, Table 1). The failure rate for each proposed canyon exhaust system assuming deletion of DOE Order 6430.1A design requirements regarding DBAs is estimated to be 3.2×10^{-7} per hour, or once every 350 years. For this scenario the fault tree assumes that the proposed exhaust system is designed and constructed using standard engineering practices and codes. Based on this assumption the proposed exhaust system will fail at a 0.1 g earthquake. This fault tree demonstrates that exhaust system safety would be decreased by a factor of 12 if the project were not designed to withstand DBAs. The fault tree for this alternative is provided in Appendix B. Results of the fault tree analysis are summarized in Table 2.

If the exhaust system failure is the only accident scenario considered, areas within the canyon building will experience static air flow and/or air reversals. Static conditions keep most radioactive material contained within the facility, and results in no significant releases. Air reversals are considered low energy events whose consequences are contained within the facility. The consequences of air reversals include building contamination, worker contamination, and worker assimilation. There are accident scenarios which could cause the canyon to become pressurized and result in unfiltered releases of radionuclides. These accident scenarios include a major fire or an uncontrolled reaction and are classified as medium energetic events. Calculation of individual frequencies and consequences of an exhaust system failure and a

coincident medium energetic event is outside the scope of this analysis.

Conclusions:

The objective of this work was to perform an analysis and compare failure rates for the existing F & H Canyon exhaust systems with the proposed project exhaust system and proposed project alternatives. Based on fault tree analysis, two conclusions are made. First, D & D activities can be eliminated from the project with no significant decrease to exhaust system safety. Deletion of D & D activities would result in a cost savings of \$29 million. Second, deletion of DO. Order 6430.1A requirements regarding DBAs would decrease exhaust system safety by a factor of 12.

[REDACTED]

REFERENCES

1. Safety Analysis - 200 Area, Savannah River Site, F-Canyon Operations, Chapter 9, Analysis of Operations, Volume 10, SRS Comment DRAFT issued May, 1992.
2. Seismic and Tornado Analyses of Related Structures for Building 221-H at the Savannah River Plant, Aiken, South Carolina, EDAC-253-030.01, Aiken, SC, October 30, 1981.

Table 1
Baseline Alternatives
Project S-4404, Upgrade Canyon Exhaust Systems (F&H)

		Cost
Current Project Baseline		\$177.0M
Description of Alternative	Comments	Savings
1. Delete Decontamination and Decommissioning. (F&H)	Abandon in place low level contaminated equipment and structures. Requires waiver from DOE Order 6430.1A.	\$29.2M
2. Delete and Waiver Safeguards and Security Features. (F&H) - PIDAS around fan building (\$18.5M) - Access controls for fan building [REDACTED] (\$2.0M)	Requires waiver from DOE Order 6430.1A.	\$23.2M
3. Delete Process Vessel Vent Contamination Building. (F Only)	Potential for environmental release. No waivers required.	\$ 6.2M
4. Delete 5th Fan Room. (F&H)	No future capacity increase capability. No waivers required.	\$ 0.5M
5. Delete DOE Order 6430.1A Design Basis Accident (DBA) Requirements. (F&H) - Fan building. (\$18.0M) - Diesel storage tanks. (\$6.0M)	Facilities will be susceptible to (DBAs), in particular; - earthquake - tornado - fire Requires waiver from DOE Order 6430.1A.	\$19.0M
6. Schedule for review cycles shortened by one year. (F&H)	Requires waiver from DOE Order 4700.	\$ 4.0M

TABLE 2

System	Rate of Failure (return interval)	Comments
Current	2.7×10^{-6} /hour (every 42 years)	The fault tree is based on the H-Canyon Systems Analysis. This scenario assumes that the [REDACTED] fails at a 0.04 g earthquake and plugs ~~the exhaust system~~
Baseline Case	2.7×10^{-8} /hour (every 4200 years)	This fault tree is based on the system description provided by Hafeez Chaudhry of PC&I. This scenario assumes that the system is designed to withstand 0.2 g (DBE) earthquake. The frequency of a beyond DBE is estimated to be 2.1×10^{-8} /hr. The fault tree does not consider a beyond design basis earthquake.
Alternative Case 1	2.7×10^{-8} /hour (every 4200 years)	Delete Decontamination and Decommission Only. This scenario assumes that the existing stack withstands a 0.2 g (DBE) earthquake. This assumption is based on EDAC analysis. Fault tree does not consider a beyond design basis earthquake. The frequency of a beyond DBE is estimated to be 2.1×10^{-8} /hr. If a beyond DBE occurs, the new exhaust system and the existing stack are assumed to fail.
Alternative Case 5	3.2×10^{-7} /hour (every 350 years)	Delete DOE Order 6430.1A requirements regarding DBAs. This scenario assumes that the exhaust system fails at 0.1 g earthquake.

APPENDIX A

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Gate/Event Name	Page	Gate/Event Name	Page	Gate/Event Name	Page	Gate/Event Name	Page
[REDACTED]	10	[REDACTED]	3	[REDACTED]	6	[REDACTED]	17
[REDACTED]	10	[REDACTED]	2	[REDACTED]	15	[REDACTED]	11
[REDACTED]	16	[REDACTED]	8	[REDACTED]	15	[REDACTED]	12
[REDACTED]	16	[REDACTED]	13	[REDACTED]	6	[REDACTED]	17
[REDACTED]	6	[REDACTED]	2	[REDACTED]	15	[REDACTED]	18
[REDACTED]	15	[REDACTED]	13	[REDACTED]	6	[REDACTED]	10
[REDACTED]	10	[REDACTED]	3	[REDACTED]	15	[REDACTED]	10
[REDACTED]	11	[REDACTED]	7	[REDACTED]	15	[REDACTED]	16
[REDACTED]	10	[REDACTED]	15	[REDACTED]	6	[REDACTED]	16
[REDACTED]	12	[REDACTED]	3	[REDACTED]	6	[REDACTED]	11
[REDACTED]	16	[REDACTED]	7	[REDACTED]	15	[REDACTED]	12
[REDACTED]	17	[REDACTED]	14	[REDACTED]	6	[REDACTED]	17
[REDACTED]	16	[REDACTED]	5	[REDACTED]	15	[REDACTED]	18
[REDACTED]	18	[REDACTED]	6	[REDACTED]	6		
[REDACTED]	1	[REDACTED]	3	[REDACTED]	16		
[REDACTED]	2	[REDACTED]	5	[REDACTED]	2		
[REDACTED]	1	[REDACTED]	14	[REDACTED]	4		
[REDACTED]	2	[REDACTED]	2	[REDACTED]	4		
[REDACTED]	13	[REDACTED]	9	[REDACTED]	13		
[REDACTED]	2	[REDACTED]	13	[REDACTED]	2		
[REDACTED]	10	[REDACTED]	2	[REDACTED]	4		
[REDACTED]	1	[REDACTED]	13	[REDACTED]	13		
[REDACTED]	13	[REDACTED]	15	[REDACTED]	1		
[REDACTED]	13	[REDACTED]	15	[REDACTED]	11		
[REDACTED]	16	[REDACTED]	15	[REDACTED]	12		
[REDACTED]	2	[REDACTED]	6	[REDACTED]	17		
[REDACTED]	13	[REDACTED]	6	[REDACTED]	18		
[REDACTED]	10	[REDACTED]	6	[REDACTED]	11		
[REDACTED]	10	[REDACTED]	13	[REDACTED]	12		
[REDACTED]	10	[REDACTED]	14	[REDACTED]	17		
[REDACTED]	10	[REDACTED]	14	[REDACTED]	18		
[REDACTED]	16	[REDACTED]	7	[REDACTED]	11		
[REDACTED]	16	[REDACTED]	8	[REDACTED]	12		
[REDACTED]	16	[REDACTED]	5	[REDACTED]	17		
[REDACTED]	16	[REDACTED]	9	[REDACTED]	18		
[REDACTED]	3	[REDACTED]	8	[REDACTED]	11		
[REDACTED]	4	[REDACTED]	8	[REDACTED]	12		
[REDACTED]	14	[REDACTED]	9	[REDACTED]	17		
[REDACTED]	2	[REDACTED]	9	[REDACTED]	18		

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
MODULE TOP				2.71E-08		1.68E+02		4.56E-06
CUTSET 1				9.74E-09		1.68E+02		1.64E-06
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM ^{north} AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
CUTSET 2				9.74E-09		1.68E+02		1.64E-06
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM ^{north} AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #1 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
CUTSET 3				5.20E-09		1.68E+02		8.76E-07
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM ^{north} AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
CUTSET 4				7.75E-10		1.68E+02		1.30E-07
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM ^{north} AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #1 CIRCUIT BREAKER FAILS TO CLOSE	1	1.70E-03	N	1.00E+00	N	1.70E-03
	E	DIESEL GENERATOR #2 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
CUTSET 5				7.75E-10		1.68E+02		1.30E-07
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM ^{north} AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #2 BREAKER FAILS TO CLOSE	1	1.70E-03	N	1.00E+00	N	1.70E-03
	E	DIESEL GENERATOR #1 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
CUTSET 6				4.14E-10		1.68E+02		6.97E-08
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM ^{north} AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #1 CIRCUIT BREAKER FAILS TO CLOSE	1	1.70E-03	N	1.00E+00	N	1.70E-03
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
CUTSET 7				4.14E-10		1.68E+02		6.97E-08
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM ^{north} AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #2 BREAKER FAILS TO CLOSE	1	1.70E-03	N	1.00E+00	N	1.70E-03

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
CUTSET 8				3.29E-11		1.68E+02		5.54E-09
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM <i>north</i> AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #1 CIRCUIT BREAKER FAILS TO CLOSE	1	1.70E-03	N	1.00E+00	N	1.70E-03
	E	DIESEL GENERATOR #2 BREAKER FAILS TO CLOSE	1	1.70E-03	N	1.00E+00	N	1.70E-03
CUTSET 9				7.07E-12		3.91E+00		2.76E-11
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM <i>north</i> AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	IE	TIE-BREAKER FAILS OPEN	1	1.50E-05	H	8.00E+00	H	1.20E-04
	IE	TIE-BREAKER FAILS OPEN	1	1.50E-05	H	8.00E+00	H	1.20E-04
CUTSET 10				3.32E-12		1.20E+01		3.99E-11
	E	DIESEL GENERATOR #1 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 11				3.32E-12		1.20E+01		3.99E-11
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 12				2.05E-12		7.64E+00		1.56E-11
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM <i>north</i> NORTH AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #1 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	IE	TIE-BREAKER FAILS OPEN	1	1.50E-05	H	8.00E+00	H	1.20E-04
	E	TIE-BREAKER FAILS TO CLOSE	0	0.00E+00		1.70E-03	N	1.70E-03
CUTSET 13				2.05E-12		7.64E+00		1.56E-11
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM <i>north</i> AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #2 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	IE	TIE-BREAKER FAILS OPEN	1	1.50E-05	H	8.00E+00	H	1.20E-04
	E	TIE-BREAKER FAILS TO CLOSE	0	0.00E+00		1.70E-03	N	1.70E-03

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 14				1.77E-12		1.20E+01		2.13E-11
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 15				1.53E-12		9.73E-01		1.49E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 DOWN FOR MAINTENANCE	1	1.00E-04	H	1.00E+00	H	1.00E-04
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
CUTSET 16				1.53E-12		9.73E-01		1.49E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 4 DOWN FOR MAINTENANCE	1	1.00E-04	H	1.00E+00	H	1.00E-04
CUTSET 17				1.53E-12		9.73E-01		1.49E-12
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 1 DOWN FOR MAINTENANCE	1	1.00E-04	H	1.00E+00	H	1.00E-04
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
CUTSET 18				1.09E-12		7.64E+00		8.36E-12
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM <i>north</i> AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TIE-BREAKER FAILS OPEN	1	1.50E-05	H	8.00E+00	H	1.20E-04
	E	TIE-BREAKER FAILS TO CLOSE	0	0.00E+00		1.70E-03	N	1.70E-03
CUTSET 19				1.09E-12		7.64E+00		8.36E-12
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM NORTH AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TIE-BREAKER FAILS OPEN	1	1.50E-05	H	8.00E+00	H	1.20E-04
	E	TIE-BREAKER FAILS TO CLOSE	0	0.00E+00		1.70E-03	N	1.70E-03

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATL)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 20				9.85E-13		6.00E+00		5.91E-12
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	IE	15KVSG INTERRUPTER W/FUSE FAILS TO REMAIN CLOSED	1	4.00E-06	H	8.00E+00	H	3.20E-05
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 21				9.85E-13		6.00E+00		5.91E-12
	E	DIESEL GENERATOR #1 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
	IE	15KVSG INTERRUPTER W/FUSE FAILS TO REMAIN CLOSED	1	4.00E-06	H	8.00E+00	H	3.20E-05
CUTSET 22				9.85E-13		6.00E+00		5.91E-12
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
	IE	15KVSG INTERRUPTER W/FUSE FAILS TO REMAIN CLOSED	1	4.00E-06	H	8.00E+00	H	3.20E-05
CUTSET 23				9.85E-13		6.00E+00		5.91E-12
	E	DIESEL GENERATOR #1 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	15KVSG INTERRUPTER W/FUSE FAILS TO REMAIN CLOSED	1	4.00E-06	H	8.00E+00	H	3.20E-05
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 24				8.91E-13		2.40E+01		2.14E-11
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
CUTSET 25				5.26E-13		6.00E+00		3.16E-12
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
	IE	15KVSG INTERRUPTER W/FUSE FAILS TO REMAIN CLOSED	1	4.00E-06	H	8.00E+00	H	3.20E-05

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 26				5.26E-13		6.00E+00		3.16E-12
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	15KVSG INTERRUPTER W/FUSE FAILS TO REMAIN CLOSED	1	4.00E-06	H	8.00E+00	H	3.20E-05
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 27				4.92E-13		6.00E+00		2.95E-12
	IE	13.8KV FUSED INTERRUPTER FAILS TO REMAIN CLOSED	1	2.00E-06	H	8.00E+00	H	1.60E-05
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 28				4.92E-13		6.00E+00		2.95E-12
	IE	13.8KV FUSED INTERRUPTER FAILS TO REMAIN CLOSED	1	2.00E-06	H	8.00E+00	H	1.60E-05
	E	DIESEL GENERATOR #1 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 29				4.92E-13		6.00E+00		2.95E-12
	IE	13.8KV FUSED INTERRUPTER FAILS TO REMAIN CLOSED	1	2.00E-06	H	8.00E+00	H	1.60E-05
	E	DIESEL GENERATOR #1 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 30				4.92E-13		6.00E+00		2.95E-12
	IE	13.8KV FUSED INTERRUPTER FAILS TO REMAIN CLOSED	1	2.00E-06	H	8.00E+00	H	1.60E-05
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 31				3.57E-13		2.40E+01		8.57E-12
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 1 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 32				3.57E-13		2.40E+01		8.57E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 2 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 33				3.57E-13		2.40E+01		8.57E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 4 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 34				3.44E-13		6.91E+00		2.38E-12
ENAL	IE	LACK OF NORMAL ELECTRICAL POWER FROM NORTH AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	IE	TIE-BREAKER FAILS OPEN	1	1.50E-05	H	8.00E+00	H	1.20E-04
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
CUTSET 35				2.73E-13		6.55E+00		1.79E-12
	IE	FAN 2 100 AMP BREAKER FAILS OPEN	1	1.50E-05	H	8.00E+00	H	1.20E-04
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
CUTSET 36				2.73E-13		6.55E+00		1.79E-12
	IE	FAN 4 100 AMP BREAKER FAILS	1	1.50E-05	H	8.00E+00	H	1.20E-04
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
CUTSET 37				2.73E-13		6.55E+00		1.79E-12
	IE	FAN 1 100 AMP BREAKER FAILS OPEN	1	1.50E-05	H	8.00E+00	H	1.20E-04
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 38				2.64E-13		1.20E+01		3.17E-12
	E	DIESEL GENERATOR #2 BREAKER FAILS TO CLOSE	1	1.70E-03	N	1.00E+00	N	1.70E-03
	E	DIESEL GENERATOR #1 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 39				2.64E-13		1.20E+01		3.17E-12
	E	DIESEL GENERATOR #1 CIRCUIT BREAKER FAILS TO CLOSE	1	1.70E-03	N	1.00E+00	N	1.70E-03
	E	DIESEL GENERATOR #2 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 40				2.63E-13		6.00E+00		1.58E-12
	IE	13.8KV FUSED INTERRUPTER FAILS TO REMAIN CLOSED	1	2.00E-06	H	8.00E+00	H	1.60E-05
	E	DIESEL GENERATOR FAILS TO CONTINUE TO RUN #1	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR FAILS TO CONTINUE TO RUN #2	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 41				2.63E-13		6.00E+00		1.58E-12
	IE	13.8KV FUSED INTERRUPTER FAILS TO REMAIN CLOSED	1	2.00E-06	H	8.00E+00	H	1.60E-05
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 42				2.48E-13		2.40E+01		5.97E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	OPERATOR FAILS TO OPEN DAMPER FOLLOWING MAINTENANCE OF CAN	1	2.00E-03	N	1.00E+00	N	2.00E-03
CUTSET 43				2.48E-13		1.44E+01		3.57E-12
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 1 MOTOR FAILS MECHANICALLY	1	1.00E-05	H	2.40E+01	H	2.40E-04

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 44				2.48E-13		1.44E+01		3.57E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 2 MOTOR FAILS MECHANICALLY	1	1.00E-05	H	2.40E+01	H	2.40E-04
CUTSET 45				2.48E-13		1.44E+01		3.57E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 4 MOTOR MECHANICAL FAILURE	1	1.00E-05	H	2.40E+01	H	2.40E-04
CUTSET 46				1.82E-13		6.55E+00		1.19E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BELT FAILURE	1	1.00E-05	H	8.00E+00	H	8.00E-05
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
CUTSET 47				1.82E-13		6.55E+00		1.19E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BELT FAILURE	1	1.00E-05	H	8.00E+00	H	8.00E-05
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
CUTSET 48				1.82E-13		6.55E+00		1.19E-12
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 1 BELT FAILURE	1	1.00E-05	H	8.00E+00	H	8.00E-05
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
CUTSET 49				1.79E-13		2.40E+01		4.30E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 BEARING FAILURE	3	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 50				1.43E-13		2.40E+01		3.43E-12
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 1 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
	IE	CANYON FAN NO. 2 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 51				1.43E-13		2.40E+01		3.43E-12
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 1 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
	IE	CANYON FAN NO. 4 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 52				1.43E-13		2.40E+01		3.43E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 2 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
	IE	CANYON FAN NO. 4 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 53				1.41E-13		1.20E+01		1.69E-12
	E	DIESEL GENERATOR #1 CIRCUIT BREAKER FAILS TO CLOSE	1	1.70E-03	N	1.00E+00	N	1.70E-03
	E	DIESEL GENERATOR #2 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 54				1.41E-13		1.20E+01		1.69E-12
	E	DIESEL GENERATOR #2 BREAKER FAILS TO CLOSE	1	1.70E-03	N	1.00E+00	N	1.70E-03
	E	DIESEL GENERATOR #1 FAILS TO CONTINUE TO RUN	3	3.00E-04	H	7.20E+01	H	2.14E-02
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
	IE	TRANSFORMER FAILS	1	9.00E-06	H	2.40E+01	H	2.16E-04
CUTSET 55				1.34E-13		2.40E+01		3.22E-12
	E	FAN 3 100 AMP BREAKER FAILS	3	1.50E-05	H	7.20E+01	H	1.08E-03
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 56				9.94E-14		2.40E+01		2.39E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	OPERATOR FAILS TO OPEN DAMPER FOLLOWING MAINTENANCE OF CAN	1	2.00E-03	N	1.00E+00	N	2.00E-03
	IE	CANYON FAN NO. 2 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 57				9.94E-14		2.40E+01		2.39E-12
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	OPERATOR FAILS TO OPEN DAMPER FOLLOWING MAINTENANCE OF CAN	1	2.00E-03	N	1.00E+00	N	2.00E-03
	IE	CANYON FAN NO. 1 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 58				9.94E-14		2.40E+01		2.39E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	OPERATOR FAILS TO OPEN DAMPER FOLLOWING MAINTENANCE OF CAN	1	2.00E-03	N	1.00E+00	N	2.00E-03
	IE	CANYON FAN NO. 4 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 59				9.91E-14		1.44E+01		1.43E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 2 MOTOR FAILS MECHANICALLY	1	1.00E-05	H	2.40E+01	H	2.40E-04
	IE	CANYON FAN NO. 4 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 60				9.91E-14		1.44E+01		1.43E-12
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 2 MOTOR FAILS MECHANICALLY	1	1.00E-05	H	2.40E+01	H	2.40E-04
	IE	CANYON FAN NO. 1 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 61				9.91E-14		1.44E+01		1.43E-12
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 1 MOTOR FAILS MECHANICALLY	1	1.00E-05	H	2.40E+01	H	2.40E-04
	IE	CANYON FAN NO. 4 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 62				9.91E-14		1.44E+01		1.43E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 4 MOTOR MECHANICAL FAILURE	1	1.00E-05	H	2.40E+01	H	2.40E-04
	IE	CANYON FAN NO. 2 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 63				9.91E-14		1.44E+01		1.43E-12
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 1 MOTOR FAILS MECHANICALLY	1	1.00E-05	H	2.40E+01	H	2.40E-04
	IE	CANYON FAN NO. 2 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 64				9.91E-14		1.44E+01		1.43E-12
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 4 MOTOR MECHANICAL FAILURE	1	1.00E-05	H	2.40E+01	H	2.40E-04
	IE	CANYON FAN NO. 1 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 65				8.94E-14		2.40E+01		2.15E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 BELT FAILURE	3	1.00E-05	H	7.20E+01	H	7.20E-04
CUTSET 66				8.94E-14		2.40E+01		2.15E-12
	E	FAILURE OF AUTO-START SENSOR FOR CANYON FAN NO. 3	3	1.00E-05	H	7.20E+01	H	7.20E-04
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
CUTSET 67				8.94E-14		2.40E+01		2.15E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 MOTOR MECHANICAL FAILURE	3	1.00E-05	H	7.20E+01	H	7.20E-04

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 68				7.15E-14		2.40E+01		1.72E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 SHAFT FAILURE	3	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 69				7.15E-14		2.40E+01		1.72E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 BEARING FAILURE	3	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 70				7.15E-14		2.40E+01		1.72E-12
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 BEARING FAILURE	3	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 71				7.15E-14		2.40E+01		1.72E-12
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 BEARING FAILURE	3	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 1 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 72				5.71E-14		2.40E+01		1.37E-12
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03
	IE	CANYON FAN NO. 1 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
	IE	CANYON FAN NO. 2 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
	IE	CANYON FAN NO. 4 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 73				5.37E-14		2.40E+01		1.29E-12
	E	FAN 3 100 AMP BREAKER FAILS	3	1.50E-05	H	7.20E+01	H	1.08E-03
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04

FAULT TREE/EVENT NAME	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	U	TAU (FACTOR)	U	UNAVAIL.
CUTSET 74				5.37E-14		2.40E+01		1.29E-12
	E	FAN 3 100 AMP BREAKER FAILS	3	1.50E-05	H	7.20E+01	H	1.08E-03
	IE	CANYON FAN NO. 1 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 75				5.37E-14		2.40E+01		1.29E-12
	E	FAN 3 100 AMP BREAKER FAILS	3	1.50E-05	H	7.20E+01	H	1.08E-03
	IE	CANYON FAN NO. 2 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	IE	CANYON FAN NO. 1 SHAFT FAILURE	1	8.00E-06	H	7.20E+01	H	5.76E-04
CUTSET 76				2.67E-14		5.05E+01		1.35E-12
	IE	LACK OF NORMAL ELECTRICAL POWER FROM NORTH AREA LOOP	1	1.00E-01	Y	1.68E+02	H	1.92E-03
	E	DIESEL GENERATOR #1 DOWN FOR MAINTENANCE	1	4.00E-02	N	1.00E+00	N	4.00E-02
	E	TIE-BREAKER FAILS TO CLOSE	0	0.00E+00		1.70E-03	N	1.70E-03
	IE	CANYON FAN NO. 4 BEARING FAILURE	1	2.00E-05	H	7.20E+01	H	1.44E-03
	E	CANYON FAN NO. 3 DOWN FOR MAINTENANCE	3	1.00E-04	H	7.20E+01	H	7.17E-03

APPENDIX B

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Gate/Event Name	Page	Gate/Event Name	Page	Gate/Event Name	Page	Gate/Event Name	Page
[REDACTED]	10	[REDACTED]	3	[REDACTED]	6	[REDACTED]	12
[REDACTED]	10	[REDACTED]	2	[REDACTED]	15	[REDACTED]	17
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[REDACTED]	16	[REDACTED]	9	[REDACTED]	11	[REDACTED]	
[REDACTED]	16	[REDACTED]	8	[REDACTED]	12	[REDACTED]	
[REDACTED]	3	[REDACTED]	8	[REDACTED]	17	[REDACTED]	
[REDACTED]	4	[REDACTED]	8	[REDACTED]	18	[REDACTED]	
[REDACTED]	14	[REDACTED]	9	[REDACTED]	11	[REDACTED]	
[REDACTED]	2	[REDACTED]	9	[REDACTED]		[REDACTED]	

CUTSET RELIABILITY AVAIL. MAINT. REPORT

DONE\NEWSEIS2.CSR

Filter: 'ALL'

MODULE TOP	CUTSET	YBL002J	CUTSET	YBL001E	CUTSET	YBL002E	CUTSET	CLASS IN/EN	DESCRIPTION (truncated)	CALC TYPE	LAMBDA (RATE)	TAU (FACTOR)	U	UNAVAIL.
								I	EARTHQUAKE WITH INTENSITY GREATER THAN MM-7	0	3.57E-07	0.00E+00	0.00E+00	0.00E+00
								I	STACK COLLAPSE AND PLUGGAGE OF EXH PASSAGE (W/O EARTHQUAKE	0	2.30E-07	0.00E+00	0.00E+00	0.00E+00
								I	COLLAPSE AND PLUGGAGE OF EXH PASSAGE (W/O EARTHQUAKE	0	0.00E+00	2.30E-07	H	0.00E+00
								I	ALL CANYON FANS INOPERATIVE	0	5.00E-08	0.00E+00	0.00E+00	0.00E+00
								I	STACK COLLAPSE AND PLUGGAGE OF EXH PASSAGE (W/O EARTHQUAKE	0	0.00E+00	5.00E-08	H	0.00E+00
								I	COLLAPSE AND PLUGGAGE OF EXH PASSAGE (W/O EARTHQUAKE	0	5.00E-08	0.00E+00	0.00E+00	0.00E+00
								I	ALL CANYON FANS INOPERATIVE	0	2.71E-08	0.00E+00	0.00E+00	0.00E+00
								I	ALL CANYON FANS INOPERATIVE	0	0.00E+00	2.71E-08	0.00E+00	0.00E+00

**DATE
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5/10/94

END