RELIABILITY ASSESSMENT OF THE SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1 SALTWATER COOLING SYSTEM

April, 1987

Prepared By:

ERIN Engineering And Research, Incorporated
1850 Mt. Diablo Boulevard
Suite 600
Walnut Creek, CA 94596

Prepared For:

Southern California Edison Company

8704060536 870401
PDR ADOCK 05000206
P PDR

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1.0 INTRODUCTION

2.0 OVERVIEW OF THE SALTWATER COOLING SYSTEM AND ITS SUPPORT SYSTEMS

- 2.1 Saltwater Cooling System Design Bases
- 2.2 Saltwater Cooling System Design and Operation (Maximum Heat Load Conditions)
- 2.3 Saltwater Cooling System Design and Operation (Normal Heat Load Conditions)
- 2.4 Saltwater Cooling System Success Criteria
- 2.5 Saltwater Cooling System Support Systems
- 2.6 Saltwater Cooling System Operating Experience at SONGS-1
- 2.7 Comparison of the SONGS-1 Saltwater Cooling System With Other Saltwater Cooling Systems

3.0 METHODOLOGY OF THE STUDY

- 3.1 Analysis Guidelines and Fundamental Assumptions
- 3.2 Computer Codes Utilized
- 3.3 Fault Tree Detail
- 3.4 Data Sources

TABLE OF CONTENTS (CONTINUED)

4.0 OVERVIEW OF THE SALTWATER COOLING SYSTEM RELIABILITY ASSESSMENT

4.1 Description of Cases Studied
4.2 Fault Tree Models Developed
4.3 Assumptions Used in Development of the Fault Trees
4.4 Data Base Used For This Study

5.0 RESULTS OF THE STUDY

5.1 Overview
5.2 Normal Heat Load Case
5.3 Maximum Heat Load Case

6.0 CONCLUSIONS AND INSIGHTS

7.0 REFERENCES

APPENDIX A - Fault Trees
APPENDIX B - Basic Event Data Base
APPENDIX C - Analysis Code Output

LIST OF TABLES

Table	Title	Page
2-1	Front-Line vs. Support System Dependencies	2-10
2-2	Support System vs. Support System Dependencies	2-11
2-3	Power Supplies to Saltwater Cooling System Components	2-12
4-1	Key Generic Basic Event Data Used in the Analysis	4-10
5-1	Basic Events Exhibiting Significant Importance for Saltwater Cooling System - Maximum Heat Load Conditions	5-5
5-2	Dominant Minimal Cut Sets for Saltwater Cooling System - Maximum Heat Load Conditions	5-7

LIST OF FIGURES

Figure	Title	Page
2-1	Saltwater Cooling System Simplified Piping Diagram	2-4
2-2	AC Power System Simplified Diagram	2-13
2-3	DC Power System Simplified Diagram	2-18
3-1	Reliability Analysis Computer Code Flowchart	3-3
5-1	Saltwater Cooling System 90% Probability Interval of Uncertainty	5-3

EXECUTIVE SUMMARY

This report describes a reliability assessment performed for the Saltwater Cooling (SWC) System at the San Onofre Nuclear Generating Station, Unit 1 (SONGS-1). The SWC System is the ultimate heat sink for all safety related loads at SONGS-1 providing cooling for the closed loop Component Cooling Water (CCW) System and a backup supply of saltwater to the turbine plant cooling water heat exchangers. The purpose of this study is to evaluate the overall reliability of the SWC System under all modes of operation in order to determine whether potentially significant failure modes exist which have not previously been identified or corrected.

The reliability assessment considers two cases for the SWC System operation: normal and maximum heat load conditions. Normal heat load conditions exist during steady state power operation and steady state shutdown cooling modes. Maximum heat load conditions exist during use of the RHR System during cooldown from power operation. For the case of normal heat load, at least one SWC pump or the auxiliary SWC pump is required to provide sufficient saltwater flow through the CCW heat exchanger(s) to prevent excessive CCW heatup. Also, both screen wash pumps or both fire water pumps are capable of providing sufficient water flow through the CCW heat exchangers to prevent excessive CCW heatup in the event of a failure of both SWC pumps and the auxiliary SWC pump.

Under maximum heat load conditions (4 hours after shutdown when first entering Residual Heat Removal operation), at

least one of the two SWC pumps or the auxiliary SWC pump is required for CCW heat removal. The screen wash and fire water pumps are not assumed to be a viable backup to the SWC pumps for this case since the adequacy of these pumps under this service condition has neither been analyzed nor demonstrated.

The reliability assessment provides a detailed description of the SWC System design and operation, support system dependencies affecting the operation of the SWC System, and the success criteria for the SWC System operation.

The results of the reliability assessment of the two cases discussed above are as follows:

Case	Mean Unavailability (failure probability) (per 24 hour period)
SWC System (normal conditions)	3.5E-05
SWC System (maximum conditions)	3.6E-05

These results indicate that the SWC System is now very reliable and should experience failure only once every 100 years. They further demonstrate that there are no inherent problems with SWC System design and operation. The major contributor to the failure rate of the system is failure of the AC Power System. Individual hardware faults of SWC System components do not have a significant impact upon the overall unavailability of the system. Hence, this study did not identify any SWC System procedural or design changes that would further improve the system availability.

1.0 INTRODUCTION

SONGS-1 is a 450 MWe commercial nuclear electric generating facility located on the California coast approximately 60 miles south of Los Angeles, California. The facility utilizes a three loop pressurized water reactor nuclear steam supply system designed by Westinghouse Electric Corporation. The facility is primarily owned and operated by Southern California Edison Company (SCE) and began commercial operation on January 1, 1968.

The SWC System consists of two independent trains, each with one SWC pump and one component cooling water heat exchanger. The SWC System also has an auxiliary (third) pump available for instances in which the normal pumps are unavailable. In addition, the plant's screen wash pumps and/or firewater pumps could also be utilized to provide water flow through the CCW heat exchanger(s) in the event of loss of all SWC pumps. These pumps are capable of removing heat during normal system operation but have not been demonstrated or analyzed as being capable of removing maximum (cooldown) heatloads. (Overall system reliability was high such that further analysis in order that these pumps may be credited was not warranted.)

The SWC System has experienced numerous failures since the plant began commercial operation. As a result of these events, several modifications were made to improve the reliability of the SWC System. Among these modifications are:

- Tsunami gates were removed.

- Air-operators on valves in the SWC pump discharge lines were removed and the valves are now normally open.
- Check valves were installed on pump discharge lines to prevent back flow.

Since these projects represent significant evaluation and correction of specific problems, it was assumed that they have been successful in correcting previous system deficiencies. The purpose of this assessment is not, therefore, to further examine these problems; rather, it is to determine if there are other problems inherent to current system design and operation. The SWC System is analyzed under two demand conditions: normal and maximum heat load conditions.

This assessment has been performed using a methodology that is consistent with those of recent probabilistic risk assessments (PRA'S), including the Interim Reliability Evaluation Program (IREP) studies. The key steps in the analysis include the following:

- understanding of system performance in response to the normal and maximum conditions studied,

- understanding of system interactions which may cause undesirable consequences,

- development of system success criteria for the two cases analyzed,

- development of system descriptions and simplified system diagrams, which show system interfaces and support system requirements,

- development of fault tree models of the SWC System and its support systems,

- incorporation of operating procedures, test and maintenance procedures, and Technical Specification constraints in the analyses,

- quantification of the fault trees using best available data,

- summation of all identified failure sequences and evaluation of results, and

- assessment of uncertainties associated with each analysis.

The results of this study provide an overall appraisal of SWC System reliability with respect to the two operating environments that were studied. The response of the system to a given set of initiating events is not specifically addressed in this study. However, the system success criteria used in this study bound the system requirements to respond to a wide range of initiating events.

Section 2.0 provides a detailed description of the SWC System and its support systems. The description includes the design and operation of the system. Other areas discussed include: the success criteria for the SWC System, operating experience

of the SWC System, and a comparison of the SWC System at SONGS-1 to those used at other pressurized water reactors.

Section 3.0 describes the methodology of the study including analysis guidelines, fundamental assumptions, fault tree detail, data sources, and the solution codes utilized.

Section 4.0 describes the detailed reliability assessment of the SWC System. The areas discussed include: the fault tree modeling of the two cases, the assumptions in the fault tree models, and the data base used in this study.

Section 5.0 provides the results of the reliability study. The unavailability of the SWC System for the two cases is identified. The dominant failure sequences (or cut sets) for each case are discussed and analyzed. The uncertainty of the reliability analysis is also discussed.

Section 6.0 is a summary of the results and the conclusions of the reliability analysis. Insights gained from the assessment of the SWC System reliability are also provided.

Section 7.0 lists the references utilized in the assessment.

2.0 OVERVIEW OF THE SALTWATER COOLING SYSTEM AND ITS SUPPORT SYSTEMS

This section of the report provides descriptions of each of the plant systems that were modeled as part of this study. The intent of these summaries is to provide an overview of the design and operation of the SWC System and its support systems and to highlight key aspects that were significant to the modeling effort. Simplified piping diagrams and electrical one-line diagrams are included for each system.

2.1 Saltwater Cooling System Design Bases

The SONGS-1 SWC System has the following main function:

- to provide an adequate supply of saltwater to the component cooling water (CCW) heat exchangers to remove waste heat from primary plant components.

The SWC System has the following additional functions:

- provide a back-up supply of saltwater to the Turbine Plant Cooling Water (TPCW) Heat Exchangers.

- provide a means of partially dewatering a circulating water bay.

These additional functions are not required for plant safety and were not considered in this analysis.

The SWC System has the following design bases:

- There are two separate trains of saltwater cooling which are designed such that a failure of one train does not prevent the removal of residual heat.

- The system is designed to maintain the Component Cooling Water (CCW) System below its design temperature during maximum heat load conditions on the CCW System (4 hours after plant shutdown) by providing adequate cooling water flow to a CCW heat exchanger.

2.2 Saltwater Cooling System Design and Operation (Maximum Heat Load Conditions)

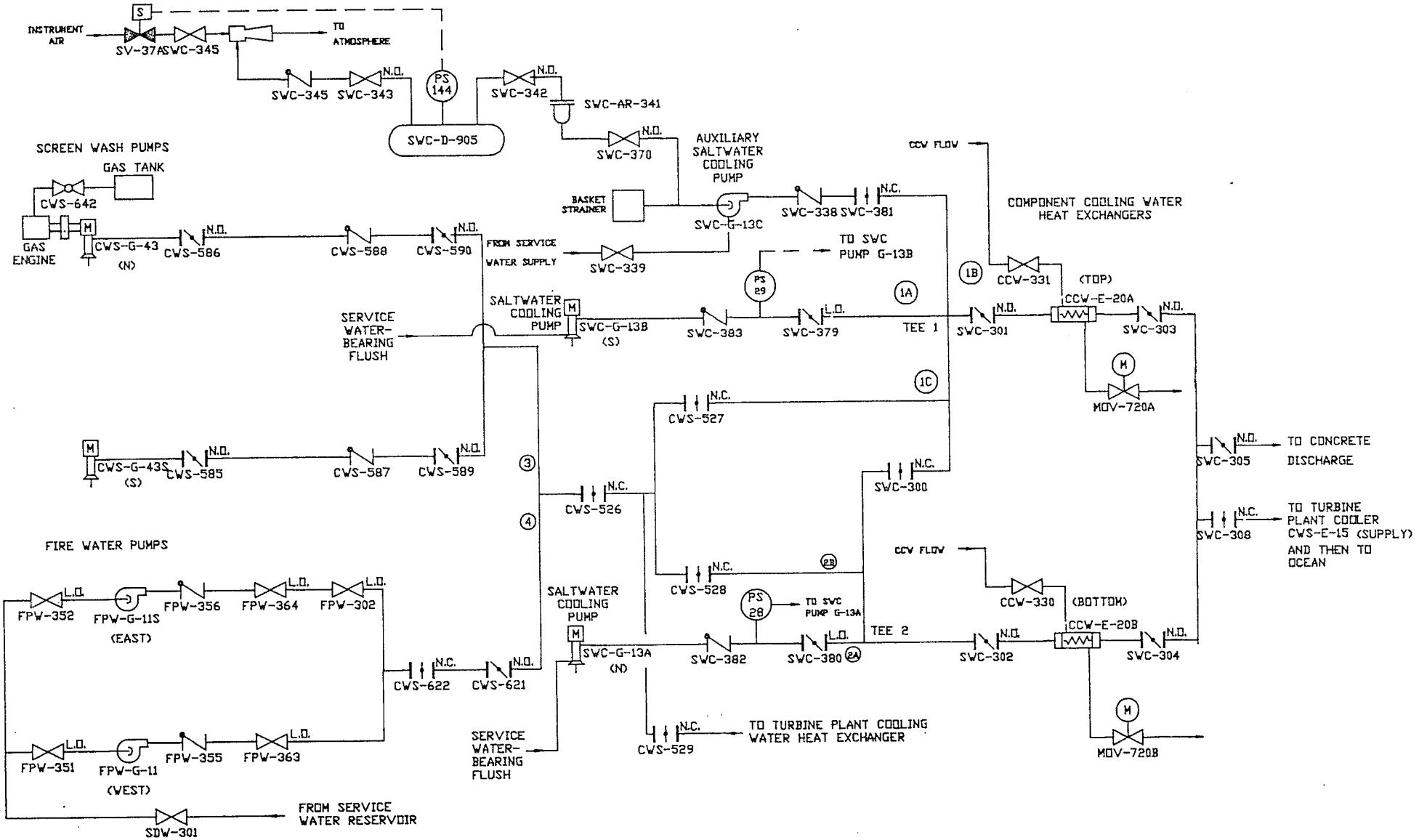
Maximum heat load conditions for this system are experienced during plant cooldown evolutions (typically about 4 hours after reactor shutdown when first entering RHR operation). In order to remove this heat load, at least one SWC train must be in operation, utilizing one of the main SWC pumps or the auxiliary SWC pump.

The SWC System consists of two independent and redundant trains for reliability. Figure 2-1 is a simplified piping diagram of the SWC System.

Normally, one saltwater cooling pump (north or south) is running and the other is in standby. The standby pump is normally in the 'auto' position and will start automatically when the discharge pressure of the operating pump drops below 20 pounds per square inch (psi). The saltwater cooling pumps are vertical centrifugal wet pit pumps. Each of the SWC pumps takes suction from a separate forebay of the intake structure and discharges through an independent check valve and a locked open butterfly valve to its respective component cooling water heat exchanger. Isolation valves and a crosstie provide flexibility for the use of the saltwater cooling pumps in supplying either heat exchanger.

FIGURE 2-1

SONGS-1 SALT WATER COOLING SYSTEM



From the component cooling water heat exchangers, the flow is directed through the butterfly outlet isolation valves to an outlet header. The discharge then flows into a single header with a normally open butterfly valve through the outfall conduit to the ocean.

In the event that the normal saltwater cooling pumps become inoperable, the auxiliary SWC pump can be used as a backup. This pump is not designed for continuous use since the suction strainer can become plugged during extended operation. The pump must be primed by an air-operated eductor in conjunction with a vacuum priming tank. On decreasing vacuum in the vacuum priming tank, pressure switch PS-144 actuates solenoid valve SV-37A to supply service air to the eductor until sufficient vacuum is established.

2.3 Saltwater Cooling System Design and Operation (Normal Heat Load Conditions)

Under normal steady state operating conditions (e.g., power operation, cold shutdown, etc.)., the CCW System heat load is significantly less than that experienced during a plant cooldown. It is possible to utilize the plant's screen wash pumps or firewater pumps as a backup to the SWC pumps in the event the SWC pumps or auxiliary SWC pump become inoperable. Abnormal Operating Procedure SO1-2.4-1, "Loss of Saltwater Cooling System" specifies how and when the screen wash pumps or firewater pumps should be aligned to the SWC System to provide flow through the CCW heat exchanger.

It is assumed that either both screen wash pumps or both firewater pumps are required to operate in order to provide adequate water flow to the CCW heat exchangers. The adequacy of the screen wash pumps or firewater pumps has not been analyzed, however, the screen wash pumps were successfully used as a backup to the SWC pumps in a 1980 event and demonstrated that they could provide sufficient flow to keep CCW temperatures below the maximum of 150°F. The adequacy of the firewater pumps as a backup to the SWC pumps is inferred since the pump performance specifications for the firewater and screen wash water pumps are similar.

The alignment of the screen wash pumps consists of isolating the pumps from the screens and opening the manual valves on the headers into the SWC System.

Each of the screen wash pumps discharge through two normally open butterfly valves and one check valve to a common header. The common header then splits to connect into the SWC headers downstream of each of the SWC pumps. A normally closed manual valve on the common header and one normally closed manual valve on each of the headers to the SWC System need to be opened to provide flow to the CCW heat exchangers.

The alignment of the firewater pumps to the SWC System consists of manually opening the firewater pump header isolation valves. The firewater pumps are rated at 1000 gpm each at 170 psig.

Each of the firewater pumps discharge through their respective check valves and locked open gate valves to a common header. The two valves, one normally open and one

normally closed, have to be manually aligned to provide firewater to the CCW heat exchanger. This header ties into the backup supply line from the screen wash pumps.

The screen wash pumps were used as backup to the SWC pumps in March of 1980 when the two SWC pumps and the auxiliary SWC pump all suffered a failure. Approximately one hour after the SWC pumps failed, the auxiliary SWC pump was restored to service.

2.4 Saltwater Cooling System Success Criteria

The SWC System is designed to: provide an adequate supply of saltwater to the CCW heat exchanger(s) to remove waste heat from primary plant components, and to maintain the CCW temperature below 120 degrees fahrenheit even under maximum heat load conditions (four hours after shutdown when RHR is first initiated).

The success criteria for the SWC System is determined by evaluating the functional parameters which result in the SWC System meeting its design bases. These functional parameters required for SWC System (maximum conditions) success include:

- o either one of the SWC pumps or the auxiliary SWC pump and one CCW heat exchanger in operation at all times.

Those functional parameters required for SWC System (normal conditions) success include:

- o either one of the SWC pumps, the auxiliary SWC pump, both the screen wash pumps, or both the firewater pumps and one CCW heat exchanger in operation at all times. (Note: The use of only one firewater pump or screen wash pumps would provide significant cooling. However, it is conservatively assumed that both of the pumps are required since taking credit for only one pump would require further analysis which is not necessary given the already good system reliability.)

A loss of all SWC to the plant during the plant shutdown would require the use of an alternate shutdown method developed during the fire protection project, which requires no SWC or CCW operation.

2.5 Saltwater Cooling System Support Systems

This section describes the systems required to support the operation of the SWC System. These support systems include: the AC Power System, the DC Power System, and the Compressed Air System. Table 2-1 provides a matrix listing of the dependencies of the SWC System and its support systems. Table 2-2 provides a matrix listing of the dependencies of the SWC support systems on other support systems. Table 2-3 lists the power supplies for SWC System components.

2.5.1 AC Power System

2.5.1.1 AC Power System Description and Operation

The electrical distribution system at SONGS-1 consists of 220kV AC Switchyard System, the 4160 V AC System, the 480 V AC System, the 120 V AC system, and the Onsite AC Power System (composed of the diesel generators). Figure 2-2 is a simplified one-line drawing of the AC Power System.

2.5.1.2 220kV Switchyard System

SONGS-1 is located at the point of interconnection between Southern California Edison's (SCE's) 230 kV system and San Diego Gas & Electric Company's (SDG&E's) 230kV/138 kV system. A single line diagram of the switchyard showing the

TABLE 2-1

Front-Line System vs. Support System Dependencies

Front-Line System	Support System: Offsite AC	Onsite AC	DC	SWS	Compressed Air
SWC System	x	x	x	1	2
Screen Wash Pumps	x	x	x	1	--
Fire Water Pumps	x	x	x	--	--

Offsite AC = Offsite AC Power System
Onsite AC = Onsite AC Power System
DC = 125V DC Power System
SWS = Service Water System

Notes:
x = Direct dependency over a long term time period
1 = Service Water System bearing flush water for the SWC pumps and screen wash pumps can be unavailable for up to 7 days without affecting pump operation.
2 = Compressed air is required for the auxiliary saltwater cooling pump priming system.

TABLE 2-2

Support System vs. Support System Dependencies

Support System	Offsite AC	Onsite AC	DC	Compressed Air
Offsite AC	--			
Onsite AC		--	x	2
DC	1	1	--	
Compressed Air	x			--

Offsite AC = Offsite AC Power System
Onsite AC = Onsite AC Power System
DC = 125 V DC Power System
Compressed Air = Compressed Air System backed up by bottled nitrogen supplies

NOTES:

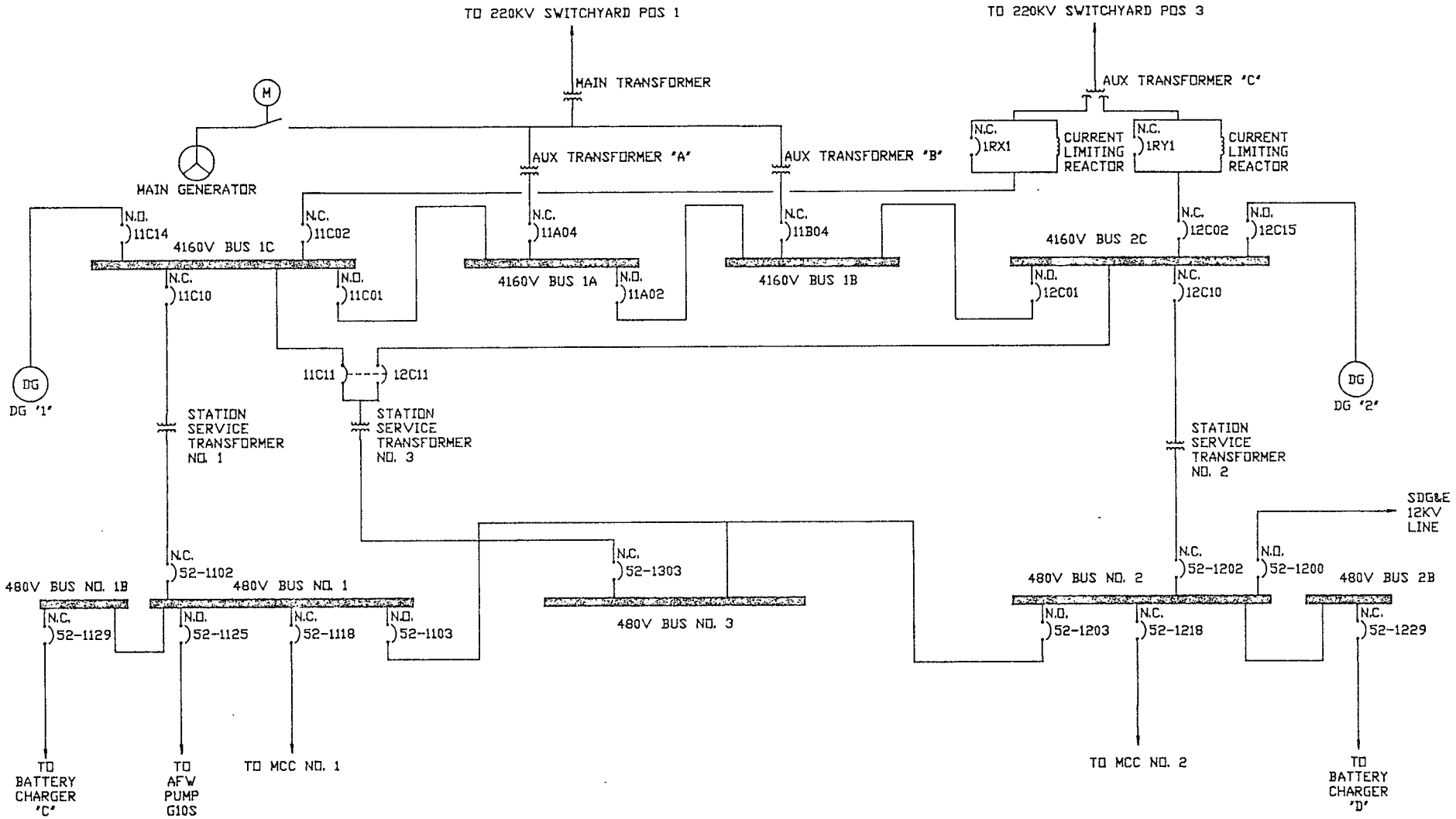
x = Direct Dependency over a long term time period
1 = AC power needed within 8 hours in order to prevent battery depletion
2 = Diesel generator starting air accumulators have sufficient air supply for 3 successful starts. Subsequent start attempts, if required, would require the availability of AC power to operate the starting air compressors.

TABLE 2-3

Power Supplies to Saltwater Cooling System Components

Component	Power Supply
SWC Pump G-13A	480 V AC Bus No. 1
SWC Pump G-13B	480 V AC Bus No. 2
Auxiliary SWC Pump G-13C	480 V AC Bus No. 3
Screen Wash Pump G-43	480 V AC Bus No. 1
Screen Wash Pump G-43S	480 V AC Bus No. 2
Fire Water Pump G-11	480 V AC Bus No. 1
Fire Water Pump G-11S	480 V AC Bus No. 2
MOV-720A	480 V AC Bus No. 1
MOV-720B	480 V AC Bus No. 2

FIGURE 2-2
SAN ONOFRE UNIT 1 AC POWER SYSTEM



220 kV SCE and SDG&E connections, and the interconnection of the switchyard with the station 4160 V AC System is shown in Figure 2-2. The 220 kV switchyard is of the double breaker, double bus design and operates with all the breakers normally closed. Plant connections to the switchyard are provided by (1) connection to auxiliary transformer C (30,000 kVA, 230 kV/4160 V transformer) and by (2) a connection through the main generator step-up transformer (485,000 KVA, 230 KV/18 KV transformer) and then through auxiliary transformers A and B (10,000 kVA, 18 kV/4160 V transformers). During normal operation, the power source for auxiliary transformers A and B is the main generator, but power can be delivered to the plant from the switchyard via this path if a second supply is required. Figure 2-2 shows the configuration described above and denotes the circuit breaker designations.

2.5.1.3 4160V AC System

The 4160 V AC System consists of the four busses 1A, 1B, 1C and 2C shown in Figure 2-2. Busses 1A and 1B are normally fed from the 18 kV output of the main generator. These busses are powered by auxiliary transformers A and B, and do not normally power components that are required for the safe shutdown of the plant. Busses 1C and 2C are normally fed from the 220 kV switchyard via auxiliary transformer C. These busses provide the redundant power sources for both normal operation and safe shutdown system components. They also provide power for the 480V System by way of station service transformers 1, 2 and 3.

Auxiliary transformers A, B, and C are equipped with protective relays that isolate them, via the circuit breakers, from the electrical system. The circuit breakers that connect the 4160 V AC System with the switchyard and interconnect the 4160 V AC busses are noted on Figure 2-2.

2.5.1.4 480 V AC and Lower Voltage AC Systems

The 480 V AC and the 120 V AC Distribution Systems consist of the busses and motor-control centers shown in Figure 2-2.

2.5.1.5 Diesel Generators

Two redundant diesel generators provide an immediate (within ten seconds) onsite backup 4160 V AC power source in the event that offsite power sources cannot be made available. Either diesel generator is capable of providing sufficient power for safety related systems required for normal and emergency/accident conditions. The diesel generators are automatically started on a loss of offsite power (LOP), a safety injection signal (SIS), a loss of their respective busses, or an SIS incident with an LOP. The diesel generators are automatically loaded only on a combined SIS LOP event. The diesel generator auxiliaries are provided by systems that are powered by 4160 V AC busses 1C and 2C. Therefore, when 4160 V AC power is restored after diesel start, diesel generator auxiliaries are immediately available. In addition, the diesel generators can operate unloaded for an adequate time to allow manual actions with no power to the diesel generator auxiliary systems. The circuit breakers that provide connection of the diesel generators with the 4160 V AC System are shown in Figure 2-2.

2.5.1.6 Loss of Voltage Automatic Transfer Sequence (LOVATS)

The purpose of the LOVATS is to align electrical breakers in the event of under voltage sensed on 4160 V AC busses 1C and 2C by associated under voltage relays. This alignment then allows the operator to re-energize the onsite AC power distribution system by using either the offsite power system or the emergency diesel generators. The operation of LOVATS described below reflects the current configuration which includes modifications made during the Cycle 9 refueling outage.

With 220 kV CB's 4012 and 6012 open, 4160 V AC busses 1C and 2C deenergized and the generator motor-operated disconnect (MOD) switch shut, the LOVATS is initiated. LOVATS opens 4160 V tie breakers to buses 1C and 2C (11C01 and 12C01), and 4160 V AC busses 1A and 1B feeder breakers (11A04 and 11B04), isolating the 18 kV system and illuminating the "18 KV SYSTEM ISOLATED" light in the control room (the service transformers are not disconnected). LOVATS also opens the exciter motor breaker, generates an additional turbine trip signal and opens the three reactor coolant pump breakers at this time. Concurrently, the 4160 V AC bus 1C and 2C undervoltage systems would open their respective motor circuit breakers. Once the main generator 18 kV voltage has decayed to less than 40% of normal and after an additional 30 second time delay, the LOVATS sends an open signal to the 18 kV MOD. Once the MOD has opened (approximately 30 seconds), a close permissive is satisfied for switchyard CB's 4012 and 6012, and the 1A feeder and 1B feeder breakers are automatically re-closed -- illuminating the "END OF SEQUENCE" light in the control room.

This final system lineup, consisting of all 4160 V motors stripped and buses 1A and 1B connected to auxiliary

transformers A and B, provides the operator with two options for reenergizing buses 1C and 2C:

1. If offsite power is available, 220 kV CB 4012 or 6012 is closed and 4160 VAC bus tie breakers 11C01 and 12C01 are closed.

2. If offsite power is not available, emergency diesel generators are connected to busses 1C and 2C by closing breakers 11C14 and 12C15.

2.5.2 DC Power System

The DC Power System provides a reliable source of DC power for use with various plant instrumentation and DC-operated valves. The DC power system also provides power to the 125 V AC vital power busses. Figure 2-3 is a simplified one-line diagram of the DC Power System. Vital bus no. 4 is not shown on the diagram since it doesn't feed any loads related to this analysis.

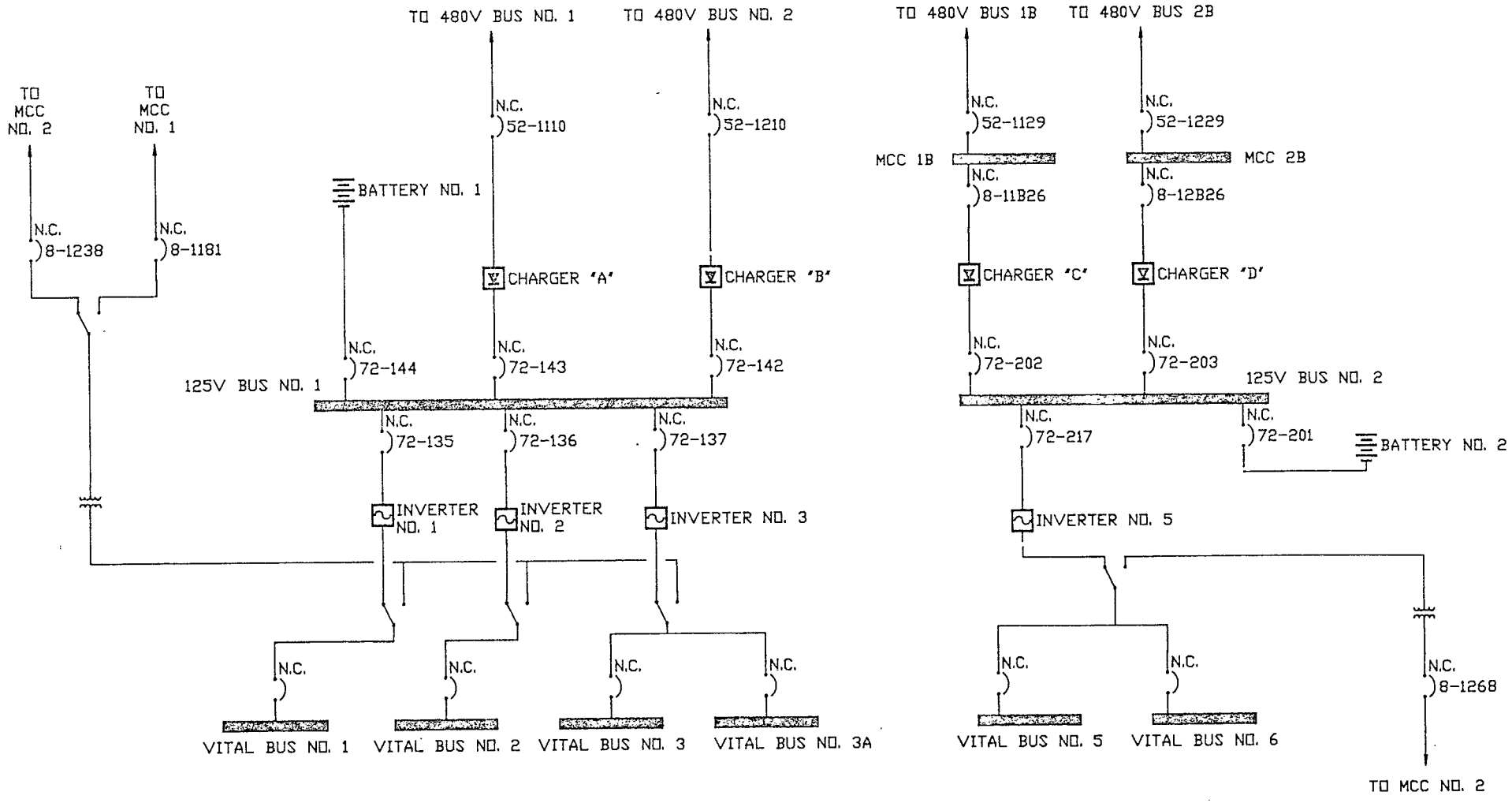
The DC batteries have an 8-hour storage capacity and are normally continuously charged from the 480 V AC busses. Hence, the DC Power System has a long-term dependency upon the AC Power System.

2.5.3 Compressed Air System

The Compressed Air System provides control air to various valves and instrumentation throughout the plant. Figure 2-1 shows the compressed air supplies for the eductor in the priming system for the auxiliary saltwater cooling pump. For the purposes of this study, only the system's interactions

FIGURE 2-3

SAN ONOFRE UNIT 1 DC POWER SYSTEM



with the auxiliary saltwater cooling pump was modeled. The system is normally dependent upon offsite AC power to power the air compressors; however, a small diesel engine-powered compressor is also available. The use of this compressor was not considered as a part of this study.

2.6 Saltwater Cooling System Operating Experience at SONGS-1

Most of the SWC System failure incidents in the past were minor. Modifications were made following each event to address the failures and failure modes. License Event Reports and studies prepared as a result of the incidents were reviewed and are discussed in this report.

The following is a list of incidents which are significant in terms of system reliability:

March, 1975 - Shaft of north SWC pump sheared because of fatigue from excessive vibration resulting from worn shaft bearings.

January 16, 1978 - A SWC pump breaker tripped open when the other SWC pump was out for maintenance.

June 9, 1981 - SWC discharge of the component cooling water (CCW) heat exchanger was partially blocked resulting in low flow and malfunction of butterfly valve. The blockage was caused by a build-up of gooseneck barnacles. A long shutdown had prevented heat treatment of the system.

May 13, 1982 - South SWC pump was removed from its pedestal for maintenance. Water entered the intake area from the hole and rose to within 2 inches of the elevation of the north SWC pump motor vents. The north pump was secured when pump amperage and discharge valve cycled erratically. The procedures did not provide adequate precautions with regard to tide level.

August 19, 1982 - With the south SWC pump out for maintenance, the north pump had to be secured because of degraded motor bearings. Saltwater intrusion from a packing leak was the cause.

The most significant incident occurred on March 10, 1980 in which SONGS-1 experienced a complete loss of flow from the SWC System. The following describes this incident in detail.

While operating at 100% power, San Onofre Unit No. 1 experienced a complete loss of flow from the SWC System. The event involved a triple failure consisting of (1) shearing of the south saltwater cooling pump shaft, (2) failure to open of the north saltwater cooling pump discharge valve, and (3) failure of the auxiliary saltwater cooling pump air priming system. As a result, the plant was totally without saltwater cooling flow for ten minutes, at which time an operator cross-connected the screen wash pumps to provide saltwater flow to a CCW heat exchanger. This limited the CCW temperature rise (from 66^{o}F to 82^{o}F in the

ten minutes) and brought the equilibrium temperature down to 70°F.

At 41 minutes into the event, the auxiliary saltwater cooling pump was restored to service and flow through it to the in-service CCW heat exchanger began seventeen minutes later.

As mentioned before, most of the incidents were minor and have been alleviated by modifications to the system. Failures (2) and (3) from the March 10, 1980 incident have both been corrected. The air-operator on the discharge valve in (2) was removed and the value was to be left normally in the open position. The failure of the Auxiliary SWC Pump Air Priming System was due to air leakage into the system to the point that an insufficient vacuum existed to prime the pump. All places where air could leak into the system were re-sealed and no failures of the priming system have been reported since that time.

2.7 Comparison of the SONGS-1 Saltwater Cooling System with Other Saltwater Cooling Systems

The SONGS-1 SWC System is similar in design to typical light water reactor SWC Systems or ultimate heat sinks for Component Cooling Water (CCW) Systems. Most systems utilize two 100% capacity safety related pumps with two 100% capacity safety related CCW heat exchangers as does the SONGS-1 SWC System.

The primary differences between the SONGS-1 SWC System and other SWC Systems are:

- The SONGS-1 SWC has an additional 100% capacity non-safety related pump available. This pump is powered from a safety-related AC power source. Most others don't have backup pumps.

- SONGS-1 SWC System saltwater flow can be provided by either the screen wash pumps or the fire water pumps. These backup pumps provide adequate heat removal capability for normal conditions. Most other SWC Systems do not have backup pumps of any capacity.

- The SONGS-1 SWC System does not utilize any remotely operated valves with the exception of the CCW MOV's on the CCW side of the CCW heat exchangers. The MOV on each CCW heat exchanger is open when the respective SWC train is in use and visa-versa. All other valves are manually operated locally. Most other SWC System's utilize remotely operated pneumatic or motor-operated valves on the discharge of the SWC pumps and the CCW heat exchangers. The SONGS-1 SWC System's manually operated valves are located in close proximity to the Control Room (less than 5 minutes) since the intake structure is inside the primary protected area boundary. Therefore, realignment of the SWC System or backup pump flow paths can be achieved before significant CCW heatup occurs in the case of a loss of normal SWC flow. Use of the backup pumps and flow paths is

proceduralized in Abnormal Operating Instruction SO1-2.4-1.

- The SONGS-1 SWC System has a cross-tie to permit use of a Train A SWC pump with a Train B CCW heat exchanger and vice-versa. Many plants do not have this capability.

- The SONGS-1 SWC System has not experienced significant debris fouling over the life of the plant due to the height of the SWC pumps in the intake structure and the large size of the CCW heat exchanger tubes. Bio-fouling of the CCW heat exchanger outlet with gooseneck barnacles has been experienced following long shutdowns where the CCW heat load was minimal and the SWC temperature was near the ocean temperature. This failure mode has not been observed to occur during power operation. The suction strainer to the auxiliary SWC pump has become clogged during periods of extended operation since the suction for the pump is directly from the circulating water inlet tunnel and does not benefit from the effects of the circulating water pumps in the forebay on debris movement. Nevertheless, these failures have not occurred during or immediately following power operation where SWC capability is needed the most for decay heat removal. Many other plants have experienced significant bio-fouling problems of their SWC Systems.

3.0 METHODOLOGY OF THE STUDY

This reliability study is performed in accordance with the guidelines presented in the IREP Procedures Guide.[1] The system models and success criteria are developed using best-estimate data. Conservatisms are included, where necessary, to allow for model simplifications or for those instances where best-estimate data was not available. To the extent possible, such conservatisms are identified in Section 4.0 of this report.

3.1 Analysis Guidelines and Fundamental Assumptions

Purpose of the Analysis

The study assesses the reliability of the SWC System in achieving long term stable operation of the plant under normal and maximum heat load conditions.

Demand Environments

The reliability of the SWC System is determined for normal and maximum heat load conditions. Normal heat load conditions exist during steady state power operation and steady state shutdown cooling modes. Maximum heat load conditions are assumed to occur 4 hours after shutdown from power operation. At this time, the SWC System is required to remove the heat from the RCS via the RHR heat exchangers. The maximum heat removal rate is 91.1×10^6 BTU/HR with both SWC pumps and CCW heat exchangers in operation.

Plant Configuration

System data is obtained from official plant drawings, emergency operating instructions, systems descriptions, training materials, and discussions with plant operations and engineering staff. The configuration of the plant systems is assumed to be that of the plant following the completion of the Cycle 9 refueling outage (which commenced in November, 1985).

The reliability of the SWC System is evaluated for both normal and maximum heat load conditions. Under normal heat load conditions, at least one SWC pump is required to operate and the screen wash and fire water pumps are available as a backup to the SWC pumps. Under maximum conditions, only one of the SWC pumps or the auxiliary SWC pump is capable of handling the heat load from the CCW System without causing the design temperature of the CCW System to be exceeded.

3.2 Computer Codes Utilized

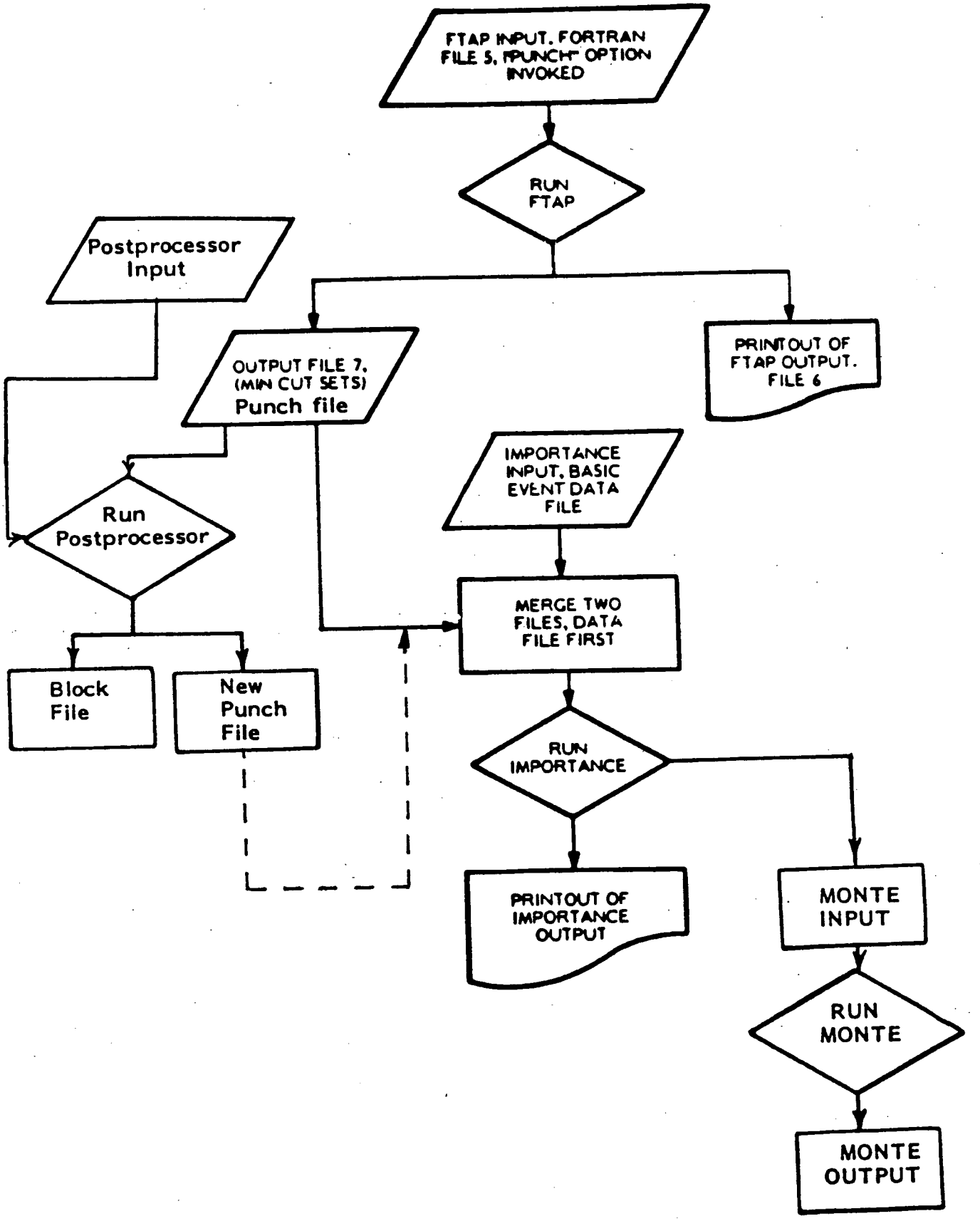
The following computer codes are used to perform the reliability analyses:

- FTAP
- FTAP POSTPROCESSOR
- IMPORTANCE
- MONTE

A flow chart of the overall execution of these codes is shown in Figure 3-1.

FIGURE 3-1

Computer Code Flowchart



FTAP and FTAP POSTPROCESSOR perform the qualitative evaluation; IMPORTANCE, performs the probabilistic evaluation; and MONTE performs the uncertainty analysis. Boeing Aerospace Co.[7] ranked these codes first in suiting the needs of the U.S. Air Force in reliability analysis, and performed an extensive QA check of these codes. The codes are used by corporations and government agencies worldwide.

FTAP accepts as input a Boolean equation for each gate event in the fault tree or logic model. FTAP contains routines for checking the input fault tree for logic errors and inconsistencies [8].

The code can eliminate minimal cut sets or event sequences according to probability or cut set order, which is particularly useful for analysis of complex systems.

In addition, FTAP's TRUE and FALSE commands allow the user to selectively modify the fault tree model to meet specific failure conditions. For example, if the TRUE command is used to specify a loss of AC power (i.e., loss of AC power is true), the code will automatically generate a minimized fault tree for this condition and generate cut sets for only the non-AC-dependent systems (since all AC-dependent systems are assumed to be failed).

FTAP POSTPROCESSOR is particularly useful for the enhancement of fault tree analyses. The features of FTAP POSTPROCESSOR include:

- conducting common cause analyses,

- o dropping complemented events and performing the subsequent minimization.
- o elimination of cut sets containing mutually exclusive events, and
- o generation of block files (i.e., sets of Boolean equations for systems and subsystems).

The user provides an input data file specifying the mutually exclusive items to be dropped from the cut set solution and/or the basic event combinations that are to be replaced in the minimal cut sets with alternate events (e.g. common cause failure events). FTAP POSTPROCESSOR then modifies the FTAP cut set file (i.e., the PUNCH file in Figure 3-1) in accordance with the user's instructions.

IMPORTANCE accepts as input both basic event data (i.e. failure rates, error factors) and the minimal cut set file generated by FTAP or FTAP POSTPROCESSOR. The code generates as output the top event probability and the ranking of basic events and minimal cut sets according to various user-selected importance measures.

In addition to its usefulness in performing reliability analyses, additional code options are available to perform availability analyses. Code input for these options include repair times and inspection intervals. The code output includes mean occurrence of the top event and system unavailability, as well as importance rankings as described above.

The MONTE code is used to perform a Monte Carlo-type uncertainty analysis. Both normal and lognormal uncertainty

distributions are allowed for each event. MONTE calculates confidence intervals for the top event probability and, optionally, for basic event and minimal cut set importance rankings.

3.3 Fault Tree Detail

The fault trees developed for this study are plant-specific logic models. They extend to the component level, which is generally consistent with available data. Subcomponent parts are not treated separately. The logic models include the treatment of both the successful and failed states of active and passive components. Partial component operation is considered to be a failure (and is a conservatism). Dependent failure mechanisms are characterized, including primarily functional dependencies. The fault tree includes all components in the system whose operation affect system function, including safety and non-safety related components. The modeling of safety-related and non-safety related components is treated the same in this study due to the lack of component failure rate data for each different class since reliability differences between the two classes of components have not been identified.

Rather than modeling maintenance contributions as mutually exclusive events in the fault trees, a significant analytical enhancement to the FTAP code series has been utilized to remove all excluded plant operating conditions from the analysis. This is done through the use of the FTAP POSTPROCESSOR to remove non-existent cut sets from the analytical solution derived by FTAP. In addition, the FTAP POSTPROCESSOR searches for statistically dependent events in

the minimal cut set solution and performs a Boolean substitution for these events. Hence, in most cases, common cause failures are not modeled directly in the fault trees, since they can be added during the FTAP POSTPROCESSOR analysis.

3.4 Data Sources

The quantification of the fault trees is performed using the best available data sources for each identified basic event, as described below.

Component Failure Rate Data

Plant-specific failure rate data is collected only for the diesel generators and SWC pumps. In general, detailed plant records for all plant components are available only for the last two years (following the implementation of a computerized maintenance management system.) In addition, the plant has been shutdown for modification activities during much of the time period for which computerized data is available. Other plant specific sources of failure rate data, such as Licensee Event Reports (LER's), are generally not utilized since they generally under-report failures. The reporting requirements for these reports in the Technical Specification, and mode of operation the plant is in at the time of the failure, determine whether or not a report is generated. Hence, it is generally impractical to develop statistically important failure rate estimates for the individual plant components evaluated in this study.

Hence for most components, the Interim Reliability Evaluation Program (IREP) generic data base is utilized as the source of the failure rate data. Data from other recent PRA's (e.g. Limerick, Calvert Cliffs IREP) are also used as necessary. Finally, where more recent data was not available, WASH-1400 is relied upon. A detailed description of the specific basic event failure rates used in this analysis is contained in Section 4.4.

Maintenance and Test Data

Plant-specific maintenance data is analyzed only for the diesel generators (due to the limitations on available plant-specific data as noted above). For other components, maintenance experience from recent PRA's, particularly the Calvert Cliffs IREP, is used to estimate the San Onofre values.

In general, the contribution of testing activities is quite small for the systems modeled herein. Hence component unavailability due to testing is assumed to be encompassed by the maintenance unavailability.

Human Reliability Data

Operator actions can play an important role in any reactor accident or transient. Therefore, an effort is made to include significant operator actions in this reliability study. Explicit inclusion is achieved for errors associated with improper valve alignments following maintenance actions and for operator failures to follow procedures calling for manual alignment and initiation of backup pumps. However,

operator errors of commission, which defeat system performance or which aggravate normal system responses to an event, are generally not explicitly evaluated. This is consistent with previous PRA studies including the IREP and Reactor Safety (RSSMAP) studies.

For human error rate estimates, the guidelines of NUREG/CR-1278[6] are applied in concert with discussions with plant operations personnel and review of the emergency operating instructions. Interviews with plant operations and technical personnel were conducted on March 31, 1986 as part of this study.

4.0 OVERVIEW OF THE SALTWATER COOLING SYSTEM RELIABILITY ASSESSMENT

4.1 Description of Cases Studied

A total of two analyses are performed as part of this study (one for each of the cases). Only one fault tree model is required to perform these analyses, through the use of the tree modification features of the FTAP code. Appendix A presents the fault tree model used in the analyses.

4.1.1 Saltwater Cooling System Under Normal Heat Load Conditions

Under normal heat load conditions, the SWC System will have one train operating and the other train in standby. Upon low discharge pressure of the operating pump, the standby pump starts and the motor-operated valve on the outlet of the CCW side of the CCW heat exchanger opens. In the event that both the SWC pumps become inoperable, the auxiliary SWC pump can be manually started and aligned to provide a backup to the SWC pumps.

In the event that the SWC pumps and the auxiliary SWC pump become inoperable, either the screen wash or the firewater pumps can be manually started and aligned to provide backup to the SWC pumps. It is assumed that either both the screen wash pumps or both the firewater pumps are required to provide adequate backup for one SWC pump.

4.1.2 Saltwater Cooling System Under Maximum Heat Load Conditions

Under maximum heat load conditions, only the SWC pumps and the auxiliary SWC pump provide adequate saltwater cooling flow. One SWC train is considered to provide sufficient cooling flow to bring the plant to cold shutdown. This case of the analysis did not include the screen wash pumps or firewater pumps because there have been no formal analyses or tests demonstrating the adequacy of the screen wash and firewater pumps as backups to the SWC pumps.

When the SWC System fails, a time frame of approximately 10 minutes exits before the CCW System heats up to maximum allowable temperature of 150°F, the reactor coolant pump thermal barrier temperatures exceed 120°F, and charging pump bearing oil cooler outlet temperatures exceed 120°F. Due to this short time span, recovery of the SWC pumps was not modeled.

4.2 Fault Tree Models Developed

As noted previously, only one fault tree model is developed in support of this reliability study. The fault tree set (presented in Appendix A) is used to evaluate the SWC System for both normal and maximum heat load conditions.

Fault tree models are developed for the following systems:

- Saltwater Cooling System (with the screen wash and firewater pumps as backup)

- o AC Power System
- o DC Power System

In addition, a very simple model is developed for the loss of voltage (LOV) signal circuitry. This simple model considers only the overall failure of an actuation signal train and operator failure to manually initiate the desired actuation signal.

The SWC System tree, as noted above, is a combined SWC System with the screen wash and firewater pumps as backup to the SWC pumps. However, for the case of the SWC System under maximum heat load, the FTAP "TRUE" instruction is used to instruct the code to fail the backup pumps. Hence, the branches for the screen wash and the fire water pumps are disabled, enabling the use of the same fault tree for both cases.

4.3 Assumptions Used in the Development of the Fault Trees

4.3.1 Saltwater Cooling System (Normal Heat Load Conditions)

The following assumptions are used in constructing the SWC System fault tree:

1. It is assumed that SWC pump SWC-G-13A is normally running and is aligned to heat exchanger CCW-E-20B.

2. The service water bearing flush to the SWC pumps is not modeled in the fault trees. The SWC pumps can operate for 7 days without bearing flush water without suffering deleterious consequences.[19]

3. Flow diversion back to the auxiliary SWC pump, the screen wash pumps, and the firewater pumps is not modeled because each line has a check valve and a butterfly valve that is closed when these pumps are not being used as saltwater backup. The probability of failure of a check valve and the butterfly valve being inadvertently left open is considered insignificantly small compared to other failure cut set probabilities.

4. Piping failures are not included.

5. Control circuit failures of the motor-driven pumps and 480 V AC valves are not included. Circuit failures are relatively unlikely and there is a high likelihood the operator could override the circuits locally in the event of failure.

6. The dominant failure mode of manual valves that are required to be open is due to errors in leaving the valves closed after maintenance.

7. Either both screen wash pumps or both firewater pumps are required as adequate backup to one SWC pump.

8. The use of the gasoline engine driver of the north screen wash pump is not modeled since the use of only one screen wash pump is not known to be adequate in any condition. In any event, loss of all AC power would remove the CCW pumps from operation and severely curtail decay heat removal from the RCS.

9. Flow diversion from the SWC System to the screens is not modeled. The operator must be locally at the valves to align the system and would immediately be aware of the flow being diverted to the screens.

10. Fouling of the SWC pump intake screens from debris is not modeled. The height of the SWC pumps in the intake structure and the large size of the CCW heat exchanger tubes makes fouling unlikely as indicated by the operating history of the system.

11. The impact of external initiators such as seismic events, fire, flooding, or sabotage are not included in the analysis. These types of events impact other systems as well as the SWC System and are generally treated on the plant as a whole.

12. Operator recovery of failed SWC components was not modeled since the results of the fault tree model for the case without recovery indicated that recovery would provide insignificant benefit due to the high redundancy of the SWC System.

13. Failures of the Auxiliary SWC Pump Primary System due to piping leaks were not included in the analysis since: (1) piping failures are not normally included in such studies and (2) repairs to the primary system following the March 10, 1980 failure have been successful in preventing leaks.

4.3.2 Saltwater Cooling System (Maximum Heat Load Conditions)

1. The screen wash pumps and fire pumps are not adequate backup to the SWC pumps under maximum load conditions.

2. Flow diversion back to the auxiliary SWC pump is not modeled because the discharge line has a check valve and a butterfly valve that is closed when the pump is not being used as backup.

Assumptions 1, 2, 4, 5, 6, 10, 11, 12, and 13 from Section 4.3.1 apply to this case as well.

4.3.3 AC Power System

The following assumptions are considered in the development of the fault tree for the AC Power System:

1. The loss of offsite power is a conditional loss of offsite power given a turbine generator trip.

2. The failure of control power for circuit breakers from the diesel generators to the 4160 V busses is included in the fault tree.

3. Failures of the normally closed breakers connecting the auxiliary transformers and the 4160 B busses, and connecting the 4160 V busses and 480 V busses are not modeled since the failure mode is significantly less likely than other modeled failure modes.

4. Failures of the 4160 V/480 V transformers are not included in the fault trees due to their significantly lower failure rates than other associated components. Failures of auxiliary transformers A, B, and C are included.

5. Operator failures to load the diesel generators to the 4160 V AC busses and failures to realign the 4160 V AC busses from normal configurations to emergency configurations are included.

4.3.4 DC Power

The following assumptions are considered in the development of the fault trees for DC busses:

1. The major failure modes of DC power sources considered include battery unavailability and failure of the battery charger to operate, given insufficient power from the battery.

2. The breakers between the motor control centers and the battery chargers, and the breakers between the battery chargers and the DC busses are normally closed and are thus not modeled. Normally closed breakers have a significantly lower failure rate than breakers which must change state to operate affected system components.

4.3.5 Loss of Voltage Actuation Signal

In the process of developing this fault tree, the following assumptions are used:

1. All hardware and human failures associated with voltage sensing and relay logic circuits are modeled as a single aggregate event.

2. Operator action to manually initiate the LOV signal, if automatic actuation fails, is included.

4.4 Data Base Used for This Study

4.4.1 Component Failure Rate Data

The mission time (or length of time which components must operate) is 24 hours (except where noted). This is based upon the time required to bring the plant from hot standby to cold shutdown. The major sources of basic event data include:

- Plant-specific data
- IREP procedures guide (NUREG/CR-2728)
- WASH-1400
- Limerick PRA
- ORNL AC Power Reliability Study (NUREG/CR-2989)
- Calvert Cliffs IREP Study (NUREG/CR-3511)
- Shoreham PRA
- Engineering judgment

Appendix B provides a summary of the unavailabilities used for each basic event. Table 4-1 presents a listing of the key generic basic event unavailabilities used in this study.

The following sub-sections highlight the assumptions considered in the process of developing the data base:

Saltwater Cooling Pumps

An attempt was made to collect SWC pump failure to start data. However, testing records for these pumps were not in a form readily usable in this application. Plant personnel indicate that numerous failure to start events have occurred for the SWC pumps. However, the failures to start were generally attributable to design features of the system, not the pumps, and the design features contributing to the failures have since been corrected.

Plant personnel with historical knowledge of the SWC System operation indicated that the SWC pumps have failed 4 times while running over the past 10 years of plant operation. Assuming that each of the two pumps was operating 50% of the time, the equivalent failure to run rate would be 4.6×10^{-5}/hr. This failure rate is very similar to the IREP Procedures Guide motor-driven pump failure to run probability of 3.0×10^{-5}/hr. This indicates that the SWC pumps at SONGS-1 are about as reliable as the average motor-driven pump used in commercial nuclear power plants.

Failure rates (both failure to start and failure to run) and associated error factors for the pumps are taken directly from the generic data base defined in the IREP Procedures Guide.[1]

TABLE 4-1

GENERIC BASIC EVENT UNAVAILABILITY DATA

BASIC EVENT DESCRIPTION	BASIC EVENT PROB.	IREP GUIDE PROB.	OCONEE PROB.	CALVERT CLIFFS PROB.	OTHER PROB.	REFERENCE
MOTOR DRIVEN PUMP FAILS TO START	3.0E-03	3.0E-03	5.0E-04	3.0E-03		
MOTOR DRIVEN PUMP FAILS TO RUN, GIVEN START	3.0E-05/HR	3.0E-05/HR	5.0E-04	3.0E-05/HR		
TURBINE DRIVEN PUMP FAILS TO START	3.0E-02	3.0E-02	4.0E-03			
TURBINE DRIVEN PUMP FAILS TO RUN, GIVEN START	1.0E-05/HR	1.0E-05/HR	2.0E-05/HR			
DIESEL DRIVEN PUMP FAILS TO START	1.0E-03	1.0E-03				
DIESEL DRIVEN PUMP FAILS TO RUN, GIVEN START	8.0E-04/HR	8.0E-04/HR				
MOTOR OPERATED VALVE FAILS TO OPEN	3.0E-03	3.0E-03	4.0E-03	3.0E-03		
MOTOR OPERATED VALVE FAILS TO REMAIN OPEN	1.0E-07/HR	1.0E-07/HR	2.3E-07/HR	1.0E-07/HR		
CATASTROPHIC FAILURE OF MOTOR OPERATED VALVE	5.0E-07/HR	5.0E-07/HR				
SOLENOID VALVE FAILS TO OPERATE	1.0E-03	1.0E-03	2.4E-03	1.0E-03		
AIR OF FLUID OPERATED VALVE FAILS TO OPEN	3.0E-03	3.0E-03	9.0E-04	3.0E-03		
CHECK VALVE FAILS TO OPEN	1.0E-04	1.0E-04	9.8E-05	1.0E-04		
CHECK VALVE FAILS TO CLOSE	1.0E-03	1.0E-03	1.0E-04			
CHECK VALVE LEAKS (CATASTROPHIC)	5.0E-07/HR	5.0E-07/HR				
MANUAL VALVE LEFT CLOSED AFTER MAINTENANCE	1.0E-04	1.0E-04				
RELIEF VALVE FAILS TO CLOSE, GIVEN OPEN	2.0E-02	2.0E-02		3.0E-06/HR		
CIRCUIT BREAKER FAILS TO TRANSFER	3.0E-03	3.0E-03	1.0E-06/HR	3.0E-03		
CIRCUIT BREAKER- SPURIOUS TRIP	3.0E-05	3.0E-05				
BUS FAILS TO FUNCTION	1.0E-08/HR	1.0E-08/HR	4.2E-07/HR			
ORIFICE FAILS TO REMAIN OPEN (PLUG)	3.0E-04	3.0E-04				
BATTERY FAILS TO PROVIDE PROPER OUTPUT	1.0E-06/HR	1.0E-06/HR	9.0E-08/HR	1.0E-06/HR		
BATTERY CHARGER FAILS TO OPERATE	1.0E-06/HR	1.0E-06/HR	3.1E-06/HR	1.0E-06/HR		
INVERTER FAILS TO OPERATE	1.0E-04/HR	1.0E-04/HR	4.3E-05/HR	1.0E-04/HR		
WIRE FAILS- OPEN CIRCUIT	3.0E-06/HR	3.0E-06/HR		3.0E-06/HR		
WIRE FAILS- SHORT TO GROUND	3.0E-07/HR	3.0E-07/HR		3.0E-07/HR		
MANUAL VALVE DOES NOT OPEN	1.0E-04	1.0E-04				
CONTROL VALVE UNAVAILABLE DUE TO MAINTENANCE	3.6E-06/HR			3.6E-06/HR		
MOTOR PUMP UNAVAILABLE DUE TO MAINTENANCE	4.6E-04/HR			4.6E-04/HR		
PIPE PLUGGED	8.5E-09/HR			8.5E-09/HR		
TANK FAILS TO FUNCTION	8.5E-10/HR			8.5E-10/HR	8.5E-10/HR	WASH-1400
MANUAL VALVE PLUGS	3.0E-07/HR	3.0E-07/HR		1.0E-07/HR		
AIR OPERATED VALVE FAILS TO REMAIN OPEN	1.3E-04			1.0E-07/HR	1.3E-04	WASH-1400
TURBINE PUMP UNAVAILABLE DUE TO MAINTENANCE	4.6E-04			4.6E-04		
NITROGEN GAS BOTTLES FAIL	1.2E-03		1.2E-03			
DIESEL GENERATOR FAILS TO RUN	2.3E-03/HR			3.0E-03/HR	2.3E-03/HR	NUREG CR-2989
DIESEL GENERATOR FAILS TO START	2.5E-02			5.4E-02	2.5E-02	NUREG CR-2989
HEAT EXCHANGER FOULS	8.5E-08/HR			8.5E-08/HR		
AIR OPERATED VALVE UNAVAILABLE DUE TO MAINT.	4.9E-05/HR			4.9E-05/HR		

Diesel Generators

Failure to start data was collected for the two main diesels since their installation in 1977. This data was derived from reviewing maintenance testing logs and Nuclear Plant Reliability Data Systems (NPRDS) reports for this time period. The calculated failure to start probability for diesel generator 1 is 0.059 per demand.

Failure to run data was not available for these diesels. Therefore, the failure rates and error factors are taken directly from a recent study performed by Oak Ridge National Laboratories [2].

Valves

Failure rates (both per demand and per hour) and associated error factors for motor-operated valves, solenoid valves, check valves and manual valves are taken directly from the generic data base defined in the IREP Procedures Guide. [1]

Electrical Components

Failure rates (both per demand and per hour) and associated error factors for circuit breakers, busses, batteries, battery chargers and cables are taken directly from the generic data base defined in the IREP Procedures Guide. [1]

Loss of Voltage (LOV) Actuation Signal

The LOV actuation signal logic initiates upon a detection of voltage loss on 4160 V buses 1C & 2C. For purposes of this

study, an aggregated failure rate per channel of 2×10^{-3} per demand was assumed. This value should be conservative since there are no mechanical sensors employed in this logic circuit. Miscalibration errors are much less likely to degrade system performance. Hence, the failure to detect a loss of voltage should be less likely than a failure to detect a pre-set pressure or level value.

4.4.2 Test and Maintenance Data

The contribution of testing to system unavailability is generally much smaller than that due to maintenance because of the relatively short test durations and the fact that components usually can be utilized to perform their safety function even while in a test mode. Hence, only maintenance unavailability is included in the fault tree models.

Saltwater Cooling Pumps

For the SWC pumps, the auxiliary SWC pump, the screen wash pumps, and the firewater pumps, maintenance data from the Calvert Cliffs IREP[3] was used. Maintenance records for the SWC pumps were not in a form suitable for data collection and did not accurately indicate actual repair times. The turbine-driven auxiliary feedwater (AFW) pump maintenance unavailability of 3.7×10^{-3} from the Calvert Cliffs IREP was used for the SONGS-1 SWC and auxiliary pumps maintenance unavailability. This value is based upon a maintenance frequency of 4.6×10^{-4} per hour and a mean repair time of 8 hours. The maintenance unavailability of the Calvert Cliffs turbine-driven AFW pump is expected to be greater than that of a SONGS-1 SWC pump. This represents conservatism in the

analysis. Motor-driven AFW pump data from the Calvert Cliffs IREP may be non-conservative for the SONGS-1 SWC pumps since the SONGS-1 SWC pumps have required significant corrective maintenance.

Diesel Generators

Plant data was also collected for each of the two main diesel generators as a part of this study. Detailed maintenance records could be readily obtained only for those maintenance activities which were performed since June, 1984. Hence, this data interval (despite its relatively short duration) was used to estimate maintenance unavailability. It should be noted that this data is based upon interpretation of somewhat incomplete maintenance order forms. In addition, the unit was in cold shutdown for a significant portion of the time. Therefore, it is difficult to identify only those maintenance items that would have been performed if the plant was in a normal power operations routine.

A value of .046 was used for diesel generator unavailability in this study, based upon a average of approximately 560 hours of maintenance over a 17 month period. This value is quite high and hence, may be overly conservative.

4.4.3 Human Reliability Data

Key human reliability actions modeled in the fault trees include the following: common mode LOV miscalibration, operator failures to backup SWC pumps and LOV, operator error in operating manual valves, operator failures to cross-tie 480 V or 4160 V busses, failure to utilize the

SDG&E 12 kV line, and inadvertent paralleling of unsynchronized power sources.

Failures to Cross-tie 480 V or 4160 V Busses

The Unit 1 AC Power System has a number of cross-tie circuit breakers that would allow plant operators the ability to connect various busses (in particular, 480 V bus no. 1) to alternate energized busses. In general, the cross-connection of various busses are described in various normal operating instructions, but typically, are not discussed in the abnormal operating instructions (AOI's). Some cross-tie breakers also have protective interlocks to prevent inadvertent paralleling of unsynchronized buses; however, these interlocks can be bypassed by the operators through the use of special breaker adjustment sequences as indicated in normal operating procedures for use only during plant shutdown.

In general, an error probability of 0.01 was assigned for an operator failure to connect one bus to another (the exception to this rule is the use of a 0.05 failure probability to connect 480 V bus no. 1 to bus no. 2 (e.g., to enable bus no. 1 to receive power from the SDG&E line connected to bus no. 2), since multiple breaker realignments are necessary for this configuration and the evolution is not proceduralized).

Failure to Utilize the SDG&E 12kV Line

The SDG&E line is a separate 12kV circuit that can be used as an alternate power source for 480 V bus no. 2. The use of this line is not proceduralized at present. If this line was

available following a loss of normal switchyard power, the operators would know this fact by either examining the control room electrical panel instrumentation or by noting that the "12kV LINE UNAVAILABLE" annunciator was not lit. Because neither of these methods provides a conspicuous indication that the line is available, a 0.2 "failure to recognize" error was assumed.

Inadvertent Paralleling of Unsynchronized Power Sources

As noted above, the presence of the various bus tie breakers could allow an operator to unintentionally parallel unsynchronized power sources if electrical interlocks were inadvertently bypassed and procedural precautions were not heeded during power operation of the plant. Of particular concern is the possibility of damage to one or both diesel generators if they were connected to an energized bus.

To account for this potential failure mechanism, a conservative failure probability of $1x10^{-3}$ is assumed. This event would require multiple procedural step violations. If two power sources are loaded onto the same bus, "bus parallel alarms" occur for some busses. In addition, bus transfer evolutions are, in general, practiced routinely by plant operators.

Failure to Align Backup Systems or Start Backup Pumps

The success of the backup pumps to the SWC pumps depends on the operators recognizing the loss of the normal SWC pumps, aligning the backup pumps and starting the backup pumps. Also, the firewater pumps are not used regularly, therefore,

the possibility exists that the locked open manual valves could inadvertently be closed.

In general, the operator actions required to open or close manual valves to align the backup systems and to start the backup pumps were assigned an error probability of .003. This value is based on the operator having a short procedure without checkoff provisions to follow. A value of $1x10^{-4}$ is assigned to the locked open manual valve inadvertently left closed based on the generic value for manual valves in the IREP Procedure Guide data base.

4.4.4 Common Mode Failure Data

In general, common mode failure effects are not deemed to be significant for the SWC System. Common mode failure of both SWC pumps is unlikely, since one pump is normally operating and the other is in a standby mode. In addition, the auxiliary SWC pump is of a different design than the SWC pumps. Since the system is normally running and contains only manually operated valves, common mode valve failures are also unlikely. Hence only common mode failures of the emergency diesel generators are considered. Common mode failures are not modeled directly in the fault trees, but rather are incorporated into the analysis through the use of the FTAP POSTPROCESSOR.

For failures to start of the main diesel generators, the Shoreham PRA dependency model is used [4]. This model assumes a 0.19 conditional failure probability for the second diesel generator given that the first diesel

generator has failed. This conditional failure probability is also applied for failures to run.

In summary, the basic event data used in the fault tree analyses is chosen to be as realistic as possible. Where the uncertainty is large or insufficient historical data is available, conservative mean values are used. The use of generic data, site specific data, and conservative estimates of reliability based on engineering judgment is consistent with the methodology employed in other published reliability assessments.

5.0 RESULTS OF THE STUDY

5.1 Overview

The results of each of the cases studied are summarized below:

	Mean Unavailability (per 24 hour interval)
Normal Conditions	3.5E-05
Maximum Conditions	3.6E-05

The results indicate that the SWC System will experience a total failure approximately once in every 100 years. This reliability is good for a system required to be operable at all times and is due to the system simplicity and redundancy of SWC pumps.

As can be seen, there is little difference in system unavailability between the two cases, despite the fact that the "normal conditions" case has two additional backup pump sources available. This small difference is the result of the fact that all the pumps (SWC, screen wash, firewater) are all AC-power dependent. Hence, the increased redundancy in the "normal conditions" case is largely negated due to the common dependency upon AC power.

AC power faults dominate both analyses, such that the key contributor to the loss of all saltwater cooling is a loss of all AC power event. It should be noted, however, that under loss of all AC power conditions, almost all the SWC heat

loads would be eliminated. The only contribution to CCW System and hence SWC System heat load would be the DC thermal barrier pumps cooling the reactor coolant pump seals. Therefore, the unavailability of the SWC System when it could be effective is substantially lower than the values quoted above.

Figure 5-1 presents the 95% probabilistic uncertainty intervals for the maximum and normal conditions, respectively. The uncertainty intervals for each case are considerable, as is true of all probabilistic assessments. These uncertainties must be considered when attempting to utilize these results.

Each of the sections below evaluates the results of the two cases in greater detail.

5.2 Normal Heat Load Case

The SWC System under normal heat load conditions shows a good reliability. The results of the analysis show that the total unavailability of the system is dominated by various combinations of electrical failures that lead to a loss of all AC power (i.e., station blackout). These electrical failures account for approximately 87% of the total unavailability.

SWC component failures are not significant due to the high degree of redundancy of the active components (i.e., one normally running pump, several standby pumps).

FIGURE 5-1
SONGS-1 SALTWATER COOLING SYSTEM
RELIABILITY STUDY RESULTS

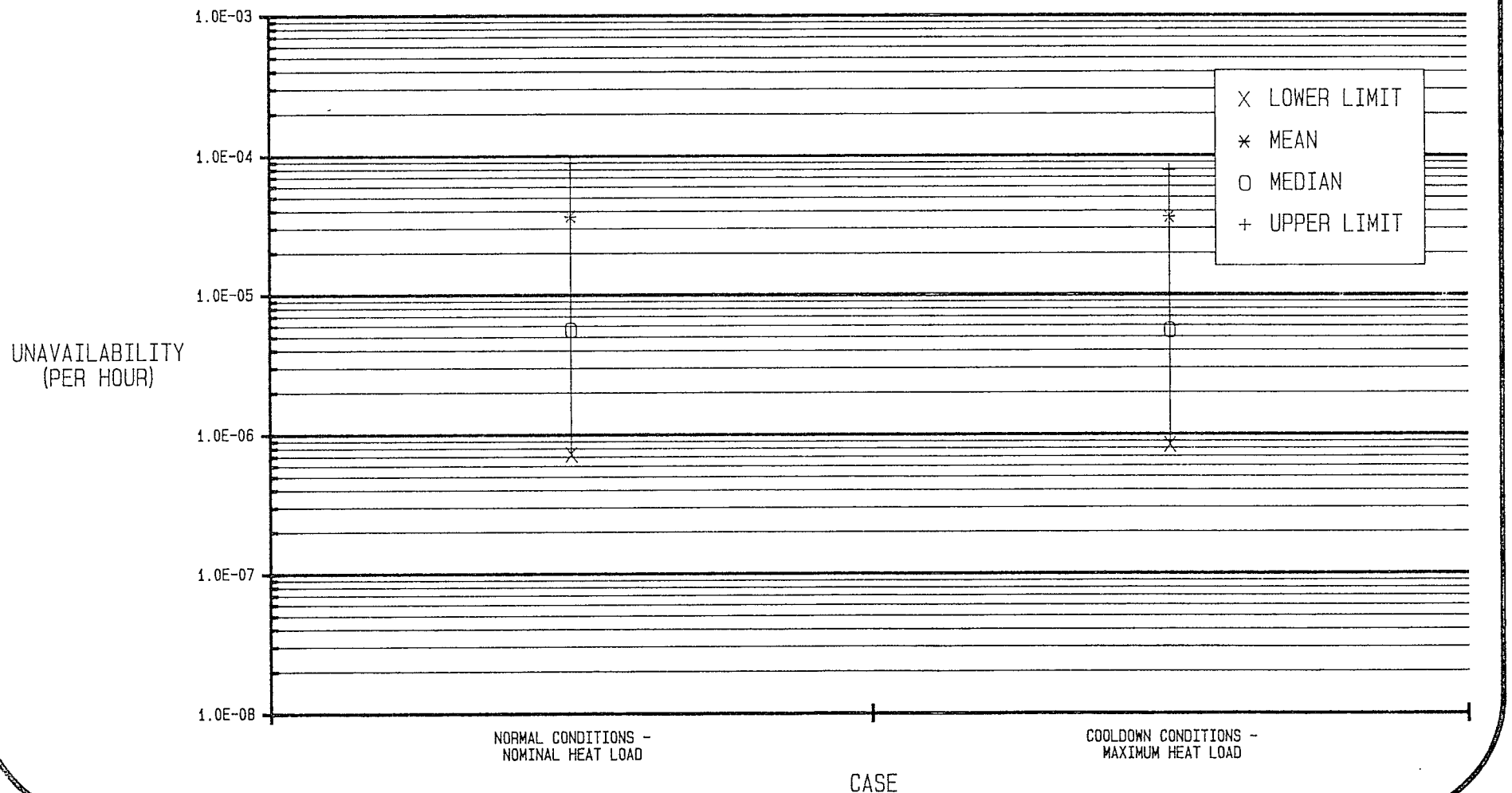


Table 5-1 presents the most significant basic events for this case. As noted above, electrical system faults dominate the analysis. Table 5-2 lists the minimal cut sets that contribute 88% of the total unavailability. As can be seen, SWC component failures do not appear in the dominant cut sets.

5.3 Maximum Heat Load Case

The results of the maximum heat load case contain, as expected, the same dominant minimal cut sets (Table 5-2) identified in the normal heat load case (i.e., those involving a complete loss of AC power). This is due to the fact that the same components used in the normal heat load case are available for this case with the exception of the screen wash pumps and firewater pumps. However, these pumps are of no benefit in any of the dominant cut sets, since the pumps are also AC-powered and would be rendered inoperable during a station blackout event.

TABLE 5-1

Basic Events Exhibiting Significant Importance
For
Saltwater Cooling System

RANK	BASIC EVENT	FUSSELL-VESELY IMPORTANCE*
1	CONDITIONAL LOSS OF OFFSITE POWER	0.959
2	SDGE 12KV IS UNAVAILABLE AFTER LOSS OF SWITCHYARD	0.792
3	DIESEL GENERATOR NO. 1 FAILS TO START	0.555
4	DIESEL GENERATOR NO. 2 FAILS GIVEN DIESEL GENERATOR NO. 1 FAILS	0.353
5	DIESEL GENERATOR NO. 2 FAILS TO RUN	0.291
6	DIESEL GENERATOR NO. 1 FAILS TO RUN FOR 24 HOURS	0.222
7	DIESEL GENERATOR NO. 2 UNAVAILABLE DUE TO MAINTENANCE	0.177
8	OPERATOR FAILS TO REALIGN BUS NO. 2 TO SDGE LINE	0.167
9	DIESEL GENERATOR NO. 1 UNAVAILABLE DUE TO MAINTENANCE	0.119
10	DIESEL GENERATOR NO. 2 FAILS TO START	0.0652
11	INSUFFICIENT WATER SUPPLY IN FOREBAY	0.0317

* The Fussell-Vesely measure of importance of any given event is equal to the sum of the probabilities of all cut sets containing that event divided by the total probability of all cut sets.

TABLE 5-1 (CONTINUED)

RANK	BASIC EVENT	FUSSELL-VESELY IMPORTANCE
12	OPERATORS INADVERTENTLY PARALLEL 4160V BUSSES	0.0315
13	OPERATOR INCORRECTLY CLOSES BREAKER 12C15	0.0264
14	OPERATOR FAILS TO CORRECTLY CLOSE BREAKER 11C14	0.0201
15	CIRCUIT BREAKER 12C15 FAILS TO CLOSE	0.0159
16	CIRCUIT BREAKER 11C14 FAILS TO CLOSE	0.0121
17	SALTWATER COOLING PUMP G-13C UNAVAILABLE DUE TO MAINTENANCE	0.0107
18	SALTWATER COOLING PUMP G-13C FAILS TO START	0.00865

TABLE 5-2

Dominant Minimal Cut Sets
For
Saltwater Cooling System

MEAN CUT SET PROB.	CUT SET DESCRIPTION	FRACTION OF TOTAL UNRELIA-BILITY	CUMUL-ATIVE FRACTION OF TOTAL UNRELIA-BILITY
1.1E-05	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATORS 1 AND 2 FAIL TO START -SDGE 12KV LINE IS UNAVAILABLE AFTER LOSS OF SWITCHYARD	0.291	0.291
3.1E-06	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 FAILS TO START -DIESEL GENERATOR NO. 2 FAILS TO RUN -SDGE 12KV LINE IS UNAVAILABLE AFTER LOSS OF SWITCHYARD	0.0843	0.3753
2.9E-06	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 FAILS TO RUN FOR 24 HOURS -DIESEL GENERATOR NO. 2 FAILS TO RUN -SDGE 12KV LINE IS UNAVAILABLE AFTER LOSS OF SWITCHYARD	0.0786	0.4539
2.6E-06	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 FAILS TO START -DIESEL GENERATOR NO. 2 UNAVAILABLE DUE TO MAINTENANCE -SDGE 12KV LINE IS UNAVAILABLE AFTER LOSS OF SWITCHYARD	0.0705	0.5244

TABLE 5-2 (CONTINUED)

MEAN CUT SET PROB.	CUT SET DESCRIPTION	FRACTION OF TOTAL UNRELIA-BILITY	CUMUL-ATIVE FRACTION OF TOTAL UNRELIA-BILITY
2.4E-06	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 UNAVAILABLE DUE TO MAINTENANCE -DIESEL GENERATOR NO. 2 FAIL TO RUN -SDGE 12KV LINE IS UNAVAILABLE AFTER LOSS OF SWITCHYARD	0.0657	0.5901
2.4E-06	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 FAILS TO RUN FOR 24 HOURS -DIESEL GENERATOR NO. 2 UNAVAILABLE DUE TO MAINTENANCE -SDGE 12KV LINE IS UNAVAILABLE AFTER LOSS OF SWITCHYARD	0.0657	0.6558
2.2E-06	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATORS 1 AND 2 FAIL TO START -OPERATOR FAILS TO REALIGN BUS NO. 2 TO SDGE LINE	0.0613	0.7171
9.9E-07	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 FAILS TO RUN FOR 24 HOURS -DIESEL GENERATOR NO. 2 FAILS TO START -SDGE 12KV LINE IS UNAVAILABLE AFTER LOSS OF SWITCHYARD	0.0271	0.7442
9.5E-07	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -OPERATORS INADVERTENTLY PARALLEL 4160V BUSSES -SDGE 12KV LINE IS UNAVAILABLE AFTER LOSS OF SWITCHYARD	0.0260	0.7702

TABLE 5-2 (CONTINUED)

MEAN CUT SET PROB.	CUT SET DESCRIPTION	FRACTION OF TOTAL UNRELIA-BILITY	CUMUL-ATIVE FRACTION OF TOTAL UNRELIA-BILITY
8.3E-07	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 UNAVAILABLE DUE TO MAINTENANCE -DIESEL GENERATOR NO. 2 FAILS TO START -SDGE 12KV LINE IS UNAVAILABLE AFTER LOSS OF SWITCHYARD	0.0227	0.7929
6.5E-07	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 FAILS TO START -DIESEL GENERATOR NO. 2 FAILS TO RUN -OPERATOR FAILS TO REALIGN BUS NO. 2 TO SDGE LINE	0.0177	0.8106
6.1E-07	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 FAILS TO RUN FOR 24 HOURS -DIESEL GENERATOR NO. 2 FAILS TO RUN -OPERATOR FAILS TO REALIGN BUS NO. 2 TO SDGE LINE	0.0165	0.8271
5.4E-07	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 FAILS TO START -DIESEL GENERATOR NO. 2 UNAVAILABLE DUE TO MAINTENANCE -OPERATOR FAILS TO REALIGN BUS NO. 2 TO SDGE LINE	0.0148	0.8419
5.1E-07	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 FAILS TO RUN FOR 24 HOURS -DIESEL GENERATOR NO. 2 UNAVAILABLE DUE TO MAINTENANCE -OPERATOR FAILS TO REALIGN BUS NO. 2 TO SDGE LINE	0.0138	0.8557

TABLE 5-2 (CONTINUED)

MEAN CUT SET PROB.	CUT SET DESCRIPTION	FRACTION OF TOTAL UNRELIA-BILITY	CUMUL-ATIVE FRACTION OF TOTAL UNRELIA-BILITY
5.1E-07	-CONDITIONAL LOSS OF OFFSITE POWER GIVEN TURBINE GENERATOR TRIP -DIESEL GENERATOR NO. 1 UNAVAILABLE DUE TO MAINTENANCE -DIESEL GENERATOR NO. 2 FAILS TO RUN -OPERATOR FAILS TO REALIGN BUS NO. 2 TO SDGE LINE	0.0138	0.8695
3.7E-07	-INSUFFICIENT WATER IN FOREBAYS -SALTWATER COOLING PUMP G-13C UNAVAILABLE DUE TO MAINTENANCE	0.0101	0.8796

6.0 CONCLUSIONS AND INSIGHTS

The results of this analysis show that the SONGS-1 SWC System is very reliable and should now be expected to suffer a complete failure only once in every 100 years. All the dominant failure sequences for the SWC System involve loss of station AC power events, which are highly unlikely events. These sequences would also disrupt CCW System operation, the heat load for SWC System. Thus, no modifications to the SWC System could be made to significantly improve its reliability.

The study analyzes the reliability of the SWC System for two cases; normal steady state plant operation and the maximum heat load condition. The maximum heat load condition does not include the screen wash pumps and firewater pumps as backups to the SWC pumps. The analysis indicates that the capability of the SWC System to respond to the maximum heat load condition is not significantly less than for normal steady heat load conditions. The combined reliability of the SWC pumps and auxiliary SWC pump is high enough that the screen wash pumps or firewater pumps do not provide significant benefit. The simplicity of the SWC System in its current design and the existence of two 100% capacity backup pumps result in the high predicted reliability of the system.

7.0 REFERENCES

1. NUREG/CR-2728, P.D. Carlson, et. al., "Interim Reliability Evaluation Program Procedures Guide," January, 1983.

2. NUREG/CR-2928, R. E. Battle and D. J. Campbell, "Reliability of Emergency AC Power Systems at Nuclear Power Plants," July, 1983.

3. NUREG/CR-3511, A.C. Payne, et. al. "Interim Reliability Evaluation Program" Analysis of the Calvert Cliffs Unit 1 Nuclear Power Plant," August, 1984.

4. SAI-372-83-PA-01, "Probabilistic Risk Assessment, Shoreham Nuclear Power Station," June 24, 1983.

5. San Onofre Nuclear Generating Station, Unit 1 Final Safety Analysis, Docket 50-206, Amendment No. 52, December 1975.

6. NUREG/CR-1278, "Handbook of Human Reliability," August, 1983.

7. Nuclear Safety Analysis Computer Program Description Document, Boeing Aerospace Company, Report DS-118655-1, February, 1979.

8. Willie, R., Computer Aided Fault Tree Analysis, Operations Research Center, Report No. 78-14, University of California, Berkeley, Report No. UCRL-13981, Lawrence Livermore National Laboratory, (1978).

9. Letter, J.G. Haynes, SCE to D.M. Crutchfield, NRC, "Failure of the Salt Water Cooling System San Onofre Nuclear Generating Station Unit 1," August 8, 1980.

10. Letter, J.G. Haynes, SCE to D.M. Crutchfield, NRC, "Failure of the Salt Water Cooling System San Onofre Nuclear Generating Station Unit 1," July 24, 1980.

11. "Loss of Component Cooling Water System," Operating Instruction S01-2.1-10, Revision 0, San Onofre Nuclear Generating Station, Unit 1.

12. NUREG-0829, "Integrated Plant Safety Assessment Systematic Evaluation Program San Onofre Nuclear Generating Station, Unit 1," April, 1985.

13. Letter, W. Paulson, NRC to R. Dietch, SCE. "SEP TOPIC IX-3, Station Service and Cooling Water Systems San Onofre Nuclear Generating Station, Unit 1,"December 27, 1982.

14. Letter, W.C. Moody, SCE to D.M. Crutchfield, NRC. "SEP TOPIC IX-3 San Onofre Nuclear Generating Station Unit 1," November 2, 1981.

15. Letter, J.G. Haynes, SCE to R.H. Engelken, NRC. " Instrument Air System Malfunction San Onofre - Unit 1," February 23, 1981.

16. Letter, H.L. Ottoson, SCE to R.H. Engelken, NRC. "30 Day Reportable Occurrence Involving the Saltwater Cooling System," August 21, 1980.

17. Letter, J.G. Haynes, SCE to R.H. Engelken, NRC. "Follow-up to Letter of May 13, 1980," December 26, 1980.

18. Letter, R.H. Engelken, NRC to L.T. Papay, SCE. "Failure of the San Onofre Unit 1 Salt Water Cooling System," April 4, 1980.

19. Meeting minutes of SCE/ERIN meeting at SONGS on March 31, 1986.

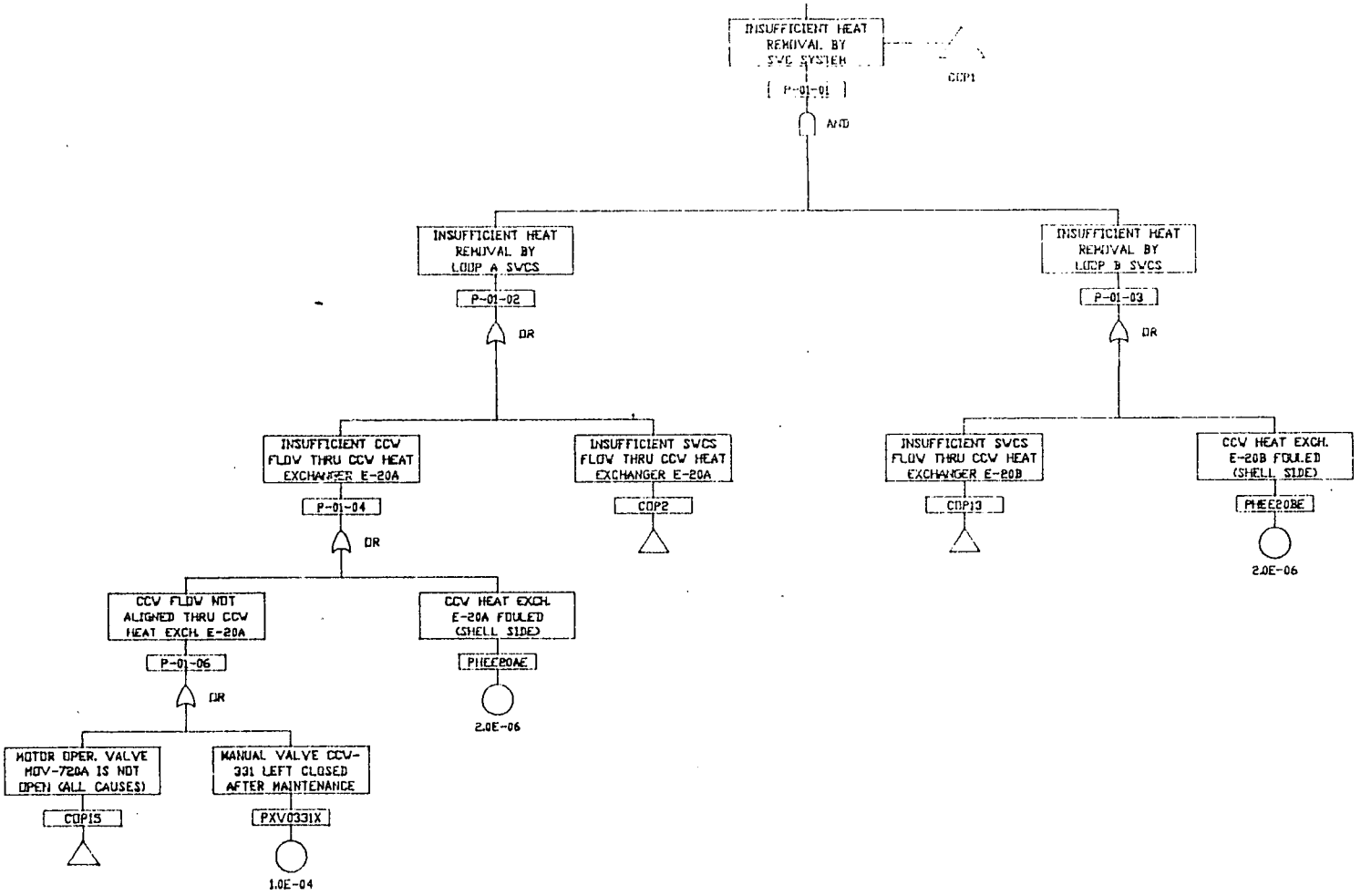
20. Telecon between M. Schwaebe of SCE and T. Hook of ERIN on July 1, 1986.

APPENDIX A

FAULT TREES

FIGURE P-1: SALTWATER COOLING SYSTEM FAULT TREE

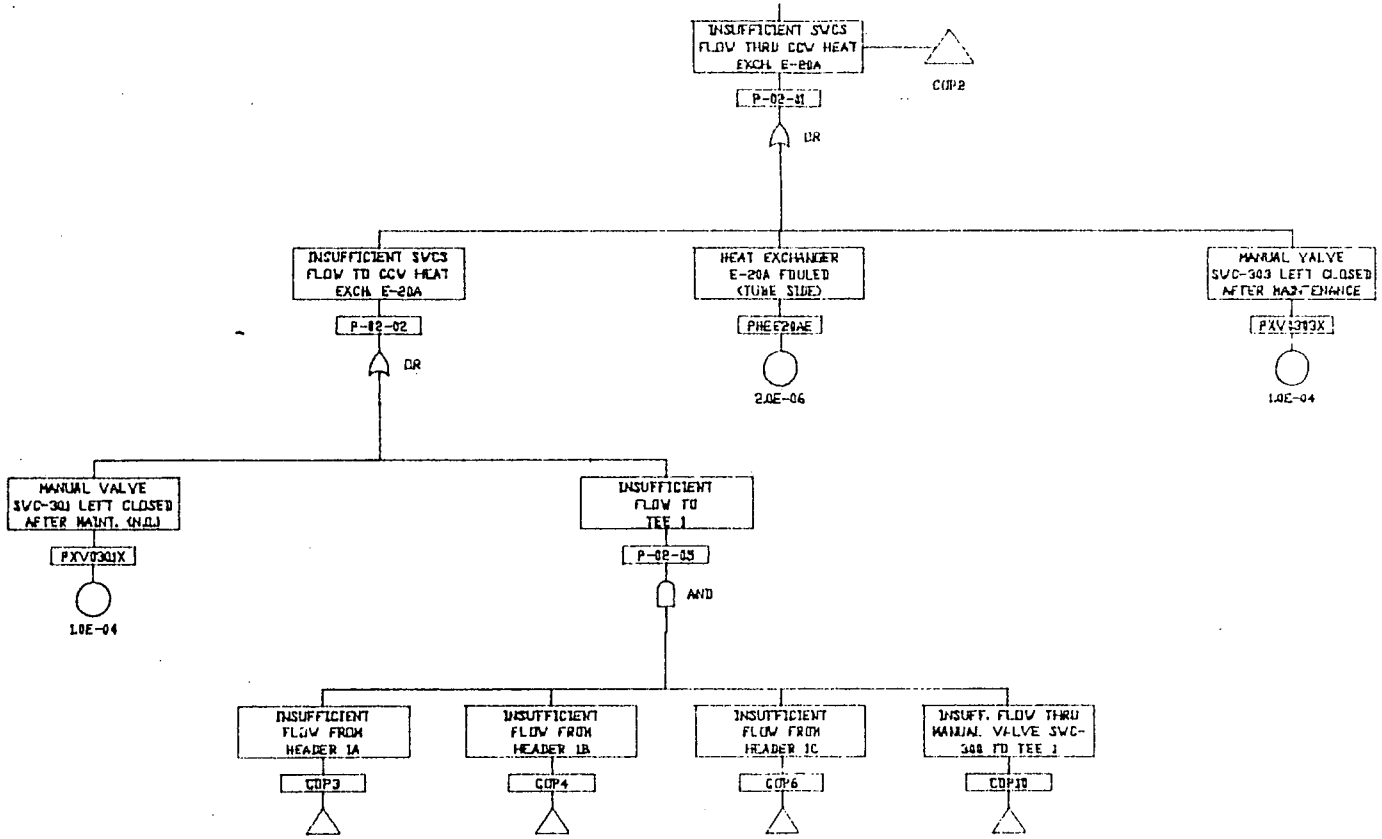
UNIT 1



5/13/86

FIGURE P-1, SHEET 2

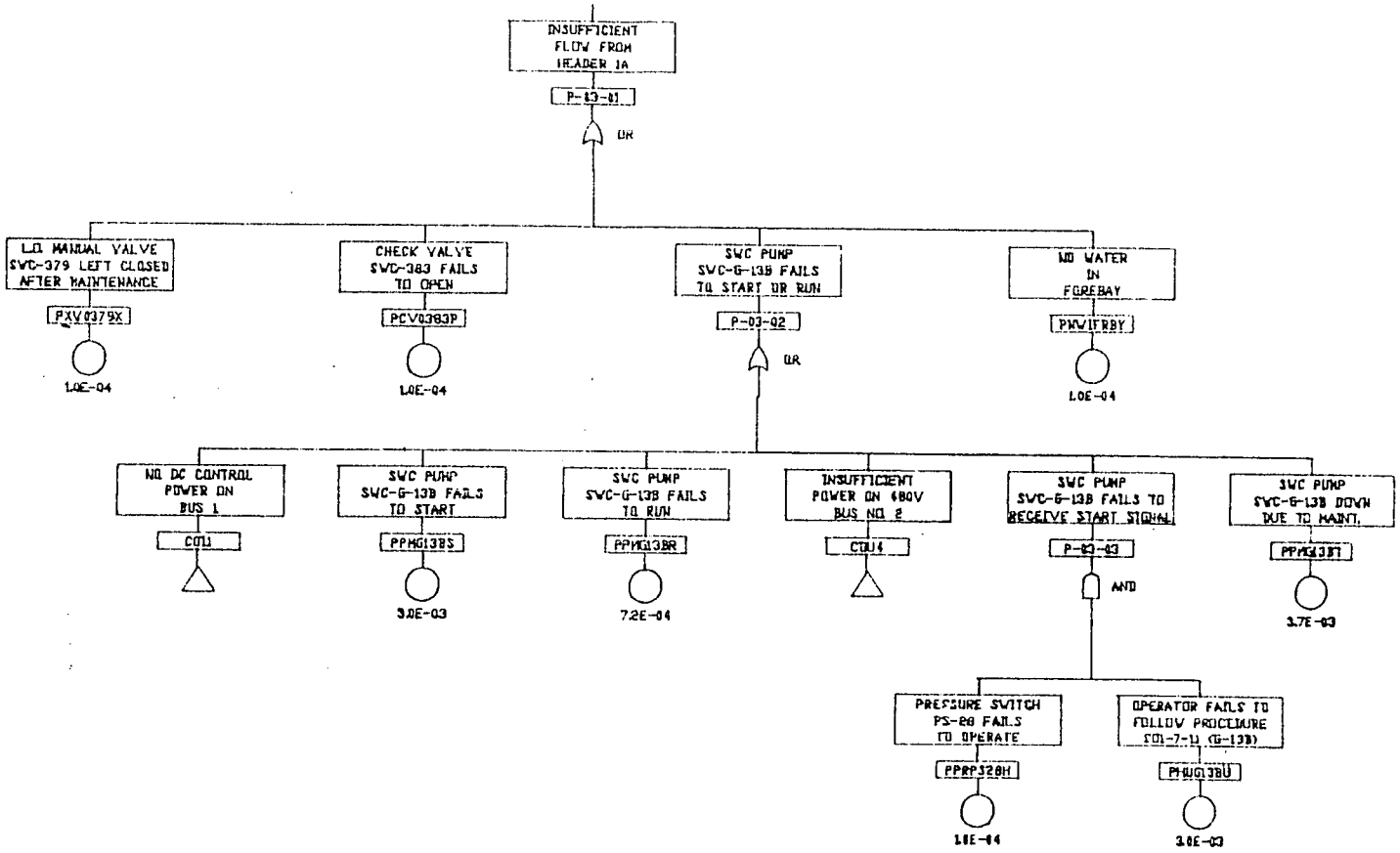
UNIT 1



5/9/86

FIGURE P-1, SHEET 3

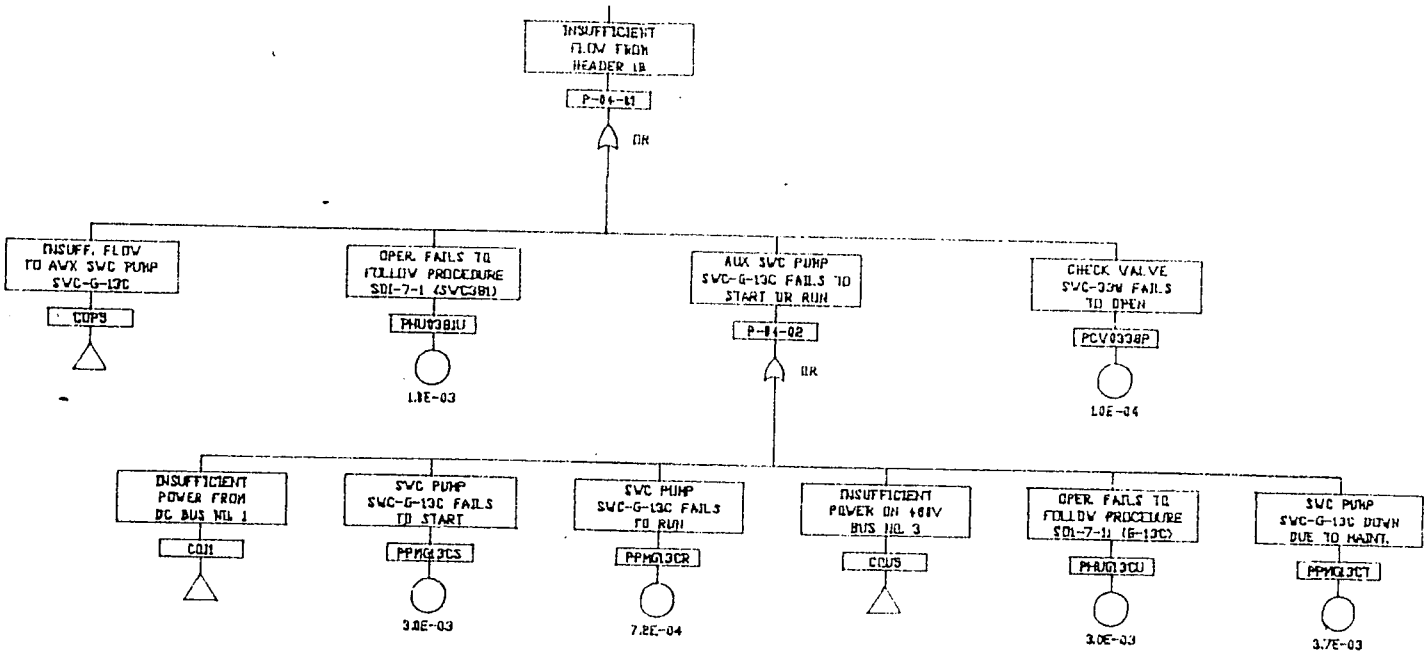
UNIT 1



5/12/86

-IGURE P-1, SHEET 4

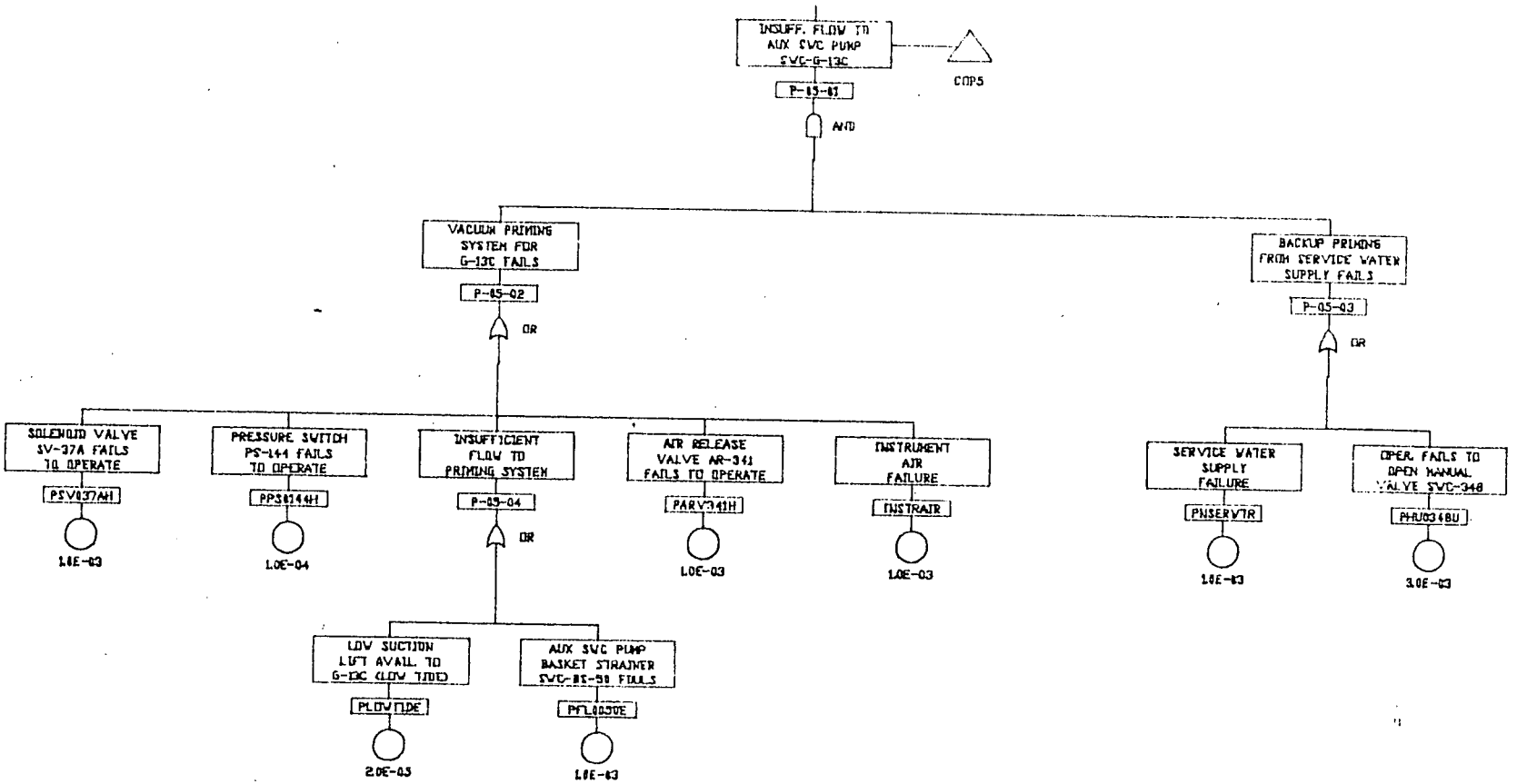
UNIT 1



5/12/86

FIGURE P-1, SHEET 5

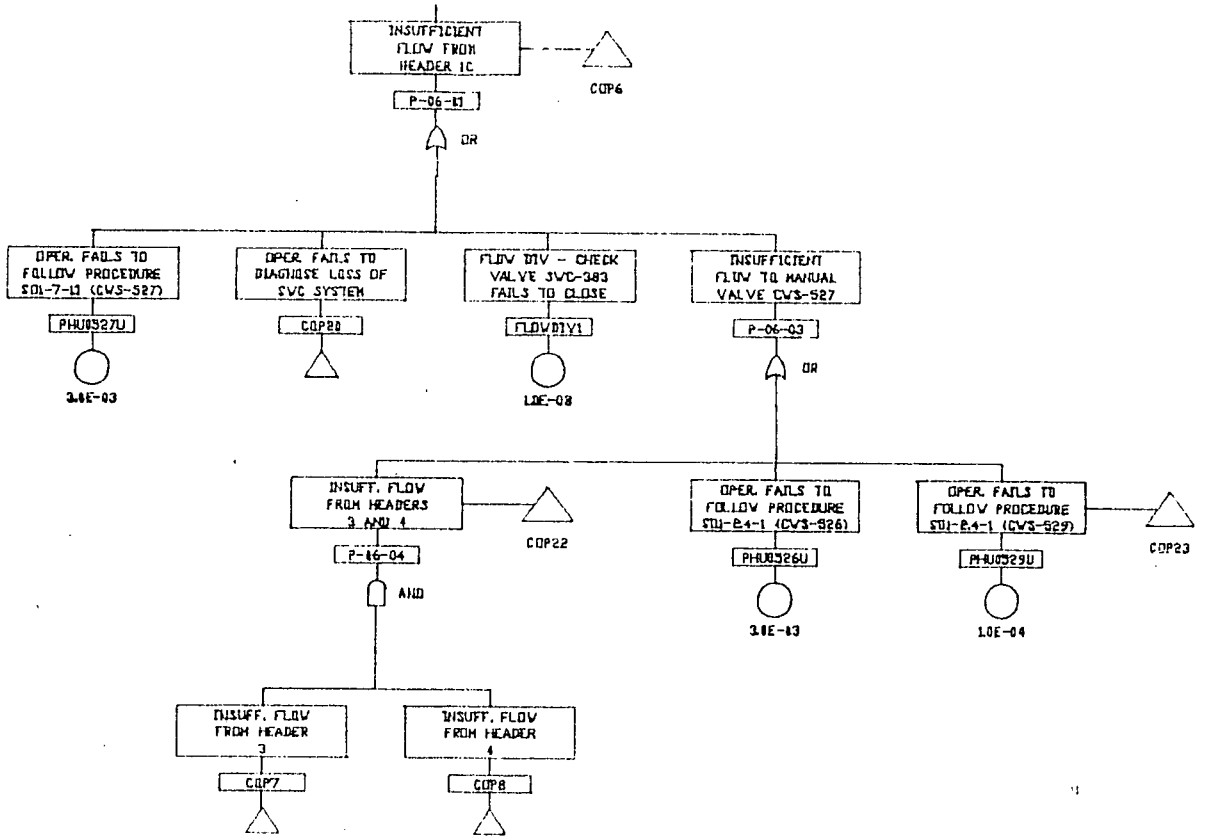
UNIT 1



5/11/86

FIGURE P-1, SHEET 6

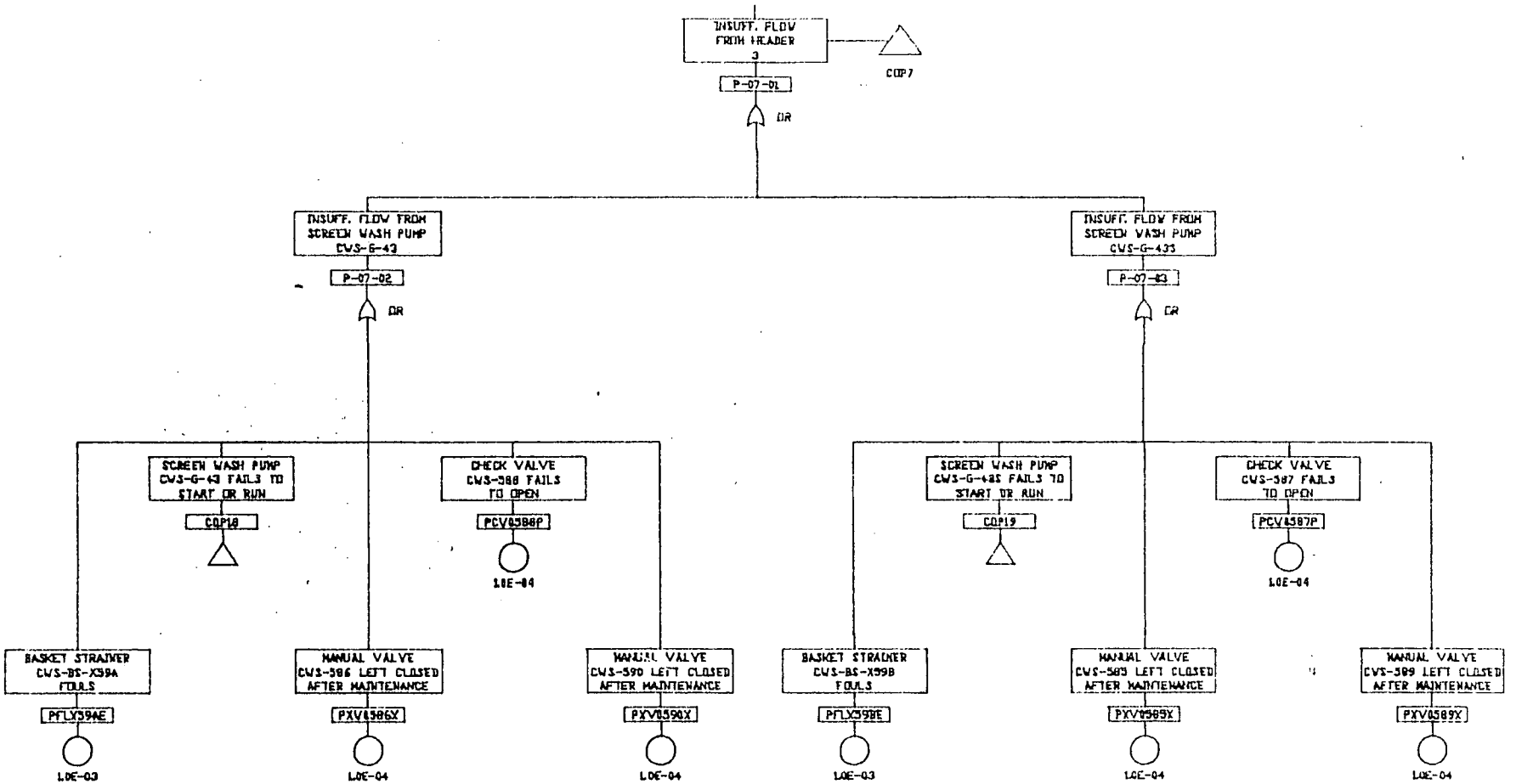
UNIT 1



5/12/86

FIGURE P-1, SHEET 7

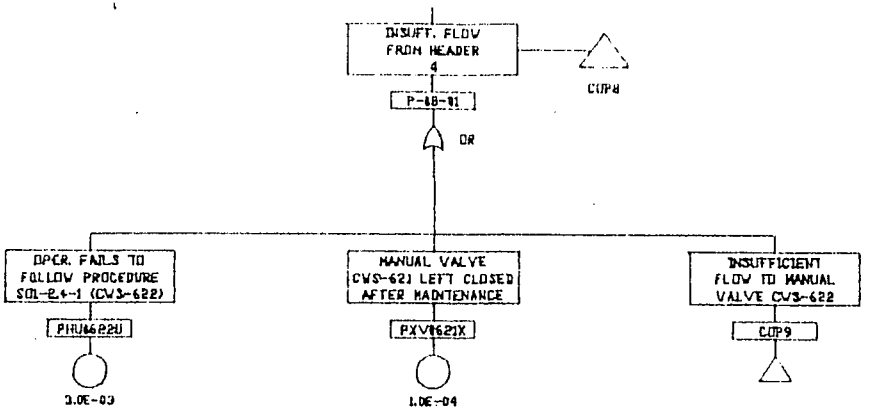
UNIT 1



5/12/86

FIGURE P-1, SHEET 8

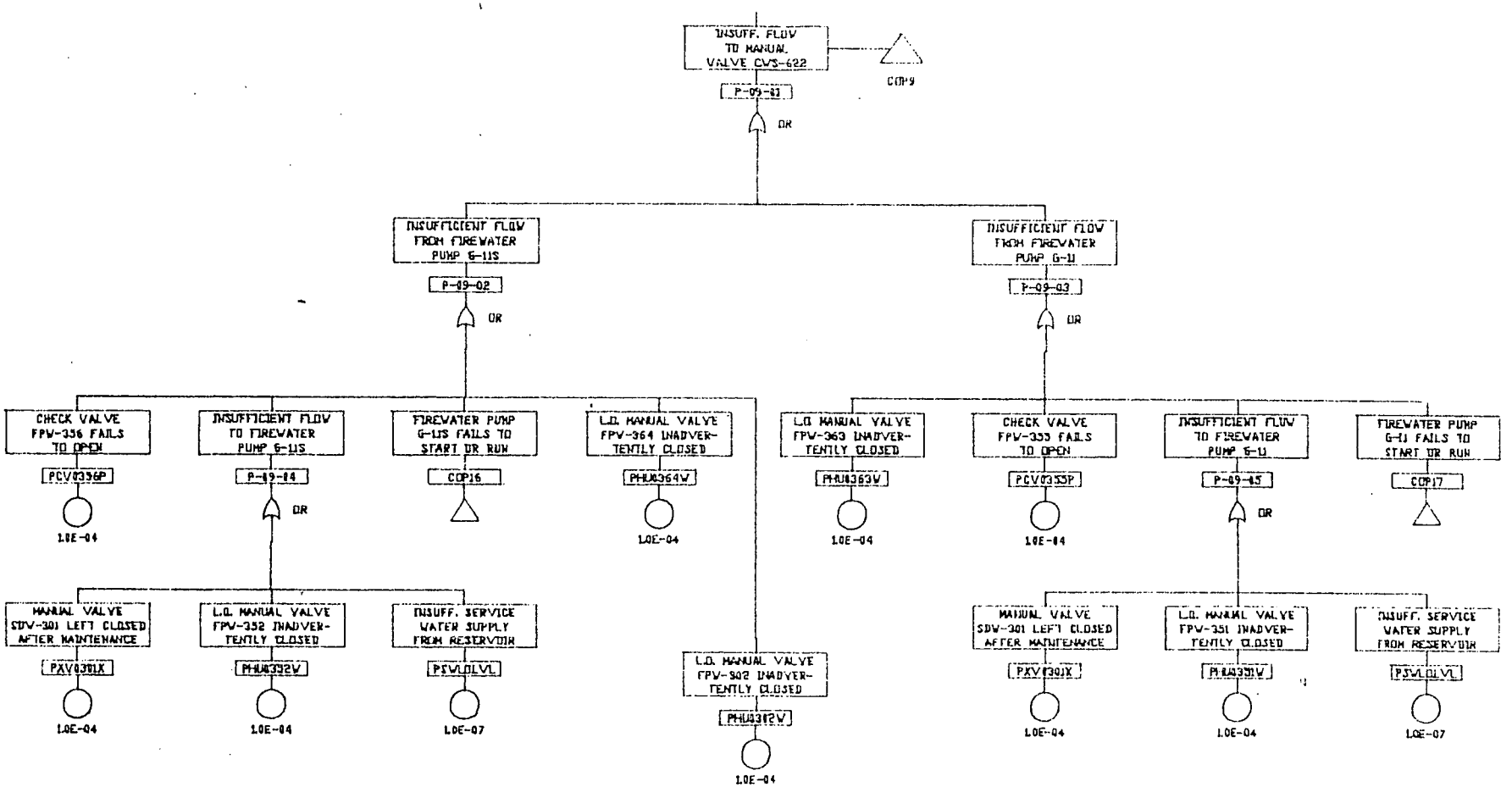
UNIT 1



5/10/86

FIGURE P-1, SHEET 9

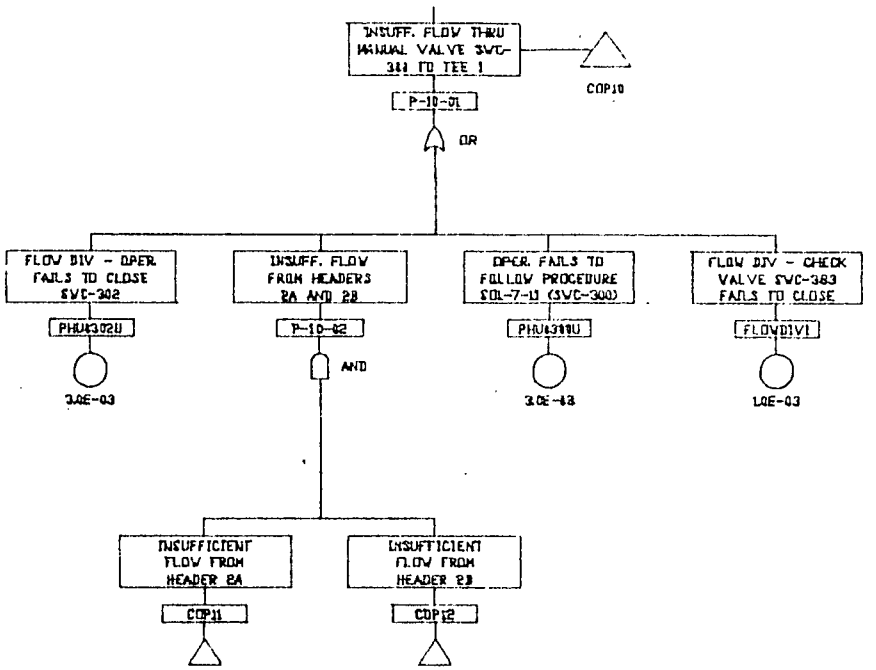
UNIT 1



5/12/'86

FIGURE P-1, SHEET 10

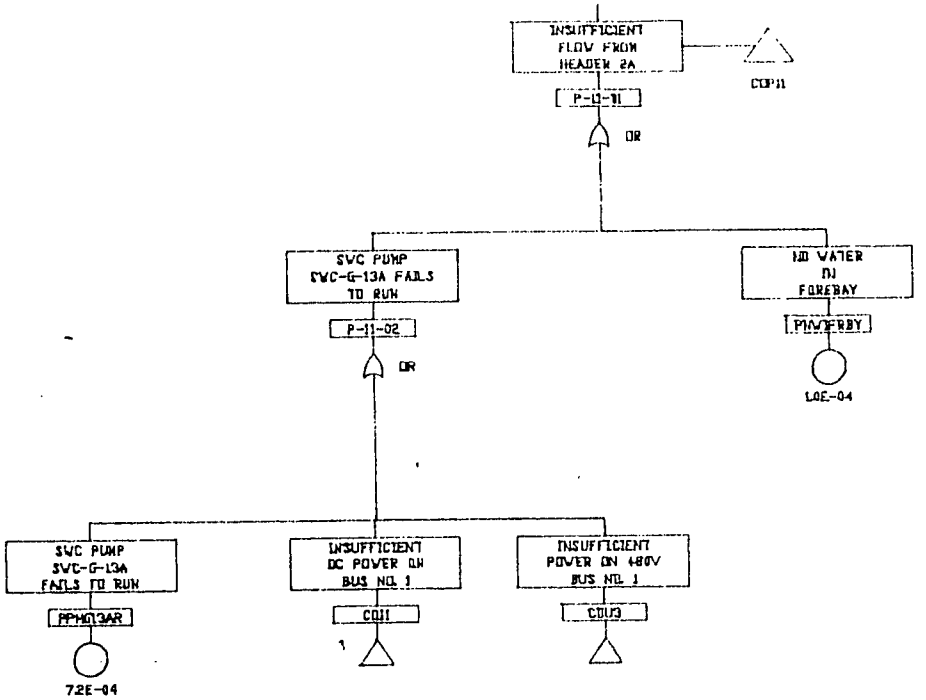
UNIT 1



5/11/85

FIGURE P-1, SHEET 11

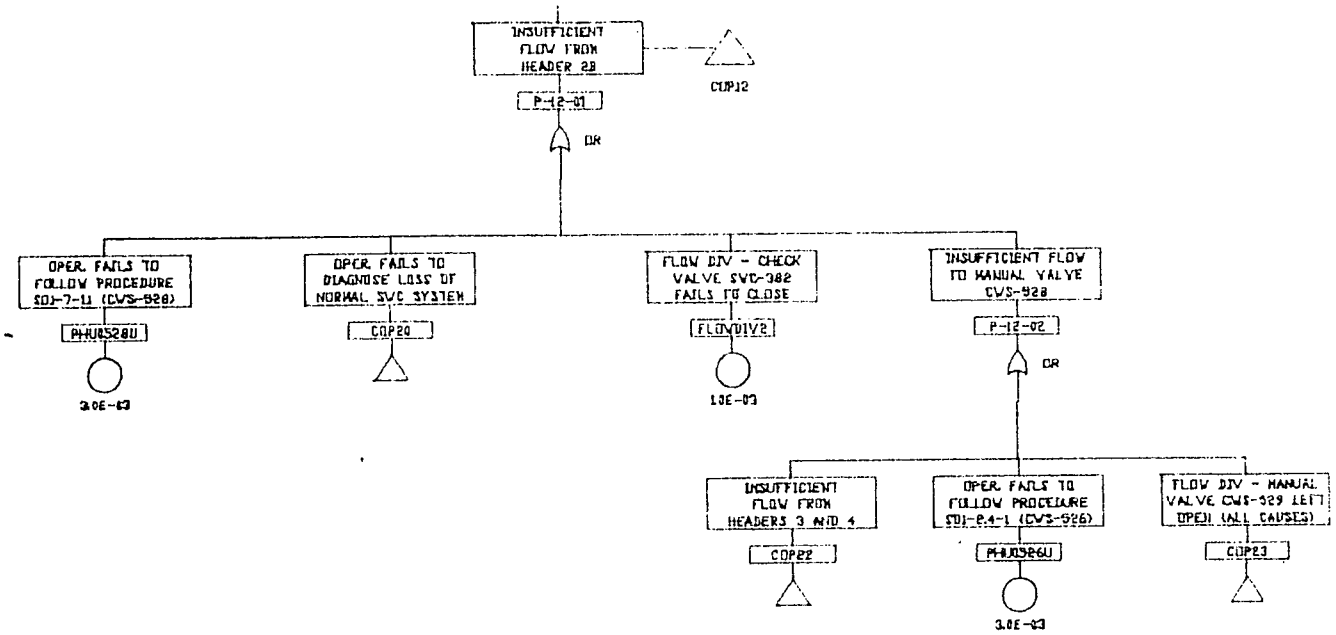
UNIT 1



5/12/86

FIGURE P-1, SHEET 12

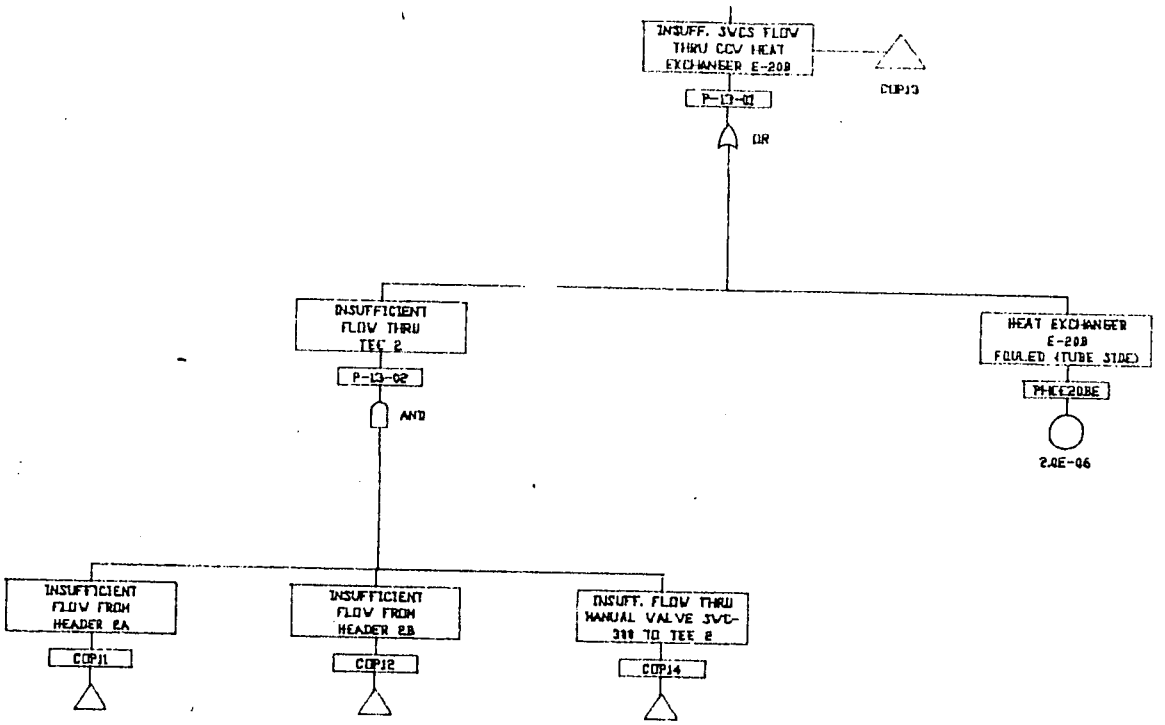
UNIT 1



5/13/86

FIGURE P-1, SHEET 13

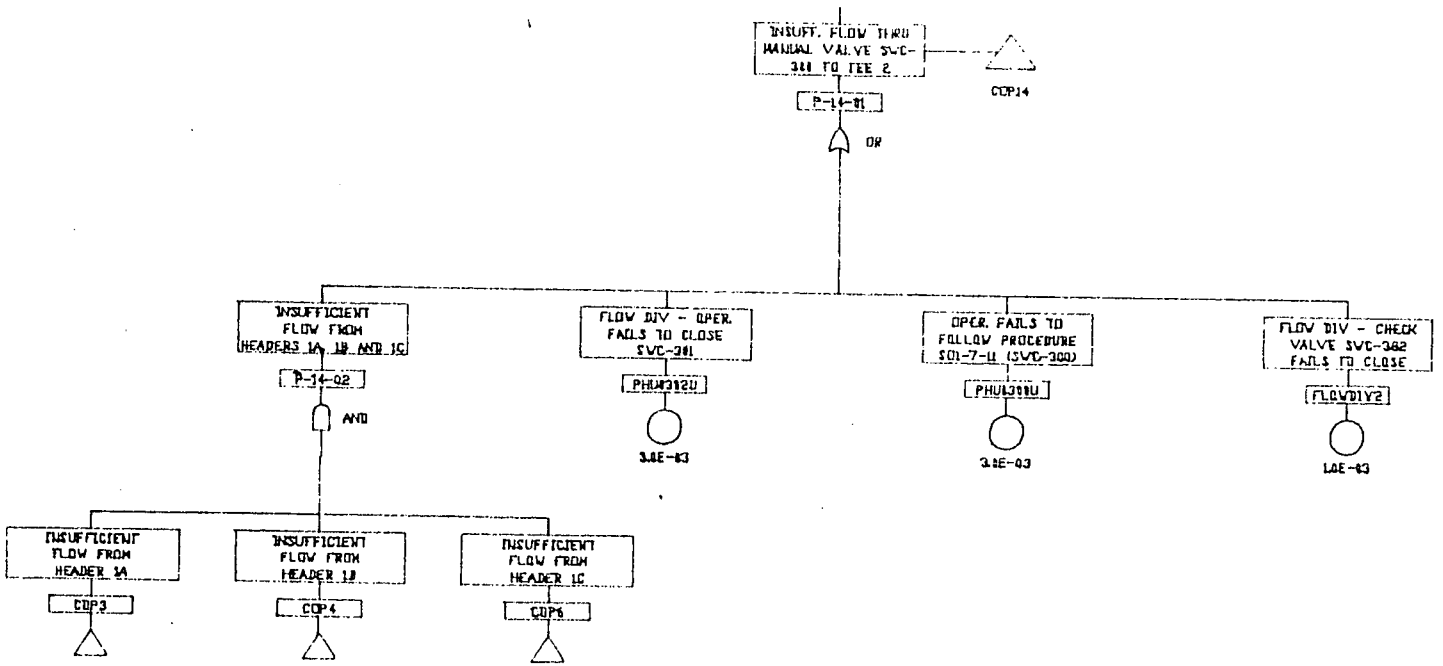
UNIT 1



5/10/86

FIGURE P-1, SHEET 14

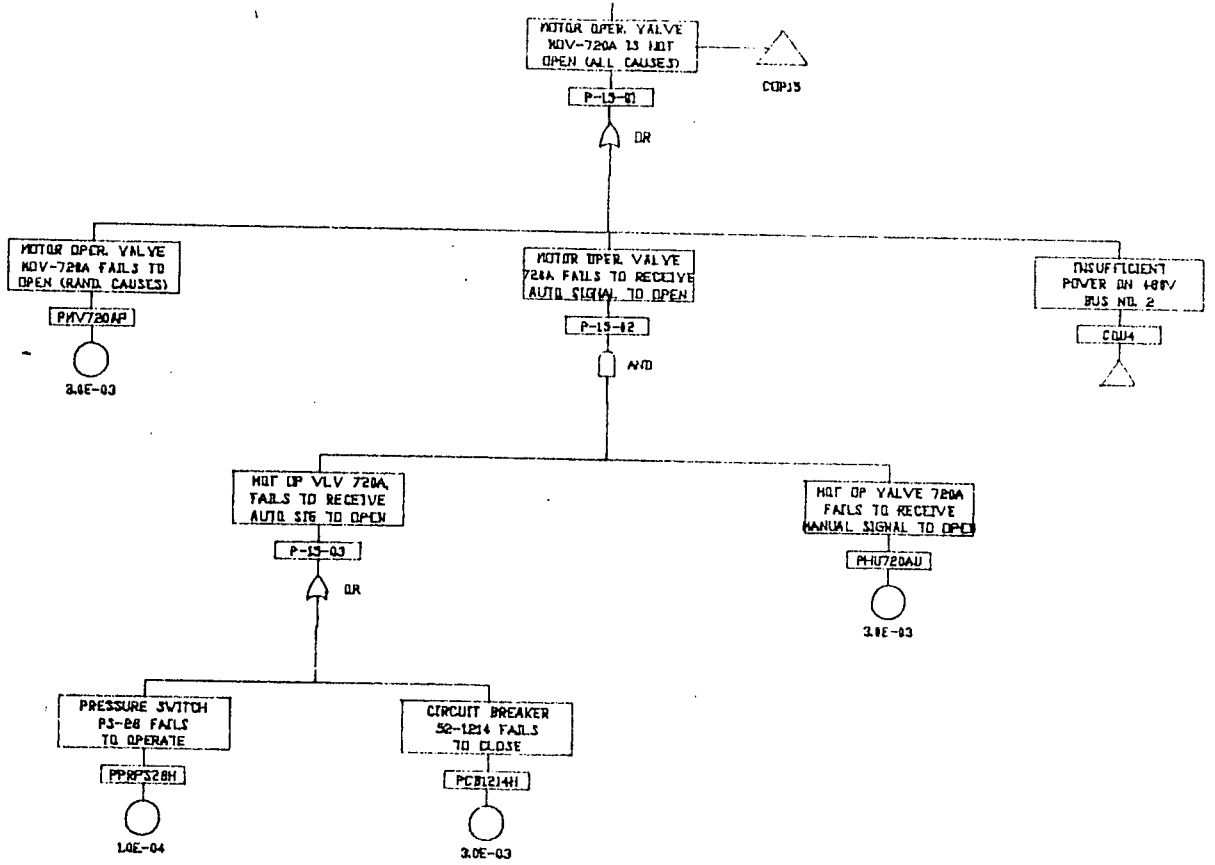
UNIT 1



5/13/86

FIGURE P-1, SHEET 15

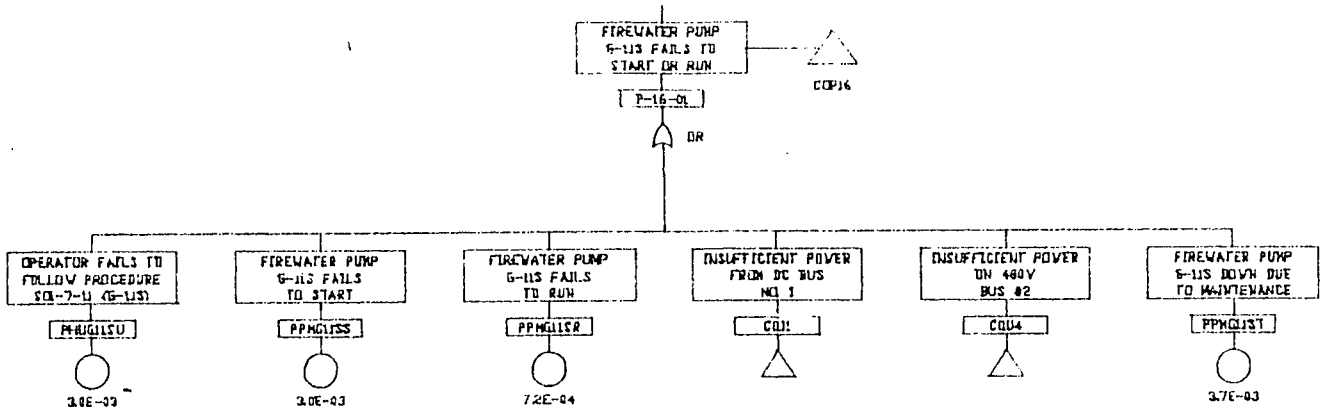
UNIT 1



5/13/86

FIGURE P-1, SHEET 16

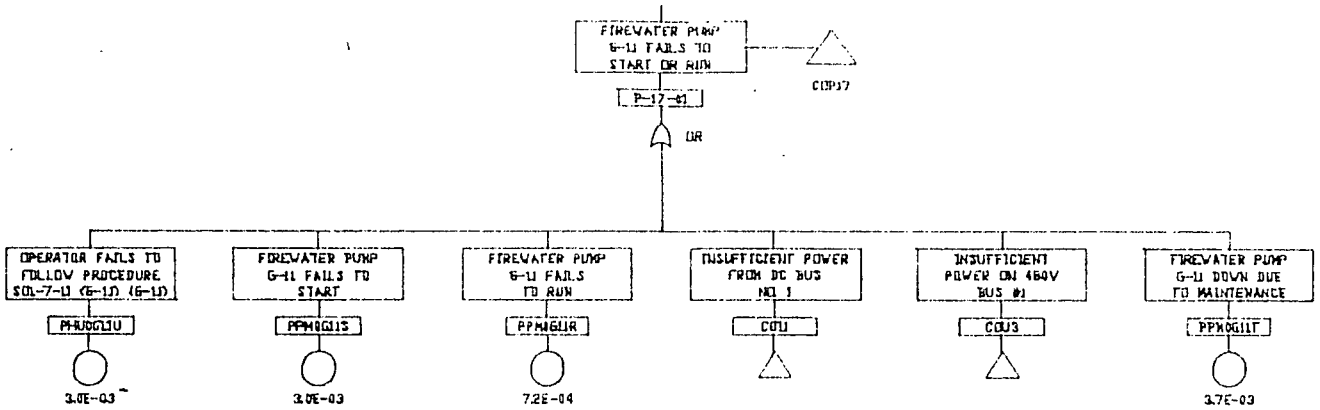
UNIT 1



5/11/86

FIGURE P-1, SHEET 17

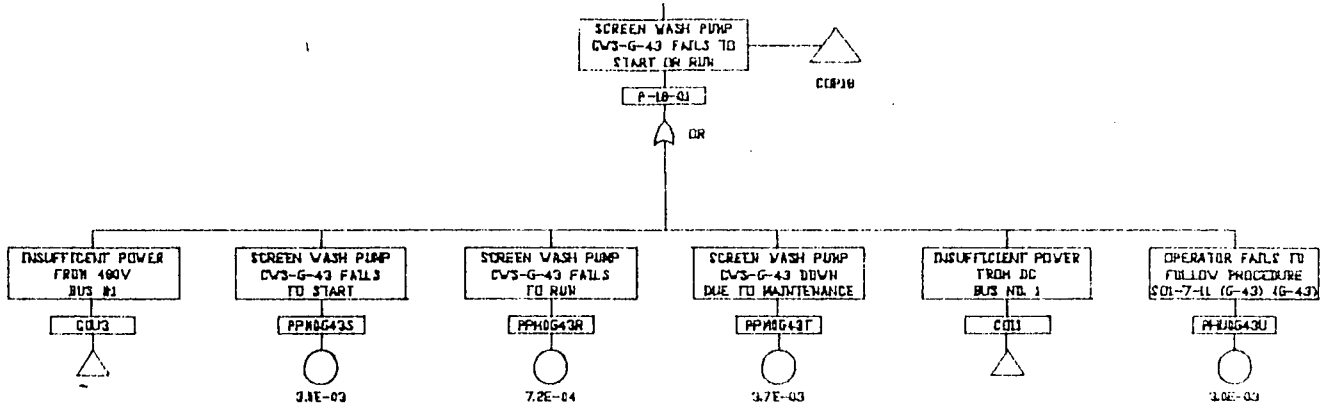
UNIT 1



5/11/86

FIGURE P--1, SHEET 18

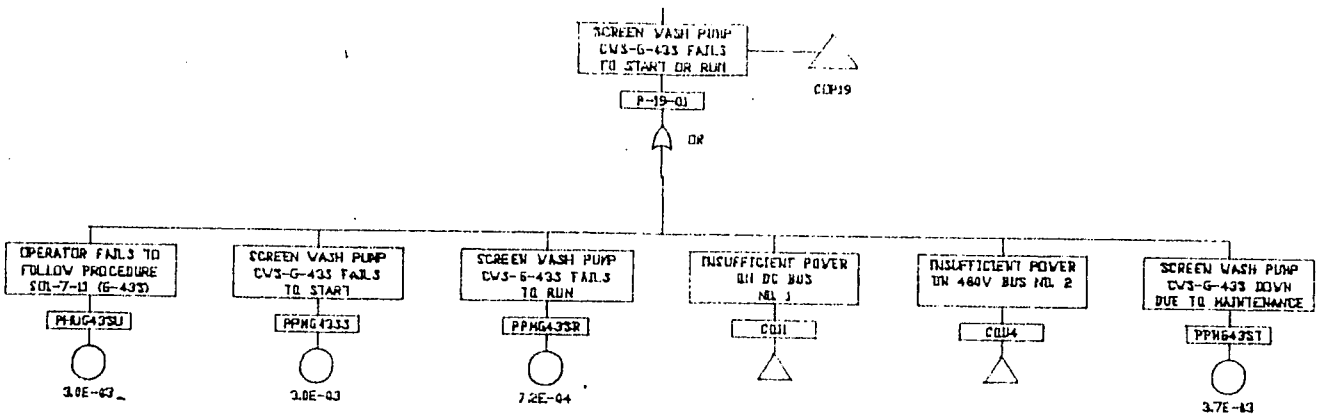
UNIT 1



5/11/88

FIGURE P-1, SHEET 19

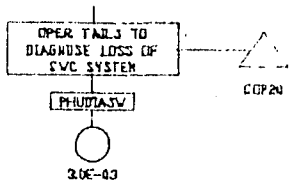
UNIT 1



5/11/86

FIGURE P-1, SHEET 20

UNIT 1



5/10/86

FIGURE KL-1: LOSS OF VOLTAGE (LOV) ACTUATION SIGNAL FAULT TREE

UNIT 1

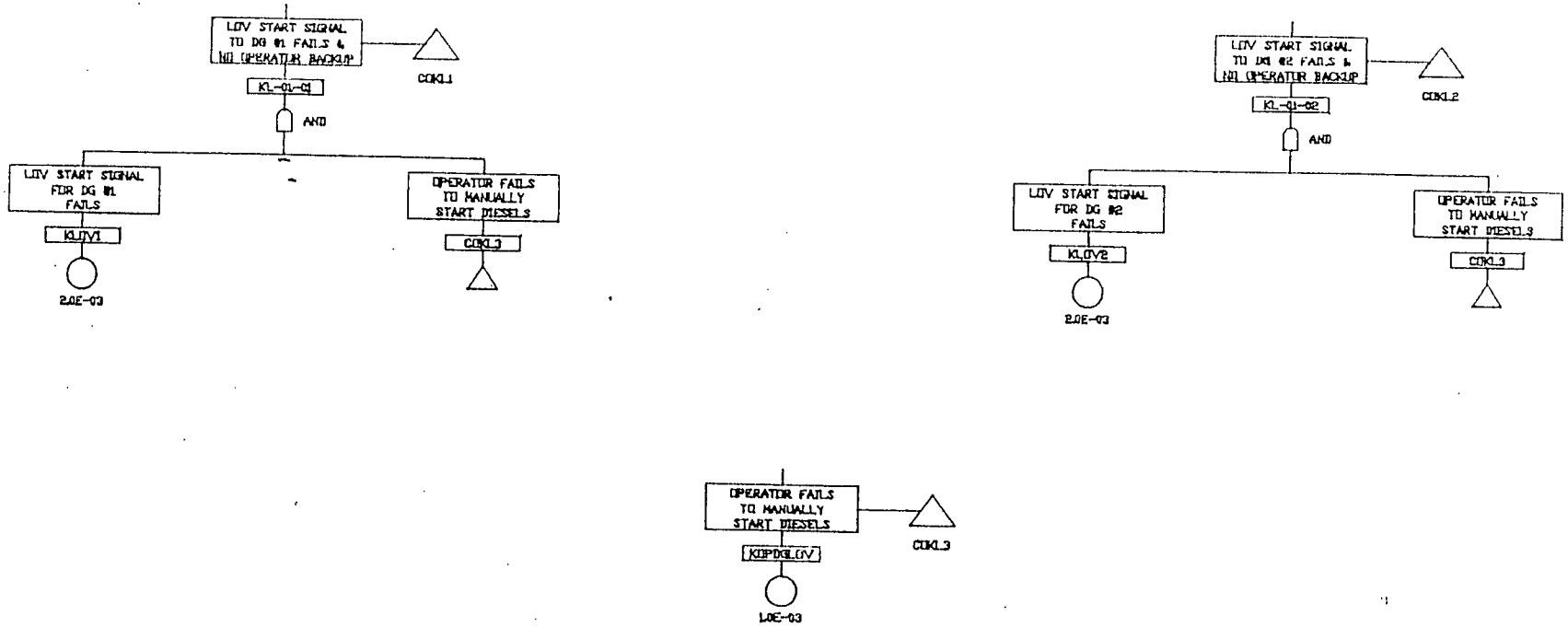


FIGURE U-1: AC POWER FAULT TREE

UNIT 1

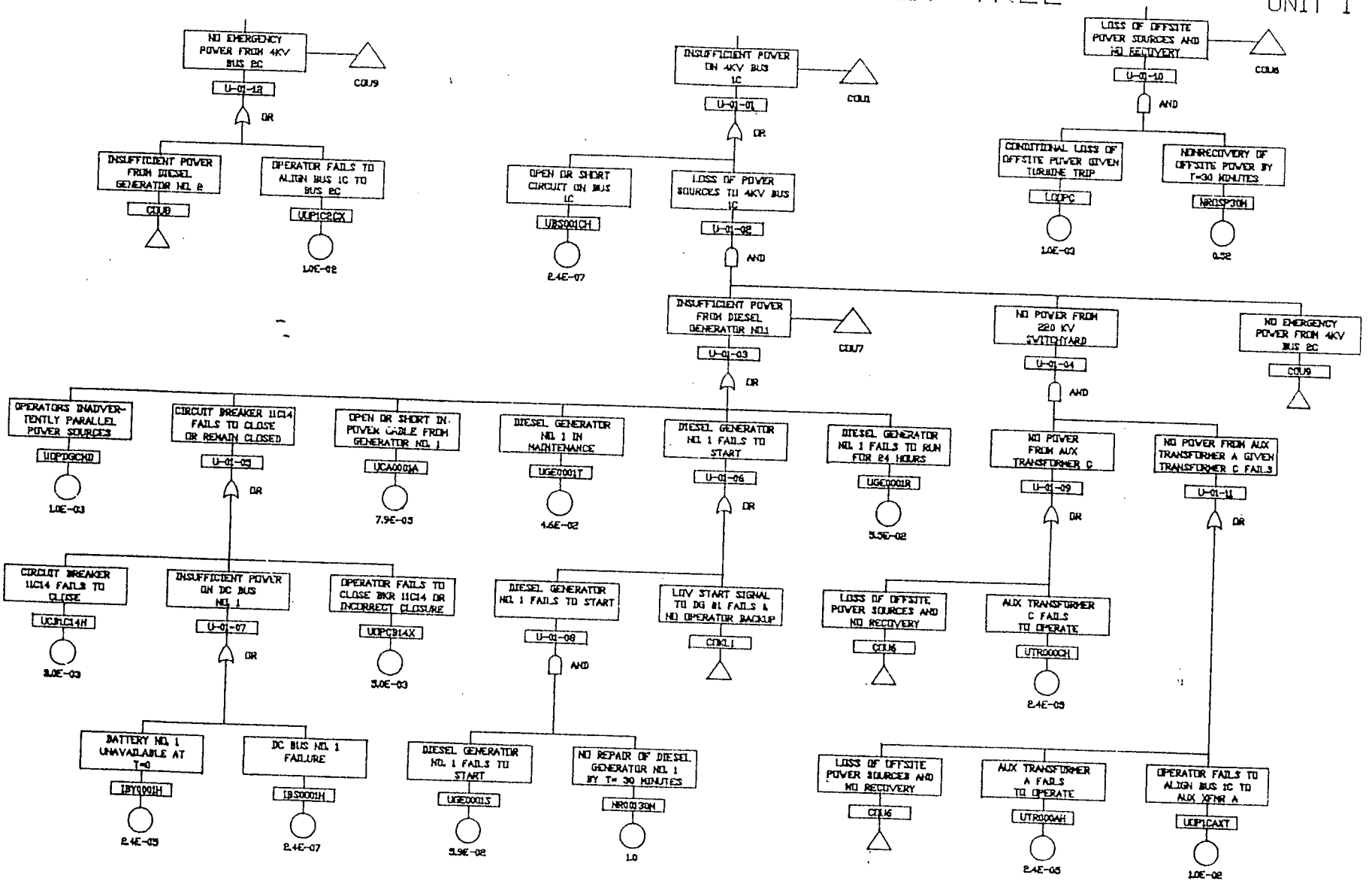


FIGURE U-1, SHEET 2

UNIT 1

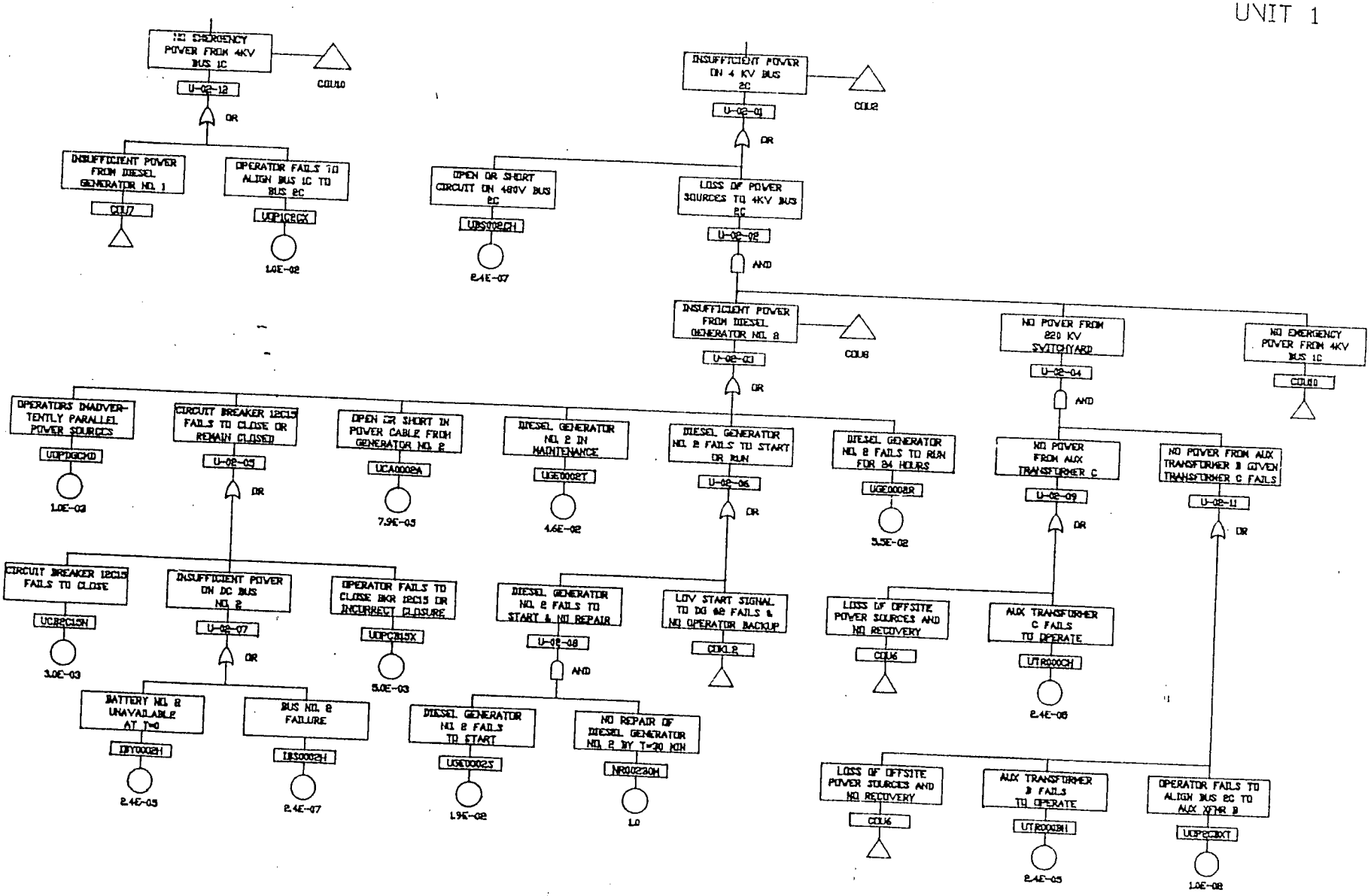


FIGURE U-1, SHEET 3

UNIT 1

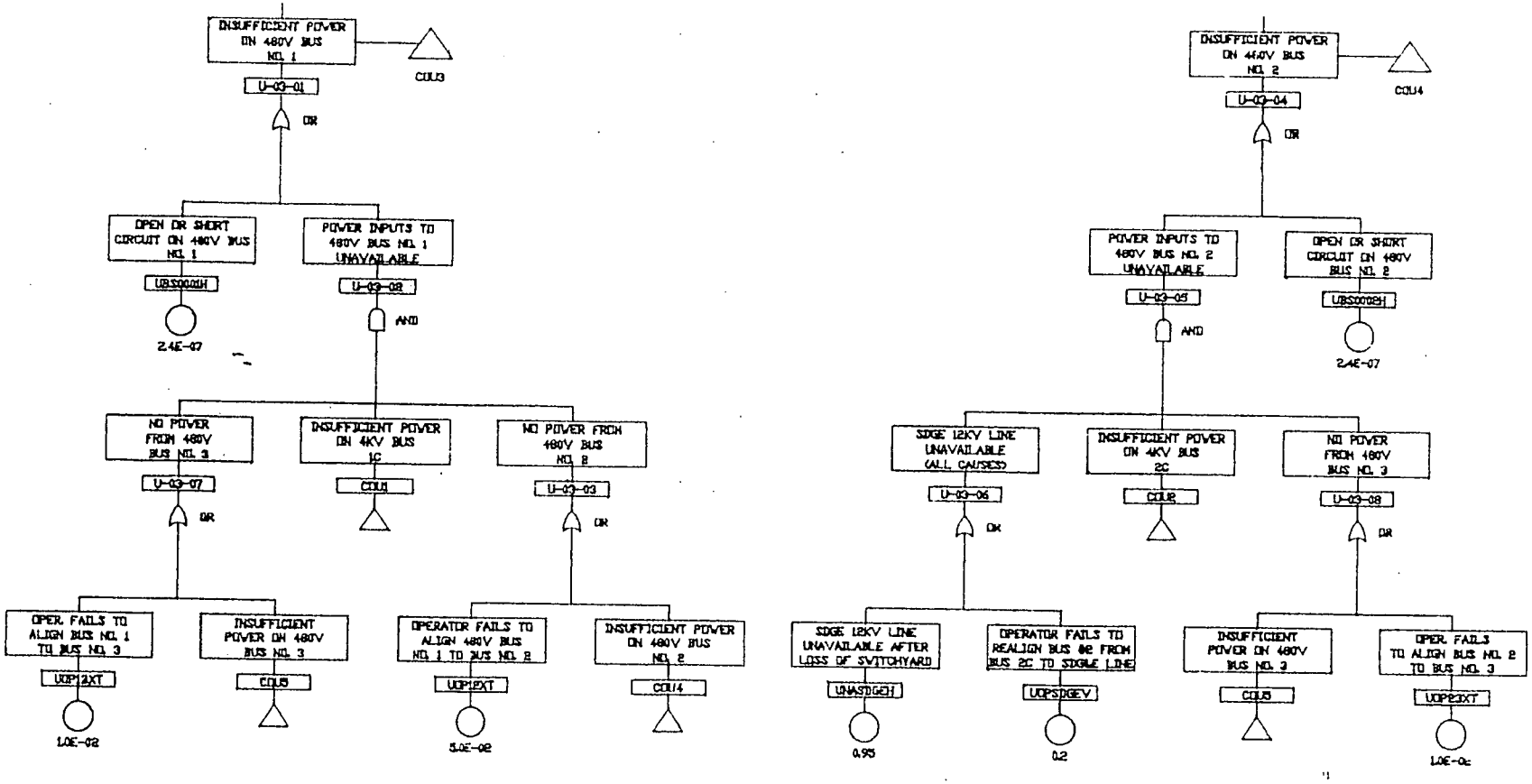


FIGURE U-1, SHEET 4

UNIT 1

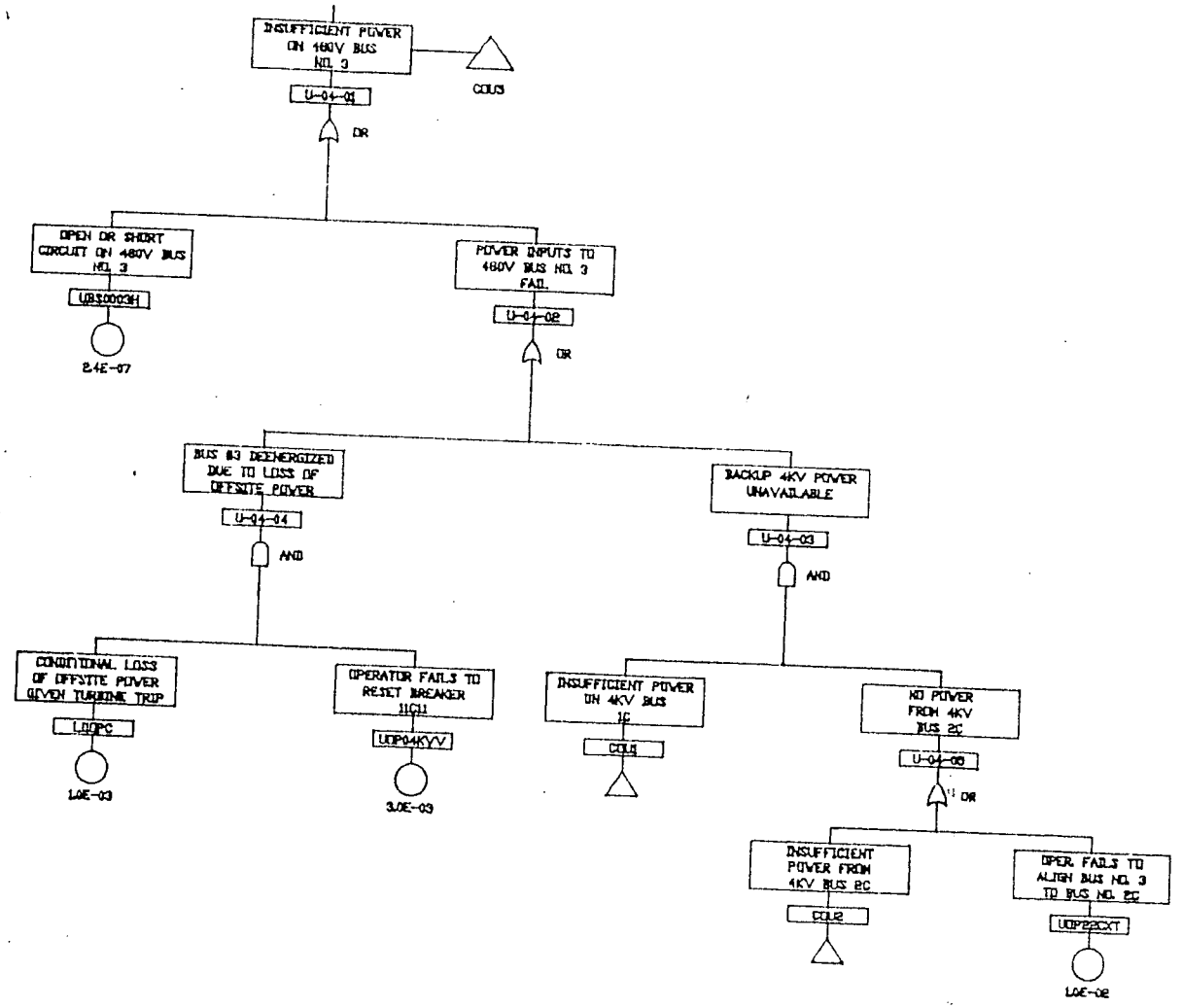
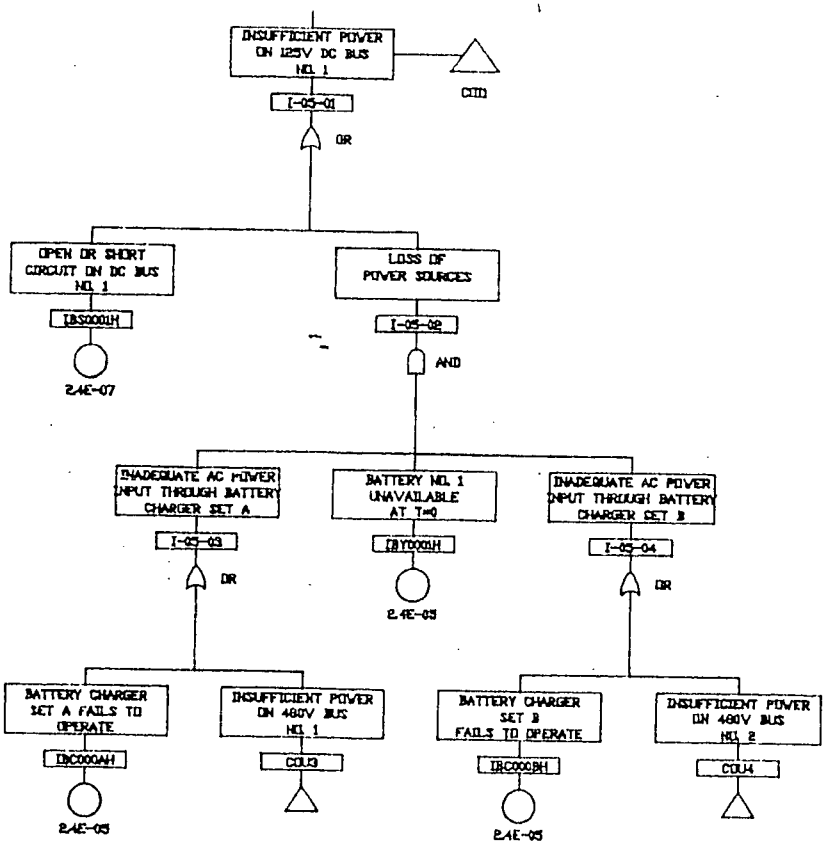
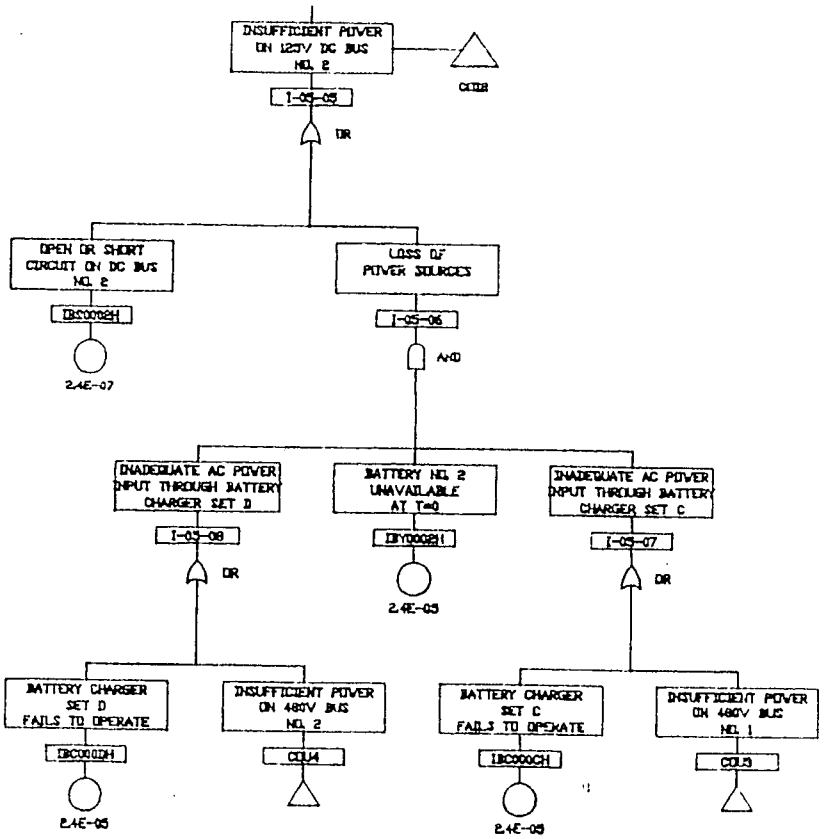


FIGURE U-1, SHEET 5

UNIT 1





APPENDIX B

BASIC EVENT DATA BASE

APPENDIX 9
SAN ONOFRE UNIT 1
BASIC EVENT UNAVAILABILITY DATA
USED FOR SWC RELIABILITY STUDY

BASIC EVENT NAME	FAILURE PER DEMAND	FAILURE RATE	MISSION TIME	MEAN UNAVAILABILITY	ERROR FACTOR	REFERENCE	REMARKS
J62/1	0.1Y			1.9E-01	5.3	6	
FLOWDIV1	1.0E-03			1.0E-03	3.0	1	
FLOWDIV2	1.0E-03			1.0E-03	3.0	1	
FLOWTIDE	2.0E-05			2.0E-05	10.0	7	
[illegible]CCAH		1.0E-06	24 HRS.	2.4E-05	3.0	1	
[illegible]CCA08H		1.0E-06	24 HRS.	2.4E-05	3.0	1	
[illegible]CC300CH		1.0E-06	24 HRS.	2.4E-05	3.0	1	
[illegible]CC000DH		1.0E-06	24 HRS.	2.4E-05	3.0	1	
[illegible]CC00401H		1.0E-08	24 HRS.	2.4E-07	3.0	1	
[illegible]CC00402H		1.0E-08	24 HRS.	2.4E-07	3.0	1	
[illegible]		1.0E-06	24 HRS.	2.4E-05	3.0	1	
[illegible]		1.0E-06	24 HRS.	2.4E-05	3.0	1	
[illegible]HST-HAIR	1.0E-03			1.0E-03	10.0	7	
KL[illegible]1	2.0E-03			2.0E-03	10.0	5	
[illegible]LOYC	2.0E-03			2.0E-03	10.0	5	
LOOPC	1.0E-03			1.0E-03	10.0	2	
[illegible]001304	1.0			1.0E+00	0.0	7	
MR00200M	1.0			1.0E+00	0.0	7	
MR02P30M	0.32			5.2E-01	1.3	8	
PARV341M	1.0E-03			1.0E-03	10.0	7	
PCV0338P	1.0E-04			1.0E-04	3.0	1	
PCV0339P	1.0E-04			1.0E-04	3.0	1	
PCV0356P	1.0E-04			1.0E-04	3.0	1	
PCV0383P	1.0E-04			1.0E-04	3.0	1	
PCV0587P	1.0E-04			1.0E-04	3.0	1	
PCV0588P	1.0E-04			1.0E-04	3.0	1	
PFLDDE0E		3.0E-05	24 HRS	7.2E-04	10.0	1	
PFLX59AE		3.0E-05	24 HRS	7.2E-04	10.0	1	
PFLX59BE		3.0E-05	24 HRS	7.2E-04	10.0	1	
PHEE20AE		8.5E-09	24 HRS	2.0E-06	10.0	1	
PHEE20BE		8.5E-08	24 HRS	2.0E-06	10.0	1	
PHU720AU	3.0E-03			3.0E-03	10.0	11	
PHUD1A5W	3.0E-03			3.0E-03	10.0	11	
PHUG11SU	3.0E-03			3.0E-03	10.0	11	
PHUG13BU	3.0E-03			3.0E-03	10.0	11	
PHUG13CU	3.0E-03			3.0E-03	10.0	11	
PHUG439U	3.0E-03			3.0E-03	10.0	11	
PHUD348U	3.0E-03			3.0E-03	10.0	11	
PHUD351W	1.0E-04			1.0E-04	10.0	7	
PHUD352W	1.0E-04			1.0E-04	10.0	7	
PHUD363W	1.0E-04			1.0E-04	10.0	7	
PHUD364W	1.0E-04			1.0E-04	10.0	7	
PHUD381U	1.0E-03			1.0E-03	10.0	11	
PHUD302U	3.0E-03			3.0E-03	10.0	11	
PHUD302W	1.0E-04			1.0E-04	10.0	7	
PHUD300U	3.0E-03			3.0E-03	10.0	11	
PHUD526U	3.0E-03			3.0E-03	10.0	11	
PHUD527U	3.0E-03			3.0E-03	10.0	11	

APPENDIX 3
SAN ONOFRE UNIT 1
BASIC EVENT UNAVAILABILITY DATA
USED FOR SWC RELIABILITY STUDY

BASIC EVENT NAME	FAILURE PER DEMAND	FAILURE RATE	MISSION TIME	MEAN UNAVAILABILITY	ERROR FACTOR	REFERENCE	REMARKS
PHUUE12U	3.0E-03			3.0E-03	10.0	11	
PHUU524U	1.0E-04			1.0E-04	10.0	7	
PHUU622U	3.0E-03			3.0E-03	10.0	11	
PHUU611U	3.0E-03			3.0E-03	10.0	11	
PHUU643U	3.0E-03	10.0		3.0E-03	10.0	11	
PMV7J04P	3.0E-03			3.0E-03	10.0	1	
PNSERWTR	1.0E-03			1.0E-03	10.0	7	
PNWIFRBV	1.0E-04			1.0E-04	10.0	7	
PPMG118R		3.0E-05	24 HRS	7.2E-04	10.0	1	
PPMG118S	3.0E-03			3.0E-03	10.0	1	
PPMG118T		4.6E-04	8 HRS	3.7E-03	10.0	5	8.9-15
PPMG12AR		3.0E-05	24 HRS	7.2E-04	10.0	1	
PPME12BR		3.0E-05	24 HRS	7.2E-04	10.0	1	
PPMG12BS	3.0E-03			3.0E-03	10.0	1	
PPMG12BT		4.6E-04	8 HRS	3.7E-03	10.0	5	8.9-15
PPMG13DR		3.0E-05	24 HRS	7.2E-04	10.0	1	
PMG13D3	3.0E-03			3.0E-03	10.0	1	
PPME13DT		4.6E-04	8 HRS	3.7E-03	10.0	5	8.9-15
PPMG43BR		3.0E-05	24 HRS	7.2E-04	10.0	1	
PPMG43BS	3.0E-03			3.0E-03	10.0	1	
PPMG43BT		4.6E-04	8 HRS	3.7E-03	10.0	5	8.9-15
PPMG811R		3.0E-05	24 HRS	7.2E-04	10.0	1	
PPMG811S	3.0E-03			3.0E-03	10.0	1	
PPMG811T		4.6E-04	8 HRS	3.7E-03	10.0	5	8.9-15
PPMG843R		3.0E-05	24 HRS	7.2E-04	10.0	1	
PPMG843S	3.0E-03			3.0E-03	10.0	1	
PPMG843T		4.6E-04	8 HRS	3.7E-03	10.0	5	8.9-15
PPRPS28H	1.0E-04			1.0E-04	3.0	1	
PPS0144H	1.0E-04			1.0E-04	3.0	1	
PSV037AH	1.0E-03			1.0E-03	3.0	1	
PSWLOLVL	1.0E-07			1.0E-07	10.0	7	
PXV0621X	1.0E-04			1.0E-04	3.0	1	
PXV0331X	1.0E-04			1.0E-04	3.0	1	
PXV0330X	1.0E-04			1.0E-04	3.0	1	
PXV0379X	1.0E-04			1.0E-04	3.0	1	
PXV0301X	1.0E-04			1.0E-04	3.0	1	
PXV0303X	1.0E-04			1.0E-04	3.0	1	
PXV0585X	1.0E-04			1.0E-04	3.0	1	
PXV0596X	1.0E-04			1.0E-04	3.0	1	
PXV0589X	1.0E-04			1.0E-04	3.0	1	
PXV0590X	1.0E-04			1.0E-04	3.0	1	
RS0001H		1.0E-08	24 HRS.	2.4E-07	3.0	1	
UBS002H		1.0E-08	24 HRS.	2.4E-07	3.0	1	
UBS003H		1.0E-08	24 HRS.	2.4E-07	3.0	1	
UBS001CH		1.0E-08	24 HRS.	2.4E-07	3.0	1	
UBS002CH		1.0E-08	24 HRS.	2.4E-07	3.0	1	
UCA0001A		3.2E-07	24 HRS.	7.9E-05	10.0	1	COMBINED SHORT/OPEN FAIL. RATE
UCA0002A		3.2E-07	24 HRS.	7.9E-05	10.0	1	COMBINED SHORT/OPEN FAIL RATES

APPENDIX B
SAN ONOFRE UNIT 1
BASIC EVENT UNAVAILABILITY DATA
USED FOR SWC RELIABILITY STUDY

BASIC EVENT NAME	FAILURE PER DEMAND	FAILURE RATE	MISSION TIME	MEAN UNAVAILABILITY	ERROR FACTOR	REFERENCE	REMARKS
UCB1D14N	3.0E-03			3.0E-03	10.0	1	
UCB2D15N	3.0E-03			3.0E-03	10.0	1	
UGE0001R		2.3E-03	24 HRS.	5.5E-02	10.0	4	
UGE00013	4.6E-02			4.6E-02	3.0	9	
UGE0001T	4.6E-02			4.6E-03	10.0	7	
UGE0002R		2.3E-03	24 HRS.	5.5E-02	10.0	4	
UGE00023	1.9E-02			1.9E-02	3.0	9	
UGE0002T	4.6E-02			4.6E-02	10.0	9	
UNAED6EH	9.5E-01			9.5E-01	10.0	7	
UOP04KVV	3.0E-02			3.0E-02	10.0	11	
UOP12XT	5.0E-02			5.0E-02	10.0	11	
UOP13XT	1.0E-03			1.0E-03	10.0	11	
UOP1D2DX	1.0E-02			1.0E-02	10.0	11	
UOP1D3XT	1.0E-02			1.0E-02	3.0	11	
UOP23XT	1.0E-02			1.0E-02	10.0	11	
UOP2D3XT	1.0E-02			1.0E-02	3.0	11	
UOPC01AX	5.0E-02			5.0E-02	3.0	11	
UOPC01BX	5.0E-02			5.0E-02	3.0	11	
UOP0GCMD	1.0E-03			1.0E-03	10.0	11	
UOP6D6EV	.2			2.0E-01	10.0	7	NOT PROCEDURALIZED
UTR000AH		1.0E-06	24 HRS.	2.4E-05	3.0	1	
UTR0008H		1.0E-06	24 HRS.	2.4E-05	3.0	1	
UTR000CH		1.0E-06	24 HRS.	2.4E-05	3.0	1	

References

1. NUREG/CR-2728, P. D. Carlson, et.al, "Interim Reliability Evaluation Program Procedures Guide," January,1983.

2. WASH-1400, "Reactor Safety Study. An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," Appendix III, Failure Data, October, 1975.

3. Docket No. 50-352, 50-353, "Probabilistic Risk Assessment Limerick Generating Station," Philadelphia Electric Company, September, 1982.

4. NUREG/CR-2989, R. E. Battle and D. J. Campbell, "Reliability of Emergency AC Power Systems at Nuclear Power Plants," July, 1983.

5. NUREG/CR-3511, A. C. Payne, et.al. "Interim Reliability Evaluation Program: Analysis of the Calvert Cliffs Unit 1 Nuclear Power Plant," August, 1984.

6. SAI-372-83-PA-01, "Probabilistic Risk Assessment, Shoreham Nuclear Power Station," June 24, 1983.

7. Judgement

8. NSAC/80, H. Wycoff, "Loss of Offsite Power at U.S. Nuclear Power Plants, All Years Through 1983," July, 1984.

9. Plant Data

References (Continued)

10. "Preliminary Probabilistic Risk Assessment of Overall Plant Safety, Babcock & Wilcox, May 1985.

11. "Oconee PRA: A Probabilistic Risk Assessment of Oconee Unit 3," NSAC-60, June 1984.

12. NUREG/CR-1278, "Handbook of Human Reliability"

APPENDIX C

ANALYSIS CODE OUTPUT

KLOV2	0.200E-02	MEAN	10.0	LOGNORMAL	1-LOV-LOV START SIGNAL FOR DG #2 FAILS
KOPDGLOV	0.100E-02	MEAN	10.0	LOGNORMAL	1-LOV-OP FAILS TO MANUALLY START DIESELS
LOOPC	0.100E-02	MEAN	10.0	LOGNORMAL	CONDITIONAL LOSS OF OFFSITE POWER-TT
NROSP30M	0.520E+00	MEAN	1.3	LOGNORMAL	NONRECOVERY OF OFFSITE POWER BY T=30
NR00130M	0.100E+01			CONSTANT	NO REPAIR OF DIESEL GENERATOR NO. 1 T=30 MIN
NR00230M	0.100E+01			CONSTANT	NO REPAIR OF DIESEL GENERATOR NO 2 BY T=30 MIN
PARV341H	0.100E-02	MEAN	10.0	LOGNORMAL	1-SWC-AIR RELEASE VALVE AR-341 FAILS TO OPERAT
PCB1214H	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-CIRCUIT BREAKER 1214 FAILS TO CLOSE
PCV0338P	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-CHECK VALVE SWC-338 FAILS TO OPEN
PCV0355P	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-CHECK VALVE FPW-355 FAILS TO OPEN
PCV0356P	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-CHECK VALVE FPW-356 FAILS TO OPEN
PCV0383P	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-CHECK VALVE SWC383 FAILS TO OPEN
PCV0587P	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-CHECK VALVE CWS-587 FAILS TO OPEN
PCV0588P	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-CHECK VALVE CWS-588 FAILS TO OPEN
PFLX59AE	0.100E-02	MEAN	10.0	LOGNORMAL	1-SWC-BASKET STRAINER BS-X59A FOULS
PFLX59BE	0.100E-02	MEAN	10.0	LOGNORMAL	1-SWC-BASKET STRAINER BS-X59B FOULS
PFL0050E	0.100E-02	MEAN	10.0	LOGNORMAL	1-SWC-AUX SWC PUMP BASKET STRAINER BS-50 FOULS
PHEE20AE	0.200E-05	MEAN	10.0	LOGNORMAL	1-SWC-HEAT EXCH. E-20A FOULED (TUBE)
PHEE20BE	0.200E-05	MEAN	10.0	LOGNORMAL	1-SWC-HEAT EXCHANGER E-20B FOULED (TUBE SIDE)
PHUDIASW	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPER FAILS TO DIAGNOSE LOSS OF SWCS
PHUG11SU	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPERATOR FAILS TO FOLLOW PROCEDURE SO1-7
PHUG13BU	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPER FAILS TO FOLLOW PROC SO1-7-11 (G13B
PHUG13CU	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPER FAILS TO FOLLOW PROC SO1-7-11 (G13C
PHUG43SU	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPERATOR FAILS TO FOLLOW PROCEDURE SO1-7
PHU0G11U	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPERATOR FAILS TO FOLLOW PROCEDURE SO1-7
PHU0G43U	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPERATOR FAILS TO FOLLOW PROCEDURE SO1-7
PHU0300U	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPER FAILS TO FOLLOW PROC SO1-7-11(SWC-3
PHU0302U	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-FLOW DIV - OPER FAILS TO CLOSE SWC-302
PHU0302W	0.100E-03	MEAN	10.0	LOGNORMAL	1-SWC-L.O. MANUAL VALVE FPW-302 INADVERT CLOSE

PHU0348U	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPER. FAILS TO OPEN MANUAL VALVE SWC-348
PHU0351W	0.100E-03	MEAN	10.0	LOGNORMAL	1-SWC-L.O. MAN VLV INADVERT. CLOSED
PHU0352W	0.100E-03	MEAN	10.0	LOGNORMAL	1-SWC-L.O. MAN VLV INADVERT. CLOSED
PHU0363W	0.100E-03	MEAN	10.0	LOGNORMAL	1-SWC-L.O. MANUAL VALVE FPW-363 INADVERT CLOSE
PHU0364W	0.100E-03	MEAN	10.0	LOGNORMAL	1-SWC-L.O. MANUAL VALVE FPW-364 INADVERTENTLY
PHU0381U	0.100E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPER FAILS TO FOLLOW PROC SO1-7-11 (SWC3
PHU0526U	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPER FAILS TO FOLLOW PROC SO1-2.4-1 (CWS
PHU0527U	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPER FAILS TO FOLLOW PROC SO1-7-11 (CWS
PHU0528U	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPER. FAILS TO FOLLOW PROC SO1-7-11 (CWS
PHU0529U	0.100E-03	MEAN	10.0	LOGNORMAL	1-SWC-OPER FAILS TO FOLLOW PROC SO1-2.4-1 (CWS
PHU0622U	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-OPER FAILS TO FOLLOW PROC SO1-2.4-1 (CWS
PHU720AU	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-MOT OP VLV 720A FAILS TO REC MAN SIG TO
PLOWTIDE	0.200E-04	MEAN	10.0	LOGNORMAL	1-SWC-LOW SUCTION LIFT AVAIL TO G-13C (LOW TID
PMV720AP	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-MOTOR OPER VALVE MOV-720A FAILS TO OPEN
PNSERWTR	0.100E-02	MEAN	10.0	LOGNORMAL	1-SWC-SERVICE WATER SUPPLY FAILURE
PNWIFRBY	0.100E-03	MEAN	10.0	LOGNORMAL	1-SWC-NO WATER IN FOREBAY
PPMG11SR	0.720E-03	MEAN	10.0	LOGNORMAL	1-SWC-FIREWATER PUMP G-11S FAILS TO RUN
PPMG11SS	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-FIREWATER PUMP G-11S FAILS TO START
PPMG11ST	0.370E-02	MEAN	10.0	LOGNORMAL	1-SWC-FIREWATER PUMP G-11S DOWN DUE TO MAINTEN
PPMG13AR	0.720E-03	MEAN	10.0	LOGNORMAL	1-SWC-SWC PUMP SWC-G-13A FAILS TO RUN
PPMG13BR	0.720E-03	MEAN	10.0	LOGNORMAL	1-SWC-SWC PUMP G-13B FAILS TO RUN
PPMG13BS	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-SWC PUMP G-13B FAILS TO START
PPMG13BT	0.370E-02	MEAN	10.0	LOGNORMAL	1-SWC-SWC PUMP G-13B DOWN DUE TO MAINT
PPMG13CR	0.720E-03	MEAN	10.0	LOGNORMAL	1-SWC-AUX SWC PUMP G-13C FAILS TO RUN
PPMG13CS	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-SWC PUMP G-13C FAILS TO START
PPMG13CT	0.370E-02	MEAN	10.0	LOGNORMAL	1-SWC-SWC PUMP G-13C DOWN DUE TO MAINT.
PPMG43SR	0.720E-03	MEAN	10.0	LOGNORMAL	1-SWC-SCREEN WASH PUMP CWS-G-43S FAILS TO RUN
PPMG43SS	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-SCREEN WASH PUMP CWS-G-43S FAILS TO STAR
PPMG43ST	0.370E-02	MEAN	10.0	LOGNORMAL	1-SWC-SCREEN WASH PUMP CWS-G-43S DOWN DUE TO M

PPM0G11R	0.720E-03	MEAN	10.0	LOGNORMAL	1-SWC-FIREWATER PUMP G-11 FAILS TO RUN
PPM0G11S	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-FIREWATER PUMP G-11 FAILS TO START
PPM0G11T	0.370E-02	MEAN	10.0	LOGNORMAL	1-SWC-FIREWATER PUMP G-11 DOWN DUE TO MAINTENA
PPM0G43R	0.720E-03	MEAN	10.0	LOGNORMAL	1-SWC-SCREEN WASH PUMP CWS-G-43 FAILS TO RUN
PPM0G43S	0.300E-02	MEAN	10.0	LOGNORMAL	1-SWC-SCREEN WASH PUMP CWS-G-43 FAILS TO START
PPM0G43T	0.370E-02	MEAN	10.0	LOGNORMAL	1-SWC-SCREEN WASH PUMP CWS-G-43 DOWN DUE TO MA
PPRPS28H	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-PRESSURE SWITCH PS-28 FAILS TO OPERATE
PPS0144H	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-PRESSURE SWITCH PS-144 FAILS TO OPERATE
PSV037AH	0.100E-02	MEAN	10.0	LOGNORMAL	1-SWC-SOLENOID VALVE SV-37A FAILS TO OPERATE
PSWLOLVL	0.100E-06	MEAN	10.0	LOGNORMAL	1-SWC-INSUFF SERVICE WATER SUPPLY FROM RESERVO
PXV0301X	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-MANUAL VALVE SDW-301 LEFT CLOSED AFT MAI
PXV0303X	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-MANUAL VALVE SWC303 LEFT CLOSED
PXV0331X	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-MANUAL VALVE CCW331 LEFT CLOSED
PXV0379X	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-L.O. MAN VALVE 379 LEFT CLOSED AFT MAINT
PXV0585X	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-MANUAL VALVE CWS-585 LEFT CLOSED AFT MAI
PXV0586X	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-MANUAL VALVE CWS-586 LEFT CLOSED AFT MAI
PXV0589X	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-MANUAL VALVE CWS-589 LEFT CLOSED AFT MAI
PXV0590X	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-MANUAL VALVE CWS-590 LEFT CLOSED AFT MAI
PXV0621X	0.100E-03	MEAN	3.0	LOGNORMAL	1-SWC-MANUAL VALVE CWS-621 LEFT CLOSED AFT MAI
UBS0001H	0.240E-06	MEAN	3.0	LOGNORMAL	OPEN OR SHORT CIRCUIT ON 480V BUS NO. 1
UBS0002H	0.240E-06	MEAN	3.0	LOGNORMAL	OPEN OR SHORT CIRCUIT ON 480V BUS NO. 2
UBS0003H	0.240E-06	MEAN	3.0	LOGNORMAL	OPEN OR SHORT CIRCUIT ON 480V BUS NO. 3
UBS001CH	0.240E-06	MEAN	3.0	LOGNORMAL	OPEN OR SHORT CIRCUIT ON 4KV BUS 1C
UBS002CH	0.240E-06	MEAN	3.0	LOGNORMAL	OPEN OR SHORT CIRCUIT ON 480V BUS 2C
UCA0001A	0.790E-04	MEAN	10.0	LOGNORMAL	OPEN OR SHORT IN GENERATOR 1 POWER CABLE
UCA0002A	0.790E-04	MEAN	10.0	LOGNORMAL	OPEN OR SHORT IN GENERATOR #2 POWER CABLE
UCB1C14N	0.300E-02	MEAN	10.0	LOGNORMAL	CIRCUIT BREAKER 11C14 FAILS TO CLOSE
UCB2C15N	0.300E-02	MEAN	10.0	LOGNORMAL	CIRCUIT BREAKER 12C15 FAILS TO CLOSE
UGE0001R	0.550E-01	MEAN	10.0	LOGNORMAL	1-AC-DG #1 FAILS TO RUN FOR 24 HOURS

UGE0001S	0.590E-01	MEAN	3.0	LOGNORMAL	DIESEL GENERATOR NO. 1 FAILS TO START
UGE0001T	0.460E-01	MEAN	6.0	LOGNORMAL	DIESEL GENERATOR NO. 1 IN MAINTENANCE
UGE0002R	0.550E-01	MEAN	10.0	LOGNORMAL	DIESEL GENERATOR NO. 2 FAILS TO RUN
UGE0002S	0.190E-01	MEAN	3.0	LOGNORMAL	DIESEL GENERATOR NO. 2 FAILS TO START
UGE0002T	0.460E-01	MEAN	6.0	LOGNORMAL	DIESEL GENERATOR NO. 2 IN MAINTENANCE
UNASDGEH	0.950E+00	MEAN	10.0	LOGNORMAL	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT
UOPCB14X	0.500E-02	MEAN	3.0	LOGNORMAL	1-AC-OP FAILS TO CORRECTLY CLOSE BKR 11C14
UOPCB15X	0.500E-02	MEAN	3.0	LOGNORMAL	1-AC-OP INCORRECTLY CLOSES BKR 12C15
UOPDGCMD	0.100E-02	MEAN	10.0	LOGNORMAL	1-AC-OPERATORS INADVERTENTLY PARALLEL 4160V BU
UOPSDGEV	0.200E+00	MEAN	10.0	LOGNORMAL	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE
UOP04KVV	0.300E-02	MEAN	10.0	LOGNORMAL	OPERATOR FAILS TO RESET BREAKER 11C11
UOP1CAXT	0.100E-01	MEAN	3.0	LOGNORMAL	1-AC-OP FAILS TO ALIGN BUS 1C TO AUX XFMR A
UOP1C2CX	0.100E-01	MEAN	10.0	LOGNORMAL	1-AC-OP FAILS TO ALIGN BUS 1C TO BUS 2C
UOP12XT	0.500E-01	MEAN	10.0	LOGNORMAL	OPERATOR FAILS TO ALIGN BUS #1 TO BUS #2
UOP13XT	0.100E-01	MEAN	10.0	LOGNORMAL	1-AC-OPER FAILS TO ALIGN BUS 1 TO BUS 3
UOP2CBXT	0.100E-01	MEAN	3.0	LOGNORMAL	1-AC-OP FAILS TO ALIGN BUS 2C TO AUX XFMR B
UOP22CXT	0.100E-01	MEAN	10.0	LOGNORMAL	1-AC-OPER FAILS TO ALIGN BUS 3 TO BUS 2C
UOP23XT	0.100E-01	MEAN	10.0	LOGNORMAL	1-AC-OPER FAILS TO ALIGN BUS 2 TO BUS 3
UTR000AH	0.240E-04	MEAN	3.0	LOGNORMAL	1-AC-AUX TRNSFMR A FAILS TO OPERATE
UTR000BH	0.240E-04	MEAN	3.0	LOGNORMAL	1-AC-AUX XFMR B FAILS TO OPERATE
UTR000CH	0.240E-04	MEAN	3.0	LOGNORMAL	1-AC-AUC TRANSFMR C FAILS TO OPERATE
DG2/1	0.190E+00	MEAN	5.3	LOGNORMAL	DG 002 FAILS GIVEN DG 001 FAILS

********** SALTWATER COOLING RELIABILITY STUDY - SONGS 1 **********

FUSSELL-VESELY MEASURE OF BASIC EVENT IMPORTANCE (MEASURE OF SYSTEM UNAVAILABILITY)

STEADY STATE CALCULATIONS

TOP EVENT PROBABILITY = 0.36580E-04

RANK	BASIC EVENT	IMPORTANCE	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
1	LOOPC	0.959	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
2	UNASDGEH	0.792	0.950	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT
3	UGE0001S	0.555	0.590E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 1 FAILS TO START
4	DG2/1	0.353	0.190	5.30	LOGNORML	DG 002 FAILS GIVEN DG 001 FAILS
5	UGE0002R	0.291	0.550E-01	10.0	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO RUN
6	UGE0001R	0.222	0.550E-01	10.0	LOGNORML	1-AC-DG #1 FAILS TO RUN FOR 24 HOURS
7	UGE0002T	0.177	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 2 IN MAINTENANCE
8	UOPSDGEV	0.167	0.200	10.0	LOGNORML	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE
9	UGE0001T	0.119	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 1 IN MAINTENANCE
10	UGE0002S	0.652E-01	0.190E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO START
11	PNWIFRBY	0.317E-01	0.100E-03	10.0	LOGNORML	1-SWC-NO WATER IN FOREBAY
12	UOPDGCMD	0.315E-01	0.100E-02	10.0	LOGNORML	1-AC-OPERATORS INADVERTENTLY PARALLEL 4160V BU
13	UOPCB15X	0.264E-01	0.500E-02	3.00	LOGNORML	1-AC-OP INCORRECTLY CLOSES BKR 12C15
14	UOPCB14X	0.201E-01	0.500E-02	3.00	LOGNORML	1-AC-OP FAILS TO CORRECTLY CLOSE BKR 11C14
15	UCB2C15N	0.159E-01	0.300E-02	10.0	LOGNORML	CIRCUIT BREAKER 12C15 FAILS TO CLOSE
16	UCB1C14N	0.121E-01	0.300E-02	10.0	LOGNORML	CIRCUIT BREAKER 11C14 FAILS TO CLOSE
17	PPMG13CT	0.107E-01	0.370E-02	10.0	LOGNORML	1-SWC-SWC PUMP G-13C DOWN DUE TO MAINT.
18	PPMG13CS	0.865E-02	0.300E-02	10.0	LOGNORML	1-SWC-SWC PUMP G-13C FAILS TO START
18	PHUG13CU	0.865E-02	0.300E-02	10.0	LOGNORML	1-SWC-OPER FAILS TO FOLLOW PROC SO1-7-11 (G13C
19	IBS0001H	0.656E-02	0.240E-06	3.00	LOGNORML	DC BUS NO. 1 FAILURE
20	PHU0381U	0.288E-02	0.100E-02	10.0	LOGNORML	1-SWC-OPER FAILS TO FOLLOW PROC SO1-7-11 (SWC3
21	PPMG13AR	0.219E-02	0.720E-03	10.0	LOGNORML	1-SWC-SWC PUMP SWC-G-13A FAILS TO RUN
22	PPMG13CR	0.208E-02	0.720E-03	10.0	LOGNORML	1-SWC-AUX SWC PUMP G-13C FAILS TO RUN
23	PPMG13BT	0.978E-03	0.370E-02	10.0	LOGNORML	1-SWC-SWC PUMP G-13B DOWN DUE TO MAINT

24	PPMG13BS	0.809E-03	0.300E-02	10.0	LOGNORML 1-SWC-SWC PUMP G-13B FAILS TO START
25	PMV720AP	0.636E-03	0.300E-02	10.0	LOGNORML 1-SWC-MOTOR OPER VALVE MOV-720A FAILS TO OPEN
26	UCA0002A	0.418E-03	0.790E-04	10.0	LOGNORML OPEN OR SHORT IN GENERATOR #2 POWER CABLE
27	UCA0001A	0.318E-03	0.790E-04	10.0	LOGNORML OPEN OR SHORT IN GENERATOR 1 POWER CABLE
28	UOP12XT	0.300E-03	0.500E-01	10.0	LOGNORML OPERATOR FAILS TO ALIGN BUS #1 TO BUS #2
29	PCV0338P	0.288E-03	0.100E-03	3.00	LOGNORML 1-SWC-CHECK VALVE SWC-338 FAILS TO OPEN
30	PHU0302U	0.223E-03	0.300E-02	10.0	LOGNORML 1-SWC-FLOW DIV - OPER FAILS TO CLOSE SWC-302
30	PHU0300U	0.223E-03	0.300E-02	10.0	LOGNORML 1-SWC-OPER FAILS TO FOLLOW PROC SO1-7-11(SWC-3
31	PPMG13BR	0.194E-03	0.720E-03	10.0	LOGNORML 1-SWC-SWC PUMP G-13B FAILS TO RUN
32	PHEE20BE	0.181E-03	0.200E-05	10.0	LOGNORML 1-SWC-HEAT EXCHANGER E-20B FOULED (TUBE SIDE)
33	IBY0002H	0.127E-03	0.240E-04	3.00	LOGNORML BATTERY NO. 2 UNAVAILABLE AT T=0
34	IBY0001H	0.967E-04	0.240E-04	3.00	LOGNORML BATTERY NO. 1 UNAVAILABLE AT T=0
35	FLOWDIV2	0.744E-04	0.100E-02	3.00	LOGNORML 1-SWC-FLOW DIV-CHECK VALVE SWC382 FAILS TO CLO
36	PHU0348U	0.356E-04	0.300E-02	10.0	LOGNORML 1-SWC-OPER. FAILS TO OPEN MANUAL VALVE SWC-348

FUSSELL-VESELY MEASURE OF BASIC EVENT IMPORTANCE (MEASURE OF SYSTEM UNAVAILABILITY)

STEADY STATE CALCULATIONS

OP EVENT PROBABILITY = 0.36580E-04

ANK	BASIC EVENT	IMPORTANCE	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
37	PCV0383P	0.270E-04	0.100E-03	3.00	LOGNORML	1-SWC-CHECK VALVE SWC383 FAILS TO OPEN
37	PXV0379X	0.270E-04	0.100E-03	3.00	LOGNORML	1-SWC-L.O. MAN VALVE 379 LEFT CLOSED AFT MAINT
38	PXV0301X	0.212E-04	0.100E-03	3.00	LOGNORML	1-SWC-MANUAL VALVE SDW-301 LEFT CLOSED AFT MAI

38	PXV0303X	0.212E-04	0.100E-03	3.00	LOGNORML 1-SWC-MANUAL VALVE SWC303 LEFT CLOSED
38	PXV0331X	0.212E-04	0.100E-03	3.00	LOGNORML 1-SWC-MANUAL VALVE CCW331 LEFT CLOSED
39	KOPDGLOV	0.188E-04	0.100E-02	10.0	LOGNORML 1-LOV-OP FAILS TO MANUALLY START DIESELS
40	PNSERWTR	0.119E-04	0.100E-02	10.0	LOGNORML 1-SWC-SERVICE WATER SUPPLY FAILURE
41	PFL0050E	0.115E-04	0.100E-02	10.0	LOGNORML 1-SWC-AUX SWC PUMP BASKET STRAINER BS-50 FOULS
41	PSV037AH	0.115E-04	0.100E-02	10.0	LOGNORML 1-SWC-SOLENOID VALVE SV-37A FAILS TO OPERATE
41	PARV341H	0.115E-04	0.100E-02	10.0	LOGNORML 1-SWC-AIR RELEASE VALVE AR-341 FAILS TO OPERAT
41	INSTRAIR	0.115E-04	0.100E-02	10.0	LOGNORML 1-SWC-INSTRUMENT AIR FAILURE
42	KLOV2	0.107E-04	0.200E-02	10.0	LOGNORML 1-LOV-LOV START SIGNAL FOR DG #2 FAILS
43	UOP04KVV	0.878E-05	0.300E-02	10.0	LOGNORML OPERATOR FAILS TO RESET BREAKER 11C11
44	KLOV1	0.818E-05	0.200E-02	10.0	LOGNORML 1-LOV-LOV START SIGNAL FOR DG #1 FAILS
45	UTR000CH	0.230E-05	0.240E-04	3.00	LOGNORML 1-AC-AUC TRANSFMR C FAILS TO OPERATE
45	UOP2CBXT	0.230E-05	0.100E-01	3.00	LOGNORML 1-AC-OP FAILS TO ALIGN BUS 2C TO AUX XFMR B
45	UOP1CAXT	0.230E-05	0.100E-01	3.00	LOGNORML 1-AC-OP FAILS TO ALIGN BUS 1C TO AUX XFMR A
46	PHU720AU	0.197E-05	0.300E-02	10.0	LOGNORML 1-SWC-MOT OP VLV 720A FAILS TO REC MAN SIG TO
47	PCB1214H	0.190E-05	0.300E-02	10.0	LOGNORML 1-SWC-CIRCUIT BREAKER 1214 FAILS TO CLOSE
48	IBS0002H	0.127E-05	0.240E-06	3.00	LOGNORML BUS NO. 2 FAILURE
49	PPS0144H	0.115E-05	0.100E-03	3.00	LOGNORML 1-SWC-PRESSURE SWITCH PS-144 FAILS TO OPERATE
50	UBS0001H	0.727E-06	0.240E-06	3.00	LOGNORML OPEN OR SHORT CIRCUIT ON 480V BUS NO. 1
51	UBS0003H	0.692E-06	0.240E-06	3.00	LOGNORML OPEN OR SHORT CIRCUIT ON 480V BUS NO. 3
52	PHEE20AE	0.423E-06	0.200E-05	10.0	LOGNORML 1-SWC-HEAT EXCH. E-20A FOULED (TUBE)
53	UOP1C2CX	0.353E-06	0.100E-01	10.0	LOGNORML 1-AC-OP FAILS TO ALIGN BUS 1C TO BUS 2C
54	UBS0002H	0.305E-06	0.240E-06	3.00	LOGNORML OPEN OR SHORT CIRCUIT ON 480V BUS NO. 2
55	UOP22CXT	0.230E-06	0.100E-01	10.0	LOGNORML 1-AC-OPER FAILS TO ALIGN BUS 3 TO BUS 2C
55	PLOWTIDE	0.230E-06	0.200E-04	10.0	LOGNORML 1-SWC-LOW SUCTION LIFT AVAIL TO G-13C (LOW TID
56	PPRPS28H	0.143E-06	0.100E-03	3.00	LOGNORML 1-SWC-PRESSURE SWITCH PS-28 FAILS TO OPERATE
57	PHUG13BU	0.796E-07	0.300E-02	10.0	LOGNORML 1-SWC-OPER FAILS TO FOLLOW PROC SO1-7-11 (G13B
58	UBS001CH	0.425E-07	0.240E-06	3.00	LOGNORML OPEN OR SHORT CIRCUIT ON 4KV BUS 1C
59	UBS002CH	0.142E-07	0.240E-06	3.00	LOGNORML OPEN OR SHORT CIRCUIT ON 480V BUS 2C

60	FLOWDIV1	0.355E-08	0.100E-02	3.00	LOGNORML 1-SWC-FLOW DIV- CHK VLV SWC-383 FAILS TO CLOSE
61	UOP23XT	0.222E-08	0.100E-01	10.0	LOGNORML 1-AC-OPER FAILS TO ALIGN BUS 2 TO BUS 3
62	UTR000BH	0.210E-08	0.240E-04	3.00	LOGNORML 1-AC-AUX XFMR B FAILS TO OPERATE
62	UTR000AH	0.210E-08	0.240E-04	3.00	LOGNORML 1-AC-AUX TRNSFMR A FAILS TO OPERATE
63	IBC000BH	0.378E-09	0.240E-04	3.00	LOGNORML BATTERY CHARGER SET B FAILS TO OPERATE
63	IBC000AH	0.378E-09	0.240E-04	3.00	LOGNORML BATTERY CHARGER SET A FAILS TO OPERATE

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE (MEASURE OF SYSTEM UNAVAILABILTY)

TOP EVENT PROBABILITY = 0.36580E-04

RANK IMPORTANCE

1 0.291E+00 CUT SET 446

MIN CUT SET PROBABILITY = 0.106E-04

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
DG2/1	0.190E+00	5.30	LOGNORML	DG 002 FAILS GIVEN DG 001 FAILS
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001S	0.590E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 1 FAILS TO START
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

2 0.843E-01 CUT SET 335

MIN CUT SET PROBABILITY = 0.308E-05

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION

LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001S	0.590E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 1 FAILS TO START
UGE0002R	0.550E-01	10.0	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO RUN
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

3 0.786E-01 CUT SET 327

MIN CUT SET PROBABILITY = 0.287E-05

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001R	0.550E-01	10.0	LOGNORML	1-AC-DG #1 FAILS TO RUN FOR 24 HOURS
UGE0002R	0.550E-01	10.0	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO RUN
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

4 0.705E-01 CUT SET 337

MIN CUT SET PROBABILITY = 0.258E-05

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001S	0.590E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 1 FAILS TO START
UGE0002T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 2 IN MAINTENANCE
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE (MEASURE OF SYSTEM UNAVAILABILTY)

TOP EVENT PROBABILITY = 0.36580E-04

RANK IMPORTANCE

5 0.657E-01 CUT SET 341

MIN CUT SET PROBABILITY = 0.240E-05

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 1 IN MAINTENANCE
UGE0002R	0.550E-01	10.0	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO RUN
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

5 0.657E-01 CUT SET 331

MIN CUT SET PROBABILITY = 0.240E-05

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001R	0.550E-01	10.0	LOGNORML	1-AC-DG #1 FAILS TO RUN FOR 24 HOURS
UGE0002T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 2 IN MAINTENANCE
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

6 0.613E-01 CUT SET 447

MIN CUT SET PROBABILITY = 0.224E-05

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION

DG2/1	0.190E+00	5.30	LOGNORML	DG 002 FAILS GIVEN DG 001 FAILS
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001S	0.590E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 1 FAILS TO START
UOPSDGEV	0.200E+00	10.0	LOGNORML	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE

7 0.271E-01 CUT SET 329

MIN CUT SET PROBABILITY = 0.993E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001R	0.550E-01	10.0	LOGNORML	1-AC-DG #1 FAILS TO RUN FOR 24 HOURS
UGE0002S	0.190E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO START
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

8 0.260E-01 CUT SET 37

MIN CUT SET PROBABILITY = 0.950E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT
UOPDGCMD	0.100E-02	10.0	LOGNORML	1-AC-OPERATORS INADVERTENTLY PARALLEL 4160V BU

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE (MEASURE OF SYSTEM UNAVAILABILTY)

TOP EVENT PROBABILITY = 0.36580E-04

RANK IMPORTANCE

9 0.227E-01 CUT SET 343

MIN CUT SET PROBABILITY = 0.830E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 1 IN MAINTENANCE
UGE0002S	0.190E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO START
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

10 0.177E-01 CUT SET 336

MIN CUT SET PROBABILITY = 0.649E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001S	0.590E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 1 FAILS TO START
UGE0002R	0.550E-01	10.0	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO RUN
UOPSDGEV	0.200E+00	10.0	LOGNORML	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE

11 0.165E-01 CUT SET 328

MIN CUT SET PROBABILITY = 0.605E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION

LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001R	0.550E-01	10.0	LOGNORML	1-AC-DG #1 FAILS TO RUN FOR 24 HOURS
UGE0002R	0.550E-01	10.0	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO RUN
UOPSDGEV	0.200E+00	10.0	LOGNORML	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE

12 0.148E-01 CUT SET 338

MIN CUT SET PROBABILITY = 0.543E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001S	0.590E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 1 FAILS TO START
UGE0002T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 2 IN MAINTENANCE
UOPSDGEV	0.200E+00	10.0	LOGNORML	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE (MEASURE OF SYSTEM UNAVAILABILTY)

TOP EVENT PROBABILITY = 0.36580E-04

RANK IMPORTANCE

13 0.138E-01 CUT SET 332

MIN CUT SET PROBABILITY = 0.506E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT

UGE0001R	0.550E-01	10.0	LOGNORML	1-AC-DG #1 FAILS TO RUN FOR 24 HOURS
UGE0002T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 2 IN MAINTENANCE
UOPSDGEV	0.200E+00	10.0	LOGNORML	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE

13 0.138E-01 CUT SET 342

MIN CUT SET PROBABILITY = 0.506E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 1 IN MAINTENANCE
UGE0002R	0.550E-01	10.0	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO RUN
UOPSDGEV	0.200E+00	10.0	LOGNORML	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE

14 0.101E-01 CUT SET 13

MIN CUT SET PROBABILITY = 0.370E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
PNWIFRBY	0.100E-03	10.0	LOGNORML	1-SWC-NO WATER IN FOREBAY
PPMG13CT	0.370E-02	10.0	LOGNORML	1-SWC-SWC PUMP G-13C DOWN DUE TO MAINT.

15 0.820E-02 CUT SET 9

MIN CUT SET PROBABILITY = 0.300E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
PHUG13CU	0.300E-02	10.0	LOGNORML	1-SWC-OPER FAILS TO FOLLOW PROC SO1-7-11 (G13C
PNWIFRBY	0.100E-03	10.0	LOGNORML	1-SWC-NO WATER IN FOREBAY

15 0.820E-02 CUT SET 12

MIN CUT SET PROBABILITY = 0.300E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
PNWIFRBY	0.100E-03	10.0	LOGNORML	1-SWC-NO WATER IN FOREBAY
PPMG13CS	0.300E-02	10.0	LOGNORML	1-SWC-SWC PUMP G-13C FAILS TO START

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE (MEASURE OF SYSTEM UNAVAILABILTY)

TOP EVENT PROBABILITY = 0.36580E-04

RANK IMPORTANCE

16 0.766E-02 CUT SET 339

MIN CUT SET PROBABILITY = 0.280E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001S	0.590E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 1 FAILS TO START
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT
UOPCB15X	0.500E-02	3.00	LOGNORML	1-AC-OP INCORRECTLY CLOSES BKR 12C15

17 0.714E-02 CUT SET 333

MIN CUT SET PROBABILITY = 0.261E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001R	0.550E-01	10.0	LOGNORML	1-AC-DG #1 FAILS TO RUN FOR 24 HOURS
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT
UOPCB15X	0.500E-02	3.00	LOGNORML	1-AC-OP INCORRECTLY CLOSES BKR 12C15

17 0.714E-02 CUT SET 347

MIN CUT SET PROBABILITY = 0.261E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0002R	0.550E-01	10.0	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO RUN
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT
UOPCB14X	0.500E-02	3.00	LOGNORML	1-AC-OP FAILS TO CORRECTLY CLOSE BKR 11C14

18 0.656E-02 CUT SET 1

MIN CUT SET PROBABILITY = 0.240E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
IBS0001H	0.240E-06	3.00	LOGNORML	DC BUS NO. 1 FAILURE

19 0.597E-02 CUT SET 345

MIN CUT SET PROBABILITY = 0.218E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION

LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 1 IN MAINTENANCE
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT
UOPCB15X	0.500E-02	3.00	LOGNORML	1-AC-OP INCORRECTLY CLOSES BKR 12C15

********** SALTWATER COOLING RELIABILITY STUDY - SONGS 1 **********

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE (MEASURE OF SYSTEM UNAVAILABILTY)

TOP EVENT PROBABILITY = 0.36580E-04

RANK IMPORTANCE

19 0.597E-02 CUT SET 351

MIN CUT SET PROBABILITY = 0.218E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0002T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 2 IN MAINTENANCE
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT
UOPCB14X	0.500E-02	3.00	LOGNORML	1-AC-OP FAILS TO CORRECTLY CLOSE BKR 11C14

20 0.571E-02 CUT SET 330

MIN CUT SET PROBABILITY = 0.209E-06

BASIC EVENT MEAN PROBABILITY ERROR FACTOR DISTRIBUTION BASIC EVENT DESCRIPTION

LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001R	0.550E-01	10.0	LOGNORML	1-AC-DG #1 FAILS TO RUN FOR 24 HOURS
UGE0002S	0.190E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO START
UOPSDGEV	0.200E+00	10.0	LOGNORML	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE

21 0.547E-02 CUT SET 38

MIN CUT SET PROBABILITY = 0.200E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UOPDGCMD	0.100E-02	10.0	LOGNORML	1-AC-OPERATORS INADVERTENTLY PARALLEL 4160V BU
UOPSDGEV	0.200E+00	10.0	LOGNORML	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE

22 0.478E-02 CUT SET 344

MIN CUT SET PROBABILITY = 0.175E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UGE0001T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 1 IN MAINTENANCE
UGE0002S	0.190E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO START
UOPSDGEV	0.200E+00	10.0	LOGNORML	1-AFW-OP FAILS TO REALIGN BUS #2 TO SDGE LINE

23 0.460E-02 CUT SET 321

MIN CUT SET PROBABILITY = 0.168E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION

LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UCB2C15N	0.300E-02	10.0	LOGNORML	CIRCUIT BREAKER 12C15 FAILS TO CLOSE
UGE0001S	0.590E-01	3.00	LOGNORML	DIESEL GENERATOR NO. 1 FAILS TO START
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE (MEASURE OF SYSTEM UNAVAILABILTY)

TOP EVENT PROBABILITY = 0.36580E-04

RANK IMPORTANCE

24 0.429E-02 CUT SET 311

MIN CUT SET PROBABILITY = 0.157E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UCB1C14N	0.300E-02	10.0	LOGNORML	CIRCUIT BREAKER 11C14 FAILS TO CLOSE
UGE0002R	0.550E-01	10.0	LOGNORML	DIESEL GENERATOR NO. 2 FAILS TO RUN
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

24 0.429E-02 CUT SET 319

MIN CUT SET PROBABILITY = 0.157E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT

UCB2C15N	0.300E-02	10.0	LOGNORML	CIRCUIT BREAKER 12C15 FAILS TO CLOSE
UGE0001R	0.550E-01	10.0	LOGNORML	1-AC-DG #1 FAILS TO RUN FOR 24 HOURS
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

25 0.358E-02 CUT SET 323

MIN CUT SET PROBABILITY = 0.131E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UCB2C15N	0.300E-02	10.0	LOGNORML	CIRCUIT BREAKER 12C15 FAILS TO CLOSE
UGE0001T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 1 IN MAINTENANCE
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

25 0.358E-02 CUT SET 315

MIN CUT SET PROBABILITY = 0.131E-06

BASIC EVENT	MEAN PROBABILITY	ERROR FACTOR	DISTRIBUTION	BASIC EVENT DESCRIPTION
LOOPC	0.100E-02	10.0	LOGNORML	CONDITIONAL LOSS OF OFFSITE POWER-TT
UCB1C14N	0.300E-02	10.0	LOGNORML	CIRCUIT BREAKER 11C14 FAILS TO CLOSE
UGE0002T	0.460E-01	6.00	LOGNORML	DIESEL GENERATOR NO. 2 IN MAINTENANCE
UNASDGEH	0.950E+00	10.0	LOGNORML	1-AC-SDGE 12KV LINE UNAVAIL AFTER LOSS OF SWIT

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE

FOR CUT SETS OF RANK 26 AND HIGHER

STEADY STATE CALCULATIONS

TOP EVENT PROBABILITY = 0.36580E-04

RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*
26	10	0.273E-02*	51	111	0.728E-04*	78	307	0.103E-04*	92	725	0.529E-05*
27	349	0.247E-02*	52	110	0.590E-04*	79	122	0.102E-04*	93	266	0.506E-05*
28	11	0.197E-02*	52	18	0.590E-04*	80	246	0.887E-05*	94	694	0.429E-05*
29	340	0.161E-02*	53	786	0.567E-04*	81	242	0.827E-05*	95	265	0.410E-05*
30	348	0.150E-02*	54	124	0.524E-04*	82	294	0.821E-05*	96	701	0.358E-05*
30	334	0.150E-02*	54	130	0.524E-04*	82	108	0.820E-05*	97	664	0.319E-05*
31	313	0.148E-02*	55	310	0.492E-04*	82	32	0.820E-05*	98	192	0.312E-05*
32	346	0.126E-02*	56	785	0.460E-04*	82	35	0.820E-05*	98	208	0.312E-05*
32	352	0.126E-02*	57	123	0.425E-04*	82	62	0.820E-05*	99	499	0.306E-05*
33	322	0.968E-03*	57	69	0.425E-04*	82	39	0.820E-05*	100	660	0.298E-05*
34	320	0.902E-03*	57	126	0.425E-04*	82	17	0.820E-05*	101	483	0.286E-05*
34	312	0.902E-03*	58	293	0.390E-04*	83	205	0.774E-05*	101	497	0.286E-05*
35	316	0.755E-03*	59	204	0.368E-04*	84	247	0.742E-05*	101	243	0.286E-05*
35	324	0.755E-03*	60	186	0.343E-04*	85	138	0.728E-05*	102	63	0.273E-05*
36	353	0.649E-03*	60	202	0.343E-04*	85	45	0.728E-05*	102	34	0.273E-05*
37	350	0.519E-03*	61	444	0.306E-04*	85	57	0.728E-05*	102	40	0.273E-05*
38	325	0.390E-03*	62	190	0.287E-04*	86	203	0.722E-05*	102	120	0.273E-05*
38	317	0.390E-03*	62	206	0.287E-04*	86	187	0.722E-05*	102	33	0.273E-05*
39	314	0.312E-03*	63	304	0.255E-04*	87	249	0.692E-05*	103	665	0.267E-05*

40	2	0.273E-03*	64	78	0.246E-04*	87	244	0.692E-05*	104	189	0.249E-05*
41	132	0.269E-03*	64	92	0.246E-04*	88	289	0.616E-05*	105	662	0.249E-05*
42	309	0.234E-03*	65	292	0.238E-04*	88	299	0.616E-05*	105	667	0.249E-05*
43	131	0.218E-03*	65	302	0.238E-04*	89	191	0.604E-05*	106	487	0.239E-05*
43	71	0.218E-03*	66	306	0.199E-04*	89	207	0.604E-05*	106	501	0.239E-05*
43	128	0.218E-03*	66	296	0.199E-04*	90	51	0.590E-05*	106	250	0.239E-05*
44	127	0.177E-03*	67	728	0.164E-04*	90	44	0.590E-05*	107	298	0.216E-05*
44	79	0.177E-03*	68	724	0.153E-04*	90	56	0.590E-05*	107	308	0.216E-05*
44	70	0.177E-03*	69	109	0.142E-04*	90	99	0.590E-05*	108	25	0.197E-05*
44	93	0.177E-03*	70	729	0.137E-04*	90	101	0.590E-05*	108	53	0.197E-05*
45	4	0.164E-03*	71	697	0.133E-04*	90	85	0.590E-05*	108	112	0.197E-05*
46	354	0.137E-03*	72	726	0.128E-04*	90	100	0.590E-05*	108	26	0.197E-05*
47	303	0.121E-03*	73	693	0.124E-04*	90	86	0.590E-05*	108	24	0.197E-05*
48	291	0.113E-03*	74	188	0.118E-04*	90	136	0.590E-05*	109	184	0.187E-05*
48	301	0.113E-03*	75	698	0.111E-04*	90	72	0.590E-05*	109	200	0.187E-05*
49	295	0.944E-04*	76	784	0.110E-04*	90	87	0.590E-05*	110	787	0.153E-05*
49	305	0.944E-04*	77	700	0.104E-04*	91	6	0.547E-05*	110	779	0.153E-05*
50	318	0.820E-04*	77	695	0.104E-04*	91	7	0.547E-05*	111	730	0.149E-05*
50	326	0.820E-04*	78	297	0.103E-04*	91	5	0.547E-05*	112	55	0.142E-05*

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE

FOR CUT SETS OF RANK 26 AND HIGHER

STEADY STATE CALCULATIONS

TOP EVENT PROBABILITY = 0.36580E-04

RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*
112	43	0.142E-05*	134	209	0.656E-06*	157	21	0.273E-06*	178	287	0.162E-06*
112	134	0.142E-05*	135	500	0.645E-06*	157	119	0.273E-06*	179	597	0.160E-06*
113	727	0.139E-05*	136	254	0.629E-06*	157	20	0.273E-06*	180	780	0.159E-06*
113	731	0.139E-05*	136	251	0.629E-06*	158	663	0.271E-06*	181	988	0.158E-06*
114	300	0.130E-05*	137	484	0.601E-06*	158	670	0.271E-06*	181	1004	0.158E-06*
114	290	0.130E-05*	137	498	0.601E-06*	159	489	0.260E-06*	182	495	0.156E-06*
115	699	0.121E-05*	138	691	0.566E-06*	159	503	0.260E-06*	182	481	0.156E-06*
116	733	0.116E-05*	138	687	0.566E-06*	159	253	0.260E-06*	182	235	0.156E-06*
117	696	0.113E-05*	139	366	0.531E-06*	160	621	0.236E-06*	183	599	0.149E-06*
117	703	0.113E-05*	139	368	0.531E-06*	161	686	0.234E-06*	183	594	0.149E-06*
118	661	0.103E-05*	140	502	0.503E-06*	162	672	0.226E-06*	184	1031	0.147E-06*
119	485	0.987E-06*	140	488	0.503E-06*	162	669	0.226E-06*	185	750	0.143E-06*
120	264	0.984E-06*	141	41	0.492E-06*	163	617	0.220E-06*	185	535	0.143E-06*
121	702	0.943E-06*	142	239	0.484E-06*	164	261	0.218E-06*	186	1022	0.138E-06*
121	705	0.943E-06*	143	732	0.480E-06*	164	214	0.218E-06*	186	1026	0.138E-06*
122	722	0.895E-06*	144	234	0.451E-06*	164	359	0.218E-06*	187	222	0.137E-06*
123	668	0.860E-06*	144	238	0.451E-06*	164	378	0.218E-06*	187	267	0.137E-06*
124	717	0.834E-06*	145	753	0.444E-06*	164	427	0.218E-06*	188	654	0.136E-06*
124	721	0.834E-06*	145	538	0.444E-06*	165	486	0.208E-06*	188	658	0.136E-06*
125	107	0.820E-06*	146	749	0.413E-06*	166	994	0.202E-06*	189	734	0.126E-06*
125	96	0.820E-06*	146	534	0.413E-06*	167	622	0.198E-06*	190	542	0.119E-06*
125	82	0.820E-06*	147	185	0.394E-06*	168	42	0.197E-06*	190	757	0.119E-06*
125	97	0.820E-06*	147	201	0.394E-06*	168	46	0.197E-06*	191	67	0.118E-06*

125	95	0.820E-06*	148	704	0.390E-06*	169	596	0.192E-06*	191	65	0.118E-06*
125	81	0.820E-06*	149	240	0.377E-06*	170	982	0.189E-06*	192	3	0.109E-06*
125	83	0.820E-06*	149	236	0.377E-06*	171	619	0.184E-06*	193	476	0.104E-06*
126	782	0.816E-06*	150	539	0.371E-06*	172	592	0.179E-06*	194	706	0.103E-06*
127	248	0.806E-06*	150	754	0.371E-06*	173	259	0.177E-06*	195	671	0.935E-07*
128	252	0.752E-06*	151	170	0.368E-06*	173	425	0.177E-06*	196	149	0.898E-07*
128	245	0.752E-06*	152	756	0.346E-06*	173	213	0.177E-06*	197	171	0.774E-07*
129	690	0.726E-06*	152	541	0.346E-06*	173	358	0.177E-06*	198	618	0.761E-07*
130	1030	0.699E-06*	152	751	0.346E-06*	173	377	0.177E-06*	199	723	0.759E-07*
131	719	0.698E-06*	152	536	0.346E-06*	173	162	0.177E-06*	199	720	0.759E-07*
132	685	0.677E-06*	153	168	0.343E-06*	174	657	0.174E-06*	200	367	0.738E-07*
132	689	0.677E-06*	154	666	0.290E-06*	175	998	0.169E-06*	200	365	0.738E-07*
133	781	0.662E-06*	155	718	0.288E-06*	176	106	0.164E-06*	201	445	0.735E-07*
134	14	0.656E-06*	156	172	0.287E-06*	177	652	0.162E-06*	202	146	0.728E-07*
134	193	0.656E-06*	157	22	0.273E-06*	177	656	0.162E-06*	202	148	0.728E-07*

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE

FOR CUT SETS OF RANK 26 AND HIGHER

STEADY STATE CALCULATIONS

TOP EVENT PROBABILITY = 0.36580E-04

RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*

202	76	0.728E-07*	220	423	0.425E-07*	239	929	0.309E-07*	260	1002	0.184E-07*
202	260	0.728E-07*	220	212	0.425E-07*	240	960	0.298E-07*	260	710	0.184E-07*
202	363	0.728E-07*	220	376	0.425E-07*	241	958	0.278E-07*	261	680	0.178E-07*
202	382	0.728E-07*	221	237	0.410E-07*	242	933	0.258E-07*	261	675	0.178E-07*
202	218	0.728E-07*	221	241	0.410E-07*	243	161	0.246E-07*	261	279	0.178E-07*
202	438	0.728E-07*	222	540	0.403E-07*	243	233	0.246E-07*	262	416	0.177E-07*
203	169	0.722E-07*	222	755	0.403E-07*	243	673	0.246E-07*	262	424	0.177E-07*
204	255	0.683E-07*	223	892	0.399E-07*	244	116	0.243E-07*	262	418	0.177E-07*
205	986	0.651E-07*	223	851	0.399E-07*	245	950	0.242E-07*	262	413	0.177E-07*
206	776	0.623E-07*	224	985	0.397E-07*	245	531	0.242E-07*	262	410	0.177E-07*
207	593	0.617E-07*	225	16	0.394E-07*	245	746	0.242E-07*	263	147	0.175E-07*
208	688	0.615E-07*	226	573	0.385E-07*	246	714	0.236E-07*	263	133	0.175E-07*
208	692	0.615E-07*	227	752	0.376E-07*	247	948	0.226E-07*	263	139	0.175E-07*
209	173	0.604E-07*	227	759	0.376E-07*	247	741	0.226E-07*	263	143	0.175E-07*
210	94	0.590E-07*	227	544	0.376E-07*	247	745	0.226E-07*	264	598	0.174E-07*
210	145	0.590E-07*	227	537	0.376E-07*	247	526	0.226E-07*	265	992	0.171E-07*
210	80	0.590E-07*	228	847	0.372E-07*	247	530	0.226E-07*	265	1012	0.171E-07*
210	75	0.590E-07*	228	888	0.372E-07*	248	778	0.221E-07*	266	626	0.168E-07*
210	436	0.590E-07*	229	684	0.369E-07*	248	783	0.221E-07*	267	281	0.166E-07*
210	258	0.590E-07*	230	575	0.359E-07*	249	713	0.220E-07*	267	276	0.166E-07*
210	362	0.590E-07*	230	570	0.359E-07*	249	708	0.220E-07*	268	66	0.164E-07*
210	217	0.590E-07*	231	1001	0.356E-07*	250	477	0.219E-07*	268	64	0.164E-07*
210	381	0.590E-07*	232	288	0.341E-07*	251	426	0.218E-07*	268	68	0.164E-07*
211	653	0.561E-07*	233	893	0.334E-07*	251	414	0.218E-07*	269	595	0.162E-07*
212	118	0.547E-07*	233	852	0.334E-07*	252	623	0.215E-07*	269	602	0.162E-07*
212	490	0.547E-07*	234	1007	0.332E-07*	253	278	0.213E-07*	270	559	0.161E-07*
212	504	0.547E-07*	234	991	0.332E-07*	254	620	0.200E-07*	271	558	0.150E-07*

213	1008	0.545E-07*	235	482	0.328E-07*	254	624	0.200E-07*	272	176	0.150E-07*
214	600	0.516E-07*	235	496	0.328E-07*	255	274	0.198E-07*	273	682	0.149E-07*
215	182	0.492E-07*	236	543	0.314E-07*	256	19	0.197E-07*	273	677	0.149E-07*
215	198	0.492E-07*	236	546	0.314E-07*	256	115	0.197E-07*	274	569	0.148E-07*
216	572	0.460E-07*	236	761	0.314E-07*	257	681	0.191E-07*	275	655	0.148E-07*
216	1020	0.460E-07*	236	758	0.314E-07*	258	952	0.189E-07*	275	659	0.148E-07*
217	716	0.455E-07*	237	174	0.312E-07*	258	747	0.189E-07*	276	1010	0.143E-07*
218	568	0.429E-07*	238	890	0.311E-07*	258	532	0.189E-07*	276	1016	0.143E-07*
219	997	0.426E-07*	238	895	0.311E-07*	258	528	0.189E-07*	277	144	0.142E-07*
220	257	0.425E-07*	238	849	0.311E-07*	258	743	0.189E-07*	277	88	0.142E-07*
220	357	0.425E-07*	238	854	0.311E-07*	259	166	0.187E-07*	277	102	0.142E-07*

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE

FOR CUT SETS OF RANK 26 AND HIGHER

STEADY STATE CALCULATIONS

TOP EVENT PROBABILITY = 0.36580E-04

RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*
277	129	0.142E-07*	298	589	0.105E-07*	323	508	0.595E-08*	337	1027	0.460E-08*
277	142	0.142E-07*	299	800	0.104E-07*	323	631	0.595E-08*	337	1023	0.460E-08*

277	137	0.142E-07*	299	795	0.104E-07*	324	1014	0.592E-08*	337	1029	0.460E-08*
277	74	0.142E-07*	299	183	0.104E-07*	325	435	0.590E-08*	337	1028	0.460E-08*
277	73	0.142E-07*	299	199	0.104E-07*	325	164	0.590E-08*	337	1021	0.460E-08*
277	434	0.142E-07*	300	968	0.103E-07*	325	379	0.590E-08*	338	648	0.459E-08*
277	256	0.142E-07*	300	975	0.103E-07*	325	429	0.590E-08*	339	943	0.453E-08*
277	361	0.142E-07*	301	612	0.101E-07*	325	370	0.590E-08*	339	470	0.453E-08*
277	216	0.142E-07*	302	231	0.993E-08*	325	221	0.590E-08*	339	456	0.453E-08*
277	380	0.142E-07*	302	226	0.993E-08*	325	360	0.590E-08*	340	421	0.437E-08*
278	987	0.137E-07*	303	441	0.984E-08*	325	263	0.590E-08*	341	794	0.429E-08*
279	604	0.136E-07*	304	588	0.974E-08*	325	355	0.590E-08*	342	647	0.428E-08*
279	601	0.136E-07*	304	584	0.974E-08*	325	215	0.590E-08*	342	643	0.428E-08*
280	797	0.133E-07*	305	959	0.895E-08*	325	210	0.590E-08*	343	412	0.425E-08*
281	8	0.131E-07*	306	651	0.886E-08*	325	411	0.590E-08*	343	422	0.425E-08*
281	777	0.131E-07*	307	979	0.860E-08*	325	373	0.590E-08*	344	574	0.418E-08*
282	760	0.130E-07*	307	972	0.860E-08*	326	941	0.581E-08*	345	611	0.415E-08*
282	545	0.130E-07*	308	957	0.834E-08*	326	469	0.581E-08*	346	493	0.410E-08*
283	615	0.129E-07*	309	590	0.815E-08*	327	282	0.573E-08*	346	479	0.410E-08*
284	848	0.129E-07*	309	586	0.815E-08*	328	951	0.566E-08*	346	225	0.410E-08*
284	889	0.129E-07*	310	527	0.779E-08*	329	603	0.561E-08*	346	448	0.410E-08*
285	230	0.127E-07*	310	742	0.779E-08*	330	461	0.558E-08*	347	167	0.394E-08*
286	560	0.126E-07*	311	709	0.759E-08*	331	15	0.547E-08*	348	578	0.390E-08*
287	793	0.124E-07*	312	437	0.728E-08*	332	934	0.543E-08*	348	571	0.390E-08*
288	576	0.124E-07*	313	949	0.726E-08*	333	939	0.541E-08*	349	1003	0.387E-08*
289	549	0.123E-07*	314	474	0.716E-08*	333	454	0.541E-08*	349	195	0.387E-08*
289	553	0.123E-07*	315	625	0.692E-08*	333	468	0.541E-08*	350	771	0.368E-08*
290	442	0.121E-07*	316	275	0.686E-08*	334	636	0.534E-08*	351	894	0.363E-08*
291	614	0.120E-07*	317	947	0.677E-08*	334	513	0.534E-08*	351	853	0.363E-08*
291	610	0.120E-07*	318	473	0.668E-08*	335	638	0.498E-08*	352	178	0.361E-08*
292	224	0.119E-07*	318	459	0.668E-08*	335	633	0.498E-08*	352	194	0.361E-08*

292	229	0.119E-07*	319	121	0.656E-08*	335	515	0.498E-08*	352	993	0.361E-08*
293	1009	0.115E-07*	319	36	0.656E-08*	335	510	0.498E-08*	352	1013	0.361E-08*
294	798	0.111E-07*	319	175	0.656E-08*	336	27	0.472E-08*	353	801	0.358E-08*
295	977	0.110E-07*	320	930	0.650E-08*	336	114	0.472E-08*	354	645	0.358E-08*
296	896	0.108E-07*	321	635	0.639E-08*	336	113	0.472E-08*	354	649	0.358E-08*
296	855	0.108E-07*	321	512	0.639E-08*	337	1025	0.460E-08*	355	970	0.355E-08*
297	931	0.107E-07*	322	676	0.616E-08*	337	1024	0.460E-08*	356	420	0.354E-08*

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE

FOR CUT SETS OF RANK 26 AND HIGHER

STEADY STATE CALCULATIONS

TOP EVENT PROBABILITY = 0.36580E-04

RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*
357	763	0.343E-08*	376	399	0.225E-08*	383	439	0.197E-08*	400	388	0.148E-08*
357	769	0.343E-08*	376	409	0.225E-08*	383	374	0.197E-08*	400	395	0.148E-08*
358	762	0.342E-08*	376	932	0.224E-08*	383	383	0.197E-08*	400	405	0.148E-08*
358	547	0.342E-08*	377	886	0.218E-08*	383	371	0.197E-08*	400	605	0.148E-08*
359	135	0.340E-08*	377	845	0.218E-08*	383	219	0.197E-08*	401	432	0.146E-08*
359	125	0.340E-08*	378	969	0.217E-08*	384	564	0.196E-08*	402	433	0.142E-08*

359	141	0.340E-08*	378	976	0.217E-08*	384	567	0.196E-08*	403	465	0.139E-08*
360	857	0.338E-08*	379	509	0.206E-08*	385	280	0.194E-08*	404	561	0.137E-08*
360	891	0.338E-08*	379	632	0.206E-08*	386	455	0.187E-08*	405	942	0.136E-08*
360	850	0.338E-08*	380	954	0.205E-08*	387	386	0.182E-08*	406	579	0.135E-08*
360	898	0.338E-08*	380	529	0.205E-08*	387	389	0.182E-08*	407	864	0.133E-08*
361	585	0.337E-08*	380	744	0.205E-08*	387	627	0.182E-08*	407	912	0.133E-08*
362	577	0.326E-08*	380	748	0.205E-08*	387	396	0.182E-08*	407	837	0.133E-08*
362	580	0.326E-08*	380	533	0.205E-08*	387	406	0.182E-08*	407	871	0.133E-08*
363	177	0.315E-08*	381	885	0.203E-08*	387	408	0.182E-08*	407	905	0.133E-08*
364	180	0.302E-08*	381	841	0.203E-08*	387	398	0.182E-08*	407	878	0.133E-08*
364	196	0.302E-08*	381	844	0.203E-08*	388	980	0.181E-08*	407	919	0.133E-08*
364	1017	0.302E-08*	381	882	0.203E-08*	388	973	0.181E-08*	408	450	0.130E-08*
364	1011	0.302E-08*	382	715	0.200E-08*	389	284	0.180E-08*	408	464	0.130E-08*
365	773	0.287E-08*	382	711	0.200E-08*	389	277	0.180E-08*	409	463	0.125E-08*
365	766	0.287E-08*	383	103	0.197E-08*	390	940	0.174E-08*	409	179	0.125E-08*
366	859	0.283E-08*	383	104	0.197E-08*	391	639	0.172E-08*	409	449	0.125E-08*
366	897	0.283E-08*	383	84	0.197E-08*	391	516	0.172E-08*	409	1015	0.125E-08*
366	856	0.283E-08*	383	151	0.197E-08*	392	887	0.170E-08*	410	868	0.124E-08*
366	900	0.283E-08*	383	91	0.197E-08*	392	843	0.170E-08*	410	916	0.124E-08*
367	935	0.280E-08*	383	105	0.197E-08*	392	846	0.170E-08*	410	902	0.124E-08*
368	962	0.253E-08*	383	77	0.197E-08*	392	884	0.170E-08*	410	861	0.124E-08*
369	566	0.251E-08*	383	49	0.197E-08*	393	927	0.168E-08*	410	834	0.124E-08*
370	417	0.246E-08*	383	52	0.197E-08*	394	938	0.162E-08*	410	909	0.124E-08*
370	415	0.246E-08*	383	89	0.197E-08*	395	678	0.162E-08*	410	875	0.124E-08*
371	152	0.243E-08*	383	98	0.197E-08*	395	683	0.162E-08*	411	946	0.123E-08*
371	61	0.243E-08*	383	90	0.197E-08*	396	1018	0.156E-08*	411	740	0.123E-08*
371	50	0.243E-08*	383	262	0.197E-08*	397	956	0.152E-08*	411	525	0.123E-08*
372	440	0.236E-08*	383	60	0.197E-08*	398	283	0.151E-08*	412	799	0.121E-08*
373	562	0.234E-08*	383	211	0.197E-08*	398	286	0.151E-08*	413	712	0.120E-08*

373	565	0.234E-08*	383	220	0.197E-08*	399	153	0.150E-08*	413	707	0.120E-08*
374	978	0.232E-08*	383	364	0.197E-08*	400	644	0.148E-08*	414	765	0.118E-08*
375	460	0.231E-08*	383	356	0.197E-08*	400	385	0.148E-08*	415	431	0.118E-08*

********** SALTWATER COOLING RELIABILITY STUDY - SONGS 1 **********

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE

FOR CUT SETS OF RANK 26 AND HIGHER

STEADY STATE CALCULATIONS

TOP EVENT PROBABILITY = 0.36580E-04

RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*
416	858	0.117E-08*	427	981	0.935E-09*	447	965	0.629E-09*	462	165	0.492E-09*
416	899	0.117E-08*	427	974	0.935E-09*	447	832	0.629E-09*	462	157	0.492E-09*
417	272	0.116E-08*	428	273	0.905E-09*	448	285	0.623E-09*	462	155	0.492E-09*
418	803	0.113E-08*	428	270	0.905E-09*	449	953	0.615E-09*	462	390	0.492E-09*
418	796	0.113E-08*	429	591	0.886E-09*	450	158	0.607E-09*	462	944	0.492E-09*
419	872	0.111E-08*	429	587	0.886E-09*	450	159	0.607E-09*	462	400	0.492E-09*
419	838	0.111E-08*	430	480	0.864E-09*	450	156	0.607E-09*	462	471	0.492E-09*
419	906	0.111E-08*	430	494	0.864E-09*	450	462	0.607E-09*	462	457	0.492E-09*
419	865	0.111E-08*	431	419	0.850E-09*	450	475	0.607E-09*	463	995	0.485E-09*
419	913	0.111E-08*	432	557	0.820E-09*	450	401	0.607E-09*	463	996	0.485E-09*

419	920	0.111E-08*	432	163	0.820E-09*	450	391	0.607E-09*	464	826	0.484E-09*
419	879	0.111E-08*	433	563	0.808E-09*	451	774	0.604E-09*	465	48	0.472E-09*
420	613	0.109E-08*	434	964	0.806E-09*	451	767	0.604E-09*	465	47	0.472E-09*
420	616	0.109E-08*	434	831	0.806E-09*	452	829	0.597E-09*	465	150	0.472E-09*
421	466	0.109E-08*	435	772	0.774E-09*	453	737	0.594E-09*	465	58	0.472E-09*
421	452	0.109E-08*	436	961	0.759E-09*	453	522	0.594E-09*	465	140	0.472E-09*
422	268	0.108E-08*	437	830	0.752E-09*	453	735	0.594E-09*	465	59	0.472E-09*
422	271	0.108E-08*	437	963	0.752E-09*	453	520	0.594E-09*	466	824	0.465E-09*
423	232	0.108E-08*	438	160	0.748E-09*	454	372	0.590E-09*	467	955	0.455E-09*
423	227	0.108E-08*	438	971	0.748E-09*	454	369	0.590E-09*	468	519	0.453E-09*
424	866	0.104E-08*	439	791	0.726E-09*	454	936	0.590E-09*	468	642	0.453E-09*
424	880	0.104E-08*	440	764	0.722E-09*	454	428	0.590E-09*	468	517	0.453E-09*
424	914	0.104E-08*	440	770	0.722E-09*	455	637	0.581E-09*	468	640	0.453E-09*
424	907	0.104E-08*	441	883	0.701E-09*	455	514	0.581E-09*	468	984	0.453E-09*
424	839	0.104E-08*	441	842	0.701E-09*	456	789	0.566E-09*	468	983	0.453E-09*
424	873	0.104E-08*	442	788	0.677E-09*	456	792	0.566E-09*	469	821	0.451E-09*
424	921	0.104E-08*	442	790	0.677E-09*	457	967	0.561E-09*	469	825	0.451E-09*
424	870	0.104E-08*	443	30	0.656E-09*	458	828	0.556E-09*	470	451	0.449E-09*
424	904	0.104E-08*	443	28	0.656E-09*	458	823	0.556E-09*	471	808	0.444E-09*
424	863	0.104E-08*	443	117	0.656E-09*	459	641	0.541E-09*	471	818	0.444E-09*
424	911	0.104E-08*	443	23	0.656E-09*	459	634	0.541E-09*	471	813	0.444E-09*
424	918	0.104E-08*	443	29	0.656E-09*	459	518	0.541E-09*	472	393	0.437E-09*
424	836	0.104E-08*	443	54	0.656E-09*	459	511	0.541E-09*	472	403	0.437E-09*
424	877	0.104E-08*	444	609	0.655E-09*	460	583	0.531E-09*	472	397	0.437E-09*
425	679	0.972E-09*	445	228	0.648E-09*	461	521	0.497E-09*	472	407	0.437E-09*
425	674	0.972E-09*	445	223	0.648E-09*	461	739	0.497E-09*	473	926	0.430E-09*
426	802	0.943E-09*	446	738	0.637E-09*	461	736	0.497E-09*	474	876	0.429E-09*
426	805	0.943E-09*	446	523	0.637E-09*	461	524	0.497E-09*	474	917	0.429E-09*

FUSSELL-VESELY MEASURE OF CUT SET IMPORTANCE

FOR CUT SETS OF RANK 26 AND HIGHER

STEADY STATE CALCULATIONS

TOP EVENT PROBABILITY = 0.36580E-04

RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*	RANK	CUT SET NO	IMPORTANCE*
474	903	0.429E-09*	482	989	0.378E-09*	490	402	0.354E-09*	497	1037	0.318E-09*
474	862	0.429E-09*	482	990	0.378E-09*	490	581	0.354E-09*	498	606	0.316E-09*
474	910	0.429E-09*	483	31	0.378E-09*	490	392	0.354E-09*	498	607	0.316E-09*
474	835	0.429E-09*	484	822	0.377E-09*	491	630	0.348E-09*	499	154	0.315E-09*
474	869	0.429E-09*	484	827	0.377E-09*	491	507	0.348E-09*	500	775	0.312E-09*
475	816	0.413E-09*	485	269	0.374E-09*	491	924	0.348E-09*	500	768	0.312E-09*
475	806	0.413E-09*	486	814	0.371E-09*	492	812	0.346E-09*	501	1035	0.309E-09*
475	811	0.413E-09*	486	819	0.371E-09*	492	810	0.346E-09*	501	1033	0.309E-09*
476	552	0.410E-09*	486	809	0.371E-09*	492	817	0.346E-09*	501	1032	0.309E-09*
476	556	0.410E-09*	487	945	0.369E-09*	492	820	0.346E-09*	501	1034	0.309E-09*
476	548	0.410E-09*	488	458	0.364E-09*	492	807	0.346E-09*	502	901	0.308E-09*
476	554	0.410E-09*	488	472	0.364E-09*	492	815	0.346E-09*	502	860	0.308E-09*
476	551	0.410E-09*	489	908	0.358E-09*	493	608	0.339E-09*	503	478	0.301E-09*
476	550	0.410E-09*	489	922	0.358E-09*	494	443	0.328E-09*	503	491	0.301E-09*

476	555	0.410E-09*	489	867	0.358E-09*	494	375	0.328E-09*	504	467	0.295E-09*
477	1000	0.406E-09*	489	915	0.358E-09*	494	1019	0.328E-09*	504	937	0.295E-09*
477	999	0.406E-09*	489	874	0.358E-09*	494	197	0.328E-09*	504	453	0.295E-09*
478	925	0.401E-09*	489	881	0.358E-09*	494	181	0.328E-09*	505	966	0.291E-09*
479	804	0.390E-09*	489	840	0.358E-09*	495	629	0.325E-09*	506	833	0.286E-09*
480	650	0.389E-09*	490	394	0.354E-09*	495	923	0.325E-09*	507	430	0.283E-09*
480	646	0.389E-09*	490	404	0.354E-09*	495	628	0.325E-09*	508	582	0.275E-09*
481	1036	0.381E-09*	490	387	0.354E-09*	495	506	0.325E-09*			
482	1006	0.378E-09*	490	384	0.354E-09*	495	505	0.325E-09*			
482	1005	0.378E-09*	490	928	0.354E-09*	496	492	0.323E-09*			

REFERENCE TABLE FOR MIN CUT SETS

ORDER	1	2	3	4	5	6	7
NO. OF MIN CUT SETS	1	13	140	293	340	244	6

NO. OF MIN CUT SETS = 1037

CUT SET NO.	ORDER	BASIC EVENTS	
1	1	IBS0001H	
2	2	PCV0338P	PNWIFRBY
3	2	PHEE20AE	PHEE20BE
4	2	PHEE20BE	PMV720AP
5	2	PHEE20BE	PXV0301X
6	2	PHEE20BE	PXV0303X
7	2	PHEE20BE	PXV0331X
8	2	PHEE20BE	UBS0002H
9	2	PHUG13CU	PNWIFRBY

39	3	PARV341H	PHU0348U	PNWIFRBY
40	3	PARV341H	PNSERWTR	PNWIFRBY
41	3	PCB1214H	PHEE20BE	PHU720AU
42	3	PCV0338P	PCV0383P	PPMG13AR
43	3	PCV0338P	PPMG13AR	PPMG13BR
44	3	PCV0338P	PPMG13AR	PPMG13BS
45	3	PCV0338P	PPMG13AR	PPMG13BT
46	3	PCV0338P	PPMG13AR	PXV0379X
47	3	PCV0338P	PPMG13AR	UBS0002H
48	3	PCV0338P	PPMG13BR	UBS0001H
49	3	PCV0338P	PPMG13BS	UBS0001H
50	3	PCV0338P	PPMG13BT	UBS0001H
51	3	PCV0383P	PHUG13CU	PPMG13AR
52	3	PCV0383P	PHUG13CU	UBS0001H
53	3	PCV0383P	PHU0381U	PPMG13AR
54	3	PCV0383P	PHU0381U	UBS0001H
55	3	PCV0383P	PPMG13AR	PPMG13CR
56	3	PCV0383P	PPMG13AR	PPMG13CS
57	3	PCV0383P	PPMG13AR	PPMG13CT
58	3	PCV0383P	PPMG13AR	UBS0003H
59	3	PCV0383P	PPMG13CR	UBS0001H
60	3	PCV0383P	PPMG13CS	UBS0001H
61	3	PCV0383P	PPMG13CT	UBS0001H
62	3	PFL0050E	PHU0348U	PNWIFRBY
63	3	PFL0050E	PNSERWTR	PNWIFRBY
64	3	PHEE20AE	PHU0300U	PNWIFRBY
65	3	PHEE20AE	PHU0300U	PPMG13AR
66	3	PHEE20AE	PHU0302U	PNWIFRBY
67	3	PHEE20AE	PHU0302U	PPMG13AR

68	3	PHEE20BE	PHU720AU	PPRPS28H
69	3	PHUG13CU	PPMG13AR	PPMG13BR
70	3	PHUG13CU	PPMG13AR	PPMG13BS
71	3	PHUG13CU	PPMG13AR	PPMG13BT
72	3	PHUG13CU	PPMG13AR	PXV0379X
73	3	PHUG13CU	PPMG13AR	UBS0002H
74	3	PHUG13CU	PPMG13BR	UBS0001H
75	3	PHUG13CU	PPMG13BS	UBS0001H
76	3	PHUG13CU	PPMG13BT	UBS0001H
77	3	PHUG13CU	PXV0379X	UBS0001H
78	3	PHU0300U	PMV720AP	PNWIFRBY
79	3	PHU0300U	PMV720AP	PPMG13AR
80	3	PHU0300U	PMV720AP	UBS0001H
81	3	PHU0300U	PNWIFRBY	PXV0301X
82	3	PHU0300U	PNWIFRBY	PXV0303X
83	3	PHU0300U	PNWIFRBY	PXV0331X
84	3	PHU0300U	PNWIFRBY	UBS0002H
85	3	PHU0300U	PPMG13AR	PXV0301X
86	3	PHU0300U	PPMG13AR	PXV0303X
87	3	PHU0300U	PPMG13AR	PXV0331X
88	3	PHU0300U	PPMG13AR	UBS0002H
89	3	PHU0300U	PXV0301X	UBS0001H
90	3	PHU0300U	PXV0303X	UBS0001H
91	3	PHU0300U	PXV0331X	UBS0001H
92	3	PHU0302U	PMV720AP	PNWIFRBY
93	3	PHU0302U	PMV720AP	PPMG13AR
94	3	PHU0302U	PMV720AP	UBS0001H
95	3	PHU0302U	PNWIFRBY	PXV0301X
96	3	PHU0302U	PNWIFRBY	PXV0303X

97	3	PHU0302U	PNWIFRBY	PXV0331X
98	3	PHU0302U	PNWIFRBY	UBS0002H
99	3	PHU0302U	PPMG13AR	PXV0301X
100	3	PHU0302U	PPMG13AR	PXV0303X
101	3	PHU0302U	PPMG13AR	PXV0331X
102	3	PHU0302U	PPMG13AR	UBS0002H
103	3	PHU0302U	PXV0301X	UBS0001H
104	3	PHU0302U	PXV0303X	UBS0001H
105	3	PHU0302U	PXV0331X	UBS0001H
106	3	PHU0348U	PLOWTIDE	PNWIFRBY
107	3	PHU0348U	PNWIFRBY	PPS0144H
108	3	PHU0348U	PNWIFRBY	PSV037AH
109	3	PHU0381U	PPMG13AR	PPMG13BR
110	3	PHU0381U	PPMG13AR	PPMG13BS
111	3	PHU0381U	PPMG13AR	PPMG13BT
112	3	PHU0381U	PPMG13AR	PXV0379X
113	3	PHU0381U	PPMG13AR	UBS0002H
114	3	PHU0381U	PPMG13BR	UBS0001H
115	3	PHU0381U	PPMG13BS	UBS0001H
116	3	PHU0381U	PPMG13BT	UBS0001H
117	3	PHU0381U	PXV0379X	UBS0001H
118	3	PLOWTIDE	PNSERWTR	PNWIFRBY
119	3	PNSERWTR	PNWIFRBY	PPS0144H
120	3	PNSERWTR	PNWIFRBY	PSV037AH
121	3	PNWIFRBY	UBS001CH	UOP22CXT
122	3	PPMG13AR	PPMG13BR	PPMG13CR
123	3	PPMG13AR	PPMG13BR	PPMG13CS
124	3	PPMG13AR	PPMG13BR	PPMG13CT
125	3	PPMG13AR	PPMG13BR	UBS0003H

126	3	PPMG13AR	PPMG13BS	PPMG13CR
127	3	PPMG13AR	PPMG13BS	PPMG13CS
128	3	PPMG13AR	PPMG13BS	PPMG13CT
129	3	PPMG13AR	PPMG13BS	UBS0003H
130	3	PPMG13AR	PPMG13BT	PPMG13CR
131	3	PPMG13AR	PPMG13BT	PPMG13CS
132	3	PPMG13AR	PPMG13BT	PPMG13CT
133	3	PPMG13AR	PPMG13BT	UBS0003H
134	3	PPMG13AR	PPMG13CR	PXV0379X
135	3	PPMG13AR	PPMG13CR	UBS0002H
136	3	PPMG13AR	PPMG13CS	PXV0379X
137	3	PPMG13AR	PPMG13CS	UBS0002H
138	3	PPMG13AR	PPMG13CT	PXV0379X
139	3	PPMG13AR	PPMG13CT	UBS0002H
140	3	PPMG13AR	PXV0379X	UBS0003H
141	3	PPMG13BR	PPMG13CR	UBS0001H
142	3	PPMG13BR	PPMG13CS	UBS0001H
143	3	PPMG13BR	PPMG13CT	UBS0001H
144	3	PPMG13BS	PPMG13CR	UBS0001H
145	3	PPMG13BS	PPMG13CS	UBS0001H
146	3	PPMG13BS	PPMG13CT	UBS0001H
147	3	PPMG13BT	PPMG13CR	UBS0001H
148	3	PPMG13BT	PPMG13CS	UBS0001H
149	3	PPMG13BT	PPMG13CT	UBS0001H
150	3	PPMG13CR	PXV0379X	UBS0001H
151	3	PPMG13CS	PXV0379X	UBS0001H
152	3	PPMG13CT	PXV0379X	UBS0001H
153	3	UBS001CH	UBS002CH	UNASDGEH
154	3	UBS001CH	UBS002CH	UOPSDGEV

155	4	FLOWDIV1	PHEE20BE	PHUG13CU	PPMG13BS
156	4	FLOWDIV1	PHEE20BE	PHUG13CU	PPMG13BT
157	4	FLOWDIV1	PHEE20BE	PPMG13BS	PPMG13CS
158	4	FLOWDIV1	PHEE20BE	PPMG13BS	PPMG13CT
159	4	FLOWDIV1	PHEE20BE	PPMG13BT	PPMG13CS
160	4	FLOWDIV1	PHEE20BE	PPMG13BT	PPMG13CT
161	4	FLOWDIV2	PCB1214H	PHU720AU	PNWIFRBY
162	4	FLOWDIV2	PCB1214H	PHU720AU	PPMG13AR
163	4	FLOWDIV2	PHU720AU	PNWIFRBY	PPRPS28H
164	4	FLOWDIV2	PHU720AU	PPMG13AR	PPRPS28H
165	4	IBS0002H	LOOPC	UCA0001A	UNASDGEH
166	4	IBS0002H	LOOPC	UCB1C14N	UNASDGEH
167	4	IBS0002H	LOOPC	UCB1C14N	UOPSDGEV
168	4	IBS0002H	LOOPC	UGE0001R	UNASDGEH
169	4	IBS0002H	LOOPC	UGE0001R	UOPSDGEV
170	4	IBS0002H	LOOPC	UGE0001S	UNASDGEH
171	4	IBS0002H	LOOPC	UGE0001S	UOPSDGEV
172	4	IBS0002H	LOOPC	UGE0001T	UNASDGEH
173	4	IBS0002H	LOOPC	UGE0001T	UOPSDGEV
174	4	IBS0002H	LOOPC	UNASDGEH	UOPCB14X
175	4	IBS0002H	LOOPC	UOPCB14X	UOPSDGEV
176	4	IBY0001H	IBY0002H	LOOPC	UNASDGEH
177	4	IBY0001H	IBY0002H	LOOPC	UOPSDGEV
178	4	IBY0001H	LOOPC	PNWIFRBY	UGE0002R
179	4	IBY0001H	LOOPC	PNWIFRBY	UGE0002S
180	4	IBY0001H	LOOPC	PNWIFRBY	UGE0002T
181	4	IBY0001H	LOOPC	PNWIFRBY	UOPCB15X
182	4	IBY0001H	LOOPC	UCA0002A	UNASDGEH
183	4	IBY0001H	LOOPC	UCA0002A	UOPSDGEV

184	4	IBY0001H	LOOPC	UCB2C15N	UNASDGEH
185	4	IBY0001H	LOOPC	UCB2C15N	UOPSDGEV
186	4	IBY0001H	LOOPC	UGE0002R	UNASDGEH
187	4	IBY0001H	LOOPC	UGE0002R	UOPSDGEV
188	4	IBY0001H	LOOPC	UGE0002S	UNASDGEH
189	4	IBY0001H	LOOPC	UGE0002S	UOPSDGEV
190	4	IBY0001H	LOOPC	UGE0002T	UNASDGEH
191	4	IBY0001H	LOOPC	UGE0002T	UOPSDGEV
192	4	IBY0001H	LOOPC	UNASDGEH	UOPCB15X
193	4	IBY0001H	LOOPC	UOPCB15X	UOPSDGEV
194	4	IBY0002H	LOOPC	PNWIFRBY	UGE0001R
195	4	IBY0002H	LOOPC	PNWIFRBY	UGE0001S
196	4	IBY0002H	LOOPC	PNWIFRBY	UGE0001T
197	4	IBY0002H	LOOPC	PNWIFRBY	UOPCB14X
198	4	IBY0002H	LOOPC	UCA0001A	UNASDGEH
199	4	IBY0002H	LOOPC	UCA0001A	UOPSDGEV
200	4	IBY0002H	LOOPC	UCB1C14N	UNASDGEH
201	4	IBY0002H	LOOPC	UCB1C14N	UOPSDGEV
202	4	IBY0002H	LOOPC	UGE0001R	UNASDGEH
203	4	IBY0002H	LOOPC	UGE0001R	UOPSDGEV
204	4	IBY0002H	LOOPC	UGE0001S	UNASDGEH
205	4	IBY0002H	LOOPC	UGE0001S	UOPSDGEV
206	4	IBY0002H	LOOPC	UGE0001T	UNASDGEH
207	4	IBY0002H	LOOPC	UGE0001T	UOPSDGEV
208	4	IBY0002H	LOOPC	UNASDGEH	UOPCB14X
209	4	IBY0002H	LOOPC	UOPCB14X	UOPSDGEV
210	4	INSTRAIR	PCV0383P	PHU0348U	PPMG13AR
211	4	INSTRAIR	PCV0383P	PNSERWTR	PPMG13AR
212	4	INSTRAIR	PHU0348U	PPMG13AR	PPMG13BR

213	4	INSTRAIR	PHU0348U	PPMG13AR	PPMG13BS
214	4	INSTRAIR	PHU0348U	PPMG13AR	PPMG13BT
215	4	INSTRAIR	PHU0348U	PPMG13AR	PXV0379X
216	4	INSTRAIR	PNSERWTR	PPMG13AR	PPMG13BR
217	4	INSTRAIR	PNSERWTR	PPMG13AR	PPMG13BS
218	4	INSTRAIR	PNSERWTR	PPMG13AR	PPMG13BT
219	4	INSTRAIR	PNSERWTR	PPMG13AR	PXV0379X
220	4	LOOPC	PCV0383P	PPMG13AR	UOPDGCMD
221	4	LOOPC	PCV0383P	PPMG13AR	UOP04KVV
222	4	LOOPC	PCV0383P	UOPDGCMD	UOP12XT
223	4	LOOPC	PNWIFRBY	UCA0001A	UCB2C15N
224	4	LOOPC	PNWIFRBY	UCA0001A	UGE0002R
225	4	LOOPC	PNWIFRBY	UCA0001A	UGE0002S
226	4	LOOPC	PNWIFRBY	UCA0001A	UGE0002T
227	4	LOOPC	PNWIFRBY	UCA0001A	UOPCB15X
228	4	LOOPC	PNWIFRBY	UCA0002A	UCB1C14N
229	4	LOOPC	PNWIFRBY	UCA0002A	UGE0001R
230	4	LOOPC	PNWIFRBY	UCA0002A	UGE0001S
231	4	LOOPC	PNWIFRBY	UCA0002A	UGE0001T
232	4	LOOPC	PNWIFRBY	UCA0002A	UOPCB14X
233	4	LOOPC	PNWIFRBY	UCB1C14N	UCB2C15N
234	4	LOOPC	PNWIFRBY	UCB1C14N	UGE0002R
235	4	LOOPC	PNWIFRBY	UCB1C14N	UGE0002S
236	4	LOOPC	PNWIFRBY	UCB1C14N	UGE0002T
237	4	LOOPC	PNWIFRBY	UCB1C14N	UOPCB15X
238	4	LOOPC	PNWIFRBY	UCB2C15N	UGE0001R
239	4	LOOPC	PNWIFRBY	UCB2C15N	UGE0001S
240	4	LOOPC	PNWIFRBY	UCB2C15N	UGE0001T
241	4	LOOPC	PNWIFRBY	UCB2C15N	UOPCB14X

242	4	LOOPC	PNWIFRBY	UGE0001R	UGE0002R
243	4	LOOPC	PNWIFRBY	UGE0001R	UGE0002S
244	4	LOOPC	PNWIFRBY	UGE0001R	UGE0002T
245	4	LOOPC	PNWIFRBY	UGE0001R	UOPCB15X
246	4	LOOPC	PNWIFRBY	UGE0001S	UGE0002R
247	4	LOOPC	PNWIFRBY	UGE0001S	UGE0002T
248	4	LOOPC	PNWIFRBY	UGE0001S	UOPCB15X
249	4	LOOPC	PNWIFRBY	UGE0001T	UGE0002R
250	4	LOOPC	PNWIFRBY	UGE0001T	UGE0002S
251	4	LOOPC	PNWIFRBY	UGE0001T	UOPCB15X
252	4	LOOPC	PNWIFRBY	UGE0002R	UOPCB14X
253	4	LOOPC	PNWIFRBY	UGE0002S	UOPCB14X
254	4	LOOPC	PNWIFRBY	UGE0002T	UOPCB14X
255	4	LOOPC	PNWIFRBY	UOPCB14X	UOPCB15X
256	4	LOOPC	PPMG13AR	PPMG13BR	UOPDGCMD
257	4	LOOPC	PPMG13AR	PPMG13BR	UOP04KVV
258	4	LOOPC	PPMG13AR	PPMG13BS	UOPDGCMD
259	4	LOOPC	PPMG13AR	PPMG13BS	UOP04KVV
260	4	LOOPC	PPMG13AR	PPMG13BT	UOPDGCMD
261	4	LOOPC	PPMG13AR	PPMG13BT	UOP04KVV
262	4	LOOPC	PPMG13AR	PXV0379X	UOPDGCMD
263	4	LOOPC	PPMG13AR	PXV0379X	UOP04KVV
264	4	LOOPC	PPMG13BR	UOPDGCMD	UOP12XT
265	4	LOOPC	PPMG13BS	UOPDGCMD	UOP12XT
266	4	LOOPC	PPMG13BT	UOPDGCMD	UOP12XT
267	4	LOOPC	PXV0379X	UOPDGCMD	UOP12XT
268	4	LOOPC	UBS0002H	UCB1C14N	UGE0002R
269	4	LOOPC	UBS0002H	UCB1C14N	UGE0002S
270	4	LOOPC	UBS0002H	UCB1C14N	UGE0002T

300	4	LOOPC	UCA0002A	UCB1C14N	UOPSDGEV
301	4	LOOPC	UCA0002A	UGE0001R	UNASDGEH
302	4	LOOPC	UCA0002A	UGE0001R	UOPSDGEV
303	4	LOOPC	UCA0002A	UGE0001S	UNASDGEH
304	4	LOOPC	UCA0002A	UGE0001S	UOPSDGEV
305	4	LOOPC	UCA0002A	UGE0001T	UNASDGEH
306	4	LOOPC	UCA0002A	UGE0001T	UOPSDGEV
307	4	LOOPC	UCA0002A	UNASDGEH	UOPCB14X
308	4	LOOPC	UCA0002A	UOPCB14X	UOPSDGEV
309	4	LOOPC	UCB1C14N	UCB2C15N	UNASDGEH
310	4	LOOPC	UCB1C14N	UCB2C15N	UOPSDGEV
311	4	LOOPC	UCB1C14N	UGE0002R	UNASDGEH
312	4	LOOPC	UCB1C14N	UGE0002R	UOPSDGEV
313	4	LOOPC	UCB1C14N	UGE0002S	UNASDGEH
314	4	LOOPC	UCB1C14N	UGE0002S	UOPSDGEV
315	4	LOOPC	UCB1C14N	UGE0002T	UNASDGEH
316	4	LOOPC	UCB1C14N	UGE0002T	UOPSDGEV
317	4	LOOPC	UCB1C14N	UNASDGEH	UOPCB15X
318	4	LOOPC	UCB1C14N	UOPCB15X	UOPSDGEV
319	4	LOOPC	UCB2C15N	UGE0001R	UNASDGEH
320	4	LOOPC	UCB2C15N	UGE0001R	UOPSDGEV
321	4	LOOPC	UCB2C15N	UGE0001S	UNASDGEH
322	4	LOOPC	UCB2C15N	UGE0001S	UOPSDGEV
323	4	LOOPC	UCB2C15N	UGE0001T	UNASDGEH
324	4	LOOPC	UCB2C15N	UGE0001T	UOPSDGEV
325	4	LOOPC	UCB2C15N	UNASDGEH	UOPCB14X
326	4	LOOPC	UCB2C15N	UOPCB14X	UOPSDGEV
327	4	LOOPC	UGE0001R	UGE0002R	UNASDGEH
328	4	LOOPC	UGE0001R	UGE0002R	UOPSDGEV

329	4	LOOPC	UGE0001R	UGE0002S	UNASDGEH
330	4	LOOPC	UGE0001R	UGE0002S	UOPSDGEV
331	4	LOOPC	UGE0001R	UGE0002T	UNASDGEH
332	4	LOOPC	UGE0001R	UGE0002T	UOPSDGEV
333	4	LOOPC	UGE0001R	UNASDGEH	UOPCB15X
334	4	LOOPC	UGE0001R	UOPCB15X	UOPSDGEV
335	4	LOOPC	UGE0001S	UGE0002R	UNASDGEH
336	4	LOOPC	UGE0001S	UGE0002R	UOPSDGEV
337	4	LOOPC	UGE0001S	UGE0002T	UNASDGEH
338	4	LOOPC	UGE0001S	UGE0002T	UOPSDGEV
339	4	LOOPC	UGE0001S	UNASDGEH	UOPCB15X
340	4	LOOPC	UGE0001S	UOPCB15X	UOPSDGEV
341	4	LOOPC	UGE0001T	UGE0002R	UNASDGEH
342	4	LOOPC	UGE0001T	UGE0002R	UOPSDGEV
343	4	LOOPC	UGE0001T	UGE0002S	UNASDGEH
344	4	LOOPC	UGE0001T	UGE0002S	UOPSDGEV
345	4	LOOPC	UGE0001T	UNASDGEH	UOPCB15X
346	4	LOOPC	UGE0001T	UOPCB15X	UOPSDGEV
347	4	LOOPC	UGE0002R	UNASDGEH	UOPCB14X
348	4	LOOPC	UGE0002R	UOPCB14X	UOPSDGEV
349	4	LOOPC	UGE0002S	UNASDGEH	UOPCB14X
350	4	LOOPC	UGE0002S	UOPCB14X	UOPSDGEV
351	4	LOOPC	UGE0002T	UNASDGEH	UOPCB14X
352	4	LOOPC	UGE0002T	UOPCB14X	UOPSDGEV
353	4	LOOPC	UNASDGEH	UOPCB14X	UOPCB15X
354	4	LOOPC	UOPCB14X	UOPCB15X	UOPSDGEV
355	4	PARV341H	PCV0383P	PHU0348U	PPMG13AR
356	4	PARV341H	PCV0383P	PNSERWTR	PPMG13AR
357	4	PARV341H	PHU0348U	PPMG13AR	PPMG13BR

358	4	PARV341H	PHU0348U	PPMG13AR	PPMG13BS
359	4	PARV341H	PHU0348U	PPMG13AR	PPMG13BT
360	4	PARV341H	PHU0348U	PPMG13AR	PXV0379X
361	4	PARV341H	PNSERWTR	PPMG13AR	PPMG13BR
362	4	PARV341H	PNSERWTR	PPMG13AR	PPMG13BS
363	4	PARV341H	PNSERWTR	PPMG13AR	PPMG13BT
364	4	PARV341H	PNSERWTR	PPMG13AR	PXV0379X
365	4	PCB1214H	PHU0300U	PHU720AU	PNWIFRBY
366	4	PCB1214H	PHU0300U	PHU720AU	PPMG13AR
367	4	PCB1214H	PHU0302U	PHU720AU	PNWIFRBY
368	4	PCB1214H	PHU0302U	PHU720AU	PPMG13AR
369	4	PCV0338P	PHUG13BU	PPMG13AR	PPRPS28H
370	4	PCV0383P	PFL0050E	PHU0348U	PPMG13AR
371	4	PCV0383P	PFL0050E	PNSERWTR	PPMG13AR
372	4	PCV0383P	PHU0348U	PPMG13AR	PPS0144H
373	4	PCV0383P	PHU0348U	PPMG13AR	PSV037AH
374	4	PCV0383P	PNSERWTR	PPMG13AR	PSV037AH
375	4	PCV0383P	UBS001CH	UOP12XT	UOP22CXT
376	4	PFL0050E	PHU0348U	PPMG13AR	PPMG13BR
377	4	PFL0050E	PHU0348U	PPMG13AR	PPMG13BS
378	4	PFL0050E	PHU0348U	PPMG13AR	PPMG13BT
379	4	PFL0050E	PHU0348U	PPMG13AR	PXV0379X
380	4	PFL0050E	PNSERWTR	PPMG13AR	PPMG13BR
381	4	PFL0050E	PNSERWTR	PPMG13AR	PPMG13BS
382	4	PFL0050E	PNSERWTR	PPMG13AR	PPMG13BT
383	4	PFL0050E	PNSERWTR	PPMG13AR	PXV0379X
384	4	PHEE20BE	PHUG13CU	PHU0300U	PPMG13BR
385	4	PHEE20BE	PHUG13CU	PHU0300U	PPMG13BS
386	4	PHEE20BE	PHUG13CU	PHU0300U	PPMG13BT

387	4	PHEE20BE	PHUG13CU	PHU0302U	PPMG13BR
388	4	PHEE20BE	PHUG13CU	PHU0302U	PPMG13BS
389	4	PHEE20BE	PHUG13CU	PHU0302U	PPMG13BT
390	4	PHEE20BE	PHU0300U	PHU0381U	PPMG13BS
391	4	PHEE20BE	PHU0300U	PHU0381U	PPMG13BT
392	4	PHEE20BE	PHU0300U	PPMG13BR	PPMG13CS
393	4	PHEE20BE	PHU0300U	PPMG13BR	PPMG13CT
394	4	PHEE20BE	PHU0300U	PPMG13BS	PPMG13CR
395	4	PHEE20BE	PHU0300U	PPMG13BS	PPMG13CS
396	4	PHEE20BE	PHU0300U	PPMG13BS	PPMG13CT
397	4	PHEE20BE	PHU0300U	PPMG13BT	PPMG13CR
398	4	PHEE20BE	PHU0300U	PPMG13BT	PPMG13CS
399	4	PHEE20BE	PHU0300U	PPMG13BT	PPMG13CT
400	4	PHEE20BE	PHU0302U	PHU0381U	PPMG13BS
401	4	PHEE20BE	PHU0302U	PHU0381U	PPMG13BT
402	4	PHEE20BE	PHU0302U	PPMG13BR	PPMG13CS
403	4	PHEE20BE	PHU0302U	PPMG13BR	PPMG13CT
404	4	PHEE20BE	PHU0302U	PPMG13BS	PPMG13CR
405	4	PHEE20BE	PHU0302U	PPMG13BS	PPMG13CS
406	4	PHEE20BE	PHU0302U	PPMG13BS	PPMG13CT
407	4	PHEE20BE	PHU0302U	PPMG13BT	PPMG13CR
408	4	PHEE20BE	PHU0302U	PPMG13BT	PPMG13CS
409	4	PHEE20BE	PHU0302U	PPMG13BT	PPMG13CT
410	4	PHUG13BU	PHUG13CU	PPMG13AR	PPRPS28H
411	4	PHUG13BU	PHU0381U	PPMG13AR	PPRPS28H
412	4	PHUG13BU	PPMG13AR	PPMG13CR	PPRPS28H
413	4	PHUG13BU	PPMG13AR	PPMG13CS	PPRPS28H
414	4	PHUG13BU	PPMG13AR	PPMG13CT	PPRPS28H
415	4	PHU0300U	PHU720AU	PNWIFRBY	PPRPS28H

416	4	PHU0300U	PHU720AU	PPMG13AR	PPRPS28H
417	4	PHU0302U	PHU720AU	PNWIFRBY	PPRPS28H
418	4	PHU0302U	PHU720AU	PPMG13AR	PPRPS28H
419	4	PHU0348U	PLOWTIDE	PPMG13AR	PPMG13BR
420	4	PHU0348U	PLOWTIDE	PPMG13AR	PPMG13BS
421	4	PHU0348U	PLOWTIDE	PPMG13AR	PPMG13BT
422	4	PHU0348U	PPMG13AR	PPMG13BR	PPS0144H
423	4	PHU0348U	PPMG13AR	PPMG13BR	PSV037AH
424	4	PHU0348U	PPMG13AR	PPMG13BS	PPS0144H
425	4	PHU0348U	PPMG13AR	PPMG13BS	PSV037AH
426	4	PHU0348U	PPMG13AR	PPMG13BT	PPS0144H
427	4	PHU0348U	PPMG13AR	PPMG13BT	PSV037AH
428	4	PHU0348U	PPMG13AR	PPS0144H	PXV0379X
429	4	PHU0348U	PPMG13AR	PSV037AH	PXV0379X
430	4	PLOWTIDE	PNSERWTR	PPMG13AR	PPMG13BR
431	4	PLOWTIDE	PNSERWTR	PPMG13AR	PPMG13BS
432	4	PLOWTIDE	PNSERWTR	PPMG13AR	PPMG13BT
433	4	PNSERWTR	PPMG13AR	PPMG13BR	PPS0144H
434	4	PNSERWTR	PPMG13AR	PPMG13BR	PSV037AH
435	4	PNSERWTR	PPMG13AR	PPMG13BS	PPS0144H
436	4	PNSERWTR	PPMG13AR	PPMG13BS	PSV037AH
437	4	PNSERWTR	PPMG13AR	PPMG13BT	PPS0144H
438	4	PNSERWTR	PPMG13AR	PPMG13BT	PSV037AH
439	4	PNSERWTR	PPMG13AR	PSV037AH	PXV0379X
440	4	PPMG13BR	UBS001CH	UOP12XT	UOP22CXT
441	4	PPMG13BS	UBS001CH	UOP12XT	UOP22CXT
442	4	PPMG13BT	UBS001CH	UOP12XT	UOP22CXT
443	4	PXV0379X	UBS001CH	UOP12XT	UOP22CXT
444	4	DG2/1	LOOPC	PNWIFRBY	UGE0001S

445	4	DG2/1	LOOPC	UBS0002H	UGE0001S	
446	4	DG2/1	LOOPC	UGE0001S	UNASDGEH	
447	4	DG2/1	LOOPC	UGE0001S	UOPSDGEV	
448	5	FLOWDIV2	LOOPC	PMV720AP	UOPDGCMD	UOP12XT
449	5	IBY0001H	KLOV2	KOPDGLOV	LOOPC	UNASDGEH
450	5	IBY0001H	LOOPC	PPMG13BR	UGE0002R	UOP12XT
451	5	IBY0001H	LOOPC	PPMG13BR	UGE0002S	UOP12XT
452	5	IBY0001H	LOOPC	PPMG13BR	UGE0002T	UOP12XT
453	5	IBY0001H	LOOPC	PPMG13BS	UCB2C15N	UOP12XT
454	5	IBY0001H	LOOPC	PPMG13BS	UGE0002R	UOP12XT
455	5	IBY0001H	LOOPC	PPMG13BS	UGE0002S	UOP12XT
456	5	IBY0001H	LOOPC	PPMG13BS	UGE0002T	UOP12XT
457	5	IBY0001H	LOOPC	PPMG13BS	UOPCB15X	UOP12XT
458	5	IBY0001H	LOOPC	PPMG13BT	UCB2C15N	UOP12XT
459	5	IBY0001H	LOOPC	PPMG13BT	UGE0002R	UOP12XT
460	5	IBY0001H	LOOPC	PPMG13BT	UGE0002S	UOP12XT
461	5	IBY0001H	LOOPC	PPMG13BT	UGE0002T	UOP12XT
462	5	IBY0001H	LOOPC	PPMG13BT	UOPCB15X	UOP12XT
463	5	IBY0002H	KLOV1	KOPDGLOV	LOOPC	UNASDGEH
464	5	IBY0002H	LOOPC	PPMG13BR	UGE0001R	UOP12XT
465	5	IBY0002H	LOOPC	PPMG13BR	UGE0001S	UOP12XT
466	5	IBY0002H	LOOPC	PPMG13BR	UGE0001T	UOP12XT
467	5	IBY0002H	LOOPC	PPMG13BS	UCB1C14N	UOP12XT
468	5	IBY0002H	LOOPC	PPMG13BS	UGE0001R	UOP12XT
469	5	IBY0002H	LOOPC	PPMG13BS	UGE0001S	UOP12XT
470	5	IBY0002H	LOOPC	PPMG13BS	UGE0001T	UOP12XT
471	5	IBY0002H	LOOPC	PPMG13BS	UOPCB14X	UOP12XT
472	5	IBY0002H	LOOPC	PPMG13BT	UCB1C14N	UOP12XT
473	5	IBY0002H	LOOPC	PPMG13BT	UGE0001R	UOP12XT

474	5	IBY0002H	LOOPC	PPMG13BT	UGE0001S	UOP12XT
475	5	IBY0002H	LOOPC	PPMG13BT	UOPCB14X	UOP12XT
476	5	KLOV1	KLOV2	KOPDGLOV	LOOPC	UNASDGEH
477	5	KLOV1	KLOV2	KOPDGLOV	LOOPC	UOPSDGEV
478	5	KLOV1	KOPDGLOV	LOOPC	PNWIFRBY	UGE0002R
479	5	KLOV1	KOPDGLOV	LOOPC	UCA0002A	UNASDGEH
480	5	KLOV1	KOPDGLOV	LOOPC	UCA0002A	UOPSDGEV
481	5	KLOV1	KOPDGLOV	LOOPC	UCB2C15N	UNASDGEH
482	5	KLOV1	KOPDGLOV	LOOPC	UCB2C15N	UOPSDGEV
483	5	KLOV1	KOPDGLOV	LOOPC	UGE0002R	UNASDGEH
484	5	KLOV1	KOPDGLOV	LOOPC	UGE0002R	UOPSDGEV
485	5	KLOV1	KOPDGLOV	LOOPC	UGE0002S	UNASDGEH
486	5	KLOV1	KOPDGLOV	LOOPC	UGE0002S	UOPSDGEV
487	5	KLOV1	KOPDGLOV	LOOPC	UGE0002T	UNASDGEH
488	5	KLOV1	KOPDGLOV	LOOPC	UGE0002T	UOPSDGEV
489	5	KLOV1	KOPDGLOV	LOOPC	UNASDGEH	UOPCB15X
490	5	KLOV1	KOPDGLOV	LOOPC	UOPCB15X	UOPSDGEV
491	5	KLOV2	KOPDGLOV	LOOPC	PNWIFRBY	UGE0001R
492	5	KLOV2	KOPDGLOV	LOOPC	PNWIFRBY	UGE0001S
493	5	KLOV2	KOPDGLOV	LOOPC	UCA0001A	UNASDGEH
494	5	KLOV2	KOPDGLOV	LOOPC	UCA0001A	UOPSDGEV
495	5	KLOV2	KOPDGLOV	LOOPC	UCB1C14N	UNASDGEH
496	5	KLOV2	KOPDGLOV	LOOPC	UCB1C14N	UOPSDGEV
497	5	KLOV2	KOPDGLOV	LOOPC	UGE0001R	UNASDGEH
498	5	KLOV2	KOPDGLOV	LOOPC	UGE0001R	UOPSDGEV
499	5	KLOV2	KOPDGLOV	LOOPC	UGE0001S	UNASDGEH
500	5	KLOV2	KOPDGLOV	LOOPC	UGE0001S	UOPSDGEV
501	5	KLOV2	KOPDGLOV	LOOPC	UGE0001T	UNASDGEH
502	5	KLOV2	KOPDGLOV	LOOPC	UGE0001T	UOPSDGEV

503	5	KLOV2	KOPDGLOV	LOOPC	UNASDGEH	UOPCB14X
504	5	KLOV2	KOPDGLOV	LOOPC	UOPCB14X	UOPSDGEV
505	5	LOOPC	PCV0383P	PPMG13AR	UCB1C14N	UGE0002R
506	5	LOOPC	PCV0383P	PPMG13AR	UCB2C15N	UGE0001R
507	5	LOOPC	PCV0383P	PPMG13AR	UCB2C15N	UGE0001S
508	5	LOOPC	PCV0383P	PPMG13AR	UGE0001R	UGE0002R
509	5	LOOPC	PCV0383P	PPMG13AR	UGE0001R	UGE0002S
510	5	LOOPC	PCV0383P	PPMG13AR	UGE0001R	UGE0002T
511	5	LOOPC	PCV0383P	PPMG13AR	UGE0001R	UOPCB15X
512	5	LOOPC	PCV0383P	PPMG13AR	UGE0001S	UGE0002R
513	5	LOOPC	PCV0383P	PPMG13AR	UGE0001S	UGE0002T
514	5	LOOPC	PCV0383P	PPMG13AR	UGE0001S	UOPCB15X
515	5	LOOPC	PCV0383P	PPMG13AR	UGE0001T	UGE0002R
516	5	LOOPC	PCV0383P	PPMG13AR	UGE0001T	UGE0002S
517	5	LOOPC	PCV0383P	PPMG13AR	UGE0001T	UOPCB15X
518	5	LOOPC	PCV0383P	PPMG13AR	UGE0002R	UOPCB14X
519	5	LOOPC	PCV0383P	PPMG13AR	UGE0002T	UOPCB14X
520	5	LOOPC	PCV0383P	UCA0001A	UGE0002R	UOP12XT
521	5	LOOPC	PCV0383P	UCA0001A	UGE0002T	UOP12XT
522	5	LOOPC	PCV0383P	UCA0002A	UGE0001R	UOP12XT
523	5	LOOPC	PCV0383P	UCA0002A	UGE0001S	UOP12XT
524	5	LOOPC	PCV0383P	UCA0002A	UGE0001T	UOP12XT
525	5	LOOPC	PCV0383P	UCB1C14N	UCB2C15N	UOP12XT
526	5	LOOPC	PCV0383P	UCB1C14N	UGE0002R	UOP12XT
527	5	LOOPC	PCV0383P	UCB1C14N	UGE0002S	UOP12XT
528	5	LOOPC	PCV0383P	UCB1C14N	UGE0002T	UOP12XT
529	5	LOOPC	PCV0383P	UCB1C14N	UOPCB15X	UOP12XT
530	5	LOOPC	PCV0383P	UCB2C15N	UGE0001R	UOP12XT
531	5	LOOPC	PCV0383P	UCB2C15N	UGE0001S	UOP12XT

532	5	LOOPC	PCV0383P	UCB2C15N	UGE0001T	UOP12XT
533	5	LOOPC	PCV0383P	UCB2C15N	UOPCB14X	UOP12XT
534	5	LOOPC	PCV0383P	UGE0001R	UGE0002R	UOP12XT
535	5	LOOPC	PCV0383P	UGE0001R	UGE0002S	UOP12XT
536	5	LOOPC	PCV0383P	UGE0001R	UGE0002T	UOP12XT
537	5	LOOPC	PCV0383P	UGE0001R	UOPCB15X	UOP12XT
538	5	LOOPC	PCV0383P	UGE0001S	UGE0002R	UOP12XT
539	5	LOOPC	PCV0383P	UGE0001S	UGE0002T	UOP12XT
540	5	LOOPC	PCV0383P	UGE0001S	UOPCB15X	UOP12XT
541	5	LOOPC	PCV0383P	UGE0001T	UGE0002R	UOP12XT
542	5	LOOPC	PCV0383P	UGE0001T	UGE0002S	UOP12XT
543	5	LOOPC	PCV0383P	UGE0001T	UOPCB15X	UOP12XT
544	5	LOOPC	PCV0383P	UGE0002R	UOPCB14X	UOP12XT
545	5	LOOPC	PCV0383P	UGE0002S	UOPCB14X	UOP12XT
546	5	LOOPC	PCV0383P	UGE0002T	UOPCB14X	UOP12XT
547	5	LOOPC	PCV0383P	UOPCB14X	UOPCB15X	UOP12XT
548	5	LOOPC	PHUG13BU	PPRPS28H	UOPDGCMD	UOP12XT
549	5	LOOPC	PHU0300U	PMV720AP	UOPDGCMD	UOP12XT
550	5	LOOPC	PHU0300U	PXV0301X	UOPDGCMD	UOP12XT
551	5	LOOPC	PHU0300U	PXV0303X	UOPDGCMD	UOP12XT
552	5	LOOPC	PHU0300U	PXV0331X	UOPDGCMD	UOP12XT
553	5	LOOPC	PHU0302U	PMV720AP	UOPDGCMD	UOP12XT
554	5	LOOPC	PHU0302U	PXV0301X	UOPDGCMD	UOP12XT
555	5	LOOPC	PHU0302U	PXV0303X	UOPDGCMD	UOP12XT
556	5	LOOPC	PHU0302U	PXV0331X	UOPDGCMD	UOP12XT
557	5	LOOPC	PNWIFRBY	UCB1C14N	UOP1C2CX	UOP22CXT
558	5	LOOPC	PNWIFRBY	UGE0001R	UOP1C2CX	UOP22CXT
559	5	LOOPC	PNWIFRBY	UGE0001S	UOP1C2CX	UOP22CXT
560	5	LOOPC	PNWIFRBY	UGE0001T	UOP1C2CX	UOP22CXT

561	5	LOOPC	PNWIFRBY	UOPCB14X	UOP1C2CX	UOP22CXT
562	5	LOOPC	PPMG13AR	PPMG13BR	UCB1C14N	UGE0002R
563	5	LOOPC	PPMG13AR	PPMG13BR	UCB1C14N	UGE0002S
564	5	LOOPC	PPMG13AR	PPMG13BR	UCB1C14N	UGE0002T
565	5	LOOPC	PPMG13AR	PPMG13BR	UCB2C15N	UGE0001R
566	5	LOOPC	PPMG13AR	PPMG13BR	UCB2C15N	UGE0001S
567	5	LOOPC	PPMG13AR	PPMG13BR	UCB2C15N	UGE0001T
568	5	LOOPC	PPMG13AR	PPMG13BR	UGE0001R	UGE0002R
569	5	LOOPC	PPMG13AR	PPMG13BR	UGE0001R	UGE0002S
570	5	LOOPC	PPMG13AR	PPMG13BR	UGE0001R	UGE0002T
571	5	LOOPC	PPMG13AR	PPMG13BR	UGE0001R	UOPCB15X
572	5	LOOPC	PPMG13AR	PPMG13BR	UGE0001S	UGE0002R
573	5	LOOPC	PPMG13AR	PPMG13BR	UGE0001S	UGE0002T
574	5	LOOPC	PPMG13AR	PPMG13BR	UGE0001S	UOPCB15X
575	5	LOOPC	PPMG13AR	PPMG13BR	UGE0001T	UGE0002R
576	5	LOOPC	PPMG13AR	PPMG13BR	UGE0001T	UGE0002S
577	5	LOOPC	PPMG13AR	PPMG13BR	UGE0001T	UOPCB15X
578	5	LOOPC	PPMG13AR	PPMG13BR	UGE0002R	UOPCB14X
579	5	LOOPC	PPMG13AR	PPMG13BR	UGE0002S	UOPCB14X
580	5	LOOPC	PPMG13AR	PPMG13BR	UGE0002T	UOPCB14X
581	5	LOOPC	PPMG13AR	PPMG13BR	UOPCB14X	UOPCB15X
582	5	LOOPC	PPMG13AR	PPMG13BS	UCA0002A	UGE0001S
583	5	LOOPC	PPMG13AR	PPMG13BS	UCB1C14N	UCB2C15N
584	5	LOOPC	PPMG13AR	PPMG13BS	UCB1C14N	UGE0002R
585	5	LOOPC	PPMG13AR	PPMG13BS	UCB1C14N	UGE0002S
586	5	LOOPC	PPMG13AR	PPMG13BS	UCB1C14N	UGE0002T
587	5	LOOPC	PPMG13AR	PPMG13BS	UCB1C14N	UOPCB15X
588	5	LOOPC	PPMG13AR	PPMG13BS	UCB2C15N	UGE0001R
589	5	LOOPC	PPMG13AR	PPMG13BS	UCB2C15N	UGE0001S

590	5	LOOPC	PPMG13AR	PPMG13BS	UCB2C15N	UGE0001T
591	5	LOOPC	PPMG13AR	PPMG13BS	UCB2C15N	UOPCB14X
592	5	LOOPC	PPMG13AR	PPMG13BS	UGE0001R	UGE0002R
593	5	LOOPC	PPMG13AR	PPMG13BS	UGE0001R	UGE0002S
594	5	LOOPC	PPMG13AR	PPMG13BS	UGE0001R	UGE0002T
595	5	LOOPC	PPMG13AR	PPMG13BS	UGE0001R	UOPCB15X
596	5	LOOPC	PPMG13AR	PPMG13BS	UGE0001S	UGE0002R
597	5	LOOPC	PPMG13AR	PPMG13BS	UGE0001S	UGE0002T
598	5	LOOPC	PPMG13AR	PPMG13BS	UGE0001S	UOPCB15X
599	5	LOOPC	PPMG13AR	PPMG13BS	UGE0001T	UGE0002R
600	5	LOOPC	PPMG13AR	PPMG13BS	UGE0001T	UGE0002S
601	5	LOOPC	PPMG13AR	PPMG13BS	UGE0001T	UOPCB15X
602	5	LOOPC	PPMG13AR	PPMG13BS	UGE0002R	UOPCB14X
603	5	LOOPC	PPMG13AR	PPMG13BS	UGE0002S	UOPCB14X
604	5	LOOPC	PPMG13AR	PPMG13BS	UGE0002T	UOPCB14X
605	5	LOOPC	PPMG13AR	PPMG13BS	UOPCB14X	UOPCB15X
606	5	LOOPC	PPMG13AR	PPMG13BT	UCA0001A	UGE0002R
607	5	LOOPC	PPMG13AR	PPMG13BT	UCA0002A	UGE0001R
608	5	LOOPC	PPMG13AR	PPMG13BT	UCA0002A	UGE0001S
609	5	LOOPC	PPMG13AR	PPMG13BT	UCB1C14N	UCB2C15N
610	5	LOOPC	PPMG13AR	PPMG13BT	UCB1C14N	UGE0002R
611	5	LOOPC	PPMG13AR	PPMG13BT	UCB1C14N	UGE0002S
612	5	LOOPC	PPMG13AR	PPMG13BT	UCB1C14N	UGE0002T
613	5	LOOPC	PPMG13AR	PPMG13BT	UCB1C14N	UOPCB15X
614	5	LOOPC	PPMG13AR	PPMG13BT	UCB2C15N	UGE0001R
615	5	LOOPC	PPMG13AR	PPMG13BT	UCB2C15N	UGE0001S
616	5	LOOPC	PPMG13AR	PPMG13BT	UCB2C15N	UOPCB14X
617	5	LOOPC	PPMG13AR	PPMG13BT	UGE0001R	UGE0002R
618	5	LOOPC	PPMG13AR	PPMG13BT	UGE0001R	UGE0002S

619	5	LOOPC	PPMG13AR	PPMG13BT	UGE0001R	UGE0002T
620	5	LOOPC	PPMG13AR	PPMG13BT	UGE0001R	UOPCB15X
621	5	LOOPC	PPMG13AR	PPMG13BT	UGE0001S	UGE0002R
622	5	LOOPC	PPMG13AR	PPMG13BT	UGE0001S	UGE0002T
623	5	LOOPC	PPMG13AR	PPMG13BT	UGE0001S	UOPCB15X
624	5	LOOPC	PPMG13AR	PPMG13BT	UGE0002R	UOPCB14X
625	5	LOOPC	PPMG13AR	PPMG13BT	UGE0002S	UOPCB14X
626	5	LOOPC	PPMG13AR	PPMG13BT	UGE0002T	UOPCB14X
627	5	LOOPC	PPMG13AR	PPMG13BT	UOPCB14X	UOPCB15X
628	5	LOOPC	PPMG13AR	PXV0379X	UCB1C14N	UGE0002R
629	5	LOOPC	PPMG13AR	PXV0379X	UCB2C15N	UGE0001R
630	5	LOOPC	PPMG13AR	PXV0379X	UCB2C15N	UGE0001S
631	5	LOOPC	PPMG13AR	PXV0379X	UGE0001R	UGE0002R
632	5	LOOPC	PPMG13AR	PXV0379X	UGE0001R	UGE0002S
633	5	LOOPC	PPMG13AR	PXV0379X	UGE0001R	UGE0002T
634	5	LOOPC	PPMG13AR	PXV0379X	UGE0001R	UOPCB15X
635	5	LOOPC	PPMG13AR	PXV0379X	UGE0001S	UGE0002R
636	5	LOOPC	PPMG13AR	PXV0379X	UGE0001S	UGE0002T
637	5	LOOPC	PPMG13AR	PXV0379X	UGE0001S	UOPCB15X
638	5	LOOPC	PPMG13AR	PXV0379X	UGE0001T	UGE0002R
639	5	LOOPC	PPMG13AR	PXV0379X	UGE0001T	UGE0002S
640	5	LOOPC	PPMG13AR	PXV0379X	UGE0001T	UOPCB15X
641	5	LOOPC	PPMG13AR	PXV0379X	UGE0002R	UOPCB14X
642	5	LOOPC	PPMG13AR	PXV0379X	UGE0002T	UOPCB14X
643	5	LOOPC	PPMG13BR	UCA0001A	UGE0002R	UOP12XT
644	5	LOOPC	PPMG13BR	UCA0001A	UGE0002S	UOP12XT
645	5	LOOPC	PPMG13BR	UCA0001A	UGE0002T	UOP12XT
646	5	LOOPC	PPMG13BR	UCA0001A	UOPCB15X	UOP12XT
647	5	LOOPC	PPMG13BR	UCA0002A	UGE0001R	UOP12XT

648	5	LOOPC	PPMG13BR	UCA0002A	UGE0001S	UOP12XT
649	5	LOOPC	PPMG13BR	UCA0002A	UGE0001T	UOP12XT
650	5	LOOPC	PPMG13BR	UCA0002A	UOPCB14X	UOP12XT
651	5	LOOPC	PPMG13BR	UCB1C14N	UCB2C15N	UOP12XT
652	5	LOOPC	PPMG13BR	UCB1C14N	UGE0002R	UOP12XT
653	5	LOOPC	PPMG13BR	UCB1C14N	UGE0002S	UOP12XT
654	5	LOOPC	PPMG13BR	UCB1C14N	UGE0002T	UOP12XT
655	5	LOOPC	PPMG13BR	UCB1C14N	UOPCB15X	UOP12XT
656	5	LOOPC	PPMG13BR	UCB2C15N	UGE0001R	UOP12XT
657	5	LOOPC	PPMG13BR	UCB2C15N	UGE0001S	UOP12XT
658	5	LOOPC	PPMG13BR	UCB2C15N	UGE0001T	UOP12XT
659	5	LOOPC	PPMG13BR	UCB2C15N	UOPCB14X	UOP12XT
660	5	LOOPC	PPMG13BR	UGE0001R	UGE0002R	UOP12XT
661	5	LOOPC	PPMG13BR	UGE0001R	UGE0002S	UOP12XT
662	5	LOOPC	PPMG13BR	UGE0001R	UGE0002T	UOP12XT
663	5	LOOPC	PPMG13BR	UGE0001R	UOPCB15X	UOP12XT
664	5	LOOPC	PPMG13BR	UGE0001S	UGE0002R	UOP12XT
665	5	LOOPC	PPMG13BR	UGE0001S	UGE0002T	UOP12XT
666	5	LOOPC	PPMG13BR	UGE0001S	UOPCB15X	UOP12XT
667	5	LOOPC	PPMG13BR	UGE0001T	UGE0002R	UOP12XT
668	5	LOOPC	PPMG13BR	UGE0001T	UGE0002S	UOP12XT
669	5	LOOPC	PPMG13BR	UGE0001T	UOPCB15X	UOP12XT
670	5	LOOPC	PPMG13BR	UGE0002R	UOPCB14X	UOP12XT
671	5	LOOPC	PPMG13BR	UGE0002S	UOPCB14X	UOP12XT
672	5	LOOPC	PPMG13BR	UGE0002T	UOPCB14X	UOP12XT
673	5	LOOPC	PPMG13BR	UOPCB14X	UOPCB15X	UOP12XT
674	5	LOOPC	PPMG13BS	UCA0001A	UCB2C15N	UOP12XT
675	5	LOOPC	PPMG13BS	UCA0001A	UGE0002R	UOP12XT
676	5	LOOPC	PPMG13BS	UCA0001A	UGE0002S	UOP12XT

677	5	LOOPC	PPMG13BS	UCA0001A	UGE0002T	UOP12XT
678	5	LOOPC	PPMG13BS	UCA0001A	UOPCB15X	UOP12XT
679	5	LOOPC	PPMG13BS	UCA0002A	UCB1C14N	UOP12XT
680	5	LOOPC	PPMG13BS	UCA0002A	UGE0001R	UOP12XT
681	5	LOOPC	PPMG13BS	UCA0002A	UGE0001S	UOP12XT
682	5	LOOPC	PPMG13BS	UCA0002A	UGE0001T	UOP12XT
683	5	LOOPC	PPMG13BS	UCA0002A	UOPCB14X	UOP12XT
684	5	LOOPC	PPMG13BS	UCB1C14N	UCB2C15N	UOP12XT
685	5	LOOPC	PPMG13BS	UCB1C14N	UGE0002R	UOP12XT
686	5	LOOPC	PPMG13BS	UCB1C14N	UGE0002S	UOP12XT
687	5	LOOPC	PPMG13BS	UCB1C14N	UGE0002T	UOP12XT
688	5	LOOPC	PPMG13BS	UCB1C14N	UOPCB15X	UOP12XT
689	5	LOOPC	PPMG13BS	UCB2C15N	UGE0001R	UOP12XT
690	5	LOOPC	PPMG13BS	UCB2C15N	UGE0001S	UOP12XT
691	5	LOOPC	PPMG13BS	UCB2C15N	UGE0001T	UOP12XT
692	5	LOOPC	PPMG13BS	UCB2C15N	UOPCB14X	UOP12XT
693	5	LOOPC	PPMG13BS	UGE0001R	UGE0002R	UOP12XT
694	5	LOOPC	PPMG13BS	UGE0001R	UGE0002S	UOP12XT
695	5	LOOPC	PPMG13BS	UGE0001R	UGE0002T	UOP12XT
696	5	LOOPC	PPMG13BS	UGE0001R	UOPCB15X	UOP12XT
697	5	LOOPC	PPMG13BS	UGE0001S	UGE0002R	UOP12XT
698	5	LOOPC	PPMG13BS	UGE0001S	UGE0002T	UOP12XT
699	5	LOOPC	PPMG13BS	UGE0001S	UOPCB15X	UOP12XT
700	5	LOOPC	PPMG13BS	UGE0001T	UGE0002R	UOP12XT
701	5	LOOPC	PPMG13BS	UGE0001T	UGE0002S	UOP12XT
702	5	LOOPC	PPMG13BS	UGE0001T	UOPCB15X	UOP12XT
703	5	LOOPC	PPMG13BS	UGE0002R	UOPCB14X	UOP12XT
704	5	LOOPC	PPMG13BS	UGE0002S	UOPCB14X	UOP12XT
705	5	LOOPC	PPMG13BS	UGE0002T	UOPCB14X	UOP12XT

706	5	LOOPC	PPMG13BS	UOPCB14X	UOPCB15X	UOP12XT
707	5	LOOPC	PPMG13BT	UCA0001A	UCB2C15N	UOP12XT
708	5	LOOPC	PPMG13BT	UCA0001A	UGE0002R	UOP12XT
709	5	LOOPC	PPMG13BT	UCA0001A	UGE0002S	UOP12XT
710	5	LOOPC	PPMG13BT	UCA0001A	UGE0002T	UOP12XT
711	5	LOOPC	PPMG13BT	UCA0001A	UOPCB15X	UOP12XT
712	5	LOOPC	PPMG13BT	UCA0002A	UCB1C14N	UOP12XT
713	5	LOOPC	PPMG13BT	UCA0002A	UGE0001R	UOP12XT
714	5	LOOPC	PPMG13BT	UCA0002A	UGE0001S	UOP12XT
715	5	LOOPC	PPMG13BT	UCA0002A	UOPCB14X	UOP12XT
716	5	LOOPC	PPMG13BT	UCB1C14N	UCB2C15N	UOP12XT
717	5	LOOPC	PPMG13BT	UCB1C14N	UGE0002R	UOP12XT
718	5	LOOPC	PPMG13BT	UCB1C14N	UGE0002S	UOP12XT
719	5	LOOPC	PPMG13BT	UCB1C14N	UGE0002T	UOP12XT
720	5	LOOPC	PPMG13BT	UCB1C14N	UOPCB15X	UOP12XT
721	5	LOOPC	PPMG13BT	UCB2C15N	UGE0001R	UOP12XT
722	5	LOOPC	PPMG13BT	UCB2C15N	UGE0001S	UOP12XT
723	5	LOOPC	PPMG13BT	UCB2C15N	UOPCB14X	UOP12XT
724	5	LOOPC	PPMG13BT	UGE0001R	UGE0002R	UOP12XT
725	5	LOOPC	PPMG13BT	UGE0001R	UGE0002S	UOP12XT
726	5	LOOPC	PPMG13BT	UGE0001R	UGE0002T	UOP12XT
727	5	LOOPC	PPMG13BT	UGE0001R	UOPCB15X	UOP12XT
728	5	LOOPC	PPMG13BT	UGE0001S	UGE0002R	UOP12XT
729	5	LOOPC	PPMG13BT	UGE0001S	UGE0002T	UOP12XT
730	5	LOOPC	PPMG13BT	UGE0001S	UOPCB15X	UOP12XT
731	5	LOOPC	PPMG13BT	UGE0002R	UOPCB14X	UOP12XT
732	5	LOOPC	PPMG13BT	UGE0002S	UOPCB14X	UOP12XT
733	5	LOOPC	PPMG13BT	UGE0002T	UOPCB14X	UOP12XT
734	5	LOOPC	PPMG13BT	UOPCB14X	UOPCB15X	UOP12XT

735	5	LOOPC	PXV0379X	UCA0001A	UGE0002R	UOP12XT
736	5	LOOPC	PXV0379X	UCA0001A	UGE0002T	UOP12XT
737	5	LOOPC	PXV0379X	UCA0002A	UGE0001R	UOP12XT
738	5	LOOPC	PXV0379X	UCA0002A	UGE0001S	UOP12XT
739	5	LOOPC	PXV0379X	UCA0002A	UGE0001T	UOP12XT
740	5	LOOPC	PXV0379X	UCB1C14N	UCB2C15N	UOP12XT
741	5	LOOPC	PXV0379X	UCB1C14N	UGE0002R	UOP12XT
742	5	LOOPC	PXV0379X	UCB1C14N	UGE0002S	UOP12XT
743	5	LOOPC	PXV0379X	UCB1C14N	UGE0002T	UOP12XT
744	5	LOOPC	PXV0379X	UCB1C14N	UOPCB15X	UOP12XT
745	5	LOOPC	PXV0379X	UCB2C15N	UGE0001R	UOP12XT
746	5	LOOPC	PXV0379X	UCB2C15N	UGE0001S	UOP12XT
747	5	LOOPC	PXV0379X	UCB2C15N	UGE0001T	UOP12XT
748	5	LOOPC	PXV0379X	UCB2C15N	UOPCB14X	UOP12XT
749	5	LOOPC	PXV0379X	UGE0001R	UGE0002R	UOP12XT
750	5	LOOPC	PXV0379X	UGE0001R	UGE0002S	UOP12XT
751	5	LOOPC	PXV0379X	UGE0001R	UGE0002T	UOP12XT
752	5	LOOPC	PXV0379X	UGE0001R	UOPCB15X	UOP12XT
753	5	LOOPC	PXV0379X	UGE0001S	UGE0002R	UOP12XT
754	5	LOOPC	PXV0379X	UGE0001S	UGE0002T	UOP12XT
755	5	LOOPC	PXV0379X	UGE0001S	UOPCB15X	UOP12XT
756	5	LOOPC	PXV0379X	UGE0001T	UGE0002R	UOP12XT
757	5	LOOPC	PXV0379X	UGE0001T	UGE0002S	UOP12XT
758	5	LOOPC	PXV0379X	UGE0001T	UOPCB15X	UOP12XT
759	5	LOOPC	PXV0379X	UGE0002R	UOPCB14X	UOP12XT
760	5	LOOPC	PXV0379X	UGE0002S	UOPCB14X	UOP12XT
761	5	LOOPC	PXV0379X	UGE0002T	UOPCB14X	UOP12XT
762	5	LOOPC	PXV0379X	UOPCB14X	UOPCB15X	UOP12XT
763	5	LOOPC	UBS001CH	UGE0002R	UNASDGEH	UOP1C2CX

764	5	LOOPC	UBS001CH	UGE0002R	UOPSDGEV	UOP1C2CX	
765	5	LOOPC	UBS001CH	UGE0002S	UNASDGEH	UOP1C2CX	
766	5	LOOPC	UBS001CH	UGE0002T	UNASDGEH	UOP1C2CX	
767	5	LOOPC	UBS001CH	UGE0002T	UOPSDGEV	UOP1C2CX	
768	5	LOOPC	UBS001CH	UNASDGEH	UOPCB15X	UOP1C2CX	
769	5	LOOPC	UBS002CH	UGE0001R	UNASDGEH	UOP1C2CX	
770	5	LOOPC	UBS002CH	UGE0001R	UOPSDGEV	UOP1C2CX	
771	5	LOOPC	UBS002CH	UGE0001S	UNASDGEH	UOP1C2CX	
772	5	LOOPC	UBS002CH	UGE0001S	UOPSDGEV	UOP1C2CX	
773	5	LOOPC	UBS002CH	UGE0001T	UNASDGEH	UOP1C2CX	
774	5	LOOPC	UBS002CH	UGE0001T	UOPSDGEV	UOP1C2CX	
775	5	LOOPC	UBS002CH	UNASDGEH	UOPCB14X	UOP1C2CX	
776	5	UNASDGEH	UOPDGCMD	UOP1CAXT	UOP2CBXT	UTR000CH	
777	5	UOPDGCMD	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH	
778	5	DG2/1	LOOPC	PCV0383P	PPMG13AR	UGE0001S	
779	5	DG2/1	LOOPC	PCV0383P	UGE0001S	UOP12XT	
780	5	DG2/1	LOOPC	PPMG13AR	PPMG13BR	UGE0001S	
781	5	DG2/1	LOOPC	PPMG13AR	PPMG13BS	UGE0001S	
782	5	DG2/1	LOOPC	PPMG13AR	PPMG13BT	UGE0001S	
783	5	DG2/1	LOOPC	PPMG13AR	PXV0379X	UGE0001S	
784	5	DG2/1	LOOPC	PPMG13BR	UGE0001S	UOP12XT	
785	5	DG2/1	LOOPC	PPMG13BS	UGE0001S	UOP12XT	
786	5	DG2/1	LOOPC	PPMG13BT	UGE0001S	UOP12XT	
787	5	DG2/1	LOOPC	PXV0379X	UGE0001S	UOP12XT	
788	6	FLOWDIV2	LOOPC	PMV720AP	UCB1C14N	UGE0002R	UOP12XT
789	6	FLOWDIV2	LOOPC	PMV720AP	UCB1C14N	UGE0002T	UOP12XT
790	6	FLOWDIV2	LOOPC	PMV720AP	UCB2C15N	UGE0001R	UOP12XT
791	6	FLOWDIV2	LOOPC	PMV720AP	UCB2C15N	UGE0001S	UOP12XT
792	6	FLOWDIV2	LOOPC	PMV720AP	UCB2C15N	UGE0001T	UOP12XT

793	6	FLOWDIV2	LOOPC	PMV720AP	UGE0001R	UGE0002R	UOP12XT
794	6	FLOWDIV2	LOOPC	PMV720AP	UGE0001R	UGE0002S	UOP12XT
795	6	FLOWDIV2	LOOPC	PMV720AP	UGE0001R	UGE0002T	UOP12XT
796	6	FLOWDIV2	LOOPC	PMV720AP	UGE0001R	UOPCB15X	UOP12XT
797	6	FLOWDIV2	LOOPC	PMV720AP	UGE0001S	UGE0002R	UOP12XT
798	6	FLOWDIV2	LOOPC	PMV720AP	UGE0001S	UGE0002T	UOP12XT
799	6	FLOWDIV2	LOOPC	PMV720AP	UGE0001S	UOPCB15X	UOP12XT
800	6	FLOWDIV2	LOOPC	PMV720AP	UGE0001T	UGE0002R	UOP12XT
801	6	FLOWDIV2	LOOPC	PMV720AP	UGE0001T	UGE0002S	UOP12XT
802	6	FLOWDIV2	LOOPC	PMV720AP	UGE0001T	UOPCB15X	UOP12XT
803	6	FLOWDIV2	LOOPC	PMV720AP	UGE0002R	UOPCB14X	UOP12XT
804	6	FLOWDIV2	LOOPC	PMV720AP	UGE0002S	UOPCB14X	UOP12XT
805	6	FLOWDIV2	LOOPC	PMV720AP	UGE0002T	UOPCB14X	UOP12XT
806	6	FLOWDIV2	LOOPC	PXV0301X	UGE0001R	UGE0002R	UOP12XT
807	6	FLOWDIV2	LOOPC	PXV0301X	UGE0001R	UGE0002T	UOP12XT
808	6	FLOWDIV2	LOOPC	PXV0301X	UGE0001S	UGE0002R	UOP12XT
809	6	FLOWDIV2	LOOPC	PXV0301X	UGE0001S	UGE0002T	UOP12XT
810	6	FLOWDIV2	LOOPC	PXV0301X	UGE0001T	UGE0002R	UOP12XT
811	6	FLOWDIV2	LOOPC	PXV0303X	UGE0001R	UGE0002R	UOP12XT
812	6	FLOWDIV2	LOOPC	PXV0303X	UGE0001R	UGE0002T	UOP12XT
813	6	FLONDIV2	LOOPC	PXV0303X	UGE0001S	UGE0002R	UOP12XT
814	6	FLOWDIV2	LOOPC	PXV0303X	UGE0001S	UGE0002T	UOP12XT
815	6	FLOWDIV2	LOOPC	PXV0303X	UGE0001T	UGE0002R	UOP12XT
816	6	FLOWDIV2	LOOPC	PXV0331X	UGE0001R	UGE0002R	UOP12XT
817	6	FLOWDIV2	LOOPC	PXV0331X	UGE0001R	UGE0002T	UOP12XT
818	6	FLOWDIV2	LOOPC	PXV0331X	UGE0001S	UGE0002R	UOP12XT
819	6	FLOWDIV2	LOOPC	PXV0331X	UGE0001S	UGE0002T	UOP12XT
820	6	FLOWDIV2	LOOPC	PXV0331X	UGE0001T	UGE0002R	UOP12XT
821	6	KLOV1	KOPDGLOV	LOOPC	PPMG13BS	UGE0002R	UOP12XT

822	6	KLOV1	KOPDGLOV	LOOPC	PPMG13BS	UGE0002T	UOP12XT
823	6	KLOV1	KOPDGLOV	LOOPC	PPMG13BT	UGE0002R	UOP12XT
824	6	KLOV1	KOPDGLOV	LOOPC	PPMG13BT	UGE0002T	UOP12XT
825	6	KLOV2	KOPDGLOV	LOOPC	PPMG13BS	UGE0001R	UOP12XT
826	6	KLOV2	KOPDGLOV	LOOPC	PPMG13BS	UGE0001S	UOP12XT
827	6	KLOV2	KOPDGLOV	LOOPC	PPMG13BS	UGE0001T	UOP12XT
828	6	KLOV2	KOPDGLOV	LOOPC	PPMG13BT	UGE0001R	UOP12XT
829	6	KLOV2	KOPDGLOV	LOOPC	PPMG13BT	UGE0001S	UOP12XT
830	6	LOOPC	PCV0383P	UGE0001R	UOP1C2CX	UOP12XT	UOP22CXT
831	6	LOOPC	PCV0383P	UGE0001S	UOP1C2CX	UOP12XT	UOP22CXT
832	6	LOOPC	PCV0383P	UGE0001T	UOP1C2CX	UOP12XT	UOP22CXT
833	6	LOOPC	PHEE20BE	UGE0002R	UNASDGEH	UOP1C2CX	UOP23XT
834	6	LOOPC	PHUG13BU	PPRPS28H	UGE0001R	UGE0002R	UOP12XT
835	6	LOOPC	PHUG13BU	PPRPS28H	UGE0001R	UGE0002S	UOP12XT
836	6	LOOPC	PHUG13BU	PPRPS28H	UGE0001R	UGE0002T	UOP12XT
837	6	LOOPC	PHUG13BU	PPRPS28H	UGE0001S	UGE0002R	UOP12XT
838	6	LOOPC	PHUG13BU	PPRPS28H	UGE0001S	UGE0002T	UOP12XT
839	6	LOOPC	PHUG13BU	PPRPS28H	UGE0001T	UGE0002R	UOP12XT
840	6	LOOPC	PHUG13BU	PPRPS28H	UGE0001T	UGE0002S	UOP12XT
841	6	LOOPC	PHU0300U	PMV720AP	UCB1C14N	UGE0002R	UOP12XT
842	6	LOOPC	PHU0300U	PMV720AP	UCB1C14N	UGE0002S	UOP12XT
843	6	LOOPC	PHU0300U	PMV720AP	UCB1C14N	UGE0002T	UOP12XT
844	6	LOOPC	PHU0300U	PMV720AP	UCB2C15N	UGE0001R	UOP12XT
845	6	LOOPC	PHU0300U	PMV720AP	UCB2C15N	UGE0001S	UOP12XT
846	6	LOOPC	PHU0300U	PMV720AP	UCB2C15N	UGE0001T	UOP12XT
847	6	LOOPC	PHU0300U	PMV720AP	UGE0001R	UGE0002R	UOP12XT
848	6	LOOPC	PHU0300U	PMV720AP	UGE0001R	UGE0002S	UOP12XT
849	6	LOOPC	PHU0300U	PMV720AP	UGE0001R	UGE0002T	UOP12XT
850	6	LOOPC	PHU0300U	PMV720AP	UGE0001R	UOPCB15X	UOP12XT

851	6	LOOPC	PHU0300U	PMV720AP	UGE0001S	UGE0002R	UOP12XT
852	6	LOOPC	PHU0300U	PMV720AP	UGE0001S	UGE0002T	UOP12XT
853	6	LOOPC	PHU0300U	PMV720AP	UGE0001S	UOPCB15X	UOP12XT
854	6	LOOPC	PHU0300U	PMV720AP	UGE0001T	UGE0002R	UOP12XT
855	6	LOOPC	PHU0300U	PMV720AP	UGE0001T	UGE0002S	UOP12XT
856	6	LOOPC	PHU0300U	PMV720AP	UGE0001T	UOPCB15X	UOP12XT
857	6	LOOPC	PHU0300U	PMV720AP	UGE0002R	UOPCB14X	UOP12XT
858	6	LOOPC	PHU0300U	PMV720AP	UGE0002S	UOPCB14X	UOP12XT
859	6	LOOPC	PHU0300U	PMV720AP	UGE0002T	UOPCB14X	UOP12XT
860	6	LOOPC	PHU0300U	PMV720AP	UOPCB14X	UOPCB15X	UOP12XT
861	6	LOOPC	PHU0300U	PXV0301X	UGE0001R	UGE0002R	UOP12XT
862	6	LOOPC	PHU0300U	PXV0301X	UGE0001R	UGE0002S	UOP12XT
863	6	LOOPC	PHU0300U	PXV0301X	UGE0001R	UGE0002T	UOP12XT
864	6	LOOPC	PHU0300U	PXV0301X	UGE0001S	UGE0002R	UOP12XT
865	6	LOOPC	PHU0300U	PXV0301X	UGE0001S	UGE0002T	UOP12XT
866	6	LOOPC	PHU0300U	PXV0301X	UGE0001T	UGE0002R	UOP12XT
867	6	LOOPC	PHU0300U	PXV0301X	UGE0001T	UGE0002S	UOP12XT
868	6	LOOPC	PHU0300U	PXV0303X	UGE0001R	UGE0002R	UOP12XT
869	6	LOOPC	PHU0300U	PXV0303X	UGE0001R	UGE0002S	UOP12XT
870	6	LOOPC	PHU0300U	PXV0303X	UGE0001R	UGE0002T	UOP12XT
871	6	LOOPC	PHU0300U	PXV0303X	UGE0001S	UGE0002R	UOP12XT
872	6	LOOPC	PHU0300U	PXV0303X	UGE0001S	UGE0002T	UOP12XT
873	6	LOOPC	PHU0300U	PXV0303X	UGE0001T	UGE0002R	UOP12XT
874	6	LOOPC	PHU0300U	PXV0303X	UGE0001T	UGE0002S	UOP12XT
875	6	LOOPC	PHU0300U	PXV0331X	UGE0001R	UGE0002R	UOP12XT
876	6	LOOPC	PHU0300U	PXV0331X	UGE0001R	UGE0002S	UOP12XT
877	6	LOOPC	PHU0300U	PXV0331X	UGE0001R	UGE0002T	UOP12XT
878	6	LOOPC	PHU0300U	PXV0331X	UGE0001S	UGE0002R	UOP12XT
879	6	LOOPC	PHU0300U	PXV0331X	UGE0001S	UGE0002T	UOP12XT

880	6	LOOPC	PHU0300U	PXV0331X	UGE0001T	UGE0002R	UOP12XT
881	6	LOOPC	PHU0300U	PXV0331X	UGE0001T	UGE0002S	UOP12XT
882	6	LOOPC	PHU0302U	PMV720AP	UCB1C14N	UGE0002R	UOP12XT
883	6	LOOPC	PHU0302U	PMV720AP	UCB1C14N	UGE0002S	UOP12XT
884	6	LOOPC	PHU0302U	PMV720AP	UCB1C14N	UGE0002T	UOP12XT
885	6	LOOPC	PHU0302U	PMV720AP	UCB2C15N	UGE0001R	UOP12XT
886	6	LOOPC	PHU0302U	PMV720AP	UCB2C15N	UGE0001S	UOP12XT
887	6	LOOPC	PHU0302U	PMV720AP	UCB2C15N	UGE0001T	UOP12XT
888	6	LOOPC	PHU0302U	PMV720AP	UGE0001R	UGE0002R	UOP12XT
889	6	LOOPC	PHU0302U	PMV720AP	UGE0001R	UGE0002S	UOP12XT
890	6	LOOPC	PHU0302U	PMV720AP	UGE0001R	UGE0002T	UOP12XT
891	6	LOOPC	PHU0302U	PMV720AP	UGE0001R	UOPCB15X	UOP12XT
892	6	LOOPC	PHU0302U	PMV720AP	UGE0001S	UGE0002R	UOP12XT
893	6	LOOPC	PHU0302U	PMV720AP	UGE0001S	UGE0002T	UOP12XT
894	6	LOOPC	PHU0302U	PMV720AP	UGE0001S	UOPCB15X	UOP12XT
895	6	LOOPC	PHU0302U	PMV720AP	UGE0001T	UGE0002R	UOP12XT
896	6	LOOPC	PHU0302U	PMV720AP	UGE0001T	UGE0002S	UOP12XT
897	6	LOOPC	PHU0302U	PMV720AP	UGE0001T	UOPCB15X	UOP12XT
898	6	LOOPC	PHU0302U	PMV720AP	UGE0002R	UOPCB14X	UOP12XT
899	6	LOOPC	PHU0302U	PMV720AP	UGE0002S	UOPCB14X	UOP12XT
900	6	LOOPC	PHU0302U	PMV720AP	UGE0002T	UOPCB14X	UOP12XT
901	6	LOOPC	PHU0302U	PMV720AP	UOPCB14X	UOPCB15X	UOP12XT
902	6	LOOPC	PHU0302U	PXV0301X	UGE0001R	UGE0002R	UOP12XT
903	6	LOOPC	PHU0302U	PXV0301X	UGE0001R	UGE0002S	UOP12XT
904	6	LOOPC	PHU0302U	PXV0301X	UGE0001R	UGE0002T	UOP12XT
905	6	LOOPC	PHU0302U	PXV0301X	UGE0001S	UGE0002R	UOP12XT
906	6	LOOPC	PHU0302U	PXV0301X	UGE0001S	UGE0002T	UOP12XT
907	6	LOOPC	PHU0302U	PXV0301X	UGE0001T	UGE0002R	UOP12XT
908	6	LOOPC	PHU0302U	PXV0301X	UGE0001T	UGE0002S	UOP12XT

909	6	LOOPC	PHU0302U	PXV0303X	UGE0001R	UGE0002R	UOP12XT
910	6	LOOPC	PHU0302U	PXV0303X	UGE0001R	UGE0002S	UOP12XT
911	6	LOOPC	PHU0302U	PXV0303X	UGE0001R	UGE0002T	UOP12XT
912	6	LOOPC	PHU0302U	PXV0303X	UGE0001S	UGE0002R	UOP12XT
913	6	LOOPC	PHU0302U	PXV0303X	UGE0001S	UGE0002T	UOP12XT
914	6	LOOPC	PHU0302U	PXV0303X	UGE0001T	UGE0002R	UOP12XT
915	6	LOOPC	PHU0302U	PXV0303X	UGE0001T	UGE0002S	UOP12XT
916	6	LOOPC	PHU0302U	PXV0331X	UGE0001R	UGE0002R	UOP12XT
917	6	LOOPC	PHU0302U	PXV0331X	UGE0001R	UGE0002S	UOP12XT
918	6	LOOPC	PHU0302U	PXV0331X	UGE0001R	UGE0002T	UOP12XT
919	6	LOOPC	PHU0302U	PXV0331X	UGE0001S	UGE0002R	UOP12XT
920	6	LOOPC	PHU0302U	PXV0331X	UGE0001S	UGE0002T	UOP12XT
921	6	LOOPC	PHU0302U	PXV0331X	UGE0001T	UGE0002R	UOP12XT
922	6	LOOPC	PHU0302U	PXV0331X	UGE0001T	UGE0002S	UOP12XT
923	6	LOOPC	PPMG13AR	PPMG13BS	UGE0001R	UOP1C2CX	UOP22CXT
924	6	LOOPC	PPMG13AR	PPMG13BS	UGE0001S	UOP1C2CX	UOP22CXT
925	6	LOOPC	PPMG13AR	PPMG13BT	UGE0001R	UOP1C2CX	UOP22CXT
926	6	LOOPC	PPMG13AR	PPMG13BT	UGE0001S	UOP1C2CX	UOP22CXT
927	6	LOOPC	PPMG13AR	UCB2C15N	UNASDGEH	UOP04KVV	UOP1C2CX
928	6	LOOPC	PPMG13AR	UCB2C15N	UOPSDGEV	UOP04KVV	UOP1C2CX
929	6	LOOPC	PPMG13AR	UGE0002R	UNASDGEH	UOP04KVV	UOP1C2CX
930	6	LOOPC	PPMG13AR	UGE0002R	UOPSDGEV	UOP04KVV	UOP1C2CX
931	6	LOOPC	PPMG13AR	UGE0002S	UNASDGEH	UOP04KVV	UOP1C2CX
932	6	LOOPC	PPMG13AR	UGE0002S	UOPSDGEV	UOP04KVV	UOP1C2CX
933	6	LOOPC	PPMG13AR	UGE0002T	UNASDGEH	UOP04KVV	UOP1C2CX
934	6	LOOPC	PPMG13AR	UGE0002T	UOPSDGEV	UOP04KVV	UOP1C2CX
935	6	LOOPC	PPMG13AR	UNASDGEH	UOPCB15X	UOP04KVV	UOP1C2CX
936	6	LOOPC	PPMG13AR	UOPCB15X	UOPSDGEV	UOP04KVV	UOP1C2CX
937	6	LOOPC	PPMG13BR	UCB1C14N	UOP1C2CX	UOP12XT	UOP22CXT

938	6	LOOPC	PPMG13BR	UGE0001R	UOP04KVV	UOP1C2CX	UOP12XT
939	6	LOOPC	PPMG13BR	UGE0001R	UOP1C2CX	UOP12XT	UOP22CXT
940	6	LOOPC	PPMG13BR	UGE0001S	UOP04KVV	UOP1C2CX	UOP12XT
941	6	LOOPC	PPMG13BR	UGE0001S	UOP1C2CX	UOP12XT	UOP22CXT
942	6	LOOPC	PPMG13BR	UGE0001T	UOP04KVV	UOP1C2CX	UOP12XT
943	6	LOOPC	PPMG13BR	UGE0001T	UOP1C2CX	UOP12XT	UOP22CXT
944	6	LOOPC	PPMG13BR	UOPCB14X	UOP1C2CX	UOP12XT	UOP22CXT
945	6	LOOPC	PPMG13BS	UCB1C14N	UOP04KVV	UOP1C2CX	UOP12XT
946	6	LOOPC	PPMG13BS	UCB1C14N	UOP1C2CX	UOP12XT	UOP22CXT
947	6	LOOPC	PPMG13BS	UGE0001R	UOP04KVV	UOP1C2CX	UOP12XT
948	6	LOOPC	PPMG13BS	UGE0001R	UOP1C2CX	UOP12XT	UOP22CXT
949	6	LOOPC	PPMG13BS	UGE0001S	UOP04KVV	UOP1C2CX	UOP12XT
950	6	LOOPC	PPMG13BS	UGE0001S	UOP1C2CX	UOP12XT	UOP22CXT
951	6	LOOPC	PPMG13BS	UGE0001T	UOP04KVV	UOP1C2CX	UOP12XT
952	6	LOOPC	PPMG13BS	UGE0001T	UOP1C2CX	UOP12XT	UOP22CXT
953	6	LOOPC	PPMG13BS	UOPCB14X	UOP04KVV	UOP1C2CX	UOP12XT
954	6	LOOPC	PPMG13BS	UOPCB14X	UOP1C2CX	UOP12XT	UOP22CXT
955	6	LOOPC	PPMG13BT	UCB1C14N	UOP04KVV	UOP1C2CX	UOP12XT
956	6	LOOPC	PPMG13BT	UCB1C14N	UOP1C2CX	UOP12XT	UOP22CXT
957	6	LOOPC	PPMG13BT	UGE0001R	UOP04KVV	UOP1C2CX	UOP12XT
958	6	LOOPC	PPMG13BT	UGE0001R	UOP1C2CX	UOP12XT	UOP22CXT
959	6	LOOPC	PPMG13BT	UGE0001S	UOP04KVV	UOP1C2CX	UOP12XT
960	6	LOOPC	PPMG13BT	UGE0001S	UOP1C2CX	UOP12XT	UOP22CXT
961	6	LOOPC	PPMG13BT	UOPCB14X	UOP04KVV	UOP1C2CX	UOP12XT
962	6	LOOPC	PPMG13BT	UOPCB14X	UOP1C2CX	UOP12XT	UOP22CXT
963	6	LOOPC	PXV0379X	UGE0001R	UOP1C2CX	UOP12XT	UOP22CXT
964	6	LOOPC	PXV0379X	UGE0001S	UOP1C2CX	UOP12XT	UOP22CXT
965	6	LOOPC	PXV0379X	UGE0001T	UOP1C2CX	UOP12XT	UOP22CXT
966	6	UCA0002A	UGE0001S	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH

967	6	UCB1C14N	UCB2C15N	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
968	6	UCB1C14N	UGE0002R	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
969	6	UCB1C14N	UGE0002R	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH
970	6	UCB1C14N	UGE0002S	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
971	6	UCB1C14N	UGE0002S	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH
972	6	UCB1C14N	UGE0002T	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
973	6	UCB1C14N	UGE0002T	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH
974	6	UCB1C14N	UNASDGEH	UOPCB15X	UOP1CAXT	UOP2CBXT	UTR000CH
975	6	UCB2C15N	UGE0001R	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
976	6	UCB2C15N	UGE0001R	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH
977	6	UCB2C15N	UGE0001S	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
978	6	UCB2C15N	UGE0001S	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH
979	6	UCB2C15N	UGE0001T	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
980	6	UCB2C15N	UGE0001T	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH
981	6	UCB2C15N	UNASDGEH	UOPCB14X	UOP1CAXT	UOP2CBXT	UTR000CH
982	6	UGE0001R	UGE0002R	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
983	6	UGE0001R	UGE0002R	UNASDGEH	UOP1CAXT	UTR000BH	UTR000CH
984	6	UGE0001R	UGE0002R	UNASDGEH	UOP2CBXT	UTR000AH	UTR000CH
985	6	UGE0001R	UGE0002R	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH
986	6	UGE0001R	UGE0002S	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
987	6	UGE0001R	UGE0002S	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH
988	6	UGE0001R	UGE0002T	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
989	6	UGE0001R	UGE0002T	UNASDGEH	UOP1CAXT	UTR000BH	UTR000CH
990	6	UGE0001R	UGE0002T	UNASDGEH	UOP2CBXT	UTR000AH	UTR000CH
991	6	UGE0001R	UGE0002T	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH
992	6	UGE0001R	UNASDGEH	UOPCB15X	UOP1CAXT	UOP2CBXT	UTR000CH
993	6	UGE0001R	UOPCB15X	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH
994	6	UGE0001S	UGE0002R	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH
995	6	UGE0001S	UGE0002R	UNASDGEH	UOP1CAXT	UTR000BH	UTR000CH

1025	6	DG2/1	LOOPC	PHU0300U	PXV0331X	UGE0001S	UOP12XT	
1026	6	DG2/1	LOOPC	PHU0302U	PMV720AP	UGE0001S	UOP12XT	
1027	6	DG2/1	LOOPC	PHU0302U	PXV0301X	UGE0001S	UOP12XT	
1028	6	DG2/1	LOOPC	PHU0302U	PXV0303X	UGE0001S	UOP12XT	
1029	6	DG2/1	LOOPC	PHU0302U	PXV0331X	UGE0001S	UOP12XT	
1030	6	DG2/1	UGE0001S	UNASDGEH	UOP1CAXT	UOP2CBXT	UTR000CH	
1031	6	DG2/1	UGE0001S	UOPSDGEV	UOP1CAXT	UOP2CBXT	UTR000CH	
1032	7	LOOPC	PHUG13CU	PPMG13AR	UGE0002R	UNASDGEH	UOP1C2CX	UOP23XT
1033	7	LOOPC	PHU0300U	PPMG13AR	UGE0002R	UNASDGEH	UOP1C2CX	UOP23XT
1034	7	LOOPC	PHU0302U	PPMG13AR	UGE0002R	UNASDGEH	UOP1C2CX	UOP23XT
1035	7	LOOPC	PPMG13AR	PPMG13CS	UGE0002R	UNASDGEH	UOP1C2CX	UOP23XT
1036	7	LOOPC	PPMG13AR	PPMG13CT	UGE0002R	UNASDGEH	UOP1C2CX	UOP23XT
1037	7	LOOPC	PPMG13AR	PPMG13CT	UGE0002T	UNASDGEH	UOP1C2CX	UOP23XT