DRAFT

INDIAN POINT 3
SERVICE WATER SYSTEM

A. SUMMARY

A.1 INTRODUCTION

The service water system (SWS) acts as a heat transport medium, removing heat from the components that it supplies, and transferring this heat to the Hudson River. This system is necessary to remove reactor decay heat under LOCA conditions and most transient events.

This analysis is carried out under the following conditions:

- The system is quantified to the first isolation valve capable of isolating a major component. The component isolation valves are, in most cases, included with the components which are isolated; for example, the component cooling heat exchanger isolation valves are included with the component cooling heat exchangers.

- Operator interaction with the SWS to correct deficiencies or to recover the system following failure are considered for the mode selector switch; and, after the first hour, for errors in shifting the system lineup.

- Prior to the initiating event, two service water pumps were supplying the nuclear header and two service water pumps were supplying the conventional header.

- Success of the system is defined as two service water pumps supplying the nuclear header for 24 hours after the initiating event, and one service water pump supplying the conventional header for 24 hours after the initiating event.

A.2 RESULTS

Table 1 summarizes the results obtained for the service water system analysis. Two cases for electric power are presented: "No Loss of Offsite Power" and "Loss of Offsite Power." Three boundary conditions for each electric power case are analyzed: "Power at all 480V buses"; "Loss of power at a single 480V bus"; and "Loss of power at two 480V buses."

The analysis has revealed the following dominant contributors to failure of the SWS to supply water to time t = 24 hours:

	Mean
• Case 1 - No Loss of Offsite Power	
- Power at all 480V buses.	
• Mispositioned mode selector switch (96.4%)	2.2×10^{-3}

	Mean
- Loss of power at a single 480V bus	
• Random failure of the pumps selected to supply the nuclear header (63%)	3.9×10^{-3}
• Mispositioned mode selector switch (37%)	2.2×10^{-3}
- Loss of power at two 480V buses	
• Failure of the pumps selected to supply the nuclear header due to insufficient power (100%)	1.0
• Case 2 - Loss of Offsite Power	
- Power at all 480V buses	
• Mispositioned mode selector switch (93%)	2.2×10^{-3}
- Loss of power at one 480V bus	
• Random failure of the pumps selected to supply the nuclear header (69.5%)	5.3×10^{-3}
• Mispositioned mode selector switch (29%)	2.2×10^{-3}
- Loss of power at two 480V buses	
• Failure of the pumps selected to supply the nuclear header due to insufficient power (100%)	1.0

No comparison is made to WASH-1400 results as there is no comparable system analysis in WASH-1400.

A.3 CONCLUSIONS

The service water system is required to support plant operation and will be operating at the time of the initiating event. For this reason, the system is unusual in relation to the plant standby emergency systems.

Failure of this system is dominated by the human error of mispositioning the mode selector switch. There is no indication in the control room which can aid the operator in determining the correct position for this switch during normal plant operation; and, under the assumptions used in this analysis, if undetected, this error leads directly to system failure.

B. SYSTEM DESCRIPTION

B.1 SYSTEM FUNCTION

The SWS provides water from the Hudson River to various plant components requiring heat removal for proper operation during normal plant operation and during abnormal plant conditions.

This analysis was performed to determine the frequency of failure of the SWS to supply sufficient cooling water to the components required during abnormal plant operations. The components requiring service water during abnormal plant conditions are: the three emergency diesel generators (EDGs); the five containment building ventilation fan cooler recirculation units (FCUs); and the two component cooling heat exchangers.

The SWS consists of three groups of three pumps and two cooling water headers. One group of three pumps normally supplies essential plant services (the nuclear header) which, for this analysis, consists of the EDGs and the containment FCUs. The second group of three pumps supplies nonessential plant services (the conventional header) which, for this analysis, consists of the component cooling heat exchangers. The third group of pumps, backup service water pumps numbers 37, 38, and 39, are provided to supply essential plant services in the event of loss of the normal water supply. The third set of pumps cannot be selected for automatic starting, are not considered a part of the engineered safeguards system and, for these reasons, are excluded from this analysis.

Nuclear plant services and conventional plant services can be supplied from either of the first two groups of pumps. Operator action to manually realign the service water headers is required in order to shift header services. The pumps selected to supply the nuclear header are selected for automatic starting by the control room operator by shifting a mode selector switch.

System failure is defined as "No or Insufficient Flow from the Service Water System" which may be further defined as failure of two of three service water pumps selected for nuclear plant service to supply water to the nuclear services header and failure of one pump selected for conventional plant service to supply water to the conventional services header.

B.2 SYSTEM DIAGRAMS

The block diagram, Figure 1, is a schematic representation of the SWS which depicts the system success requirements.

Figure 2, is a system functional diagram showing the basic system piping arrangements.

B.3 SERVICE WATER SYSTEM AND OPERATION

B.3.1 SYSTEM NORMAL OPERATION

The SWS consists of nine identical vertical, centrifugal sump-type pumps rated at 5,000 gpm at 220 ft. TDH. These pumps supply two independent supply headers. One header normally provides cooling water for the plant essential loads (nuclear header), the other header provides cooling water for the plant nonessential loads (conventional header). The backup pumps are normally lined up to both service water headers; however, these pumps are provided for loss of the normal water supply only.

During normal operation, the essential cooling loads are supplied by two of the three service water pumps aligned to the nuclear header while the nonessential loads are supplied by two of the three service water pumps aligned to the conventional header. During plant emergency conditions, any two of the three service water pumps on the nuclear header can supply all of the cooling water requirements for essential plant equipment; any one of the three service water pumps on the conventional header can supply all of the cooling loads for nonessential equipment.

The service water pumps supplying the essential cooling loads are selected for automatic starting during engineered safeguards system (ESS) actuation by means of a mode selector switch in the control room. This mode selector switch has two positions "4, 5, 6," and "1, 2, 3." The "4, 5, 6" position closes contacts in the ESS actuation control circuits and opens contacts in the safety injection recirculation control circuits for service water pumps 34, 35, and 36. The opposite conditions exist for the service water pumps controlled by the position not selected (for this analysis, pumps 31, 32, and 33). The "1, 2, 3" position performs the same functions for service water pumps 31, 32, and 33 that the "4, 5, 6" position performs for pumps 34, 35, and 36. For the purposes of this analysis, service water pumps 34, 35, and 36 are assumed to be selected to supply essential plant services.

The discharge of each service water pump passes through a self-washing, automatic blowdown strainer. These strainers function to remove particles >1/8" in diameter from the service water flow stream. Cleaning and blowdown of the service water discharge strainers is automatic in response to the following signals: every 24 hours, the strainer is cleaned and blown down for five minutes; and whenever the Δp across the strainer reaches 3 psid, the strainer is cleaned and blown down until the strainer Δp is reduced to <3 psid. The strainer motors receive power from MCCs 36A and 36B which are the essential 480V MCCs for Indian Point 3.

Each service water pump discharges through a check valve and a normally open butterfly valve to its respective service water header. The butterfly valve is used to isolate a service water pump for maintenance, and the check valve is used to prevent back flow through an idle service water pump.

The essential cooling header supplies the following systems and components:

- Containment Building Fan Cooler Recirculation Units.
- Containment Building Fan Cooler Recirculation Units' Fan Motor Cooling Coils.
- Instrument Air Compressors' Closed Cooling System.
- Main Boiler Feed Pump Lube Oil Coolers.
- Main Turbine Oil Coolers.
- Generator Seal Oil Coolers.
- Emergency Diesel Generator Cooling Services.
- Control Room Air Conditioning Unit.

The conventional header supplies the component cooling heat exchangers and various conventional plant loads.

The EDGs and the containment building FCUs have automatic valves which operate in response to a safeguards actuation signal. The operation of these valves is discussed below:

- Service water for the EDGs provides lube oil cooling and jacket water cooling. Each diesel generator has a header supply isolation from both service water supply headers and an outlet isolation valve. The outlet from each diesel combines into a single outlet header and passes to a parallel flow control valve arrangement. These pneumatically operated valves maintain a total flow of 1,200 gpm through the EDGs. In the event of a high diesel generator jacket water temperature or a safeguards actuation signal, the air to the flow control valves is vented from the controller, and the valves go to the full open position. During normal plant power operation, one of the diesel generator flow control valves throttles open to maintain a total diesel generator cooling flow of 400 gpm.

- The service water system supplies cooling water to the five containment building FCUs. This water cools the air in the containment and the fan motors. The inlet and outlet isolation valves for each unit are located outside the containment building and may be operated during plant abnormal conditions. The outlet line from each fan motor cooler is combined into a single header and passes through a flow indicator and temperature indicator. Flow through the fan motor coolers is maintained at 55 gpm (total). The outlets from the FCU cooling coils are combined into a common outlet header. During normal plant operation, the service water flow from the FCUs is throttled to maintain containment ambient temperature $<120^{o}F$. Two parallel bypass valves around the

temperature control valve are automatically opened in response to a safeguards actuation signal. As these valves are pneumatically closed, loss of air or loss of power to the associated solenoid valve causes the bypass valves to open. The containment building FCU automatic outlet valves are included with the containment fan cooler system description as failure of the valves to open does not result in SWS failure.

The normal service water pumps are located in a common well of the intake structure and take their suction from this well. The service water well receives river water through its own debris screen system and from either or both of the circulating water pump wells. The gates on the main circulating supply openings are normally open. The backup pumps are located in the plant discharge canal. This location allows the pumps to supply essential plant service in the event of a loss of the normal service water supply.

Table 2 lists the required flows for the SWS for various plant conditions. During normal operation, two nuclear service water pumps and two conventional service water pumps are required to support power operation. During LOCA conditions, two of the three nuclear service water pumps are required to start and run. After the shift from injection to recirculation, two nuclear service water pumps are required to continue running and one conventional service water pump is required to start and run.

B.3.2 SYSTEM OPERATION DURING EMERGENCY CONDITIONS

Four conditions of emergency operation of the SWS are discussed below. These conditions are: "Unit Trip, No Blackout, No Safety Injection"; "Unit Trip, Blackout, No Safety Injection"; "Unit Trip, No Blackout and Safety Injection"; and "Unit Trip, Blackout, and Safety Injection."

1. <u>Unit Trip, No Blackout and No Safety Injection</u>. When the unit trips and no blackout or safety injection occurs the system will remain in operation as it was before the event, since all power requirements will have transferred from the unit auxiliary transformer to the station auxiliary transformer, and the service water pumps will continue to operate.

2. <u>Unit Trip, With Blackout and No Safety Injection</u>. When this condition occurs, all service water pumps are tripped. Electrical power is reestablished using the EDGs and the essential service water header is automatically reestablished in order to support the EDG cooling requirements. The nonessential service water header is then operator reestablished to support the component cooling heat exchangers since a component cooling pump is automatically started by this event. By reestablishing these headers all other loads are then supplied with water as necessary.

3. <u>Unit Trip, No Blackout and Safety Injection</u>. Under this condition, the service water pumps which were running remain running, and an additional pump selected by the mode selector switch to supply the essential heater will start.

4. Unit Trip, With Blackout and With Safety Injection. When this condition occurs, all service water pumps are tripped. Electrical power is reestablished using the EDGs. The ESS safeguards sequence signal then starts the service water pumps selected by the mode selector switch (right-hand safeguards panel) to supply the essential header.

When active safety injection is completed and the recirculation phase is entered into, two pumps (with outside power or three diesels running) or one pump (with only two of the diesels running) of the nonessential header will be started by recirculation phase switches RS-2 and RS-5. RS-2 will start one pump; RS-5 will start the other pump if three diesels are running or outside power is available. Assuming pumps 34, 35, and 36 were chosen for essential loads, essential service pumps 31, 32, and 33 would be used for the recirculation phase. Positioning switch RS-2 to "On" would start pump 31; if it failed to start, pump 32 would be started; and if 32 failed to start, pump 33 would be started. Switch RS-2 is independent of power available. Positioning switch RS-5 to "On" will cause the following action only if three diesels are running or outside power is available: pump 32 will be started; if it is running and pump 31 is not running, pump 31 is started; if pump 31 is running and pump 32 fails to start, pump 33 is started.

B.4 INSTRUMENTATION AND CONTROLS

The operator controls the service water pumps from the control room. In addition to the mode selector switch which determines the service water pumps selected for automatic starting during the injection phase of an ESS actuation, the operator has individual pump breaker control switches in the control room at the cooling water and air panel. There are nine switches, one for each service water pump. Each breaker control switch for the normal service water pumps has four positions (spring-return-to-Auto):

- Pull Out. The pump is disabled from starting by any automatic start signal. With the switch in this position, the "Safeguards Equipment Locked Open" alarm will be annunciated in the control room on the safeguards panel.

- Stop. The pump breaker is tripped open.

- Auto. The pump will be started for any one of the following conditions:

  - If selected for essential service, the pump will start upon receipt of a safety injection signal or a unit trip with blackout and no safety injection signal.

  - If not selected for essential service, the pump will start when the recirculation phase switches are positioned for the blackout and safety injection condition. For the unit trip with blackout condition, operator action is necessary to start a nonessential service water pump.

- Start. The pump will be started.

While the pump is running, it may be tripped by:

- Placing the control switch to the Stop or Pull Out position
- Overload.

The backup service water pump breakers are controlled from the control room by "On-Off" switches on the cooling water and air panel. In addition to the control room breaker control switches, each normal pump may be started locally at the 480V switchgear. To start a pump locally, a "Local/Remote" selector switch is positioned to "Local" and the pump is started. With the "Local/Remote" selector switch in "Local," the pump cannot be started automatically, and all control room indication of pump breaker status is lost. This condition is annunciated in the control room.

The controls for the self-cleaning strainers are located at the intake structure or by the backup pumps, each strainer having its own control panel. Three switches are located on each panel: a disconnect switch which removes all power from the unit; a three-position (Off-Hand-Auto) condition of operation selector; and a two-position (Intermittent-Continuous) mode of operation selector. A "Service Water Strainer Trouble" alarm is indicated in the control room if strainer $\Delta p > 3$ psid or if trouble has occurred to defeat the normal operation of the strainer motor.

During operation, pressure in the service water headers is monitored and an alarm is sounded in the control room if abnormally high or low. In addition, flow indicators and temperature detectors indicate the condition of the components served by the SWS.

B.5 TECHNICAL SPECIFICATIONS

The plant technical specifications require three service water pumps on the designated essential header and two pumps on the designated nonessential and their associated piping and valves be operable at all times. If, during power operation, these requirements cannot be met within twelve hours the operators shall proceed to bring the reactor to the cold shutdown condition utilizing normal operating procedures. In addition, the isolation between the headers shall be maintained at all times except for a period of 8 hours allowed to shift service water header services.

B.6 TESTING AND MAINTENANCE

B.6.1 TESTING AND SURVEILLANCE

Periodic testing of the service water pumps is required by ASME Section XI. The required frequency of testing is monthly during normal plant operation. Plant test procedure 3PT-M35 tests all service water pumps monthly. Successful completion of this test requires that the service water pump under test run successfully for 15 minutes.

Automatic starting of the service water pumps in response to a safety injection signal is performed every refueling cycle in conjunction with EDG tests. In addition to the above tests, plant operating procedures require shifting of running service water pumps weekly.

Monitoring of the SWS is performed routinely by the plant operators to determine system status.

B.6.2 MAINTENANCE

Periodic maintenance is performed as required on the service water pumps and associated equipment. Due to the plant technical specification limits on the number of operable service water pumps on the nuclear header, periodic maintenance is not performed on a service water pump that is lined up to this header. Instead, the header services are shifted and the pump is placed out of service for maintenance. The periodic maintenance consists of a range of actions from cleaning and servicing the self-cleaning strainers to pump disassembly and seal replacement.

Based upon our review of plant work permits, the probability of a service water pump being out of service for maintenance is:

Mean: 1.47×10^{-2}

Variance: 3.95×10^{-5}.

Upon the completion of pump train maintenance, testing is required to determine pump operability and to ensure correct system lineup. At the completion of this testing, the pump is returned to its normal lineup.

B.7 SUPPORT SYSTEMS

The system required for operation of the SWS is the electric power system. Table 3 identifies the service water pumps and the electrical power supplies for the pumps.

B.8 OPERATOR INTERACTION WITH THE SERVICE WATER SYSTEM

Operator action or inaction can affect the operation of the SWS. As this system is required to support normal plant operation, most operator errors that affect system operation will be annunciated or indicated in the control room within a short period of time after their occurrance. These actions include shifting pump control to Local (annunciated in the control room), inadvertently securing a running service water pump (alarmed in the control room), and mispositioning manual valves which control service water flow to individual components or groups of components. Because of the reasons stated above and because the SWS is required to be in operation to support plant operation, these types of human errors do not contribute to the failure of the SWS to start and continue running following an initiating event.

The operator may affect the automatic starting of the service water pumps selected to supply the nuclear services header by mispositioning the mode selector switch in the control room. This results in the wrong set of service water pumps starting automatically in the event of a safeguards actuation or blackout condition. If uncorrected, this condition results in failure of the EDGs due to overheating. This condition is indicated immediately after ESS actuation by low flow alarms on the containment building FCUs followed shortly by low flow alarms and high temperatures on the EDGs. This condition is rapidly corrected in the control room by starting the required service water pumps and securing the misselected service water pumps, and returning the mode selector switch to the correct position (this allows subsequent restart of the service water pumps selected to the conventional header during the shift to recirculation).

From NUREG/CR-1278*, the error of omission while using a procedure with check-off provisions is 0.001 (.0001 to .005) (Table 20-21). Using the guidance presented in the Human Error Rates section of this report, we take the upper bound as the 90th percentile value and the best estimate as the median value of a lognormal distribution. This leads to the following distribution for the error of omission when written procedures are used in nonpassive tasks:

Mean: 2.20×10^{-3}

Variance: 1.88×10^{-5}.

The probability of not discovering this error (switch position only) from Table 20-28 (Item 21) of NUREG/CR-1278 is 0.98 (.94 to .994). Again, using the guidance presented in the Human Error Rates section of this report, we take the upper bound (.994) as the 90th percentile value, and the best estimate (.98) as the median value of a lognormal distribution. This leads to the following distribution for the probability of not discovering the mispositioned switch:

Mean: 9.80×10^{-1}

Variance: 1.93×10^{-4}.

Combining the error of omission with the probability of not discovering the error, we obtain the frequency of occurrence for this mispositioned switch. The mean and variance for this event are:

Mean: 2.16×10^{-3}

Variance: 1.48×10^{-5}.

Swain, A.D. and H.E. Guttman, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications," *NUREG/CR-1278, Draft Report, April 1980.

On demand the operator will receive immediate indication that system operation is incorrect (low flow alarms, etc.); however, the operator is also receiving numerous indications and alarms. The operator will probably pass over the first low flow alarms and miss the status of the SWS until diesel generator temperature alarms occur. At this point, with a loss of offsite power, system failure due to loss of electric power is imminent and, for this analysis, system failure is assumed to occur.

B.9 COMMON CAUSE ANALYSIS

The normal service water pumps are located in a common well of the intake structure. The backup service water pumps are located at the discharge canal. The intake structure is designated as Seismic Class I, as is the SWS itself. The breakers for the service water pumps are located at the 480V essential switchgear at elevation 15' of the control building. The manual valves for aligning the service water supplies to the various components served are located in common locations throughout the plant (i.e., diesel generator valves are located together, containment building supply valves are located together).

Common generic components in the SWS are manufactured by the same manufacturer, are subject to common maintenance, test, and operation procedures, and have common susceptibilities to secondary causes of failure (grit, moisture, vibration). Table 4 presents a listing of the components included in the SWS analysis and the susceptibilities to the various categories of failure. Further discussion of the effect of common cause failures on system failure is presented in Section D.6 of this analysis.

C. SYSTEM MODELING

C.1 EVENT TREES

The top event for the SWS in the event trees for Indian Point 3 is "No or Insufficient Flow from the Service Water System." This is further defined as failure of the pumps selected to the nuclear header to start or run, or failure of the pumps selected to the conventional header to start or run. In the event trees, the SWS appears with the events concerning the containment fan coolers.

C.2 FAULT TREES

Figure 3 presents the system fault tree developed for the Indian Point 3 SWS. The top event, "No or Insufficient Flow (NOIF) from Service Water System" is defined as no or insufficient flow from service water header no. 1 (nuclear) or no flow from service water header no. 2 (conventional). For the purposes of this analysis, service water pump nos. 34, 35, and 36 are aligned to supply the nuclear header and pump nos. 31, 32, and 33 are aligned to supply the conventional header. The assumptions used in developing the fault tree are presented below.

- Four pumps were in operation prior to the initiating event - two on the nuclear services header, and two on the conventional services header.
- A safeguards actuation signal is present.
- The system is analyzed to the first valve which is capable of isolating a major component or group of components.
- System success requires that two pumps on the nuclear services header and one pump on the conventional services header operate for 24 hours.

C.3 BASIC EVENT CODING

Table 4 presents the basic event coding used in the SWS analysis and discusses the failure modes associated with these basic events. Also included is the failure data used in this analysis and the location and susceptibility coding for the basic events.

C.4 BLOCK DIAGRAM

Figure 1 presents the block diagram developed for the SWS. The components contained in each block of this diagram are presented below.

- Block A - Service Water Intake. The service water intake consists of the service water screens and the bypass gates. As failures in the screens and bypass gates cause failure of the nuclear and conventional service water headers, we treat the service water intake as a single failure point for the SWS.

- Block B - Service Water Pump Number 36 Train. Consists of the following components:

TPMP36-S	Pump 36 fails mechanically (start or run)
TMOP36-S	Pump 36 motor fails (start or run)
TCCP36-F	Pump 36 control circuit fails
JBS-36AD	No power from bus 6A
4BS-332D	No DC control power at bus 6A
TXVSW26C	Pump discharge valve transfers closed
TCVSW16C	Pump discharge check valve fails closed
TFLSW46G	Strainer SWN-4-6 plugs
TXJSW36L	Expansion joint SWN-3-6 ruptures.

- Block C - Service Water Pump Number 35 Train. Consists of the following components:

TPMP35-S	Pump 35 fails mechanically (start or run)
TMOP35-S	Pump 35 motor fails (start or run)
TCCP35-F	Pump 35 control circuit fails
JBS-334D	No power from bus 3A
4BS-333D	No DC control power at bus 3A
TXVSW25C	Pump discharge valve transfers closed
TCVSW15C	Pump discharge check valve fails closed
TFLSW45G	Strainer SWN-4-5 plugs
TXJSW35L	Expansion joint SWN-3-5 ruptures.

- Block D - Service Water Pump Number 34 Train. Consists of the following components:

TPMP34-S	Pump 34 fails mechanically (start or run)
TMOP34-S	Pump 34 motor fails (start or run)
TCCP34-F	Pump 34 control circuit fails
JBS-35AD	No power from bus 5A
4BS-331D	No DC control power at bus 5A
TXVSW24C	Pump discharge valve transfers closed
TCVSW14C	Pump discharge check valve fails closed
TFLSW44G	Strainer SWN-4-4 plugs
TXJSW34L	Expansion joint SWN-3-4 ruptures.

- Block E - Service Water Pump Number 33 Train. Consists of the following components:

TPMP33-S	Pump 33 fails mechanically (start or run)
TMOP33-S	Pump 33 motor fails (start or run)
TCCP33-F	Pump 33 control circuit fails
JBS-36AD	No power from bus 6A
4BS-332D	No DC control power at bus 6A
TXVSW23C	Pump discharge valve transfers closed
TCVSW13Q	Pump discharge check valve fails closed
TFLSW43G	Strainer SWN-4-3 plugs
TXJSW33L	Expansion joint SWN-3-3 ruptures.

- Block F - Service Water Pump Number 32 Train. Consists of the following components:

TPMP32-S	Pump 32 fails mechanically (start or run)
TMOP32-S	Pump 32 motor fails (start or run)
TCCP32-F	Pump 32 control circuit fails
JBS-32AD	No power from bus 2A
4BS-333D	No DC control power at bus 2A
TXUSW22C	Pump discharge valve transfers closed
TCVSW12Q	Pump discharge check valve fails closed
TFLSW42G	Strainer SWN-4-2 plugs
TXJSW32L	Expansion joint SWN-3-2 ruptures.

- Block G - Service Water Pump Number 31 Train. Consists of the following components:

TPMP31-S	Pump 31 fails mechanically (start or run)
TMOP31-S	Pump motor fails (start or run)
TCCP32-F	Pump 31 control circuit fails
JBS-35AD	No power from bus 5A
4BS-331D	No DC control power at bus 5A
TXVSW21C	Pump discharge valve transfers closed
TCVSW11Q	Pump discharge check valve fails closed
TFLSW41G	Strainer SWN-4-1 plugs
TXJSW31L	Expansion joint SWN-3-1 ruptures.

- Block H - Diesel Generator Outlet. Consists of the following component:

TFVS76-Q	FCV-1176 does not open.

- Block I - Diesel Generator Outlet. Consists of the following component:

TFVS76AQ	FCV-1176A does not open.

- Block J - Nuclear Header Piping and valves. Consists of the following components:

TXVSW99C	Header discharge valve transfers closed
TCV100AQ	Header discharge check valve fails closed
TPP1FAIL	Nuclear header piping fails (identified in Table 6).

- Block K - Conventional Header Piping and Valves. Consists of the following components:

TXVSW98C	Header discharge valve transfers closed
TCV100BQ	Header discharge check valve fails closed
TPP2FAIL	Conventional header piping fails (identified in Table 6).

C.5 CUTSETS

Table 5 presents the [illegible] minimal cutsets which lead directly to the top event of the fault tree.

D. QUANTIFICATION

Quantification of the SWS is based upon the reliability block diagram presented as Figure 1. The components on these blocks are described in Section C of this analysis and defined as a train for the purposes of this analysis.

In the following sections, quantification of the nuclear header and the conventional header contributions to system failure are presented separately. The results of the header analysis are combined to present the probability of system failure.

D.1 SINGLE FAILURES

Observation of Figure 1 reveals the service water intake (Block A) as a single contributor to SWS failure. As this train can fail the nuclear and the conventional service water headers, this failure is treated as a single failure.

This failure consists of failures of the service water intake screen and the two screen bypass gates. The bypass gates are normally open.

Because the bypass gates are normally open, and must be manually inserted to block flow, no credible failure mechanism was found which could result in these gates transferring closed. The probability of occurrence of water supply failure is assigned a value of zero.

Also included as single failures for the individual headers are Blocks J and K, which consist of: header piping failures; the header discharge isolation valve; and the header discharge check valve. These events are discussed below.

1. Pipe Failures. Table 6 identifies the system effects of pipe failure for various sections of pipe in the SWS. Failures in piping which is less than 10 inches in diameter are not presented. The table is presented in two sections; the nuclear header which is defined as the header supplied by pumps 34, 35, and 36; and the conventional header which is supplied by pumps 31, 32, and 33.

   Our mean and variance for the probability of failure of a single pipe section are:

   Mean: 8.60×10^{-10}

   Variance: 6.00×10^{-17}.

   For the nuclear header, Table 6 identifies ten sections of pipe where rupture will cause immediate failure of the SWS. For the conventional header, Table 6 identifies eight sections of pipe where rupture will cause immediate failure of the SWS. This results in the following distribution for the probability of piping failure per hour for the nuclear and conventional service water headers:

Mean (nuclear):	6.60×10^{-9}
Variance:	4.29×10^{-15}
Mean (conventional):	6.88×10^{-9}
Variance:	2.75×10^{-15}.

Piping failures during plant operation are immediately detectable and result in either plant shutdown or header realignment for repair. We are interested in those piping failures which occur after the start of an initiating event. The time period of interest is the first 24 hours after the initiating event. This leads to the following distributions for failure of the nuclear or conventional service water headers due to piping failures:

Mean (nuclear):	2.06×10^{-7}
Variance:	2.47×10^{-12}
Mean (conventional):	1.65×10^{-7}
Variance:	1.58×10^{-12}.

2. Isolation Valve. Each service water header contains a manual header isolation valve and a header check valve. A failure in either of these valves during plant operation is immediately detectable and would require plant shutdown for repair. We are interested in those failures which occur after initiation of the system. The mean and variance for these events are:

Manual Valve Transfers Closed (per hour)	Mean:	9.15×10^{-8}
	Variance:	1.01×10^{-14}
Check Valve Fails to Open (on demand)	Mean:	6.91×10^{-5}
	Variance:	1.03×10^{-8}.

With no loss of offsite power, the pumps selected to supply the nuclear header will continue to run and the pumps selected to supply the conventional pumps will trip. The conventional header pumps are later started by operator action. With a loss of offsite power, all pumps are initially tripped and subsequently restarted (either automatically or by operator action).

For the case of no loss of offsite power, we have the following distribution for failure of a header isolation or check valve to time, $t = 24$ hours:

Mean:	2.20×10^{-6}
Variance:	5.51×10^{-12}.

with a loss of offsite power, or when the pumps are tripped by plant action, we have the following distribution for failure of a header isolation or check valve to time, t = 24 hours:

Mean: 7.13×10^{-5}

Variance: 8.93×10^{-9}.

D.2 DOUBLE FAILURES

D.2.1 NUCLEAR HEADER

Nuclear header double contributions to system failure consist of failure of two of the three pump trains and failure of the two diesel generator outlet flow control valves.

1. Service water pump train, Block B. Section C of this analysis presents the components which are included in a single pump train. Table 4 identifies the failure rates associated with these components. Presented below is the component failure data for a single pump train.

	Mean	Variance
Pump fails (on demand)	1.36×10^{-3}	1.22×10^{-6}
(per hour)	4.68×10^{-5}	1.07×10^{-9}
Motor fails (with pump failure)	-	-
Control circuit fails (with pump failure)	-	-
Switchgear bus fails	*	-
Control power to switchgear bus fails	*	-
Expansion joint ruptures, per hour	8.60×10^{-9}	6.00×10^{-15}
Discharge strainer plugs	**	-
Discharge check valve fails, to open, demand	6.91×10^{-5}	1.03×10^{-8}
Discharge valve transfers closed, per hour	9.15×10^{-8}	1.01×10^{-14}

Blocks C, D, E, F, and G consist of similar components.

For an operating pump train, the probability of failure per hour is described by the following probability distribution (made up of pump failure to continue running, expansion joint rupture, and discharge valve transferring closed):

Mean: 4.69×10^{-5}

Variance: 9.54×10^{-10}.

*Shown for completeness only, quantified in the electric power analysis.
**Negligibly small probability of failure.

For a time $t = 24$ hours, we have the following distribution for failure of an operating pump train:

Mean: 1.13×10^{-3}

Variance: 5.51×10^{-7}.

At Indian Point 3, with no loss of offsite power, and a safeguards actuation signal, the nonvital electric loads are stripped from the 480V switchgear buses. The pumps selected by the mode selector switch to supply the nuclear header will remain operating while the pumps not selected (the conventional header pumps) will be stripped. The standby nuclear header pump will be sent a starting signal by the safeguards sequence system. With a loss of offsite power all service water pumps will be stripped from the 480V switchgear buses. When power is available, the pumps selected to supply the nuclear header will be sent starting signals by the safeguards sequencing system.

The probability of failure to start of a previously running service water pump is made up of: pump failure to start on demand; expansion joint rupture; check valve failure to open on demand; and discharge valve transferring closed. The expansion joint rupture and the discharge valve closure must have occurred while the pump was idle ($t < 1$ hour). The probability of failure on demand for the expansion joint and discharge valve with $t < 1$ hour are:

Mean (expansion joint): 8.60×10^{-9}

Variance: 6.00×10^{-15}

Mean (discharge valve): 9.15×10^{-8}

Variance: 1.01×10^{-14}.

For a single previously operating pump train, the probability of failure on demand is described by the following distribution:

Mean: 1.43×10^{-3}

Variance: 1.12×10^{-6}.

Given a successful start, the service water pump must operate for 24 hours. The total probability of failure (start and operate for 24 hours) for a single previously operating service water pump train is now:

Mean: 2.55×10^{-3}

Variance: 1.36×10^{-6}.

During plant operation, one service water pump selected to supply the nuclear header will be in standby. Pump failure to start on demand and check valve failure to open on demand remain as previously defined; however, the discharge valve and the expansion joint contributions to pump train failure on demand must be developed.

Plant procedures require shifting of the operating service water pumps weekly. Failure in either component could have occurred at any time during this period without being detected. The fault detection time for the failures is taken as one half of the test interval (84 hours). This results in the following distributions for the probability of failure on demand of an expansion joint and the discharge valve:

Mean (expansion joint): 7.22×10^{-7}

Variance: 3.03×10^{-11}

Mean (discharge valve): 7.69×10^{-6}

Variance: 8.03×10^{-11}.

This results in the following probability of failure on demand for a single standby service water pump train:

Mean: 1.44×10^{-3}

Variance: 1.11×10^{-6}.

Given a successful start, the pump must continue to operate for 24 hours, which results in the following probability distribution for failure of a standby service water pump train:

Mean: 2.56×10^{-3}

Variance: 1.36×10^{-6}.

The following expression defines the probability of failure of the nuclear service water header due to pump train failures:

$$Q_{pumps} = 2[P(OP) \times P(STBY)] + [P(OP)]^2 + [P(OP)]^2 \times P(STBY)$$

where

P(OP) = Probability of failure of a running (or previously running) pump to t = 24 hours.

P(STBY) = Probability of failure of a standby pump to t = 24 hours.

With offsite power available, and all 480V switchgear buses energized, the pump train's contribution to header failure for the pumps selected to supply the nuclear header is described by the following distribution:

Mean: 7.59×10^{-6}

Variance: 5.50×10^{-11}.

With a loss of offsite power, and all 480V switchgear buses energized, the pump train's contribution to header failure is described by the following distribution:

Mean: 2.10×10^{-5}

Variance: 2.48×10^{-10}.

2. Diesel generator outlet flow control valves, Blocks H and J. Failure of valves FCV-1176 and FCV-1176A to open on demand or to remain open for 24 hours results in failure of all three EDGs. The probability of a single valve not opening on demand is represented by the following distribution:

   Mean: 4.99×10^{-4}

   Variance: 4.03×10^{-7}.

   For two valves in parallel we obtain the following distribution for the probability of system failure:

   Mean: 6.27×10^{-7}

   Variance: 1.54×10^{-11}.

D.2.2 CONVENTIONAL HEADER

There is no double failure contribution to conventional header failure as only one of three pump trains is required for system success.

D.3 TRIPLE FAILURES

D.3.1 NUCLEAR HEADER

There is no triple failure contribution to nuclear header failure.

D.3.2 CONVENTIONAL HEADER

The contribution of triple failures to failure of the conventional header consists of failure of all three pump trains.

Upon receipt of a safety injection signal, the pumps selected to supply conventional plant services are stripped from their respective 480V switchgear buses. These pumps are not restarted until the recirculation

phase of LOCA recovery. System success requires that a single pump selected to supply the conventional header start and operate for 24 hours.

The following expression defines the probability of failure for the service water pump trains selected to supply the conventional service water header.

$$Q_{pumps} = P(1S)\ [P(OP)^2 \times P(STBY)] + 3 \times P(OS)\ [P(OP)]^2$$

where

- P(OP) = Probability of failure of a previously running pump to t = 24 hours (from Section D.2.1)
- P(STBY) = Probability of failure of a standby pump to t = 24 hours (from Section D.2.1)
- P(1S) = Probability of having a standby pump [1 - P(OS)]
- P(OS) = Probability of maintenance of a service water pump (from Section B.6.2)

With power available at all 480V switchgear buses (with or without offsite power), the probability of conventional header failure due to pump train failure is described by the following distribution:

Mean: 3.61×10^{-7}

Variance: 1.49×10^{-13}.

D.4 TEST AND MAINTENANCE FAILURES

D.4.1 NUCLEAR HEADER

Due to the plant technical specifications and the discussion presented in Section B.6 of this report, no test or maintenance failure contribution to system failure is assigned for the nuclear header.

D.4.2 CONVENTIONAL HEADER

There is no contribution to system failure due to the testing performed upon the service water pumps selected to supply the conventional header.

The maintenance contribution to system failure is included with the quantification of the conventional pump train's effect on system failure.

D.5 HUMAN INTERACTION FAILURES

D.5.1 NUCLEAR HEADER

From Section B.8, the operator error of omission and nondiscovery of the error resulted in the following distribution for the frequency of occurrence of a mispositioned mode selector switch:

Mean: 2.16×10^{-3}

Variance: 1.46×10^{-5}.

This failure results in failure of the SWS.

D.5.2 CONVENTIONAL HEADER

As two service water pumps aligned to the conventional header are always running to support plant operations, no human error contribution is assigned for the conventional header. The human error of failing to shift to recirculation from injection is analyzed with the recirculation system description.

D.6 COMMON CAUSE FAILURES

Although there are many similar components sharing common locations in the SWS, a large portion of the components are not susceptible to most common cause failure mechanisms because they perform a passive function (items such as manual valves, check valves, piping, etc.). Active components of the system, the service water pumps, are more likely candidates for common cause failure and are discussed below. External events such as earthquakes and flooding are discussed elsewhere in this report.

1. Fire. The normal service water pumps are located at the screen well structure. The pumps are not enclosed and the fire loading in the area is low (as defined in the "Review of the Indian Point Station Fire Protection Program"). No fires are postulated in this area that could disable all service water pumps.

2. Moisture. The service water pump motors are designed for outdoor service and are protected by design from the effects of moisture.

3. Grit. Due to the design of the service water pump motors and the location of the service water pumps, airborne grit is not a common cause candidate.

4. Other Causes. Other common cause susceptibilities, such as manufacturer, test and maintenance procedures, etc., are possible contributors to common cause failure of the service water pumps. However, the plant test program, maintenance program, and technical specifications combine to 1) aid in discovery of pump problems and, 2) limit the effects of common cause failures. No quantification is performed for these causes of failure.

   NOTE: The service water pump breakers are susceptible to the common cause failure mechanisms of fire, moisture, and grit due to their common location in the switchgear room. Quantification and discussion of these effects is presented in the event tree analysis as these effects would be felt throughout the plant.

D.7 SYSTEM FAILURE

Failure of the service water system is defined as failure of the nuclear header or conventional header to supply sufficient water to time t = 24 hours. The frequency of failure for each header is presented separately below. The failure frequency for each header is made up of the following contributors: single event, double event, and triple event random hardware failures; test and maintenance failures (which are included with the triple event failures); human errors which result in system failure; and the common cause contribution to system failure.

1. Nuclear Header Failure. The probability of failure of the nuclear header with offsite power available is characterized by the following mean and variance:

   Mean: αsingles + αdoubles + αtriples + αtest and maintenance

   + αoperator error + αcommon cause

   $= 2.17 \times 10^{-3}$

   Variance: 1.41×10^{-5}.

   The probability of failure of the nuclear header with a loss of offsite power is characterized by the following mean and variance:

   Mean: 2.25×10^{-3}

   Variance: 1.41×10^{-5}.

2. Conventional Header Failure. The probability of failure of the conventional header with or without offsite power is characterized by the following mean and variance:

   Mean: αsingles + αdoubles + αtriples + αtest and maintenance

   + αoperator error + αcommon cause + αother

   $= 7.18 \times 10^{-5}$

   Variance: 8.84×10^{-9}.

3. System Failure. The frequency of failure of the service water system is made up of those failures in the two headers which result in header failure. For the case "Offsite Power Available" and under the condition "Power Available at All 480V Switchgear Buses," we have the following distribution for the following distribution for the frequency of failure of the service water system to time, t = 24 hours:

   Mean: 2.24×10^{-3}

   Variance: 1.41×10^{-5}.

For the case "Loss of Offsite Power" and under the condition "Power Available at All 480V Switchgear Buses," we have the following distribution for the frequency of failure of the service water system to time, t = 24 hours:

Mean: 2.33×10^{-3}

Variance: 1.41×10^{-5}.

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E. SYSTEM QUANTIFICATION WITH DIFFERING BOUNDARY CONDITIONS FOR ELECTRIC POWER

E.1 LOSS OF POWER AT A SINGLE BUS

This condition is defined as loss of power to switchgear buses 5A, 6A, or 2A and 3A. Switchgear buses 2A and 3A are defined as a single bus for the following reason: a single EDG supplies both buses upon a loss of offsite power.

The loss of power at the various switchgear buses only affects the number of service water pump trains available; all other contributions to system failure remain as stated in Section D of this analysis.

For the purposes of this analysis, an operating (or previously operating) service water pump is assumed to have been powered from the switchgear bus that is now unavailable. This is a conservative assumption in that it results in a higher probability of failure for the pump trains. This assumption is used for all loss of power calculations which follow.

1. Effect on the nuclear header. The following expression defines the probability of system failure due to pump train failures for the pumps selected to supply the nuclear header:

   $Q_{pumps} = P(OP) + P(STBY)$

   where P(OP) and P(STBY) remain as defined in Section D.

   For the condition "Offsite Power Available," this results in the following distribution for the probability of header failure due to pump train failure:

   Mean: 3.69×10^{-3}

   Variance: 1.88×10^{-6}.

   The probability of failure of the nuclear header, with offsite power available and a loss of power at a single 480V switchgear bus is:

   Mean: 5.85×10^{-3}

   Variance: 1.58×10^{-5}.

   With a loss of offsite power, the probability of header failure due to pump train failures with a loss of power at a single 480V switchgear bus is:

   Mean: 5.11×10^{-3}

   Variance: 2.68×10^{-6}

which results in the following distribution for the probability of failure of the nuclear header with a loss of offsite power and loss of power at a single 480V switchgear bus:

Mean: 7.35×10^{-3}

Variance: 1.66×10^{-5}.

2. Effect on the conventional header. The following expression defines the probability of header failure due to pump train failures for the pumps selected to supply the conventional header:

$$C_{pumps} = P(1S)\,[P(OP) \times P(STBY)] + P(OS)\,[P(OP)]$$

where the terms of the expression remain as defined in Section D. This results in the following distribution for the probability of header failure due to pump train failures:

Mean: 4.40×10^{-5}

Variance: 5.94×10^{-10}.

The probability of conventional header failure with a loss of power at a single 480V switchgear bus (with or without offsite power) is:

Mean: 1.15×10^{-4}

Variance: 9.34×10^{-9}.

3. Effect on the system. The probability of system failure, given a loss of a single 480V switchgear bus and offsite power available is now:

Mean: 5.97×10^{-3}

Variance: 1.58×10^{-5}.

For the "Loss of Offsite Power" case, we have the following distribution for the probability of system failure with loss of a single 480V switchgear bus:

Mean: 7.46×10^{-3}

Variance: 1.66×10^{-5}.

E.2 LOSS OF POWER AT TWO BUSES

This condition is defined as loss of power to switchgear buses 5A and 6A, 5A and 2A and 3A, or 6A and 2A and 3A. The discussion for buses 2A and 3A remains as presented in Section E.1. The assumption concerning which buses are lost is modified as follows: the previously operating service water pumps are assumed to have been powered by the switchgear buses that are now unavailable.

1. Effect on the nuclear header. Loss of power to the combinations of switchgear buses identified above results in failure of the nuclear header due to insufficient flow.

2. Effect on the conventional header. Loss of power to the combinations of switchgear buses defined above leads to the following expression for the probability of pump train failures which result in header failure.

   $$Q_{pumps} = P(1S) \times P(STBY) + P(0S).$$

   This results in the following distribution for the probability of header failure due to pump train failures:

   Mean: 1.72×10^{-2}

   Variance: 3.87×10^{-5}.

   The probability of failure of the conventional header with a loss of power at two 480V switchgear buses is:

   Mean: 1.73×10^{-2}

   Variance: 3.85×10^{-5}.

3. Effect on the system. The probability of system failure given loss of two 480V switchgear buses is 1.0 due to the effect of this condition upon the nuclear header pumps.

TABLE 1

SUMMARY OF RESULTS - SERVICE WATER SYSTEM ANALYSIS

Case 1 - Offsite Power Available
Boundary Condition: Power at All 480V Switchgear Buses

	Mean	Variance	5th Percentile	95th Percentile	Median	WASH-1400
A. Nuclear Header						
1. Single events						
a. Piping	2.1×10^{-7}	2.5×10^{-12}	4.0×10^{-10}	6.0×10^{-7}	5.3×10^{-8}	No Comparable Analysis
b. Header valves	2.2×10^{-6}	5.5×10^{-12}	2.8×10^{-7}	5.5×10^{-6}	1.0×10^{-6}	
2. Double events						
a. Pump Trains	7.6×10^{-6}	5.5×10^{-11}	1.4×10^{-6}	1.8×10^{-5}	5.3×10^{-6}	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Human Error	2.7×10^{-3}	1.5×10^{-5}	9.7 x 10[illegible]	6.5×10^{-3}	1.0×10^{-3}	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	2.2×10^{-3}	1.4×10^{-5}	1.1×10^{-4}	6.2×10^{-3}	1.0×10^{-3}	
B. Conventional Header						
1. Single events						
a. Piping	1.7×10^{-7}	1.6×10^{-12}	3.0×10^{-10}	4.3×10^{-7}	4.3×10^{-8}	
b. Header valves	7.1×10^{-5}	8.9×10^{-9}	9.0×10^{-6}	2.3×10^{-4}	4.0×10^{-5}	
2. Triple events						
a. Pump Trains	3.6×10^{-7}	1.5×10^{-13}	5.1×10^{-8}	9.0×10^{-7}	2.3×10^{-7}	
3. Test and maintenance (with conventional pumps)	-	-	-	-	-	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	7.2×10^{-5}	8.8×10^{-9}	1.0×10^{-6}	2.0×10^{-4}	4.1×10^{-5}	
C. System						
1. Single events						
a. Piping	3.7×10^{-7}	8.0×10^{-12}	8.0×10^{-10}	1.0×10^{-6}	9.8×10^{-8}	
b. Header valves	7.3×10^{-5}	9.0×10^{-9}	1.0×10^{-5}	2.[illegible] $\times 10^{-4}$	4.2×10^{-5}	
2. Double events						
a. "Nuclear" Pumps	7.6×10^{-6}	5.5×10^{-11}	1.4×10^{-6}	1.8×10^{-5}	5.3×10^{-6}	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Triple events						
a. "Conventional" Pumps	3.6×10^{-7}	1.5×10^{-13}	5.1×10^{-8}	9.0×10^{-7}	2.3×10^{-7}	
4. Test and maintenance (with conventional pumps)	-	-	-	-	-	
5. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
6. Common Cause	*	-	-	-	-	
7. Other	*	-	-	-	-	
SYSTEM TOTAL	2.2×10^{-3}	1.4×10^{-5}	1.9×10^{-4}	6.2×10^{-3}	1.2×10^{-3}	

*Negligibly small failure probability.

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TABLE 1 (continued)

SUMMARY OF RESULTS - SERVICE WATER SYSTEM ANALYSIS

Case 2 - Loss of Offsite Power
Boundary Condition: Power at All 480V Switchgear Buses

	Mean	Variance	5th Percentile	95th Percentile	Median	WASH-1400
A. Nuclear Header						
1. Single events						
a. Piping	2.1×10^{-7}	2.5×10^{-12}	4.0×10^{-10}	6.0×10^{-7}	5.3×10^{-8}	No Comparable Analysis
b. Header valves	7.1×10^{-5}	8.9×10^{-9}	9.0×10^{-6}	2.1×10^{-4}	4.0×10^{-5}	
2. Double events						
a. Pump Trains	2.1×10^{-5}	2.5×10^{-10}	6.3×10^{-6}	4.1×10^{-5}	1.6×10^{-5}	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	2.3×10^{-3}	1.4×10^{-5}	2.1×10^{-4}	6.1×10^{-3}	1.2×10^{-3}	
B. Conventional Header						
1. Single events						
a. Piping	1.7×10^{-7}	1.6×10^{-12}	3.0×10^{-10}	4.3×10^{-7}	4.3×10^{-8}	
b. Header valves	7.1×10^{-5}	8.9×10^{-9}	9.0×10^{-6}	2.1×10^{-4}	4.0×10^{-5}	
2. Triple events						
a. Pump Trains	3.6×10^{-7}	1.5×10^{-13}	5.1×10^{-8}	9.0×10^{-7}	2.3×10^{-7}	
3. Test and maintenance (with conventional pumps)	-	-	-	-	-	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
- TOTAL	7.2×10^{-5}	8.8×10^{-9}	1.0×10^{-6}	2.0×10^{-4}	4.1×10^{-5}	
C. System						
1. Single events						
a. Piping	3.7×10^{-7}	8.0×10^{-12}	8.0×10^{-10}	1.0×10^{-6}	9.8×10^{-8}	
b. Header valves	1.4×10^{-4}	3.6×10^{-8}	1.8×10^{-5}	4.4×10^{-4}	7.9×10^{-5}	
2. Double events						
a. "Nuclear" Pumps	2.1×10^{-5}	2.5×10^{-10}	6.3×10^{-6}	4.3×10^{-5}	1.6×10^{-5}	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Triple events						
a. "Conventional" Pumps	3.6×10^{-7}	1.5×10^{-14}	5.1×10^{-8}	9.0×10^{-7}	2.3×10^{-7}	
4. Test and maintenance (with conventional pumps)	-	-	-	-	-	
5. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
6. Common Cause	*	-	-	-	-	
7. Other	*	-	-	-	-	
SYSTEM TOTAL	2.3×10^{-3}	1.4×10^{-5}	2.9×10^{-4}	6.1×10^{-3}	1.3×10^{-3}	

*Negligibly small failure probability.
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TABLE I (continued)

SUMMARY OF RESULTS - SERVICE WATER SYSTEM ANALYSIS

Case I - Offsite Power Available
Boundary Condition: Power Lost at One 480V Switchgear Bus

	Mean	Variance	5th Percentile	95th Percentile	Median	WASH-1400
A. Nuclear Header						
1. Single events						
a. Piping	2.1×10^{-7}	2.5×10^{-12}	4.0×10^{-10}	6.0×10^{-7}	5.1×10^{-8}	No Comparable Analysis
b. Header valves	2.2×10^{-6}	5.5×10^{-12}	$2{:}8 \times 10^{-7}$	5.5×10^{-6}	1.0×10^{-6}	
2. Double events						
a. Pump Trains	3.7×10^{-3}	1.9×10^{-6}	1.9×10^{-3}	5.6×10^{-3}	3.4×10^{-3}	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	5.9×10^{-3}	1.6×10^{-5}	2.6×10^{-3}	1.0×10^{-2}	5.0×10^{-3}	
B. Conventional Header						
1. Single events						
a. Piping	1.7×10^{-7}	1.6×10^{-12}	3.0×10^{-10}	4.3×10^{-7}	4.3×10^{-8}	
b. Header valves	7.1×10^{-5}	8.9×10^{-9}	9.0×10^{-6}	2.3×10^{-4}	4.0×10^{-5}	
2. Triple events						
a. Pump Trains	4.4×10^{-5}	5.9×10^{-10}	1.7×10^{-5}	8.2×10^{-5}	3.8×10^{-5}	
3. Test and maintenance (with conventional pumps)	-	-	-	-	-	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	1.2×10^{-4}	9.3×10^{-9}	3.7×10^{-5}	2.4×10^{-4}	8.8×10^{-5}	
C. System						
1. Single events						
a. Piping	3.7×10^{-7}	8.0×10^{-12}	8.0×10^{-10}	1.0×10^{-6}	9.8×10^{-8}	
b. Header valves	7.3×10^{-5}	9.0×10^{-9}	1.0×10^{-5}	2.2×10^{-4}	4.2×10^{-5}	
2. Double events						
a. "Nuclear" Pumps	3.7×10^{-3}	1.9×10^{-6}	1.9×10^{-3}	5.6×10^{-3}	3.4×10^{-3}	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Triple events						
a. "Conventional" Pumps	4.4×10^{-5}	5.9×10^{-10}	1.7×10^{-5}	8.2×10^{-5}	3.8×10^{-5}	
4. Test and maintenance (with conventional pumps)	-	-	-	-	-	
5. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
6. Common Cause	*	-	-	-	-	
7. Other	*	-	-	-	-	
SYSTEM TOTAL	6.0×10^{-3}	1.6×10^{-5}	2.7×10^{-3}	1.0×10^{-2}	5.1×10^{-3}	

*Negligibly small failure probability.

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TABLE 1 (continued)

SUMMARY OF RESULTS - SERVICE WATER SYSTEM ANALYSIS

Case 2 - Loss of Offsite Power
Boundary Condition: Power Lost at One 480V Switchgear Bus

	Mean	Variance	5th Percentile	95th Percentile	Median	WASH-1400
A. Nuclear Header						
1. Single events						
a. Piping	2.1×10^{-7}	2.5×10^{-12}	4.0×10^{-10}	6.0×10^{-7}	5.3×10^{-8}	No Comparable Analysis
b. Header valves	7.1×10^{-5}	8.9×10^{-9}	9.0×10^{-6}	2.3×10^{-4}	4.0×10^{-5}	
2. Double events						
a. Pump Trains	5.1×10^{-3}	2.7×10^{-6}	3.0×10^{-3}	7.6×10^{-3}	5.1×10^{-3}	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	7.3×10^{-3}	1.7×10^{-5}	3.8×10^{-3}	1.3×10^{-2}	6.5×10^{-3}	
B. Conventional Header						
1. Single events						
a. Piping	1.7×10^{-7}	1.6×10^{-12}	3.0×10^{-10}	4.3×10^{-7}	4.3×10^{-8}	
b. Header valves	7.1×10^{-5}	8.9×10^{-9}	9.0×10^{-6}	2.3×10^{-4}	4.0×10^{-5}	
2. Triple events						
a. Pump Trains	4.4×10^{-5}	5.9×10^{-10}	1.7×10^{-5}	8.2×10^{-5}	3.8×10^{-5}	
3. Test and maintenance (with conventional pumps)	-	-	-	-	-	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	1.2×10^{-4}	9.3×10^{-9}	3.7×10^{-5}	2.4×10^{-4}	8.8×10^{-5}	
C. System						
1. Single events						
a. Piping	3.7×10^{-7}	8.0×10^{-12}	8.0×10^{-10}	1.0×10^{-6}	9.8×10^{-8}	
b. Header valves	1.4×10^{-4}	3.0×10^{-8}	1.8×10^{-5}	4.4×10^{-4}	7.9×10^{-5}	
2. Double events						
a. "Nuclear" Pumps	5.1×10^{-3}	2.7×10^{-6}	3.0×10^{-3}	7.6×10^{-3}	5.1×10^{-3}	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Triple events						
a. "Conventional" Pumps	4.4×10^{-5}	5.9×10^{-10}	1.7×10^{-5}	8.2×10^{-5}	3.8×10^{-5}	
4. Test and maintenance (with conventional pumps)	-	-	-	-	-	
5. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
6. Common Cause	*	-	-	-	-	
7. Other	*	-	-	-	-	
SYSTEM TOTAL	7.5×10^{-3}	1.7×10^{-5}	4.0×10^{-3}	1.7×10^{-2}	6.6×10^{-3}	

*Negligibly small failure probability.

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TABLE 1 (continued)

SUMMARY OF RESULTS - SERVICE WATER SYSTEM ANALYSIS

Case 1 - Offsite Power Available
Boundary Condition: Power Lost at Two 480V Switchgear Buses

	Mean	Variance	5th Percentile	95th Percentile	Median	WASH-1400
A. Nuclear Header						
1. Single events						
a. Piping	2.1×10^{-7}	2.5×10^{-12}	4.0×10^{-10}	6.0×10^{-7}	5.3×10^{-8}	No Comparable Analysis
b. Header valves	2.2×10^{-6}	5.5×10^{-12}	2.0×10^{-7}	5.5×10^{-6}	1.0×10^{-6}	
2. Double events						
a. Pump Trains	1.0	0.0	-	-	-	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	1.0	0.0	-	-	1.0	
B. Conventional Header						
1. Single events						
a. Piping	1.7×10^{-7}	1.6×10^{-12}	3.0×10^{-10}	4.3×10^{-7}	4.3×10^{-8}	
b. Header valves	7.1×10^{-5}	8.9×10^{-9}	9.0×10^{-6}	2.1×10^{-4}	4.0×10^{-5}	
2. Triple events						
a. Pump Trains	1.7×10^{-2}	3.9×10^{-5}	9.0×10^{-3}	2.7×10^{-2}	1.6×10^{-2}	
3. Test and maintenance (with conventional pumps)	-	-	-	-	-	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	1.7×10^{-2}	3.9×10^{-5}	9.1×10^{-3}	2.7×10^{-2}	1.6×10^{-2}	
C. System						
1. Single events						
a. Piping	3.7×10^{-7}	8.0×10^{-12}	8.0×10^{-10}	1.0×10^{-6}	9.8×10^{-8}	
b. Header valves	7.3×10^{-5}	9.0×10^{-9}	1.0×10^{-5}	2.2×10^{-4}	4.2×10^{-5}	
2. Double events						
a. "Nuclear" Pumps	1.0	0.0	-	-	-	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Triple events						
a. "Conventional" Pumps	1.7×10^{-2}	3.9×10^{-5}	9.0×10^{-3}	2.7×10^{-2}	1.6×10^{-2}	
4. Test and maintenance (with conventional pumps)	-	-	-	-	-	
5. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
6. Common Cause	*	-	-	-	-	
7. Other	*	-	-	-	-	
SYSTEM TOTAL	1.0	0.0	-	-	1.0	

*Negligibly small failure probability.

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TABLE 1 (continued)

SUMMARY OF RESULTS - SERVICE WATER SYSTEM ANALYSIS

Case 2 - Loss of Offsite Power
Boundary Condition: Power Lost at Two 480V Switchgear Buses

	Mean	Variance	5th Percentile	95th Percentile	Median	WASH-1400
A. Nuclear Header						
1. Single events						
a. Piping	2.1×10^{-7}	2.5×10^{-12}	4.0×10^{-10}	6.0×10^{-7}	5.3×10^{-8}	No Comparable Analysis
b. Header valves	7.1×10^{-5}	8.9×10^{-9}	9.0×10^{-6}	2.1×10^{-4}	4.0×10^{-5}	
2. Double events						
a. Pump Trains	1.0	0.0	-	-	-	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	1.0	0.0	-	-	1.0	
B. Conventional Header						
1. Single events						
a. Piping	1.7×10^{-7}	1.6×10^{-12}	3.0×10^{-10}	4.3×10^{-7}	4.3×10^{-8}	
b. Header valves	7.1×10^{-5}	8.9×10^{-9}	9.0×10^{-6}	2.3×10^{-4}	4.0×10^{-5}	
2. Triple events						
a. Pump Trains	1.7×10^{-2}	3.9×10^{-5}	9.0×10^{-3}	2.7×10^{-2}	1.6×10^{-2}	
3. Test and maintenance (with conventional pumps)	-	-	-	-	-	
4. Common Cause	*	-	-	-	-	
5. Other	*	-	-	-	-	
TOTAL	1.7×10^{-2}	3.9×10^{-5}	9.1×10^{-3}	2.7×10^{-2}	1.6×10^{-2}	
C. System						
1. Single events						
a. Piping	3.7×10^{-7}	8.0×10^{-12}	8.0×10^{-10}	1.0×10^{-6}	9.8×10^{-8}	
b. Header valves	1.4×10^{-4}	3.6×10^{-8}	1.8×10^{-5}	4.4×10^{-4}	7.9×10^{-5}	
2. Double events						
a. "Nuclear" Pumps	1.0	0.0	-	-	-	
b. EDG flow control valves	6.3×10^{-7}	1.5×10^{-11}	2.4×10^{-9}	2.0×10^{-6}	7.5×10^{-8}	
3. Triple events						
a. "Conventional" Pumps	1.7×10^{-2}	3.9×10^{-5}	9.0×10^{-3}	2.7×10^{-2}	1.6×10^{-2}	
4. Test and maintenance (with conventional pumps)	-	-	-	-	-	
5. Human Error	2.2×10^{-3}	1.5×10^{-5}	9.7×10^{-5}	6.5×10^{-3}	1.0×10^{-3}	
6. Common Cause	*	-	-	-	-	
7. Other	*	-	-	-	-	
SYSTEM TOTAL	1.0	0.0	-	-	1.0	

*Negligibly small failure probability.

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TABLE 2

FLOW REQUIREMENTS FOR THE SERVICE WATER SYSTEM

Essential Header (Nuclear)		Design Flow Each (gpm)	Normal Operation	Injection Phase	Recirculation Phase
Containment Fan Cooler Units and Motor Coolers	(5)	2,000	2,850	10,000 (5 of 5)	6,000 (3 of 5)
Diesel Generators	(3)	400	Not Required	1,200 (3 of 3)	500 (2 of 3)
Instrument Air Compressor Cooling System	(2	65	65	65	65
Strainer Blowdown	(3	100	100	300	200
Component Cooling Heat Exchangers	(2)	3,500	Not Supplied	Not Required	3,500 (1 of 2)
Radiation Sample Mixing Nozzle		80	80	80	80
Other Miscellaneous		810	1,480	1,480	40
Total				13,045	10,685

Nonessential Header (Conventional)		Design Flow Each (gpm)	Normal Operation	Injection Phase	Recirculation Phase
Diesel Generator		400	Not Required	Not Required	400 (1 of 3)
Component Cooling Heat Exchangers	(2)	3,500	7,000 (2 of 2)	Not Required	3,500 (1 of 2)
Strainer Blowdown	(3)	100	200	Not Required	100
Other Miscellaneous		4,690	4,650	0	40
Total			11,850	0	4,040

( ) Number of like components cooled.

TABLE 3

ELECTRICAL SUPPLY BUSES FOR INDIAN POINT 3 SERVICE WATER PUMPS

Pump Number	480V Bus
31	5A
32	2A
33	6A
34	5A
35	3A
36	6A
37	5A
38	3A
39	6A

TABLE 4

BASIC EVENT DATA - INDIAN POINT 3 SERVICE WATER SYSTEM

Event Description and Failure Mode	Fault Tree Coding	Failure Data					Common Cause Data		Comments
		Mean	H/D	Variance	MTTR	Ref. (1)	Location	Susceptibility	
No power at switchgear bus 2A	JBS-32AD	-	-	-	-	-	See EP Analysis	-	See EP analysis
No power at switchgear bus 3A	JBS-33AD	-	-	-	-	-	"	-	See EP analysis
No power at switchgear bus 5A	JBS-35AD	-	-		-	-	"	-	See EP analysis
No power at switchgear bus 6A	JBS-36AD	-	-	-	-	-	"	-	See EP analysis
No DC control power at switchgear bus 2A	4BS-333D	-	-	-	-	-	"	-	See EP analysis
No DC control power at switchgear bus 3A	4BS-333D	-	-	-	-	-	"	-	See EP analysis
No DC control power at switchgear bus 5A	4BS-331D	-	-	-	-	-	"	-	See EP analysis
No DC control power at switchgear bus 6A	4BS-332D	-	-	-	-	-	"	-	See EP analysis
SW pump no, 31 does not start does not continue to run	IPMP31-S	1.36×10^{-3} 4.68×10^{-5}	D H	1.22×10^{-6} 1.07×10^{-9}	- see text	11 17	Intake well	I, V	
SW pump no. 32 does not start does not continue to run	IPMP32-S	1.36×10^{-3} 4.68×10^{-5}	D H	1.22×10^{-6} 1.07×10^{-9}	- see text	11 17	"	I, V	
SW pump no. 33 does not start does not continue to run	IPMP33-S	1.36×10^{-3} 4.68×10^{-5}	D H	1.22×10^{-6} 1.07×10^{-9}	- see text	11 17	"	I, V	
SW pump no. 34 does not start does not continue to run	IPMP34-S	1.36×10^{-3} 4.68×10^{-5}	D H	1.22×10^{-6} 1.07×10^{-9}	- see text	11 17	"	I, V	

(1) Reference - refers to item numbers in the plant failure data section of this report.

TABLE 4 (continued)

BASIC EVENT DATA - INDIAN POINT 3 SERVICE WATER SYSTEM

Event Description and Failure Mode	Fault Tree Coding	Failure Data					Common Cause Data		Comments
		Mean	H/D	Variance	MTTR	Ref. (1)	Location	Susceptibility	
SW pump no. 35 does not start does not continue to run	TPMP35-S	1.36×10^{-3} 4.68×10^{-5}	D H	1.22×10^{-6} 1.07×10^{-9}	- see text	11 17	"	I, V	
SW pump no. 36 does not start does not continue to run	TPMP36-S	1.36×10^{-3} 4.68×10^{-5}	D H	1.22×10^{-6} 1.07×10^{-9}	- see text	11 17	"	I, V	
SW pump no. 31 motor does not start/run	TMOP31-S	-	-	-	-	-	Intake structure	I, V, M	with pump
SW pump no. 32 motor does not start/run	TMOP32-S	-	-	-	-	-	"	"	with pump
SW pump no. 33 motor does not start/run	TMOP33-S	-	-	-	-	-	"	"	with pump
SW pump no. 34 motor does not start/run	TMOP34-S	-	-	-	-	-	"	"	with pump
SW pump no. 35 motor does not start/run	TMOP35-S	-	-	-	-	-	"	"	with pump
SW pump no. 36 motor does not start/run	TMOP36-S	-	-	-	-	-	"	"	with pump
SW pump no. 31 control circuit fails	TCCP31-F	-	-	-	-	-	Cont. Rm/480V Swgr	"	with pump
SW pump no. 32 control circuit fails	TCCP32-F	-	-	-	-	-	"	"	with pump
SW pump no. 33 control circuit fails	TCCP33-F	-	-	-	-	-	"	"	with pump
SW pump no. 34 control circuit fails	TCCP34-F	-	-	-	-	-	"	"	with pump
SW pump no. 35 control circuit fails	TCCP35-F	-	-	-	-	-	"	"	with pump
SW pump no. 36 control circuit fails	TCCP36-F	-	-	-	-	-	"	"	with pump
Expansion joint SWN-3-1 ruptures	TXJSW31L	8.60×10^{-9}	H	6.00×10^{-15}	see text	47	Intake well	I, V	
Expansion joint SWN-3-2 ruptures	TXJSW32L	8.60×10^{-9}	H	6.00×10^{-15}	see text	47	"	"	

(1) Reference - Refers to item numbers in the plant failure data section of this report.

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TABLE 4 (continued)

BASIC EVENT DATA - INDIAN POINT 3 SERVICE WATER SYSTEM

Event Description and Failure Mode	Fault Tree Coding	Failure Data					Common Cause Data		Comments
		Mean	H/D	Variance	MTTR	Ref. (1)	Location	Susceptibility	
Expansion joint SWN-3-3 ruptures	TXJSW33L	8.60×10^{-9}	H	6.00×10^{-15}	see text	47	-	-	
Expansion joint SWN-3-4 ruptures	TXJSW34L	8.60×10^{-9}	H	6.00×10^{-15}	see text	47	-	-	
Expansion joint SWN-3-5 ruptures	TXJSW35L	8.60×10^{-9}	H	6.00×10^{-15}	see text	47	-	-	
Expansion joint SWN-3-6 ruptures	TXJSW36L	8.60×10^{-9}	H	6.00×10^{-15}	see text	47	-	-	
Check valve SWN-1-1 fails to open	TCVSW11Q	6.91×10^{-5}	D	1.03×10^{-8}	-	3	Strainer enclosure	I	
Check valve SWN-1-2 fails to open	TCVSW12Q	6.91×10^{-5}	D	1.03×10^{-8}	-	3	-	-	
Check valve SWN-1-3 fails to open	TCVSW13Q	6.91×10^{-5}	D	1.03×10^{-8}	-	3	-	-	
Check valve SWN-1-4 fails to open	TCVSW14Q	6.91×10^{-5}	D	1.03×10^{-8}	-	3	-	-	
Check valve SWN-1-5 fails to open	TCVSW15Q	6.91×10^{-5}	D	1.03×10^{-8}	-	3	-	-	
Check valve SWN-1-6 fails to open	TCVSW16Q	6.91×10^{-5}	D	1.03×10^{-8}	-	3	-	-	
Discharge valve SWN-2-1 transfers closed	TXVSW21C	9.15×10^{-8}	H	1.01×10^{-14}	see text	1	-	-	
Discharge valve SWN-2-2 transfers closed	TXVSW22C	9.15×10^{-8}	H	1.01×10^{-14}	see text	1	-	-	
Discharge valve SWN-2-3 transfers closed	TXVSW23C	9.15×10^{-8}	H	1.01×10^{-14}	see text	1	-	-	
Discharge valve SWN-2-4 transfers closed	TXVSW24C	9.15×10^{-8}	H	1.01×10^{-14}	see text	1	-	-	
Discharge valve SWN-2-5 transfers closed	TXVSW25C	9.15×10^{-8}	H	1.01×10^{-14}	see text	1	-	-	
Discharge valve SWN-2-6 transfers closed	TXVSW26C	9.15×10^{-8}	H	1.01×10^{-14}	see text	1	-	-	

(1) Reference - Refers to item numbers in the plant failure data section of this report.

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TABLE 4 (continued)

BASIC EVENT DATA - INDIAN POINT 3 SERVICE WATER SYSTEM

Event Description and Failure Mode	Fault Tree Coding	Failure Data					Common Cause Data		Comments
		Mean	H/D	Variance	MTTR	Ref. (1)	Location	Susceptibility	
Discharge strainer SWN-4-1 plugged	IFLSW41G	(2)	-	-	-	-	Strainer enclosure	I	
Discharge strainer SWN-4-2 plugged	IFLSW42G	(2)	-	-	-	-	"	"	
Discharge strainer SWN-4-3 plugged	IFLSW43G	(2)	-	-	-	-	"	"	
Discharge strainer SWN-4-4 plugged	IFLSW44G	(2)	-	-	-	-	"	"	
Discharge strainer SWN-4-5 plugged	IFLSW45G	(2)	-	-	-	-	"	"	
Discharge strainer SWN-4-6 plugged	IFLSW46G	(2)	-	-	-	-	"	"	
FCV 1176 does not open	IFVS76-Q	4.98×10^{-4}	D	4.03×10^{-7}	-	8	DG Building	I, V	
FCV 1176A does not open	IFVS76AQ	4.98×10^{-4}	D	4.03×10^{-7}	-	8	DG Building	I, V	
SW discharge valve SWN98 transfers closed	IXVSW98C	9.15×10^{-8}	H	1.01×10^{-14}	see text	1	Valve pit	I	
SW discharge valve SWN99 transfers closed	IXVSW99C	9.15×10^{-8}	H	1.01×10^{-14}	see text	1	Valve pit	I	
SW discharge check valve SWN-100A fails closed	ICV100AQ	6.91×10^{-5}	D	1.03×10^{-8}	-	3	Valve pit	I	
SW discharge check valve SWN-100B fails closed	ICV100BQ	6.91×10^{-5}	D	1.03×10^{-8}	-	3	Valve pit	I	
SW piping nuclear fails	IPP1FAIL	8.60×10^{-10}	H	6.00×10^{-17}	see text	48	Various	I	
SW piping conventional fails	IPP2FAIL	8.60×10^{-10}	H	6.00×10^{-17}	see text	48	Various	I	

(1) Reference - refers to item numbers in the plant failure data section of this report.
(2) Negligibly small failure probability.

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PRINTOUT OF MINIMAL CUT SETS FOR PHASE 1

TABLE 5

TITLE: SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS

SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS
(Sheet 1 of 7)

CUT SETS WITH 1 BASIC EVENTS.

5)	1)	IXVSW38C	2)	ICV1008O	3)	IPP2FAIL	4)	IXVSW39C	5)	ICV1600
6)	6)	IPP1FAIL								

CUT SETS WITH 2 BASIC EVENTS.

10)	1)	IFVS76-O	IFVS76AO	2)	ICVSW160	ICVSW150	3)	IXVSW26C	ICVSW150	4)	IXJSW36L	ICVSW150
14)	5)	IFLSW46G	ICVSW150	6)	ICVSW160	IXVSW25C	7)	IXVSW26C	IXVSW25C	8)	IXJSW36L	IXVSW25C
18)	9)	IFLSW46G	IXVSW25C	10)	ICVSW160	IXJSW35L	11)	IXVSW26C	IXJSW35L	12)	IXJSW36L	IXJSW35L
22)	13)	IFLSW46G	IXJSW35L	14)	ICVSW160	IFLSW45G	15)	IXVSW26C	IFLSW45G	16)	IXJSW36L	IFLSW45G
26)	17)	IFLSW46G	IFLSW45G	18)	ICVSW160	ICVSW140	19)	IXVSW26C	ICVSW140	20)	IXJSW36L	ICVSW140
30)	21)	IFLSW46G	ICVSW140	22)	ICVSW160	IXVSW24C	23)	IXVSW26C	IXVSW24C	24)	IXJSW36L	IXVSW24C
34)	25)	IFLSW46G	IXVSW24C	26)	ICVSW160	IXJSW34L	27)	IXVSW26C	IXJSW34L	28)	IXJSW36L	IXJSW34L
38)	29)	IFLSW46G	IXJSW34L	30)	ICVSW160	IFLSW44G	31)	IXVSW26C	IFLSW44G	32)	IXJSW36L	IFLSW44G
42)	33)	IFLSW46G	IFLSW44G	34)	ICVSW150	ICVSW140	35)	IXVSW25C	ICVSW140	36)	IXJSW35L	ICVSW140
46)	37)	IFLSW45G	ICVSW140	38)	ICVSW150	IXVSW24C	39)	IXVSW25C	IXVSW24C	40)	IXJSW35L	IXVSW24C
50)	41)	IFLSW45G	IXVSW24C	42)	ICVSW150	IXJSW34L	43)	IXVSW25C	IXJSW34L	44)	IXJSW35L	IXJSW34L
54)	45)	IFLSW45G	IXJSW34L	46)	ICVSW150	IFLSW44G	47)	IXVSW25C	IFLSW44G	48)	IXJSW35L	IFLSW44G
58)	49)	IFLSW45G	IFLSW44G	50)	ICVSW160	JBS-33AD	51)	IXVSW26C	JBS-33AD	52)	IXJSW36L	JBS-33AD
62)	53)	IFLSW46G	JBS-33AD	54)	ICVSW160	IPMP35-S	55)	IXVSW26C	IPMP35-S	56)	IXJSW36L	IPMP35-S
66)	57)	IFLSW46G	IPMP35-S	58)	ICVSW160	IMOP35-S	59)	IXVSW26C	IMOP35-S	60)	IXJSW36L	IMOP35-S
70)	61)	IFLSW46G	IMOP35-S	62)	ICVSW160	ICCP35-F	63)	IXVSW26C	ICCP35-F	64)	IXJSW36L	ICCP35-F
74)	65)	IFLSW46G	ICCP35-F	66)	JBS-33AD	IPMP36-S	67)	IPMP35-S	IPMP36-S	68)	IMOP35-S	IPMP36-S
78)	69)	ICCP35-F	IPMP36-S	70)	JBS-33AD	IMOP36-S	71)	IPMP35-S	IMOP36-S	72)	IMOP35-S	IMOP36-S
82)	73)	ICCP35-F	IMOP36-S	74)	JBS-33AD	ICCP36-F	75)	IPMP35-S	ICCP36-F	76)	IMOP35-S	ICCP36-F
86)	77)	ICCP35-F	ICCP36-F	78)	ICVSW150	IPMP36-S	79)	IXVSW25C	IPMP36-S	80)	IXJSW35L	IPMP36-S
90)	81)	IFLSW45G	IPMP36-S	82)	ICVSW150	IMOP36-S	83)	IXVSW25C	IMOP36-S	84)	IXJSW35L	IMOP36-S
94)	85)	IFLSW45G	IMOP35-S	86)	ICVSW150	ICCP36-F	87)	IXVSW25C	ICCP36-F	88)	IXJSW35L	ICCP36-F
98)	89)	IFLSW45G	ICCP36-F	90)	ICVSW160	IPMP34-S	91)	IXVSW26C	IPMP34-S	92)	IXJSW36L	IPMP34-S
102)	93)	IFLSW46G	IPMP34-S	94)	ICVSW160	IMOP34-S	95)	IXVSW26C	IMOP34-S	96)	IXJSW36L	IMOP34-S
106)	97)	IFLSW46G	IMOP34-S	98)	ICVSW160	ICCP34-F	99)	IXVSW26C	ICCP34-F	100)	IXJSW36L	ICCP34-F
110)	101)	IFLSW46G	ICCP34-F	102)	IPMP34-S	IPMP36-S	103)	IMOP34-S	IPMP36-S	104)	ICCP34-F	IPMP36-S
114)	105)	IPMP34-S	IMOP36-S	106)	IMOP34-S	IMOP36-S	107)	ICCP34-F	IMOP36-S	108)	IPMP34-S	ICCP36-F
118)	109)	IMOP34-S	ICCP36-F	110)	ICCP34-F	ICCP36-F	111)	ICVSW140	IPMP36-S	112)	IXVSW24C	IPMP36-S
122)	113)	IXJSW34L	IPMP36-S	114)	IFLSW44G	IPMP36-S	115)	ICVSW140	IMOP36-S	116)	IXVSW24C	IMOP36-S
126)	117)	IXJSW34L	IMOP36-S	118)	IFLSW44G	IMOP36-S	119)	ICVSW140	ICCP36-F	120)	IXVSW24C	ICCP36-F
130)	121)	IXJSW34L	ICCP36-F	122)	IFLSW44G	ICCP36-F	123)	ICVSW150	IPMP34-S	124)	IXVSW25C	IPMP34-S
134)	125)	IXJSW35L	IPMP34-S	126)	IFLSW44G	IPMP34-S	127)	ICVSW150	IMOP34-S	128)	IXVSW25C	IMOP34-S

PRINTOUT OF MINIMAL CUT SETS FOR PHASE 1

TITLE: SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS

TABLE 5 (continued)

SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS
(Sheet 2 of 7)

CUT SETS WITH 2 BASIC EVENTS.

1381	1291	1XJSW35L	1MOP34-S	1301	1FLSW45G	1MOP34-S	1311	1CVSW150	1CCP35-F	1321	1XVSW25C	1CCP34-F
1421	1331	1XJSW35L	1CCP34-F	1341	1FLSW45G	1CCP34-F	1351	1PMP34-S	JBS-11AD	1361	1MOP34-S	JBS-11AD
1461	1371	1CCP34-F	JBS-11AD	1381	1PMP34-S	1PMP35-S	1391	1MOP34-S	1PMP35-S	1401	1CCP34-F	1PMP35-S
1501	1411	1PMP34-S	1MOP35-S	1421	1MOP34-S	1MOP35-S	1431	1CCP34-F	1MOP35-S	1441	1PMP34-S	1CCP35-F
1541	1451	1MOP34-S	1CCP35-F	1461	1CCP34-F	1CCP35-F	1471	1CVSW140	JBS-11AD	1481	1XVSW24C	JBS-11AD
1581	1491	1XJSW34L	JBS-11AD	1501	1FLSW45G	JBS-11AD	1511	1CVSW140	1PMP35-S	1521	1XVSW24C	1PMP35-S
1621	1531	1XJSW34L	1PMP35-S	1541	1FLSW44G	1PMP35-S	1551	1CVSW140	1MOP35-S	1561	1XVSW24C	1MOP35-S
1661	1571	1XJSW34L	1MOP35-S	1581	1FLSW44G	1MOP35-S	1591	1CVSW140	1CCP35-F	1601	1XVSW24C	1CCP35-F
1701	1611	1XJSW34L	1CCP35-F	1621	1FLSW44G	1CCP35-F	1631	JBS-11AD	4BS-1120	1641	1PMP35-S	4BS-1120
1741	1651	1MOP35-S	4BS-1120	1661	1CCP35-F	4BS-1120	1671	1CVSW150	4BS-1120	1681	1XVSW25C	4BS-1120
1781	1691	1XJSW35L	4BS-1120	1701	1FLSW45G	4BS-1120	1711	1PMP34-S	4BS-1120	1721	1MOP34-S	4BS-1120
1821	1731	1CCP34-F	4BS-1120	1741	1CVSW140	4BS-1120	1751	1XVSW24C	4BS-1120	1761	1XJSW34L	4BS-1120
1861	1771	1FLSW44G	4BS-1120	1781	JBS-11AD	JBS-16AD	1791	1PMP35-S	JBS-15AD	1801	1MOP35-S	JBS-16AD
1901	1811	1CCP35-F	JBS-16AD	1821	1CVSW150	JBS-16AD	1831	1XVSW25C	JBS-16AD	1841	1XJSW35L	JBS-16AD
1941	1851	1FLSW45G	JBS-15AD	1861	1PMP34-S	JBS-15AD	1871	1MOP34-S	JBS-16AD	1881	1CCP34-F	JBS-16AD
1981	1891	1CVSW140	JBS-16AD	1901	1XVSW24C	JBS-16AD	1911	1XJSW35L	JBS-15AD	1921	1FLSW44G	JBS-15AD
2021	1931	1CVSW160	4BS-1130	1941	1XVSW26C	4BS-1130	1951	1XJSW36L	4BS-1130	1961	1FLSW46G	4BS-1110
2061	1971	4BS-1130	1PMP36-S	1981	4BS-1110	1MOP36-S	1991	4BS-1110	1CCP36-F	2001	1PMP34-S	4BS-1110
2101	2011	1MOP34-S	4BS-1130	2021	1CCP34-F	4BS-1130	2031	1CVSW140	4BS-1130	2041	1XVSW24C	4BS-1110
2141	2051	1XJSW34L	4BS-1130	2061	1FLSW44G	4BS-1110	2071	4BS-1130	4BS-1120	2081	4BS-1110	JBS-16AD
2181	2091	1CVSW160	4BS-1110	2101	1XVSW26C	4BS-1110	2111	1XJSW36L	4BS-1110	2121	1FLSW46G	4BS-1110
2221	2131	4BS-1110	1PMP36-S	2141	4BS-1110	1MOP36-S	2151	4BS-1110	1CCP36-F	2161	1CVSW150	4BS-1110
2261	2171	1XVSW25C	4BS-1110	2181	1XJSW35L	4BS-1110	2191	1FLSW45G	4BS-1110	2201	4BS-1110	JBS-11AD
2301	2211	4BS-1110	1PMP35-S	2221	4BS-1110	1MOP35-S	2231	4BS-1110	1CCP35-F	2241	4BS-1110	4BS-1120
2341	2251	4BS-1110	JBS-16AD	2261	4BS-1110	4BS-1130	2271	1CVSW160	JBS-15AD	2281	1XVSW26C	JBS-15AD
2381	2291	1XJSW35L	JBS-15AD	2301	1FLSW46G	JBS-15AD	2311	JBS-15AD	1PMP36-S	2321	JBS-15AD	1MOP36-S
2421	2331	JBS-15AD	1CCP36-F	2341	1CVSW150	JBS-15AD	2351	1XVSW25C	JBS-15AD	2361	1XJSW35L	JBS-15AD
2461	2371	1FLSW45G	JBS-15AD	2381	JBS-15AD	JBS-11AD	2391	JBS-15AD	1PMP35-S	2401	JBS-15AD	1MOP35-S
2501	2411	JBS-15AD	1CCP35-F	2421	JBS-15AD	4BS-1120	2431	JBS-15AD	JBS-16AD	2441	JBS-15AD	4BS-1110

CUT SETS WITH 3 BASIC EVENTS.

2541	11	1CVSW110	1CVSW120	1CVSW110	21	1XVSW23C	1CVSW120	1CVSW110	31	1XJSW33L	1CVSW120	1CVSW110
2581	41	1FLSW43G	1CVSW120	1CVSW110	51	1CVSW110	1XVSW22C	1CVSW110	61	1XVSW23C	1XVSW22C	1CVSW110
2591	71	1XJSW33L	1XVSW22C	1CVSW110	81	1FLSW43G	1XVSW22C	1CVSW110	91	1CVSW110	1XJSW32L	1CVSW110
2621	101	1XVSW23C	1XJSW32L	1CVSW110	111	1XJSW33L	1XJSW32L	1CVSW110	121	1FLSW43G	1XJSW32L	1CVSW110
2631	131	1CVSW110	1FLSW42G	1CVSW110	141	1XVSW23C	1FLSW42G	1CVSW110	151	1XJSW33L	1FLSW42G	1CVSW110
2641	161	1FLSW43G	1FLSW42G	1CVSW110	171	1CVSW110	1CVSW120	1XVSW21C	181	1XVSW23C	1CVSW120	1XVSW21C
2711	191	1XJSW33L	1CVSW120	1XVSW21C	201	1FLSW43G	1CVSW120	1XVSW21C	211	1CVSW110	1XVSW22C	1XVSW21C
2741	221	1XVSW23C	1XVSW22C	1XVSW21C	231	1XJSW33L	1XVSW22C	1XVSW21C	241	1FLSW43G	1XVSW22C	1XVSW21C
2771	251	1CVSW110	1XJSW32L	1XVSW21C	261	1XVSW23C	1XJSW32L	1XVSW21C	271	1XJSW33L	1XJSW32L	1XVSW21C
2801	281	1FLSW43G	1XJSW32L	1XVSW21C	291	1CVSW110	1FLSW42G	1XVSW21C	301	1XVSW23C	1FLSW42G	1XVSW21C
2811	311	1XJSW33L	1FLSW42G	1XVSW21C	321	1FLSW43G	1FLSW42G	1XVSW21C	331	1CVSW110	1CVSW120	1XJSW31L
2841	341	1XVSW23C	1CVSW120	1XJSW31L	351	1XJSW33L	1CVSW120	1XJSW31L	361	1FLSW43G	1CVSW120	1XJSW31L

PRINTOUT OF MINIMAL CUT SETS FOR PHASE 1

TITLE: SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS

TABLE 5 (continued)

SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS
(Sheet 3 of 7)

CUT SETS WITH 3 BASIC EVENTS.

289)	37)	ICVSW130	IXVSW22C	IXJSW31L	38)	IXVSW23C	IXVSW22C	IXJSW31L	39)	IXJSW33L	IXVSW22C	IXJSW31L
292)	40)	IFLSW43G	IXVSW22C	IXJSW31L	41)	ICVSW130	IXJSW32L	IXJSW31L	42)	IXVSW23C	IXJSW32L	IXJSW31L
295)	43)	IXJSW33L	IXJSW32L	IXJSW31L	44)	IFLSW43G	IXJSW32L	IXJSW31L	45)	ICVSW130	IFLSW42G	IXJSW31L
298)	46)	IXVSW23C	IFLSW42G	IXJSW31L	47)	IXJSW33L	IFLSW42G	IXJSW31L	48)	IFLSW43G	IFLSW42G	IXJSW31L
301)	49)	ICVSW130	ICVSW120	IFLSW41G	50)	IXVSW23C	ICVSW120	IFLSW41G	51)	IXJSW33L	ICVSW120	IFLSW41G
304)	52)	IFLSW43G	ICVSW120	IFLSW41G	53)	ICVSW130	IXVSW22C	IFLSW41G	54)	IXVSW23C	IXVSW22C	IFLSW41G
307)	55)	IXJSW33L	IXVSW22C	IFLSW41G	56)	IFLSW43G	IXVSW22C	IFLSW41G	57)	ICVSW130	IXJSW32L	IFLSW41G
310)	58)	IXVSW23C	IXJSW32L	IFLSW41G	59)	IXJSW33L	IXJSW32L	IFLSW41G	60)	IFLSW43G	IXJSW32L	IFLSW41G
313)	61)	ICVSW130	IFLSW42G	IFLSW41G	62)	IXVSW23C	IFLSW42G	IFLSW41G	63)	IXJSW33L	IFLSW42G	IFLSW41G
316)	64)	IFLSW43G	IFLSW42G	IFLSW41G	65)	ICVSW130	ICVSW120	IPMP31-S	66)	IXVSW23C	ICVSW120	IPMP31-S
319)	67)	IXJSW33L	ICVSW120	IPMP31-S	68)	IFLSW43G	ICVSW120	IPMP31-S	69)	ICVSW130	IXVSW22C	IPMP31-S
322)	70)	IXVSW23C	IXVSW22C	IPMP31-S	71)	IXJSW33L	IXVSW22C	IPMP31-S	72)	IFLSW43G	IXVSW22C	IPMP31-S
325)	73)	ICVSW130	IXJSW32L	IPMP31-S	74)	IXVSW23C	IXJSW32L	IPMP31-S	75)	IXJSW33L	IXJSW32L	IPMP31-S
328)	76)	IFLSW43G	IXJSW32L	IPMP31-S	77)	ICVSW130	IFLSW42G	IPMP31-S	78)	IXVSW23C	IFLSW42G	IPMP31-S
331)	79)	IXJSW33L	IFLSW42G	IPMP31-S	80)	IFLSW43G	IFLSW42G	IPMP31-S	81)	ICVSW130	ICVSW120	IMOP31-S
334)	82)	IXVSW23C	ICVSW120	IMOP31-S	83)	IXJSW33L	ICVSW120	IMOP31-S	84)	IFLSW43G	ICVSW120	IMOP31-S
337)	85)	ICVSW130	IXVSW22C	IMOP31-S	86)	IXVSW23C	IXVSW22C	IMOP31-S	87)	IXJSW33L	IXVSW22C	IMOP31-S
340)	88)	IFLSW43G	IXVSW22C	IMOP31-S	89)	ICVSW130	IXJSW32L	IMOP31-S	90)	IXVSW23C	IXJSW32L	IMOP31-S
343)	91)	IXJSW33L	IXJSW32L	IMOP31-S	92)	IFLSW43G	IXJSW32L	IMOP31-S	93)	ICVSW130	IFLSW42G	IMOP31-S
346)	94)	IXVSW23C	IFLSW42G	IMOP31-S	95)	IXJSW33L	IFLSW42G	IMOP31-S	96)	IFLSW43G	IFLSW42G	IMOP31-S
349)	97)	ICVSW130	ICVSW120	ICCP31-F	98)	IXVSW23C	ICVSW120	ICCP31-F	99)	IXJSW33L	ICVSW120	ICCP31-F
352)	100)	IFLSW43G	ICVSW120	ICCP31-F	101)	ICVSW130	IXVSW22C	ICCP31-F	102)	IXVSW23C	IXVSW22C	ICCP31-F
355)	103)	IXJSW33L	IXVSW22C	ICCP31-F	104)	IFLSW43G	IXVSW22C	ICCP31-F	105)	ICVSW130	IXJSW32L	ICCP31-F
358)	106)	IXVSW23C	IXJSW32L	ICCP31-F	107)	IXJSW33L	IXJSW32L	ICCP31-F	108)	IFLSW43G	IXJSW32L	ICCP31-F
361)	109)	ICVSW130	IFLSW42G	ICCP31-F	110)	IXVSW23C	IFLSW42G	ICCP31-F	111)	IXJSW33L	IFLSW42G	ICCP31-F
364)	112)	IFLSW43G	IFLSW42G	ICCP31-F	113)	ICVSW130	IPMP31-S	JBS-32AD	114)	IXVSW23C	IPMP31-S	JBS-32AD
367)	115)	IXJSW33L	IPMP31-S	JBS-32AD	116)	IFLSW43G	IPMP31-S	JBS-32AD	117)	ICVSW130	IMOP31-S	JBS-32AD
370)	118)	IXVSW23C	IMOP31-S	JBS-32AD	119)	IXJSW33L	IMOP31-S	JBS-32AD	120)	IFLSW43G	IMOP31-S	JBS-32AD
373)	121)	ICVSW130	ICCP31-F	JBS-32AD	122)	IXVSW23C	ICCP31-F	JBS-32AD	123)	IXJSW33L	ICCP31-F	JBS-32AD
376)	124)	IFLSW43G	ICCP31-F	JBS-32AD	125)	ICVSW130	IPMP31-S	IPMP32-S	126)	IXVSW23C	IPMP31-S	IPMP32-S
379)	127)	IXJSW33L	IPMP31-S	IPMP32-S	128)	IFLSW43G	IPMP31-S	IPMP32-S	129)	ICVSW130	IMOP31-S	IPMP32-S
382)	130)	IXVSW23C	IMOP31-S	IPMP32-S	131)	IXJSW33L	IMOP31-S	IPMP32-S	132)	IFLSW43G	IMOP31-S	IPMP32-S
385)	133)	ICVSW130	ICCP31-F	IPMP32-S	134)	IXVSW23C	ICCP31-F	IPMP32-S	135)	IXJSW33L	ICCP31-F	IPMP32-S
388)	136)	IFLSW43G	ICCP31-F	IPMP32-S	137)	ICVSW130	IPMP31-S	IMOP32-S	138)	IXVSW23C	IPMP31-S	IMOP32-S
391)	139)	IXJSW33L	IPMP31-S	IMOP32-S	140)	IFLSW43G	IPMP31-S	IMOP32-S	141)	ICVSW130	IMOP31-S	IMOP32-S
394)	142)	IXVSW23C	IMOP31-S	IMOP32-S	143)	IXJSW33L	IMOP31-S	IMOP32-S	144)	IFLSW43G	IMOP31-S	IMOP32-S
397)	145)	ICVSW130	ICCP31-F	IMOP32-S	146)	IXVSW23C	ICCP31-F	IMOP32-S	147)	IXJSW33L	ICCP31-F	IMOP32-S
400)	148)	IFLSW43G	ICCP31-F	IMOP32-S	149)	ICVSW130	IPMP31-S	ICCP32-F	150)	IXVSW23C	IPMP31-S	ICCP32-F
403)	151)	IXJSW33L	IPMP31-S	ICCP32-F	152)	IFLSW43G	IPMP31-S	ICCP32-F	153)	ICVSW130	IMOP31-S	ICCP32-F
406)	154)	IXVSW23C	IMOP31-S	ICCP32-F	155)	IXJSW33L	IMOP31-S	ICCP32-F	156)	IFLSW43G	IMOP31-S	ICCP32-F
409)	157)	ICVSW130	ICCP31-F	ICCP32-F	158)	IXVSW23C	ICCP31-F	ICCP32-F	159)	IXJSW33L	ICCP31-F	ICCP32-F
412)	160)	IFLSW43G	ICCP31-F	ICCP32-F	161)	IPMP31-S	JBS-32AD	IPMP33-S	162)	IMOP31-S	JBS-32AD	IPMP33-S
415)	163)	ICCP31-F	JBS-32AD	IPMP33-S	164)	IPMP31-S	IPMP32-S	IPMP33-S	165)	IMOP31-S	IPMP32-S	IPMP33-S
418)	166)	ICCP31-F	IPMP32-S	IPMP33-S	167)	IPMP31-S	IMOP32-S	IPMP33-S	168)	IMOP31-S	IMOP32-S	IPMP33-S
421)	169)	ICCP31-F	IMOP32-S	IPMP33-S	170)	IPMP31-S	ICCP32-F	IPMP33-S	171)	IMOP31-S	ICCP32-F	IPMP33-S
424)	172)	ICCP31-F	ICCP32-F	IPMP33-S	173)	IPMP31-S	JBS-32AD	IMOP33-S	174)	IMOP31-S	JBS-32AD	IMOP33-S
427)	175)	ICCP31-F	JBS-32AD	IMOP33-S	176)	IPMP31-S	IPMP32-S	IMOP33-S	177)	IMOP31-S	IPMP32-S	IMOP33-S

PRINTOUT OF MINIMAL CUT SETS FOR PHASE 1

TABLE 5 (continued)

TITLE: SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS

SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS
(Sheet 4 of 7)

CUT SETS WITH 3 BASIC EVENTS.

410)	178)	ICCP11-F	IPMP12-S	IMOP13-S	179)	IPMP11-S	IMOP12-S	IMOP13-S	180)	IMOP11-S	IMOP12-S	IMOP13-S
413)	181)	ICCP11-F	IMOP12-S	IMOP13-S	182)	IPMP11-S	ICCP12-F	IMOP13-S	183)	IMOP11-S	ICCP12-F	IMOP13-S
416)	184)	ICCP11-F	ICCP12-F	IMOP13-S	185)	IPMP11-S	JBS-12AD	ICCP13-F	186)	IMOP11-S	JBS-12AD	ICCP13-F
419)	187)	ICCP11-F	JBS-12AD	ICCP13-F	188)	IPMP11-S	IPMP12-S	ICCP13-F	189)	IMOP11-S	IPMP12-S	ICCP13-F
442)	190)	ICCP11-F	IPMP12-S	ICCP13-F	191)	IPMP11-S	IMOP12-S	ICCP13-F	192)	IMOP11-S	IMOP12-S	ICCP13-F
445)	193)	ICCP11-F	IMOP12-S	ICCP13-F	194)	IPMP11-S	ICCP12-F	ICCP13-F	195)	IMOP11-S	ICCP12-F	ICCP13-F
448)	196)	ICCP11-F	ICCP12-F	ICCP13-F	197)	ICVSW120	IPMP11-S	IPMP13-S	198)	IXVSW22C	IPMP11-S	IPMP13-S
451)	199)	IXJSW32L	IPMP11-S	IPMP13-S	200)	IFLSW42G	IPMP11-S	IPMP13-S	201)	ICVSW120	IMOP11-S	IPMP13-S
454)	202)	IXVSW22C	IMOP11-S	IPMP13-S	203)	IXJSW32L	IMOP11-S	IPMP13-S	204)	IFLSW42G	IMOP11-S	IPMP13-S
457)	205)	ICVSW120	ICCP11-F	IPMP13-S	206)	IXVSW22C	ICCP11-F	IPMP13-S	207)	IXJSW32L	ICCP11-F	IPMP13-S
460)	208)	IFLSW42G	ICCP11-F	IPMP13-S	209)	ICVSW120	IPMP11-S	IMOP13-S	210)	IXVSW22C	IPMP11-S	IMOP13-S
463)	211)	IXJSW32L	IPMP11-S	IMOP13-S	212)	IFLSW42G	IPMP11-S	IMOP13-S	213)	ICVSW120	IMOP11-S	IMOP13-S
466)	214)	IXVSW22C	IMOP11-S	IMOP13-S	215)	IXJSW32L	IMOP11-S	IMOP13-S	216)	IFLSW42G	IMOP11-S	IMOP13-S
469)	217)	ICVSW120	ICCP11-F	IMOP13-S	218)	IXVSW22C	ICCP11-F	IMOP13-S	219)	IXJSW32L	ICCP11-F	IMOP13-S
472)	220)	IFLSW42G	ICCP11-F	IMOP13-S	221)	ICVSW120	IPMP11-S	ICCP13-F	222)	IXVSW22C	IPMP11-S	ICCP13-F
475)	223)	IXJSW32L	IPMP11-S	ICCP13-F	224)	IFLSW42G	IPMP11-S	ICCP13-F	225)	ICVSW120	IMOP11-S	ICCP13-F
478)	226)	IXVSW22C	IMOP11-S	ICCP13-F	227)	IXJSW32L	IMOP11-S	ICCP13-F	228)	IFLSW42G	IMOP11-S	ICCP13-F
481)	229)	ICVSW120	ICCP11-F	ICCP13-F	230)	IXVSW22C	ICCP11-F	ICCP13-F	231)	IXJSW32L	ICCP11-F	ICCP13-F
484)	232)	IFLSW42G	ICCP11-F	ICCP13-F	233)	ICVSW130	ICVSW110	JBS-12AD	234)	IXVSW23C	ICVSW110	JBS-12AD
487)	235)	IXJSW33L	ICVSW110	JBS-32AD	236)	IFLSW43G	ICVSW110	JBS-12AD	237)	ICVSW130	IXVSW21C	JBS-12AD
490)	238)	IXVSW23C	IXVSW21C	JBS-32AD	239)	IXJSW33L	IXVSW21C	JBS-12AD	240)	IFLSW43G	IXVSW21C	JBS-12AD
493)	241)	ICVSW130	IXJSW31L	JBS-32AD	242)	IXVSW23C	IXJSW31L	JBS-12AD	243)	IXJSW33L	IXJSW31L	JBS-12AD
496)	244)	IFLSW43G	IXJSW31L	JBS-32AD	245)	ICVSW130	IFLSW41G	JBS-12AD	246)	IXVSW23C	IFLSW41G	JBS-12AD
499)	247)	IXJSW33L	IFLSW41G	JBS-32AD	248)	IFLSW43G	IFLSW41G	JBS-12AD	249)	ICVSW133	ICVSW110	IPMP12-S
502)	250)	IXVSW23C	ICVSW110	IPMP12-S	251)	IXJSW33L	ICVSW110	IPMP12-S	252)	IFLSW43G	ICVSW110	IPMP12-S
505)	253)	ICVSW130	IXVSW21C	IPMP12-S	254)	IXVSW23C	IXVSW21C	IPMP12-S	255)	IXJSW33L	IXVSW21C	IPMP12-S
508)	256)	IFLSW43G	IXVSW21C	IPMP12-S	257)	ICVSW130	IXJSW31L	IPMP12-S	258)	IXVSW23C	IXJSW31L	IPMP12-S
511)	259)	IXJSW33L	IXJSW31L	IPMP12-S	260)	IFLSW43G	IXJSW31L	IPMP12-S	261)	ICVSW133	IFLSW41G	IPMP12-S
514)	262)	IXVSW23C	IFLSW41G	IPMP12-S	263)	IXJSW33L	IFLSW41G	IPMP12-S	264)	IFLSW43G	IFLSW41G	IPMP12-S
517)	265)	ICVSW130	ICVSW110	IMOP12-S	266)	IXVSW23C	ICVSW110	IMOP12-S	267)	IXJSW33L	ICVSW110	IMOP12-S
520)	268)	IFLSW43G	ICVSW110	IMOP12-S	269)	ICVSW130	IXVSW21C	IMOP12-S	270)	IXVSW23C	IXVSW21C	IMOP12-S
523)	271)	IXJSW33L	IXVSW21C	IMOP12-S	272)	IFLSW43G	IXVSW21C	IMOP12-S	273)	ICVSW130	IXJSW31L	IMOP12-S
526)	274)	IXVSW23C	IXJSW31L	IMOP12-S	275)	IXJSW33L	IXJSW31L	IMOP12-S	276)	IFLSW43G	IXJSW31L	IMOP12-S
529)	277)	ICVSW133	IFLSW41G	IMOP12-S	278)	IXVSW23C	IFLSW41G	IMOP12-S	279)	IXJSW33L	IFLSW41G	IMOP12-S
532)	280)	IFLSW43G	IFLSW41G	IMOP12-S	281)	ICVSW130	ICVSW113	ICCP12-F	282)	IXVSW23C	ICVSW110	ICCP12-F
535)	283)	IXJSW33L	ICVSW110	ICCP12-F	284)	IFLSW43G	ICVSW113	ICCP12-F	285)	ICVSW133	IXVSW21C	ICCP12-F
538)	286)	IXVSW23C	IXVSW21C	ICCP12-F	287)	IXJSW33L	IXVSW21C	ICCP12-F	288)	IFLSW43G	IXVSW21C	ICCP12-F
541)	289)	ICVSW133	IXJSW31L	ICCP12-F	290)	IXVSW23C	IXJSW31L	ICCP12-F	291)	IXJSW33L	IXJSW31L	ICCP12-F
544)	292)	IFLSW43G	IXJSW31L	ICCP12-F	293)	ICVSW133	IFLSW41G	ICCP12-F	294)	IXVSW23C	IFLSW41G	ICCP12-F
547)	295)	IXJSW33L	IFLSW41G	ICCP12-F	296)	IFLSW43G	IFLSW41G	ICCP12-F	297)	ICVSW113	JBS-32AD	IPMP13-S
550)	298)	IXVSW21C	JBS-12AD	IPMP13-S	299)	IXJSW31L	JBS-12AD	IPMP13-S	300)	IFLSW41G	JBS-32AD	IPMP13-S
553)	301)	ICVSW110	IPMP12-S	IPMP13-S	302)	IXVSW21C	IPMP12-S	IPMP13-S	303)	IXJSW31L	IPMP12-S	IPMP13-S
556)	304)	IFLSW41G	IPMP12-S	IPMP13-S	305)	ICVSW110	IMOP12-S	IPMP13-S	306)	IXVSW21C	IMOP12-S	IPMP13-S
559)	307)	IXJSW31L	IMOP12-S	IPMP13-S	308)	IFLSW41G	IMOP12-S	IPMP13-S	309)	ICVSW110	ICCP12-F	IPMP13-S
562)	310)	IXVSW21C	ICCP12-F	IPMP13-S	311)	IXJSW31L	ICCP12-F	IPMP13-S	312)	IFLSW41G	ICCP12-F	IPMP13-S
565)	313)	ICVSW110	JBS-12AD	IMOP13-S	314)	IXVSW21C	JBS-12AD	IMOP13-S	315)	IXJSW31L	JBS-12AD	IMOP13-S
568)	316)	IFLSW41G	JBS-12AD	IMOP13-S	317)	ICVSW113	IPMP12-S	IMOP13-S	318)	IXVSW21C	IPMP12-S	IMOP13-S

PRINTOUT OF MINIMAL CUT SETS FOR CASE 1

TITLE: SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS

TABLE 5 (continued)

SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS
(Sheet 5 of 7)

CUT SETS WITH 3 BASIC EVENTS.

5711	3191	IXJSW31L	IPMP32-S	IMOP33-S	3201	IFLSW41G	IPMP32-S	IMOP33-S	3211	ICVSW110	IMOP32-S	IMOP33-S
5741	3221	IXVSW21C	IMOP32-S	IMOP33-S	3231	IXJSW31L	IMOP32-S	IMOP33-S	3241	IFLSW41G	IMOP32-S	IMOP33-S
5771	3251	ICVSW110	ICCP32-F	IMOP33-S	3261	IXVSW21C	ICCP32-F	IMOP33-S	3271	IXJSW31L	ICCP32-F	IMOP33-S
5801	3281	IFLSW41G	ICCP32-F	IMOP33-S	3291	ICVSW110	JBS-32AD	ICCP33-F	3301	IXVSW21C	JBS-32AD	ICCP33-F
5831	3311	IXJSW31L	JBS-32AD	ICCP33-F	3321	IFLSW41G	JBS-32AD	ICCP33-F	3331	ICVSW110	IPMP32-S	ICCP33-F
5861	3341	IXVSW21C	IPMP32-S	ICCP33-F	3351	IXJSW31L	IPMP32-S	ICCP33-F	3361	IFLSW41G	IPMP32-S	ICCP33-F
5891	3371	ICVSW110	IMOP32-S	ICCP33-F	3381	IXVSW21C	IMOP32-S	ICCP33-F	3391	IXJSW31L	IMOP32-S	ICCP33-F
5921	3401	IFLSW41G	IMOP32-S	ICCP33-F	3411	ICVSW110	ICCP32-F	ICCP33-F	3421	IXVSW21C	ICCP32-F	ICCP33-F
5951	3431	IXJSW31L	ICCP32-F	ICCP33-F	3441	IFLSW41G	ICCP32-F	ICCP33-F	3451	ICVSW120	ICVSW110	IPMP33-S
5981	3461	IXVSW22C	ICVSW110	IPMP33-S	3471	IXJSW32L	ICVSW110	IPMP33-S	3481	IFLSW42G	ICVSW110	IPMP33-S
6011	3491	ICVSW120	IXVSW21C	IPMP33-S	3501	IXVSW22C	IXVSW21C	IPMP33-S	3511	IXJSW32L	IXVSW21C	IPMP33-S
6041	3521	IFLSW42G	IXVSW21C	IPMP33-S	3531	ICVSW120	IXJSW31L	IPMP33-S	3541	IXVSW22C	IXJSW31L	IPMP33-S
6071	3551	IXJSW32L	IXJSW31L	IPMP33-S	3561	IFLSW42G	IXJSW31L	IPMP33-S	3571	ICVSW120	IFLSW41G	IPMP33-S
6101	3581	IXVSW22C	IFLSW41G	IPMP33-S	3591	IXJSW32L	IFLSW41G	IPMP33-S	3601	IFLSW42G	IFLSW41G	IPMP33-S
6131	3611	ICVSW120	ICVSW110	IMOP33-S	3621	IXVSW22C	ICVSW110	IMOP33-S	3631	IXJSW32L	ICVSW110	IMOP33-S
6161	3641	IFLSW42G	ICVSW110	IMOP33-S	3651	ICVSW120	IXVSW21C	IMOP33-S	3661	IXVSW22C	IXVSW21C	IMOP33-S
6191	3671	IXJSW32L	IXVSW21C	IMOP33-S	3681	IFLSW42G	IXVSW21C	IMOP33-S	3691	ICVSW120	IXJSW31L	IMOP33-S
6221	3701	IXVSW22C	IXJSW31L	IMOP33-S	3711	IXJSW32L	IXJSW31L	IMOP33-S	3721	IFLSW42G	IXJSW31L	IMOP33-S
6251	3731	ICVSW120	IFLSW41G	IMOP33-S	3741	IXVSW22C	IFLSW41G	IMOP33-S	3751	IXJSW32L	IFLSW41G	IMOP33-S
6281	3761	IFLSW42G	IFLSW41G	IMOP33-S	3771	ICVSW120	ICVSW110	ICCP33-F	3781	IXVSW22C	ICVSW110	ICCP33-F
6311	3791	IXJSW32L	ICVSW110	ICCP33-F	3801	IFLSW42G	ICVSW110	ICCP33-F	3811	ICVSW120	IXVSW21C	ICCP33-F
6341	3821	IXVSW22C	IXVSW21C	ICCP33-F	3831	IXJSW32L	IXVSW21C	ICCP33-F	3841	IFLSW42G	IXVSW21C	ICCP33-F
6371	3851	ICVSW120	IXJSW31L	ICCP33-F	3861	IXVSW22C	IXJSW31L	ICCP33-F	3871	IXJSW32L	IXJSW31L	ICCP33-F
6401	3881	IFLSW42G	IXJSW31L	ICCP33-F	3891	ICVSW120	IFLSW41G	ICCP33-F	3901	IXVSW22C	IFLSW41G	ICCP33-F
6431	3911	IXJSW32L	IFLSW41G	ICCP33-F	3921	IFLSW42G	IFLSW41G	ICCP33-F	3931	IPMP31-S	JBS-32AD	4BS-3320
6461	3941	IMOP31-S	JBS-32AD	4BS-3320	3951	ICCP31-F	JBS-32AD	4BS-3320	3961	IPMP31-S	IPMP32-S	4BS-3320
6491	3971	IMOP31-S	IPMP32-S	4BS-3320	3981	ICCP31-F	IPMP32-S	4BS-3320	3991	IPMP31-S	IMOP32-S	4BS-3320
6521	4001	IMOP31-S	IMOP32-S	4BS-3320	4011	ICCP31-F	IMOP32-S	4BS-3320	4021	IPMP31-S	ICCP32-F	4BS-3320
6551	4031	IMOP31-S	ICCP32-F	4BS-3320	4041	ICCP31-F	ICCP32-F	4BS-3320	4051	ICVSW120	IPMP31-S	4BS-3320
6581	4061	IXVSW22C	IPMP31-S	4BS-3320	4071	IXJSW32L	IPMP31-S	4BS-3320	4081	IFLSW42G	IPMP31-S	4BS-3320
6611	4091	ICVSW120	IMOP31-S	4BS-3320	4101	IXVSW22C	IMOP31-S	4BS-3320	4111	IXJSW32L	IMOP31-S	4BS-3320
6641	4121	IFLSW42G	IMOP31-S	4BS-3320	4131	ICVSW120	ICCP31-F	4BS-3320	4141	IXVSW22C	ICCP31-F	4BS-3320
6671	4151	IXJSW32L	ICCP31-F	4BS-3320	4161	IFLSW42G	ICCP31-F	4BS-3320	4171	ICVSW110	JBS-32AD	4BS-3320
6701	4181	IXVSW21C	JBS-32AD	4BS-3320	4191	IXJSW31L	JBS-32AD	4BS-3320	4201	IFLSW41G	JBS-32AD	4BS-3320
6731	4211	ICVSW110	IPMP32-S	4BS-3320	4221	IXVSW21C	IPMP32-S	4BS-3320	4231	IXJSW31L	IPMP32-S	4BS-3320
6761	4241	IFLSW41G	IPMP32-S	4BS-3320	4251	ICVSW110	IMOP32-S	4BS-3320	4261	IXVSW21C	IMOP32-S	4BS-3320
6791	4271	IXJSW31L	IMOP32-S	4BS-3320	4281	IFLSW41G	IMOP32-S	4BS-3320	4291	ICVSW110	ICCP32-F	4BS-3320
6821	4301	IXVSW21C	ICCP32-F	4BS-3320	4311	IXJSW31L	ICCP32-F	4BS-3320	4321	IFLSW41G	ICCP32-F	4BS-3320
6851	4331	ICVSW120	ICVSW110	4BS-3320	4341	IXVSW22C	ICVSW110	4BS-3320	4351	IXJSW32L	ICVSW110	4BS-3320
6881	4361	IFLSW42G	ICVSW110	4BS-3320	4371	ICVSW120	IXVSW21C	4BS-3320	4381	IXVSW22C	IXVSW21C	4BS-3320
6911	4391	IXJSW32L	IXVSW21C	4BS-3320	4401	IFLSW42G	IXVSW21C	4BS-3320	4411	ICVSW120	IXJSW31L	4BS-3320
6941	4421	IXVSW22C	IXJSW31L	4BS-3320	4431	IXJSW32L	IXJSW31L	4BS-3320	4441	IFLSW42G	IXJSW31L	4BS-3320
6971	4451	ICVSW120	IFLSW41G	4BS-3320	4461	IXVSW22C	IFLSW41G	4BS-3320	4471	IXJSW32L	IFLSW41G	4BS-3320
7001	4481	IFLSW42G	IFLSW41G	4BS-3320	4491	IPMP31-S	JBS-32AD	JBS-36AD	4501	IMOP31-S	JBS-32AD	JBS-36AD
7031	4511	ICCP31-F	JBS-32AD	JBS-36AD	4521	IPMP31-S	IPMP32-S	JBS-36AD	4531	IMOP31-S	IPMP32-S	JBS-36AD
7061	4541	ICCP31-F	IPMP32-S	JBS-36AD	4551	IPMP31-S	IMOP32-S	JBS-36AD	4561	IMOP31-S	IMOP32-S	JBS-36AD
7091	4571	ICCP31-F	IMOP32-S	JBS-36AD	4581	IPMP31-S	ICCP32-F	JBS-36AD	4591	IMOP31-S	ICCP32-F	JBS-36AD

PRINTOUT OF MINIMAL CUT SETS FOR PHASE I

TITLE: SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS

TABLE 5 (continued)

SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS
(Sheet 6 of 7)

CUT SETS WITH 3 BASIC EVENTS.

460)	ICCP31-F	ICCP32-F	JBS-36AD	461)	ICVSW120	IPMP31-S	JBS-36AD	462)	IXVSW22C	IPMP31-S	JBS-36AD
463)	IXJSW32L	IPMP31-S	JBS-36AD	464)	IFLSW42G	IPMP31-S	JBS-36AD	465)	ICVSW120	IMOP31-S	JBS-36AD
466)	IXVSW22C	IMOP31-S	JBS-36AD	467)	IXJSW32L	IMOP31-S	JBS-36AD	468)	IFLSW42G	IMOP31-S	JBS-36AD
469)	ICVSW120	ICCP31-F	JBS-36AD	470)	IXVSW22C	ICCP31-F	JBS-36AD	471)	IXJSW32L	ICCP31-F	JBS-36AD
472)	IFLSW42G	ICCP31-F	JBS-36AD	473)	ICVSW110	JBS-32AD	JBS-36AD	474)	IXVSW21C	JBS-32AD	JBS-36AD
475)	IXJSW31L	JBS-32AD	JBS-36AD	476)	IFLSW41G	JBS-32AD	JBS-36AD	477)	ICVSW110	IPMP32-S	JBS-36AD
478)	IXVSW21C	IPMP32-S	JBS-36AD	479)	IXJSW31L	IPMP32-S	JBS-36AD	480)	IFLSW41G	IPMP32-S	JBS-36AD
481)	ICVSW110	IMOP32-S	JBS-36AD	482)	IXVSW21C	IMOP32-S	JBS-36AD	483)	IXJSW31L	IMOP32-S	JBS-36AD
484)	IFLSW41G	IMOP32-S	JBS-36AD	485)	ICVSW110	ICCP32-F	JBS-36AD	486)	IXVSW21C	ICCP32-F	JBS-36AD
487)	IXJSW31L	ICCP32-F	JBS-36AD	488)	IFLSW41G	ICCP32-F	JBS-36AD	489)	ICVSW120	ICVSW110	JBS-36AD
490)	IXVSW22C	ICVSW110	JBS-36AD	491)	IXJSW32L	ICVSW110	JBS-36AD	492)	IFLSW42G	ICVSW110	JBS-36AD
493)	ICVSW120	IXVSW21C	JBS-36AD	494)	IXVSW22C	IXVSW21C	JBS-36AD	495)	IXJSW32L	IXVSW21C	JBS-36AD
496)	IFLSW42G	IXVSW21C	JBS-36AD	497)	ICVSW120	IXJSW31L	JBS-36AD	498)	IXVSW22C	IXJSW31L	JBS-36AD
499)	IXJSW32L	IXJSW31L	JBS-36AD	500)	IFLSW42G	IXJSW31L	JBS-36AD	501)	ICVSW120	IFLSW41G	JBS-36AD
502)	IXVSW22C	IFLSW41G	JBS-36AD	503)	IXJSW32L	IFLSW41G	JBS-36AD	504)	IFLSW42G	IFLSW41G	JBS-36AD
505)	ICVSW130	IPMP31-S	4BS-333D	506)	IXVSW23C	IPMP31-S	4BS-333D	507)	IXJSW33L	IPMP31-S	4BS-333D
508)	IFLSW43G	IPMP31-S	4BS-333D	509)	ICVSW130	IMOP31-S	4BS-333D	510)	IXVSW23C	IMOP31-S	4BS-333D
511)	IXJSW33L	IMOP31-S	4BS-333D	512)	IFLSW43G	IMOP31-S	4BS-333D	513)	ICVSW130	ICCP31-F	4BS-333D
514)	IXVSW23C	ICCP31-F	4BS-333D	515)	IXJSW33L	ICCP31-F	4BS-333D	516)	IFLSW43G	ICCP31-F	4BS-333D
517)	IPMP31-S	4BS-333D	IPMP33-S	518)	IMOP31-S	4BS-333D	IPMP33-S	519)	ICCP31-F	4BS-333D	IPMP33-S
520)	IPMP31-S	4BS-333D	IMOP33-S	521)	IMOP31-S	4BS-333D	IMOP33-S	522)	ICCP31-F	4BS-333D	IMOP33-S
523)	IPMP31-S	4BS-333D	ICCP33-F	524)	IMOP31-S	4BS-333D	ICCP33-F	525)	ICCP31-F	4BS-333D	ICCP33-F
526)	ICVSW130	ICVSW110	4BS-333D	527)	IXVSW23C	ICVSW110	4BS-333D	528)	IXJSW33L	ICVSW110	4BS-333D
529)	IFLSW43G	ICVSW110	4BS-333D	530)	ICVSW130	IXVSW21C	4BS-333D	531)	IXVSW23C	IXVSW21C	4BS-333D
532)	IXJSW33L	IXVSW21C	4BS-333D	533)	IFLSW43G	IXVSW21C	4BS-333D	534)	ICVSW130	IXJSW31L	4BS-333D
535)	IXVSW23C	IXJSW31L	4BS-333D	536)	IXJSW33L	IXJSW31L	4BS-333D	537)	IFLSW43G	IXJSW31L	4BS-333D
538)	ICVSW130	IFLSW41G	4BS-333D	539)	IXVSW23C	IFLSW41G	4BS-333D	540)	IXJSW33L	IFLSW41G	4BS-333D
541)	IFLSW43G	IFLSW41G	4BS-333D	542)	ICVSW110	4BS-333D	IPMP33-S	543)	IXVSW21C	4BS-333D	IPMP33-S
544)	IXJSW31L	4BS-333D	IPMP33-S	545)	IFLSW41G	4BS-333D	IPMP33-S	546)	ICVSW110	4BS-333D	IMOP33-S
547)	IXVSW21C	4BS-333D	IMOP33-S	548)	IXJSW31L	4BS-333D	IMOP33-S	549)	IFLSW41G	4BS-333D	IMOP33-S
550)	ICVSW110	4BS-333D	ICCP33-F	551)	IXVSW21C	4BS-333D	ICCP33-F	552)	IXJSW31L	4BS-333D	ICCP33-F
553)	IFLSW41G	4BS-331D	ICCP33-F	554)	ICVSW130	ICVSW120	4BS-331D	555)	IXVSW23C	ICVSW120	4BS-331D
556)	IXJSW33L	ICVSW120	4BS-331D	557)	IFLSW43G	ICVSW120	4BS-331D	558)	ICVSW130	IXVSW22C	4BS-331D
559)	IXVSW23C	IXVSW22C	4BS-331D	560)	IXJSW33L	IXVSW22C	4BS-331D	561)	IFLSW43G	IXVSW22C	4BS-331D
562)	ICVSW130	IXJSW32L	4BS-331D	563)	IXVSW23C	IXJSW32L	4BS-331D	564)	IXJSW33L	IXJSW32L	4BS-331D
565)	IFLSW43G	IXJSW32L	4BS-331D	566)	ICVSW130	IFLSW42G	4BS-331D	567)	IXVSW23C	IFLSW42G	4BS-331D
568)	IXJSW33L	IFLSW42G	4BS-331D	569)	IFLSW43G	IFLSW42G	4BS-331D	570)	ICVSW110	4BS-331D	JBS-32AD
571)	IXVSW21C	4BS-331D	JBS-32AD	572)	IXJSW31L	4BS-331D	JBS-32AD	573)	IFLSW41G	4BS-331D	JBS-32AD
574)	ICVSW110	4BS-331D	IPMP32-S	575)	IXVSW21C	4BS-331D	IPMP32-S	576)	IXJSW31L	4BS-331D	IPMP32-S
577)	IFLSW41G	4BS-331D	IPMP32-S	578)	ICVSW110	4BS-331D	IMOP32-S	579)	IXVSW21C	4BS-331D	IMOP32-S
580)	IXJSW31L	4BS-331D	IMOP32-S	581)	IFLSW41G	4BS-331D	IMOP32-S	582)	ICVSW110	4BS-331D	ICCP32-F
583)	IXVSW21C	4BS-331D	ICCP32-F	584)	IXJSW31L	4BS-331D	ICCP32-F	585)	IFLSW41G	4BS-331D	ICCP32-F
586)	4BS-331D	JBS-32AD	IPMP33-S	587)	4BS-331D	IPMP32-S	IPMP33-S	588)	4BS-331D	IMOP32-S	IPMP33-S
589)	4BS-331D	ICCP32-F	IPMP33-S	590)	4BS-331D	JBS-32AD	IMOP33-S	591)	4BS-331D	IPMP32-S	IMOP33-S
592)	4BS-331D	IMOP32-S	IMOP33-S	593)	4BS-331D	ICCP32-F	IMOP33-S	594)	4BS-331D	JBS-32AD	ICCP33-F
595)	4BS-331D	IPMP32-S	ICCP33-F	596)	4BS-331D	IMOP32-S	ICCP33-F	597)	4BS-331D	ICCP32-F	ICCP33-F
598)	ICVSW120	4BS-331D	IPMP33-S	599)	IXVSW22C	4BS-331D	IPMP33-S	600)	IXJSW32L	4BS-331D	IPMP33-S

PRINTOUT OF MINIMAL CUT SETS FOR PHASE I

TITLE: SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS

TABLE 5 (continued)

SERVICE WATER SYSTEM INDIAN POINT 3 CUTSETS
(Sheet 7 of 7)

CUT SETS WITH 3 BASIC EVENTS.

[illegible]	[illegible]	[illegible]	[illegible]	IPMP11-S	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	IMOP11-S	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	ICCP11-1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

TABLE 6

SYSTEM EFFECTS OF PIPE FAILURE

Pipe Section Nuclear Header	Dia. (inches)*	System Failure	Potential for Other Systems Impact	Comments
1. #40[illegible]				
a. Pumps 34, 35, 36 discharge header (to SWN-[illegible])	24	Yes	Loss of cooling to containment building fan cooling units (CBFCU) and emergency diesel generators (EDG).	Operator can isolate and shift services to an intact header. (Time required approximately one hour.)
b. Discharge header (after SWN-[illegible])	24	Yes	Same as 1a.	Same as 1a.
c. Supply to [illegible] (after SWN-[illegible])	[illegible]	Yes	Same as 1a.	Operator can isolate SWN-3[illegible] and recover EDG. (T ≈ 15 min.)
d. Supply to CBFCU (after SWN-4[illegible], 40-1)	1[illegible]	Yes	Same as 1a	Operator can isolate SWN-40 or 40-1 and recover 3 of 5 CBFCU and EDG (T ≈ 15 min.)
e. Supply to CBFCU	[illegible]	Yes	Same as 1a.	Operator can isolate SWN-35 and SWN-40 or 40-1 and recover 2 of 5 CBFCU and EDG. (T ≈ 15 min.)
f. Supply to various conventional plant services (before FCV-[illegible])	1[illegible]	Yes	Same as 1a.	Same as 1a.
2. #4[illegible]				
a. Supply to component cooling (CCS) heat exchanger (before SWN-32)	2[illegible]	Yes	Same as 1a.	Same as 1a.
3. #[illegible]				
a. Supply to EDG (after SWN-3[illegible])	1[illegible]	Yes	Same as 1a.	Same as 1a.
4. #40[illegible]				
a. Supply to Turbine oil coolers etc. (before SWN-6)	10	Yes	Same as 1a.	Same as 1a.
5. #409				
a. Supply to CBFCU (after SWN-39)	1[illegible]	Yes	Same as 1a.	Same as 1d.

TABLE 6 (continued)

SYSTEM EFFECTS OF PIPE FAILURE

Pipe Section Nuclear Header	Dia. (inches)	System Failure	Potential for Other Systems Input	Comments
6. #409				
a. Pumps 31, 32, 33 discharge header (before SWN-98)	24	Yes	Loss of cooling to CCS heat exchangers	Same as 1a.
b. Discharge header (after SWN-98)	24	Yes	Same as 1a.	Same as 1a.
c. Supply to various conventional plant services (before [illegible])	16	Yes	Same as 6a.	Same as 1a.
7. #407				
a. Supply to CCS heat exchanger (after SWN-31)	16	Yes	Loss of cooling to CCS heat exchangers.	Operator can isolate and restore cooling to one CCS heat exchanger (T ≈ 15 min.)
8. #407				
a. Supply to CCS heat exchanger (before SWN-31)	[illegible]	Yes	Same as 6a.	Same as 1a.
8. #407 (continued)				
b. Supply to CCS heat exchanger (after SWN-31, (includes 18" - 407)	18	Yes	Same as 6a.	Same as 7a.
9. #1093				
a. Supply to EDG (after SWN-32)	10	Yes	Same as 6a.	Operator can isolate at SWN-32. (T ≈ 15 min.)
10. #409				
a. Supply to turbine oil coolers etc. (before SWN-7)	10	Yes	Same as 6a.	Same as 1a.

TABLE 7

INDIAN POINT 3 SERVICE WATER SYSTEM - CAUSE TABLE

Nuclear Header
Case I Boundary Condition: Power at All 480V Switchgear Buses

Component	Failure Data (Hourly) Mean	Failure Data (Hourly) Variance	Failure Data (Demand) Mean	Failure Data (Demand) Variance	System Effect	Failure Data (t = 24 hours) Mean	Failure Data (t = 24 hours) Variance
A. Single Events							
1. Piping failures (10)	8.60×10^{-9}	4.29×10^{-15}	-	-	System failure	2.06×10^{-7}	2.47×10^{-12}
2. Header isolation valves	9.15×10^{-8}	1.01×10^{-14}	-	-	System failure	2.20×10^{-6}	5.51×10^{-12}
B. Double Events							
1. Pump trains							
a. Pump fails to start	-	-	1.36×10^{-3}	1.22×10^{-6}			
b. Pump fails to run	4.68×10^{-5}	1.07×10^{-9}	-	-			
c. Expansion joint ruptures	8.60×10^{-9}	6.00×10^{-15}	-	-			
d. Check valve fails to open	-	-	6.91×10^{-5}	1.03×10^{-8}			
e. Discharge valve fails	9.15×10^{-8}	1.01×10^{-14}	-	-			
Single train total	4.69×10^{-5}	9.54×10^{-10}	1.43×10^{-3}	1.17×10^{-6}			
2 of 3 pump trains	-	-	-	-	System failure	7.59×10^{-6}	5.50×10^{-11}
2. EDG Flow control valve							
a. valve fails	-	-	4.98×10^{-4}	4.01×10^{-7}			
2 of 2 valves	-	-	-	-	System failure	6.27×10^{-7}	1.54×10^{-11}
C. Human Error							
1. Mispositioned switch	-	-	-	-	System failure	2.16×10^{-3}	1.46×10^{-5}
D. Common Cause	*	-	-	-			
E. Other	*	-	-	-			
F. Header Total					System failure	2.17×10^{-3}	1.41×10^{-5}

*Negligibly small failure probability.

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TABLE 7 (continued)

INDIAN POINT 3 SERVICE WATER SYSTEM - CAUSE TABLE

Nuclear Header
Case 2 Boundary Condition: Power at All 480V Switchgear Buses

Component	Failure Data (Hourly) Mean	Failure Data (Hourly) Variance	Failure Data (Demand) Mean	Failure Data (Demand) Variance	System Effect	Failure Data (t = 24 hours) Mean	Failure Data (t = 24 hours) Variance
A. Single Events							
1. Piping failures (10)	8.60×10^{-9}	4.29×10^{-15}	-	-	System failure	2.06×10^{-7}	2.47×10^{-12}
2. Header isolation valves	9.15×10^{-8}	1.01×10^{-14}	6.91×10^{-5}	1.03×10^{-8}	System failure	7.13×10^{-5}	8.93×10^{-9}
B. Double Events							
1. Pump trains							
a. Pump fails to start	-	-	1.36×10^{-3}	1.22×10^{-6}			
b. Pump fails to run	4.68×10^{-5}	1.07×10^{-9}	-	-			
c. Expansion joint ruptures	8.60×10^{-9}	6.00×10^{-15}	-	-			
d. Check valve fails to open	-	-	6.91×10^{-5}	1.03×10^{-8}			
e. Discharge valve fails	9.15×10^{-8}	1.01×10^{-14}	-	-			
Single train total	4.69×10^{-5}	9.54×10^{-10}	1.43×10^{-3}	1.12×10^{-6}			
2 of 3 pump trains	-	-	-	-	System failure	2.10×10^{-5}	2.48×10^{-10}
2. EDG Flow control valve							
a. valve fails	-	-	4.98×10^{-4}	4.03×10^{-7}			
2 of 2 valves	-	-	-	-	System failure	6.27×10^{-7}	1.54×10^{-11}
C. Human Error							
1. Mispositioned switch	-	-	-	-	System failure	2.16×10^{-3}	1.46×10^{-5}
D. Common Cause	*	-	-	-			
E. Other	*	-	-	-			
F. Header Total					System failure	2.25×10^{-3}	1.41×10^{-5}

*Negligibly small failure probability.

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TABLE 7 (continued)

INDIAN POINT 3 SERVICE WATER SYSTEM - CAUSE TABLE

Nuclear Header
Case 1 Boundary Condition: Power Lost at One 480V Switchgear Bus

Component	Failure Data (Hourly) Mean	Failure Data (Hourly) Variance	Failure Data (Demand) Mean	Failure Data (Demand) Variance	System Effect	Failure Data (t = 24 hours) Mean	Failure Data (t = 24 hours) Variance
A. Single Events							
1. Piping failures (10)	8.60×10^{-9}	4.29×10^{-15}	-	-	System failure	2.06×10^{-7}	2.47×10^{-12}
2. Header isolation valves	9.15×10^{-8}	1.01×10^{-14}	-	-	System failure	2.20×10^{-6}	5.51×10^{-12}
B. Double Events							
1. Pump trains							
a. Pump fails to start	-	-	1.36×10^{-3}	1.22×10^{-6}			
b. Pump fails to run	4.68×10^{-5}	1.07×10^{-9}	-	-			
c. Expansion joint ruptures	8.60×10^{-9}	6.00×10^{-15}	-	-			
d. Check valve fails to open	-	-	6.91×10^{-5}	1.03×10^{-8}			
e. Discharge valve fails	9.15×10^{-8}	1.01×10^{-14}	-	-			
Single train total	4.69×10^{-5}	9.54×10^{-10}	1.43×10^{-3}	1.12×10^{-6}			
2 of 3 pump trains	-	-	-	-	System failure	3.69×10^{-3}	1.88×10^{-6}
2. EDG Flow control valve							
a. valve fails	-	-	4.98×10^{-4}	4.03×10^{-7}			
2 of 2 valves	-	-	-	-	System failure	6.27×10^{-7}	1.54×10^{-11}
C. Human Error							
1. Mispositioned switch	-	-	-	-	System failure	2.16×10^{-3}	1.46×10^{-5}
D. Common Cause	*	-	-	-			
E. Other	*	-	-	-			
F. Header Total					System failure	5.85×10^{-3}	1.58×10^{-5}

*Negligibly small failure probability.

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TABLE 7 (continued)

INDIAN POINT 3 SERVICE WATER SYSTEM - CAUSE TABLE

Nuclear Header
Case 2 Boundary Condition: Power Lost at One 480V Switchgear Bus

Component	Failure Data (Hourly) Mean	Failure Data (Hourly) Variance	Failure Data (Demand) Mean	Failure Data (Demand) Variance	System Effect	Failure Data (t = 24 hours) Mean	Failure Data (t = 24 hours) Variance
A. Single Events							
1. Piping failures (10)	8.60×10^{-9}	4.29×10^{-15}	-	-	System failure	2.06×10^{-7}	2.47×10^{-12}
2. Header isolation valves	9.15×10^{-8}	1.01×10^{-14}			System failure	7.11×10^{-5}	8.91×10^{-9}
B. Double Events							
1. Pump trains							
a. Pump fails to start	-	-	1.36×10^{-3}	1.22×10^{-6}			
b. Pump fails to run	4.68×10^{-5}	1.07×10^{-9}	-	-			
c. Expansion joint ruptures	8.60×10^{-9}	6.00×10^{-15}	-	-			
d. Check valve fails to open	-	-	6.91×10^{-5}	1.01×10^{-8}			
e. Discharge valve fails	9.15×10^{-8}	1.01×10^{-14}	-	-			
Single train total	4.69×10^{-5}	9.54×10^{-10}	1.43×10^{-3}	1.12×10^{-6}			
2 of 3 pump trains	-	-	-	-	System failure	5.11×10^{-3}	2.68×10^{-6}
2. EDG Flow control valve							
a. valve fails	-	-	4.98×10^{-4}	4.03×10^{-7}			
2 of 2 valves	-	-	-	-	System failure	6.27×10^{-7}	1.54×10^{-11}
C. Human Error							
1. Mispositioned switch	-	-	-	-	System failure	2.16×10^{-3}	1.46×10^{-5}
D. Common Cause	*	-	-	-			
E. Other	*	-	-	-			
F. Header Total					System failure	7.35×10^{-3}	1.66×10^{-5}

*Negligibly small failure probability.

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TABLE 7 (continued)

INDIAN POINT 3 SERVICE WATER SYSTEM - CAUSE TABLE

Nuclear Header
Case I Boundary Condition: Power Lost at Two 480V Switchgear Buses

Component	Failure Data (Hourly) Mean	Failure Data (Hourly) Variance	Failure Data (Demand) Mean	Failure Data (Demand) Variance	System Effect	Failure Data (t = 24 hours) Mean	Failure Data (t = 24 hours) Variance
A. Single Events							
1. Piping failures (10)	8.60×10^{-9}	4.29×10^{-15}	-	-	System failure	2.06×10^{-7}	2.47×10^{-12}
2. Header isolation valves	9.15×10^{-8}	1.01×10^{-14}	-	-	System failure	2.20×10^{-6}	5.51×10^{-12}
B. Double Events							
1. Pump trains							
a. Pump fails to start	-	-	1.36×10^{-3}	1.22×10^{-6}			
b. Pump fails to run	4.68×10^{-5}	1.07×10^{-9}	-	-			
c. Expansion joint ruptures	8.60×10^{-9}	6.00×10^{-15}	-	-			
d. Check valve fails to open	-	-	6.91×10^{-5}	1.03×10^{-8}			
e. Discharge valve fails	9.15×10^{-8}	1.01×10^{-14}	-	-			
Single train total	4.69×10^{-5}	9.54×10^{-10}	1.43×10^{-3}	1.12×10^{-6}			
2 of 3 pump trains	-	-	-	-	System failure	1.0	0.0
2. EDG Flow control valve							
a. valve fails	-	-	4.98×10^{-4}	4.03×10^{-7}			
2 of 2 valves	-	-	-	-	System failure	6.27×10^{-7}	1.54×10^{-11}
C: Human Error							
1. Mispositioned switch	-	-	-	-	System failure	2.16×10^{-3}	1.46×10^{-5}
D. Common Cause	*	-	-	-			
E. Other	*	-	-	-			
F. Header Total					System failure	1.0	0.0

*Negligibly small failure probability.

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TABLE 7 (continued)

INDIAN POINT 3 SERVICE WATER SYSTEM - CAUSE TABLE

Nuclear Header
Case 2 Boundary Condition: Power Lost at Two 480V Switchgear Buses

Component	Failure Data (Hourly) Mean	Failure Data (Hourly) Variance	Failure Data (Demand) Mean	Failure Data (Demand) Variance	System Effect	Failure Data (t = 24 hours) Mean	Failure Data (t = 24 hours) Variance
A. Single Events							
1. Piping failures (10)	8.60×10^{-9}	4.29×10^{-15}	-	-	System failure	2.06×10^{-7}	2.47×10^{-12}
2. Header isolation valves	9.15×10^{-8}	1.01×10^{-14}	6.91×10^{-5}	1.03×10^{-8}	System failure	7.11×10^{-5}	8.93×10^{-9}
B. Double Events							
1. Pump trains							
a. Pump fails to start	-	-	1.36×10^{-3}	1.22×10^{-6}			
b. Pump fails to run	4.68×10^{-5}	1.07×10^{-9}	-	-			
c. Expansion joint ruptures	8.60×10^{-9}	6.00×10^{-15}	-	-			
d. Check valve fails to open	-	-	6.91×10^{-5}	1.03×10^{-8}			
e. Discharge valve fails	9.15×10^{-8}	1.01×10^{-14}	-	-			
Single train total	4.69×10^{-5}	9.54×10^{-10}	1.43×10^{-3}	1.12×10^{-6}			
2 of 3 pump trains	-	-	-	-	System failure	1.0	0.0
2. EDG Flow control valve							
a. valve fails	-	-	4.98×10^{-4}	4.03×10^{-7}			
2 of 2 valves	-	-	-	-	System failure	6.27×10^{-7}	1.54×10^{-11}
C. Human Error							
1. Mispositioned switch	-	-	-	-	System failure	2.16×10^{-3}	1.46×10^{-5}
D. Common Cause	*	-	-	-			
E. Other	*	-	-	-			
F. Header Total					System failure	1.0	0.0

*Negligibly small failure probability.

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TABLE 7 (continued)

INDIAN POINT 3 SERVICE WATER SYSTEM - CAUSE TABLE

Conventional Header
Cases 1 and 2 Boundary Condition: Power at All 480V Switchgear Buses

Component	Failure Data (Hourly) Mean	Failure Data (Hourly) Variance	Failure Data (Demand) Mean	Failure Data (Demand) Variance	System Effect	Failure Data (t = 24 hours) Mean	Failure Data (t = 24 hours) Variance
A. Single Events							
1. Piping failures (8)	6.88×10^{-9}	2.75×10^{-15}	-	-	System failure	1.65×10^{-7}	1.58×10^{-12}
2. Header isolation valves	9.15×10^{-8}	1.01×10^{-14}	6.91×10^{-5}	1.03×10^{-8}	System failure	7.11×10^{-5}	8.93×10^{-9}
B. Triple Events							
1. Pump trains							
a. Pump fails to start	-	-	1.36×10^{-3}	1.22×10^{-6}			
b. Pump fails to run	4.68×10^{-5}	1.07×10^{-9}	-	-			
c. Expansion joint ruptures	8.60×10^{-9}	6.00×10^{-15}	-	-			
d. Check valve fails to open	-	-	6.91×10^{-5}	1.03×10^{-8}			
e. Discharge valve fails	9.15×10^{-8}	1.01×10^{-14}	-	-			
Single train total	4.69×10^{-5}	9.54×10^{-10}	1.43×10^{-3}	1.12×10^{-6}			
1 of 3 pump trains	-	-	-	-	System failure	3.61×10^{-7}	1.49×10^{-13}
C. Test and Maintenance (with pump trains)	-	-	-	-			
D. Common Cause	*	-	-	-			
E. Other	*	-	-	-			
F. Header Total					System failure	7.18×10^{-5}	8.84×10^{-9}

*Negligibly small failure probability.

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TABLE 7 (continued)

INDIAN POINT 3 SERVICE WATER SYSTEM - CAUSE TABLE

Conventional Header
Cases 1 and 2 Boundary Condition: Power Lost at One 480V Switchgear Bus

Component	Failure Data (Hourly) Mean	Failure Data (Hourly) Variance	Failure Data (Demand) Mean	Failure Data (Demand) Variance	System Effect	Failure Data (t = 24 hours) Mean	Failure Data (t = 24 hours) Variance
A. Single Events							
1. Piping failures (8)	6.88×10^{-9}	2.75×10^{-15}	-	-	System failure	1.65×10^{-7}	1.58×10^{-12}
2. Header isolation valves	9.15×10^{-8}	1.01×10^{-14}	6.91×10^{-5}	1.03×10^{-8}	System failure	7.11×10^{-5}	8.93×10^{-9}
B. Triple Events							
1. Pump trains							
a. Pump fails to start	-	-	1.36×10^{-3}	1.22×10^{-6}			
b. Pump fails to run	4.68×10^{-5}	1.07×10^{-9}	-	-			
c. Expansion joint ruptures	8.60×10^{-9}	6.00×10^{-15}	-	-			
d. Check valve fails to open	-	-	6.91×10^{-5}	1.03×10^{-8}			
e. Discharge valve fails	9.15×10^{-8}	1.01×10^{-14}	-	-			
Single train total	4.69×10^{-5}	9.54×10^{-10}	1.43×10^{-3}	1.12×10^{-6}			
1 of 3 pump trains	-	-	-	-	System failure	4.40×10^{-5}	5.94×10^{-10}
C. Test and Maintenance (with pump trains)	-	-	-	-			
D. Common Cause	*	-	-	-			
E. Other	*	-	-	-			
F. Header Total					System failure	1.15×10^{-4}	9.34×10^{-9}

*Negligibly small failure probability.

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TABLE 7 (continued)

INDIAN POINT 3 SERVICE WATER SYSTEM - CAUSE TABLE

Conventional Header
Cases 1 and 2 Boundary Condition: Power Lost at Two 480V Switchgear Buses

Component	Failure Data (Hourly) Mean	Failure Data (Hourly) Variance	Failure Data (Demand) Mean	Failure Data (Demand) Variance	System Effect	Failure Data (t = 24 hours) Mean	Failure Data (t = 24 hours) Variance
A. Single Events							
1. Piping failures (8)	6.88×10^{-9}	2.75×10^{-15}	-	-	System failure	1.65×10^{-7}	1.58×10^{-12}
2. Header isolation valves	9.15×10^{-8}	1.01×10^{-14}	6.91×10^{-5}	1.03×10^{-8}	System failure	7.13×10^{-5}	8.91×10^{-9}
B. Triple Events							
1. Pump trains							
a. Pump fails to start	-	-	1.36×10^{-3}	1.22×10^{-6}			
b. Pump fails to run	4.68×10^{-5}	1.07×10^{-9}	-	-			
c. Expansion joint ruptures	8.60×10^{-9}	6.00×10^{-15}	-	-			
d. Check valve fails to open	-	-	6.91×10^{-5}	1.03×10^{-8}			
e. Discharge valve fails	9.15×10^{-8}	1.01×10^{-14}	-	-			
Single train total	4.69×10^{-5}	9.54×10^{-10}	1.43×10^{-3}	1.12×10^{-6}			
1 of 3 pump trains	-	-	-	-	System failure	1.72×10^{-2}	3.87×10^{-5}
C. Test and Maintenance (with pump trains)	-	-	-	-			
D. Common Cause	*	-	-	-			
E. Other	*	-	-	-			
F. Header Total					System failure	1.73×10^{-2}	3.85×10^{-5}

*Negligibly small failure probability.

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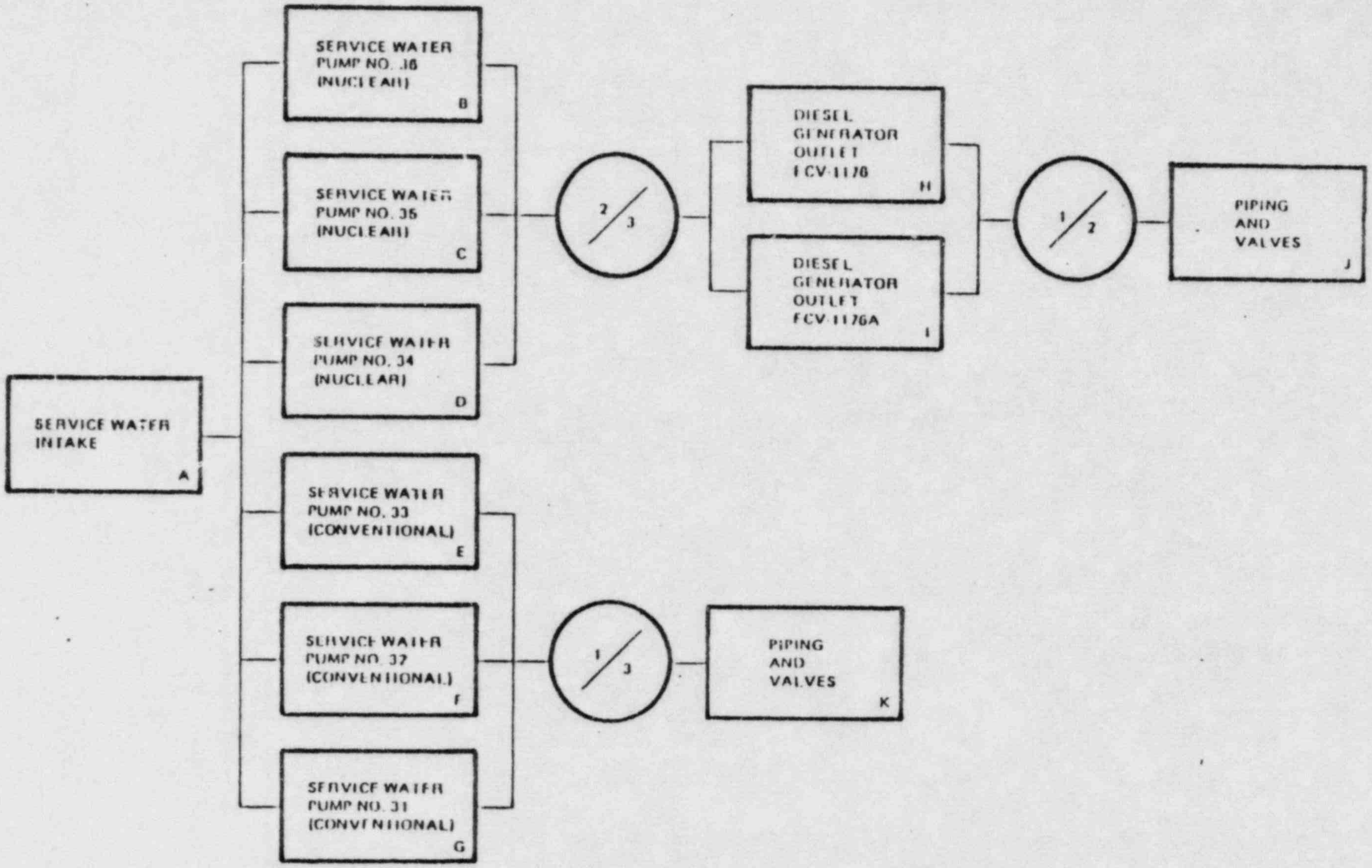


Figure 1. Service Water System Block Diagram

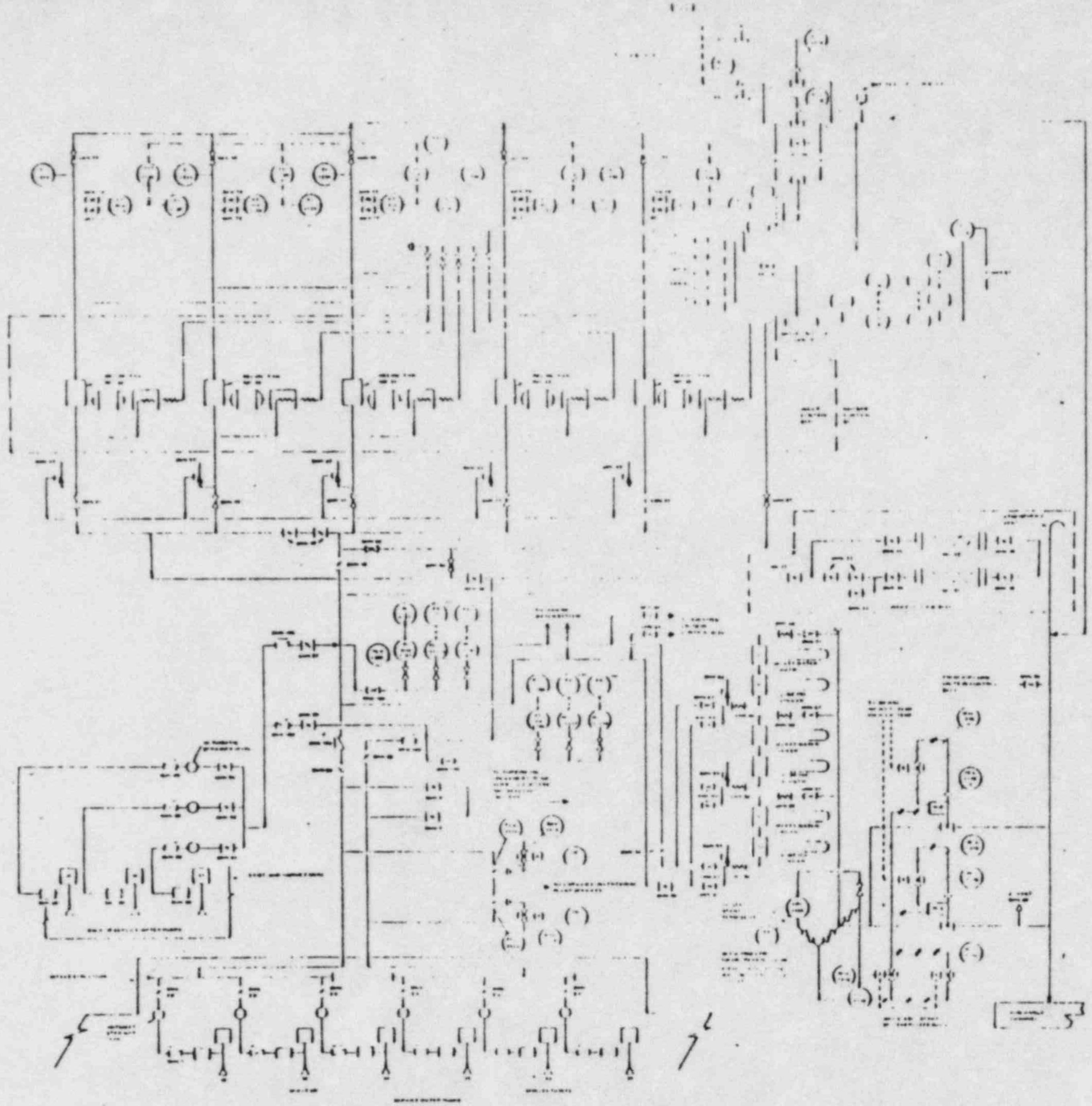


Figure 2. Simplified Schematic of Service Water System

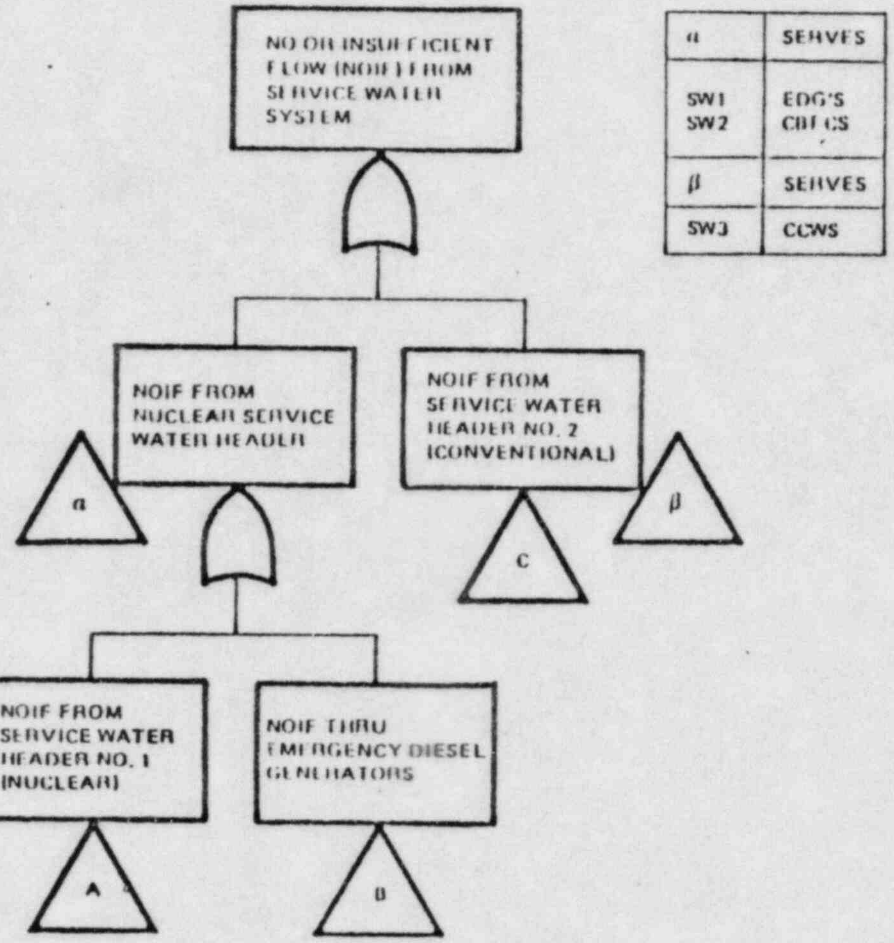


Figure 3. Service Water System Fault Trees
(Sheet 1 of 6)

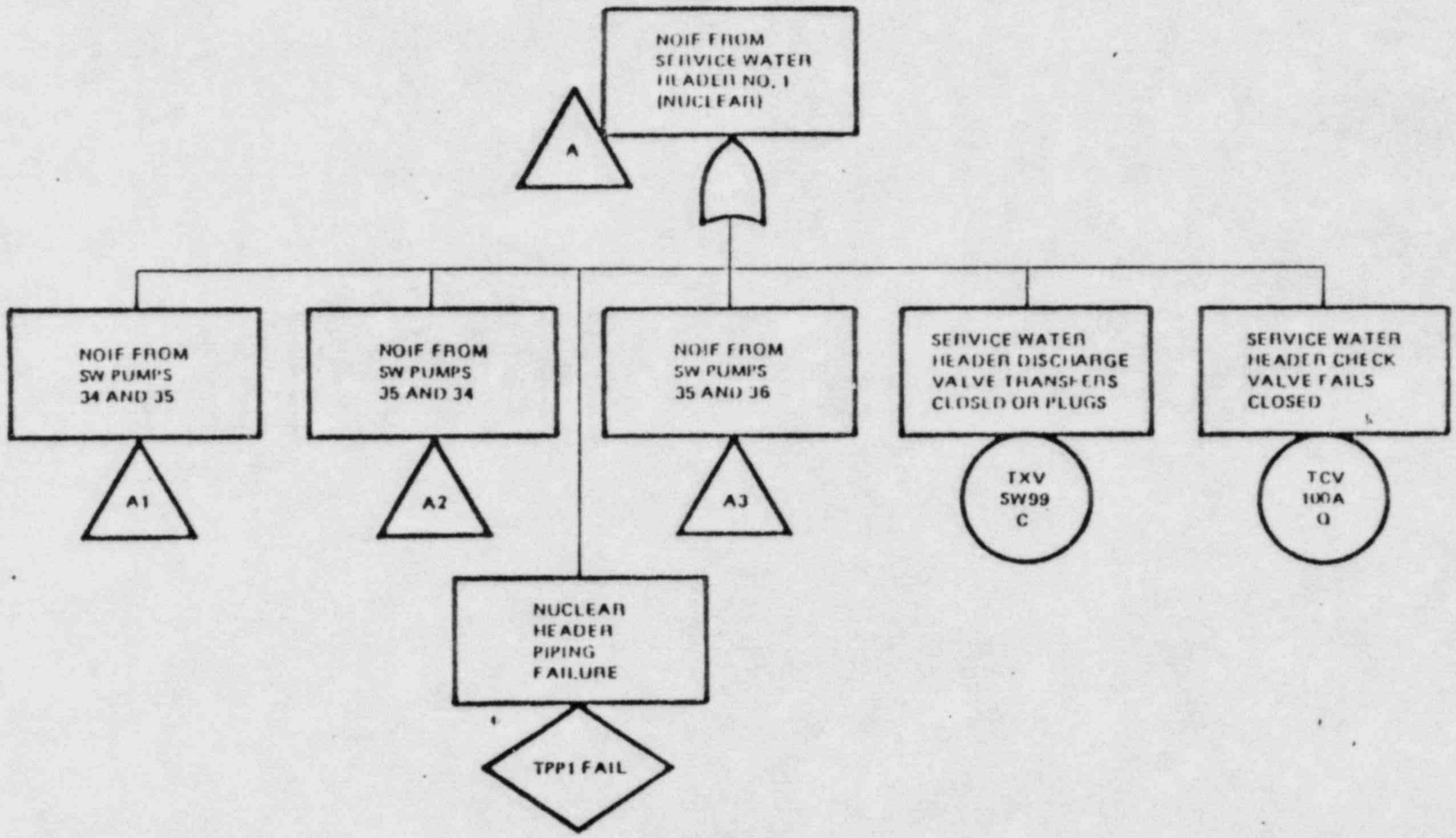


Figure 3. (Sheet 2 of 6)

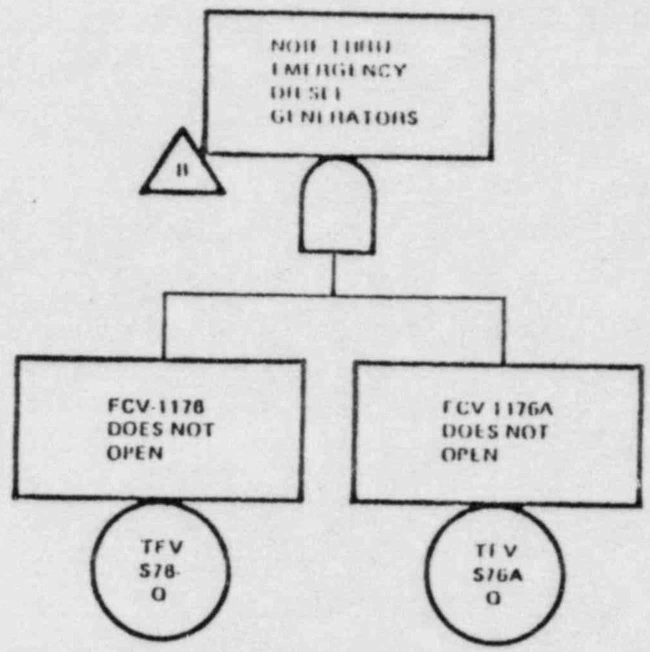


Figure 3. (Sheet 3 of 6)

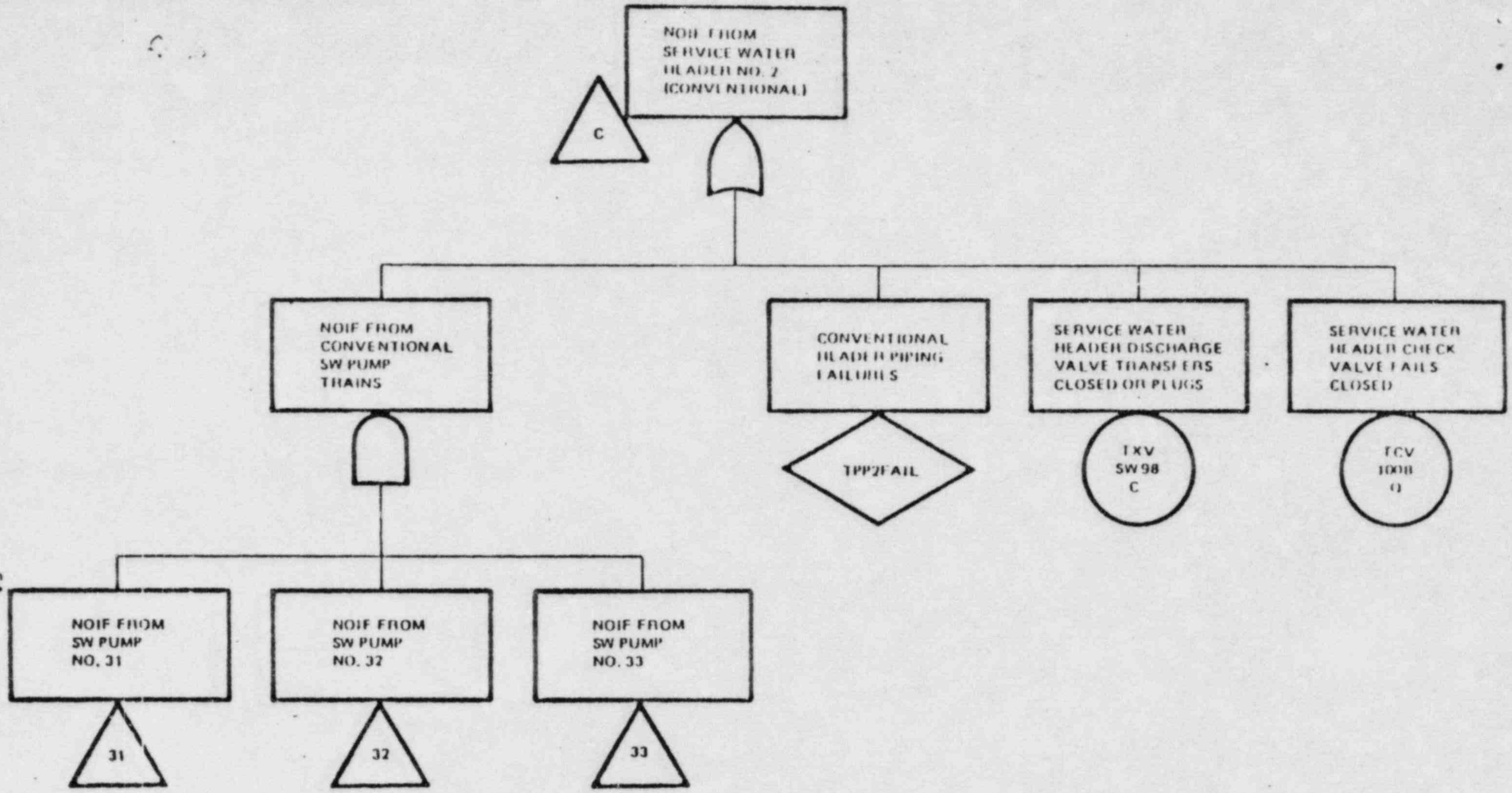
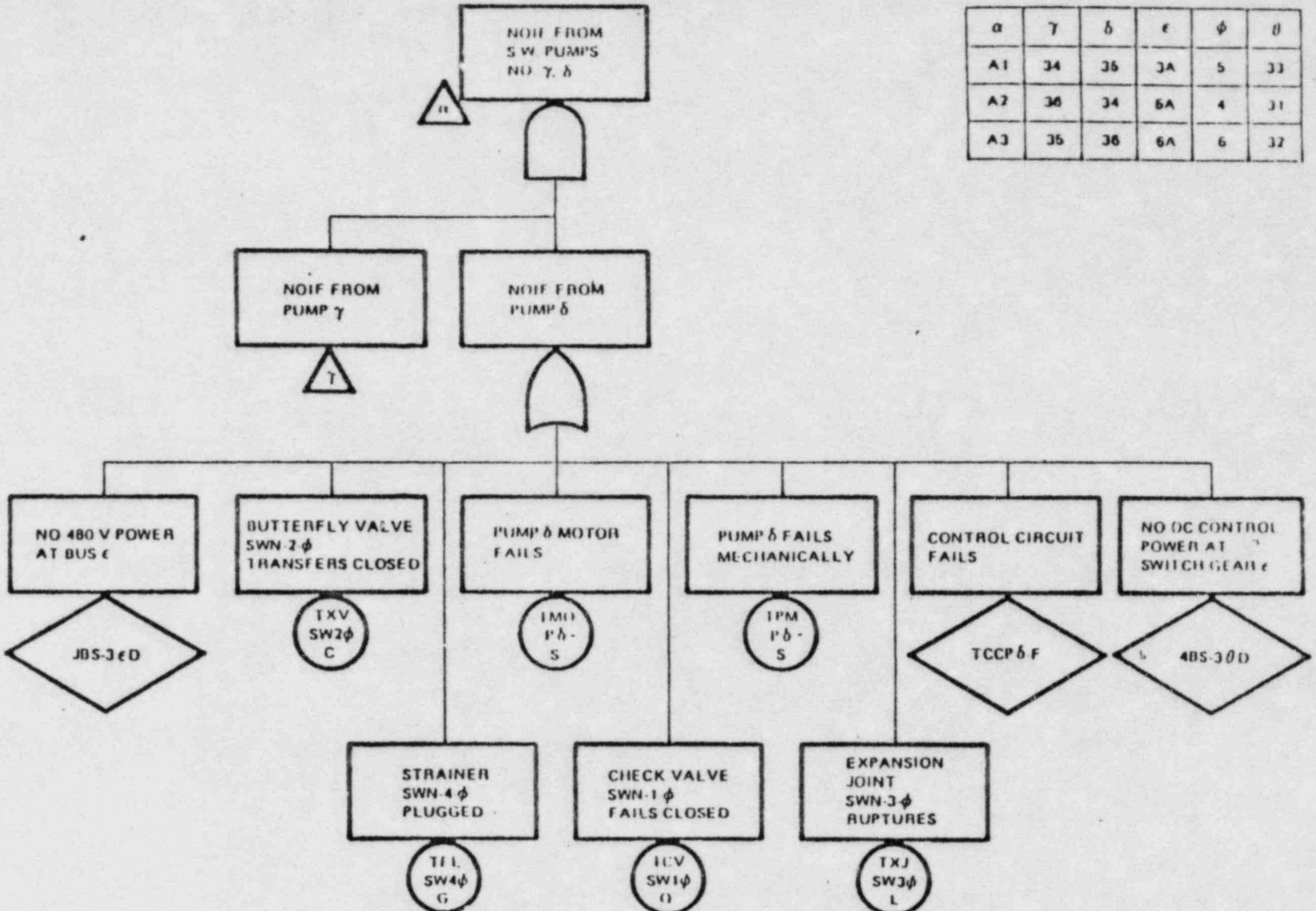


Figure 3. (Sheet 4 of 6)



α	γ	δ	ε	φ	θ
A1	34	35	3A	5	33
A2	36	34	6A	4	31
A3	35	36	6A	6	32

Figure 3. (Sheet 5 of 6)

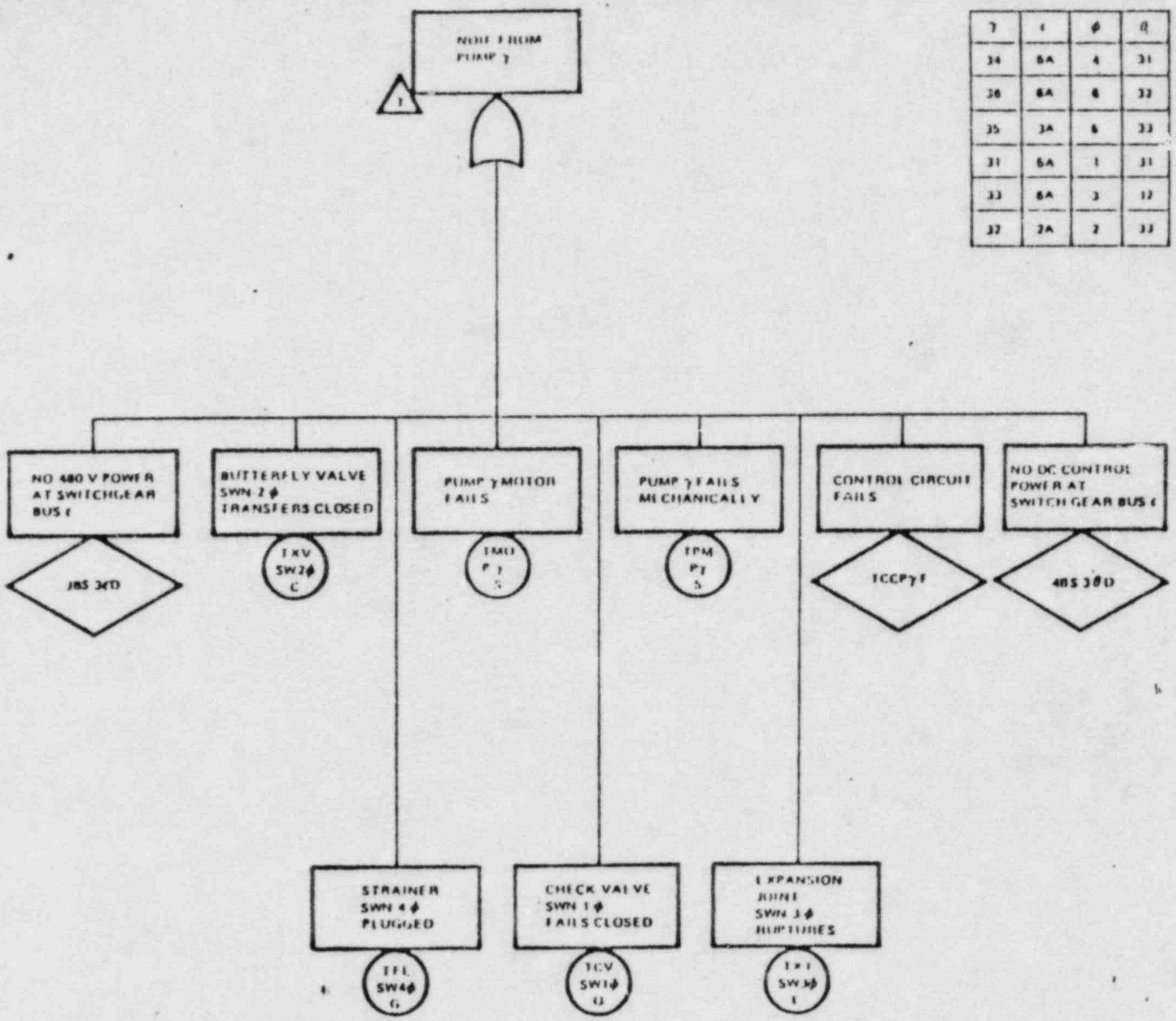


Figure 3. (Sheet 6 of 6)