VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

November 26, 1991

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Serial No. 91-134D
NO/ETS
Docket Nos. 50-280
50-281
License Nos. DPR-32
DPR-37

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
INDIVIDUAL PLANT EXAMINATION - INTERNAL FLOODING REANALYSIS

On August 30, 1991, Virginia Electric and Power Company submitted the results of the Individual Plant Examination (IPE) for Surry Power Station. In subsequent meetings with the NRC, we committed to perform a reanalysis of the internal flooding vulnerability to quantify the conservatism in the analysis and provide written responses for the additional questions that were raised by your staff. Enclosures 1 and 2 to this letter contain the Internal Flooding Reanalysis and the written responses to the staff questions, respectively. Enclosure 3 provides a summary of the completed activities and modifications and schedules for the planned activities and modifications to reduce the vulnerability to internal flooding.

As discussed with you on November 21, 1991, the activities and modifications taken to date have significantly reduced the CDF for Surry and are sufficient to address the vulnerability to internal floods. If you have any additional questions, please contact us.

Very truly yours,

W. L. Stewart
Senior Vice President - Nuclear

Enclosure 1 - Surry IPE- Internal Flood Reanalysis
Enclosure 2 - Request for Additional Information with Attachment
Enclosure 3 - Completed and Planned Activities and Modifications

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ENCLOSURE 2

NRC QUESTIONS ON IPE - INTERNAL FLOODING

a. Licensing basis (including compliance with GDC 4, GDC 17, and GDC 44), and current deviations.

Was there a moderate energy line break analysis performed for the SWS and CWS?
- What was the crack size criteria used?
- What was the leak rate criteria that was used for the expansion joints and how was it established/justified?

Does flooding scenario pose a problem for other issues such as station blackout, remote shutdown capability, fire protection, etc? Are previous licensing submittals still valid?

ANSWER:

The licensing basis for mitigation of turbine building flooding is discussed thoroughly in the SER on this subject issued on December 18, 1980. GDC 4, GDC 17 and GDC 44 concerning environmental (flooding) design bases, electric power systems design bases and cooling water system design bases respectively are satisfied by the current design. The design bases assume no failure in the seismic and safety related portions of the Circulating Water (CW) and Service Water (SW) Systems. Those portions of these systems which were non-seismic in design were addressed by using flow limiting shields, flooding sensors and automatic isolation of all CW flow at a level of 9 inches of water in the turbine building.

A review of the Surry UFSAR and the Surry SW System Design Basis Document has revealed no reference to a moderate energy line break analysis. It is concluded that no specific analysis was performed. In the turbine building, all of the CW and SW piping operate at pressures less than 15 psig and typically less than 10 psig. This low operating pressure, combined with the one half inch pipe wall thickness specified for this CW and SW piping, supports the conclusion that such an analysis is not required. Since no line break was postulated, no crack size criteria was relevant.

Design base leak rates for expansion joints were established considering the installation of flooding shields which limit the maximum leakage flow from any CW expansion joint. The hydraulic calculations used to establish this leakage flow for the installed flooding shields were performed as a part of the design change installing the shields. No leak rate contribution was considered for the seismic, safety related SW expansion joints. This is consistent with the design basis flooding analysis as noted in the SER on this subject dated December 18, 1980.

The design basis for flooding is addressed as a separately occurring event (i.e., no other accidents are assumed to be occurring concurrently). However, the design basis for flooding is to ensure that this specific event does not adversely affect other equipment important to safety. From this perspective, the design basis for flooding has been considered in other issues such as station black out, remote shutdown capability, fire protection, etc.

b. General description and arrangement of the Circulating Water System (CWS), the Service Water System (SWS), and the Turbine Building.

Are all of the first isolation valves of the main headers located inside the turbine building (including any manual isolation valves)?

Specifically what sections of the CWS and SWS are seismic category I / safety-related and which sections are not?

ANSWER:

General descriptions of the CW System, the SW System and the turbine building are attached. These descriptions are taken from Control Room Operator Training modules and provide general information concerning the configuration of these two systems and the turbine building. See Attachments 1, 2, and 3.

The first isolation valves of the main headers are all located inside the turbine building. This statement also applies to the manual isolation valves where no automatic, safety-related isolation requirements apply.

The following sections of the CW and SW Systems in the turbine building are safety-related and seismic: The CW System upstream of each of the condenser inlet isolation valve outlet flanges (1/2-CW-MOV-1/206A-D) is safety-related and seismic. The CW System downstream of the inlet flange of each of the condenser outlet isolation valves (1/2-CW-MOV-1/200A-D) is safety-related and seismic. The entire SW System is safety-related and seismic with the exception of the areas between the Bearing Cooling inlet and outlet manual isolation valves (these manual valves <u>are</u> safety-related), and the areas downstream of the Turbine Building Service Water and River Water Make-up Pump suction valves (1-SW-122 and SW-MOV-202A,B respectively). See Attachment 4.

c. Construction, installation and qualification details pertaining to the "rubber" expansion joints that are used in the CWS and SWS. A picture and vendor information would be helpful.

ANSWER:

DCP 86-10 and Specification NUS-2076 are attached to provide additional detail regarding the construction, installation and qualification of the rubber expansion joints in the Turbine Building. Vendor information for the expansion joints installed in DCP 86-10 is also provided. See Attachments 5, 6 and 7.

d. Specific locations of rubber expansion joints.

ANSWER:

The locations of the rubber expansion joints are as shown on the attached "Simplified Flow Diagram, Circulating Water System And Service Water System." See Attachment 4.

e. Rate of flooding, time required to isolate the flood, and time available before safety-related equipment is affected for the various scenarios.

What is the minimum unrecoverable leak rate? What size line or expansion joint gives this rate?

Without any sump pumps, how many gallons does it take before safety-related equipment is affected? What safety-related components or equipment is affected first?

ANSWER:

The flood damage timings for short term isolable flooding categories is given in Table E.6-11 [page E.6-61] of the Surry IPE . The IPE was submitted to the NRC on August 30, 1991.

The minimum unrecoverable leak rate assumed in the IPE report is 3,600 gpm [page E.3-7 -- note that a flood rate of 3,569 gpm is reported on this page with damage to the SW valve pits for the Recirculation Spray Heat Exchangers], which assumes 2 of 9 sump pumps and no Emergency Switchgear Room (ESGR) flooding within 24 hours. This flooding rate is not based upon a given pipe or expansion joint size, but is a calculated value based upon assumed sump pump availability. If 7 of 9 sump pumps are available, as currently assumed for IPE, the minimum unrecoverable leak rate increases to 9,100 gpm.

Without any sump pumps, a volume of approximately 1,393,000 gallons is required before water enters the Emergency Switchgear Room [page E.3-5]. Table E.3-8 and Section E.6.2.3 discuss the flood volume assumptions and flooding stages, in which at least one fire door between the Unit 1 Turbine Building and the Unit 2 Turbine Building is blocked open to increase the flooding volume. Water can flow into the Emergency Switchgear Room and the Auxiliary Building once the level in the Turbine Building reaches the top of the 24" flood protection dikes. An additional water volume of 15,750 gallons in the ESGR (for a total of approximately 1,400,000 gallons) corresponds to a 4 inch water height in the ESGR before flooding affects the 480 VAC buses and Motor Control Centers. The 4160 VAC buses, DC switch boards (120 VDC) and instrument buses (125 VAC) are not affected until a height of 8 inches in the ESGR.

f. Capability of the valves to close during flooding events given the flow rates that will be experienced and the potential for submersing the valves and/or spraying the valves during the flood.

Given failure of any of the expansion joints, is there adequate time to isolate upon detection of a leak? What is the minimum time required?

How long does it take to close the isolation valves?

ANSWER:

The design basis for flooding assumed an expansion joint failure. Mitigating this flooding event requires the isolation of the condenser inlet valves (1/2-CW-MOV-1/206A-D). The leakage flow rates past the flooding shields on the expansion joints are a factor of ten smaller than the normal operating CW System flow rate for which these valves are designed to close against. The condenser inlet isolation valves receive an automatic signal to close from turbine building flooding instrumentation at a depth of nine inches of water on the floor of the inlet valve pit. This permits these valves to close prior to the water level reaching a depth of ten inches due to the flood shield limited leak flow rate and the 60 second closure time of these valves (as verified by PT). It has been concluded that briefly spraying one of these valves during a flooding event will not affect its operability and as noted previously the valve will close before being submerged.

The design basis conservatively provides 20 minutes for operator action during a flooding event. This amount of time is based on leakage flowrates limited by the use of flooding shields installed on the expansion joints. The design evaluation associated with the installation of the flood shields concludes that the shields actually provide approximately 30 minutes for operator action. The safety related condenser inlet isolation valves are designed to close in 60 seconds, following operator manual action or automatic actuation, which represents less than one inch of additional water in the Turbine Building basement assuming full leakage flow past the flood shield.

g. Postulated core melt scenario.

What RCP seal leak rate was assumed and at what time in the event?

Does the "worst case" scenario also result in loss of DC power in addition to loss of all AC sources?

Would the steam driven auxiliary feedwater pump and associated instrumentation be available?

ANSWER:

IPE flooding scenarios affecting the ESGR (e.g., water level > 5") are assumed to result in core melt scenarios similar to those for the accident sequence, Loss of Emergency Switchgear Room Cooling. In general, core damage is assumed upon a loss of Reactor Coolant Pump (RCP) seal cooling, due to the RCP Seal LOCA that occurs when the RCP seals fail. The RCP seal leak rate is not important in this analysis since the scenario assumes core damage after RCP seal cooling is lost. No credit for mitigative actions was taken. The time of RCP seal cooling failure corresponds to the 5 inch water height in the ESGR, which is assumed to fail the 4160 VAC and 480 VAC buses [page E.3-5].

Although DC power is located at 8" in the ESGR, these scenarios assume the loss of emergency DC power in addition to the loss of emergency AC power when the water height in the ESGR reaches 5 inches.

The turbine driven auxiliary feedwater pump (FW-P-2) would not be physically affected by these scenarios, and should start and run. However, when emergency DC power is lost, instrumentation needed to monitor steam generator inventory is not available.

h. Mitigation of "single failure" scenarios.

The stop logs are credited for stopping flow to maintain the ultimate heat sink in a 1974 letter, but currently it appears that credit can not be taken for using the stop logs.

ANSWER:

In our response to a NRC question during initial licensing in October 1970, we state that "Long term cooling water canal integrity would be maintained by installing these stop logs." This statement was made in the context that credible leaks in the circulating water system would be small and the quantity of water lost would be minor. In a followup response to the same question in March 1971, we assumed a credible leak in the CW inlet piping would be limited to approximately 2000 gpm (1/8" crack around half of the circumference of a 96" line), This leakage was well within the capacity of the sump pumps. However, for long term recovery installation of the stop logs were necessary to isolate the 96" CW line from the canal for a repair.

i. Likelihood of a fire in the Turbine Building causing damage to the "rubber" expansion joints.

ANSWER:

The Turbine Building has a number of fire protection features to extinguish or minimize the effects of a fire. The general area under the turbine operating floor is protected by a wet pipe sprinkler system over each of the three levels under the turbine operating floor. Sufficient oil reservoirs and coolers are provided with concrete dikes capable of containing the contents or with a drainage trench. Many areas are provided with automatic heat detectors and manually activated deluge systems, automatic sprinkler systems or automatic CO_2 fire suppression systems. Additionally, backup fire mitigation is provided by a well trained fire brigade onsite using hose stations throughout the Turbine Building for manual fire fighting. Furthermore, station procedures control the amount of combustibles permitted into the area and a fire watch is required by procedure for any hot work such as cutting or welding. In addition, the flow shields on the expansion joints also serve as a shield from fire sources.

The frequency of fire initiated floods was judged to be a lower probability, when compared to water hammer initiated failures leading to internal flooding. Regardless, Virginia Power plans to address the frequency of internal fire initiating events in its submittal for Generic Letter 88-20, Supplement 4 - Individual Plant Examination of External Events (IPEEE) for severe Accident Vulnerabilities - 10CFR 50.54(f).

j. Existing programs for maintaining the condition and integrity of the CWS and SWS, a description of the current state of these systems, and a complete description of degradation mechanisms that have been observed.

ANSWER:

Circulating and Service Water Systems inspection and repair programs have been ongoing since 1986. The programs include cleaning, inspection, repair as necessary, and recoating. Prior to initiating this program, failure of the coal tar pipe coating had led to several localized corrosion pits resulting in leakage in the piping downstream of the condenser. Coating failures upstream of the condenser had resulted in localized corrosion but no through-wall leakage. The entire CW System has been cleaned, inspected, repaired as necessary, and recoated since these events. The coating material was changed from a coal tar to Chesterton epoxy. There has been only one recent example of through wall corrosion in the outlet piping since the recoating of the CW System. Reinspection schedules for the CW System are being reassessed based on this recent localized pit corrosion event. The SW System inspection and recoating portion of this program is continuing. Attached is the status of the inspection program by system (Attachment 8).

The butterfly valves in the CW and SW System had experienced degradation due to graphitic corrosion. The butterfly valves in the condenser inlet and outlet piping of the CW System were replaced in 1989 with new valves, having different material less suceptible to graphitic corrosion. The butterfly valves (first isolation) in the SW System piping supplying the Component Cooling, Bearing Cooling, and Recirculation Spray Heat Exchangers have also been replaced with new valves, having different material less suceptible to graphitic corrosion.

In addition to the above inspection and repair program, actions are ongoing in accordance with GL 89-13. These actions include:

- Periodic inspection of the RSHX inlet piping for the 'A" and 'C' high Level Intake Screenwells to the RSHXs. Inspection for biofouling, silt accumulation, corrosion product accumulation, foreign material/debris intrusion, and piping coating integrity.

- Periodic inspection of 8" SW piping to the control room chillers.

- Periodic inspection of the High and Low Level Intake Structures.

- Maintenance of wet layup chemistry of RSHX inlet piping from 1/2-SW-MOV-103/203 valves to just upstream of 1/2-SW-MOV-104/204 valves.

- Maintenance of dry layup of RSHXs.

- Development of an integrated Service Water Inspection and Maintenance Program.

Macroscopic biological media and silt have been observed during the inspection programs but are not considered degradative to the piping material integrity.

k. Postulated scenarios for initiating a water hammer in the CWS and SWS.

Are valve closure times fast or slow? A 1974 letter states that they are slow.

ANSWER:

Industry experience reveals that Circulating Water (CW) flooding events can occur when CW components such as expansion joints rupture during CW water hammer events. For Surry, the postulated initiator of a water hammer event resulting in a hydraulic transient with peak pressures high enough to result in component rupture would be caused by a rapid closure of the CW or Service Water (SW) isolation valves. Normal valve closure generates only a very minor pressure transient (2 psi) which is of no significance. A catastrophic valve fault is required for a Surry water hammer event, such as the following:

- Valve disk separation from valve upper stem

- Valve upper stem shear

- Failure of all valve operator mounting bolts allowing valve disk and stem to move free of restriction from operator

- Internal failure of valve operator allowing valve disk and stem to move free of restriction from operator

For a Surry water hammer event, the valve disk must rapidly move from a near fully open position to a fully closed position in the normal direction. A water hammer event in the circulating water system is addressed in the IPE - Flooding reanalysis (Section 3.3).

The RAB Questions for VEPCO

1. Discuss the results of the Surry core damage frequency calculations obtained using initiating event frequencies calculated by the "Oconee Method".

ANSWER:

The Surry IPE submittal utilizes two approaches in the determination of component specific rupture flood rate / frequency distributions [section E.2.6]. For the Service Water (SW) and Circulation Water (CW) sources inside the Turbine Building, a set of log-linear, rupture flow rate versus frequency distributions were generated, recognizing the specific characteristics of the Surry SW and CW systems. For the remaining flood sources the method adopted in the Oconee study (NSAC/60, 1984) was used. This combined approach resulted in the 1.1E-03 CDF reported.

While preparing the Surry submittal, Virginia Power originally utilized only the Oconee study method to produce a preliminary CDF of 1.5E-03. Since this calculation utilized early forms of input (e.g. parametric data base, logic models, etc.,) it is not directly comparable to the Surry submittal. However, these early results did indicate the importance of SW and CW flood sources, particularly from expansion joint and valve ruptures, and were valuable in focusing model refinements. The Oconee study also provides some verification that the log-linear distribution approach results are similar in magnitude to existing approaches.

2. Discuss all likely causes of non-isolable flood events occurring in the Turbine Building.

ANSWER:

Non-isolable floods are referred to as long term isolable floods which can only be isolated by installing the High Level Intake Structure stop logs. For the Circulating Water System, these events include breaks in the condenser inlet piping upstream of the condenser inlet valve (1-CW-MOV-106A thru D) or in the inlet valves themselves [page E.3-6, see also Table E.3-4 on page E.3-34]. For the Service Water System, these events include the piping and valves located in the Turbine Building SW valve pits [page E.3-11, see also Table E.3-9 on page E.3-40]. Any significant flood in these pits would quickly disable the valve motor operator, preventing remote closure. Manual closure is also doubtful as the control room operator may not be able to gain access to the valve handwheel for large flood flowrates. Hence, the event is considered long term isolable because it may be necessary to isolate the CW source of the SW by installing the High Level Intake Structure stop logs.

Following a review of industry data for flooding and component rupture events, the likely causes of non-isolable floods identified were expansion joint or pipe failures predominantly caused by pressure transients (water hammer) [section E.6.1.4.1]. Additional events such as valve packing leaks were identified, but these historically resulted in only minor leakage. Included in these latter events were maintenance actions, which usually resulted in only minor flooding rates. As a result, maintenance actions were concluded to be low frequency for non-isolable floods, when compared with the water hammer initiated failures. However, this initiator was addressed and quantified in the IPE reanalysis in Enclosure 1.

3. Are the Circulating Water (CW) and Service Water (SW) system valves capable of isolating under flooding flow conditions?

ANSWER:

All flooding flow rates under consideration with flooding shields installed are less than design flow values for both the SW and CW Systems. Therefore, it is concluded that if these safety-related valves are operable, they are capable of closing against flooding flow rates. See the response to Question f above.

4. Are CW and SW system welds, pipes, and valve bodies that are susceptible to breaks causing internal flooding subject to quality control and in-service testing to assure their integrity?

ANSWER:

The Inservice Inspection Program for both Surry Units 1 and 2 is based upon the 1980 Edition, Winter 1980 Addendum of the ASME Boiler and Pressure Vessel Code, Section XI. Code classification of components and component supports within the Service Water and Circulating Water systems is based on Regulatory Guide 1.26, Revision 3, "Quality Group Classification and Standards For Water, Steam, and Radioactive-Waste-Containing Components of Nuclear Power Plants," and ANSI N18.2, 1973. "Nuclear Safety Criteria For The Design Of Stationary Pressurized Water Reactor Plants."

In general, the Service Water system is classified ASME Class 3 in the portions of the system which support safety-related functions. Within the turbine building basement area, this piping starts at the Circulating Water lines to the condenser, through the MOV-SW-102 valves to the Component Cooling Heat Exchangers, or through the MOV-SW-103/203 valves to the Recirculation Spray Heat Exchangers. The Circulating Water system is classified ASME Class 3 only from the high level intake to the MOV-CW-106/206 valves. Drawings have been provided in Attachment 9, detailing the Code classification of the piping for each unit.

Inspection and testing requirements for Class 3 components are found in IWD-2000 and IWF-2000 of ASME Section XI. This is limited to visual, VT-3 examinations of the integral attachments and component supports, and visual, VT-2 examinations of the pressure boundary in conjunction with pressure testing. The pressure testing can be conducted at system pressure or at elevated hydrostatic test pressure as required in IWD-2000 and IWD-5000 of ASME Section XI. Pressure testing will be conducted three times in a normal ten year interval.

5. What were the design criteria for the shields used around the CW piping (and the 1" clearance), and those proposed for the SW piping?

ANSWER:

The design criteria used for the flooding shields for the CW System expansion joints specifically was based to provide a minimum of 20 minutes for operator action in response to a flooding event. A one half inch gap being specified between the flooding shield and the flange to limit flow. This gap provides approximately 30 minutes for operator action.

The design criteria applied for the recently installed flooding shields on the SW System expansion joints provided that the leakage rate be limited to less than the flow capacity of 7 of the turbine building sump pumps (9100 gpm). This would permit these sump pumps to control any leakage from these expansion joints with no external measures being required. Although this is the design basis, our design was intentionally more restricitve in an attempt to limit leakage to a significantly lower amount, In order to allow the operator access to manually close the motor operated valve. The shield design was tested at approximately four times maximum design pressure and a leak rate of less than 10 gpm was achieved without valve preconditioning.

ENCLOSURE 3

ACTIVITIES/MODIFICATIONS AND SCHEDULE TO REDUCE SURRY VULNERABILITY TO INTERNAL FLOODING

Activity or Modification	Schedule
Procedure Revisions for Response to Flooding (i.e., abnormal annunciator and response procedures) in TB, MER 3, Safeguards Building, and Auxiliary Building During Power Operation	Complete
Procedure Revisions for Isolation of CW and SW Piping for Maintenance During Outages	Complete
Implementation of EWR to Improve Flood Control Panel and Enhance Annunciation	Complete
Installation of Backflow Prevention Devices in Charging Pump Cubicle Drain Lines	Complete
Repair/Replacement of Certain Backflow Prevention Devices	Complete
Flow Shield Installation on Expansion Joints in Service Water Supply Lines for Bearing Cooling and Component Cooling	Complete
Communication of Importance of Flood Protection Program to Station Personnel	Complete
Procedure Revisions for CW Maintenance (i.e., double isolation, tagouts, flood watch during maintenance, slow refilling of CW lines prior to stop log removal)	Complete
Improved Sump Pump Reliability - Maintain at Least 7 Pumps Operable at All Times	Ongoing
Stop Log Staging, Procedures, and Assigned Personnel and Equipment in Place	Ongoing
Internal and External Inspection of a 96" Expansion Joint, External Inspection of the Bearing Cooling Expansion Joints, and Evaluation of Inspection Results	11/29/91
Restoration of Existing Expansion Joint Shields	12/31/91
Development of Turbine Building Sump Pump Operation Rotational Schedule	12/31/91

Development of Turbine Building Sump Pump Test Procedure (including level switches, check valves, pump flow testing)	12/31/91
Completion of Initial Performance of Turbine Building Sump Pumps Special Test to Establish Baseline for All Pumps	1/31/92
Evaluation of Insertion of Stop Logs during CW/SW Maintenance Activities	1/31/92
Reassessment of CW and SW Piping Inspection Schedules	1/31/92
Performance of Heavy Load Evaluation Using NUREG-0612 as a Guideline	1/31/92
Review of Annual PM Procedures for Flood Protection Devices and Schedule	2/15/92
Modification of CW MOV Locking Pins Such That Full Engagement into Valve Stem is Easily Discernable	To Support 2/92 U1 and 2/93 U2 Outages
Revision of Refueling Procedures for Testing Flood Protection and Alarm Systems	To Support 2/92 U1 and 2/93 U2 Outages
Development/Documentation of Expansion Joint Inspection Program and Service Life Replacement Program	To Support 2/92 U1 and 2/93 U2 Outages
Development/Documentation of Inspection Program for Valves (e.g., bolts, connecting pins, and manual operators)	To Support 2/93 U2 Outages
Development/Documentation of TB Sump Pump Reliability Program (e.g., operability requirements, surveillance and PM programs)	To Support 2/92 U1 and 2/93 U2 Outages
Replacement of Certain Expansion Joints	During 2/92 U1 and 2/93 U2 Outages
Assessment of the Need for a Flood Mitigation Equipment Reliability Program	2/28/92
Assessment of the Need for Procedures Validation of Operator Actions for Flood Mitigation	2/28/92
Assessment of Installation of Submersible Operators for BC/CC MOVs	12/31/92
Relocation of Power Source for Existing TB Sump Pumps	12/31/93

Internal Flooding Analysis Supplemental Report

Surry Nuclear Power Plant Units 1 and 2 For Individual Plant Examination

November 1991

HALLIBURTON NUS
Environmental Corporation

VIRGINIA POWER

INTERNAL FLOODING ANALYSIS

FOR THE INDIVIDUAL PLANT EXAMINATION

SUPPLEMENTAL REPORT

SURRY UNITS 1 AND 2

VIRGINIA ELECTRIC AND POWER COMPANY

NOVEMBER 1991

ABSTRACT

This document contains the results of a supplementary analysis of the potential for internal flooding events that lead to core damage at Surry Units 1 and 2 following the identification of flooding vulnerabilities during the course of the Individual Plant Examination. In this analysis a detailed review of potential water hammer events, the associated Service Water and Circulating Water System pressure transients and the potential for system component failure is addressed. Additional flooding events such as those occurring during and following maintenance are addressed, as are plant specific procedures for preventing or mitigating such events. The purpose of this reanalysis is to develop a more realistic risk model for internal flooding in order to quantify the conservatism in the model documented in the Surry IPE Report submitted to the NRC in August, 1991.

The point estimate core damage frequency for all of the current plant condition flooding events is 5.1E-5 per year compared with 7.4E-5 per year from all internal events. The highest core damage frequency from a single flood initiation event is 2.6E-5 per year compared with a core damage frequency of 1.5E-5 per year from the highest internal initiator, loss of offsite power.

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1.0 EXECUTIVE SUMMARY

1.1 BACKGROUND AND OBJECTIVES

The Surry IPE Final Report was submitted to the NRC on August 31, 1991 and a vulnerability to internal flooding was identified. The report also presented a series of modifications which, when implemented, would eliminate the vulnerabilities. In early October a presentation of the results was made to NRC. At that time Virginia Power explained that the internal flooding results were conservative and should only be viewed as a means of identifying vulnerabilities and their relative contribution to risk.

On October 23, 1991 NRC staff toured the Surry Power Station to view the Turbine Building basement and other key areas identified in the flooding analysis. At the end of the tour a meeting was held to discuss NRC comments. As part of this discussion the NRC requested a "better estimate" reanalysis to quantify the conservatism in the original submittal.

In the original base case analysis, as presented in the IPE submittal, the Circulating Water and Service Water system ruptures in the Turbine Building resulted in approximately 90% of overall risk due to flooding. Historically, the dominant contributors to major flooding events from Circulating Water (CW) systems have been caused by water hammer events. The mechanism leading to four of the reported incidents was a separation of the valve operator to disc linkage which allowed the disc to swing free and close rapidly under the forces exerted by the fluid flow. This mechanism, to some degree, is applicable to the Circulating Water and Service Water system butterfly valves at Surry. Furthermore, based on incident reports and conservative, "rule of thumb" engineering estimates, pressures due to water hammer during the previous events may have been up to 400 psig. Without detailed hydraulic calculations, pressures of this magnitude could not be ruled out for the systems at Surry, which would be sufficient to burst expansion joints or challenge the integrity of other piping components. Plant modifications and formalized procedures were therefore proposed and evaluated in the IPE submittal which would minimize the frequency of valve failures leading to water hammer, maximize the integrity of the components considered to be the most vulnerable (namely the expansion joints), and improve the ability of the plant to cope with substantial floods. This model of the potential for Turbine Building floods was believed to be quite conservative given the method used to evaluate the impact of a water hammer event.

In order to perform a better estimate analysis of the specific risk at Surry it was essential to know; (i) precisely how big of an overpressure could be generated by water hammer at specific locations in the CW and SW systems, and (ii) how strong are the components at each location. To this end, detailed hydraulic and stress calculations have now been performed for these systems. Subsequently, in the refined analysis presented within this report, the contribution from water hammer events to the Turbine Building flood hazard has been evaluated explicitly by considering the frequency of valve failures involving operator to disc separation as the rate at which the integrity of the SW and CW systems are challenged. This rate is then combined with the conditional probability of a system rupture through a deterministic analysis of the induced stress due to water hammer and an accepted correlation of stress versus failure probability. By adopting an approach which decouples the challenge rate and the system response, a more realistic analysis of the rupture frequency due to water hammer within specific segments of the SW and CW systems is possible. Since the overall flooding hazard is dependant upon the degree to which the rupture is isolable (long or short term), this information is crucial.

Having now performed an analysis specifically related to water hammer (and in fact shown that such events at Surry are much less significant than originally determined), the flooding hazard due to other mechanisms including residual internal stresses (corrosion, erosion etc.) and errors during maintenance activities, were also quantified separately. The flooding hazards associated with transportation of heavy loads, vehicular impact and fires are also considered qualitatively.

The objectives of this report are:

a) to present a refined analysis of Turbine Building floods which avoids much of the conservatism in the original analysis approach and demonstrate that the core damage frequency, today, from Turbine Building floods is approximately 2E-5 per year and the overall flood induced core damage frequency is approximately 5E-05 per year.

b) to demonstrate that the flood induced core damage frequency, event under the "base case" assumptions regarding the plant's flood protection measures, was significantly less than 1.1E-03 per year.

1.2 FLOODING RISK BASED ON CURRENT CONFIGURATION

In addition to utilizing a more refined approach for analyzing Turbine Building floods, several aspects of the existing CW and SW butterfly valve design and maintenance procedures, which were not recognized in the base case analysis, have now been accounted for, as has the improved sump pump reliability program. Furthermore, recently implemented plant modifications in the Turbine Building and Auxiliary Building have been addressed. A discussion of the results is presented below.

1.2.1 Turbine Building Floods

As discussed above, hydraulic and stress analyses to determine the specific response of the SW and CW system components to postulated water hammer inducing events were performed. The conclusion of this effort is that the peak pressure, resulting from the closure of 96" diameter valve, is approximately 61 psig. Pressures resulting from the closure of the smaller SW system valves were determined to be substantially less. The resulting maximum stresses in all components is well below yield, including reasonable factors for corrosion and mill tolerance. Using the stress versus probability of rupture correlation presented in NUREG/CR 5102, which is known to be conservative at stresses below yield, the most fragile long term isolable components were identified as being the covers over the 30" diameter manways which are located in the 48" diameter SW inlets. The conditional failure probability of these components is determined to be 3.0E-02, given exposure to the peak pressure. The most fragile short term isolable component is the condenser water box which was assigned a conditional (external) rupture probability 0.5 based on experience and judgement.

The frequency of water hammer was based on a search of historical failures involving butterfly valve operator to disc separation in CW and SW systems. Events were counted regardless of whether water hammer or flooding was reported as a consequence. The events were then evaluated against the specific features and duty of the Pratt butterfly valves installed at Surry to determine their degree of applicability, before estimating Surry specific valve failure frequencies. The pertinent features of the Surry valves are summarized below:

(i) All valves have been replaced during the last five years. Associated stress reports on sub components indicate the valves are adequately designed for their duty.

(ii) Valve to operator bolt connections were properly torqued when the valves were installed and an ongoing program to inspect and retorque these connections is being implemented. A portion of this program was already in place as part of the Virginia Power RCM program but was not accounted for in the base case flood analysis.

(iii) High strength bolts are installed in the valve operator to body mountings. This was always the case but was not accounted for in the base case analysis.

(iv) Inlet SW and CW isolation valves are normally fully open or fully closed and do not experience significant stresses or vibration that can occur on valves that are used for flow control or located on the discharge of a pump.

A formalized sump pump reliability program is being implemented to ensure that at least 7/9 Turbine Building sump pumps are available (total capacity 9100 gpm). In the base case analysis credit was given for only 2/9 pumps.

Shields have been installed on the expansion joints located in the SW valve pits inlet. This will ensure that the maximum flow rate given a rupture is within the capacity of the sump pumps.

Applying the refined analytical approach and accounting for the each of the above mentioned factors, the total contribution from Turbine Building floods to core damage frequency is 2.1E-05 per year. The contribution from each mechanism is as follows:

Flood Mechanism	Frequency/yr	Percent
Water Hammer Events	4.8E-06	22
Residual Internal Mechanisms (corrosion, erosion, etc.)	8.2E-06	38
Maintenance Activities	8.4E-06	40
Total CDF from Turbine Building Floods	2.1E-05	100

1.2.2 Auxiliary Building and Safeguard Building Floods

Floods originating in the Auxiliary Building or propagating into that area from the Safeguards Building, resulted in a significant risk contribution due to subsequent damage of all Unit 1 and Unit 2 Component Cooling Water and Charging pumps. The Component Cooling Water pumps are located in the general basement area (2' elevation) and the Charging pumps are located at the same elevation, but within individual cubicles. The cubicles are connected to each other and to the general basement area via floor drains and some pipe penetrations.

Modifications to install backflow prevention devices in the cubicle floor drains and seal two of the pipe penetrations have recently been implemented. This modification will significantly reduce the contribution from the Safeguards Building and Auxiliary Building floods ensuring that the charging pumps associated with at least one unit remain operable.

1.2.3 Overall Flooding Risk

The overall contribution due to internal flooding from all plant areas including those discussed above and the Mechanical Equipment Room No. 3, is 5.1E-05/year. This compares with the internal events core damage frequency of 7.4E-05/year. The contribution from each flood source is as follows:

Flood Source	Frequency/yr	Percent
Unit 1 and 2 Turbine Buildings	2.1E-05	41
Mechanical Equipment Room No.3	2.9E-05	57
Auxiliary Building	2.3E-07	~1
Unit 1 and Unit 2 Safeguards Building	4.5E-07	~1
Total CDF from all Flood Sources	5.1E-05	100

1.3 DISCUSSION OF CONSERVATISMS IN THE BASE CASE AND OTHER RESULTS PRESENTED PREVIOUSLY

Two sensitivity analyses have been performed to demonstrate that the analytical approach used to evaluate Turbine Building floods in the IPE submittal was indeed conservative. The results of this work also serve to clarify the reduction in the estimated risk which has been achieved by using a refined approach, relative to that brought about by actual plant changes or more realistic assumptions regarding the actual status of flood protection features at Surry.

The numerical results, presented in Table 1.3-1, indicate that if the flood hazard is evaluated under the base case, plant status assumptions but using the refined analytical approach, the estimated risk is nearly a factor of 10 below that obtained in the original study. Similar comparisons of two other cases (one of which is the current plant configuration analyzed above) indicate smaller margins due to the shift in risk dominance from water hammer mechanisms to other causes including maintenance errors and corrosion.

TABLE 1.3-1

COMPARISON OF TURBINE BUILDING FLOODING RISK ESTIMATES BASED ON DIFFERENT ANALYTICAL APPROACHES

Case	**Plant Status**	**Combined Frequency /yr of FDS 1TB5 and 2TB5** Original Analytical Method	Refined Analytical Method
1. Base Case (IPE submittal)	1. Frequency of water hammer does not account for Surry specific valve factors (see section 1.2.1) 2. Critical expansion joints replaced 3. Only CW expansion Joints shielded 4. 2/9 sump pumps operable	1.0E-03	1.2E-04
2. Plant status (as presented to NRC on 10/31/91)	1. Frequency of water hammer events accounts for Surry specific valve factors (see section 1.2.1) 2. Critical expansion joints replaced 3. Only CW expansion Joints shielded 4. 7/9 sump pumps operable	1.0E-4	3.0E-05
3. Current Plant Configuration	1. As 2 except shields installed on long term SW expansion joints.	4.0E-05	2.1E-05

2.0 INTRODUCTION

2.1 RELATIONSHIP TO THE SURRY IPE

The Surry Individual Plant Examination (IPE) was submitted on August 31, 1991. The results were atypical of most PRA's in the sense that the core damage frequency (CDF) was dominated by internal flooding events. Specifically, Turbine Building flood scenarios accounted for 91% of the CDF due to internal flooding. The base case CDF was 1.1E-3/yr. Modifications were proposed that would reduce the CDF to 9.9E-5/yr.

On October 9, 1991 an information meeting was held between Virginia Electric and Power Company (Virginia Power) and the United States Nuclear Regulatory Commission (NRC). At this meeting Virginia Power presented an overview of the flooding analysis, stressing the conservative nature of the assumptions underlying the analysis. The meeting was followed by an NRC tour of Surry on October 23, 1991. At the conclusion, a reanalysis was requested to reduce the conservatism in the original analysis.

The results of this more realistic internal flooding analysis are presented in this supplemental report to the Surry IPE report (Virginia Power, 1991). As such, this report is a stand alone document. It was prepared at the request of the NRC to reassess the conservatisms in the internal flooding analysis of the IPE submittal. The objectives of this report are:

a) to present a refined analysis of Turbine Building floods which avoids much of the conservatism in the original analysis approach and demonstrate that the core damage frequency, today, from Turbine Building floods is approximately 2E-5 per year and the overall flood induced core damage frequency is approximately 5E-05 per year.

b) to demonstrate that the flood induced core damage frequency, event under the "base case" assumptions regarding the plant's flood protection measures, was significantly less than 1.1E-03 per year.

2.2 ISSUES ADDRESSED

In the original base case analysis, as presented in the IPE submittal, the Circulating Water and Service Water system ruptures in the Turbine Building resulted in approximately 90% of overall risk due to flooding. Historically, the dominant contributors to major flooding events from Circulating Water (CW) systems have been caused by water hammer events. The mechanism leading to four of the reported incidents was a separation of the valve operator to disc linkage which allowed the disc to swing free and close rapidly under the forces exerted by the fluid flow. This mechanism, to some degree, is applicable to the Circulating Water and Service Water system butterfly valves at Surry. Furthermore, based on incident reports and conservative, "rule of thumb" engineering estimates, pressures due to water hammer during the previous events may have been up to 400 psig. Without detailed hydraulic calculations, pressures of this magnitude could not be ruled out for the systems at Surry, which would be sufficient to burst expansion joints or challenge the integrity of other piping components. Plant modifications and formalized procedures were therefore proposed and evaluated in the IPE submittal which would minimize the frequency of valve failures leading to water hammer, maximize the integrity of the components considered to be the most vulnerable (namely the expansion joints), and improve the ability of the plant to cope with substantial floods. This model of the potential for Turbine Building floods was believed to be quite conservative given the method used to evaluate the impact of a water hammer event.

In order to perform a better estimate analysis of the specific risk at Surry it was essential to know; (i) precisely how big of an overpressure could be generated by water hammer at specific locations in the CW and SW systems, and (ii) how strong are the components at each location. To this end, detailed hydraulic and stress calculations have now been performed for these systems. Subsequently, in the refined analysis presented within this report, the contribution from water hammer events to the Turbine Building flood hazard has been evaluated explicitly by considering the frequency of valve failures involving operator to disc separation as the rate at which the integrity of the SW and CW systems are challenged. This rate is then combined with the conditional probability of a system rupture through a deterministic analysis of the induced stress due to water hammer and an accepted correlation of stress versus failure probability. By adopting an approach which decouples the challenge rate and the system response, a more realistic analysis of the rupture frequency due to water hammer within specific segments of the SW and CW systems is possible. Since the overall flooding hazard is dependant upon the degree to which the rupture is isolable (long or short term), this information is crucial.

At the same time other residual mechanisms internal to the systems (e.g., corrosion, erosion, fatigue) which may result in component failures were addressed separately from water hammer.

In the IPE the contribution of flooding events following actions taken during or following maintenance activities was considered small compared with other contributors based on industry experience. Maintenance activities at Surry have now been specifically addressed quantitatively. In addition, the potential for floods as the result of fires or the dropping of heavy loads is also addressed qualitatively in this study.

The analysis of system pressure resulting from water hammer events, the stresses induced in each component in the system and the capacity of each component are developed in Section 3.1. The frequency of water hammer events is developed in Section 3.2, and the flood hazard in the Turbine Building from these events is discussed in Section 3.3. The Turbine Building flood hazard from non-water hammer randomly occurring floods is discussed in Section 3.4. The potential for floods occurring during maintenance activities is discussed in Section 3.5. Flooding induced by other events such as fires or the dropping of heavy loads is also discussed in Section 3.5. Finally the determination of the core damage frequency resulting from floods in the Turbine Building is developed in Section 3.6.

Another issue addressed is a modification to the drain lines in the charging pump cubicles which will reduce the risk from floods in the auxiliary building (Section 4.0).

2.3 DISCUSSION OF FLOODING METHODOLOGY

2.3.1 Introduction

In the initial flooding analysis (Virginia Power, 1991) for the flood areas found to be potentially significant, the frequency of flooding from system failures was determined on the basis of industry data on component leakage and rupture. This resulted in derivation of the following:

1. A distribution of flood frequency versus flooding rate using hydraulic calculations where necessary to augment industry information.

2. The identification of flood sources which result in equilibrium flood heights which do not cause damage.

3. The flood source and associated frequency at a particular location within a flood area, which is important if the flood hazard being evaluated is attributable to spraying.

As flow rate and dewatering capacity are critical items in any flooding analysis it was decided not to use the Oconee approach for specific rupture flood rate/frequency distributions (NSAC, 1984) in the Turbine Building. Virginia Power chose to develop a log-linear relationship of rupture flow rate versus frequency distributions based on a detailed examination of historical flooding events which would recognize the specific characteristics of the Service Water and Circulating Water Systems at Surry. The Oconee approach was used for all the other areas as there was insufficient historical evidence to develop a relationship.

This approach used the data for water hammer events and the resultant floods for all plants, modified for some of the specific valve characteristics at Surry. It does not however look at the complete design of the Surry CW and SW Systems, and the unique gravity feed arrangements.

2.3.2 Revised Approach to Determine Flood Hazard from Water Hammer Events

In order to reduce some conservatisms introduced by the use of generic data, the frequency of Turbine Building floods from water hammer events has been revised using the approach outlined in Appendix F of NUREG/CR-5102 (Bozoli, 1989) to assign a probability to pressure boundary failure in piping and components. The approach adopted is summarized in the following paragraphs and discussed in detail in Section 3.

The overall objectives of the investigation are:

1. To determine the frequency of water hammer events.

2. To determine the fluid pressure induced by the water hammer events.

3. To determine the induced stresses in each SW and CW component following the water hammer event.

4. To determine the probabilities of component failure.

5. To determine the potential break openings following component failure.

The water hammer event is only postulated to occur in the systems at Surry if the valve disc is no longer restrained by the valve operator so that it can rapidly rotate towards the closed position. Service Water and Circulating Water System valve failures of this type are reviewed and the appropriate events considered, based on the specific design, materials, maintenance and inspection practices at Surry to determine a frequency for water hammer events.

The butterfly valve failures are postulated for the 42 and 36 inch diameter isolation valves nearest to the Intake Canal in the SW System and for the 96 inch diameter isolation valves on both sides of the condenser waterbox in the CW System. To investigate possible pressure variation and to establish the maximum water hammer pressure, several fluid transients are analyzed.

After the fluid transient pressures are established and piping components subjected to this pressure identified, each affected component is evaluated to determine the level of stress within it. At the same time the material properties of each component are evaluated to establish average yield and ultimate stresses.

The information from the previous two steps are used to determine the failure probabilities of each component based on a distribution which maximizes uncertainty and is constrained assuming that the mean rupture inducing stress is 90% of the ultimate stress and the probability of rupture at the ultimate stress is 0.99. This method is discussed in NUREG/CR-5102.

The potential break size for the component with the highest probability of failure is also evaluated.

The next stage of the analysis is to combine all the above information to derive the flood hazard. The result is the frequency and magnitude of the predicted floods and finally the core damage frequency determined by combining the hazard with the flood mitigation features, the resulting plant trip and the impact of the flood on the system required to maintain core cooling following the plant trip.

As the above approach resulted in lowering the core damage frequency due to water hammer events, the contribution of low frequency floods as the result of other internal mechanisms, maintenance activities, movement of heavy loads, and fire events was also investigated.

3.0 ANALYSIS OF FLOODING EVENTS IN THE TURBINE BUILDING

3.1 SYSTEM INVESTIGATION FOR POSTULATED BUTTERFLY VALVE FAILURES

3.1.1 Introduction

The overall objective of this system investigation (SWEC, 1991) is to determine the potential for rupture that could exist in various Service and Circulating Water System components resulting from a water hammer event. The water hammer event is postulated to occur as a result of any mechanism that allows the valve disc to swing freely and rotate to a closed position. The effect of a downstream transient or postulated break upon the ability of the isolation valve nearest the intake canal to close is also considered.

This disc detachment is postulated to occur in the 96, 42, and 36-inch diameter butterfly isolation valves nearest to the intake canal. The increase in pressure due to this hypothetical failure will vary in magnitude depending upon the location of the valve in the system. To investigate possible pressure variations and to establish the maximum water hammer pressure to be used in the component evaluation, several fluid transient analyses are performed as discussed in Section 3.1.3.

After the fluid transient pressures are established and piping components subjected to this pressure are identified, each affected component was evaluated to determine the state of stress within it. To better determine the probability of a component failure due to fluid transient induced stresses, an evaluation of material properties is conducted to establish average yield and ultimate strengths and failure probability curves. The material properties in conjunction with the calculated stresses are then used to establish the probability of component failures.

In addition, a confidence level associated with the determination of water hammer pressures, the calculation of component stress, and the determination of average material properties is also established.

The final purpose of this investigation is to evaluate different approaches for determining potential break opening areas and resulting flow rates.

3.1.2 Description of System

3.1.2.1 Overall System Description

The Circulating Water (CW) System (see Figure 3.1-1) draws water from the James River to provide cooling water for the main condensers and to provide water for the Service Water System.

The 1.7 mile long intake canal provides a flow path for river water from the discharge of the Circulating Water pumps to the high level intake screenwells, which supply water to the condensers and the

Service Water (SW) System. Water level in the intake canal is normally kept at an elevation of approximately 25 to 30 feet.

From the intake canal, the circulating water flows by gravity through the following train of components:

- screenwell
- 96-inch line
- condenser inlet isolation valve
- inlet waterbox, tube bundle, and outlet waterbox
- 96-inch pipe with an outlet isolation valve
- discharge tunnel for that unit

There are four such trains, designated A, B, C and D for each main condenser. Each 96-inch CW line delivers approximately 193,250 gpm to the condenser. Service Water lines tap off the 96-inch inlet pipes upstream of the inlet isolation valves.

Each condenser inlet line is provided with a motor-operated isolation valve (1-CW-MOV-106A, B, C and D). These are 96-inch butterfly valves bolted to the inlet piping and to the inlet waterboxes. Each valve is provided with a locking pin which secures the valve disc in the closed position when maintenance is being performed on the valve drive train and fixes the valve disc in the position in which it has the tightest closure. Essentially identical motor-operated isolation valves (1-CW-MOV-100A, B, C and D) are installed in the outlet lines.

Both the condenser inlet and outlet lines are provided with expansion joints (flexible boots) between the isolation valves and the waterboxes. The inlet lines have one expansion joint immediately downstream of the isolation valve. The outlet lines have two expansion joints; one at the outlet waterbox and one immediately upstream of the isolation valve.

SW system piping originates from branches in the 96-inch CW lines upstream of the CW inlet MOVs. The SW system supplies cooling water through the plant by way of several supply headers which can be isolated by hand-operated or motor-operated valves.

The elevation difference between the intake canal and the discharge tunnel provides the motive force for the flow of the service water to the various loads. Various components are supplied directly by gravity flow, other components are supplied directly via booster pumps.

The following major SW system loads are supplied by gravity flow via large diameter piping:

- four Recirculating Spray (RS) heat exchangers per unit
- three Bearing Cooling (BC) heat exchangers per unit
- four Component Cooling (CC) heat exchangers serving both units

The MOVs that supply and isolate the RS heat exchangers are normally shut. They are opened automatically in the event of a containment atmosphere high-high pressure signal (CLS hi-hi), which indicates a LOCA or MSLB (Main Steam Line Break). The CW MOVs to the main condensers and SW MOVs to the BC heat exchangers and CC heater exchangers are normally open and are shut automatically upon a CLS signal initiated in the event of a LOCA (or MSLB) that occurs coincident with a loss of offsite power to both units.

Expansion joints are provided downstream of each of the MOVs located in the above supply headers. The MOVs are the first isolation valve from the intake canal. Table 3.1-1 identifies the SW system normal flow rates during power operation.

TABLE 3.1-1

SW SYSTEM OPERATING FLOW RATES

	Normal Operation		Shutdown of One Unit (i.e. cooling down of one unit)	
Components (Design Requirements)	Unit 1	Unit 2	Shutdown Unit	Operating Unit
CC heat exchangers (9,000 gpm each)	9,000[1]	9,000[1]	18,000	9,000[1]
BC heat exchangers (12,000 gpm each)	24,000	24,000	24,000	24,000
Charging pump SW pump (90 gpm each)	90	90	90	90
Control and Relay Room (AC unit (330 gpm)	330	330	330	330
Mechanical chillers (1,800 gpm)	1,800	1,800	1,800	1,800
RS heat exchangers (6,000 gpm each)	-	-	-	-

[1] Flow could be 18,000 gpm during summer operation with two CC heat exchangers operating per unit.

3.1.2.2 <u>Concerns Relating to Valve Failures</u>

Currently, the major contributors to flooding risk are associated with so-called "long-term isolable" flood sources in the Turbine Building. These consist of the following:

- Condenser inlet CW pipe sections (8) between Turbine Building floor and condenser inlet MOVs (96" x 18" long)
- Condenser inlet MOVs (8)
- Service water MOVs (6) located in Turbine Building valve pits which supply BC and CC heat exchangers
- Upstream piping associated with above-mentioned SW MOVs
- 30" manways upstream of the above-mentioned MOVs

These flood sources can only be isolated by installing stop logs at the high level intake screenwells.

The potential consequences of the above flood sources are:

- Overflow 2 ft high dike protecting Emergency Switchgear Room and flow into that room (also at 9' 6" elevation) via gaps at the sides and bottom of the doors or by forcing the doors to open. Water would initially enter the Unit 2 Emergency Switchgear Room and subsequently overflow a 3 inch high curb at the entrance to the Unit 1 Emergency Switchgear Room.
- Overflow 2 ft high dike protecting the Auxiliary Building tunnel and flow into the Auxiliary Building basement (2 ft elevation).

The focus of this effort is to examine the current assumptions which drive the estimation of the flood hazard associated with these sources and develop a more realistic model, based on analyses of the potential failure modes. In this analysis the postulated mechanism for significant valve and pipe ruptures is water hammer resulting from rapid closure of one of the SW or CW system butterfly valves. Several events have occurred at nuclear power plants that resulted in flooding due to failures caused by the rapid closure of large CW butterfly valves. The applicability of the butterfly valve failures to the Surry Power Station is provided in Section 3.2.

3.1.2.3 <u>System Boundaries Selected for Evaluation</u>

Boundaries selected for evaluation of potential impact of water hammer pressures extend from the intake canal to the first isolation valve in the CW and SW systems because this is the region associated with the "long-term isolable" flood sources in the Turbine Building. In addition, possible failure of the piping components between the first and second isolation valves in the CW and SW systems were considered as a secondary flooding risk region because these should be isolable rather quickly by closing the proper MOV nearest to the intake canal. Both boundaries are identified in Figure 3.1-1.

3.1.3 Fluid Transient Analysis

3.1.3.1 Analysis Approach and Scenarios Analyzed

The Henry Pratt Company provided operating data for their 96, 42, and 36-inch butterfly valves as a function of valve angle position and pressure differential across the valve disc. These operating data are used to develop a closing profile for a free-swinging disc that is not under positive control of the valve operator. The closing profile is then input to the Stone & Webster WATHAM fluid transient program which computed peak pressures upstream of the closing disc. These maximum transient pressures at selected locations are then used as input loading for the system piping and component analysis in Section 3.1.5 and the integrity of isolation valves evaluation in Section 3.1.6.

The Pratt valve data provides dynamic torque versus valve disc angle which is produced by the flow of water over the closing disc and bearing torque which is produced by the shaft friction for the pressure differential across the disc. The dynamic torque must overcome the bearing torque for the disc to close. Also, the disc cannot move significantly faster than the water flow velocity. Hence, the disc tip velocity was considered to be no more than 1.5 times the average flow velocity expected by Pratt data. This procedure allows the valve closure profile to be determined and input with the Pratt valve loss coefficient, K, for each valve angle into the WATHAM transient evaluation program.

This transient program is used to evaluate the 96, 42 and 36-inch valves nearest the intake canal in the circulating and service water piping. The resulting fluid deceleration generated peak pressures which are used as noted above. Similar valve closure transients in valves downstream of the subject valve sizes would have produced similar peak pressures, but the peak pressures would have been attenuated prior to reaching the valve nearest the intake canal in each line.

3.1.3.2 Assumptions

The following assumptions apply to the fluid transient analyses performed:

- Pipe sizes of 10" and smaller are not evaluated because a failure in this size pipe would not produce severe flooding.
- The reverse swing direction of the free-swinging disc is assumed to create lower peak pressures than the normal flat face upstream position because in the reversed "closed" position there is an additional clearance of 1.5" radially on

the 96" valve which represents approximately 6.3% valve open. This is additive to the normal opening at the smaller valve positions, and is judged to be less severe than the normal closure direction for the free-swinging disc.

3.1.3.3 **Summary of Results**

Results of the fluid transient analysis for a postulated valve operator failure are summarized below for the three valve sizes evaluated:

Valve Size	Peak Pressure Due to Valve Closing	Peak Pressure of Any Valve Closure
96" valve	61 psig	61 psig
42" valve	25 psig	56 psig
36" valve	37 psig	42 psig

Due to the system configuration, the closure of the upstream 96" Circulating Water valve causes the largest peak pressures in each of the significant components analyzed as shown on Figure 3.1-1. The pressures shown are attenuated for the fitting losses at tees between the 96" valve and the points where pressures are shown. Table 3.1-2 presents a tabulation of the selected maximum transient pressures for each of the 29 items selected upstream of the isolation valve nearest the intake canal. Figure 3.1-1 shows a solid line boundary at these valve locations.

Downstream of these valves there is a possibility of transient pressure waves due to either closure of the 96" valves in the Circulating Water System when the Service Water valves are open or due to closure of another downstream valve in either the Circulating Water or Service Water piping. Closure of a downstream 96" valve in the CW piping would cause similar peak pressures but these would be attenuated as they travel upstream to the MOV nearest to the intake canal. Closure of the 30" service water valves (second isolation valves in SW piping) although not analyzed are assumed to be capable of causing a peak pressure equal to the higher produced by either a 36" or 42" valve with a free-swinging disc which is 37 psig. Maximum downstream pressures are considered to be the higher of the attenuated pressures produced by the 96" valve or 37 psig. This resulted in the pressures noted on Figure 3.1-1 for points between the first and second isolation valves in the service water piping.

TABLE 3.1-2

SELECTED MAXIMUM TRANSIENT PRESSURES

ITEM #	COMPONENT DESCRIPTION	MAX PRESS. (psig)	TRANSMISSION FACTORS TRANS. FACTOR	DESCRIPTION of ATTENUATION COMPONENT
UPSTREAM OF ISOLATION VALVES				
1	96"- 90 Elbow	61.00	1.00	
2	96" X 48" Tee	61.00	1.00	
3	96" X 42" Tee	61.00	1.00	
4	96" X 30" Reinf. Tee	54.00	0.89	96x48 tee
5	96" Flange Bolts	61.00	1.00	
6	96" Flange	61.00	1.00	
7	96 (ID)-WC Pipe	61.00	1.00	
8	48" X 36" Tee	54.00	0.89	96x48 tee
9	48" X 30" Tee	54.00	0.89	96x48 tee
10	48" X 30" Reinf.Tee	38.00	0.63	96x48 tee, 2-48x30 tees
11	48" WS Pipe	54.00	0.89	96x48 tee
12	48" Cap	25.00	0.41	96x48 tee, 3-48x30 tee, 48x36 tee
13	42" X 6" Tee	56.00	0.91	96x42 tee
14	42" WS Pipe	56.00	0.91	96x42 tee
15	42" Flange Bolts	56.00	0.91	96x42 tee
16	42" Flange	56.00	0.91	96x42 tee
17	36" WS Pipe	42.00	0.69	96x48 tee, 48x36 tee
18	36" Flange Bolts	42.00	0.69	96x48 tee, 48x36 tee
19	36" Flange	42.00	0.69	96x48 tee, 48x36 tee
20	30" WS Pipe	46.00	0.75	96x48 tee, 48x30 tee
21	30" Manhole	52.00	0.85	96x48 tee, 96x30 tee
22	30" MH Flange Bolts	52.00	0.85	96x48 tee, 96x30 tee
23	30" MH Flange	52.00	0.85	96x48 tee, 96x30 tee
24	30" MH Cover (1" Thick)	52.00	0.85	96x48 tee, 96x30 tee
25	30" Flange Bolts	52.00	0.85	96x48 tee, 96x30 tee
26	30" Flange	46.00	0.75	96x48 tee, 48x30 tee
27	30" MH Cover (3/4" Thick)	32.00	0.53	96x48 tee, 3-48x30 tee
28	96" Valve Body	61.00	1.00	Source
29	42" Valve Body	56.00	0.91	96x42 tee
30	36" Valve Body	42.00	0.69	96x48 tee, 48x36 tee
DOWNSTREAM OF FIRST ISOLATION VALVE				
31	24" MH Flange	37.00	-	36" Valve Closing Pressure
32	24" MH Flange Bolts	37.00	-	36" Valve Closing Pressure
33	24" MH Cover (3/4" Thick)	37.00	-	36" Valve Closing Pressure
34	42" X 42" (22) Lateral	56.00	0.91	96x42 tee
35	36" X 36" (45) Lateral	42.00	0.69	96x48 tee, 48x36 tee

3.1.3.4 Estimate of Variation of Results

The fluid transient evaluation has several sources of variations in the valve closure profiles and peak pressures developed. The dynamic torque would be larger due to slightly higher transient fluid flow velocities than the steady state values Pratt listed for each angle position, but this is offset by two factors. First, at a valve angle of 15 to 20 degrees from the closed position, the dynamic torque is approximately zero. This is the point where peak pressures are observed. Secondly, the pressure differential across the valve disc during the transient is larger than the steady state difference which would cause a significantly larger bearing torque that would tend to reduce the closing rate of the free-swinging disc.

Use of the above procedures with the particular variables indicate that a variation of 25% would be a reasonable value for the uncertainty involved in this type of transient evaluation. Thus, a peak pressure of 80 psig or as low as 42 psig could have been obtained for closure of the 96" valve. As noted above, the calculated pressure of 61 psig is used in the stress evaluations and failure predictions which follow.

3.1.4 Material Properties

Average tensile properties of metallic materials of critical components in the CW and SW systems are determined for use in the failure probability predictions. The minimum and typical ultimate tensile strength (UTS) for the metallic materials being considered are presented in Table 3.1-4 in Section 3.1.7.

Properties were developed for carbon steel, ductile iron and stainless steel by searching available sources for test data that would allow an estimate of average tensile properties. These sources included in-house Stone and Webster Engineering Corporation data, a literature search of outside computer data bases, and telephone conversations with various organizations and individuals.

3.1.5 System Piping and Component Analysis

3.1.5.1 Analysis Approach

The analysis approach used to calculate stress in piping components consisted of a number of steps. The first identified the components subjected to water hammer induced pressures that are located upstream of the isolation valves nearest to the intake canal in either the Circulating Water or Service Water Systems. The number of affected components upstream of these isolation valves is 85 on Unit 1 and 78 on Unit 2. Components similar in geometry and size are grouped together and evaluated for the maximum pressure that is postulated to occur at any one component. An additional 44 piping components downstream of the first isolation valves are evaluated by addressing only the types of components that are determined limiting by the initial evaluation.

The calculation of stress only included pressure induced stress resulting from the fluid dynamic event associated with the postulated valve failure. Thermal stresses are considered insignificant because of the low temperature. Deadweight stresses and the unbalanced segment force due to the water hammer are also considered insignificant since most of the piping is embedded in concrete. At valve pit locations, where only a relatively small portion of piping is exposed, stresses associated with deadweight are also small.

The calculated component stresses use the minimum wall thicknesses and include a joint efficiency factor where applicable. The minimum wall is established by subtracting the mill tolerance and a corrosion allowance of 1/16 in from the nominal wall. The result of this calculation is a minimum wall of 3/8 inch for pipe sections.

For the purpose of this investigation, the valves and piping components are assumed to be free of flaws.

3.1.5.2 Component Evaluation Methodology

Straight pipe and elbows are evaluated by calculating circumferential pressure stresses. The stresses are increased by 1.25 if the material specification, fabrication and examination process indicated a joint efficiency factor was applicable.

Tees and fabricated branches are evaluated by calculating circumferential pressure stresses in the run piping portion of the intersection. The resulting stresses are increased by 1.25 if a joint efficiency factor of 0.8 is indicated as appropriate for this material. In addition, the stress is increased by an additional factor of 1.25 to account for the reduced burst strength inherent in these type of components when compared to straight pipe (WRC, 1989).

Flange connections to valves and manhole covers consist of flat faced flanges with full faced gaskets. There are no code simplified design procedures for this type of flange joint. The approach utilized to calculate flange stress and to evaluate bolt stress is a method developed by Taylor Forge.

Manhole covers consist of circular flat plates bolted to flat faced flanges. The flanges and bolts are evaluated using the flange procedure described in Taylor Forge. The cover is evaluated as a circular plate, pinned at the ends and subjected to a pressure defined over an area considering the bolt hole diameter.

Expansion joints are not stress analyzed. However, the critical expansion joints have been hydrotested to pressures significantly higher than the expected transient pressures calculated in this study. As certified by RM-HOLZ, the manufacturer of the critical expansion joints, the burst pressure is at least four (4) times the design pressure (SWEC, 1991 B).

The calculation of stress for the various piping components is estimated to have a variation as indicated below. Those with a variation of 0% are judged to have representative stresses for the mill tolerance and corrosion allowance considered.

Component	Variation
Straight pipe	0%
Elbows	0%
Tees & Branches	5%
Flanges	5%
Manhole Covers	0%

Table 3.1-5 identifies the components evaluated and the corresponding calculated stresses resulting from the peak pressure loading identified.

3.1.6 Integrity of Isolation Valves

3.1.6.1 Following a System Rupture Downstream

If there were a rupture of a piping component or fluid transient such as could be caused by the free-swinging disc closure of a butterfly valve downstream of the isolation valve nearest to the intake canal, the resultant pressure would be attenuated as it would travel through the piping to the intake canal. This downstream pressure pulse is evaluated as being no more severe than 61 psig in the CW piping due to closure of the second 96" valve or in the SW piping the higher of the attenuated 96" pressures or 37 psig as was discussed in Section 3.1.3. Hence, critical isolation valves (i.e. those nearest the intake canal) would experience lower pressures from downstream valve closure than that caused by closure of a 96" critical valve.

The evaluation of the integrity of the valve body for this loading is enveloped by the pressures considered during the isolation valve closure in Section 3.1.6.2.

3.1.6.2 During Isolation Valve Closure

Stresses in the isolation valve bodies are calculated for the peak pressures resulting from the transient fluid flow produced by the postulated failure of the valve operator. The primary membrane stress in the valve body due to the peak internal pressure is calculated using the methods and dimensional data specified in Pratt, 1987 A, B, C and ASME, 1974. The stress results for each valve size considered are:

TABLE 3.1-3

ISOLATION VALVE BODY STRESSES

Valve Size	Peak Pressure, psig	Primary Membrane Stress, psi	Primary Membrane plus Bending Stress, psi	Allowable Stress, psi
96"	61	2013	5494	13000
42"	56	467	6182*	13000
36"	42	603	5173*	13000

* These stresses are based on assumed dimensions for the valve body cross sections which result in a conservative estimation of the maximum stress.

The 42" and 36" valve flange thicknesses in Table 3.1-3 are assumed to be 1.50" and 1.34", respectively. No reinforcement of the valve body-to-flange junction is assumed for either valve. The actual dimensions of the valve body cross sections are expected to be greater than these assumed values, which would result in maximum valve body stresses lower than reported in Tables 3.1-3 and 3.1-5. Calculations reflecting the sensitivity of the valve body stresses to variations in the assumed dimensions indicate that valve body stress levels are relatively low, regardless of the dimensions assumed, and have minimal impact on the failure rate estimated in Table 3.1-5.

The valve body material is specified as ASTM A 536 Grade 65-45-12 (Virginia Power, 1987 A, C). The allowable stress used for this material is the lesser of $S_y/3$ or $S_u/5$ in accordance with standard water industry practice as specified in Pratt, 1987 A, B, and C.

Calculations for the valve body stresses due to internal peak pressure reported in Table 3.1-3 a use methodology similar to that used in Pratt, 1987 A, B, and C for qualification of the valves for system design conditions. The calculation of primary membrane stress in the valve body is based on ASME, 1974, paragraph NB-3545.1(a)(2). The calculation of primary membrane plus bending stress at the junction of the valve body and valve flange is based on the method referenced in Section 3.1.5.2 of this study.

3.1.6.3 Evaluation of Disc Deformation

The disc of an open CW or SW butterfly valve would not be subjected to significant pressure differential due to a transient pressure wave. The wave would quickly pass the open disc with approximately the same pressure buildup simultaneously on both sides.

When the disc closes, the maximum pressure differential across the disc would be the maximum pressure upstream of the closing valve to the downstream pressure, assumed to be 0 psig. The valve discs should have no significant disc deformation during this level of pressure transient.

3.1.7 Probability of Component Failures

In establishing the flooding frequency, it is not enough to know the frequency of failures in butterfly valves leading to water hammer. It is also necessary to establish whether the resulting pressure pulse in the Circulating Water and Service Water Systems is sufficient to rupture the fluid boundary and more specifically, to determine the probability of rupture. In the portions of these systems which are non-isolable, all components are metallic. The rubber expansion joints are all located in isolable portions of these systems.

The probability of rupture in piping systems is related to stress. A discussion of the background and derivation of a conservative method for estimating rupture probability is given by NUREG/CR-5102 (Bozoli, 1989) and is summarized below. Knowing the stress in various components (Section 3.1.5) and the probability relations generated by the NUREG methodology, it is possible to establish rupture probabilities for each system following the postulated water hammer. These are provided in Section 3.1.7.2.

3.1.7.1 Failure Probability Methodology

The piping rupture probabilities for the components of interest, excluding expansion joints, were calculated, using the methodology introduced in NUREG/CR-5102 for calculation of interfacing LOCA pipe break probability.

With reference to Appendix F of NUREG/CR-5102, the test data on a series of unflawed pipe specimens of A106 B steel indicated that the average rupture stress was at approximately 90% of the ultimate stress independent of the pipe size. In this analysis it is assumed that the average rupture stress for the ASTM carbon steel A283 Gr. B, and A181 Gr. I and ductile iron A536 Gr. 65-45 will also be 0.90 of their ultimate stresses. In addition we have assumed a rupture probability of 0.99 for a stress equal to the ultimate stress for the materials mentioned above. Finally, it is assumed that the range of the water hammer induced stresses lie between 1.0 and 100.0 ksi.

In accordance with NUREG/CR-5102 analysis, a rupture probability distribution reflecting the greatest degree of uncertainty given the specified constraints, for each material of interest, was assumed. To find the appropriate probability function under these conditions, a computer code called IMPAGE, was used (UnWin, 1987). This code uses information theory principles to generate a probability distribution over some specified parameter range, given a finite number of constraints, which reflects the maximum degree of uncertainty consistent with those constraints. The ultimate stress of the materials of interest is shown in Table 3.1-4 and Figures 3.1-2A, B, and C present the cumulative probability functions calculated by IMPAGE for the three of these materials.

For expansion joints the above approach was not feasible. However given that the design, test and burst pressures for the critical expansion joints are 80, 120 and 320 psig respectively, the following failure probabilities due to 60 psig overpressure were assigned judgementally:

Expansion Joint Status	Failure Probability Assigned
Replaced during last 4 years and will be subject to formalized maintenance, inspection and replacement program	1.0×10^{-2}
Expansion joints which have not been replaced (all are short term isolable flood sources)	1.0×10^{-1}

TABLE 3.1-4

ULTIMATE STRENGTH

Material	Minimum UTS (ksi)	Typical UTS (ksi)
A283 Gr. B	50	53
A181 Gr. I	60	63.6
A307 Gr. B	60	66
SAE Gr. 65-45	150	162
A536 Gr. 65-45	65	74.75
A276 Tp 316	75	82.5

TABLE 3.1–5

EVALUATION OF CIRCULATING & SERVICE WATER COMPONENTS

ITEM #	COMPONENT DESCRIPTION	MATERIAL	O.D. (in)	NOMINAL THK (in)	MAX PRESS. (psig)	CALULATED STRESS, S (psi)
UPSTREAM OF ISOLATION VALVES						
1	96"– 90 Elbow	A283 GR B	97.0	0.50	61	14793
2	96" X 48" Tee	A283 GR B	97.0	0.50	61	18491
3	96" X 42" Tee	A283 GR B	97.0	0.50	61	18491
4	96" X 30" Reinf. Tee	A283 GR B	97.0	0.50	54	16369
5	96" Flange Bolts	A307 GR B	2.250	NA	61	2119
6	96" Flange	A181 GR 1	97.0	0.50	61	21402
7	96 (ID)–WC Pipe	A283 GR B	97.0	0.50	61	14793
8	48" X 36" Tee	A283 GR B	49.0	0.50	54	8269
9	48" X 30" Tee	A283 GR B	49.0	0.50	54	8269
10	48" X 30" Reinf.Tee	A283 GR B	49.0	0.50	38	5819
11	48" WS Pipe	A283 GR B	49.0	0.50	54	6615
12	48" Cap	A283 GR B	49.0	0.50	25	9372
13	42" X 6" Tee	A283 GR B	43.0	0.50	56	7525
14	42" WS Pipe	A283 GR B	43.0	0.50	56	6020
15	42" Flange Bolts	A307 GR B	0.875	NA	56	1539
16	42" Flange	A181 GR 1	43.0	0.50	56	8774
17	36" WS Pipe	A283 GR B	37.0	0.50	42	3885
18	36" Flange Bolts	A307 GR B	0.875	NA	42	2897
19	36" Flange	A181 GR 1	37.0	0.50	42	7652
20	30" WS Pipe	A283 GR B	31.0	0.50	46	2852
21	30" Manhole	A283 GR B	31.0	0.50	52	4030
22	30" MH Flange Bolts	A307 GR B	1.250	NA	52	1464
23	30" MH Flange	A181 GR 1	31.0	0.50	52	18814
24	30" MH Cover (1" Thick)	A283 GR B	31.0	1.00	52	23723
25	30" Flange Bolts	A307 GR B	0.875	NA	46	2468
26	30" Flange	A181 GR 1	31.0	0.50	46	7991
27	30" MH Cover (3/4" Thick)	A283 GR B	31.0	0.75	38	27185
28	96" Valve Body	ASTM A 536	97	NA	61	5494
29	42" Valve Body	ASTM A 536	43	NA	56	6182
30	36" Valve Body	ASTM A 536	36	NA	42	5173
DOWNSTREAM OF FIRST ISOLATION VALVE						
31	24" MH Flange	A181 GR 1	25.0	0.50	37	10012
32	24" MH Flange Bolts	A307 GR B	1.25	NA	37	951
33	24" MH Cover (3/4" Thick)	A283 GR B	25.0	0.75	37	21106
34	42" X 42" (22) Lateral	A283 GR B	43.0	0.50	56	15050
35	36 X 36 (45) Lateral	A283 GR B	37.0	0.50	42	9713

Notes:

1. All calculations are based on Tmin=(Nominal–mill tolerance–corrosion).
2. All pipe and elbow stress calulations are based on circumferential pressure stresses.
3. Tee and branch calculations are based on circumferential run pipe pressure stresses increased by a factor of 1.25.
4. Joint effeciency factors are included were appropriate to do so.
5. Pipe components less than 10" in diameter are not included.
6. Failure rate presented on Figures 3.1–2, 3.1–3, and 3.1–4.

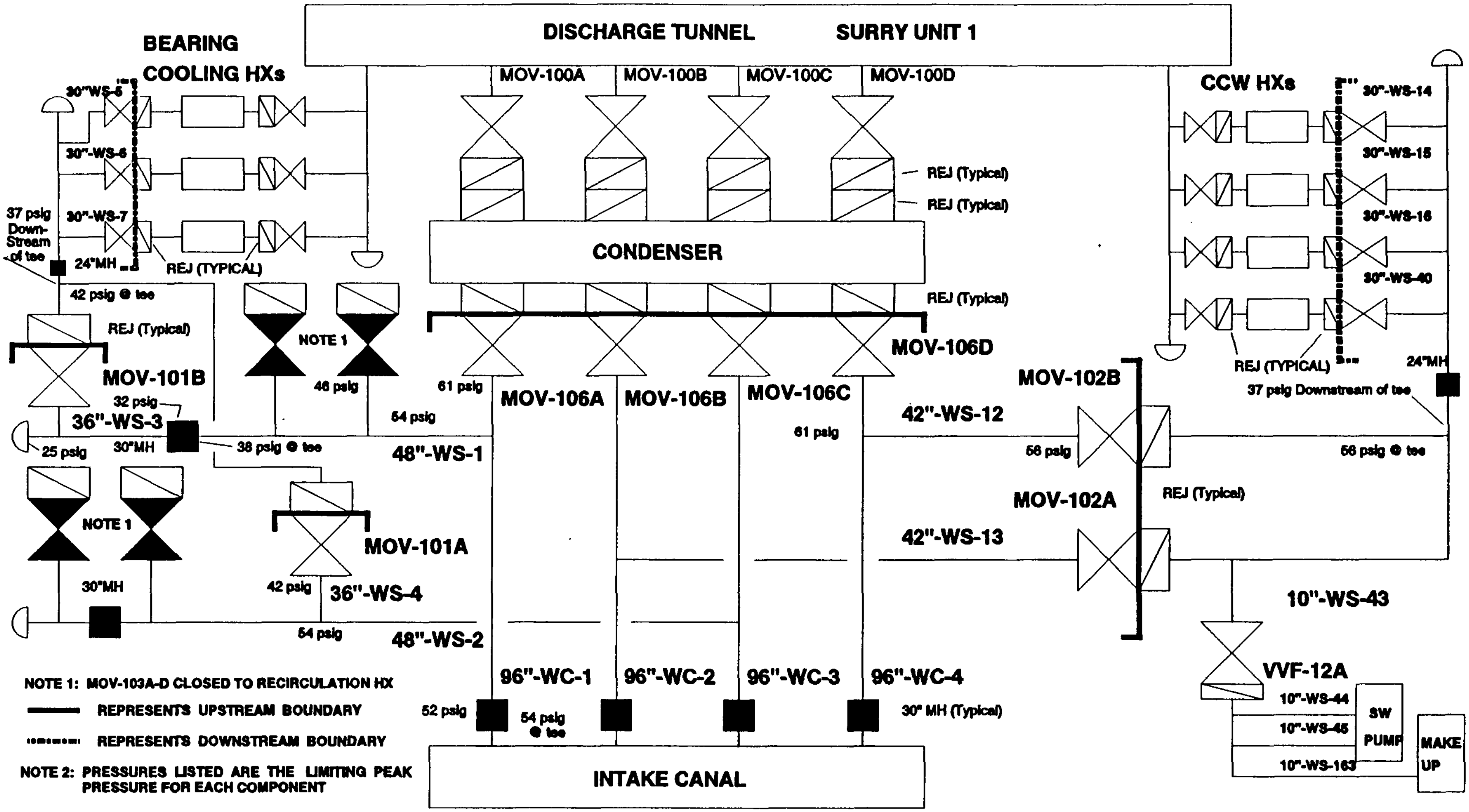

FIGURE 3.1-1: CW AND SW SYSTEM BOUNDARIES

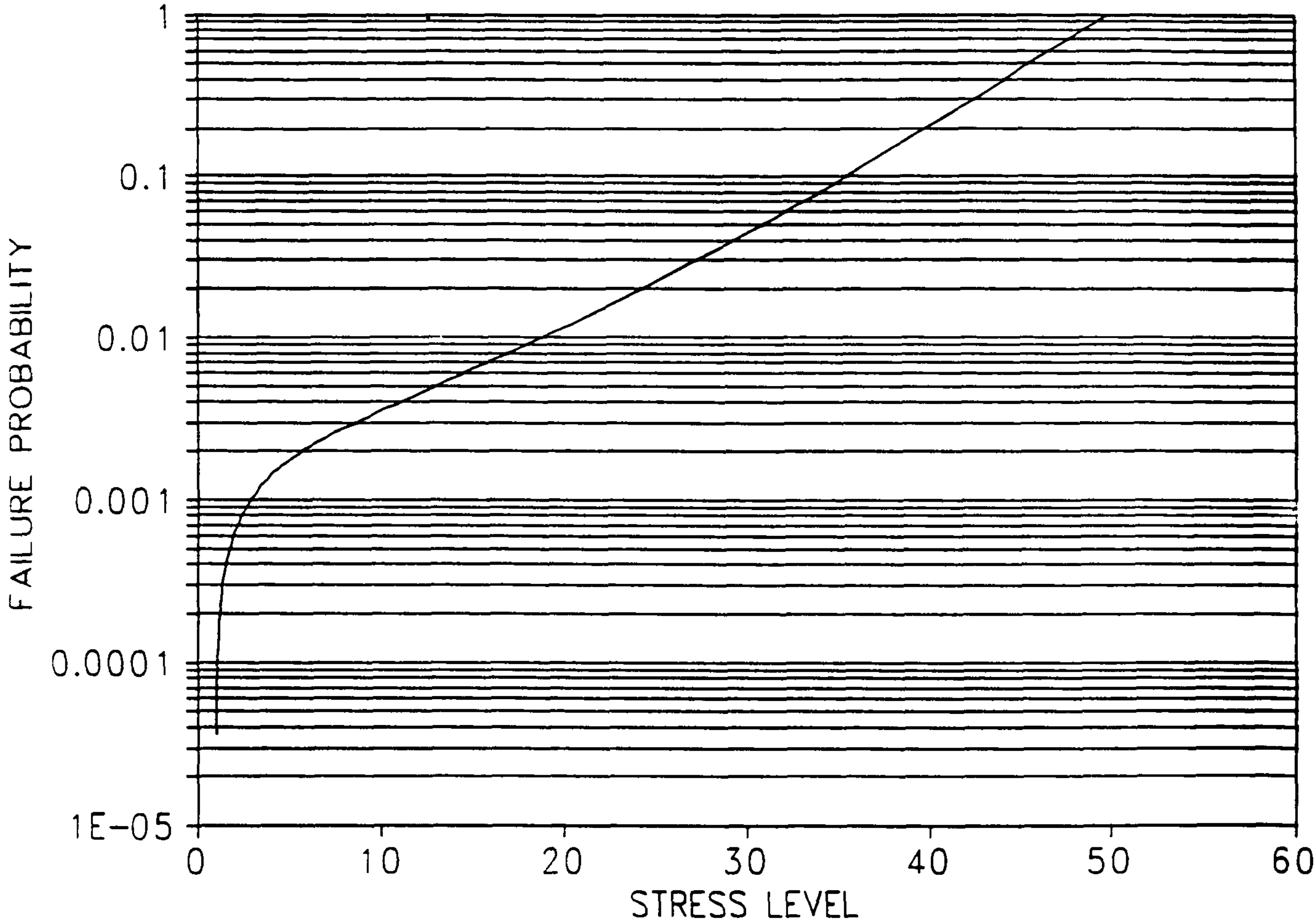

FIGURE 3.1-2 - CARBON STEEL A283 GR. B FAILURE PROBABILITY

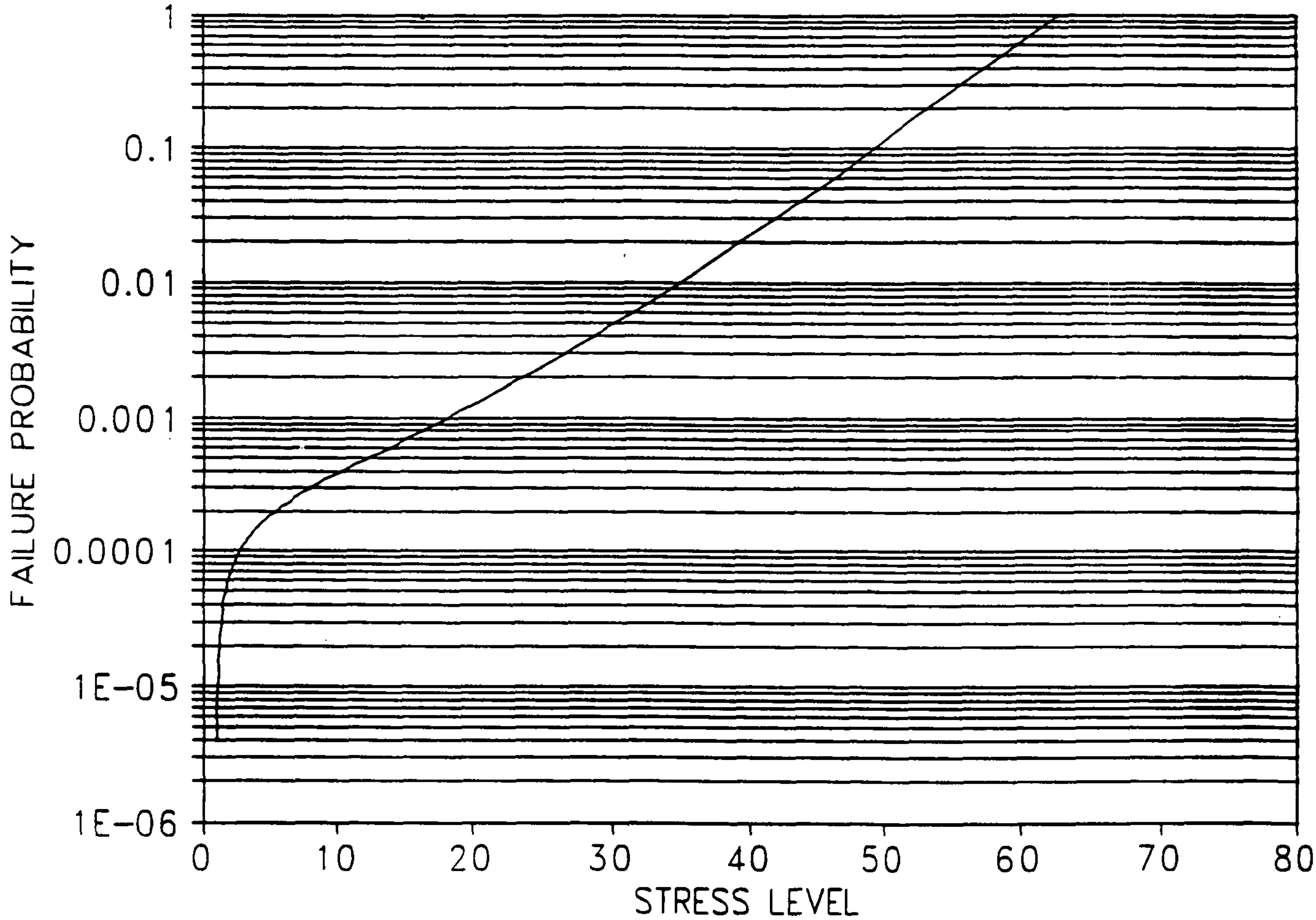

FIGURE 3.1-3 - DUCTILE IRON A536 FAILURE PROBABILITY

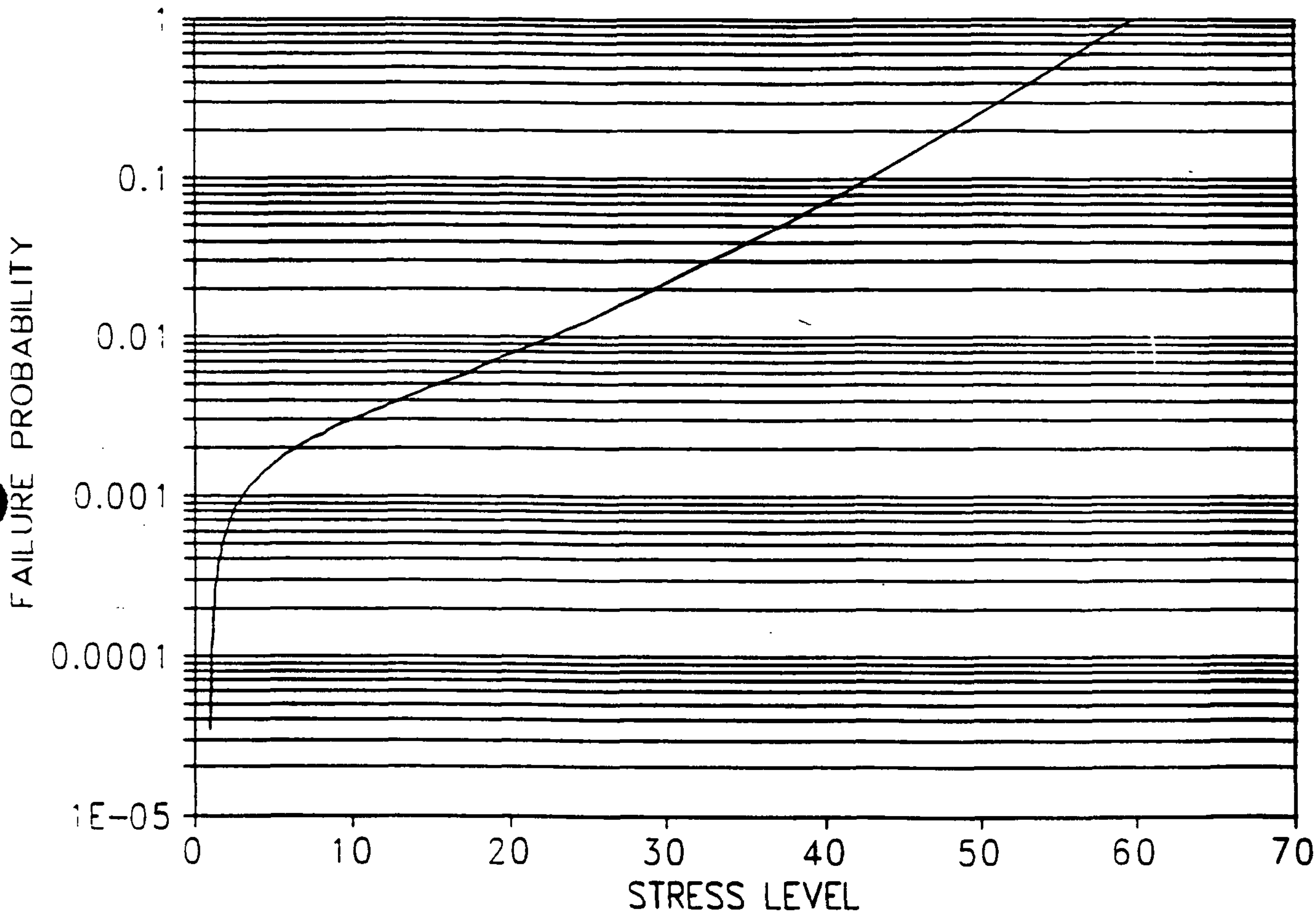

FIGURE 3.1-4 - A181 GR. I FAILURE PROBABILITY

3.1.7.2 Component Failure Probabilities

Component failure probabilities are calculated using the methodology described in Section 3.1.7.1 and the component stresses developed in Section 3.1.5.2.

Table 3.1-5 summarizes this evaluation of Circulating and Service Water system components. Twenty-nine components upstream of the isolation valves nearest to the intake canal and five additional components downstream of the first isolation valve are evaluated. The largest failure rate is 0.03 for Item 27, the 30" manhole cover (3/4" thick).

The next highest failure rate is 0.019 for Item 24, the 30" manhole cover (1" thick). The next highest failure rate is 0.009 for Item 6, the 96" flange to piping.

3.1.8 Condenser and Waterbox Evaluation

The tube or circulating water side of a condenser consists of thousands of thin walled tubes that span the shell of the condenser vacuum space and inlet and outlet waterboxes. The circulating water piping itself is attached to these waterboxes through thick rubber expansion joints and the waterbox chambers are in turn connected to the condenser shell through the tubesheet. Because the condenser tubesheet and shell are relatively flexible, the peripheral rows of tubes carry any hydraulic loads imposed on the waterboxes.

There have been several hydraulic pressure surges that have caused condenser failures. History shows that these never involve complete ruptures of the waterboxes because that is not the weakest structure. Indeed, the typical major characteristic of the failure is a pullout of a band of peripheral tubes which is followed by an in-leakage of circulating water into the steam space. The inleakage, though severe, is limited by the narrow openings and contorted flow path which results. The latter triggers control room actions to isolate that Circulating Water train and/or shutdown the unit. During one known event, coincident with tube pullout, was the failure of a Circulating Water expansion joint. That joint failure was not however catastrophic; instead the rupture consisted of an extensive tear.

The analysis performed in SWEC, 1991A supports the historical observation that the tubes will pull out before the waterboxes fail. For the record however, please note that the codes utilized at the time of construction of Surry would require each waterbox be tested to demonstrate that it could withstand 25 psig without cracking or leaking. The code also dictates the condenser shell must be designed to be capable of being filled with water to its connection with the steam turbine plus an additional atmosphere of pressure (Virginia Power, 1969). As discussed, though, these compliances have no relationship to the mode of failure.

This value clearly has some margin prior to bursting due to internal pressure, however, from a qualitative point of view a peak transient pressure of 61 psig would seem to be excessive for this chamber. As noted above, the failure would tend to be to the inside of the condenser which would not flood the Turbine Building. However, since Palo Verde (see Section 3.1.9) did experience a failure of the condenser waterbox, the probability of such a failure must be considered.

A probability of 0.5 was assigned as the likelihood that the condenser box would rupture externally causing a Turbine Building flood. This flood would be isolable by closing the condenser inlet valve.

3.1.9 <u>Break Area Evaluation</u>

The break sizes shown in Table 3.1-6 come from the review of historic events involving ruptures due to overpressurization of the Circulating Water system (SWEC, 1991A). It is interesting to note that condenser waterboxes have little margin against overpressure and the pump casing was made of cast iron, a non-ductile material. The following observation also help place this in perspective:

- LaSalle quoted a pressure pulse somewhat in excess of 50 psi, a value very similar to the pulse computed for Surry.
- There are no expansion joints in the non-isolable portion of the CW piping.
- There are expansion joints in the non-isolable SW piping but they are all shielded and the maximum flood rate is less than the sump pump capacity.

It is thus concluded that prior failures offer little useful insight into determining the probabilistic distribution of break opening areas other than to indicate that full area breaks are not a foregone conclusion.

TABLE 3.1-6

FLOW FROM CIRCULATING WATER SYSTEM RUPTURES

Plant	Pipe Diameter	Ruptured Component	Flow Rate or Area[2]	Relative Area
Quad Cities	Normal Flow 225000 gpm	Exp. Joint	150000 gpm	0.67
LaSalle	108"	Exp. Joint	2000 gpm	0.009
S. Texas	96"	Pump Casing	20 ft^2	0.44
Palo Verde	120"	Condenser Waterbox	40000 gpm (est)	0.14

Considered on mechanistic grounds, the following approach would normally be taken to establish break opening areas:

- Compute the line pressure from the system hydraulics following valve closure.
- Compute the nominal pressure stress.
- Assume a critical flaw size, i.e. one sufficiently large to propagate due to the stress.
- Consider the crack (flaw) to propagate until the stress intensity at the crack tip drops to the value for crack arrest.
- Compute the resulting crack opening and the total crack area.

The problems with this approach are twofold:

- The stresses are so low that the only pre-existing flaws which would propagate are ridiculously large (feet).
- The pressure remains high for a period long compared to the time associated with crack propagation so the event will only terminate when the opening is large enough to drop the pressure and thus reduce the stress.

[2] See SWEC, 1991A for derivation.

This basically says that, for any reasonable initial flaw size, there will be no rupture but, given a very large flaw, it will propagate unhindered until the flow area of the break is comparable to the flow area of the pipe. In essence, the mechanistic approach is not useful since the original assumption is that the pipe will rupture even though the conditions are such that a pipe would not rupture.

It is thus necessary to establish a distribution of break areas from another perspective. The most limiting design features are a 30" diameter flat manway cover, the 96" pipe flange at the butterfly valve, and the pipe flange for the manway cover.

Circulating Water System

The only short-term non-isolable portion of the CW system is an 18" long pipe of 96" diameter between the concrete floor and the first valve. Based on the computed stress at the flange, this region has the highest (though small) probability of rupture. The stress results from flange bending, causing axial tension on the outer surface of the pipe. Thus any flaw would tend to propagate in the circumferential direction. Fracture mechanics considerations lead to the conclusion that only an extremely long flaw would propagate circumferentially under the computed water hammer stress, none of the historic CW flooding events were of this type, and it is considered highly improbable that a full circumferential break could occur. A full circumferential rupture, however improbable, is chosen as an upper bound for computing break area.

The break area of a postulated double-ended rupture at the flange location is less than the flow area of the pipe due to constraints on the displacement of the two broken ends. The short stub of pipe extending up from the concrete is essentially immobile. The other section consists of a butterfly valve and an expansion joint attached to the condenser waterbox. The only component with significant flexibility is the expansion joint which has an axial spring constant of 10,800 lb/in in compression and a shear stiffness of 16,400 lb/in (Virginia Power, 1987B). The load on the closed butterfly valve is at most the design pressure (20 psi) times the area or about 145,000 lbs, giving an axial displacement of 13.4 inches. However, the maximum design deflection is 7/8 in, the expansion joint length including flanges is only 12 inches, and the design is of filled arch construction. The specified stiffness only applies within the design range and would increase with further compression. Thus, even in the most extreme cases the axial deflection is limited to about 4 to 6 inches.

Assume the expansion joint permits 6" of axial motion. The flow area is then

$$A = (PI)\ DL = 1809\ in^2$$

which is only 25% of the pipe flow area. There is no significant force producing a shear on the expansion joint and the larger diameter of the flanges blocks direct axial flow for any reasonable lateral offset.

Thus, the flow area from the worst potential break is about 1800 in^2 but smaller partial-circumferential cracks are more probable.

The pipe stress in the hoop direction is less than the axial stress at the flange. Any break due to a longitudinal split is limited in length to 18". Such a break would open into a pseudo-elliptical fish-mouth, but for conservatism consider an 18" diameter circle. This has a flow area less than 4% that of the pipe flow area.

<u>Service Water System</u>

The valve pits are 4'-8" and 6'-4" wide with the pipe traversing the span and encased in concrete to either side. Thus, each end of the pipe is rigidly held and the displacement of a full circumferential rupture is limited by the flexibility and displacement limits of the expansion joints. The 30", 36" and 42" expansion joints are 10" long, including flanges (Same ref. as above), and an axial displacement of 5" is assumed. Using the same approach as for CW, the flow areas are

30": 471 in^2
36": 565 in^2
42": 660 in^2

The longest length of pipe between the concrete and a flange is about 40.25" for the 42" line and 18.25" for the other lines. Thus, using the circular opening assumption, the worst case longitudinal split has an area of 1272 in^2 for the 42" line and 262 in^2 for the others.

<u>Man Holes in CW and SW Systems</u>

The man holes in the CW and SW systems are 30" diameter piping. Since the MH covers are not restrained, it is assumed that a full circumferential break could occur at the pipe to flange joint. This would result in a flow area of 666 in^2. However, small cracks are more probable.

3.1.10 <u>Conclusions</u>

The Surry Circulating and Service Water systems have been evaluated for the impact of water hammer-induced loads. The source of the water hammer loads is assumed to be rapid closure of the butterfly isolation valves. The propagation of the water hammer pressure has been tracked throughout the system and components subjected to pressures above the design basis pressure have been identified.

Stresses resulting from this pressure wave have been calculated for piping and valve components along with average material properties. The calculated stresses and material properties have been used to establish failure rates. Table 3.1-5 summarizes this evaluation of Circulating Water and Service Water System components. Twenty-nine components upstream of the isolation valves nearest to the intake canal and five additional components downstream of the first isolation valve are evaluated. The largest failure rate is 0.03 for Item 24, the 30" manhole cover (3/4" thick). The next highest failure rate is 0.019 for Item 24, the 30" manhole cover (1" thick).

The condenser and waterbox failure modes are discussed in Section 3.1.8, but no specific stresses are computed.

Probable break areas have been determined for the several possible break regions upstream of the isolation MOVs as presented in Section 3.1.9.

3.2 FREQUENCY OF BUTTERFLY VALVE FAILURES LEADING TO WATER HAMMER EVENTS

A significant contributor to Surry IPE flooding frequency was component rupture caused predominantly by a Circulating Water (CW) or Service Water (SW) System water hammer. The original frequency was based upon a generic flooding frequency, and did not consider all of the specific attributes of the Surry CW or SW Systems. This section addresses a revised estimate of the frequency of Surry SW and CW butterfly valve failures leading to water hammer events that have the potential to cause component failure; this frequency is combined with an estimate of Surry component rupture probability in Section 3.3 to generate a Surry specific frequency of flooding for this type of event. The remainder of this section will describe the Surry events that can initiate a CW or SW water hammer, provide a review of industry data, and describe the data reduction and data analysis. The result of this additional data review and analysis is a frequency of CW and SW System water hammer events, specific for Surry.

Description of Potential Water Hammer Initiators

Industry experience reveals that CW System flooding events have occurred when CW components, such as expansion joints and pump casings, rupture during CW water hammer events. No similar events have occurred to date in SW Systems. However, application of industry experience of floods to Surry would be conservative due to differences in component design, materials, and basic hydraulic characteristics. These differences need to be characterized, to develop a more focused review and application of industry data on valve failure leading to water hammer events. This will enable the generation of a reasonable estimate of CW and SW water hammer event frequency that is specific for the Surry systems and components.

A water hammer event resulting in a hydraulic transient with peak pressures high enough to result in component rupture would be caused by a rapid closure of the CW or SW isolation valves. Normal valve closure generates only a very minor pressure transient (2 psi) which is of no significance. Since the CW and SW valves at Surry are motor operated (i.e. not hydraulic or air operated), a catastrophic valve fault is required which permits the valve disc to rotate freely and be driven closed by forces induced by fluid flow in the pipe. Failure modes evident from historical experience include:

- Valve disc separation from valve upper stem due to failure of taper pins
- Valve stem or shear pin failures
- Loosening and subsequent failure of valve operator mounting bolts
- Internal failure of valve operator/drive train allowing valve stem and disc to move free of restriction

For a Surry water hammer event, the valve disc must rapidly move from a near fully open position to a fully closed position. Since the Surry valves do not have hard stops between the disc and body, the final disc position will not necessarily be the fully closed position, a full 360° in the valve body. When closed the valve is "position seated". The valve operator alone serves to establish the open and closed positions. The seal in the closed position is maintained by contact between the edges of the disc and an elastomeric seal. The disc is free to rotate beyond the fully closed position.

A comprehensive analysis of the historical water hammer events which have occurred due to failures of the valve operator to disc connections and the applicability of these events with regard to the type of valves and operators installed in the Surry SW and CW Systems was performed (SWEC, 1991C).

<u>Evaluation of Historical Valve Failure Information</u>

In this refined flood analysis our aim is to predict the likelihood of rupture at Surry due to water hammer based on two independent components:

- The frequency of valve failures leading to water hammer, and
- The conditional probability of component rupture given the stress induced by water hammer.

In the historical data so far examined only those valve failures which resulted in component rupture have been considered. The present approach requires the frequency of valve failures leading to water hammer independent of whether component rupture occurred.

To this end a search of various data sources was conducted to identify failure events in which valve discs had become separated from their operators. The search was limited to failures in Service Water and Circulating Water Systems and to butterfly valves in lines greater than 12", since this was judged to be the most relevant population and a population for which we have a reasonably good estimate of the historical experience based on work performed as part of IPE. The data sources reviewed were as follows:

- NRC Public Document Room: Data search using key word, <u>Service Water</u> or <u>Circulating Water</u> and <u>valve</u> or <u>crack</u> or <u>leak</u> or <u>rupture</u>. Several events associated with Circulating Water Systems were identified.

- NPRDS (Nuclear Plant Reliability Data System): All butterfly valve events for all domestic plants, where the event was detected by an operational abnormality. These faults were indicative of demand failures (fail to open, fail to close, etc.) and includes events involving valve and operator faults during system operation. No significant events found.

- IPE: All incident reports in sections covering Circulating Water, Auxiliary Systems and Safety Systems searched manually. Several significant events associated with both Service Water Systems and Circulating Water Systems were identified.

- NUREG/CR-1363 "Data Summaries of Licensee Event Reports of Valves at U.S. Commercial Nuclear Power Plants, January 1, 1976 - December 31, 1978", June 1980. Two significant events associated with Service Water identified.

The significant events identified are compiled in Table 3.2-1. These events were subsequently evaluated to determine the degree of applicability of the failures to the Surry SW and CW valves, based on differences in the characteristics of the valves themselves and the type of service. A set of correction factors were developed and quantified based on subjective arguments, as follows:

<u>Correction Factors for Surry Specific SW and CW Valve Attributes</u>

1. CF1 = 0.1 This factor accounts for reduced likelihood of valve operator to body/stem separation due to the existing valve installations which include high strength valve to operator bolts which were recently torqued according to manufacturers specifications.

2. CF2 = 0.2 This factor is applied for events which involve vibration induced by turbulence for the CW inlet valves and SW motor operated isolation valves. These valves are normally positioned fully open and thus do not experience significant turbulence. The valves are also orientated to ensure symmetric flow on both sides of the valve shaft and avoid unbalanced forces.

3. CF3 = 0.1 This factor is applied for events in which failure results from specification and installation of inadequate keys, which sheared soon after the components were put into service. Stress reports for Surry valve components indicate all subcomponents adequately sized (SWEC, 1991C).

4. CF4 = 0.2 This factor is applied for events which resulted in failures attributed to specific design features which are known to be avoided in the type of operator installed at Surry (i.e. splined adaptor in Limitorque operator installed at Surry are press fit, whereas those in the failed EIM operators are held by set screw - SWEC, 1991C).

The number and frequency of valve failures involving disconnection of valve operator from valve disc is determined below with and without applying the correction factors.

<u>Service Water System</u>

Total Years of Valve Experience (> 12" diameter, butterfly valve Reference SWEC, 1991A)	3.0×10^4

COMPONENT FAILURES/FREQUENCY	WITHOUT CORRECTION FACTORS	WITH CORRECTION FACTORS
Total number of failure events with correction factor applied to MO (Motor Operated) isolation valves	10	3.02
Total number of failure events with correction factor applied for other (manual) valves	10	6.3
Frequency of MO valve failures (per valve year)	3.3×10^{-4}	1.0×10^{-4}
Frequency of other (manual) valve failures (per valve year)	3.3×10^{-4}	2.1×10^{-4}

Circulating Water System

Total Years of Valve Experience (Reference SWEC, 1991A)	1.3×10^4

COMPONENT FAILURES/FREQUENCY	WITHOUT CORRECTION FACTORS	WITH CORRECTION FACTORS
Total number of failure events with correction factor applied for inlet valves	4	.42
Total number of failure events with correction factor applied for outlet valves	4	0.5
Frequency of inlet valve failures (per valve year)	3.0×10^{-4}	3.2×10^{-5}
Frequency of outlet valve failures (per valve year)	3.0×10^{-4}	3.8×10^{-5}

TABLE 3.2-1

SUMMARY OF HISTORICAL VALVE FAILURES INVOLVING DISCONNECTION OF THE VALVE OPERATOR FROM THE VALVE DISC

EVENT	DESCRIPTION	ROOT CAUSE	DEGREE OF APPLICABILITY TO SURRY	CORRECTION FACTOR (CF) FOR SURRY SPECIFIC ATTRIBUTES	COMMENTS
HATCH 1, SEPT 82, BWR VIII C-294, SWS	RHR SW HX OUTLET VALVE FAILED TO OPEN DUE TO LOOSENED BOLTS IN OPERATOR ALLOWING COUPLING SPRING PIN TO BREAK. VALVE FAILED IN POSITION (CLOSED)	UNKNOWN	APPLY CORRECTION FACTOR CF1 TO ACCOUNT FOR REDUCED LIKELIHOOD OF VALVE OPERATOR BODY SEPARATION.	CF1 = 0.1	
TURKEY PT 4, JULY 89, PWR VI F-120, 121, SWS	ICW HEADER ISOL. VLV (HENRY PRATT XR-70 36" BUTT.). TWO TAPERED PINS CONNECTING DISC TO STEM FAILED CAUSING DISC SEPARATION. VALVE CLOSED PARTIALLY REDUCING FLOW.	INDICATIONS WERE THAT PINS EXPERIENCED FATIGUE FAILURE DUE TO OSCILLATIONS FROM TURBULENT FLOW	ASSUME CORRECTION FACTOR CF2 = 0.2 FOR MO ISOLATION VALVES DUE TO LOW TURBULENCE BUT NO CF FOR OTHER VALVES.	(1) CF2 = 0.2 (2) 1.0	
MILLSTONE 2, 3/6/76, NUREG/CR-1363 P. 507, SWS LER 336-78031	RBCCW 18" KIELEY MUELLER MANUAL BUTTERFLY VALVE PIN SHEARED BETWEEN OPERATOR AND SEA WATER TEMP CONTROL VALVE	UNKNOWN	VALVE WHICH FAILED USED FOR THROTTLING FLOW WHICH RESULTS IN TURBULENCE, VIBRATION AND POTENTIAL FOR FATIGUE FAILURES. MO ISOLATION VALVES AT SURRY ARE FULLY OPEN (OR CLOSED) AND DO NOT EXPERIENCE SUCH STRESSES. SHEAR PINS HAVE BEEN SHOWN TO BE ADEQUATELY SIZED FOR DUTY. THEREFORE APPLY CORRECTION FACTOR CF4 = 0.2, FOR THESE VALVES. NO CORRECTION FACTOR FOR OTHER VALVES SINCE THESE MAY BE USED FOR THROTTLING.	(1) CF4 = 0.2 (2) 1.0	

TABLE 3.2-1 (Continued)

SUMMARY OF HISTORICAL VALVE FAILURES INVOLVING DISCONNECTION OF THE VALVE OPERATOR FROM THE VALVE DISC

EVENT	DESCRIPTION	ROOT CAUSE	DEGREE OF APPLICABILITY TO SURRY	CORRECTION FACTOR (CF) FOR SURRY SPECIFIC ATTRIBUTES	COMMENTS
OCONEE 3, OCT 75, PWR VIII B-65, SWS	LPSW DECAY HEAT COOLER (DETAILS NOT AVAILABLE). TAPERED COUPLING PIN (VALVE OPERATING SLEEVE TO VALVE SHAFT) VIBRATED LOOSE AND FELL OUT ALLOWING VALVE TO CLOSE PARTIALLY	MAINTENANCE ERROR - PIN IMPROPERLY INSTALLED FIRST EVENT OF THIS TYPE AT OCONEE	IN ABSENCE OF ADDITIONAL INFO. ASSUME SURRY PRONE TO MAINTENANCE ERRORS TO THE SAME DEGREE (VALVE INTERNALS MAINTENANCE PROGRAM STANDARD)	1.0	ADDITIONAL INFORMATION MAY REDUCE APPLICABILITY
FARLEY 2, SEPT 82, PWR VIII B-507, SWS	MANUAL SW ISOLATION VALVE ON CCW HX OUTLET (DETAILS NOT AVAILABLE). PIN HOLDING WORM DRIVE GEAR DISLODGED, ALLOWED dP ACROSS VALVE TO CLOSE IT	UNKNOWN	IN ABSENCE OF ADDITIONAL INFORMATION ASSUME EVENT FULLY APPLICABLE. HOWEVER LIKELIHOOD REDUCES AFTER M&I PROGRAM IMPLEMENTED	1.0	MAY ONLY BE APPLICABLE TO MANUAL VALVES. ADDITIONAL INFO MAY REDUCE APPLICABILITY
SALEM, DEC 89 - APR 90, PWR VIII B-1007, SWS	TWO SW FAST CLOSING ISOLATION VALVES (LIMITORQUE, SMB-0, 25 FT-LB) PINION TO SHAFT KEYS SHEARED IN HALF AND BADLY DAMAGED. KEYS IN OTHER MOVs INSPECTED. ONLY THOSE IN FAST CLOSING VALVES EXHIBITED DAMAGE. VALVE DISC/SHAFT APPEARED TO BE JAMMED.	INADEQUATE DESIGN WHEN VALVES REPLACED DURING PREVIOUS OUTAGE. SPECIFIED KEY MATERIAL TOO SOFT.	STRESS REPORTS FOR SURRY 96", 42", AND 36" VALVES DEMONS. ALL SUBCOMPs INCLUDING KEYS HAVE ADEQUATE CAPACITY FOR OPERATING LOADS. ALSO DESIGN ERRORS ARE NORMALLY REVEALED DURING EARLY LIFE, THESE VALVES ABOUT 4 YEARS OLD. RESIDUAL POTENTIAL FOR DESIGN ERRORS EXIST.	CF3 = 0.1	

TABLE 3.2-1 (Continued)

SUMMARY OF HISTORICAL VALVE FAILURES INVOLVING DISCONNECTION OF THE VALVE OPERATOR FROM THE VALVE DISC

EVENT	DESCRIPTION	ROOT CAUSE	DEGREE OF APPLICABILITY TO SURRY	CORRECTION FACTOR (CF)FOR SURRY SPECIFIC ATTRIBUTES	COMMENTS
PILGRIM 1, MAR 77, BWR VIII C-102, SWS	MANUAL 12" BUTT. VALVE IN SALT SERVICE WATER SYSTEM (PRATT MONO FLANGE, MH2). BROKEN PIN CAUSED VALVE TO FAIL CLOSED.	UNKNOWN	VALVE THAT FAILED WAS IN PUMP DISCHARGE AND WOULD EXPERIENCE SIGNIFICANTLY HIGHER TURBULENCE AND VIBRATION THAN VALVES IN GRAVITY FED SYSTEM AT SURRY. ASSUME CORRECTION FACTOR CF4 = 0.2 FOR MO ISOLATION VALVES DUE TO LOW TURBULENCE BUT NO CORRECTION FACTOR FOR OTHER VALVES SINCE THESE ARE USED FOR THROTTLING FLOW.	(1) CF2 = 0.2 (2) 1.0	
MILLSTONE 2, 11/7/78, NUREG/CR-1363 P. 507, SWS LER 336-78031	RBCCW VALVE FAILED TO OPERATE DUE TO FAILED TENSION PIN BETWEEN VALVE AND OPERATOR. SEEMS TO BE THE SAME AS EVENT ON 3/6/76	UNKNOWN	SEE EARLIER MILLSTONE 2 EVENT	(1) CF2 = 0.2 (2) 1.0	
SALEM, AUG 85, PWR VIII B-659, SWS	SW ISOLATION VALVE ON CCW HX OUTLET (HENRY PRATT). VALVE ACTUATOR SEPARATED FROM VALVE STEM, VALVE FAILED CLOSED.	TURBULENCE/VIBRATION FROM OPERATING SYSTEM UNDER NON-DESIGN CONFIGURATION WITH TUBE BUNDLE MISSING FROM FISHER CONTROL VALVES	POTENTIAL AT SURRY FOR TURBULENCE VARIES DEPENDING ON SPECIFIC VALVE. SW ISOLATION MOVs ARE NORMALLY FULLY OPEN THUS TURBULENCE IS MINIMAL (CF4 = .2). HX MANUAL VALVES USED FOR THROTTLING THEREFORE MAY BE SIGNIFICANT (NO FACTOR). APPLY CORRECTION FACTOR CF1 FOR REDUCED POTENTIAL FOR VALVE STEM/OPERATOR SEPARATION.	(1) CF2 X CF1 = .04 (2) CF1 = .1	

TABLE 3.2-1 (Continued)

SUMMARY OF HISTORICAL VALVE FAILURES INVOLVING DISCONNECTION OF THE VALVE OPERATOR FROM THE VALVE DISC

EVENT	DESCRIPTION	ROOT CAUSE	DEGREE OF APPLICABILITY TO SURRY	CORRECTION FACTOR (CF) FOR SURRY SPECIFIC ATTRIBUTES	COMMENTS
LASALLE, MAY 85, BWR VI F-49, CIRC WATER	108" BUTTERFLY VALVE (HENRY PRATT) ON PUMP DISCHARGE REDUCTION GEAR TO VALVE FLANGE BOLTS FAILED ALLOWING VALVE TO ROTATE. VALVE CLOSED RESULTING IN WATER HAMMER & EXP. JOINT RUPTURE.	TWO CAUSES. INSTALL. ERROR. TORQUE ON BOLTS LESS THAN MFGR. SPECS. ALSO DESIGN ERROR IN GEAR SIZING AND ASSOC. BOLTING. ASSUMED SYMMETRICAL FLOW VELOCITY ON EITHER SIDE OF VALVE SHAFT.	AT SURRY OPERATOR AND MOUNTING ARE ADEQUATE SIZED AND MUCH LARGER. FOLLOWING IMPL. OF M&I PROGRAM THERE WILL BE A HIGH DEGREE OF ASSURANCE THAT BOLTS ARE TORQUED AND WILL NOT COME LOOSE. (APPLY CF1) FURTHERMORE CW INLET VALVES WILL NOT EXPERIENCE TURBULENCE DUE TO NORMALLY FULLY OPEN POSITION. (APPLY CF 2 = 0.2 FOR THESE VALVES.)	(1) CF1 X CF2 = .02 (2) CF1 = 0.1	
SOUTH TEXAS, MARCH 17, 1987 SWEC REPORT, CIRC WATER	96" PUMP DISCHARGE VALVE (ALLIS CHAMBERS, EIM OPERATOR) OPER INTNAL CAP SCREWS LOOSENED BY DRIVE SLEEVE HITTING MECH STOP. ONCE LOOSENED SCREWS EXPERIENCED FATIGUE CYCLES FROM NORM FLOW VIB, VALVE DISC SWUNG FREELY AGAINST STOP. CLOSURE CAUSED WATER HAMMER.	MAINT ERROR. IMPROPERLY SET MECHANICAL STOP RESULTED IN EXCESSIVE TORQUE	SOUTH TEXAS HAD A HISTORY OF LOOSE SCREWS - NOT IN SURRY. LIMITORQUE OP (6 BOLTS AND A LOCK PIN TO PREVENT SLOP) VERSUS EIM (4 BOLTS). APPLY CORRECTION FACTOR CF1 TO ACCOUNT FOR REDUCED UNLIKELIHOOD OF SEPARATION.	CF1 = .1	
PALO VERDE, JUNE 28, 1987 SWEC, CIRC WATER	120" CONDENSER WATERBOX ISOL VALVE (HENRY PRATT W/ EIM OP). ONE OF 4 CAP SCREWS BACKED OUT & OTHERS SHEARED CAUSING VALVE TO CLOSE AND WATER HAMMER RUPTURED PIPING/ WATERBOX INLET AND OUTLET	MAINTENANCE ERROR. IMPROPERLY SET MECH STOPS	SIMILAR TO SOUTH TEXAS EVENT	CF1 = .1	

TABLE 3.2-1 (Continued)

SUMMARY OF HISTORICAL VALVE FAILURES INVOLVING DISCONNECTION OF THE VALVE OPERATOR FROM THE VALVE DISC

EVENT	DESCRIPTION	ROOT CAUSE	DEGREE OF APPLICABILITY TO SURRY	CORRECTION FACTOR (CF) FOR SURRY SPECIFIC ATTRIBUTES	COMMENTS
SOUTH TEXAS (2ND EVENT)	96" DIAMETER PUMP DISCHARGE VALVE (ALLIS CHALMERS VALVE WITH EIM OPERATOR). SPLINED ADAPTOR WHICH MATES VALVE TO OPERATOR HAD SLID VERTICALLY DOWN SHAFT AND DISENGAGED OPERATOR DRIVE SLEEVE FAILED VALVE POSITION. VALVE RAPIDLY CLOSED RESULTING IN WATER HAMMER (400 PSI) WHICH RUPTURED UPSTREAM PUMP HEAD.	SET SCREW WHICH HOLDS SPLINED ADAPTOR (INSIDE OPERATOR) FAILED OR MISSING AND CLAMP NOT INSTALLED	OPERATORS AT SURRY ARE LIMITORQUE; SPLINED ADAPTOR IS A PRESS FIT AND THUS NOT PRONE TO SLIPPING. DESIGN OF SURRY VALVE SIGNIFICANTLY REDUCES OR POSSIBLY ELIMINATES SIMILAR FAILURE (APPLY CF4 = 0.2)	CF4 = 0.2	POTENTIAL PROBLEM WAS IDENTIFIED EARLIER AT SOUTH TEXAS WHEN CONDENSER WATERBOX ISOLATION VALVE EXPERIENCED SIMILAR FAILURE. ACTION TO ADD CLAMPING DEVICE HAD NOT BEEN IMPLEMENTED.

(1) APPLY FOR MO SW ISOLATION VALVES OR CW INLET VALVES ONLY

(2) APPLY TO VALVES OTHER THAN THOSE MENTIONED IN (1) ABOVE

3.3 FLOOD HAZARD FROM WATER HAMMER EVENTS

As discussed previously the flooding hazard due to water hammer events is evaluated from the frequency of water hammer events, due to butterfly valve failures (Section 3.2) and the conditional probability of piping component failure when subjected to stresses induced by the water hammer (Section 3.1).

In order to avoid dependence of the estimate of failure probability given a water hammer event on piping length or number of components, it will be assumed, as in NUREG/CR-5102, that the estimated probability of failure applies to the particular piping sections exposed, as a whole. Where exposed piping sections contain segments of different properties or configurations which result in higher stresses, it is assumed that the segment with the highest probability of failure is representative of the overall exposed piping system failure probability. Since the flooding rate resulting from rupture of different piping sections may be significantly different, a check was also made to ensure that this "weakest link" model is in fact representative of the flooding risk.

The analysis proceeds by examining the piping sections which could be exposed to a water hammer resulting from each one of the CW and SW butterfly valve failures. The weakest components within the exposed piping sections are identified together with associated break flow rates in order to determine which component rupture characterizes the flood hazard from a particular valve failure induced water hammer event. For example, (referring to Figure 3.1-1), failure of CW inlet MOV, 1-CW-MOV-106A, will expose the valve itself, the upstream Circulating Water 96" diameter piping (including a 30" diameter manway) and the 48"/36" diameter SW piping serving the Recirculation Spray Heat Exchangers, Component Cooling Heat Exchangers and Bearing Cooling Heat Exchangers. Based on the analysis of water hammer induced overpressures and resulting stresses in various piping segments, the component with the highest probability of failure together with their associated break flow rates are shown in Columns 2 and 3 below.

CW or SW System Components	Rupture Probability	Maximum Flow Rate (gpm)	Rupture Probability for Breaks Exceeding Critical Flow Rate (10100 gpm) (1) (2)
30" Manway over 1" thick - 96" CW Line	1.9×10^{-2}	64000	7.6×10^{-3}
Flange on 96" diameter inlet pipe/valve	9.0×10^{-3}	164000	9.0×10^{-3}
30" manway cover (3/4" thick) on 48" SW pipe	3.0×10^{-2}	64000	1.2×10^{-2}
Flange on 36" diameter inlet pipe/valve	2.3×10^{-3}	51477	9.2×10^{-4}

(1) Based on the distribution of rupture size versus frequency discussed in Section 3.4.3.

(2) Critical flood flow rate is the minimum rate that is capable of causing damage in the switchgear room given 7/9 sump pumps and stop log installation within 24 hours.

These components are long term isolable flood sources and the risk contribution comes from breaks which exceed the critical flood flow rate and thus by definition cannot be arrested prior to damaging the emergency switchgear room (flood damage state 1TB5 and 2TB5). In the last column above, the component rupture which determines the flooding risk is the 3/4" thick manway on the 48" diameter SW pipe. The frequency of this rupture is determined from the frequency of the inlet isolation valve failing (3.2×10^{-5}/yr) and the conditional probability of a rupture exceeding the critical flood flow rate 1.2×10^{-2}.

$$F_R = (3.2 \times 10^{-5}/yr) \times (1.2 \times 10^{-2}) = 3.8 \times 10^{-7}/yr$$

Note that the failure of the downstream CW outlet isolation valve is not considered as a significant challenge to the integrity of components on the upstream side of the condenser due to the 20-30% reduction in overpressure passing through the condenser and the high likelihood of condenser waterbox rupture (taken as 0.5 for external rupture in this analysis) which would tend to act as pressure relieving device.

The flooding risk arising from all other potential SW and CW valve failures is addressed in a similar manner and the results for the significant contributors summarized in Table 3.3-1.

TABLE 3.3-1

SUMMARY OF SIGNIFICANT CONTRIBUTORS TO FLOOD HAZARD FROM WATER HAMMER

Water Hammer Inducing MOV Failure/Frequency	Representative Component Rupture Probability	Maximum Flow Rate (gpm)	Probability Component Rupture Exceeding Critical Flow Rate	Failure Probability of Isolation Prior to Damage (1TB5 or 2TB5)	Frequency of FDS 1TB5/2TB5
CW-MOV-106A/106C CW-MOV-206A/206C	30" dia., 3/4" thick man hole cover on 48" SW pipe	64000			
$F_{WH} = 4 \times 3.2 \times 10^{-5}$ $= 1.28 \times 10^{-4}$/yr	$P_R = 3.0 \times 10^{-2}$		$P_{RC} = 1.2 \times 10^{-2}$	1.0	1.5×10^{-6}
CW-MOV-106B/106D CW-MOV-206B/206D	30" dia., 1" thick man hole cover on 96" dia. CW pipe	64000			
$F_{WH} = 4 \times 3.2 \times 10^{-5}$ $= 1.28 \times 10^{-4}$/yr	$P_R = 1.9 \times 10^{-2}$		$P_{RC} = 7.6 \times 10^{-3}$	1.0	9.7×10^{-7}
SW-MOV-101A/101B SW-MOV-201A/201B	30" dia., 3/4" thick man hole cover on 48" SW pipe	64000			
$F_{WH} = 4 \times 1.0 \times 10^{-4}$ $= 4.0 \times 10^{-4}$/yr	$P_R = 8.2 \times 10^{-3}$		$P_{RC} = 3.3 \times 10^{-3}$	1.0	1.3×10^{-6}

TABLE 3.3-1 (Continued)

SUMMARY OF SIGNIFICANT CONTRIBUTORS TO FLOOD HAZARD FROM WATER HAMMER

Water Hammer Inducing MOV Failure/Frequency	Representative Component Rupture Probability	Maximum Flow Rate (gpm)	Probability Component Rupture Exceeding Critical Flow Rate	Failure Probability of Isolation Prior to Damage (1TB5 or 2TB5)	Frequency of FDS 1TB5/2TB5
CW-MOV-100A/B/C/D CW-MOV-200A/B/C/D	Unit 1/2 Condenser Waterbox External Rupture	80000			
$F_{WH} = 8 \times 3.8 \times 10^{-5}$ $= 3.0 \times 10^{-4}$/yr	$P_R = 0.5$		$P_{RC} = 0.5$	7.3×10^{-3} (auto closure of CW isolation valve)	1.1×10^{-6}
					4.8×10^{-6}/yr

3.4 FLOOD HAZARD DUE TO INTERNAL RUPTURE MECHANISMS OTHER THAN WATER HAMMER

3.4.1 Introduction

The purpose of this section is to examine the risk from component ruptures due to residual mechanisms internal to the CW and SW Systems excluding water hammer, such as corrosion, erosion and fatigue. Table 3.4-1 includes a summary of historical flood events due to such mechanisms. Most of these events have been leaks (less than 100 gpm) associated with small bore piping or gasket/seal failures. Three events have occurred with flow rates in the range of 1000 - 5000 gpm but well within the Surry Turbine Building sump pump capacity. One event (15000 gpm) having a flow rate greater than the sump pump capacity occurred due to age degradation of an expansion joint. Finally one event involving a pipe weld failure on a 120" line occurred (flow rate unknown). In this last case the pipe was located in the yard (lower 3rd buried) and was thought to result from thermal stress.

The general approach for evaluating from residual internal mechanisms was similar to that adopted in the Indian Point Safety Study (PASNY, 1982).

1. Compare the generic data on pipe failure mechanisms together with the Surry SW and CW attributes to assess the relative frequency failure at Surry.

2. Determine frequency of pipe ruptures in the SW and CW Systems using Thomas Correlation(1) and correct for specific attributes of Surry SW and CW Systems.

3. Determine the frequency of valve rupture on the same basis as for pipes. This is not unreasonable since the Pratt butterfly valves are essentially a short pipe section with a relatively small bearing housing attached at opposite poles.

4. Determine the frequency of expansion joint ruptures based on nuclear industry data, adjusted to account for the Surry program for expansion joint inspection and replacement.

5. Evaluate overall flood hazard from component ruptures due to residual mechanisms.

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(1) The Thomas Correlation was used for predicting pipe rupture frequencies in the Oconee Study and is an empirical correlation based on actual service failure statistics (Thomas, 1981).

The analysis focused on the long term isolable flood sources since although the frequency of rupture associated with short term isolable sources is significantly greater, their risk significance has been shown to be relatively small when credit has been given for isolation.

3.4.2 Frequency Reduction Factor of Surry SW and CW Specific Attributes

The data upon which the Thomas Correlation is derived comes predominantly from high pressure systems where the ratio of design pressure to system working pressure is about 1.1 to 1.5. The ratio of the Surry SW and CW design pressure, 25 psig, to operating pressure (nominally 8 psi) is about 3. This higher ratio is a measure of additional safety margin for general causes of failure.

A representative list (extracted from Thomas, 1981) of pipe failure causes and their relative contributions (fraction of failures by each cause) is:

		Percent Generic Leaks
Manufacture and Fabrication		21.4
Material Selection		28.8
Fatigue	- Vibration	4.3
	- Low Cycle	7.8
Expansion/Flexibility		2.7
Corrosion/Erosion		24.6
Mal Operation		2.1
Thermal/Mechanical Shock		1.3
Miscellaneous		7.0
		100.0

The CW and SW System at Surry is examined below against possible causes of failure in order to justify a frequency reduction factor for:

- Manufacture, Fabrication and Material Selection Errors - The SW and CW at Surry has been in operation as long as the plant has been in commercial operation (20 years) and all major components are several years old. These types of causes are generally revealed early in the life and should have already been detected at Surry if they exist. However, errors may still occur during repair work. The reduction in failure frequency is judged to be at least 90%.

- Fatigue - The SW and CW Systems operate at low temperature and do not experience wide temperature fluctuation and is therefore not susceptible to thermal fatigue. All piping is of heavy gauge and is not exposed to vibration or pressure pulses induced by pumps since it is gravity fed. At inlet valve pit locations where the most risk significant floods can occur, only a small portion of piping is exposed. Stresses associated with dead weight are small. The reduction in failure frequency is judged to be at least 95%.

- Expansion and Flexibility - Such problems may arise due to design not adequately considering and allowing for pipe expansion and flexing caused by changes in temperature, pressure or other types of loads. It is likely that such problems in the design would have already been revealed and the failure frequency is judged to be at least 95% for these categories.

- Corrosion/Erosion - The CW and SW lines have been or are being inspected and repaired in response to graphitic corrosion. The inspection report for this piping estimated that 80% of the pipe wall was still covered by coal tar coating and therefore had not corroded. As a result it can be assumed that 80% of the wall thickness is a nominal 0.5". The remaining 20% had some localized pitting and has been treated, patched and recoated. Leaks due to corrosion have generally been a result of localized pitting resulting in small volume discharge. No leaks have occurred on the inlet piping. Only one leak has occurred on the discharge piping since the recoating was completed. The minimum wall thickness based on acceptance criteria following this restoration work is 1/4". A simple calculation shows the average thickness is at least .45". Ongoing inspections and repairs will ensure that significant wall thinning due to corrosion and erosion is unlikely. The frequency of pipe failure in the Surry SW and CW Systems (leaks) is calculated below assuming a wall thickness of 3/8" (.375"). Thus a reduction in failure frequency compared with generic data at higher pressure due to corrosion and erosion is judged to be at least 80%.

- Thermal and Mechanical Shock - The CW and SW System does not experience wide temperature fluctuations and thus the potential for thermal shock is negligible. The only internal mechanism for exerting mechanical shock would be water hammer the contribution of which is addressed separately. The reduction in failure frequency is at least 99% due to these categories.

- Mal Operation - The potential for maintenance/operational errors leading to the system being left open prior to reflooding or inadvertently opened prior to isolation is addressed separately. The opportunity for mal operation of the system leading to internal stresses which caused a component failure is negligible. The contribution has been reduced by 99%.

- Miscellaneous - The contribution from this category has not been reduced.

The revised frequency contribution from each category is shown in Column 1.

	1	2	3
Pipe Failure Cause	% Generic Leaks Applicable to Surry (after applying above factors)	PC/PL	PC % of Generic Leaks Applicable to Surry
Manufacture and Fabrication	2.14	.016	.034
Material Selected	2.88	.006	.017
Fatigue			
- Vibration	0.22	.04	.009
- Low Cycle	0.39	.006	.002
Expansion and Flexibility	0.14	.02	.003
Corrosion/ Erosion	4.92	.004	.02
Mal Operation	0.02	.09	.002
Thermal and Mechanical Shock	0.01	.04	.0004
Miscellaneous	7	.008	.056
TOTAL	18.1		0.14

Also shown in the above table (Column 2) are the ratios of ruptures to leaks (PC/PL) for each type of failure mechanism. These ratios are based on information provided in Table 3 of Thomas, 1981. They have been reduced by a factor of 5 for this application to account for the low operating pressure (8 psi) of the SW and CW Systems at Surry and relatively high design to operating pressure, which will favor leakage prior to catastrophic failure compared with a high pressure system operating close to its design pressure. Column 3 is simply a multiplication of Column 1 and Column 2 and shows the frequency of rupture due to various mechanisms as a percentage of the leak frequency determined from generic data. Overall this percentage is 0.14% (i.e. a ratio of .0014).

3.4.3 Frequency of CW and SW Pipe and Valve Rupture

The frequency of pipe and valve rupture is calculated using the Thomas Correlation as discussed above. An evaluation of the condenser inlet pipes between the floor and the inlet valve is given as an example.

CW inlet - frequency of leakage (uncorrected)

$$F = PL \left(\frac{Dp \quad Lp}{tp^2} + \frac{Dw \quad Lw}{tw^2} \; A \right) \qquad \text{(Thomas, 1981)}$$

Dp	=	OD = 96" diameter
Lp	=	length = 22"
tp	=	pipe thickness = 3/8" includes corrosion
A	=	penalty factor for weld ~ 50
Lw	=	weld length ~ 1.75 x tw
tw	=	weld thickness tw ~ tp
PL	=	10^{-8} yr^{-1} (leak rate)
Dw	=	weld diameter Dw = Dp

Assume one circumferential weld connecting pipe to valve flange.

$$F = 10^{-8} \times (96 \times 22 \; / \; .14 + 96 \times .65 \times 50 \; / \; .14)$$

$$= 3.73 \times 10^{-4}/yr$$

Multiplying this leak frequency by the Surry specific rupture to leak ratio .0014 developed above gives a CW inlet pipe rupture frequency of 5.2×10^{-7}/yr. Based on 8 inlet pipes for both units the total frequency is 4.20×10^{-6}/yr.

This is the frequency of catastrophic rupture, however it includes large but less than maximum pipe failures. Thus for use in the Turbine Building flood analysis it was assumed that catastrophic ruptures are distributed in a similar manner to that adopted in the Oconee PRA as follows:

F (maximum break) = 0.1 Fc

F (break one category less severe - 1/3 maximum) = 0.3 Fc

P (break two categories less severe - 1/9 maximum) = 0.6 Fc

The maximum break size for a 96" diameter pipe on the CW inlet is estimated to be 1800 in^2 (see Section 3.1.9) which yields a break flow rate of 164000 gpm. Thus the frequency break size distribution is:

F (164000 gpm break) = 4.2×10^{-7}/yr

F (54700 gpm break) = 1.3×10^{-6}/yr

F (18200 gpm break) = 2.5×10^{-6}/yr

Note that even the smallest flooding category exceeds the critical flood flow rate for long term isolable floods (10,100 gpm assuming 7 of 9 sump pumps working and stop logs inserted within 24 hours, which may now be conservative given recent provisions for stop log insertions). This is not the case for breaks in the SW piping components for which the size at each break category is at least 60% less than for the CW piping.

A similar approach is adopted for all CW and SW pipe and valves on the inlet side of the isolation valves (i.e. long term isolable flood sources) and the results are presented in Table 3.4-2.

3.4.4 Frequency of Expansion Joint Ruptures

Based on a review of historical experience with US CW and SW system expansion joints (SWEC, 1991A) there has been one non-water hammer rupture resulting in significant flooding in 2.2×10^4 years of experience. The event was at Fort St. Vrain (4/7/88) and involved a 24" tear in a joint resulting in an estimated 15,000 gpm flood rate. The degradation and other joints at the plant indicated similar deterioration.

Thus based on experience the frequency of expansion joint rupture due to non-water hammer events is:

$$1 / 2.2 \times 10^4 = 4.5 \times 10^{-5} \text{ per year}$$

A review of available information was conducted (SWEC, 1991A) to identify rubber expansion joint failure data, life expectancy, and vendor recommendations for inspection and maintenance of rubber expansion joints. Most of the information reviewed was obtained from the expansion joint manufacturer (Holz Rubber Company) and an expansion joint specialist (Expansion Joint Designers, Inc.). The results are as follows.

Expansion Joint Failure Mechanisms

Rubber expansion joint failures are usually caused by either misapplication of the expansion joint for the intended service or poor installation of the expansion joint. Misapplication usually consists of material incompatibility with the fluid passed or the environment where the joint is installed. Poor installation could result in axial or lateral misalignment, flange face angular misalignment, torsional loading, or excessive axial elongation or compression.

Failure of rubber expansion joints usually consists of a 3 to 4 inch radial tear in the joint material at the flange neck area. Cracks often originate in the joint liner material and propagate outward until failure of the outer cover occurs. At the end of service life, a rubber expansion joint usually begins leaking at the flange face as the joint material loses its elasticity with age.

Normal life expectancy for the type of rubber expansion joints in use at Surry is at least 8 years. With careful installation and proper material selection, reliable service can be assumed for 10 to 12 years.

No comprehensive failure rate data for rubber expansion joints could be located from any source.

Expansion Joint Failure Prevention

Periodic visual inspections of rubber expansion joints to detect gouges or cracks that penetrate the expansion joint material to the fabric are recommended by expansion joint manufacturers and specialists. Minor surface cracks that do not penetrate to the fabric are normal and acceptable. Periodic replacement of rubber joints is recommended to reduce the likelihood of failure due to aging.

Post-installation and post-maintenance measurement of flange alignment, torsional alignment and cold/hot elongation and compression readings to ensure all measurements are within design tolerance is recommended to prolong expansion joint service life and improve reliability. Elongation is recommended to prolong expansion joint service life and improve reliability. Elongation and compression movement is especially critical for the "filled arch" type expansion joints used at Surry. Filled arch expansion joints have extra liner material in the arch portion of the inside surface which improves flow characteristics but reduces axial movement tolerance by approximately 50 percent.

The manufacturer and expansion joint specialist agreed that the EPDM material specified for the SW and CW expansion joints at Surry is the best choice of expansion joint material for service conditions at Surry.

The specifications (Virginia Power, 1987B) for the newer (i.e., critical) expansion joints are listed below:

Design Pressure	80 psig
Test Pressure	120 psig
Burst Pressure	320 psig

The nominal CW and SW Systems operating pressure is 8 psig. At Surry all of the expansion joints which would present a significant flooding risk have been replaced within the last 5 years. A program to inspect joints for wear and tear according to manufacturers specified service life is being implemented.

Based on the above, the probability of rupture due to residual internal causes (i.e. not water hammer, or external stresses) is extremely low and a reduction factor of at least 90% on the frequency derived from generic data is appropriate (i.e. frequency of critical expansion joint rupture at Surry (individual joint) = 4.5×10^{-6}/yr).

The only long term isolable expansion joint flood sources are in the Service Water pits. Since these have now been shielded to limit the maximum flow rate given a break to within the Turbine Building sump pump capacity the risk from long term isolable expansion joint ruptures is now negligible.

3.4.5 Flood Hazard from Residual Internal Rupture Mechanisms (Other Than Water Hammer)

Table 3.4-2 summarizes the results of the analysis of pipe and valve rupture frequencies/break flow rate distributions discussed in Section 3.4.3. The contribution from SW expansion joint ruptures prior to installation of the shields is also given to indicate the risk reduction benefit of installing the shields.

Only the contribution from long term isolable sources is quantified. The frequency of rupture from short term isolable sources is significantly higher than for long term but the risk contribution is substantially less when credit is given for automatic/manual isolation prior to damage occurring.

Thus overall, the frequency of floods via the mechanisms discussed which exceed the critical flooding rate (i.e. lead to flood damage states 1TB5/2TB5) is 8.2×10^{-6}/yr.

TABLE 3.4-1

SUMMARY OF CW AND SW FLOODING EVENTS EXCLUDING MAINTENANCE, OPERATIONAL AND WATER HAMMER EVENTS (SWEC, 1991A)

Service Water Events

9 - events associated with rigid and flexible small bore piping (1/2 - 2 inch) (cooling coils, etc.) probably caused by erosion/corrosion.

6 - events associated with deteriorated gaskets and seals and pumps (10 - 1000 gpm).

1 - Expansion joint due to missing tie rods (leak).

1 - Hx inlet nozzle broken due to improper design cast iron (leak).

2 - Erosion/corrosion caused small leaks in piping (leak).

1 - Seam weld in motor cooler (100 gpm).

Circulating Water

1 - Rubber expansion joint 24" tear, (age degradation suspected). Two prior events in same pit due to other causes. An inspection revealed other expansion joints showed deterioration (15000 gpm).

1 - Sight glass rupture (5,000 gpm).

1 - Manway gasket on waterbox, 5000 gpm, leaking on start up.

1 - Pipe weld on 120" line (lower 3rd of pipe in concrete) thought to result from thermal stress (flow rate unknown). Pipe located in yard.

TABLE 3.4-2

SUMMARY OF TURBINE BUILDING FLOOD HAZARD FROM RESIDUAL INTERNAL MECHANISMS (OTHER THAN WATER HAMMER)

Long Term Isolable	Frequency of Rupture/Yr	Frequency of Rupture Exceeding Critical Flood Flow Rate/Yr	
CW inlet piping (8 lines)	4.2×10^{-6}	4.2×10^{-6}	
CW inlet valve (8 lines)	1.8×10^{-6}	1.8×10^{-6}	
SW inlet pipe			
BC supply to Unit 1	8.5×10^{-7}	3.4×10^{-7}	
BC supply to Unit 2	8.5×10^{-7}	3.4×10^{-7}	
CC supply to Unit 1	7.2×10^{-7}	3.0×10^{-7}	
SW inlet MO valves (6)	3.0×10^{-7}	1.2×10^{-7}	
SW inlet expansion joints (6)	2.3×10^{-5}	9.2×10^{-6}	
CW and SW 30" dia manhole (pipe) (12)	2.8×10^{-6}	1.1×10^{-6}	
	3.45×10^{-5}/yr	1.74×10^{-5}	(without Expansion Joint Shields)
		8.2×10^{-6}	(with SW Expansion Joint Shields)

3.4.6 Other Flood Initiating Mechanisms

The Surry IPE final report considers primarily internal flooding resulting from water hammer events. The conclusions of that study indicated that this cause was so dominant that all other causes were negligible. This conclusion was based on a review of other flooding analyses such as the Oconee PRA (NSAC, 1984).

The dynamic analysis of water hammer events presented in Section 3.1 produces failure probabilities that are significantly lower than previous results. For this reason it is now necessary to consider other mechanisms that can create floods. The purpose of this section is to review these other mechanisms that have been identified in earlier PRA's.

Heavy Loads and Vehicle Damage

The primary source of load handling accidents in the Turbine Building are the turbine overhead bridge cranes. Load drops are considered as unlikely initiators of internal flooding events because:

- during power operations, the bridge cranes are normally parked at the far eastern and western ends of the Turbine Building
- crane operators are trained per ANSI B30.2
- slings and rigging hardware are periodically inspected, maintained and tested using station procedures which exceed the requirements of ANSI B30.9
- cranes and hoisting equipment are periodically inspected, maintained and tested
- the turbine bridge crane original design satisfies EOCI-61, the industry standard for overhead cranes which was in effect prior to CMAA-70

The installation and removal of Turbine Building equipment is governed by Attachment 15 to general maintenance procedure (GMP-001). The procedure requires that heavy loads not be moved over safety related equipment if possible. If required, communications are established with the Main Control Room. The loading is verified and the rigging is inspected with minimal ground clearance. If damage is found the rigging is replaced before movement is made.

Finally, the 50.59 safety evaluation contains question #50 regarding heavy loads: "Will the activity involve heavy loads (including the transfer of heavy loads in areas housing safety related equipment)"? If this question is answered in the affirmative an evaluation must be performed. The safety evaluation refers the preparer to NUREG-0612 for guidance during preparation of the evaluation.

Vehicle Damage

The only conceivable vehicle-induced CW or SW system failure in the Turbine Building basement could be caused by a forklift, or similar material-handling vehicle. Practically all equipment movements in the basement are performed using dollies or rollers. Motorized vehicles are rarely utilized in the basement because there is no ramp for convenient access to the basement. The turbine crane must be used to raise or lower such a vehicle into the basement.

Forklift use in the Turbine Building basement is more common during an outage, when equipment handling needs are the greatest. Forklift access to potential flooding targets is greatly restricted by the congested piping, structural and equipment layouts in the basement.

Turbine basement flooding due to vehicle damage to the CW or SW systems is extremely unlikely due to the limited use of such vehicles and their limited accessibility to potential flooding targets.

The above discussions provide an assessment of the potential impact of heavy loads and vehicle impact on the Service Water supply isolation valves. It is shown that these activities occur primarily during outages and that the safety evaluation process considers heavy load paths. Therefore, core damage resulting from a heavy load which creates a non-isolable flood is considered negligible.

Fire

Systems located within the Turbine Building that have the potential to cause flooding are the Service Water (SW) and Circulating Water (CW) Systems. Failure of the piping, expansion joints, valves or MOV actuator control cables are the components of these systems that would be postulated in creating a flooding condition from a fire initiating event. This equipment for the most part is located at the 9'-6" elevation.

The Turbine Building has combustibles located at all elevations. Combustibles are in the form a cable insulation, lube oil in piping and reservoirs, hydrogen, grease used in valve packings. Various transient combustible materials including lubricants, welding gas, lumber, and miscellaneous class A combustibles used during maintenance and outages are also found in the Turbine Building.

The Turbine Building has a number of fire protection features to extinguish or minimize the effects of a fire. The general area under the Turbine Building operating floor is protected by a wet pipe sprinkler system. Sprinkler protection is provided over each of the three levels under the turbine operating floor. The turbine oil reservoirs and coolers (21,000 gal.) at the 29'-6" elev. are provided with 3'-6" high concrete dike which is capable of containing the entire contents of the reservoirs. The turbine lube oil tanks (44,000 gal.) are located at the 9'-6" elev. within the turbine lube oil room and are arranged with diking to contain the contents of the tanks. The hydrogen seal oil units (70 gal.) are located at the 9'-6" elev. and are provided with a drainage trench that surrounds the units. The lube oil conditioners (1,100 gal.) are also located at the 9'-6" elev. However, they are not provided with any curbing or trenches. The turbine oil reservoirs and coolers, hydrogen seal oil units, and lube oil conditioners are provided with automatic heat detectors and manual activated deluge systems. The lube oil tanks are protected by an automatic sprinkler system. The turbine generator bearing enclosures are protected by an automatic CO2 fire suppression system. Backup fire protection is provided throughout the Turbine Building in the form of hose stations used for manual fire fighting.

To address the potential to create flooding from an initiating event such as fire one must consider what would happen if a fire were to occur in the Turbine Building. Any fire involving a lube oil or hydrogen system is expected to be extinguished by the sprinkler system or contained until extinguished by the fire brigade. The station has a welding and flame permit program that posts a fire watch in the vicinity of any hot work. The fire watch remains in the area after the hot work is completed to watch for possible ignition of combustibles.

The potential to create a flood from an initiating event such as a fire in the Turbine Building is considered unlikely for the following reasons:

1. The general area under the operating floor of the Turbine Building is protected by sprinklers and heat detectors. This will provide early detection in the event of a fire and either extinguish the fire or contain it until the fire brigade can extinguish it.

2. Any potential source of ignition caused by hot work such as cutting or welding will be detected and controlled by a trained fire watch.

3. The combustibles in the vicinity of the rubber expansion joints for the SW and CW systems are limited in quantity and separated from the joints so that any heat or flame generated by a fire is not expected to impinge on the joint.

4. The rubber expansion joints for the condensate lines are protected by a metal band that reduces the flow in the event of a joint failure. This band also serves to shield the rubber joint from any heat or flame generated by a fire.

5. The station has administrative procedures to control the amount of combustibles allowed in the station. This will limit transient combustibles that could contribute to a fire.

6. The station has a trained fire brigade that will respond using manual hose stations to an emergency such as a fire and provide backup to the fixed fire suppression systems.

7. If a fire consumed the control cables for a MOV controlling the SW or CW piping it is not expected to cause flooding. The valve could be operated manually and the piping would still be intact.

8. The fire in the nuclear plant in October 1989 in Spain that ruptured the expansion joint of the CW system is not likely to occur at Surry. This particular fire was caused when a section of 36 blades in the high pressure turbine broke off. The resultant axial and radial shifts of the turbine caused 3 out of 4 main steam lines to rupture, and oil piping to the bearings to rupture. The oil ignited and eventually caused failure of a flexible joint in the CW system. Apparently there was no fixed fire suppression system on the bearings or in the Turbine Building. The root cause of the Spain incident was the lack of a good turbine maintenance program that would have detected and prevented this type of failure. The main differences between the Spain plant and Surry are:

   a. Surry is fully sprinklered below the turbine floor, and has an automatic CO_2 system for protection of the bearings.

   b. The Spain event was the result of multiple, highly unlikely failures which would have been mitigated at Surry by fire suppression systems.

   c. Surry does have a good turbine maintenance program.

   d. Surry's CW expansion joints are shielded by a metal band.

3.5 FLOODING EVENTS DURING MAINTENANCE

Maintenance activities can initiate a flood which could lead to core damage. This analysis will calculate the core damage frequencies (CDFs) for maintenance related floods. The results of this analysis may be combined with the mechanical equipment failure CDFs for an understanding of the overall CDF due to flooding. Maintenance induced flooding will be limited to the maintenance activities associated with the Circulating Water and Service Water systems in the Unit 1 or 2 Turbine Buildings.

A system fault tree was developed to analyze the possible ways that a flood could be initiated due to maintenance activities. Initiating event frequencies were incorporated into the maintenance flood fault tree so that an event tree was not necessary. The data analysis for the basic events in the fault tree used the THERP method for human reliability analysis (HRA) and the Surry IPE report for equipment failure probabilities. The initiating event frequencies were determined by reviewing the work planning and tracking system (WPTS) for Surry Power Station. Each basic event used in the fault tree is defined in Appendix A, Section A.4.2.

The maintenance floods associated with the Circulating Water and Service Water systems are divided into same two categories defined by the equipment failure analysis. These categories are long term or short term isolable floods. The long term isolable maintenance floods are those which require the high level intake structure stop logs to be installed. The short term isolable floods are those which do not require stop logs to be installed to complete the maintenance.

3.5.1 Long Term Isolable Maintenance Floods

Stop logs, or seal plates are steel plates that are used to isolate the 96" Circulating Water (CW) lines from the intake canal. Each stop log is a steel plate approximately nine feet tall and sixteen feet wide. Four of these plates are used to isolate one 96" CW line from the intake canal.

The long term isolable maintenance floods are those associated with the use of the stop logs to allow dewatering a Circulating Water or Service Water line. There are two types of events which can lead to a flood during maintenance while the stop logs are installed. One type is when maintenance is attempted on the wrong component. The second type is when the wrong stop log is removed.

Attempting maintenance on the wrong component will result in a flood because typically only one CW pipe is dewatered at a time. If maintenance is attempted on a component which is not dewatered, then opening the component will result in a flood.

Floods which are likely to occur while at least one set of stop logs are installed at the high level intake structure may be characterized by the sequence during which a manway (or other component) is opened on a pipe which has not been dewatered.

Maintenance floods which are likely to occur while two or more sets of stop logs are installed may be characterized by the sequence during which the wrong stop log is removed. This will lead to core damage if the dewatered pipe downstream of the stop log has a component open allowing a flow path directly into the Turbine Building basement.

A vulnerability was found with the maintenance procedures when two sets of stop logs were in place. This vulnerability was eliminated by revising the maintenance procedure for removing the stop logs. The old revision of the procedure allowed removing a stop log with the downstream section of pipe dewatered. The revised procedure requires that the downstream section of pipe be filled with water prior to stop log removal using a controllable process (eg., pumps or siphon). Filling the pipe first will allow a positive check that the piping is fully intact prior to removing a stop log. This limits the amount of water to a quantity which will not cause ESGR flooding. The CDF after revising the maintenance procedure is 6.0E-6/yr.

3.5.2 <u>Short Term Isolable Maintenance Floods</u>

Short term isolable maintenance floods are those associated with maintenance activities which do not require the use of the stop logs to dewater a Circulating Water or Service Water line. There are three major maintenance activities which are classified as short term isolable. They are maintenance on the condenser waterboxes, the CC heat exchangers, and BC heat exchangers. The most frequent maintenance performed is tube and tube sheet cleaning. Because of the build up of trash and marine life in the waterboxes and heat exchangers it is necessary to carry out cleaning operations at regular intervals. This requires isolation of an individual heat exchanger and opening up of the manway covers for access.

There are three types of floods which may occur when one of these heat exchangers is in maintenance. One type is when maintenance is attempted on the wrong component. The second type is when the isolation valve is opened; and the third is when a manway is left off after maintenance is completed.

Attempting maintenance on the wrong component will result in flood because typically only one heat exchanger is dewatered at a time. If maintenance is attempted on a component which is not dewatered, then opening the component will result in a flood. The potential for a significant flood to occur is negligible. If the operator fails to close the isolation valve the mechanic will be aware of this as he loosens the bolts on the first manway cover and water leaks out. To stop the flood the bolts can be tightened and/or the isolation valve closed.

If a heat exchanger is open for maintenance and the isolation valve is inadvertently opened or ruptures then a flood will result until the valve is reclosed. The contribution from valve rupture is negligible as the maximum time the waterboxes are open a few hours and the valve rupture failure rate is negligible (NSAC, 1984). If the inlet valve is inadvertently moved from the fully closed position the flooding will be immediately apparent and the valve can be reclosed to isolate the flood.

Leaving any component whether it is a manway, a valve, an expansion joint or any device on the CW or SW system open during returning the system to service will cause a flood. The contribution of floods when restoring the system following maintenance is dependent upon ensuring that all components are restored before opening the inlet valve. The restoration procedure has been analyzed and the human error probability of failing to carry out the procedure evaluated. If the inlet valve is opened the personnel monitoring the manway will immediately report the flood and the inlet valve can be reclosed.

3.5.3 Industry Maintenance Related Floods

The occurrence of flooding events in SW and CW systems during maintenance at all plants in the United States is summarized in Table 3.5-1 (SWEC, 1991A). Of the nine events reported, two events are not applicable to Surry due to valve operator design differences. The inlet valves for the Surry Service and Circulating Water Systems are motor operated whereas other plants use pneumatic and hydraulic operators in addition to motor operators on valves in these systems. Therefore, the failure of power to solenoid valves which resulted in two major floods at other plants, is not applicable to the Surry design. It should be noted that there is no reported occurrence of motor operated valves inadvertently opening and causing floods.

The butterfly valve design for the Surry CW and SW System isolation valves also precludes the two bonnet failure events at other plants. The bonnet primarily provides access to the stem packing and bearings; the valve body is generally removed for access to the valve disc and seal. A missing bonnet would yield only a small flooding rate, so the two bonnet failures are judged not applicable. Thus there are five events applicable to the Surry specific design.

The flood rate for each of the events which have occurred, with the exception of the events associated with solenoid valve failure, has ranged from 100 gpm to 6,250 gpm. All such events would have been within the capacity of the sump pumps at Surry and therefore whether isolable or non-isolable would not lead to core damage.

3.5.4 Summary of Maintenance Contributions

The total CDF due to maintenance induced floods at Surry Power Station is 8.4E-6/yr. A break down of these maintenance floods into various categories may be summarized as follows.

	Unit 1	Unit 2	Total
Long Term Isolable:			
Stop Logs	3.0E-6	3.0E-6	6.0E-6
Short Term Isolable:			
Waterboxes	1.02E-8	1.77E-8	2.79E-8
CC heat exchangers	1.65E-6	none	1.65E-6
BC heat exchangers	2.53E-7	4.75E-7	7.29E-7
Long term total	3.0E-6	3.0E-6	6.0E-6
Short term total	1.93E-6	4.93E-7	2.41E-6
Combined totals	4.9E-6	3.5E-6	8.4E-6

TABLE 3.5-1

INDUSTRY FLOODING EVENTS DURING MAINTENANCE

Date	Plant	Affected Component	Description	Flooding Rate (gpm)	Flood Quantity (gal)	Flood Isolated
10/72	Surry 2	Open Valve	Personnel forgot to close valve opened for maintenance	100	Unknown	Yes
05/87	Zion 2	Missing Valve Bonnet	Wrong bonnet removed for maintenance and not replaced	5,000	181,000	Yes
01/91	Clinton	Missing Valve Bonnet	Workers removed bonnet - valve not isolated (8")	6,000	150,000	Yes
12/87	Salem	Valve Seal	30" service water blind flange was loosened to drain and permit work - subsequent seal failure	600 2000	140,000	Yes
08/84	Indian Point	Removed Valve	Valve removed from train with incorrect isolation. Pump/ train realigned		50,000	Yes
01/79	Crystal River	Open Hx	Solenoid valve burnt out causing isolation valve to open (14")	65,200	325,000	Yes
10/76	Oconee	Open Manway	Failure of electrical supply inlet valve to open	63,000	200,000	Yes
01/84	Peach Bottom	Valve	Improper valve line up during maintenance	3,000	200,000	Yes
10/71	Surry	Valve	Valve malfunction during maintenance	1,000	Unknown	Yes

3.6 SUMMARY OF TURBINE BUILDING FLOODING RISK

The contribution of floods in the Turbine Building from each of the sources is summarized in Table 3.6-1. The contribution from floods due to residual random failure is about the same as the contribution from maintenance activities. Contributions from maintenance activities are 8.4E-6/yr which is 40% of Turbine Building contribution and 16% of the revised overall CDF. The contribution from water hammer internal events is 22% and from random failure 38%. It can be seen that the assumption made that maintenance activities and random failures would not contribute significantly to the base case in the original IPE analysis was justified (i.e. 1.7E-5/yr / 1.1E-3/yr x 100 = 1.5%).

The overall contribution from floods in the Turbine Building compared with floods in other areas is discussed in Section 6.0.

TABLE 3.6-1

SUMMARY OF TURBINE BUILDING FLOODING RISK

Source	Core Damage Frequency/Yr	Percent
Water Hammer Events	4.8E-6	22
Residual Random Failure	8.2E-6	38
Maintenance Activities	8.4E-6	40
TOTAL	2.1E-5	100

4.0 ANALYSIS OF FLOODING EVENTS WHICH IMPACT THE AUXILIARY BUILDING

4.1 BASE CASE

The Auxiliary Building contains the charging pumps and component cooling pumps for both units. Flooding this building could therefore jeopardize the ability of the operators to maintain reactor coolant pump seal injection and the ability to mitigate a seal LOCA which may result. The IPE final report discusses this area in detail. Only a summary is presented here to provide continuity.

The flood sources of importance to the Auxiliary Building equipment are the Unit 1 and Unit 2 RWST and fire protection piping located within the Auxiliary Building itself, and RWST piping located within the Safeguards Building. Flood propagation from the Safeguards Building to the Auxiliary Building is possible via a piping tunnel at the 2' elevation. (Note flood propagation from the Turbine Building to Auxiliary Building is also possible but such flooding is assumed to result in damage to the switchgear room earlier than in the Auxiliary Building, at which time the latter becomes irrelevant).

Within the Auxiliary Building all six charging pumps are located in individual cubicles whereas the component cooling water pumps are located on the general floor area. All cubicles and the general floor are interconnected by a floor drain system.

The RWST supply flood sources in the Auxiliary Building are from 10" and 8" diameter piping running from the tank to the charging pump cubicle. The 1AB2 flood damage state results from a rupture of this piping and is defined as the point when the water in the Auxiliary Building basement reaches a depth of 18.5" so that all the charging and component cooling pumps are lost. Four flood categories were defined based on a spectrum of flood rates for the failed component. Two of the four categories lead directly to core damage. The third and fourth category flood rates are low enough that sufficient time exists to stabilize the flood before all equipment is damaged. The frequency of 1AB2 is 1.3E-4/yr.

Since seal cooling is lost in this flood damage state the plant damage state loss of seal cooling event tree shown in Figure 4.1-1 was modified for use in determining the contribution to core damage frequency from 1AB2. The event tree was used with the functions modified appropriately for the flood condition and gave a contribution to core damage frequency of 2.1E-5/yr.

The fire protection sources in the Auxiliary Building are from 4" and 6" fire water supply lines. Floods from these sources lead to flood damage state 1AB3 which is less severe than 1AB2 since the safeguards equipment remains available. However, it was convenient and conservative to treat it in the same manner as the 1AB2 flood damage state. The resulting frequency for the 1AB3 flood damage state is 1.5E-5/yr and its contribution to core damage frequency is 2.3E-6/yr. In the results presented in the IPE submittal the contribution from 1AB2 and 1AB3 are combined in the contribution from 1AB2.

Floods which occur in the Unit 1 or Unit 2 Safeguards Building in any of the sub areas will drain to the lowest elevation in the Main Steam Valve House and flow unrestricted to the Auxiliary Building (2' elevation) via a connecting pipe tunnel. When the level reaches 18.5" in the Auxiliary Building, all the Unit 1 and Unit 2 charging pumps and component cooling pumps will be lost. In the case of the charging pumps damage occurs due to backflow into the charging pump cubicles through the drain lines. The flood damage states are designated 1SG2 (floods from Unit 1 equipment) and 2SG3 (floods from Unit 2 equipment) and each have a frequency of 2.0E-4/yr.

The contributions to core damage frequency are 3.1E-5/yr and 1.5E-5/yr respectively (Table 4.2-2).

4.2 IMPACT OF MODIFICATION

Backflow into the Charging Pump Cubicle drains is now prevented as the result of installing backflow prevention devices in each of the drains similar to those currently installed in the Emergency Switchgear Room. These devices will be maintained and tested periodically. This will have the following impact on the floods summarized in Table 4.2-1.

1. For all floods occurring in the Safeguards Buildings both Unit 1 and Unit 2 charging cubicles will not be affected, thus RCP seal injection will be maintained and there will be no seal LOCA initiating event. The core damage frequency from this event is therefore on the order of 3E-7/yr if it is assumed that the failure probability of the backflow devices is 1E-2. Small seepage or weeping past the device is not considered a failure.

2. In the event of a flood from the fire protection system in the Auxiliary Building (1AB3) the backflow prevention devices in the drains will prevent flow into the charging pump cubicles so seal LOCA will not occur and the charging pumps will remain available. The core damage frequency is reduced by approximately two orders of magnitude as in the previous case, i.e. < 1.0E-7/yr.

3. The RWST piping within the Auxiliary Building is located mainly in charging pump cubicles 1c and 2c. The three Unit 1 cubicles are connected by pipe penetrations as are the Unit 2 cubicles, but there is no interconnection between Unit 1 and Unit 2. Thus, in the event of a flood in the Unit 1 RWST supply, the Unit 1 charging pump cubicles and the general Auxiliary Building 2' elevation (CCW pumps) will be flooded but the Unit 2 cubicles remain unflooded.

The current event tree assumes that the failure of the charging pumps and CCW pumps for the unit will result in a seal LOCA because there are no procedures to direct the operator to cross connect Unit 2 seal injection in the event of this scenario. However, if the seal LOCA occurs, the LOCA procedure is entered and the operator is directed to use the Unit 2 charging system to maintain inventory in Unit 1. Thus core damage may be prevented by injection from the Unit 2 charging system.

The original frequency of unisolated floods leading to flood damage state 1AB2 due to Unit 1 or Unit 2 RWST supply failures, to both Units 1 and 2 is 1.3E-4/yr (Table 4.2-1). Thus the frequency of floods to each charging cubicle is half this value; that is 6.5E-5/yr. A flood to the Unit 2 charging pump cubicles will not cause loss of the Unit 1 charging pumps therefore no seal LOCA will occur on Unit 1. Based on the assumption that the backflow prevention device failure probability is .01, the core damage frequency contribution from floods in Unit 2 charging pump cubicles will be as follows:

$$\frac{6.5E-5}{1.3E-4} \times 2.0E-5 \text{ (base case core damage frequency)} \times .01$$

$$= \text{approximately } 1.0E-7/yr$$

In the case of floods in the Unit 1 charging pump cubicles, the flood will result in core damage if either the flood spreads to the Unit 2 cubicles as the result of failure of either the backflow prevention devices in the cubicle or failure of the Unit 2 charging system to maintain inventory following the seal LOCA on Unit 1. The initiating event frequency is half the original value, that is 6.5E-5/yr. The backflow prevention device failure probability is .01 and the combined human reliability and mechanical failure probability of the Unit 2 charging system is approximately 3.1E-3 based on the original analysis of this function (Function D102 and human error probability HEP-1FRC:1-2 in Appendix B of the IPE Report). The frequency contribution from floods in the Unit 1 charging cubicle is

$$\frac{6.5E-5}{1.3E-4} \times 2.0E-5 \times (1.0E-2 + 3.1E-3) = \text{approximately } 1.3E-7/yr$$

The revised core damage frequency for flood damage state 1AB2 is therefore:

1.0E-7 + 1.3E-7 = 2.3E-7/yr

TABLE 4.2-1

SUMMARY OF FLOOD DAMAGE STATE FREQUENCY FOLLOWING FLOODS IN THE AUXILIARY AND SAFEGUARDS BUILDING (TAKEN FROM TABLE E.3-22b OF THE IPE REPORT)

FLOOD SOURCE	FLOOD DAMAGE STATE	FREQUENCY	INTERNAL EVENTS MODEL
	AUXILIARY BUILDING		
RWST supply to charging pumps (Units 1&2)	1AB2 o loss of all charging and CCW pumps (Units 1 & 2) o loss of Unit 1 RWST supply	1.3E-4/yr	loss of seal cooling (T4)
Fire Protection	1AB3 o loss of all Charging and CCW Pumps (Units 1 & 2) (conservatively modeled as 1AB2)	1.5E-05/yr	loss of seal cooling (T4)
	SAFEGUARDS AREA UNIT 1		
RWST Supply LHSI, CS and charging pumps (unit 1)	1SG2 o loss of all Charging and CCW Pumps (Units 1 & 2) o loss of LHSI Pumps (Unit 1) o loss of Outside Recirc. Spray Pumps (Unit 1) o loss of inside Containment Air System (Unit 1) o loss of unit 1 RWST supply	2.0E-04/yr	loss of seal cooling (T4)
	SAFEGUARDS AREA UNIT 2		
RWST Supplies LHSI, and charging pumps (unit 2)	2SG3 o loss of all Charging and CCW Pumps (Units 1 & 2) o loss of LHSI pumps (Unit 2) o loss of Outside Recirc. Spray Pumps (Unit 2) o loss of inside Containment Air System (Unit 2) o loss of unit 2 RWST supply	2.0E-04/yr (same as Unit 1)	loss of seal cooling (T4)

TABLE 4.2-2

IMPACT OF FITTING BACKFLOW PREVENTION DEVICES TO CHARGING PUMP CUBICLE DRAINS

Flood Damage State	Significant Failure		Contribution to Core Damage Frequency/Yr	
	Before	After	Before	After
1AB2	Loss of all Charging and CCW Pumps (Units 1 and 2)	Loss of all Charging Pumps (Unit 1)	2.1E-5	~2.3E-7
1AB3	Loss of all Charging and CCW Pumps (Units 1 and 2)	No loss of Charging Pumps	2.1E-6	<1.0E-7
1SG2	Loss of all Charging and CCW Pumps (Units 1 and 2)	No loss of Charging Pumps	3.1E-5	~3E-7
2SG3	Loss of all Charging and CCW Pumps (Units 1 and 2)	No loss of Charging Pumps	1.5E-5	~1.5E-7

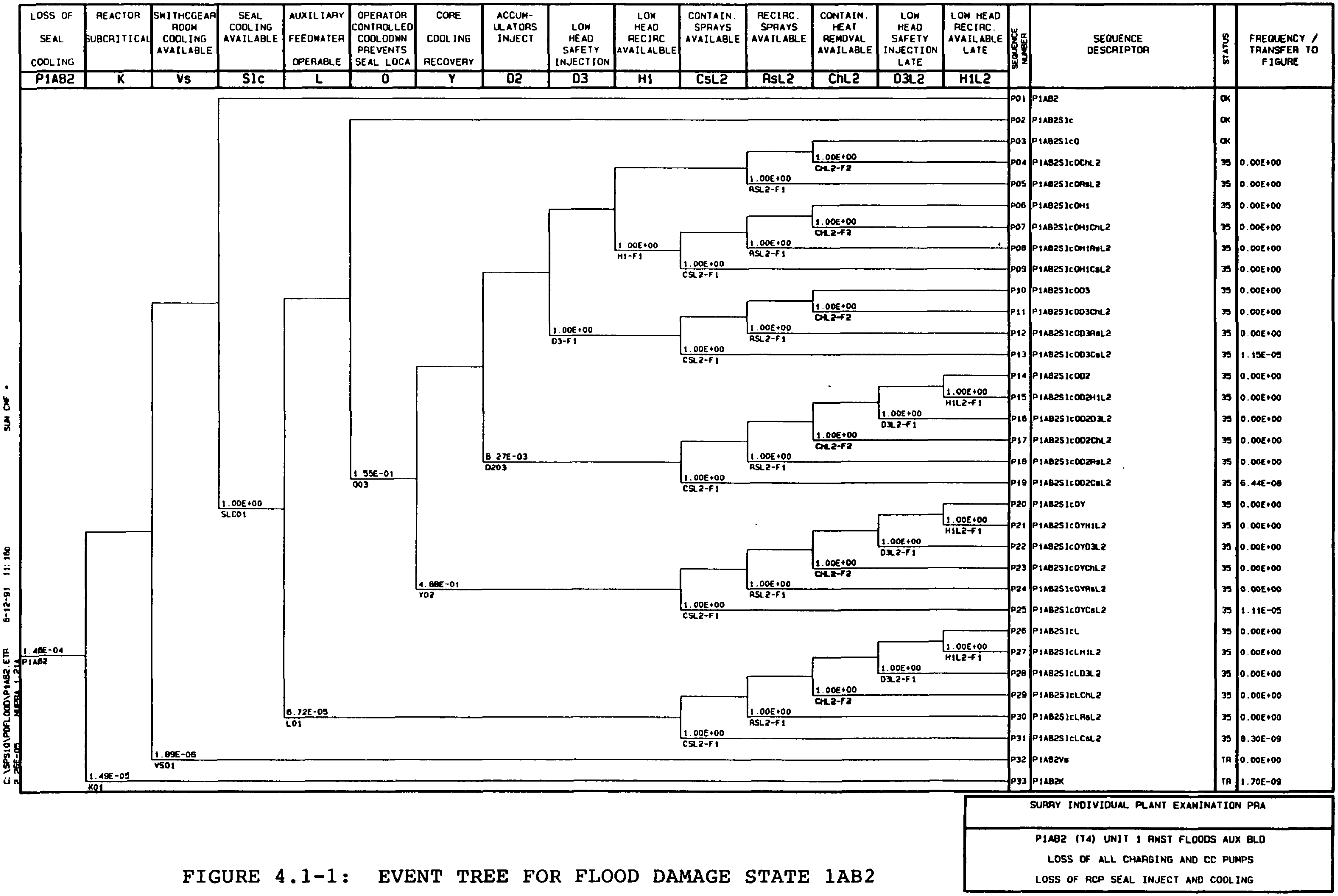


FIGURE 4.1-1: EVENT TREE FOR FLOOD DAMAGE STATE 1AB2

5.0 ANALYSIS OF FLOODING EVENTS IN MECHANICAL EQUIPMENT ROOM NO. 3

Mechanical Equipment Room (MER) #3 contains pumps and chillers that are used to supply HVAC for the control room and the relay room. Two of four service water supply pumps for cooling the charging pumps are also located in this room. Significant flood sources in this room are SW supplies to the chillers and charging pump SW pumps.

Three flood damage states have been defined for floods that originate in MER 3 and cause increasingly severe damage. FDS 1ME1 occurs first and results in loss of control/relay room HVAC when the flood height reaches 16" in MER #3. FDS 2ME2 includes damage sustained at 1ME1 but adds the impact of flooding the Unit 2 switchgear room. Finally, 1ME2 includes 2ME2 and adds damage to the Unit 1 switchgear room.

Flood categories were obtained by distributing the flood rates over the various sizes using the same method as in the Oconee PRA. Each flood category frequency was assigned to a flood damage state using simplified event trees to define the likelihood of flood progression. The resulting flood damage state frequencies are 1.2E-4/yr (1ME1), 1.7E-5/yr (2ME2) and 2.6E-5/yr (1ME2). These results are input to the appropriate event tree from the internal events analysis to determine the contribution to core damage frequency. The original submittal contained the following CDF results: 3.4E-6/yr (1ME1), 2.6E-5/yr (1ME2) and 3.5E-6/yr (2ME2). The summary of these flood damage states are shown in Table 5.1-1.

The reanalysis reported herein did not include any change to the methods or assumptions used to evaluate the probability of floods from MER #3. Therefore, the CDF originating from this area remains as reported in the original analysis.

TABLE 5.1-1

SUMMARY OF SPS INTERNAL FLOOD DAMAGE STATES FOR MER #3 (TAKEN FROM TABLE E.3-22b OF THE IPE REPORT)

FLOOD SOURCE	FLOOD DAMAGE STATE	FREQUENCY	INTERNAL EVENTS MODEL
	MECHANICAL EQUIPMENT ROOM NO. 3		
SW supply to charging pump SW pumps and HVAC Chillers	1ME1 o loss of control/ relay room HVAC chillers o loss of Charging Pump SW pumps 1-SW-P10B and 2-SW-P10B	1.2E-04/yr	loss of HVAC (Units 1 and 2)
"	2ME2 (IF-2ME2-SW) o as 1ME1 plus o loss of all Unit 2 4.16kv switchgear and emergency buses	1.7E-05/yr	loss of seal cooling (Unit 2 only) loss of HVAC (Units 1 and 2)
"	1ME2 (IF-1ME2-SW) o as 1TB5	2.6E-05/yr	loss of seal cooling (Unit 1 and 2)

6.0 SUMMARY OF INTERNAL FLOODING RISK

The base case analysis results indicate that flooding scenarios at SPS now contribute 5.1E-05/year to the core damage frequency compared with the base case assessment in the IPE study of 1.1E-03/year. This represents a reduction by a factor of 22 compared with the earlier results. The original frequency and revised frequency for each of the defined plant damage states are shown in Table 6.1-1.

The reduction in the core damage frequency is the result of removing the conservatism in the original analysis and performing the plant modifications previously described in this report.

TABLE 6.1-1

SUMMARY OF CORE DAMAGE FREQUENCY DUE TO INTERNAL FLOODS

Plant Damage State/Location	Core Damage Frequency Original	Core Damage Frequency Current	Percentage Contribution to Core Damage
Unit 1 Turbine Building 1TB5	5.9E-4	2.1E-5	41
Unit 2 Turbine Building 2TB5	4.2E-4		
Safeguards Building 1SG2	3.1E-5	3.0E-7	1
Safeguards Building 2SG3	1.5E-5	1.5E-7	-
Auxiliary Building 1AB2	2.3E-5	2.4E-7	-
Mechanical Equipment Room #3 (1ME2)	2.6E-5	2.6E-5	51
Mechanical Equipment Room #3 (1ME1)	3.4E-6	3.4E-6	7
TOTAL	1.1E-3	5.1E-5*	100

* For Unit 2 the overall CDF due to internal flooding is increased by 3.5E-6/yr by a contribution from MER #3 that affects Unit 2 ESGR in addition to MCR/RR HVAC.

7.0 REFERENCES

NSAC (Nuclear Safety Analysis Center, Electric Power Research Institute), 1984. Oconee PRA: A Probabilistic Risk Assessment of Oconee Unit 3, NSAC/60, Palo Alto, California, June.

Virginia Power, 1991. Probabilistic Risk Assessment Surry Nuclear Power Station Units 1 and 2 for the Individual Plant Examination: Final Report, Richmond, Virginia, August.

Bozoli, G., P. Kohut, R. Fitzpatrick, 1989. Interfacing System LOCA: Pressurized Water Reactors NUREG/CR-5102, Brookhaven National Laboratory, Upton, New York, February.

SWEC, 1991A. Letter Report NUS-16,199, Review of Draft Flooding Evaluation, Surry Power Station - Unit 1, April.

WRC, 1989. "Welded Tee Connections of Pipes Exposed to Slowly Increasing Internal Pressures,", Bulleting No. 347, September.

Taylor Forge Bulletin No. 502, 7th Edition.

Pratt, 1987A. Henry Pratt Company Stress Report for 96" 25# Triton XL Butterfly Valve, Pratt Job No.71456-5,8, September.

Pratt, 1987B. Henry Pratt Company Stress Report for 42" 75A Triton XR-70 Butterfly Valve, Pratt Job No.71456-4, September.

Pratt, 1987C. Henry Pratt Company Stress Report for 36" 75A Triton XR-70 Butterfly Valve, Pratt Job No.71456-3,7, September.

ASME, 1974. Boiler & Pressure Vessel Code, Section III, Subsection NB.

Virginia Power, 1987A. Specification For Motor-Operated Butterfly Valves, Surry Specification No. NUS-2074, Rev. 1, Addendum No. 1, December.

Pratt, 1987D. Henry Pratt Company letter from B.R. Cummins (Pratt) to T.B. Sowers, September.

Virginia Power, 1987B. Specification For Rubber Expansion Joints, Surry Specification No. NUS-2076, Addendum No. 2, December.

Thomas, H. M., 1981. "Pipe and Vessel Failure Probability," Reliability Engineering, Vol. 2, pp 83-124.

PASNY, 1982. "Indian Point Probabilistic Safety Study," Power Authority of the State of New York and Consolidated Edison Co., 1982.

SWEC, 1991B. Letter Report: System Investigation For Postulated Butterfly Valve Failures, NUS-16,745, Boston, November.

SWEC, 1991C. Letter Report: Applicability of Butterfly Valve Failures, NUS-16,732, Boston, November.

Virginia Power, 1987C. Henry Pratt Company letter from B. R. Cummins (Pratt) to T. B. Sowers, September.

UnWin, S. D., 1987. "An Information Theory-Based Probability Assignment Generator. Brief Code Description & User's Guide." Department of Nuclear Energy, Brookhaven National Laboratory, August 1987.

Virginia Power, 1969. Specification For Steam Surface Condenser Equipment, Surry Specification No. NUS-2, Rev. 3, November.

APPENDIX A: MAINTENANCE INDUCED FLOODS

TABLE OF CONTENTS

A.1 OVERVIEW OF MAINTENANCE INDUCED FLOODS

Maintenance activities can initiate a flood which could lead to core damage. This analysis will calculate the core damage frequencies (CDFs) for maintenance related floods. The results of this analysis may be combined with the mechanical equipment failure CDFs for an understanding of the overall CDF due to flooding.

Quantifying the flooding frequency due to maintenance activities is not a well established practice. The approach chosen herein is a modification of the Technique for Human Error Rate Prediction (THERP) defined in NUREG/CR-1278. A system fault tree was developed to analyze the possible ways that a flood could be initiated due to maintenance activities. Initiating event frequencies were incorporated into the maintenance flood fault tree so that an event tree was not necessary. This allows the CDF to be determined directly from fault tree quantification.

The data analysis for the basic events in the fault tree used the THERP method for human reliability analysis (HRA) and the Surry IPE report for equipment failure probabilities. The initiating event frequencies were determined by reviewing the work planning and tracking system (WPTS) for Surry Power Station. Each basic event used in the fault tree is defined in Section A.4.2.

Maintenance induced flooding will be limited to the maintenance activities associated with the Circulating Water and Service Water systems in the Unit 1 or 2 Turbine Buildings. Other systems and flood areas can be screened out from this analysis due to the limited flood water volume or the small flooding consequence.

The maintenance floods associated with the Circulating Water and Service Water systems are divided into same two categories defined by the equipment failure analysis. These categories are long term or short term isolable floods. The long term isolable maintenance floods are those which require the high level intake structure stop logs to be installed. The short term isolable floods are those which do not require stop logs to be installed to complete the maintenance.

A.2 LONG TERM ISOLABLE FLOODS

The long term isolable maintenance floods are those associated with the use of the stop logs to allow dewatering a Circulating Water or Service Water line. There are two types of events which can lead to a flood during maintenance while the stop logs are installed. One type is when maintenance is attempted on the wrong component. The second type is when the wrong stop log is removed.

Attempting maintenance on the wrong component will result in a flood because typically only one CW pipe is dewatered at a time. If maintenance is attempted on a component which is not dewatered, then opening the component will result in a flood. Wrong train or wrong unit choices are represented by a single basic event called "WRONG-MANWAY." This basic event is intended to represent selecting the wrong component whether it is a manway, a valve, an expansion joint or any device on the CW or SW system. The component name manway was selected only as a representative device.

The frequency for stop logs being inserted is based on scheduled maintenance and inspection of the CW and SW systems. These maintenance and inspections are performed during refueling outages. Typically only one CW line will be isolated at a time. However an estimated 50% of the time if one CW line is isolated a second CW line on the other unit may be isolated.

Maintenance floods associated with the stop logs will be calculated on a per station basis but there is no difference between the Unit 1 and Unit 2 flood frequency due to maintenance activities requiring stop log insertion.

A.2.1 Floods While At Least One Set of Stop Logs Are Inserted

Floods which are likely to occur while at least one set of stop logs are installed at the high level intake structure may be characterized by the sequence during which a manway (or other component) is opened on a pipe which has not been dewatered. The CDF for Unit 1 is 3.0E-6. The CDF when at least one stop log is in place is 6.0E-6/yr. The top cutsets follow:

1	6.0E-6	STOP-LOGS	RECLOSE-MANWAY	WRONG-MANWAY

A.2.2 Floods While Two Sets of Stop Logs Are Installed

Maintenance floods which are likely to occur while two or more sets of stop logs are installed may be characterized by the sequence during which the wrong stop log is removed. This will lead to core damage if the dewatered pipe downstream of the stop log has a component open allowing a flow path directly into the Turbine Building basement.

A vulnerability was found with the maintenance procedures when two sets of stop logs were in place. This vulnerability was originally quantified as a CDF of 9.03E-4/yr with the top cutsets as follows:

1	9.0000E-004	STOP-LOGS-STUCK TWO-STOP-LOGS	WRONG-STOP-LOG	STOP-LOGS
2	3.0000E-006	TWO-STOP-LOGS TRY-STOP-LOG	STOP-LOGS	WRONG-STOP-LOG
3	4.2000E-008	MOV-FAILS STOP-LOGS	RECLOSE-MANWAY	WRONG-MANWAY

4	2.4000E-011	FLOOD-WATCH WRONG-MANWAY	ALARM STOP-LOGS	RECLOSE-MANWAY
5	7.2000E-012	STOP-LOGS ALARM	WRONG-MANWAY FLOOD-WATCH-MCR	RECLOSE-MANWAY

This vulnerability was considerably reduced by revising the maintenance procedure for removing the stop logs. The old revision of the procedure allowed removing a stop log with the downstream section of pipe dewatered. The revised procedure requires that the downstream section of pipe be filled with water prior to stop log removal using a controllable process (eg., pumps or siphon). Filling the pipe first will allow a positive check that the piping is fully intact prior to removing a stop log. This limits the amount of water to a quantity which will not cause ESGR flooding. The CDF after revising the maintenance procedure is 8.4E-6/yr. The cutsets are the same as those for only one set of stop logs in place.

A.3 SHORT TERM ISOLABLE FLOODS

Short term isolable maintenance floods are those associated with maintenance activities which do not require the use of the stop logs to dewater a Circulating Water or Service Water line. There are three major maintenance activities which are classified as short term isolable. They are maintenance on the condenser waterboxes, the CC heat exchangers, and BC heat exchangers. The most frequent maintenance performed is tube and tube sheet cleaning.

There are three types of floods which may occur when one of these heat exchangers is in maintenance. One type is when maintenance is attempted on the wrong component. The second type is when the isolation valve is inadvertently opened; and the third is when a manway is left off after maintenance is completed.

Attempting maintenance on the wrong component will result in flood because typically only one heat exchanger is dewatered at a time. If maintenance is attempted on a component which is not dewatered, then opening the component will result in a flood. Wrong train or wrong unit choices are represented by a single basic event called "WRONG-MANWAY." This basic event is intended to represent selecting the wrong component whether it is a manway, a valve, an expansion joint or any device on the CW or SW system. The component name manway was selected only as a representative device.

If a heat exchanger is open for maintenance and the isolation valve is inadvertently opened then a flood will result until the valve is reclosed. The 96" CW inlet valves are reclosed automatically, electrically remotely or manually locally depending on the valve's status. The SW isolation valves are reclosed electrically remotely or manually locally.

A manway left off after maintenance is represented by the basic event "COVER-OFF." This basic event is intended to represent leaving any component whether it is a manway, a valve, an expansion joint or any device on the CW or SW system. The component name cover was selected only as a representative device.

A.3.1 Floods While Waterboxes Are In Maintenance

Unit 1 and Unit 2 waterbox analysis will be calculated individually since there is a significant difference in each unit's frequency of waterbox removal for condenser tube cleaning. Since the CW side of the condenser waterboxes and the procedures are essentially identical, the frequency of maintenance floods for waterboxes will be based on grouping all of the Unit 1 waterboxes together.

The Unit 1 waterboxes have been removed from service approximately 121 times between July 1, 1990 and November 2, 1991. This corresponds to a Unit 1 frequency of 91 times per year that the waterboxes are removed from service for condenser tube cleaning.

The same approach applied to the Unit 1 analysis was applied to the Unit 2 CW waterbox analysis. The only significant difference is the frequency for a Unit 2 waterbox being removed from service is different than the frequency for Unit 1 waterboxes.

The Unit 2 waterboxes have been removed from service approximately 212 times between July 1, 1990 and November 6, 1991. This corresponds to a Unit 2 frequency of 159 times per year that the waterboxes are removed from service for condenser tube cleaning.

The current applicable procedures for the Unit 1 waterboxes are 1-MOP-48.1 to 1-MOP-48.8 for removing and returning a waterbox to service. The Unit 2 procedures are 2-MOP-48.1 to 2-MOP-28.8.

The two most likely sources of flooding due to waterbox maintenance are the manways or the inlet drain valve. Since the drain valve flow rate is less than the capacity of the sump pumps, the operator will be able to identify the flood and correct the situation without significant equipment damage. The waterbox drain valves will not be considered in any further analysis.

The maintenance flood CDF for removing the Unit 1 condenser waterboxes from service is 1.02E-8/yr. The top cutsets follow:

1	8.9180E-009	MOV-FAILS UNIT-1-WB	MOV-POWERED MOV-SHAFT-PIN	VERIFIER ATTEMPT-MOV
2	7.6440E-010	RECLOSE-MANWAY UNIT-1-WB	WRONG-MANWAY AUTO-CLOSURE	MOV-FAILS
3	4.0950E-010	COVER-OFF VERIFIER COVER-OFF-AGAIN	RECLOSE-MOV UNIT-1-WB	WALKDOWN COVER-OFF-MISSED

4	5.4600E-011	COVER-OFF VERIFIER COVER-OFF-AGAIN	ALARM UNIT-1-WB	WALKDOWN COVER-OFF-MISSED
5	5.0960E-012	FLOOD-WATCH VERIFIER ATTEMPT-MOV	ALARM UNIT-1-WB	MOV-POWERED MOV-SHAFT-PIN
6	1.5288E-012	UNIT-1-WB ALARM ATTEMPT-MOV	VERIFIER FLOOD-WATCH-MCR	MOV-POWERED MOV-SHAFT-PIN

The maintenance flood CDF for removing the Unit 2 condenser waterboxes from service is 1.77E-8/yr. The top cutsets follow:

1	1.5582E-008	MOV-FAILS UNIT-2-WB	MOV-POWERED MOV-SHAFT-PIN	VERIFIER ATTEMPT-MOV
2	1.3356E-009	RECLOSE-MANWAY UNIT-2-WB	WRONG-MANWAY AUTO-CLOSURE	MOV-FAILS
3	7.1550E-010	COVER-OFF VERIFIER COVER-OFF-AGAIN	RECLOSE-MOV UNIT-2-WB	WALKDOWN COVER-OFF-MISSED
4	9.5400E-011	COVER-OFF VERIFIER COVER-OFF-AGAIN	ALARM UNIT-2-WB	WALKDOWN COVER-OFF-MISSED
5	8.9040E-012	FLOOD-WATCH VERIFIER ATTEMPT-MOV	ALARM UNIT-2-WB	MOV-POWERED MOV-SHAFT-PIN
6	2.6712E-012	UNIT-2-WB ALARM ATTEMPT-MOV	VERIFIER FLOOD-WATCH-MCR	MOV-POWERED MOV-SHAFT-PIN

The maintenance flood CDF for removing the Unit 1 and Unit 2 condenser waterboxes from service is 2.79E-8/yr. The top cutsets are a combination of the Unit 1 and Unit 2 waterbox maintenance floods previously listed.

A.3.2 Floods While CC Heat Exchangers Are In Maintenance

The CC heat exchangers and SW supply lines are located in the Unit 1 Turbine Building. The maintenance floods associated with these heat exchangers will be included in the flood damage state for 1TB5 and no contribution will be included in flood damage state 2TB5.

All four CC heat exchangers will be analyzed together and not as separate components. The CC heat exchangers have been removed from service approximately 104 times between July 1, 1990 and November

2, 1991. This corresponds to a frequency of 104 times per year that the CC heat exchangers are removed from service for tube cleaning.

The current applicable procedures for the CC heat exchangers are 0-MOP-51.16 and 0-MOP-51.17.

The CDF for floods due to the CC heat exchanger maintenance is 1.65E-6/yr. The top cutsets follow:

1	1.6380E-006	MOV-FAILS CC	RECLOSE-MANWAY	WRONG-MANWAY
2	7.6440E-009	MOV-FAILS CC	MOV-POWERED MOV-SHAFT-PIN	VERIFIER ATTEMPT-MOV
3	9.3600E-010	FLOOD-WATCH WRONG-MANWAY	ALARM CC	RECLOSE-MANWAY
4	3.5100E-010	COVER-OFF VERIFIER COVER-OFF-AGAIN	RECLOSE-MOV CC	WALKDOWN COVER-OFF-MISSED
5	2.8080E-010	CC ALARM	WRONG-MANWAY FLOOD-WATCH-MCR	RECLOSE-MANWAY
6	4.6800E-011	COVER-OFF VERIFIER COVER-OFF-AGAIN	ALARM CC	WALKDOWN COVER-OFF-MISSED
7	4.3680E-012	FLOOD-WATCH VERIFIER ATTEMPT-MOV	ALARM CC	MOV-POWERED MOV-SHAFT-PIN
8	1.3104E-012	CC ALARM ATTEMPT-MOV	VERIFIER FLOOD-WATCH-MCR	MOV-POWERED MOV-SHAFT-PIN

A.3.3 Floods While BC Heat Exchangers Are In Maintenance

Unit 1 and Unit 2 BC heat exchanger analysis will be calculated individually since there is a significant difference in each unit's frequency of waterbox removal for condenser tube cleaning. Since the three BC heat exchangers on each unit are essentially identical, the frequency of maintenance floods for BC heat exchangers will be based on grouping all of the Unit 1 heat exchangers together for Unit 1 analysis and the Unit 2 heat exchangers together for the Unit 2 analysis.

The Unit 1 BC heat exchangers have been removed from service approximately 16 times between July 1, 1990 and November 2, 1991. This corresponds to a frequency of 12 times per year that the BC heat exchangers are removed from service for tube cleaning.
The Unit 2 BC heat exchangers have been removed from service

approximately 30 times between July 1, 1990 and November 2, 1991. This corresponds to a frequency of 22.5 times per year that the BC heat exchangers are removed from service for tube cleaning.

The current applicable procedures for the BC heat exchangers are 1-MOP-50.9, 1-MOP-50.10, 2-MOP-50.9, and 2-MOP-50.10.

The CDF for maintenance floods due to the Unit 1 BC heat exchangers from service is 2.53E-7/yr. The top cutsets follow:

1	2.5200E-007	MOV-FAILS UNIT-1-BC	RECLOSE-MANWAY	WRONG-MANWAY
2	1.1760E-009	MOV-FAILS UNIT-1-BC	MOV-POWERED MOV-SHAFT-PIN	VERIFIER ATTEMPT-MOV
3	1.4400E-010	FLOOD-WATCH WRONG-MANWAY	ALARM UNIT-1-BC	RECLOSE-MANWAY
4	5.4000E-011	COVER-OFF VERIFIER COVER-OFF-AGAIN	RECLOSE-MOV UNIT-1-BC	WALKDOWN COVER-OFF-MISSED
5	4.3200E-011	UNIT-1-BC ALARM	WRONG-MANWAY FLOOD-WATCH-MCR	RECLOSE-MANWAY
6	7.2000E-012	COVER-OFF VERIFIER COVER-OFF-AGAIN	ALARM UNIT-1-BC	WALKDOWN COVER-OFF-MISSED

The CDF for maintenance floods due to the Unit 2 BC heat exchangers from service is 4.75E-7/yr. The top cutsets follow:

1	4.7250E-007	MOV-FAILS UNIT-2-BC	RECLOSE-MANWAY	WRONG-MANWAY
2	2.2050E-009	MOV-FAILS UNIT-2-BC	MOV-POWERED MOV-SHAFT-PIN	VERIFIER ATTEMPT-MOV
3	2.7000E-010	FLOOD-WATCH WRONG-MANWAY	ALARM UNIT-2-BC	RECLOSE-MANWAY
4	1.0125E-010	COVER-OFF VERIFIER COVER-OFF-AGAIN	RECLOSE-MOV UNIT-2-BC	WALKDOWN COVER-OFF-MISSED
5	8.1000E-011	UNIT-2-BC ALARM	WRONG-MANWAY FLOOD-WATCH-MCR	RECLOSE-MANWAY
6	1.3500E-011	COVER-OFF VERIFIER COVER-OFF-AGAIN	ALARM UNIT-2-BC	WALKDOWN COVER-OFF-MISSED

7	1.2600E-012	FLOOD-WATCH	ALARM	MOV-POWERED
		VERIFIER	UNIT-2-BC	MOV-SHAFT-PIN
		ATTEMPT-MOV		

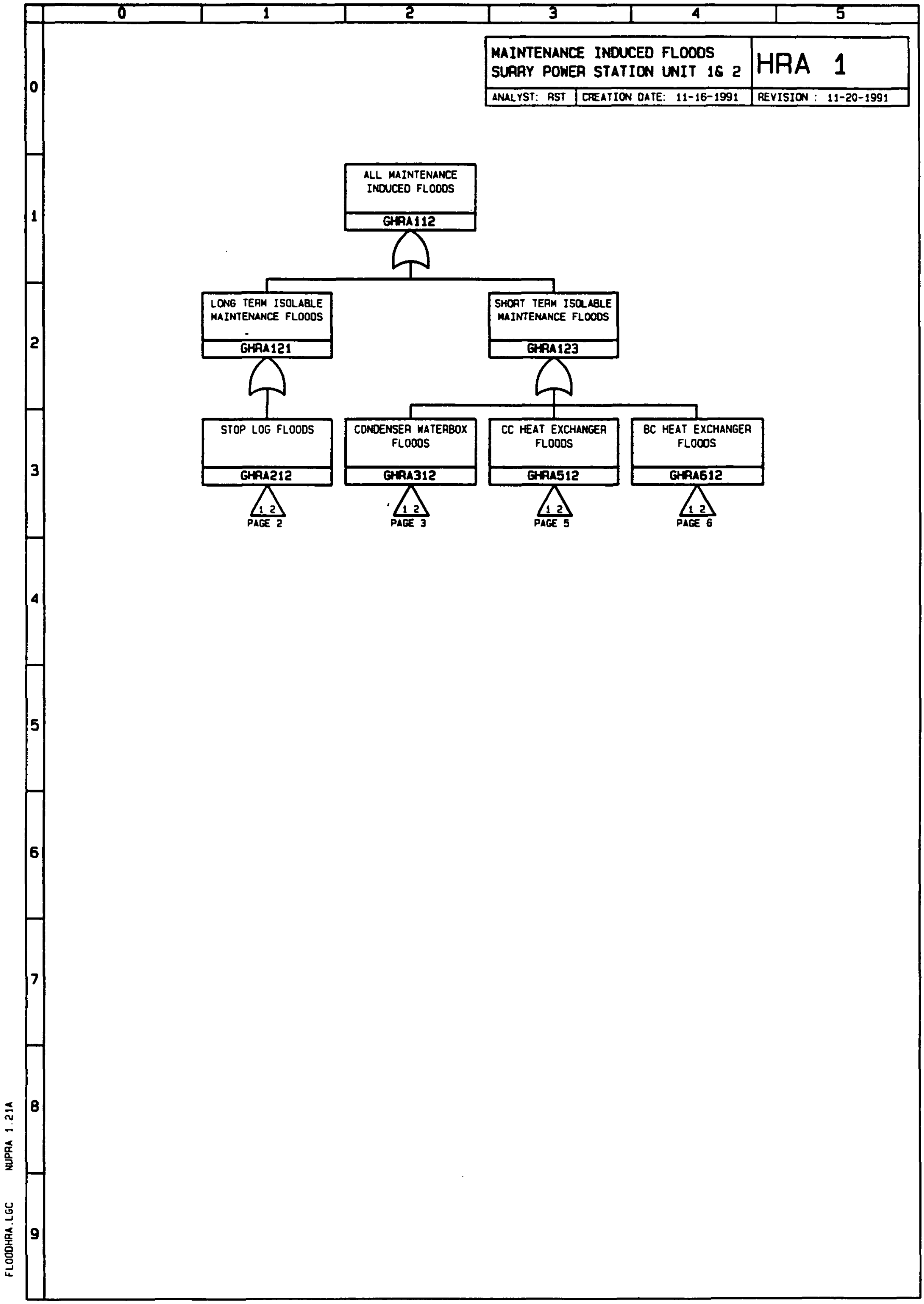
The CDF for maintenance floods due to the Unit 1 and 2 BC heat exchangers from service is 7.28E-7/yr. The top cutsets are a combination of the Unit 1 and Unit 2 BC heat exchanger maintenance floods previously listed.

A.4 FAULT TREE DEVELOPED TO QUANTIFY MAINTENANCE FLOODS

A.4.1 Fault Tree

The following six pages show the fault tree structure used to quantify the CDF due to maintenance activities. The first page shows the basic structure and allows quantifying the total CDF due to all maintenance floods. Page two is the structure for stop log analysis. Note how the fault tree includes the initiating event frequency so that the quantification of the top gates is a frequency not just a probability. Page three is the structure for condenser waterbox maintenance. Waterbox analysis is divided into Unit 1 and Unit 2 so that they may be quantified individually if so desired. Page four contains the operator actions which can be taken to recover from the maintenance floods. The other pages use only the applicable part of the recovery actions. Page five is the structure for the Component Cooling heat exchanger maintenance floods. Page six contains the events leading to Bearing Cooling maintenance floods.

The Service Water MOVs or expansion joints which supply water to the Recirculation Spray heat exchangers are not included in the fault tree because of the low initiating event frequency. This frequency is estimated to be less than once per year, which is far less than the initiating event frequency for the other maintenance activities included in the analysis.



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1
2
3
4
5
MAINTENANCE INDUCED FLOODS
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HRA 1
ANALYST: RST
CREATION DATE: 11-16-1991
REVISION : 11-20-1991
ALL MAINTENANCE INDUCED FLOODS
GHRA112
LONG TERM ISOLABLE MAINTENANCE FLOODS
GHRA121
SHORT TERM ISOLABLE MAINTENANCE FLOODS
GHRA123
STOP LOG FLOODS
GHRA212
CONDENSER WATERBOX FLOODS
GHRA312
CC HEAT EXCHANGER FLOODS
GHRA512
BC HEAT EXCHANGER FLOODS
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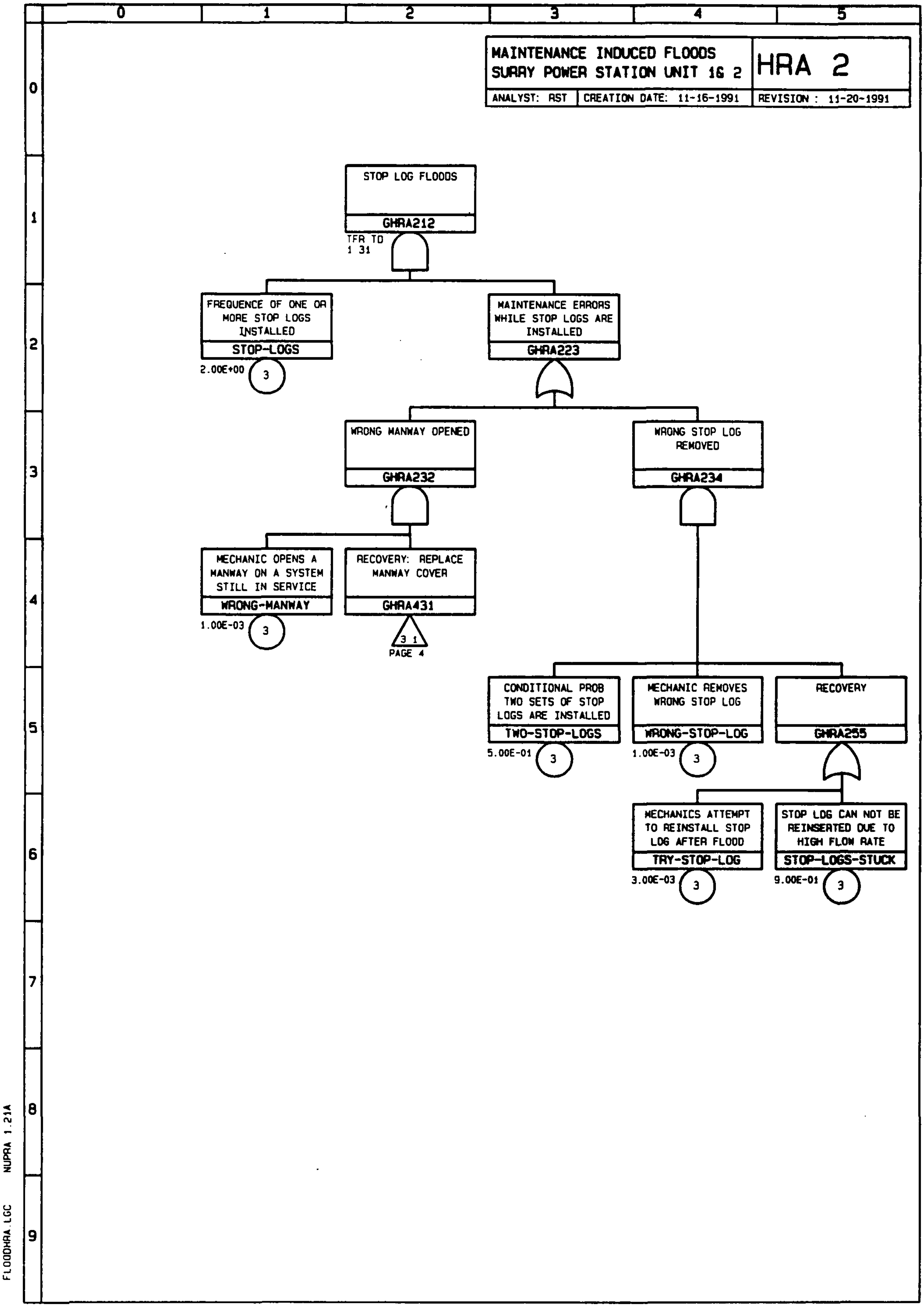
MAINTENANCE INDUCED FLOODS
SURRY POWER STATION UNIT 1& 2
HRA 2
ANALYST: RST
CREATION DATE: 11-16-1991
REVISION : 11-20-1991
STOP LOG FLOODS
GHRA212
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FREQUENCE OF ONE OR MORE STOP LOGS INSTALLED
STOP-LOGS
2.00E+00
3
MAINTENANCE ERRORS WHILE STOP LOGS ARE INSTALLED
GHRA223
WRONG MANWAY OPENED
GHRA232
WRONG STOP LOG REMOVED
GHRA234
MECHANIC OPENS A MANWAY ON A SYSTEM STILL IN SERVICE
WRONG-MANWAY
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RECOVERY: REPLACE MANWAY COVER
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PAGE 4
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WRONG-STOP-LOG
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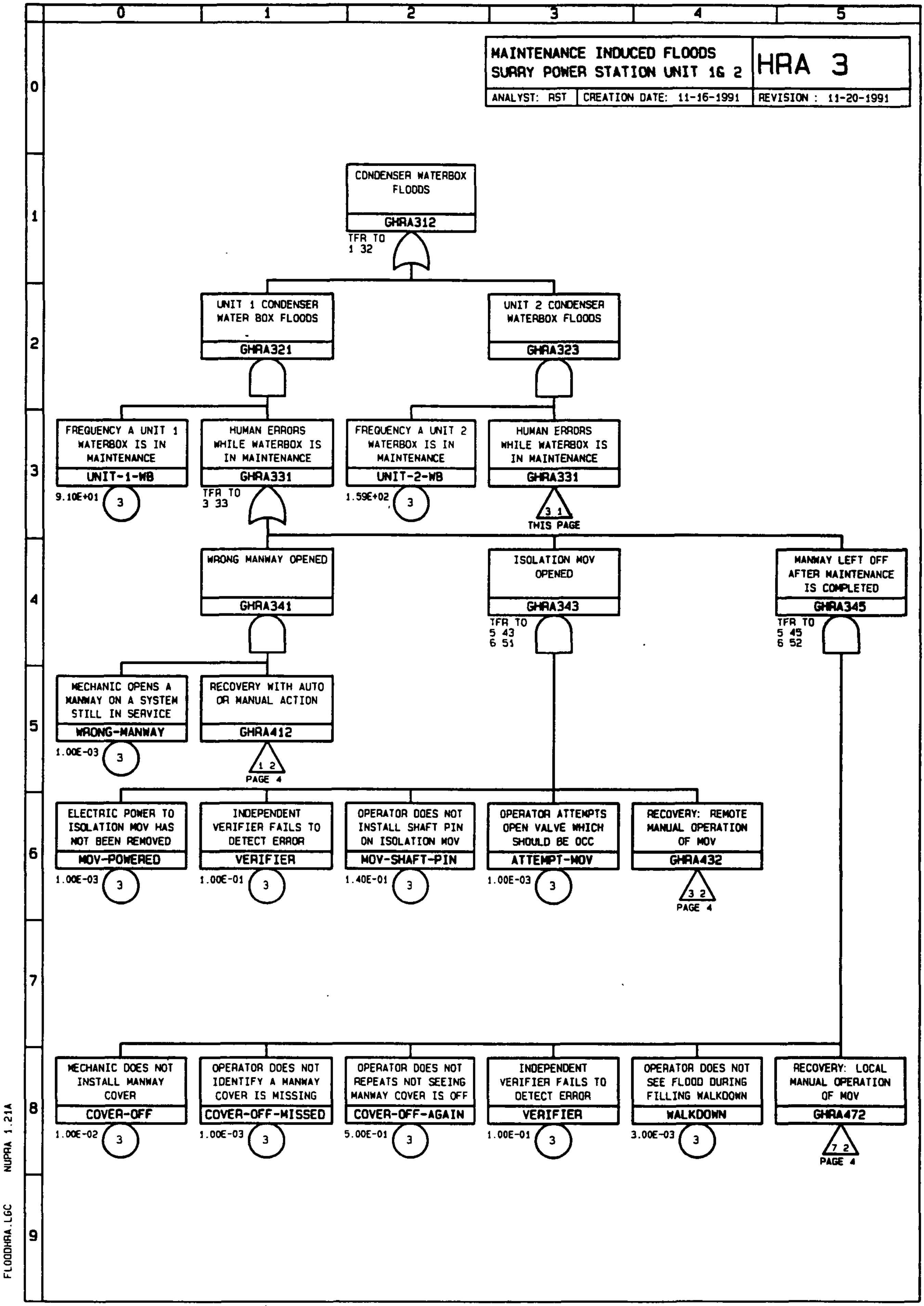
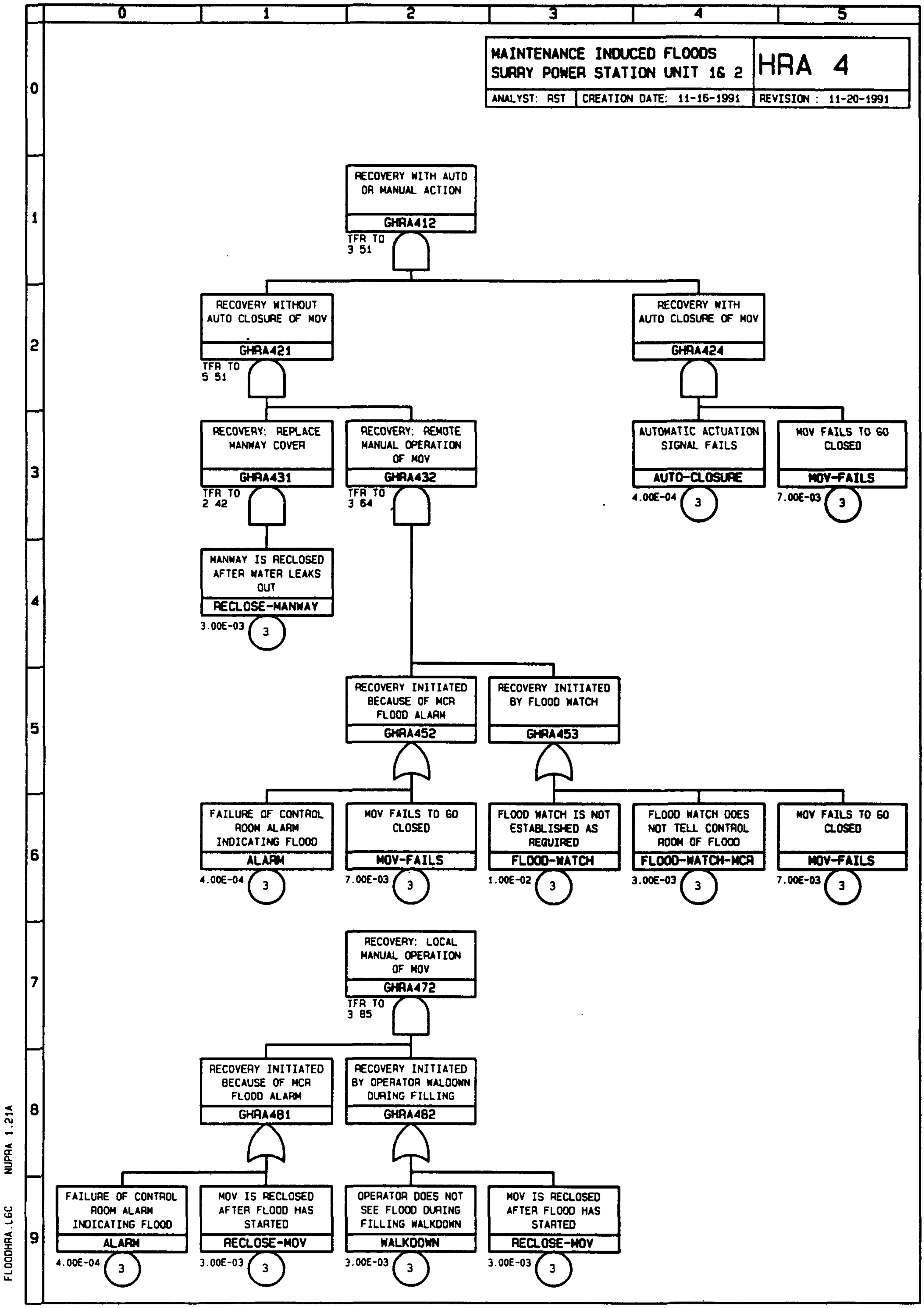
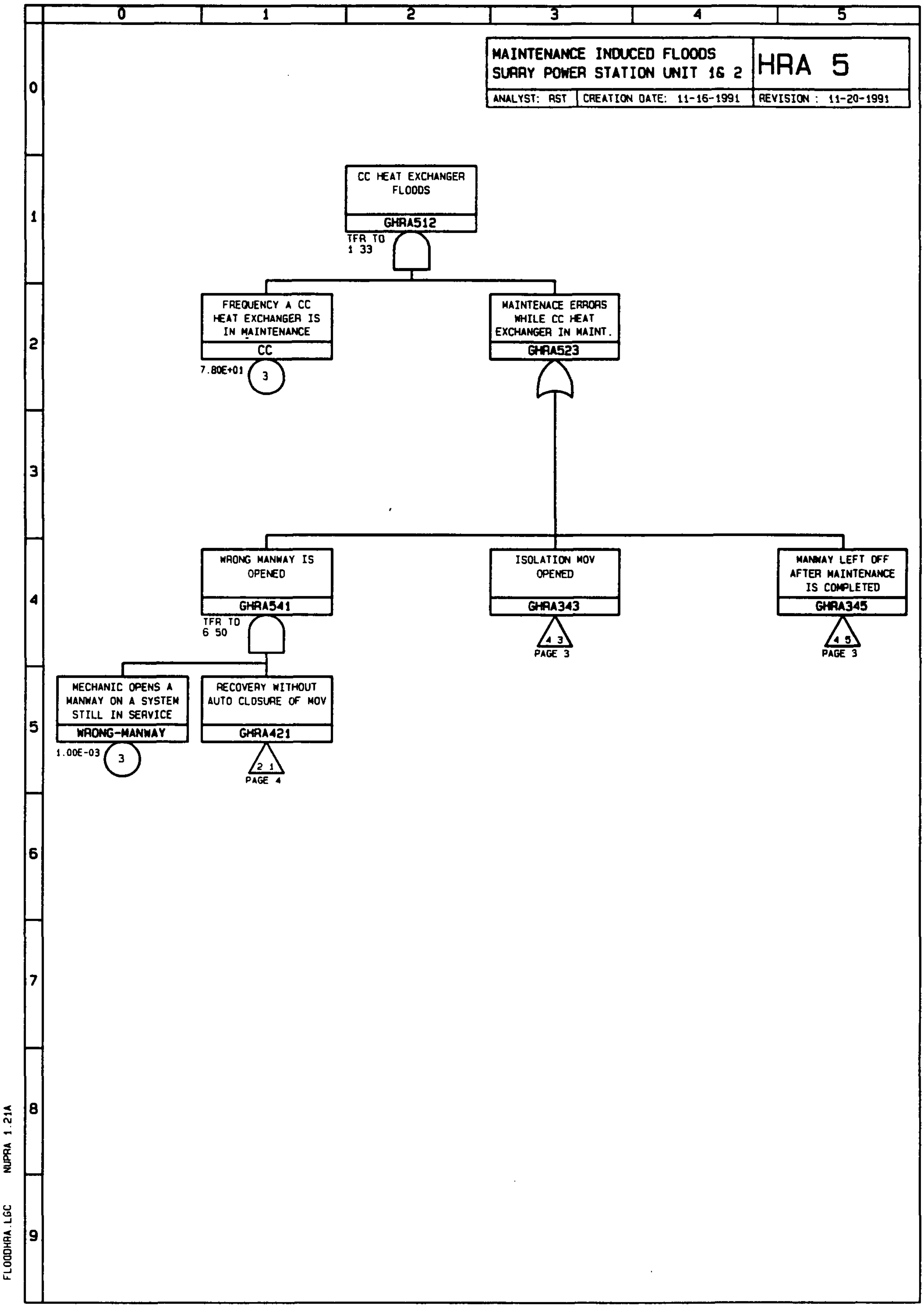
RECOVERY
GHRA255
MECHANICS ATTEMPT TO REINSTALL STOP LOG AFTER FLOOD
TRY-STOP-LOG
3.00E-03
3
STOP LOG CAN NOT BE REINSERTED DUE TO HIGH FLOW RATE
STOP-LOGS-STUCK
9.00E-01
3
FLOODHRA.LGC NUPRA 1.21A



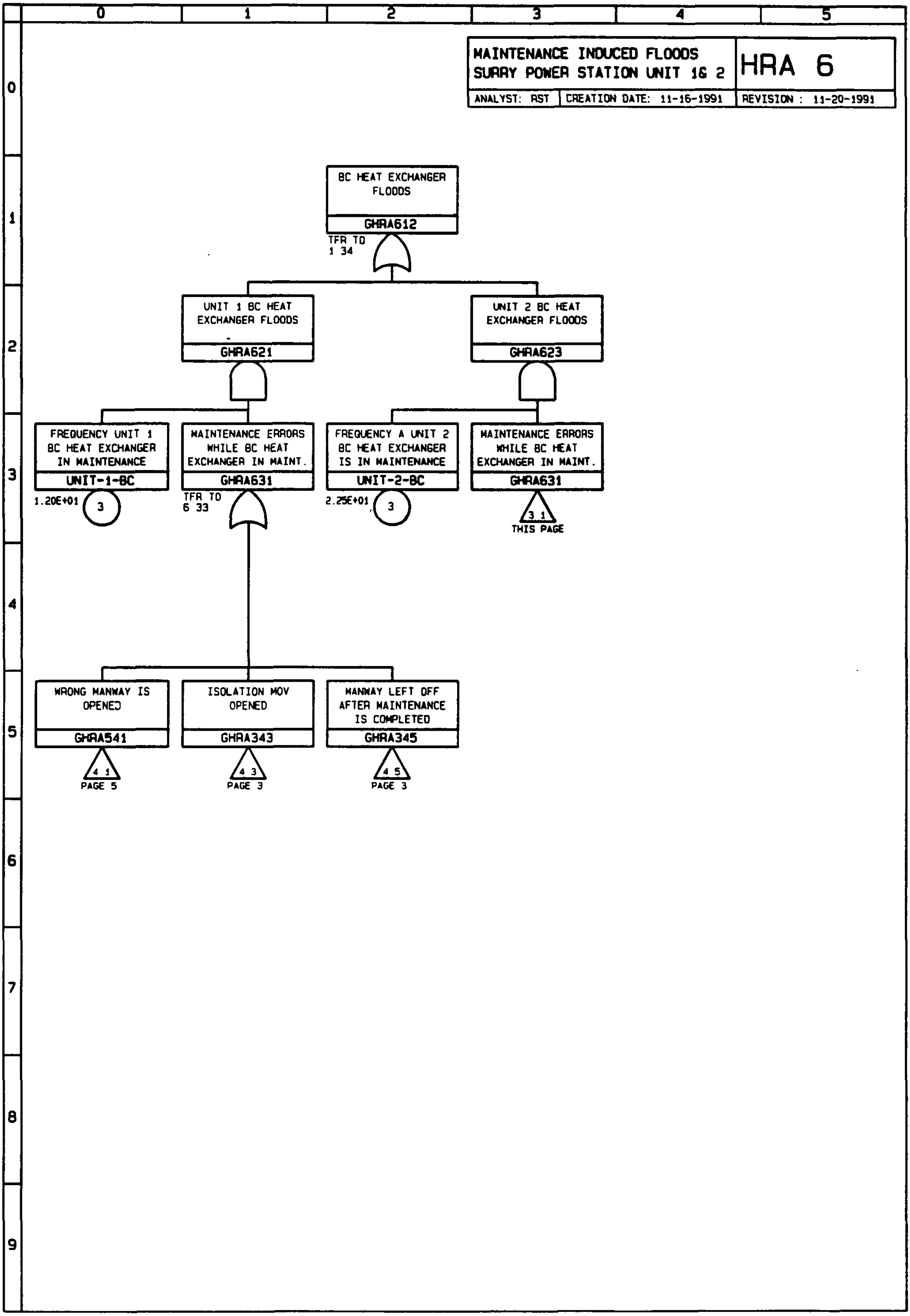
0
1
2
3
4
5
MAINTENANCE INDUCED FLOODS
SURRY POWER STATION UNIT 1& 2
HRA 3
ANALYST: RST
CREATION DATE: 11-16-1991
REVISION : 11-20-1991
CONDENSER WATERBOX FLOODS
GHRA312
TFR TO 1 32
UNIT 1 CONDENSER WATER BOX FLOODS
GHRA321
UNIT 2 CONDENSER WATERBOX FLOODS
GHRA323
FREQUENCY A UNIT 1 WATERBOX IS IN MAINTENANCE
UNIT-1-WB
9.10E+01
HUMAN ERRORS WHILE WATERBOX IS IN MAINTENANCE
GHRA331
TFR TO 3 33
FREQUENCY A UNIT 2 WATERBOX IS IN MAINTENANCE
UNIT-2-WB
1.59E+02
HUMAN ERRORS WHILE WATERBOX IS IN MAINTENANCE
GHRA331
3 1
THIS PAGE
WRONG MANWAY OPENED
GHRA341
ISOLATION MOV OPENED
GHRA343
TFR TO 5 43 6 51
MANWAY LEFT OFF AFTER MAINTENANCE IS COMPLETED
GHRA345
TFR TO 5 45 6 52
MECHANIC OPENS A MANWAY ON A SYSTEM STILL IN SERVICE
WRONG-MANWAY
1.00E-03
RECOVERY WITH AUTO OR MANUAL ACTION
GHRA412
1 2
PAGE 4
ELECTRIC POWER TO ISOLATION MOV HAS NOT BEEN REMOVED
MOV-POWERED
1.00E-03
INDEPENDENT VERIFIER FAILS TO DETECT ERROR
VERIFIER
1.00E-01
OPERATOR DOES NOT INSTALL SHAFT PIN ON ISOLATION MOV
MOV-SHAFT-PIN
1.40E-01
OPERATOR ATTEMPTS OPEN VALVE WHICH SHOULD BE OCC
ATTEMPT-MOV
1.00E-03
RECOVERY: REMOTE MANUAL OPERATION OF MOV
GHRA432
3 2
PAGE 4
MECHANIC DOES NOT INSTALL MANWAY COVER
COVER-OFF
1.00E-02
OPERATOR DOES NOT IDENTIFY A MANWAY COVER IS MISSING
COVER-OFF-MISSED
1.00E-03
OPERATOR DOES NOT REPEATS NOT SEEING MANWAY COVER IS OFF
COVER-OFF-AGAIN
5.00E-01
INDEPENDENT VERIFIER FAILS TO DETECT ERROR
VERIFIER
1.00E-01
OPERATOR DOES NOT SEE FLOOD DURING FILLING WALKDOWN
WALKDOWN
3.00E-03
RECOVERY: LOCAL MANUAL OPERATION OF MOV
GHRA472
7 2
PAGE 4
6
7
8
9
NUPRA 1.21A
FLOODHRA.LGC



MAINTENANCE INDUCED FLOODS
SURRY POWER STATION UNIT 1& 2
HRA 4
ANALYST: RST
CREATION DATE: 11-16-1991
REVISION : 11-20-1991
RECOVERY WITH AUTO OR MANUAL ACTION
GHRA412
TFR TO 3 51
RECOVERY WITHOUT AUTO CLOSURE OF MOV
GHRA421
TFR TO 5 51
RECOVERY WITH AUTO CLOSURE OF MOV
GHRA424
RECOVERY: REPLACE MANWAY COVER
GHRA431
TFR TO 2 42
RECOVERY: REMOTE MANUAL OPERATION OF MOV
GHRA432
TFR TO 3 64
AUTOMATIC ACTUATION SIGNAL FAILS
AUTO-CLOSURE
4.00E-04
3
MOV FAILS TO GO CLOSED
MOV-FAILS
7.00E-03
3
MANWAY IS RECLOSED AFTER WATER LEAKS OUT
RECLOSE-MANWAY
3.00E-03
3
RECOVERY INITIATED BECAUSE OF MCR FLOOD ALARM
GHRA452
RECOVERY INITIATED BY FLOOD WATCH
GHRA453
FAILURE OF CONTROL ROOM ALARM INDICATING FLOOD
ALARM
4.00E-04
3
MOV FAILS TO GO CLOSED
MOV-FAILS
7.00E-03
3
FLOOD WATCH IS NOT ESTABLISHED AS REQUIRED
FLOOD-WATCH
1.00E-02
3
FLOOD WATCH DOES NOT TELL CONTROL ROOM OF FLOOD
FLOOD-WATCH-MCR
3.00E-03
3
MOV FAILS TO GO CLOSED
MOV-FAILS
7.00E-03
3
RECOVERY: LOCAL MANUAL OPERATION OF MOV
GHRA472
TFR TO 3 85
RECOVERY INITIATED BECAUSE OF MCR FLOOD ALARM
GHRA481
RECOVERY INITIATED BY OPERATOR WALDOWN DURING FILLING
GHRA482
FAILURE OF CONTROL ROOM ALARM INDICATING FLOOD
ALARM
4.00E-04
3
MOV IS RECLOSED AFTER FLOOD HAS STARTED
RECLOSE-MOV
3.00E-03
3
OPERATOR DOES NOT SEE FLOOD DURING FILLING WALKDOWN
WALKDOWN
3.00E-03
3
MOV IS RECLOSED AFTER FLOOD HAS STARTED
RECLOSE-MOV
3.00E-03
3
NUPRA 1.21A
FLOODHRA.LGC



MAINTENANCE INDUCED FLOODS
SURRY POWER STATION UNIT 1& 2
HRA 5
ANALYST: RST
CREATION DATE: 11-16-1991
REVISION : 11-20-1991
CC HEAT EXCHANGER FLOODS
GHRA512
TFR TO 1 33
FREQUENCY A CC HEAT EXCHANGER IS IN MAINTENANCE
CC
7.80E+01
3
MAINTENACE ERRORS WHILE CC HEAT EXCHANGER IN MAINT.
GHRA523
WRONG MANWAY IS OPENED
GHRA541
TFR TO 6 50
ISOLATION MOV OPENED
GHRA343
4 3
PAGE 3
MANWAY LEFT OFF AFTER MAINTENANCE IS COMPLETED
GHRA345
4 5
PAGE 3
MECHANIC OPENS A MANWAY ON A SYSTEM STILL IN SERVICE
WRONG-MANWAY
1.00E-03
3
RECOVERY WITHOUT AUTO CLOSURE OF MOV
GHRA421
2 1
PAGE 4
FLOODHRA.LGC
NUPRA 1.21A



FLOODHRA.LGC NUPRA 1.21A

A.4.2 Definition of Basic Events

ALARM	=	4E-4, expected failure probability for the actuation signal, this failure estimated by a single relay failure probability.
ATTEMPT-MOV	=	0.001, probability that the operator will inadvertently operate the inlet MOV while the waterbox is open for cleaning and the MOV is still energized. From NUREG/CR-1278 Table 20-12 (errors of commission, inadvertent activation of a control in arranged in a well delineated functional grouping. Error factor 3.
AUTO-CLOSURE	=	4E-4, expected failure probability for the actuation signal, this failure estimated by a single relay failure probability.
CC	=	78/year, frequency of removing a CC heat exchanger for tube cleaning.
COVER-OFF	=	0.01, probability that a maintenance personnel will leave a manhole cover off, from NUREG/CR-1278 Table 20-6 (failure of administrative control, carry out a scheduled task). Error factor 5.
COVER-OFF-AGAIN	=	0.50, probability that the operator using the return to service MOP will repeat the error of COVER-OFF-MISSED and will not identify a manhole cover not properly installed. Because this HEP is highly dependent on COVER-OFF-MISSED. Using NUREG/CR-1278 Table 20-17 (conditional probabilities) COVER-OFF-AGAIN = (1+COVER-OFF-MISSED)/2 =.50
COVER-OFF-MISSED	=	0.001, probability that the operator using the return to service MOP will not identify a manhole cover not properly installed, from NUREG/CR-1278 Table 20-7 (errors of omission, procedures with checkoffs and long list). Error factor 3.
FLOOD-WATCH	=	0.01, probability that a flood watch will not be established as required by the remove from service MOPs. From NUREG/CR-1278 Table 20-6 (errors of omission, procedures with checkoffs and long list). Alternately if a flood watch is not in place, credit can be taken for the automatic flood alarm system.

FLOOD-WATCH-MCR	=	3E-3, probability that the flood closure watch will not notify the control room that a flood is in progress due to opening of the inlet MOV. The value of 3E-3 is from NUREG/CR-4550 analysis and was the standard value used for type C operator actions in the Surry IPE.
MOV-FAILS	=	7E-3, expected failure probability for the MOV to fail to go close. The value is the generic value used for the probability of a valve failing to go closed in the Surry IPE.
MOV-POWERED	=	0.001, probability that the operator using the remove from service MOPs will not open the breaker to the inlet MOV, from NUREG/CR-1278 Table 20-7 (errors of omission, procedures with checkoffs and long list). Error factor 3.
MOV-SHAFT-PIN	=	0.14, probability that the operator using the remove from service MOPs will not insert a shaft locking pin to prevent the valve disk from moving. Because this HEP is moderately dependent on MOV-POWERED using NUREG/CR-1278 Table 20-17 (conditional probabilities) MOV-SHAFT-PIN = (1+MOV-POWERED)/7 =1.43E-1.
RECLOSE-MANWAY	=	3E-3, probability that after a mechanic opens the wrong manhole cover the mechanic recloses manhole or notifies the control room operator who then closes the appropriate isolation valve. The value of 3E-3 is from NUREG/CR-4550 analysis and was the standard value used for type C operator actions in the Surry IPE.
RECLOSE-MOV	=	3E-3, probability that a isolation MOV is reclosed after the valve is inadvertently opened. The value of 3E-3 is from NUREG/CR-4550 analysis and was the standard value used for type C operator actions in the Surry IPE.
STOP-LOGS	=	2.0 per year, frequency a CW line is required to be dewatered for maintenance or inspections.
STOP-LOGS-STUCK	=	0.9, probability that the stop log can not be reinserted due to high flow rate.

TRY-STOP-LOG = 3E-3, probability that the mechanics will attempt to reinstall the stop logs after flood is identified. The value of 3E-3 is from NUREG/CR-4550 analysis and was the standard value used for type C operator actions in the Surry IPE.

TWO-STOP-LOGS = 0.5 the conditional probability that two sets of stop log are installed.

UNIT-1-BC = 12 per year, frequency of removing a Unit 1 BC heat exchanger for tube cleaning.

UNIT-1-WB = 91 per year, frequency of removing a Unit 1 waterbox from service for condenser tube cleaning.

UNIT-2-BC = 22.5 per year, frequency of removing a Unit 2 BC heat exchanger for tube cleaning.

UNIT-2-WB = 159 per year, frequency of removing a Unit 2 waterbox from service for condenser tube cleaning.

VERIFIER = 0.1, recovery factor, NUREG/CR-1278 Table 20-22, checker using written procedure, EF = 5. Remove form service MOPs independent verification.

WALKDOWN = 3E-3, probability that an operator present during the filling and venting process as required by the return to service MOPs will fail to take the proper corrective action of closing the inlet MOV after it has been opened by an operator in step 5.3.10. The value of 3E-3 is from NUREG/CR-4550 analysis and was the standard value used for type C operator actions in the Surry IPE.

WRONG-MANWAY = 0.001, probability that a mechanic will inadvertently open a manhole cover on a waterbox still in service. From NUREG/CR-1278 Table 20-13 (selection errors for locally operated valves, clearly and ambiguously labeled, part of a group of two or more valves that are similar in all of the following: size, and shape, and presence of tags). Even though this table is intended for manual operation of valve, it can be reasonably applied to the condenser manhole covers.

WRONG-STOP-LOG	=	1E-3, probability that a mechanic removes the wrong stop log. From NUREG/CR-1278 Table 20-13 (selection errors for locally operated valves, clearly and ambiguously labeled, part of a group of two or more valves that are similar in all of the following: size, and shape, and presence of tags). Even though this table is intended for manual operation of valve, it can be reasonably applied to the stop logs.

A.5 FLOOD PROTECTION PROCEDURES SUMMARY

Many enhancements have been made to the operating and maintenance procedures at Surry Power Station as part of the strategy to eliminate the flooding vulnerability identified by the Surry IPE. The following is a brief description of the applicable procedures.

A.5.1 Operations Response Procedures

Procedure No.	Title
1E-D2	CNDSR PIT HI LVL
1E-B3	CNDSR PIT HI HI LVL
1E-B4	AMERTAP PIT HI LVL
1E-C5	AMERTAP PIT HI HI LVL
2E-D2	CNDSR PIT HI LVL
2E-D3	CNDSR PIT HI HI LVL
2E-D4	AMERTAP PIT HI LVL
2E-C5	AMERTAP PIT HI HI LVL
VSP-M4	FLOOD CONT PNL TRBL
0-AP-13.00	TURBINE BUILDING #3 MER FLOODING

The Annunciator Response Procedures (ARPs) were revised to transition to 0-AP-13.00. Annunciator Response Procedure VSP-M4 was revised to specifically address #3 MER flooding and to transition to 0-AP-13.00.

Abnormal Procedure 0-AP-13.00 was revised to add response to #3 MER flooding. In addition, 0-AP-13.00 was revised to provide more detailed information on isolating flood sources and when to trip the Reactor based on flood water levels in the turbine building, #3 MER and the Unit 2 ESGR.

The Hi Hi Condenser and Amertap Pit ARPs were revised to include a step to establish a Roving Watch to monitor the Condenser, Amertap Pit and SW Valve Pit levels when the Hi Hi level alarm is locked in and attempts to dewater pit are ineffective. ARP VSP-M4 was revised to include a step to specifically address SW Valve Pit flooding. In addition, VSP-M4 was revised to include steps to establish a Roving Watch to monitor flood areas when attempts to dewater are ineffective. This watch will also be established if the Hi Hi Pit level or Flood Control Panel Trbl (VSP-M4) alarm actuates and it is determined that the cause of the alarm is instrumentation failure.

A.5.2 Normal Operations Procedures

To reduce the potential of a flood in the turbine building, the following groups of procedures have been modified.

Procedure No.	Title
1-MOP-48.1	Removal from Service of 1A Waterbox
1-MOP-48.3	Removal from Service of 1B Waterbox
1-MOP-48.5	Removal from Service of 1C Waterbox
1-MOP-48.7	Removal from Service of 1D Waterbox
2-MOP-48.1	Removal from Service of 2A Waterbox
2-MOP-48.3	Removal from Service of 2B Waterbox
2-MOP-48.5	Removal from Service of 2C Waterbox
2-MOP-48.7	Removal from Service of 2D Waterbox
1 MOP-50.9	BC Heat Exchanger Removal from Service for Maintenance
2 MOP-50.9	BC Heat Exchanger Removal from Service for Maintenance
0-MOP-51.16	CC Heat Exchanger Removal from Service for Maintenance

The following warning has been added to the above Removal from Service procedures:

To prevent uncontrolled turbine building flooding, a Flood Closure Watch shall be established prior to initiating any of the following maintenance activities unless the associated high level intake stop logs are installed.

- Removal of any expansion joint
- Removal of any valve larger than 2 inches
- Removal of any piping larger than 2 inches
- Opening of a Heat Exchanger (Waterbox) Manway
- Removal of a Heat Exchanger Endbell

Also, the following procedural steps have been added to verify compliance with the warning:

- Notify Maintenance to establish a Flood Closure Watch at the effected work area.

- Log the name and badge number of the Flood Closure Watch in the CRO Log.

- Brief the Flood Closure Watch to maintain continuous communication capabilities with the Control Room and immediately notify the Control Room of any leakage from the effected component.

Procedure No.	Title
1-MOP-48.2	Return to Service of 1A Waterbox
1-MOP-48.4	Return to Service of 1B Waterbox
1-MOP-48.6	Return to Service of 1C Waterbox
1-MOP-48.8	Return to Service of 1D Waterbox
2-MOP-48.2	Return to Service of 2A Waterbox
2-MOP-48.4	Return to Service of 2B Waterbox
2-MOP-48.6	Return to Service of 2C Waterbox
2-MOP-48.8	Return to Service of 2D Waterbox
1 MOP-50.10	BC heat Exchanger Return to Service Following Maintenance
2 MOP-50.10	BC Heat Exchanger Return to Service Following Maintenance
0-MOP-51.17	CC Heat Exchanger Return to Service Following Maintenance

The following warning has been added to the above Return to Service procedures:

> Prior to filling of the system and piping with water, a walkdown to verify system integrity shall be performed if any of the following maintenance activities have been performed.
>
> - Any expansion joint was removed
> - Maintenance on any valve larger than 2 inches
> - Replacement or welding on any pipe larger than 2 inches
> - Opening of any manway
> - Removal of any Heat Exchanger Endbell (Waterbox)

Also, the following procedural steps have been added to verify compliance with the warning:

- Inspect system expansion joints for integrity
- Inspect system valves and piping for integrity
- Verify Heat Exchanger (Waterbox) Manways are properly closed
- Verify Heat Exchanger Endbells are installed
- During filling, continuously walk down the system and components for evidence of leaks

Procedure No.	Title
1-MOP-48.14	Removal of Stop Logs from 1A Waterbox
1-MOP-48.16	Removal of Stop Logs from 1B Waterbox
1-MOP-48.18	Removal of Stop Logs from 1C Waterbox
1-MOP-48.20	Removal of Stop Logs from 1D Waterbox
2-MOP-48.14	Removal of Stop Logs from 2A Waterbox
2-MOP-48.16	Removal of Stop Logs from 2B Waterbox

Procedure No.	Title
2-MOP-48.18	Removal of Stop Logs from 2C Waterbox
2-MOP-48.20	Removal of Stop Logs from 2D Waterbox

A step was added to the above Removal of Stop Logs procedures for communications to be established between the Flood Closure Watch and the MCR before Stop Log removal.

Also, a requirement was added to establish a Flood Closure Water to perform walkdown of waterbox and associated piping while removing Stop Logs. Flood Closure Watch shall not be secured until after system is filled.

Procedure No.	Title
1-MOP-48.13	Installation of Stop Logs for 1A Waterbox
1-MOP-48.15	Installation of Stop Logs for 1B Waterbox
1-MOP-48.17	Installation of Stop Logs for 1C Waterbox
1-MOP-48.19	Installation of Stop Logs for 1D Waterbox
2-MOP-48.13	Installation of Stop Logs for 2A Waterbox
2-MOP-48.15	Installation of Stop Logs for 2B Waterbox
2-MOP-48.17	Installation of Stop Logs for 2C Waterbox
2-MOP-48.19	Installation of Stop Logs for 2D Waterbox

A step was added to the above Installation of Stop Logs procedures to have Operations locally verify the Stop Logs have been installed.

Procedure No.	Title
1-OPT-CW-001	Leak Test of the Circulating Water Inlet and Outlet 96" Valves
2-OPT-CW-001	Leak Test of the Circulating Water Inlet and Outlet 96" Valves
1-OPT-SW-001	Leak Test of SW Valves 1-SW-MOV-101A and 1-SW-MOV-101B
2-OPT-SW-001	Leak Test of SW Valves 1-SW-MOV-101A and 1-SW-MOV-101B
1-OPT-SW-002	Leak Testing of Component Cooling Water heat Exchanger Service Water Valves
2-OPT-SW-002	Leak Testing of Service Water Valves 2-SW-MOV-202A and 2-SW-MOV-202B

The above Leak Testing procedures were written to measure leakage across CW and SW valves. These tests ensure that water loss to non-safety equipment is limited.

Procedure No.	Title
1-PT-18.10P	Verification of Local and Remote Valve Position Indications in the Turbine and Service Buildings

Procedure No.	Title
2-PT-18.10P	Verification of Local and Remote Valve Position Indications in the Turbine and Service Buildings

Procedures verify the remote valve position indication and the local valve position indication are the same IAW IWV-3300, Section XI ASME Code.

Procedures also perform an ERFCS verification for each valve by ensuring the valve position as indicated by the single "Digital Point Review" display from an ERFCS Console is the same as the valve position from local or remote indications.

Procedure No.	Title
1-PT-25.1	Quarterly Testing of Circulating Water and Service Water System Valves
2-PT-25.1	Quarterly Testing of Circulating Water and Service Water System Valves

Procedures quarterly cycle each Service Water and Circulating Water valve to its required position for an accident as outlined in Section XI ASME Code, and provide for operability testing of the Service Water and Circulating Water valves following maintenance.

Procedure No.	Title
OC-47	Turbine Building Sump Pump Status Verification

Assures on a shift basis that the status and condition of the turbine building sump pumps is known and equipment is in satisfactory condition and verifies nine out of nine sump pumps are operable or immediate attention for repairs of inoperable pumps has been initiated.

Procedure No.	Title
OC-48	Assessment of Maintenance Activities for Potential Flooding of Turbine Building and Associated Areas

Documents the required actions for maintenance activities which have the potential of causing flooding of the turbine buildings and associated areas.

This OC shall be implemented for SW or CW system work located in the turbine building. Components to be evaluated shall be components which generate an opening larger than 2" in diameter.

A.5.3 Maintenance Procedures

Procedure No.	Title
GMP-001	Heavy Load Rigging and Movement NUREG-0612

Procedure provides instructions for the rigging and movement of heavy loads IAW NUREG-0612. This procedure also provides instructions for rigging and movement of equipment in the turbine building basement.

This procedure was revised to include instruction for movement of equipment in the turbine building basement.

Procedure No.	Title
GMP-011	Installation and Removal of Stop Logs

GMP-011 provides Site Services with instruction for installation and removal of Stop Logs during normal operating conditions, and emergency flood conditions.

Procedure No.	Title
GMP-012	Roving Flood Watch Responsibilities

GMP-012 sets responsibilities, and provides instructions for performing the duties of Roving Flood Watch. This procedure assures that the Control Room is aware of turbine building flood area conditions based on hourly walkdowns. This procedure also provides forms for documentation of Flood Watch Personnel observations during shift walkdowns.

Procedure No.	Title
GMP-013	Removal and Installation of Flood Protection Dikes

GMP-013 provides instruction for removal and installation of flood protection dike during normal, and emergency flood operating conditions. This procedure assures that a roving flood watch will be on duty, in accordance with GMP-012, and a flood closure watch with two-way Control Room communication is established with the capability of reinstalling the flood protection dike immediately upon Control Room notification.

Procedure No.	Title
0-MPM-1900-01	Annual Inspection of Flood and Spill Protection Dikes, Dams and Expansion Joint Shields
0-MPM-1900-02	Annual Flood Protection Floor Drain Back Water Stop Valve Inspection

0-MPM-1900-01 provides instruction for annual inspection of flood protection dikes, dams, and expansion joint shields in the flood area of the turbine building basement.

0-MPM-1900-02 provides instructions for inspection of floor drain backflow water stop valves installed in the Units 1 and 2 Cable Vaults, Emergency Switch Gear Rooms, and Mechanical Equipment Rooms (MER) 3 and 4. This procedure also provides instructions for corrective actions necessary to correct floor drain back water stop valve defects.

Procedure No.	Title
0-MCM-1003-01	Expansion Joint Removal, Inspection, and Installation

This procedure provides instructions for normal maintenance rework or replacement of expansion joints. This procedure also provides instructions for refueling frequency Preventive Maintenance Program inspection of expansion joints, and eight year frequency replacement of expansion joints in the turbine building basement.

Procedure No.	Title
1-PT-45	Flood Control
2-PT-45	Flood Control

Procedures test operability of level probes, level switches, and alarms in flood control - Circulating Water condenser inlet valve test circuit, and verify ability of level switch system to initiate valve closure each refueling.

Procedure No.	Title
STP-70.4	Flood Protection Floor Drain Back Water Sewer Stop Valve Operability Test

Procedure verifies the operability of the floor drain back water sewer stop valves installed in the Units 1 and 2 cable vaults and Emergency Switch Gear Rooms.

Procedure No.	Title
STP-70.5	Flood Detection

Procedure tests the operability of level probes, relays, alarms and lights in the station flood detection circuits once per year.

Procedure No.	Title
0-NSP-CW-001	Visual Inspection of CW and SW Bolted Connections at Valves

This procedure was developed to facilitate an external visual inspection of CW and SW bolted connections.

A.6 CONCLUSIONS

The total CDF due to maintenance induced floods at Surry Power Station is 8.4E-6/yr. A break down of these maintenance floods into various categories may be summarized as follows.

	Unit 1	Unit 2	Total
Long Term Isolable:			
Stop Logs	3.0E-6	3.0E-6	6.0E-6
Short Term Isolable:			
Waterboxes	1.02E-8	1.77E-8	2.79E-8
CC heat exchangers	1.65E-6	none	1.65E-6
BC heat exchangers	2.53E-7	4.75E-7	7.29E-7
Long term total	3.0E-6	3.0E-6	6.0E-6
Short term total	1.93E-6	4.93E-7	2.41E-6
Combined totals	4.9E-6	3.5E-6	8.4E-6

A sensitivity analysis was performed on the value selected for not being able to reinsert a stop log sticking after it has been removed. The total CDF remained at 2.43E-6/yr when the value for STOP-LOG-STUCK was increase from 0.9 to 1.

A sensitivity analysis was performed on the FLOOD-WATCH and FLOOD-WATCH-MCR basic events. Changing the value for both of these basic events to 1.0, the equivalent of not having a flood watch during maintenance changed the total CDF from 8.4E-6/yr to 2.72E-6/yr. This small change in CDF is partially due to analysis not taking credit for the flood watch.

A.7 REFERENCES

Swain, A. D. and Guttman, H. E., 1983. "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications," Final Report, NUREG/CR-1278, Sandia National Labs for the NRC, August.

Procedures for the Unit 1 waterboxes:

1-MOP-48.1 "Removal From Service of 1A Waterbox," Rev 2, 10-31-91.
1-MOP-48.2 "Return to Service of 1A Waterbox," Rev 3, 11-1-91.
1-MOP-48.3 "Removal From Service of 1B Waterbox," Rev 2, 10-31-91.
1-MOP-48.4 "Return to Service of 1B Waterbox," Rev 3, 11-1-91.
1-MOP-48.5 "Removal From Service of 1C Waterbox," Rev 2, 10-31-91.
1-MOP-48.6 "Return to Service of 1C Waterbox," Rev 3, 11-1-91.
1-MOP-48.7 "Removal From Service of 1D Waterbox," Rev 2, 10-31-91.
1-MOP-48.8 "Return to Service of 1D Waterbox," Rev 3, 11-1-91.

Procedures for the Unit 2 waterboxes:

2-MOP-48.1 "Removal From Service of 2A Waterbox," Rev 2, 10-31-91.
2-MOP-48.2 "Return to Service of 2A Waterbox," Rev 2, 10-31-91.
2-MOP-48.3 "Removal From Service of 2B Waterbox," Rev 2, 10-31-91.
2-MOP-48.4 "Return to Service of 2B Waterbox," Rev 2, 10-31-91.
2-MOP-48.5 "Removal From Service of 2C Waterbox," Rev 2, 10-31-91.
2-MOP-48.6 "Return to Service of 2C Waterbox," Rev 2, 10-31-91.
2-MOP-48.7 "Removal From Service of 2D Waterbox," Rev 2, 10-31-91.
2-MOP-48.8 "Return to Service of 2D Waterbox," Rev 2, 10-31-91.

Procedures for the BC heat exchangers:

1-MOP-50.9 "BC Heat Exchanger Removal From Service For Maintenance," Unit 1, Rev 0, 10-31-91.
1-MOP-50.10 "BC Heat Exchanger Return To Service Following Maintenance," Unit 1, Rev 0, 10-31-91.
2-MOP-50.9 "BC Heat Exchanger Removal From Service For Maintenance," Unit 2, Rev 0, 10-31-91.
2-MOP-50.10 "BC Heat Exchanger Return To Service Following Maintenance," Unit 2, Rev 0, 10-31-91.

Procedures for the CC heat exchangers:

0-MOP-51.16	"CC Heat Exchanger Removal From Service For Maintenance," Units 1 & 2, Rev 0, 10-31-91.
0-MOP-51.17	"CC Heat Exchanger Return To Service Following Maintenance," Units 1 & 2, Rev 0, 10-31-91.

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ENCLOSURE 2
RESPONSE TO IPE
INTERNAL FLOODING QUESTIONS

ENCLOSURE 2

NRC QUESTIONS ON IPE - INTERNAL FLOODING

a. Licensing basis (including compliance with GDC 4, GDC 17, and GDC 44), and current deviations.

Was there a moderate energy line break analysis performed for the SWS and CWS?
- What was the crack size criteria used?
- What was the leak rate criteria that was used for the expansion joints and how was it established/justified?

Does flooding scenario pose a problem for other issues such as station blackout, remote shutdown capability, fire protection, etc? Are previous licensing submittals still valid?

ANSWER:

The licensing basis for mitigation of turbine building flooding is discussed thoroughly in the SER on this subject issued on December 18, 1980. GDC 4, GDC 17 and GDC 44 concerning environmental (flooding) design bases, electric power systems design bases and cooling water system design bases respectively are satisfied by the current design. The design bases assume no failure in the seismic and safety related portions of the Circulating Water (CW) and Service Water (SW) Systems. Those portions of these systems which were non-seismic in design were addressed by using flow limiting shields, flooding sensors and automatic isolation of all CW flow at a level of 9 inches of water in the turbine building.

A review of the Surry UFSAR and the Surry SW System Design Basis Document has revealed no reference to a moderate energy line break analysis. It is concluded that no specific analysis was performed. In the turbine building, all of the CW and SW piping operate at pressures less than 15 psig and typically less than 10 psig. This low operating pressure, combined with the one half inch pipe wall thickness specified for this CW and SW piping, supports the conclusion that such an analysis is not required. Since no line break was postulated, no crack size criteria was relevant.

Design base leak rates for expansion joints were established considering the installation of flooding shields which limit the maximum leakage flow from any CW expansion joint. The hydraulic calculations used to establish this leakage flow for the installed flooding shields were performed as a part of the design change installing the shields. No leak rate contribution was considered for the seismic, safety related SW expansion joints. This is consistent with the design basis flooding analysis as noted in the SER on this subject dated December 18, 1980.

The design basis for flooding is addressed as a separately occurring event (i.e., no other accidents are assumed to be occurring concurrently). However, the design basis for flooding is to ensure that this specific event does not adversely affect other equipment important to safety. From this perspective, the design basis for flooding has been considered in other issues such as station black out, remote shutdown capability, fire protection, etc.

b. General description and arrangement of the Circulating Water System (CWS), the Service Water System (SWS), and the Turbine Building.

Are all of the first isolation valves of the main headers located inside the turbine building (including any manual isolation valves)?

Specifically what sections of the CWS and SWS are seismic category I / safety-related and which sections are not?

ANSWER:

General descriptions of the CW System, the SW System and the turbine building are attached. These descriptions are taken from Control Room Operator Training modules and provide general information concerning the configuration of these two systems and the turbine building. See Attachments 1, 2, and 3.

The first isolation valves of the main headers are all located inside the turbine building. This statement also applies to the manual isolation valves where no automatic, safety-related isolation requirements apply.

The following sections of the CW and SW Systems in the turbine building are safety-related and seismic: The CW System upstream of each of the condenser inlet isolation valve outlet flanges (1/2-CW-MOV-1/206A-D) is safety-related and seismic. The CW System downstream of the inlet flange of each of the condenser outlet isolation valves (1/2-CW-MOV-1/200A-D) is safety-related and seismic. The entire SW System is safety-related and seismic with the exception of the areas between the Bearing Cooling inlet and outlet manual isolation valves (these manual valves <u>are</u> safety-related), and the areas downstream of the Turbine Building Service Water and River Water Make-up Pump suction valves (1-SW-122 and SW-MOV-202A,B respectively). See Attachment 4.

c. Construction, installation and qualification details pertaining to the "rubber" expansion joints that are used in the CWS and SWS. A picture and vendor information would be helpful.

ANSWER:

DCP 86-10 and Specification NUS-2076 are attached to provide additional detail regarding the construction, installation and qualification of the rubber expansion joints in the Turbine Building. Vendor information for the expansion joints installed in DCP 86-10 is also provided. See Attachments 5, 6 and 7.

d. Specific locations of rubber expansion joints.

ANSWER:

The locations of the rubber expansion joints are as shown on the attached "Simplified Flow Diagram, Circulating Water System And Service Water System." See Attachment 4.

e. Rate of flooding, time required to isolate the flood, and time available before safety-related equipment is affected for the various scenarios.

What is the minimum unrecoverable leak rate? What size line or expansion joint gives this rate?

Without any sump pumps, how many gallons does it take before safety-related equipment is affected? What safety-related components or equipment is affected first?

ANSWER:

The flood damage timings for short term isolable flooding categories is given in Table E.6-11 [page E.6-61] of the Surry IPE . The IPE was submitted to the NRC on August 30, 1991.

The minimum unrecoverable leak rate assumed in the IPE report is 3,600 gpm [page E.3-7 -- note that a flood rate of 3,569 gpm is reported on this page with damage to the SW valve pits for the Recirculation Spray Heat Exchangers], which assumes 2 of 9 sump pumps and no Emergency Switchgear Room (ESGR) flooding within 24 hours. This flooding rate is not based upon a given pipe or expansion joint size, but is a calculated value based upon assumed sump pump availability. If 7 of 9 sump pumps are available, as currently assumed for IPE, the minimum unrecoverable leak rate increases to 9,100 gpm.

Without any sump pumps, a volume of approximately 1,393,000 gallons is required before water enters the Emergency Switchgear Room [page E.3-5]. Table E.3-8 and Section E.6.2.3 discuss the flood volume assumptions and flooding stages, in which at least one fire door between the Unit 1 Turbine Building and the Unit 2 Turbine Building is blocked open to increase the flooding volume. Water can flow into the Emergency Switchgear Room and the Auxiliary Building once the level in the Turbine Building reaches the top of the 24" flood protection dikes. An additional water volume of 15,750 gallons in the ESGR (for a total of approximately 1,400,000 gallons) corresponds to a 4 inch water height in the ESGR before flooding affects the 480 VAC buses and Motor Control Centers. The 4160 VAC buses, DC switch boards (120 VDC) and instrument buses (125 VAC) are not affected until a height of 8 inches in the ESGR.

f. Capability of the valves to close during flooding events given the flow rates that will be experienced and the potential for submersing the valves and/or spraying the valves during the flood.

Given failure of any of the expansion joints, is there adequate time to isolate upon detection of a leak? What is the minimum time required?

How long does it take to close the isolation valves?

ANSWER:

The design basis for flooding assumed an expansion joint failure. Mitigating this flooding event requires the isolation of the condenser inlet valves (1/2-CW-MOV-1/206A-D). The leakage flow rates past the flooding shields on the expansion joints are a factor of ten smaller than the normal operating CW System flow rate for which these valves are designed to close against. The condenser inlet isolation valves receive an automatic signal to close from turbine building flooding instrumentation at a depth of nine inches of water on the floor of the inlet valve pit. This permits these valves to close prior to the water level reaching a depth of ten inches due to the flood shield limited leak flow rate and the 60 second closure time of these valves (as verified by PT). It has been concluded that briefly spraying one of these valves during a flooding event will not affect its operability and as noted previously the valve will close before being submerged.

The design basis conservatively provides 20 minutes for operator action during a flooding event. This amount of time is based on leakage flowrates limited by the use of flooding shields installed on the expansion joints. The design evaluation associated with the installation of the flood shields concludes that the shields actually provide approximately 30 minutes for operator action. The safety related condenser inlet isolation valves are designed to close in 60 seconds, following operator manual action or automatic actuation, which represents less than one inch of additional water in the Turbine Building basement assuming full leakage flow past the flood shield.

g. Postulated core melt scenario.

What RCP seal leak rate was assumed and at what time in the event?

Does the "worst case" scenario also result in loss of DC power in addition to loss of all AC sources?

Would the steam driven auxiliary feedwater pump and associated instrumentation be available?

ANSWER:

IPE flooding scenarios affecting the ESGR (e.g., water level > 5") are assumed to result in core melt scenarios similar to those for the accident sequence, Loss of Emergency Switchgear Room Cooling. In general, core damage is assumed upon a loss of Reactor Coolant Pump (RCP) seal cooling, due to the RCP Seal LOCA that occurs when the RCP seals fail. The RCP seal leak rate is not important in this analysis since the scenario assumes core damage after RCP seal cooling is lost. No credit for mitigative actions was taken. The time of RCP seal cooling failure corresponds to the 5 inch water height in the ESGR, which is assumed to fail the 4160 VAC and 480 VAC buses [page E.3-5].

Although DC power is located at 8" in the ESGR, these scenarios assume the loss of emergency DC power in addition to the loss of emergency AC power when the water height in the ESGR reaches 5 inches.

The turbine driven auxiliary feedwater pump (FW-P-2) would not be physically affected by these scenarios, and should start and run. However, when emergency DC power is lost, instrumentation needed to monitor steam generator inventory is not available.

h. Mitigation of "single failure" scenarios.

The stop logs are credited for stopping flow to maintain the ultimate heat sink in a 1974 letter, but currently it appears that credit can not be taken for using the stop logs.

ANSWER:

In our response to a NRC question during initial licensing in October 1970, we state that "Long term cooling water canal integrity would be maintained by installing these stop logs." This statement was made in the context that credible leaks in the circulating water system would be small and the quantity of water lost would be minor. In a followup response to the same question in March 1971, we assumed a credible leak in the CW inlet piping would be limited to approximately 2000 gpm (1/8" crack around half of the circumference of a 96" line), This leakage was well within the capacity of the sump pumps. However, for long term recovery installation of the stop logs were necessary to isolate the 96" CW line from the canal for a repair.

i. Likelihood of a fire in the Turbine Building causing damage to the "rubber" expansion joints.

ANSWER:

The Turbine Building has a number of fire protection features to extinguish or minimize the effects of a fire. The general area under the turbine operating floor is protected by a wet pipe sprinkler system over each of the three levels under the turbine operating floor. Sufficient oil reservoirs and coolers are provided with concrete dikes capable of containing the contents or with a drainage trench. Many areas are provided with automatic heat detectors and manually activated deluge systems, automatic sprinkler systems or automatic CO_2 fire suppression systems. Additionally, backup fire mitigation is provided by a well trained fire brigade onsite using hose stations throughout the Turbine Building for manual fire fighting. Furthermore, station procedures control the amount of combustibles permitted into the area and a fire watch is required by procedure for any hot work such as cutting or welding. In addition, the flow shields on the expansion joints also serve as a shield from fire sources.

The frequency of fire initiated floods was judged to be a lower probability, when compared to water hammer initiated failures leading to internal flooding. Regardless, Virginia Power plans to address the frequency of internal fire initiating events in its submittal for Generic Letter 88-20, Supplement 4 - Individual Plant Examination of External Events (IPEEE) for severe Accident Vulnerabilities - 10CFR 50.54(f).

j. Existing programs for maintaining the condition and integrity of the CWS and SWS, a description of the current state of these systems, and a complete description of degradation mechanisms that have been observed.

ANSWER:

Circulating and Service Water Systems inspection and repair programs have been ongoing since 1986. The programs include cleaning, inspection, repair as necessary, and recoating. Prior to initiating this program, failure of the coal tar pipe coating had led to several localized corrosion pits resulting in leakage in the piping downstream of the condenser. Coating failures upstream of the condenser had resulted in localized corrosion but no through-wall leakage. The entire CW System has been cleaned, inspected, repaired as necessary, and recoated since these events. The coating material was changed from a coal tar to Chesterton epoxy. There has been only one recent example of through wall corrosion in the outlet piping since the recoating of the CW System. Reinspection schedules for the CW System are being reassessed based on this recent localized pit corrosion event. The SW System inspection and recoating portion of this program is continuing. Attached is the status of the inspection program by system (Attachment 8).

The butterfly valves in the CW and SW System had experienced degradation due to graphitic corrosion. The butterfly valves in the condenser inlet and outlet piping of the CW System were replaced in 1989 with new valves, having different material less suceptible to graphitic corrosion. The butterfly valves (first isolation) in the SW System piping supplying the Component Cooling, Bearing Cooling, and Recirculation Spray Heat Exchangers have also been replaced with new valves, having different material less suceptible to graphitic corrosion.

In addition to the above inspection and repair program, actions are ongoing in accordance with GL 89-13. These actions include:

- Periodic inspection of the RSHX inlet piping for the 'A" and 'C' high Level Intake Screenwells to the RSHXs. Inspection for biofouling, silt accumulation, corrosion product accumulation, foreign material/debris intrusion, and piping coating integrity.

- Periodic inspection of 8" SW piping to the control room chillers.

- Periodic inspection of the High and Low Level Intake Structures.

- Maintenance of wet layup chemistry of RSHX inlet piping from 1/2-SW-MOV-103/203 valves to just upstream of 1/2-SW-MOV-104/204 valves.

- Maintenance of dry layup of RSHXs.

- Development of an integrated Service Water Inspection and Maintenance Program.

Macroscopic biological media and silt have been observed during the inspection programs but are not considered degradative to the piping material integrity.

k. Postulated scenarios for initiating a water hammer in the CWS and SWS.

Are valve closure times fast or slow? A 1974 letter states that they are slow.

ANSWER:

Industry experience reveals that Circulating Water (CW) flooding events can occur when CW components such as expansion joints rupture during CW water hammer events. For Surry, the postulated initiator of a water hammer event resulting in a hydraulic transient with peak pressures high enough to result in component rupture would be caused by a rapid closure of the CW or Service Water (SW) isolation valves. Normal valve closure generates only a very minor pressure transient (2 psi) which is of no significance. A catastrophic valve fault is required for a Surry water hammer event, such as the following:

- Valve disk separation from valve upper stem

- Valve upper stem shear

- Failure of all valve operator mounting bolts allowing valve disk and stem to move free of restriction from operator

- Internal failure of valve operator allowing valve disk and stem to move free of restriction from operator

For a Surry water hammer event, the valve disk must rapidly move from a near fully open position to a fully closed position in the normal direction. A water hammer event in the circulating water system is addressed in the IPE - Flooding reanalysis (Section 3.3).

The RAB Questions for VEPCO

1. Discuss the results of the Surry core damage frequency calculations obtained using initiating event frequencies calculated by the "Oconee Method".

ANSWER:

The Surry IPE submittal utilizes two approaches in the determination of component specific rupture flood rate / frequency distributions [section E.2.6]. For the Service Water (SW) and Circulation Water (CW) sources inside the Turbine Building, a set of log-linear, rupture flow rate versus frequency distributions were generated, recognizing the specific characteristics of the Surry SW and CW systems. For the remaining flood sources the method adopted in the Oconee study (NSAC/60, 1984) was used. This combined approach resulted in the 1.1E-03 CDF reported.

While preparing the Surry submittal, Virginia Power originally utilized only the Oconee study method to produce a preliminary CDF of 1.5E-03. Since this calculation utilized early forms of input (e.g. parametric data base, logic models, etc.,) it is not directly comparable to the Surry submittal. However, these early results did indicate the importance of SW and CW flood sources, particularly from expansion joint and valve ruptures, and were valuable in focusing model refinements. The Oconee study also provides some verification that the log-linear distribution approach results are similar in magnitude to existing approaches.

2. Discuss all likely causes of non-isolable flood events occurring in the Turbine Building.

ANSWER:

Non-isolable floods are referred to as long term isolable floods which can only be isolated by installing the High Level Intake Structure stop logs. For the Circulating Water System, these events include breaks in the condenser inlet piping upstream of the condenser inlet valve (1-CW-MOV-106A thru D) or in the inlet valves themselves [page E.3-6, see also Table E.3-4 on page E.3-34]. For the Service Water System, these events include the piping and valves located in the Turbine Building SW valve pits [page E.3-11, see also Table E.3-9 on page E.3-40]. Any significant flood in these pits would quickly disable the valve motor operator, preventing remote closure. Manual closure is also doubtful as the control room operator may not be able to gain access to the valve handwheel for large flood flowrates. Hence, the event is considered long term isolable because it may be necessary to isolate the CW source of the SW by installing the High Level Intake Structure stop logs.

Following a review of industry data for flooding and component rupture events, the likely causes of non-isolable floods identified were expansion joint or pipe failures predominantly caused by pressure transients (water hammer) [section E.6.1.4.1]. Additional events such as valve packing leaks were identified, but these historically resulted in only minor leakage. Included in these latter events were maintenance actions, which usually resulted in only minor flooding rates. As a result, maintenance actions were concluded to be low frequency for non-isolable floods, when compared with the water hammer initiated failures. However, this initiator was addressed and quantified in the IPE reanalysis in Enclosure 1.

3. Are the Circulating Water (CW) and Service Water (SW) system valves capable of isolating under flooding flow conditions?

ANSWER:

All flooding flow rates under consideration with flooding shields installed are less than design flow values for both the SW and CW Systems. Therefore, it is concluded that if these safety-related valves are operable, they are capable of closing against flooding flow rates. See the response to Question f above.

4. Are CW and SW system welds, pipes, and valve bodies that are susceptible to breaks causing internal flooding subject to quality control and in-service testing to assure their integrity?

ANSWER:

The Inservice Inspection Program for both Surry Units 1 and 2 is based upon the 1980 Edition, Winter 1980 Addendum of the ASME Boiler and Pressure Vessel Code, Section XI. Code classification of components and component supports within the Service Water and Circulating Water systems is based on Regulatory Guide 1.26, Revision 3, "Quality Group Classification and Standards For Water, Steam, and Radioactive-Waste-Containing Components of Nuclear Power Plants," and ANSI N18.2, 1973. "Nuclear Safety Criteria For The Design Of Stationary Pressurized Water Reactor Plants."

In general, the Service Water system is classified ASME Class 3 in the portions of the system which support safety-related functions. Within the turbine building basement area, this piping starts at the Circulating Water lines to the condenser, through the MOV-SW-102 valves to the Component Cooling Heat Exchangers, or through the MOV-SW-103/203 valves to the Recirculation Spray Heat Exchangers. The Circulating Water system is classified ASME Class 3 only from the high level intake to the MOV-CW-106/206 valves. Drawings have been provided in Attachment 9, detailing the Code classification of the piping for each unit.

Inspection and testing requirements for Class 3 components are found in IWD-2000 and IWF-2000 of ASME Section XI. This is limited to visual, VT-3 examinations of the integral attachments and component supports, and visual, VT-2 examinations of the pressure boundary in conjunction with pressure testing. The pressure testing can be conducted at system pressure or at elevated hydrostatic test pressure as required in IWD-2000 and IWD-5000 of ASME Section XI. Pressure testing will be conducted three times in a normal ten year interval.

5. What were the design criteria for the shields used around the CW piping (and the 1" clearance), and those proposed for the SW piping?

ANSWER:

The design criteria used for the flooding shields for the CW System expansion joints specifically was based to provide a minimum of 20 minutes for operator action in response to a flooding event. A one half inch gap being specified between the flooding shield and the flange to limit flow. This gap provides approximately 30 minutes for operator action.

The design criteria applied for the recently installed flooding shields on the SW System expansion joints provided that the leakage rate be limited to less than the flow capacity of 7 of the turbine building sump pumps (9100 gpm). This would permit these sump pumps to control any leakage from these expansion joints with no external measures being required. Although this is the design basis, our design was intentionally more restricitve in an attempt to limit leakage to a significantly lower amount, In order to allow the operator access to manually close the motor operated valve. The shield design was tested at approximately four times maximum design pressure and a leak rate of less than 10 gpm was achieved without valve preconditioning.

Objectives

Upon completion of this section, you will be able to

A. Describe in detail the major flow paths, and the operation and location of the major components associated with the Low Level Intake Structure.

B. Describe in detail the major flow paths, and the operation and location of the major components associated with the High Level Intake Structure.

C. Describe in detail the major flow paths, and the operation and location of the major components associated with the main condenser (circulating water side).

D. Describe in detail the major flow paths, and the operation and location of the major components associated with the Amertap Condenser Tube Cleaning Subsystem.

E. Describe in detail the major flow paths, and the operation and location of the major circulating water discharge components.

F. List the power supplies to the major electrical components in the Circulating Water System.

G. DESCRIBE IN DETAIL THE MAJOR FLOW PATHS, THE OPERATION AND LOCATION OF THE MAJOR COMPONENTS, AND THE POWER SUPPLIES ASSOCIATED WITH THE CIRCULATING WATER SYSTEM.

This section presents a detailed description of the Circulating Water System through a discussion of the following major components and subsystems that comprise it:

1. Low Level Intake Structure,

2. High Level Intake Structure,

3. main condenser,

4. Amertap Condenser Tube Cleaning Subsystem, and

5. circulating water discharge components.

Also presented in this section are the power supplies for the major components and the impact of maintenance on the system. Note that all of the vacuum priming and other support system piping at the Intake Structures are provided with heat tracing to prevent freezing during cold weather. The components for each unit are similar. This text describes the components in Unit 1. Differences in Unit 2 components are noted where applicable. Component design data is listed in Table 12-1; component locations are listed in Table 12-2.

The Circulating Water System (see Figures 12-1 and 12-5) draws water into the Low Level Intake Structure from the James River, approximately 1.7 miles east of the station. The eight circulating water pumps (four for each unit) discharge into a common, concrete- lined intake canal that directs circulating water to the station area.

The High Level Intake Structure directs the water into four pipes that carry water to the individual main condenser half-shells. In the main condensers, heat from the turbine exhaust steam is transferred to the Circulating Water System across the condenser tubes.

Condenser discharge circulating water flows to a common concrete discharge tunnel, together with waste water from other systems, and then to the discharge canal before being returned to the river.

Low Level Intake Structure

The purpose of the Low Level Intake Structure is to direct river water to the circulating water pumps after removing large trash and debris and marine life from the circulating water inlet flow path.

The structure consists of the following major components:

1. Intake Structure,
2. trash racks and trash rake,
3. fish screens,
4. Fish Screen Wash Subsystem,
5. circulating water pumps,
6. Intake Vacuum Priming House,
7. emergency service water pumps, and
8. emergency service water pump diesel drives.

Each unit has a similar layout of these components. Refer to Figures 12-2 and 12-3 during the following discussion.

The Intake Vacuum Priming House, emergency service water pumps, and diesel drives are not discussed in this module; detailed descriptions are available in modules NCRODP-14, Vacuum Priming System and NCRODP-13, Service Water System.

<u>Low Level Intake Structure</u>. The Low Level Intake Structure (also referred to as the Low Level Screenwell Area or simply the Low Level) is an eight-bay (four bays per unit) reinforced concrete structure, located approximately 1.7 miles east of the Surry Power Station on the shore of the James River. On top of the structure are two smaller structures, the Low Level Control House and the

Service Water House. The Control House contains the electrical switchgear required to operate the equipment at the Low Level. The Service Water House contains switchgear, emergency service water pumps, and the emergency service water diesels.

One intake bay, or screenwell, is provided for each main circulating water pump and its associated components (see Figure 12-2). The supporting system components, including the various pump motors, strainers, and control panels, are located at the Low Level Intake Structure. The unit's four pump motors are in a circulating water pump pit, one for each unit. The pump pit is kept dry by the use of portable pumps. The four screenwells for Unit 1 are north of the Unit 2 screenwells. The circulating water pumps draw water into the screenwells from the James River.

Each screenwell is numbered and supplies river water to the following components:

1. 1A - circulating water pump 1-CW-P-1A;

2. 1B - circulating water pump 1-CW-P-1B;

3. 1C - circulating water pump 1-CW-P-1C, screenwash pump 1-FS-P-1A;

4. 1D - circulating water pump 1-CW-P-1D, screenwash pump 1-FS-P-1B, emergency service water pump 1-SW-P-1A;

5. 2A - circulating water pump 2-CW-P-1A, emergency service water pump 1-SW-P-1B;

6. 2B - circulating water pump 2-CW-P-1B, emergency service water pump 1-SW-P-1C;

7. 2C - circulating water pump 2-CW-P-1C, screenwash pump 2-FS-P-1A; and

8. 2D - circulating water pump 2-CW-P-1D, screenwash pump 2-FS-P-1B.

The screenwash pumps take a suction on the related CW pump piping.

<u>Trash racks and rake</u>. Incoming water initially passes through the trash racks, one for each circulating water pump screenwell. Each trash rack is composed of several parallel vertical steel bars that extend from the bottom of the intake water flow path to above the expected high river level (7 feet, 8 inches). These steel bars prevent any large debris, such as floating logs, from entering downstream components. This prevents damage to the traveling fish screens, located next in the flow path.

Large, rectangular, beam-reinforced metal plates (called stop logs) stop the inlet flow into a circulating water screenwell as required for maintenance. These stop logs are lowered with a portable crane into vertical guide channels just upstream of the trash racks and fit tightly against them. During maintenance periods the screenwells are kept dry enough for personnel access by the use of portable pumps, if necessary. The stop log must be removed prior to starting any pump located in the screenwell so that a suction flow path is available.

A trash rake, common to all eight trash racks, is used to remove debris from the trash racks when necessary. It consists of a pivoted steel rake attached to a steel frame, which is moved along the top of the Intake Structure on steel tracks. The trash rake frame is attached by means of steel cables to hoisting machinery mounted on a structural steel head frame. The head frame is mounted on car wheels that run on T-rail tracks. The head frame is moved by means of a motorized drive, with precise adjustments made using a hand crank to position it over the trash rake bars to be cleaned. The rake assembly, in the open position, is lowered by a hoist motor to the desired position below the debris to be removed. The assembly is then hoisted into the cleaning position (i.e., rake teeth engaged) moving the debris up the trash rack bars. When the rake is withdrawn, the debris is dumped into a metal basket that is suspended from the bottom of the frame assembly for removal. The basket hangs inside the trash rake flume. The trash rake is controlled from a local control panel mounted on the end of the frame assembly.

The trash rake flume is a concrete trough located in the top of the Intake Structure, in front of the traveling fish screens and under the trash rake frame. The T-rail tracks are on either side of the flume. It is sloped downward toward the north end of the top of the Intake Structure and discharges into the river.

Fish screens. The next component in the intake flow path is the traveling fish screen. These motor-operated fish screens (1-FS-S-8A through -8D) are installed to prevent marine life from being swept into the intake canal. There is one screen assembly, installed in each circulating water pump screenwell primarily for environmental reasons, which also removes smaller trash and debris from the water before it enters the circulating water pump inlet. The fish screens have small buckets that lift the fish and return them, via a fish flume, to the river downstream of the structure. The fish flume passes a counting station that is periodically used to satisfy environmental requirements for examining the number, type, and condition of the marine life.

The screens are moved by single-speed, reversible, 10.5 HP drive motors and are protected from overload by drive shear pins and motor thermal overloads. The screen drives are mounted on the end of the top of the screen assembly and must be operated manually. The operation of the screen changes the section of screen exposed to the circulating water intake flow.

Three types of shear pins can be inserted into one of the two holes in the drive sprocket. A normal pin is a small, solid pin that fits in the smaller hole. The test pin is a small pin with a ground concave portion that fits in the smaller hole and is used to test proper operation. The balance pin is a large pin, fits in the large hole, and is used only for motor overload tests.

Fish Screen Wash Subsystem. The fish screens are washed by the Fish Screen Wash Subsystem (see Figure 12-3). The subsystem is an interconnected system that also provides cooling water to the Low Level Intake Vacuum Priming Subsystem vacuum priming pumps and the CW pump bearings. There are two, horizontal, centrifugal screenwash pumps per unit (1-FS-P-1A and -1B, and 2-FS-P-1A and -1B). They are located above the respective circulating water pump discharge pipes in separate enclosures west of the Intake Structure. FS-P-1A takes a suction on the discharge piping of CW-P-1C, and FS-P-1B takes a suction on the discharge piping of CW-P-1D.

The discharges from each unit's pair of pumps join in a common header that splits to flow through separate strainers (1-FS-S-1A and -1B and 2-FS-S-1A and -1B). Three of the strainers' outputs are directed to a common header that supplies wash water to the fish screens of both units. The wash water is directed against the back of the downstream side of the traveling fish screen to effectively backwash it free of accumulated debris. Trough flush water provides sufficient flow to ensure the survival of any marine life washed from the screen. The fourth strainer, 1-FS-S-1B, supplies cooling water to the vacuum priming pump seal water coolers in the Low Level Intake Vacuum Priming Subsystem and all eight CW pump bearings.

Circulating water pumps. There are four circulating water pumps per unit (CW-P-1A through -1D). The pumps are classified as vertical, centrifugal pumps but actually have features of both centrifugal and turbine-type pumps. The pump mechanical design (including that of the impeller and the suction and discharge port locations) allows for drawing water into the pump and along the shaft like a vertical, centrifugal pump. At the pump discharge elbow, the water flows across the shaft such as in a turbine-type pump. These features give the pump an unusual pump characteristic curve representative of the centrifugal-turbine pump combination.

The four circulating water pumps per unit provide a total of 840,000 gpm of water to condense turbine exhaust steam and to supply water to the Service Water System. Each pump has a capacity of 210,000 gpm at a 28-foot total dynamic head; and each is driven by a 2000 HP, 4160 VAC, squirrel-cage induction motor. Bearing cooling water is provided by the Fish Screen Wash Subsystem.

No automatic start features are provided on these pumps. They are manually controlled remotely from the Intake Structure Panel in the MCR or from the Low Level Control House. Manual start permissive features must be satisfied before the pumps can be started. Manual stop and automatic trip features are also provided. These features are described in the Instrumentation and Controls section of this module.

Each pump takes a suction on an individual intake screenwell, and discharges through a 96-inch diameter steel discharge line. A tapoff provides local pressure indication and a seal water supply to the shaft seal. The discharge line passes over a dike and into a common, concrete-lined intake canal that carries the water to the station area. At the outlet of the discharge piping is a 10-foot, 6-inch square flapper that acts as a check valve. It is constructed of southern pine timbers treated with creosote.

The Low Level Intake Vacuum Priming Subsystem is housed in the Intake Vacuum Priming House located at the top of the dike. The subsystem provides evacuation and vacuum breaking capabilities via connections at the high point of the circulating pump discharge piping. The valves necessary to provide this function are interlocked with the respective CW pump motors so that vacuum priming is in operation when the pump is running and the vacuum breakers are open when the pump is stopped.

Vacuum priming is used to evacuate air and ensure that the circulating water pumps and discharge piping are filled with water when the pump is started. This prevents pump and motor damage and ensures flow into the intake canal. Vacuum breaking is utilized when the associated pump is shut down. This action, together with the flapper valves, prevents siphoning the water out of the canal through an idle pump. A detailed description is available in module NCRODP-14, Vacuum Priming System.

A passive vacuum breaker, designed to conserve intake canal water, in the event of a failure of the paired active vacuum breaker valves and flap gates, is also located on the discharge end of each 96 inch diameter pipe. The passive vacuum breaker consists of a 20 inch diameter low profile vertical pipe projection which extends to elevation +25 feet of the intake canal. The passive vacuum breakers are designed to interrupt the postulated siphon action prior to reaching the technical specification limitation for canal water level.

Intake Canal

The intake canal provides a flowpath for river water from the discharge of the Circulating Water Pumps to the High Level Intake screenwells, which supply water to the condensers and the Service Water System. The intake canal is concrete lined along its 1.7 mile length. The canal walls slope from top to bottom; the average width of the canal is 125 feet. The bottom of the canal slopes from an elevation of 6 feet 8 inches at the Low Level Intake end to an elevation of 5 feet at the High Level Intake. Here, the bottom of the canal slopes sharply to the base of the High Level Intake Structure at 0 feet 8 inches. Water level in the intake canal is normally kept at an elevation of approximately 25 to 30 feet; Circulating Water flows through the condensers by gravity, with Vacuum Priming provided to establish and maintain a siphon.

The intake canal is part of the flowpath for both the Circulating Water System and the Service Water System, and acts as a reservoir for these systems. One purpose of the Service Water System is to provide emergency cooling to the Containment (through the Recirculating Spray Heat Exchangers) during a severe loss of coolant accident (LOCA). In the event that adequate intake canal inventory for post-accident containment cooling cannot be maintained, unnecessary flowpaths of Circulating Water and Service Water through the station are automatically isolated. These isolation signals are outlined in the description of the Condenser motor-operated inlet and outlet valves.

High Level Intake Structure

The purpose of the High Level Intake Structure is to direct canal water to the main condenser after removing large trash and debris from the circulating water inlet flow path. The High Level Intake Structure (or High Level Screenwell Area or simply High Level) is similar to the Low Level Intake Structure. Each unit has its own High Level Intake Structure.

The structure consists of the following major components:

1. Intake Structure,

2. trash racks,

3. traveling screens, and

4. screenwash pumps and strainers.

High Level Intake Structure. The High Level Intake Structures of the two units are separated by the Reserve Station Service Transformer Enclosure. The High Level is a four-bay reinforced concrete structure that houses the remainder of the system components (see Figure 12-4). On the top of the High Level is another structure, the High Level Control House. This houses the switchgear required to operate the equipment at the High Level. A 3-ton capacity monorail hoist, similar to that at the Low Level, is used for maintenance.

Each screenwell is numbered and lettered as in the Low Level Intake Structure. Screenwells 1B and 1C contain screenwash pumps 1-CW-P-2A and -2B, respectively. Each screenwell directs water to a 96-inch diameter concrete pipe that provides a flow path under the south yard of the station to the Turbine Building. There, the concrete pipe joins a steel pipe.

Trash racks. Incoming water initially passes through the trash racks, one for each screenwell. Each trash rack is similar to those at the Low Level. Rectangular stop logs are also provided at the High Levels for maintenance.

Traveling water screens. The next component in the intake flow path is the traveling water screen. These screens (1-CW-S-1A through -1D) are similar to the fish screens at the Low Level but with smaller trash buckets, and installed primarily to prevent condenser and heat exchanger tube fouling. There is one screen assembly for each screenwell which removes smaller trash and debris from the water before it enters the screenwell. The 0.375-inch mesh screens have openings approximately one-half the size of the condenser tube inside diameter.

The screens are moved by single-speed, non-reversing, 5 HP drive motors and are protected from overload by drive shear pins and motor thermal overloads. The screen drives are mounted on the end of the top of the screen assembly and permit automatic or manual screen operation. The operation of the screen changes the section of screen exposed to the circulating water intake flow.

Each screen is provided with a differential level sensor (LDS-CW-105A, B, C, and D). The sensor provides local indication of screen differential level and alarm signals for a common alarm in the MCR when differential level between the upstream and downstream sides of the screen reaches 10 inches. The differential level sensors provide control input during automatic screen operation. When differential level reaches 6 inches, in automatic screen operation, the debris is washed from the screen into the trash flume. The screen rotates so that an unclogged area is exposed to the circulating water inlet flow path. If a screen stops moving while the drive unit is energized, a motion detector on each screen drive unit actuates a common alarm signal in the MCR. Normally the screen wash pumps are secured. The operator monitors screen differential level on a periodic basis and, at an indicated level of 2 to 3 inches of water, manually initiates washing. More information is presented in the Instrumentation and Controls section of this module.

Screenwash pumps and strainers. Each unit's screen is washed by two screenwash pumps/strainers. This wash is initiated in three ways: manually, automatically on a timed exercise cycle, and automatically on excessive level differential across the screens. The screen wash water and any debris are directed through a buried pipe to the discharge canal. The strainers filter debris from the discharge of the pump.

There are two, vertical turbine, screenwash pumps per unit. They are located in the screenwells downstream of the traveling water screens. The wash water is directed against the back of the upstream side of the traveling water screen to effectively backwash it free of accumulated debris. The pumps have a design flow rate of 850 gpm, with a total dynamic head of 300 feet. The pumps are driven by 75 HP, squirrel-cage, 480 VAC induction motors. Pump CW-P-2A is located in screenwell 1B and supplies screens 1A and 1B. Pump CW-P-2B is located in screenwell 1C and supplies screens 1C and 1D. A manual cross-connect valve can be opened to allow either pump to wash any of the four screens.

Both screenwash pumps are controlled from the High Level Control House on the top of the Intake Structure. They are provided with local discharge pressure indication on PI-CW-105A and -105B. The pump discharge flow passes through 1/2 HP motor-operated strainers CW-S-3A and -3B. The strainers are rotated by the motor to keep them clean and are in operation when their associated screenwash pumps are running. Flow passes through a check valve designed to prevent reverse flow through the system and through a manually operated isolation valve. Flow then enters the screenwash header, which supplies water to the individual screens via manual isolation valves. Normally shut isolation valve CW-19 separates the discharge of pump CW-P-2A from that of CW-P-2B. Each traveling water screen is provided with a pressure switch (PS-CW-105A, B, C, and D) to provide a screen drive motor control signal.

Either screenwash pump can be operated manually or automatically on a timed cycle, usually for 10 minutes every 12 hours. When a screenwash pump is cycled on for any reason, its associated traveling water screens also are energized when their individual screenwash pressures reach 80 psig.

The trash flume is a concrete trough located in the top of the Intake Structure, in front of the traveling water screens. It collects screenwash waste water and debris washed from the screens and backflushed out of the screenwash strainers. The screen wash water also acts as flume wash water to keep debris moving down the flume. The flume is sloped downward toward the west end of the top of the Intake Structure and discharges into a trash collection basket, normally removed. The basket is raised or lowered by the motor-operated hoist. The hoist and attached basket are moved along the monorail so that accumulated debris can be removed from the Intake Structure area. The flume water runs through an underground pipe past the South Annex, parking lot, Sewage Treatment Plant, and into the discharge canal.

Main Condenser

The circulating water from the High Level Intake screenwells is supplied to the Main Condenser through four 96-inch lines. Each unit's condenser is divided into two half-shells. Each half-shell has two tube bundles, and each tube bundle has an inlet waterbox and an outlet waterbox. (The combination of inlet waterbox, tube bundle, and outlet waterbox is commonly called a "waterbox.") From the intake canal, the Circulating Water flows through the following train of components:

- Screenwell;
- 96-inch line;
- Condenser inlet isolation valve;
- Inlet waterbox, tube bundle, and outlet waterbox;

- 96-inch pipe with an outlet isolation valve;
- Discharge tunnel for that unit.

There are four such trains, designated A, B, C, and D, for each main condenser.

Service water lines tap off the 96-inch inlet pipes upstream of the inlet isolation valves. The service water system is described in module NCRODP-13.

Steam from the exhaust of each low pressure turbine flows into one condenser half-shell. The heat from the steam is transferred through the condenser tube walls into the circulating water, causing the steam to condense. The condenser shell is maintained in a high vacuum to allow maximum differential pressure and temperature from one end of the turbine to the other, thereby allowing the most energy transfer from the steam as it flows through the turbine package. Each condenser half-shell has two sets of tubes, each set with separate supply lines, waterboxes, and isolation valves; this arrangement allows one set of tubes to be removed from service for cleaning or maintenance with the unit on the line. The reduction of tube surface area when this is done will result in some loss of condenser vacuum, with a resulting loss of unit efficiency. The condenser tubes are made of titanium for maximum corrosion resistance.

In order to prime and evacuate air from the Circulating Water System, the Station Vacuum Priming Subsystem of the Vacuum Priming System (see module NCRODP-14) takes a suction on the condenser water boxes through a level control valve.

The following condenser components are described below (see Figures 12-5 and 12-6):

1. condenser motor-operated inlet and outlet valves, and

2. inlet and outlet water boxes and condenser tubes.

<u>Condenser motor-operated inlet and outlet valves</u>. Each condenser inlet line is provided with an motor-operated isolation valve (1-CW-MOV-106 A, B, C, D). These are 96-inch butterfly valves bolted to the inlet piping and to the inlet waterboxes. The 5-HP motors are powered by emergency buses and controlled

by switches mounted on Main Control Room benchboard 1-1. Each valve is provided with a locking pin which secures the valve disc in the closed position when maintenance is being performed on the valve drive train, and fixes the valve disc in the position in which it has the tightest closure. Essentially identical motor-operated isolation valves (1-CW-MOV-100 A, B, C, D) are installed in the outlet lines.

The inlet and outlet CW MOVs are required to operate under certain accident conditions, so they are powered by emergency bus Motor Control Centers. One valve on each tube bundle is powered by a Bus H MCC (1H1-1), and the other valve on that tube bundle is powered by a Bus J MCC (1J1-1A)_. The power supplies for Unit 1 are listed in Table 12-3. Note that the inlet valve to tube bundle A (MOV-106A) is powered by an H bus MCC, and the outlet valve (MOV-100A) is powered by a J bus MCC. Note also that the power supplies are staggered: two inlet valves are powered by the H bus MCC and the other two are powered by the J bus MCC.

On Unit 2, four CW MOVs are powered by MCC 2H1-1 and the other four are powered by MCC 1J1-1A.

Note that four CW MOVs on each unit are powered by MCC 1J1-1A. This Motor Control Center is located in Emergency Diesel Room 3. It normally gets power from 480 V Switchgear 1J1, but its power supply switches automatically to MCC 2J1-1 on loss of the normal power supply. This power supply arrangement ensures that, in the event of a loss of all offsite power, at least one MOV in each of the eight CW lines in the station can be closed electrically to conserve intake canal level. The automatic closure signals to these valves are described in the Instrumentation and Control section of this module.

<u>Inlet and outlet water boxes and condenser tubes</u>. The main condensers are divided into four sets of tubes on the circulating water side. Both the condenser inlet and outlet lines are provided with expansion joints (flexible boots) between the inlet valves and the inlet water boxes, and between the outlet water boxes and the outlet valves. These expansion joints allow for settling of system components after installation without putting unacceptable stresses on the piping. They are located in the respective Condenser Pits.

The condensers are airtight heat exchangers with a high vacuum maintained on the shell side during plant power operations. Each condenser has 71,328 titanium tubes with a 0.875-inch outside diameter, providing a heat transfer surface area of 650,870 ft^2. Circulating water from the High Level Intake Structure flows inside the tubes at a velocity of 6.6 feet per second (fps).

Steam from the low pressure turbine exhaust or steam dump transfers its heat through the tube wall to the circulating water inside. The heat transfer capacity is rated at 5,870 X 10^6 Btu/hr at a vacuum of 3.29 inches of mercury absolute and circulating water temperature of 90°F. During this process, the steam condenses and the resulting condensate collects in the bottom of the condensers (condenser hotwell), to be recycled by the Main Condensate System. For a detailed description of condenser construction and operation, refer to module NCRODP-25, Main Condensate System.

Connections are provided on each water box for the Station Vacuum Priming Subsystem of the Vacuum Priming System. The vacuum pump evacuates the air in the circulating water side of the condenser prior to operation and continuously during operation. This ensures that the entire tube surface is covered with water, providing efficient heat transfer.

Two air-operated vacuum breaker valves are mounted on each condenser outlet waterbox at the highest point in the Circulating Water System. These valves are designed to interrupt the siphon action of circulating water flowing through the condenser and conserve intake canal water during a postulated Appendix "R" event which prevents closure of the condenser inlet and outlet valves.

Circulating Water Discharge Components

The major circulating water discharge components are

1. discharge tunnel,

2. seal weir, and

3. discharge canal.

__Discharge tunnel__. Outlet water from the main condensers is directed to a single, concrete discharge tunnel via four steel pipes, one from each condenser half-shell. A separate discharge tunnel is provided for each unit. The 12-foot, 6-inch square tunnel extends for approximately 470 feet to the seal weir at the discharge canal. In this distance, the tunnel floor rises from elevation -7 feet, 6 inches to 8 feet and then drops to -16 feet, 6 inches. The tunnel is provided with a closed 12-inch vacuum breaking vent valve in a small pit just upstream of the discharge vacuum priming house. The manually operated valve is opened between 1 and 4 hours after a Design Basis Accident (DBA) and/or Loss of Off-Site Power (LOOP) to minimize the outflow of water from the intake canal through the various heat exchangers serviced by the Service Water System.

The discharge tunnel is served by the Discharge Vacuum Priming Subsystem which evacuates air from it at the high point and near the end, allowing it to fill with circulating water. This priming is required to prevent air pockets and subsequent pressure transients in the tunnel which would increase head loss in the tunnel and reduce the flow efficiency.

Waste water, including potentially radioactive water, from other systems is also directed to the discharge tunnel for dilution by the circulating water prior to being released to the river. The discharge tunnel receives waste water from the following sources:

1. bearing cooling water effluent (two discharge connections),

2. ventilation heating steam condensate from the Turbine Building and Service Building Ventilation Systems,

3. recirculation spray heat exchanger drains and outlets,

4. steam generator blowdown,

5. service water effluent,

6. pipe tunnel sump pump discharge,

7. condensate polishing sump pump discharge,

8. flash evaporator drains,

9. component cooling water heat exchanger outlets,

10. component cooling water heat exchanger radiation monitor sample flow effluent,

11. air conditioning unit and charging pump cooling water effluent, and

12. condensate pump discharge link.

A pipe manifold (sometimes called a Christmas tree) collects the drains into a single header that discharges to the tunnel.

The tunnel radiation monitor (RM-SW-120) monitors the activity level of the water in the discharge tunnel near the end of the tunnel, beyond the last point of potentially radioactive material addition. It provides signals to the radiation monitoring instrument racks in the MCR for indication, recording, and alarms.

Seal weir. The discharge tunnel ends at a seal weir, where the tunnel widens to approximately 40 feet. The seal weir is a 12-foot high wall across the mouth of the tunnel that forms a dead end, forcing the flow up and over the wall. This effectively slows the flow of the circulating water. This arrangement maintains the water level at a proper elevation to ensure that flow through the system is slow enough to keep the main condenser outlet water box full.

Discharge canal. From the seal weir area the water enters the discharge canal. It is here that the circulating water is returned to the main body of the river. The canal extends approximately 1200 feet into the river through rock-filled groins, or walls. These are designed to minimize siltation and maintain a 6 fps terminal velocity. The opening is designed to ensure proper mixing of the now warm circulating water with the river water. A timber-pile trestle stretches across the mouth of the groin. Timber gates may be placed in the trestle to control the flow of water when only one unit is in operation. This provides for minimal environmental impact on the river.

Power Supplies

Power supplies to the system major components are listed in Table 12-3 and illustrated in Figures 12-8 through 12-11.

Objectives

Upon completion of this section, you will be able to:

A. Describe the purpose, location, and operation of the following gravity-flow-supplied Service Water System loads:

   1. recirculation spray heat exchangers,
   2. bearing cooling water heat exchangers, and
   3. component cooling heat exchangers.

B. Describe the purpose, location, and operation of the following Mechanical Equipment Room Service Water System loads:

   1. control room and relay room air conditioning unit chiller condensers, and
   2. Charging Pump Service Water Subsystem.

C. Describe the purpose, location, and operation of the following Turbine Building Service Water Subsystem components:

   1. service water pumps,
   2. self-cleaning strainers,
   3. station vacuum priming seal water coolers,
   4. 555-ton air conditioning unit chiller condensers,
   5. steam-supplied chilled water unit, and
   6. river water makeup pumps.

D. Describe the purpose, location, and operation of the following Emergency Service Water Subsystem components:

1. emergency service water pumps, and
2. Service Water Fuel Oil Subsystem.

E. List the power supplies for all major components of the Service Water System.

F. **DESCRIBE THE OVERALL OPERATION OF THE SERVICE WATER SYSTEM, INCLUDING ITS SUBSYSTEMS, COMPONENTS, AND POWER SUPPLIES.**

This section provides a detailed description of the major components that comprise the Service Water System; the operational interfaces that exist between these components and other plant systems; and other information that ensures the safe and reliable operation of the components and systems. The purpose of this section is to provide a detailed understanding of the SW System operation. The Unit 1 components are discussed, with Unit 2 differences identified where they exist. Table 13-1 presents the design characteristics of the SW System components. Component locations are detailed in Table 13-2.

Water is supplied to the SW System from the James River via the CW pumps in the Low Level Intake Structure, the Intake Canal, the High Level Intake Structure, and the four 96-inch diameter CW intake pipes (see Figure 13-1). Each intake pipe is supplied from a separate High Level Intake Structure screenwell. Each screenwell has an alphanumeric designation used to identify it and the portions of the SW System served by that screenwell (see Table 13-3).

Five SW supply headers in each unit supply three major groupings of systems:

- Gravity-flow-supplied Service Water System loads:

    1. recirculation spray heat exchangers,

    2. bearing cooling water coolers, and

3. component cooling heat exchangers (Unit 1 only).

- Mechanical Equipment Room Service Water System loads:

  1. control room and relay room air conditioning unit chiller condensers, and

  2. Charging Pump Service Water Subsystem.

- Turbine Building Service Water Subsystem:

  1. station vacuum priming seal water coolers,

  2. 555-ton air conditioning unit chiller condensers,

  3. steam-supplied chilled water unit (Unit 1 only), and

  4. river water makeup pumps.

Additionally, the Emergency SW Subsystem contains:

1. emergency service water pumps, and

2. Service Water Fuel Oil Subsystem.

Each of these three groups of system loads are discussed in the following sections.

Gravity-flow-supplied Service Water System Loads

The SW System supplies three major loads by gravity flow due to the differential head between the Intake Canal and the Discharge Canal (see Figure 13-2). These loads are the:

1. recirculation spray (RS) heat exchangers,

2. bearing cooling water (BC) coolers, and

3. component cooling (CC) heat exchangers.

The BC and CC heat exchangers are utilized during normal operation and remove most of the heat developed in auxiliary loads. The RS heat exchangers are designed to remove heat from the RS System during a LOCA. Flow is controlled by the use of remotely operated motor-operated valves (MOVs). The power supplies for the MOVs are listed in Table 13-4.

<u>Recirculation spray heat exchangers</u>. Each unit has four recirculation spray heat exchangers (1-RS-E-1A, B, C, and D) located in Containment that are isolated and drained during normal plant operations. The RS heat exchangers are used during a LOCA to cool the RS water that initially depressurizes Containment and maintains containment pressure subatmospheric. Only the Unit 1 heat exchangers are described; the Unit 2 heat exchangers are identical. SW from screenwell 1C supplies water to RS heat exchangers A and D through two supply header valves, MOV-SW-103A and B. Screenwell 1A supplies water to RS heat exchangers B and C through MOV-SW-103C and D.

The RS heat exchanger supply header MOVs are located in the Turbine Building and are operated from benchboard 1-1 in the MCR. They are normally shut and automatically open on receipt of a high-high CLS signal. The supply MOVs from each header are piped in parallel to increase the probability that at least one valve opens on receipt of a CLS signal to provide RS heat exchanger cooling. Remote SW temperature and flow indication in the individual return lines is provided on vertical panel 1-1 in the MCR and on the ERFCS as required by Reg. Guide 1.97.

Each of the RS heat exchanger supply headers and the heat exchanger inlet lines has a check valve. The internals of these valves are permanently removed to reduce flow restrictions in the piping.

Each heat exchanger supply header splits to supply two heat exchangers individually.

Each RS heat exchanger is supplied with SW through a normally closed, inlet isolation valve, MOV-SW-104A/B/C/D. The inlet MOVs are located in the Safeguards Building and are controlled from benchboard 1-1. These valves will open automatically upon receipt of a high-high CLS signal.

The RSHX SW supply headers are maintained in wet layup downstream of 1/2-SW-MOV-1/203A-D. The level of chemically treated condensate should be maintained at elevation 12' +/- 3". This places water partway up the riser from the 36" alleyway header to the 1/204 valves. This level is checked weekly and trimmed as required.

The wet layup serves two purposes. First, by displacing the air with water, the possibility of air entrapment in the RSHXs is reduced following a CLS Hi-Hi event. Second, when the 1/203s are opened against a dry system the initial velocities is on the order of 35 feet per second (approx 200,000 GPM) compared to normal "accident" velocity of 4 to 8.5 fps (22,000 to 48,000 GPM). These initial velocities are high enough to tear the marine growth from the pipe walls and block the RSHx tubesheets, reducing SW flow and accident heat removal capability. In fact, this actually occurred during the RSHx SW Flow Special Test (1-ST-290) and resulted in the shutdown of Unit 2 on October 23, 2990.
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The total volume of each header in wet layup is approximately 17,000 gallons. However, the volume per inch of elevation is not constant due to the piping configuration. When filling an empty pipe at a constant fill rate, the level will suddenly rise from approximately 4'-9" to 8'-6" and then resume the previous level increase. Again, at around 11'-9", the level will suddenly rise. The 11'-9" elevation is the lower limit of the wet layup boundary. From this point up to 12'-6" elevation, the volume per inch is only 7.8 gallons. Thus, to fill from 11'-9" to 12'-3", only 47 gallons is required - very little compared to total header volume. The SW headers should never be filled above elev 12'-6" as this places water against the 1/204 valves and increases the probability of RSHX water intrustion.

Condensate will be chemically treated to provide the RSHX SW piping wet lay-up boundary. A tie-in will be made into the condensate makeup system downstream of the mixed bed demineralizer and flash evaporator demineralizers. A flanged tee connection along with an isolation valve has been installed.

A flow element and pressure gauge will be located downstream of the Condensate Makeup System tie-in isolation valve to monitor and control flow and pressure of condensate to the RSHX wet lay-up fill connection. The maximum operating condition pressure of the SW Class 10 piping and expansion joints is 20 psi.

The condensate will be chemically treated by discharge of a chemical metering pump into the flexible hose in close proximity to the tie-in point to the condensate makeup system.

The fill line hose will be connected to a stub hose which runs from the turbine basement deck down to the fill points. The fill hose should be disconnected when filling is not in progress and the stub hose should be blanked.

From the inlet isolation valve, the SW is directed through the tube side of the RS heat exchanger. In the heat exchanger, during operation, the heat from the RS water is transferred to the SW in the tubes. The RS heat exchangers are drained during normal operations to minimize the possibility of the heat transfer surfaces becoming fouled.

As the SW leaves the RS heat exchangers, it passes through a normally closed outlet isolation valve, MOV-SW-105A/B/C/D. The outlet MOVs are located in the Safeguards Building and are controlled from benchboard 1-1. These valves will open automatically upon receipt of a high-high CLS signal. Remote SW temperature and flow indication in the individual return lines is provided on vertical panel 1-1 in the MCR and on the ERFCS as required by Reg. Guide 1.97.

Air in the supply and return lines for each heat exchanger is vented through a pipe with a check valve. The discharges of the supply line check valves are connected to an 8" header which vents the air water mixture outside the safeguards building. The return line vents discharge in the safeguards building. The tops of the vent lines are at an elevation well above normal canal level.

The RECIRCULATION SPRAY SERVICE WATER RADIATION MONITORING SAMPLE PUMPS 1-SW-P-5A, B, C, and D take a suction on the SW outlet from each of the RS heat exchangers. Each pump directs the SW sample through a RECIRCULATION SPRAY SERVICE WATER RADIATION MONITOR (RM-SW-114, -115, -116, and -117) to detect any RS-to-SW leakage of radioactive water. The SW RM pumps start automatically upon receipt of a high-high CLS signal.

The RS SW RMs for each unit are located in the opposite unit's Safeguards Building so that, in the event of a LOCA, background radiation from the containment wall does not affect the output of the RM. The samples are returned to the SW outlet lines in the opposite unit's Safeguards Building. The radiation monitor provides indication and an alarm light on the radiation monitoring panel in the MCR. The possibility of an RS-to-SW leak is remote.

The individual heat exchanger outlet lines combine to form two return headers. The two headers direct return water to the Discharge Tunnel.

Bearing cooling water coolers. Three bearing cooling water coolers, located in the west side of the Turbine Building basement, supply the cooling needs of the BC System. Two BC coolers are designed to be in service during normal plant operations. Screenwells 1A and 1C supply SW to any of the three BC coolers through one of two MOVs (MOV-SW-101A or B).

The MOVs are normally open and are located in the Turbine Building basement. They are operated from benchboard 1-1 and automatically shut on receipt of a high-high CLS signal coincident with a loss of reserve station services or on low intake canal level.

From the inlet MOVs, the SW is directed through the tube side of the BC coolers. In the cooler, the heat from the BC System is transferred to the SW in the tubes. A manual inlet and outlet isolation valve is provided for each cooler. A relief valve provides overpressure protection. Each cooler is provided with local inlet and outlet pressure indication and outlet temperature indication. The water boxes are provided with vacuum priming to keep the tubes full.

Component cooling heat exchangers. Four component cooling heat exchangers, located in the northeast corner of the Unit 1 Turbine Building basement, supply the CC needs of both units. All four CC heat exchangers are in service during normal plant operations. Screenwells 1B and 1D supply SW to any of the four CC heat exchangers through one of two MOVs (MOV-SW-102A and B). Service water is also supplied to the Turbine Building SW Subsystem via these MOVs.

The MOVs are normally open and are located in the Turbine Building basement. They are operated from benchboard 1-1 and automatically shut on receipt of a high-high CLS signal coincident with a loss of reserve station services or low intake canal level.

From the inlet MOVs, the SW is directed through the tube side of the appropriate CC heat exchanger. In the heat exchanger, the heat from the CC System is transferred to the SW in the tubes. A manual inlet and outlet isolation valve is provided for each heat exchanger. Each heat exchanger is provided with local inlet and outlet pressure indication and outlet temperature indication. The water boxes are provided with vacuum priming to keep the tubes full.

The COMPONENT COOLING SERVICE WATER RADIATION MONITORS are located on the SW discharge side of CC heat exchangers to detect any CC-to-SW leakage of radioactive material. The detectors are located in the discharge pipe of heat exchangers 1-CC-E-1A&B, and in the heat exchanger discharge nozzles of 1-CC-E-1C&D. The CC SW RM provides indication and an alarm light on the radiation monitoring panel in the MCR.

Mechanical Equipment Room Service Water System Loads

SW is provided from both units' SW Systems (screenwells 1B and 2A), through valves 1- and 2-SW-11. In addition, SW can be provided by way of Crosstie Valve 1-SW-474 from 1D screenwell and Crosstie Valve 2-SW-474 from 2C screenwell. SW from these Crosstie Valves goes through a common header to supply the:

1. control room and relay room air conditioning unit chiller condensers, and

2. Charging Pump Service Water Subsystem.

The SW piping to the Mechanical Equipment Room loads taps off the SW supply headers, upstream of the supply header isolation MOVs (see Figure 13-3). This ensures that cooling water is available when the MOVs are shut which would be during Phase III containment isolation in Unit 1 or during normal operation in Unit 2.

Flow from each unit passes through separate MOTOR-OPERATED SELF-CLEANING STRAINERS (1-VS-S-1A and -1B). A backup duplex strainer is provided to bypass self-cleaning strainer 1A in the event of malfunction. Differential pressure indication is provided locally at each strainer. The outlet of the strainers join in a common header to supply the chiller condensers and Charging Pump Service Water Subsystem.

Control room and relay room air conditioning unit chiller condensers. There are three control room and relay room air conditioning (A/C) units that are common to both reactor units. Flow from the common header supplies the suction of the CHILLER CONDENSER SERVICE WATER PUMPS (1-VS-P-1A, B, and C). These pumps supply the 90-ton air conditioner chiller condensers, where heat is transferred to the SW from the Freon as it condenses. The pumps also supply backwash flow to the self-cleaning strainers. A local pressure gage indicates discharge pressure.

Pressure control valves PCV-SW-100A/B/C and -101A/B/C work together to maintain proper flow through the chiller condensers. Each pair of valves receives control signals from the associated A/C unit.

Charging Pump Service Water Subsystem. Four tap-offs from the common header supply the two Charging Pump SW Subsystems, two tap-offs for each unit. Only the Unit 1 subsystem is discussed; the Unit 2 subsystem is similar. A duplex strainer (1-DS-S-2A and -2B) filters the SW prior to its passing to the suction of the charging pump SW pumps (1-SW-P-10A and -10B). Appropriate local pressure indication is provided. The discharge of each pump is cross-connected via a normally shut, manually operated valve with the discharge of a charging pump SW pump in the Unit 2 subsystem.

SW-263 crossties the sections of the charging pump Service Water pumps. This valve will automatically close on the following and will alarm on the VSP annunciator panel in the control room.

1. Smoke or fire in either the pump room in Unit 2 turbine building or in MER 3.

2. Loss of power to Fire Detection panel for the Charging Pump Service Water Pumps.

3. Trouble or alarm on the Fire Detection Panel for the Charging Pump Service Water Pumps.

An alarm will also be received if SW-263 is closed.

SW-263 can be manually overridden open by turning the handwheel in the clockwise direction. The handwheel override must be disengaged by turning it in the counterclockwise direction before the valve can go shut by de-energizing the solenoid.

SW is provided to the charging pump intermediate seal coolers and lube oil coolers of all six charging pumps (three per unit). The six charging pumps are identical. Detailed information on the charging pump components can be found in module NCRODP-41, Chemical and Volume Control System.

SW flow from either charging pump SW pump is provided through manual isolation valves and check valves. The discharge lines join together to form a common supply that provides flow to the charging pump lube oil coolers (1-CH-E-5A, -5B, and -5C) and the charging pump intermediate seal coolers (1-SW-E-1A and -1B). A temperature control valve (TCV-SW-108A/B/C) is adjusted by charging pump lube oil temperature to throttle SW flow to maintain the proper lube oil temperature. Local flow indication is provided for each cooler.

The returns from each of the coolers join to form a single return line. The return line directs SW to the Unit 1 Discharge Tunnel. The return from the Unit 2 subsystem joins this line and also returns to the Unit 1 Discharge Tunnel.

Turbine Building Service Water Subsystem

The Turbine Building SW Subsystem is supplied from screenwells 1B and 1D (see Figure 13-4) through MOV-SW-102A and B. The water is directed through 1-SW-12 to the suction of the SERVICE WATER PUMPS (1-SW-P-4A and -4B) and the RIVER WATER MAKEUP PUMP (1-SW-P-100A). The river water makeup pump is discussed later in this section.

Service water pumps. The SW pumps are centrifugal pumps powered by 480 VAC motors. One pump runs continuously while the other is in a standby condition. The pumps are interlocked with MOV-SW-102A and -B so that they are stopped when the valves are shut. Local pressure instruments indicate discharge pressure.

Self-cleaning strainers. The common pump discharge is directed to the motor-operated, SELF-CLEANING STRAINERS (1-CW-S-4 and -8). Local pressure instruments indicate inlet and outlet pressure. SW is then directed to the

1. station vacuum priming pump seal water coolers,
2. 555-ton air conditioning unit chiller condensers, and
3. steam-supplied chilled water unit.

Station vacuum priming pump seal water coolers. Three seal water coolers remove the heat from the station vacuum priming pump seal water recirculation flow. One cooler serves each pump. These coolers are usually left in service to provide a flow path for the SW pumps. Outlet piping joins with that of the other loads and is directed to the Discharge Tunnel.

Steam-supplied chilled water unit. The steam-supplied chilled water unit chills water by evaporation at a vacuum. SW was supplied to the chilled water condenser (1-CD-SC-1) and the chilled water condenser air ejector condensers (1-CD-EJ-2A and -2B). Condenser outlet water was returned to the supply header. Motive force was provided by the pressure differential across a spectacle flange, with the open end installed to act as an orifice. The condensers are normally isolated since the chilled water unit is no longer used.

Air conditioning unit chiller condensers. Three 555-ton A/C units are installed to provide chilled water for A/C and ventilation. The units are referred to as the "triple nickels" or the mechanical chiller condensers.

The units are similar, and two units (1-CD-REF-1A and -1B) are in the northeast corner of the mezzanine level in the Unit 1 Turbine Building. The Unit 2 A/C unit is located in the northeast area of the Unit 2 Turbine Building basement. A/C unit 1-CD-REF-1A supplies the cooling requirements for Unit 1, and 2-CD-REF-1 supplies the cooling requirements for Unit 2. 1-CD-REF-1B is a spare chiller, capable of supplying either unit. Only 1-CD-REF-1A is described.

SW passes through a manually operated isolation valve and a check valve to the chiller condenser, where heat is transferred to the SW from the Freon as it condenses. Local gages indicate inlet and outlet pressure, outlet temperature, and flow.

Temperature control valve TCV-SW-107A and chiller recirculation pump 1-SW-P-13A work together to maintain a minimum SW temperature of 60°F through the chiller condensers. As SW temperature drops, TCV-SW-107A throttles to slow the flow. At 62°F, the chiller recirculation pump starts, recirculating the SW through the mechanical chiller condenser. Outlet piping joins with that of the other loads and is directed to the Discharge Tunnel.

River water makeup pump. The river water makeup pump (1-SW-P-100A) may be supplied from the suction header of the SW pumps through MOV-SW-102A/b. The pump is located in the Turbine Building Basement near the TB SW pumps. The pump was once a source of makeup to the Flash Evaporator, it is no longer in service.

Emergency Service Water Subsystem

The Emergency Service Water Subsystem (see Figure 13-5) is housed in the Service Water House at the Low Level Intake Structure. The subsystem consists of the:

1. emergency service water pumps, and

2. Service Water Fuel Oil Subsystem.

The subsystem is operated locally in the SW House. In the event of a loss of all CW pumps, the Emergency Service Water Subsystem provides adequate amounts of water to meet plant requirements for auxiliary and emergency cooling. More information is presented in the General System Operation section of this module.

<u>Emergency service water pumps</u>. Three emergency SW pumps (1-SW-P-1A, -1B, and -1C) are provided. Pump 1A is in screenwell 1D, pump 1B is in screenwell 2A, and pump 1C is in screenwell 2B.

Each vertical, turbine-type pump is powered by a diesel engine connected to the pump by an angled gear drive. The diesel speed is automatically regulated by an installed governor at 1800 rpm. Pump 1A also has a motor drive connected to the pump through a one-way clutch. The motor is powered by 4160 VAC bus 1G. The capacity of each pump is 16,500 gpm at a discharge head of 46 feet; the minimum flow to meet the accident design basis is 15,000 gpm.

Each pump discharges through its own discharge line into the Intake Canal. There is no vacuum priming on the discharge line and no check valve installed in the pipe. Part of the pump discharge flows into a line that supplies cooling water for the diesel and for the angled gear drive. The cooling water flows through a duplex strainer which prevents fouling of the diesel water jacket and the gear drive cooler. The cooling water flow returns to the screenwell.

The diesel is started by a 24 VDC electric motor. A 24 VDC battery is supplied for each ESW diesel to provide power ot the starting motor and the control circuit for the engine. Each battery is kept charged by its own battery charger and may also be charged by a generator mounted on the diesel.

<u>Service Water Fuel Oil Subsystem</u>. The Service Water Fuel Oil Subsystem supplies fuel oil to the three diesel engines. A 4800- gallon tank (1-SW-TK-1) is located in the tank storage room in the SW House. The fill connection is outside the SW House, on the southeast side. The tank is vented to the outside

atmosphere. The tank contains enough fuel oil to operate all three diesels for 95 hours. The tank storage room is protected from fire by high pressure cardox.

Power Supplies

The power supplies to the major components are listed in Table 13-4 and illustrated in Figures 13-6 through 13-10.

Objectives

Upon completion of this section, you will be able to:

A. Describe in detail the major flow paths; operation and location of the major components; and the instrumentation, alarms, and controls associated with the Turbine Building Sump Subsystem.

B. Describe in detail the major flow paths; operation and location of major components; and the instrumentation, alarms, and controls associated with the Waste Oil Separation Subsystem.

C. Describe in detail, the operation and location of major components both active and passive; and the instrumentation, alarms, and controls associated with the Condenser Flood Control Subsystem.

D. List the power distribution to the major components of the systems covered herein.

E. **DESCRIBE IN DETAIL THE MAJOR FLOW PATHS; OPERATION AND LOCATION OF MAJOR COMPONENTS; INSTRUMENTATION, ALARMS, AND CONTROLS; POWER SUPPLIES; AND MAINTENANCE ASSOCIATED WITH SYSTEMS COVERED HEREIN.**

This section describes in detail the major flow paths; the operation, location, and power supplies of the major components; and the instrumentation, alarms, and controls associated with the Turbine Building Services. Figures 9-1 through 9-5 present the systems as described herein. For ease of understanding, the system has been broken down into three major subsystems: the Turbine Building Sump and Floor Drains Subsystem, Condenser Flood Control

Subsystem, and the Waste Oil Separation Subsystem. The interrelationships between these subsystems are described in this section.

Turbine building sump no. 1 receives drainage from Unit 1 components. Turbine building sump no. 2 (the common sump) receives drainage from both Unit 1 and Unit 2 components. Turbine building sump no. 3 receives drainage from Unit 2 components only and is not described in this module. Its associated sump pumps, oil skimmer, and instruments are similar to those described for sumps no. 1 and 2.

Turbine Building Sump and Floor Drains Subsystem

The Turbine Building Sump and Floor Drains Subsystem is composed of three vertical, wet pit sump pumps for each of sumps no. 1 and 2, and the associated valves, instruments, and piping.

Turbine building sumps. Turbine building sump no. 1 is located in the floor of the northwest corner of the Turbine Building. Turbine building sump no. 2 (common sump) is located in the floor of the northwest corner of the Unit 2 turbine area, which is almost between the two Turbine Building areas. The sumps are approximately 12 feet wide, 12 feet long, and 8.5 feet deep. Each sump has metal plate covers for access, as necessary. The sump pump and instrument arrangements for Turbine Building sumps no. 1 and 2 are identical. Therefore, only sump no. 1 is described in detail, with the comparable sump no. 2 components given in parentheses where applicable.

Turbine building sump pumps. Turbine building sump pumps 2A, 2B, and 2C (2D, 2E, and 2F) are 1300 gpm (high volume), vertical, wet pit sump pumps located in turbine building sump no. 1 (no. 2). The sump pumps automatically cycle on sump level as sensed by level switches. They are controlled by three-position (HAND, AUTO, OFF) selector switches, located near the sump. An alternator is provided to alternate the lead pump starting function in automatic control to allow for even wear of the pumps. The other two pumps thus provide standby and backup functions as necessary to maintain the desired sump level.

A motor-operated switch inside the pump control cabinet controls the alternating feature of the pumps. In the AUTO position, the lead pump is automatically alternated in numerical sequence (1, 2, 3) corresponding to the three sump pumps, after each pump has operated as the lead pump.

The pump sequence is as follows:

1. The lead pump starts at 60 inches above the bottom of the sump, as sensed by LS-1.

2. Increasing sump level starts the first standby pump at 66 inches above the bottom of the sump, as sensed by LS-2.

3. Further increasing level starts the second standby pump at 72 inches above the bottom of the sump, as sensed by LS-3.

4. At 36 inches above the bottom of the sump decreasing level, as sensed by LS-1, all the pumps stop running.

5. At a sump level of 78 inches above the bottom of the sump, or on loss of control power to the sump pumps, the TURBINE ROOM SUMP HIGH - LOSS OF CONTROL VOLTAGE alarm (window 1J-E6) annunciates in the Main Control Room (MCR).

The operator can start each pump separately by placing the selector switch in HAND. For either HAND or AUTO selection the pump will not start if a motor overload condition exists.

Flow path. The turbine building sump pumps discharge through individual check and isolation valves to prevent reverse flow and to permit isolation of a pump, respectively. The combined discharge of the three pumps for each sump is directed to the Yard Drain System, which empties into the discharge canal.

Waste Oil Separation Subsystem

The Waste Oil Separation Subsystem is composed of the following major components:

1. an oil skimmer for each sump,

2. a waste oil pad and associated waste oil pit,

3. a waste oil pump,

4. a waste oil storage tank, and

5. a truck station.

The waste oil skimmers and their associated components are identical for turbine building sumps no. 1 and 2. Therefore, only the skimmer for sump no. 1 is described.

Oil skimmers. An oil skimmer is mounted above each turbine building sump and functions to remove the oil floating on top of the water in the sumps. Each skimmer runs continuously, removing oil from the sump and discharging the oil into a 55-gallon drum positioned next to the skimmer. Each skimmer consists of the following major components:

1. electric drive motor,

2. drive wheel,

3. pulley wheel,

4. four scrapers,

5. flexible oil collector tube, and

6. decanter assembly.

The 0.5 HP electric drive motor powers the drive wheel, which pulls the collector tube over the pulley wheel. The flexible collector tube is guided through the four scrapers, which scrape the oil and sludge from the tube. The collector tube is of sufficient length to float on top of the oil in the sump. As it "snakes" through the oil, it picks up oil (and some water) and carries it to the scrapers.

The oil/water mixture removed by the scrapers is drained to a decanter assembly. Due to the lower density of oil, oil floats on water. The box-like decanter assembly allows the scraper drains to separate the water and oil. The top of the decanter assembly (oil location) contains an opening, which permits oil to drain to a 55-gallon drum. The lower section of the assembly is also equipped with an opening, allowing water to return to the sump.

Waste oil pad. The 55-gallon drums are delivered from the Turbine Building to the waste oil pad. The 20-foot by 30-foot awning-covered pad contains a waste oil pit where the contents of the drums are poured. The pad is sloped toward the pit to collect spillage or leakage. The waste oil pump is mounted on the northwest corner of the pad.

The waste oil pit is 3 feet long; 3 feet wide; and 2 feet, 6 inches deep and has a capacity of 168 gallons. A handrail and splash shield are provided on three sides of the sump to prevent oil spillage.

Waste oil pump. When pumping waste oil to the waste oil storage tank, the waste oil pump (1-WO-P-1) takes suction on the waste oil pit via a strainer. The positive-displacement rotary gear-driven pump is controlled locally by a two-position (ON, OFF) control switch. A check valve on the discharge side of the pump prevents backflow from the vertical run of piping at the tank to the pit.

The pump is driven at a speed of 380 rpm by a 480 VAC, 5 HP, 1750 rpm electric motor. A 4.6 to 1 gear reduction transforms the relatively high speed of the motor to the relatively low speed of the pump. The pump takes suction on any of the following locations:

1. waste oil pit,

2. waste oil storage tank, or

3. 1000-gallon underground tank, located at the truck station.

Waste oil storage tank. The waste oil storage tank (1-WO-TK-1) is used for holding waste oil, prior to discharging it to a truck for ultimate disposal. The tank receives the discharge of the waste oil pump and discharges to the truck station located just outside the protected area. The tank contents can either be pumped or gravity-drained to the truck station.

The waste oil storage tank has a capacity of 10,000 gallons. It is enclosed in a concrete dike, 8 inches thick and 42 inches high. The dike is sized to hold the contents of a full storage tank in the event of a rupture. The storage tank is nearly 23 feet high and approximately 9 feet in diameter. A side-mounted ladder is provided for accessing the top of the tank. The waste oil storage tank is mounted just inside the protected area on the northwest side.

Truck station. The truck station is located just outside the protected area near the waste oil pad. The station contains connections for receiving diesel fuel oil and discharging the contents of the waste oil storage tank. Additionally, a 1000-gallon tank is buried beneath the truck station to collect any spillage or leakage that might occur at the truck station.

The waste oil storage tank contains water and oil; therefore, separate connections are provided for discharging water and oil. During discharge evolutions, water is discharged first to a water truck. When oil begins to issue from the tank, the evolution is stopped and an oil truck is driven to the truck station. The oil is then either pumped, using the waste oil pump, or gravity-drained to the oil truck. A flexible hose is provided for draining the oil and water to the trucks (see Figure 9-1). A wire mesh screen is attached to the end of the hose at the truck station to prevent debris from entering the truck during draining evolutions. The screen fits around the connection on the top of the water/oil truck. A drain at the truck station permits spillage or leakage to drain into a 1000-gallon underground tank directly below the station. This tank can then be pumped to the waste oil storage tank by the waste oil pump.

Condenser Flood Control Subsystem

The purpose of the Condenser Flood Control Subsystem is to alert the operator through alarms that flooding is taking place in the Turbine Building that could impair safety-related equipment. This subsystem will allow the operator approximately 20 minutes to isolate the source of the flooding after the receipt of the first alarm before the condenser CW inlet valves are automatically closed. The system consists of level sensing detector probes, associated alarm circuitry, and a control system using a redundant, 2/3 matrix to initiate automatic closing of associated condenser CW inlet valves.

Level Sensing Devices. The level switches (LS) are stainless steel electrodes which generate an output signal when submerged in water. Sic level detector assemblies are employed - three for alarms and three for CW valve closing (see Figure 9-2). Level switches with the "-106" mark numbers are associated with CW valve closing circuitry, while the "-107" mark numbers are associated with the alarm circuitry. Each "106" level assembly contains two 12" probes, both which terminate 9" above the floor; one probe is part of the "A" train circuitry while the second probe is part of the "B" train circuitry. Each "107" level assembly also contains two probes, however, one probe terminates 12" off the floor to generate a HI alarm while the second probe terminates 24" off the floor to give the HI-HI alarm. The following is a summary of the level switches, their function, and their location:

- LS-CW-106 A1 and B1 - CW inlet valve close detector. Located adjacent to west end of condenser outlet pit; mounted on basement floor.

- LS-CW-106 A2 and B2 - CW inlet valve close detector. Located adjacent to east end of condenser outlet pit; mounted on basement floor.

- LS-CW-106 A3 and B3 - CW inlet valve close detector. Located between the "A" and "B" condensers south side inlet pit; mounted on basement floor.

- LS-CW-107 A1 and A2 - Condenser outlet pit HI and HI-HI alarm detector. Mounted on the pit floor between the A and B condensers, north side.

- LS-CW-107 B1 and B2 - Condenser inlet pit HI and HI-HI alarm detector. Mounted on the pit floor between the A and B condensers, south side.

- LS-CW-107 C1 and C2 - Amertap pit HI and HI-HI alarm detector. Mounted on the Amertap pit floor extreme southwest corner.

Flood Control Panels. The two Flood Control Panels contain the solid state relays associated with the system. Flood Control Panel "A" is located at the west end of the condenser inlet pit approximately 4 feet off the basement floor mounted on iron brackets. Flood Control Panel "B" is located at the east end of the condenser inlet pit approximately 4 feet off the basement floor on a south facing wall. These panels provide an enclosure for the relays and electronic control/alarm circuitry and the following system status indicating lights (see Figure 9-3):

- LT-74 - Indicates power is available to the system; normally lighted.

- LT - When illuminated, indicates no partial trip signals are actuated; normally lighted.

- LT-SW3 - Lighted when test switch #3 (TS-3) is in the TEST position.

- LT 2/3 - Lighted when test switch #2 (TS-2) is in the TEST position.

- LT-1A - (Panel "A" only) Monitors integrity of closing circuit for MOV-CW-106A; normally lighted.

- LT-1C - (Panel "A" only) Monitors integrity of closing circuit for MOV-CW-106C; normally lighted.

- LT-1B - (Panel "B" only) Monitors integrity of closing circuit for MOV-CW-016B; normally lighted.

- LT-1D - (Panel "B" only) Monitors integrity of closing circuit for MOV-CW-016D; normally lighted.

- LT-A - When lighted, indicates the "A" flood control relay is energized. Input is from LS-CW-106-A1 to the "A" panel and from LS-CW-106-B1 to the "B" panel (same level detector, different electrodes). This relay closes the "A" contacts in the 2/3 matrix.

- LT-B - Same as "A" above, except the input signal is from LS-CW-106-A2 for the "A" panel and LS-CW-106-B2 for the "B" panel. Closes the "B" contacts in the 2/3 matrix.

- LT-C - Same as above except input is from LS-CW-106-A3 and LS-CW-106-B3. Closes the "C" contacts in the 2/3 matrix.

- LT-XA - Indicates the XA relay has energized. This relay is picked up when 2/3 flood signals are present. Contacts from the XA relay are in the CW inlet MOV closing circuits and cause the valves to close.

In addition to the aforementioned indication lights, the panel contains three test switches, TS-1, TS-2, and TS-3, used for functionally testing the system during refueling outages. The switches are located under the locked cover on the panels. Also, the level alarm outputs to the Control Room are generated in the flood control panels. A loss of power to either food control panel causes a Turbine Building Flood Trouble Alarm to sound in the Control Room. Refer to Table 9-5 for a summary of all subsystem alarms.

<u>Passive Flood Control Devices In Turbine Building</u>. The Service Water Valve Pits are waterproofed to prevent flooding of the recirc spray, bearing cooling, and component cooling heat exchangers' motor-operated valves. These areas' safety-related valves must function to mitigate accidents when service water is necessary to cool the reactor and depressurize the reactor containment. Flood control of these areas include dikes, neoprene gaskets, rubber sealant, and stoppers in and around the pits.

One of the four checker floor plates over the Amertap Pit is replaced with open grid grating to allow flood water to enter the pit. This creates additional storage area and assures actuation of the Amertap Pit high water level alarms.

Each Condenser Circulating Water System expansion joint is enclosed with removeable 3/8 inch carbon steel spray shields. These shields act a passive restraints against any water flow should a joint fail.

Concrete or steel plate dikes are installed to provide barriers to food waters into adjacent areas where safety-related equipment is installed. The dikes are two feet high which surround the access to the Auxiliary Building pipe tunnel, the entrances to the Emergency Switchgear Room (ESGR) from the Turbine Building and Cable Vault Tunnels, and the entrance to the charging pump service water pump room off Unit 2 Turbine Building.

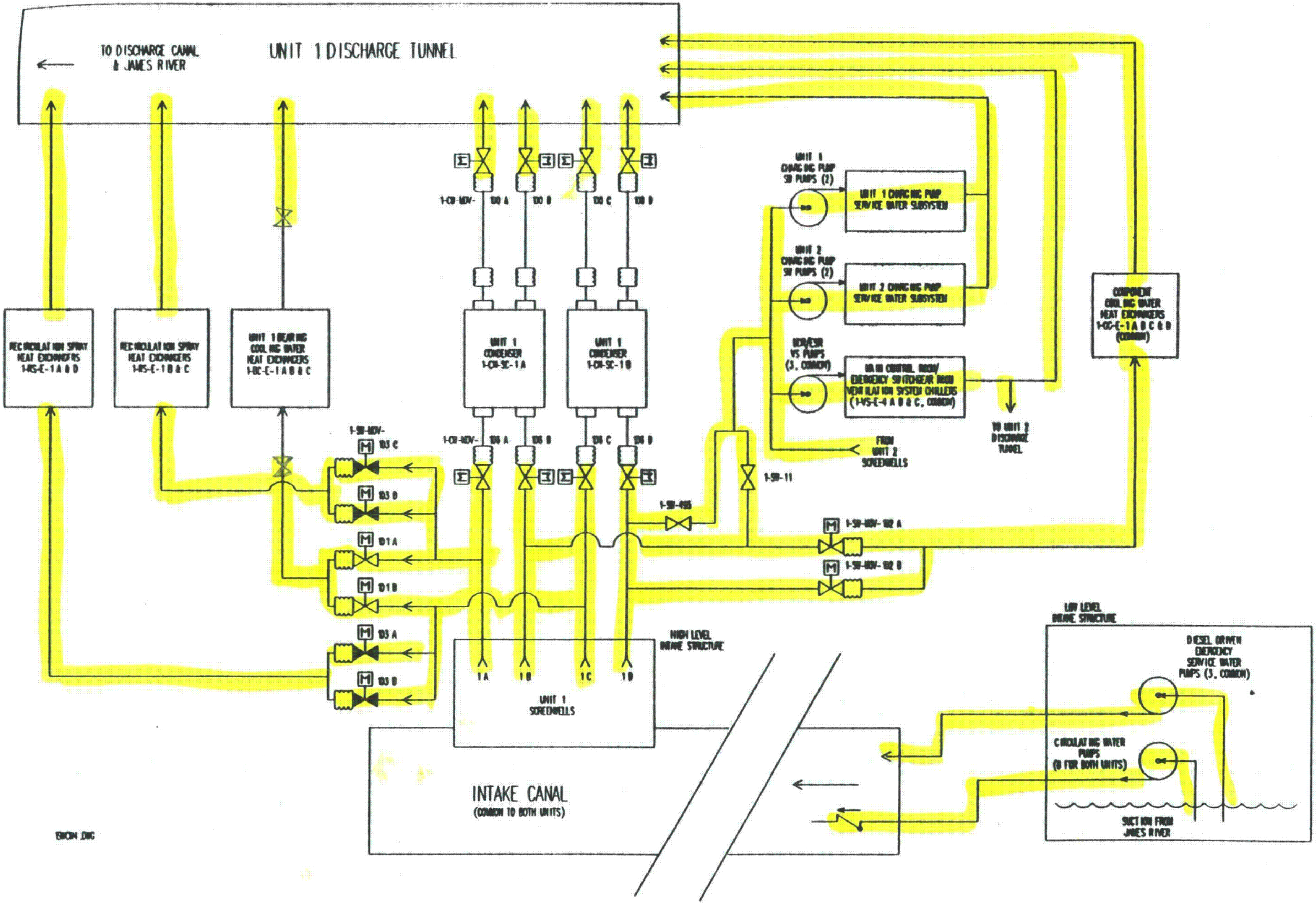
Drain lines from the ESGR and charging pump SW pump room have float type check valves installed to prevent backflood of water from the Turbine Building should the sump pumps not be able to keep up a flooding event. Also, the drain valve in the charging pump SW pump room may be manually closed, if required.

<u>Flooding Event</u>. Should a condenser expansion joint fail or some other flood-causing casualty occur, the system automatically alerts the Control Room personnel as the level alarms are received (Refer to Figure 9-4). The time

interval between HI and HI-HI alarms will indicate the flooding severity. In all cases, the alarm(s) are investigated and corrective action is taken. If the flooding cannot be stopped before the water level reaches nine (9) inches on the basement floor, the system automatically closes the condenser CW inlet valves. If the plant is at power, the turbine will trip on low vacuum as cooling water is lost. Once the cause of the flooding is identified and flooding stopped, the Turbine Building sump pumps will function to dewater the basement.

Power Supplies

The power supplies to the major system components are listed in Table 9-3 and illustrated in Figures 9-2 through 9-5.



SIMPLIFIED FLOW DIAGRAM
CIRCULATING WATER SYSTEM
AND SERVICE WATER SYSTEM

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WITHIN THIS PACKAGE

FORM: 97888190
REV.: 6

FINAL DESIGN CONTROLLING PROCEDURE
NUCLEAR POWER STATION

P2-U1

VIRGINIA POWER

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1	DESIGN CHANGE NO.: (2 DC-86-10-1
PREPARING ENGINEER/AFFILIATION: (3 W McClosky / SWEC	DATE: (4 2-22-88
REVIEWING ENGINEER/AFFILIATION: (5 M&McClellan / SWEC	DATE: (6 2/22/88
REVIEWED BY LEAD ENGINEER: (7 W. D. Corbin / Va. Power	DATE: (8 3.10.88
REVIEWED BY DESIGN CONTROL ENGINEER: (9	DATE: (10
STATION NUCLEAR SAFETY AND OPERATING COMMITTEE APPROVAL: (11	DATE: (12

FINAL DESIGN CONTROLLING PROCEDURE: (13

1.0 PURPOSE

This procedure provides instructions to replace the following butterfly valves and their adjacent rubber expansion joints with new valves and expansion joints.

MOV-CW-100A,B,C,D
MOV-SW-101A,B
1-SW-27, 31, 35, 39

This procedure also dewaters and refills the discharge tunnel, and removes/installs the temporary 24 in. service water discharge line from the CCW heat exchangers.

2.0 INITIAL CONDITIONS

2.1 Surry Units 1 and 2 shall be in any mode of operation for steps 4.4 and 4.5 as long as requirements of Technical Specification 3.14.B for control area air-conditioning system operating conditions are met.

FINAL DRAFT

T.S. 3.14.B requires that there shall be an operating service water flowpath to and from one operating control area air-conditioning condenser, and at least one operable service water flowpath to and from at least one operable control area air-conditioning condenser whenever fuel is loaded in the reactor core.

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: (2 DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE DATE

2.2 Surry Units 1 and 2 shall be in any mode of operation for steps 4.6.1 through 4.6.4 as long as requirements of Technical Specification 3.13.A for component cooling water system operating conditions are met. Surry Unit 1 must be in the cold shutdown mode before Step 4.6.5 can be performed (connection of the 24 inch temporary line to the second CCW heat exchangers).

NOTE 1: This requirement is based on step 4.6.3 being performed prior to 4.6.5. If step 4.6.5 is performed prior to step 4.6.3, then Unit 1 must be in cold shutdown mode before step 4.6.3 (not 4.6.5) can be performed.

NOTE 2: T.S. 3.13.A requires that 3 CCW Heat Exchangers be operational for two unit operation.

______ ____ (Sta Shift Supv)

2.3 Notify Station Shift Supervisor that work on this procedure is to begin. ✓

______ ____

2.4 The 8 inch permanent alternate service water supply line (8"-WS-466-151) to the charging pump service water subsystem has been installed by DC-86-09-3.

3.0 PRECAUTIONS

3.1 All work shall be performed in accordance with the Vepco Accident Prevention Manual. ✓

FINAL DRAFT

3.2 Obtain a flame permit prior to performing any welding and/or burning. ✓

4.0 INSTRUCTIONS

NOTES: 1. All electrical installation shall be performed in accordance with NUS-2030, "Specification for Electrical Installation for Surry 1 and 2".

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: (2 DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE DATE

2. All piping, valves, and expansion joints shall be.installed in accordance with NUS-20 "Specification for Piping."

3. The existing valves and expansion joints will be replaced with new valves and joints. The existing Limitorque operators will not be replaced, but will be reused and installed on the new valves.

4. Security personnel shall be present at the worksite whenever an open path exists into the protected area. A path will exist when the discharge tunnel is dewatered and the condenser outlet valves MOV-CW-100A, B, C, or D, expansion joints REJ-4, or waterbox manhole covers (discharge side only) are removed. Work should be sequenced to minimize time periods when these conditions exist or blank flanges should be installed on the 96 in. lines when the valves and expansion joints are removed, and the condenser waterbox manhole covers should be installed.

5. In order for Unit 2 to remain operational, the instructional steps (i.e., 4.4, 4.5, 4.6...) must be worked in numerical sequence due to the valve line ups and isolations required. Certain steps may be performed out of sequence, and are indicated in the body of this procedure.

FINAL DRAFT

_________ ____
(ANI)

4.1 The Authorized Nuclear Inspector (ANI) has been notified that work on a safety related fluid system, circulating and service water system, is about to begin.

DESIGN CHANGE TITLE / STATION / UNIT:	DESIGN CHANGE NO.:
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT):

SIGNATURE	DATE		
(Sta Engr)		4.2	Initiate ASME Repair/Replacement follower in accordance with Administrative Procedure SUADM-M-27 and attach to this DCP.
(Const Eng)		4.3	Initiate "Form NIS-2 Owners Report of Repair or Replacement."
		4.4	Diversion of control and relay room air-conditioning condenser service water return.

NOTE: Steps 4.4 and 4.5 may be performed in any order, however, the substeps of these sections must be performed in numerical sequence.

SIGNATURE	DATE		
		4.4.1	Fabricate blank flange for line No. 3"-WS-326-9107 in accordance with drawing S-8610-1-M-800. N/A this step if not required.

NOTE: Ensure service water discharge from 1-VS-E-4B and 1-VS-E-4C is lined up to the Unit 2 discharge tunnel.

SIGNATURE	DATE		
(Ops)		4.4.2	De-energize the equipment listed below and tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-VS-E-4A	
1-VS-P-1A	

FINAL DRAFT

SIGNATURE	DATE		
(Ops)		4.4.3	Tag out the valves listed below in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-347	
1-SW-346	
1-SW-314	

DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________	____	4.4.4	Install blank flange in line 3"-WS-326-9107 in accordance with drawing S-8610-1-M-100.
________ (Ad Ops)	____	4.4.5	Leak test the blank flange installation in accordance with the Final Design Test Matrix. N/A this step if not required.
________ (Ops)	____	4.4.6	Remove tags from the equipment listed below in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-314	________
1-SW-347	________
1-SW-346	________
1-VS-E-4A	________
1-VS-P-1A	________

________ (Ops)	____	4.4.7	Mechanically re-instate the equipment listed below in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-VS-E-4A	________
1-VS-P-1A	________

________ (Ops)	____	4.4.8	Verify operability of the control and relay room air-conditioning system.

FINAL DRAFT

4.5 Diversion of containment cooling service water

NOTE: Steps 4.4 and 4.5 may be performed in any order, however, the substeps of these sections must be performed in numerical sequence.

________	____	4.5.1	Fabricate blank flange for line no. 10"-WS-104-136 in accordance with drawing S-8610-1-M-800. N/A this step if not required.

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: DC-86-10-1 (2

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________ (Ops)	____	4.5.2	De-energize the equipment listed below and tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-P-13A	________
1-SW-P-13B	________
1-CD-REF-1A	________
1-CD-REF-1B	________

________ (Ops)	____	4.5.3	Mechanically isolate the equipment listed below and tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-P-13A	________
1-SW-P-13B	________
1-CD-REF-1A	________
1-CD-REF-1B	________

________ (Ops)	____	4.5.4	Tag out valve 1-CP-465 in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________.
________ (Ops)	____	4.5.5	Isolate flow through line 4"-WS-67-136. Make necessary valve lineups to ensure that satisfactory operation of the vacuum priming system is maintained.
________	____	4.5.6	Install blank flange in line No. 10"-WS-104-136 in accordance with drawing S-8610-1-M-101.
________ (Ad Ops)	____	4.5.7	Leak test the blank flange installation in accordance with the Final Design Test Matrix. N/A this step if not required.

FINAL DRAFT

DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________ (Ops)	____	4.5.8	Remove tags from the equipment listed below in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-P-13A	________
1-SW-P-13B	________
1-CD-REF-1A	________
1-CD-REF-1B	________
1-CP-465	________

SIGNATURE	DATE		
________ (Ops)	____	4.5.9	Mechanically re-instate the equipment listed below in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-P-13A	________
1-SW-P-13B	________
1-CD-REF-1A	________
1-CD-REF-1B	________

SIGNATURE	DATE		
________ (Ops)	____	4.5.10	Restore flow through line 4"-WS-67-136. Ensure valve lineup for the vacuum priming is returned to normal.
________ (Ops)	____	4.5.11	Verify the operability of the containment cooling service water system.
________ (Ops)	____	4.5.12	Perform a valve lineup to align service water discharge from 1-CD-REF-1A and 1B to the Unit 2 discharge tunnel as directed by Operations.

FINAL DRAFT

4.6 Installation of 24 Inch Temporary S.W. Discharge Line From CCW Heat Exchangers

4.6.1 Fabrication of Spoolpieces

SIGNATURE	DATE		
________	____	4.6.1.1	Fabricate piping spoolpieces, as needed, in accordance with drawings

SIGNATURE	DATE			
				S-8610-1-M-400, S-8610-1-M-401,. S-8610-1-M-402 and NUS-20 except for the existing spoolpiece which penetrates the Unit 1/ Unit 2 Turbine Building wall. N/A this step if not required.
		4.6.2	Install Fabricated Spoolpieces	
________	____		4.6.2.1	Install piping and supports up to, but not including, expansion joints at 1-CC-E-1A, 1-CC-E-1B, and the Unit 2 "A" condenser outlet waterbox in accordance with drawing S-8610-1-M-400, M-401, M-402, M-700, M-701, M-702, and M-703.
________ (Ad Ops)	____		4.6.2.2	Hydrostatically test temporary line to 38 psig (150 percent design pressure) in accordance with Final Design Test Matrix. N/A this step if not required.
		4.6.3	Installation of Temporary Line at 1-CC-E-1A	
________ (Ops)	____		4.6.3.1	Mechanically isolate component cooling heat exchanger 1-CC-E-1A and drain the service water side. Tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ________.
________	____		4.6.3.2	Remove 24 in. blind flange from the 30 in x 24 in. tee on the service water discharge of 1-CC-E-1A.

FINAL DRAFT

DESIGN CHANGE TITLE / STATION / UNIT:	DESIGN CHANGE NO.:
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT):

SIGNATURE	DATE			
			Note:	Do not discard this flange as it will be reinstalled in step 4.12.2 of this procedure.
________	____		4.6.3.3	Install expansion joint between piping and the 30 in. x 24 in. tee in accordance with drawing S-8610-1-M-400.
________ (Ops)	____		4.6.3.4	Mechanically reinstate component cooling heat exchanger 1-CC-E-1A in accordance with Administrative Procedure SUADM-0-13. Position temporary valve V-1 as required by operations. Tag Report No. ________.
________ (Ad Ops)	____		4.6.3.5	Perform leak test of piping in accordance with Final Design Test Matrix. N/A this step if not required.
		4.6.4	<u>Installation of Temporary Line at Unit 2"A" Condenser Outlet Waterbox</u>	
________ (Ops)	____		4.6.4.1	Remove Unit 2 "A" condenser waterbox from service in accordance with Maintenance Operating Procedure 2-MOP-48-1.
________	____		4.6.4.2	Open lowest manway on Unit 2 "A" condenser outlet waterbox.
________	____		4.6.4.3	Install expansion joint and piping to tie into the condenser manway in accordance with drawings S-8610-1-M-401, and M-402.

FINAL DRAFT

SIGNATURE	DATE		
________ (Ad Ops)	____	4.6.4.4	Perform leak test of piping in accordance with Final Design Test Matrix. N/A this step if not required.
________ (Ops)	____	4.6.4.5	Return Unit 2 "A" condenser waterbox to service in accordance with Maintenance Operating Procedure 2-MOP-48.2.

4.6.5 Installation of Temporary Line at 1-CC-E-1B

NOTE: This step shall not be implemented until Unit 1 is in the cold shutdown mode. See paragraph 2.2 of this procedure.

SIGNATURE	DATE		
________ (Ops)	____	4.6.5.1	Mechanically isolate component cooling heat exchanger 1-CC-E-1B and drain the service water side. Tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ________.
________	____	4.6.5.2	Remove 24 in. blind flange from the 30 in x 24 in. tee on the service water discharge of 1-CC-E-1B.

FINAL DRAFT

Note: Do not discard this flange as it will be reinstalled in step 4.12.2 of this procedure.

SIGNATURE	DATE		
________	____	4.6.5.3	Install expansion joint between piping and 30 in. x 24 in. tee in accordance with drawing S-8610-1-M-400.

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: DC-86-10-1 (2

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________ (Ops)	____	4.6.5.4	Mechanically reinstate component cooling heat exchanger 1-CC-E-1B in accordance with Administrative Procedure SUADM-0-13. Position temporary valve V-2 as required by operations. Tag Report No. ________.
________ (Ad Ops)	____	4.6.5.5	Perform leak test of piping in accordance with the Final Design Test Matrix. N/A this step if not required.

Engineering Hold

________ (Lead Site Engr) ____

4.6.6 Perform a technical review of work completed to this point on the temporary 24 inch line.

NOTE: This review is intended to ensure the 24 inch alternate discharge line is installed and available for use prior to dewatering the tunnel for valve replacement.

________ (Ops) ____

4.6.7 Testing complete. 24-inch temporary service water discharge line system has been released to Operations.

4.7 Secure and isolate flows into the Unit 1 discharge tunnel as follows:

FINAL DRAFT

________ (Ops) ____

4.7.1 Isolate flow from line 4"-WPCD-39-301 into the Unit 1 discharge tunnel. Tag out isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________.

DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________ (Ops)	____	4.7.2	Isolate flow from line 2"-WBC-121 into the Unit 1 discharge tunnel. Tag out isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________.
________ (Ops)	____	4.7.3	Isolate flow from line 2"-WHD-121 into the Unit 1 discharge tunnel. Tag out isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________.
________ (Ops)	____	4.7.4	Isolate flow from line 2"-DA-151 into the Unit 1 discharge tunnel. Tag out isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________.
________ (Ops)	____	4.7.5	Establish necessary plant conditions and secure the flash evaporator. Isolate flow from line 3"-WCW-1-136 into the Unit 1 discharge tunnel. Tag out isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________
________ (Ops)	____	4.7.6	Isolate flow from line 3"-WGCB-120-151 and 3"-WGCB-121-151 to the Unit 1 condenser waterboxes. Tag out isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________
________ (Ops)	____	4.7.7	Isolate flow to the Unit 1 discharge tunnel from the component cooling service water radiation monitoring system. De-energize and mechanically isolate the pumps listed below, and tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13.

FINAL DRAFT

DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE DATE

	Tag Report No.
1-SW-P-6A	__________
1-SW-P-6B	__________
1-SW-P-6C	__________
1-SW-P-6D	__________

Sample as required by Technical Specification 3.7.E.

________ ____
(Ops)

4.7.8 Establish necessary plant conditions and secure the bearing cooling water system. Isolate service water flow from the bearing cooling water heat exchangers to the Unit 1 discharge tunnel, line 42"-WS-11-10. Tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.__________

NOTE: This step may be accomplished out of sequence in order to allow continued service of the bearing cooling system. However, this flow must be isolated prior to personnel entering the discharge tunnel in step 4.8.

________ ____
(Ops)

4.7.9 Establish necessary plant conditions and isolate service water flow from the recirculation spray heat exchangers to the Unit 1 discharge tunnel, lines 30"-WS-37-10 and 30"-WS-38-10. Tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.__________

FINAL DRAFT

________ ____
(Ops)

4.7.10 Isolate condensate polisher waste to Unit 1 discharge tunnel, line 8"-CP-392-136. Tag out isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.__________

DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE DATE

Ensure discharge path to Unit 2 discharge tunnel is available via line 8"-WS-109-136.

______ ____
(Ops)

4.7.11 Verify that service water discharge from containment cooling chiller condensers 1-CD-REF-1A and 1-CD-REF-1B have been lined up to the Unit 2 discharge tunnel via line 8"-WS-109-136, and that line 10"-WS-104-136 has had a blind flange installed by step 4.5 of this procedure.

______ ____
(Ops)

4.7.12 Verify that service water discharge from the control and relay room air-conditioning condensers (line 3"-WS-326-9107) has been lined up to the Unit 2 discharge tunnel, and that discharge to the Unit 1 tunnel has been blocked by a blind flange installed by step 4.4 of this procedure.

______ ____
(Ops)

4.7.13 When plant conditions permit, line up component cooling heat exchangers 1-CC-E-1A and 1-CC-E-1B to carry all component cooling system loads. Establish service water return flow from 1-CC-E-1A and 1-CC-E-1B to the Unit 2 circulating water system via the 24 in. temporary line installed by step 4.6 of this procedure. Isolate the service water discharge to the Unit 1 discharge tunnel from 1-CC-E-1A and 1-CC-E-1B by closing valves 1-SW-39 and 1-SW-35. Close service water inlet valves to 1-CC-E-1C and 1-CC-E-1D (valves 1-SW-29 and 1-SW-25). Tag with special blue tags with instructions that they should not be opened until the discharge tunnel is cleared of personnel. Tag out the following valves in accordance with Administrative Procedure SUADM-0-13.

FINAL DRAFT

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: (2 DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE DATE

	Tag Report No.
1-SW-39	________
1-SW-35	________
1-SW-29 (blue tag)	________
1-SW-25 (blue tag)	________

4.8 Dewater Tunnel

________ ____ (Ops)

4.8.1 Remove condenser waterboxes from service in accordance with 1-MOP-48.1, -48.3, -48.5, and -48.7.

NOTE: The CW outlet valves shall be fully open (MOV-CW-100A, 100B, 100C, and 100D). The CW inlet valves will be closed by the above procedures (MOV-CW-106A, 106B, 106C, and 106D). Unless required to be opened, the manhole covers on the downstream side of the condensers shall remain closed for the security reasons identified in Note 4 of Step 4.0.

________ ____ (Ops)

4.8.2 Close, de-energize, and tag out valve MOV-SW-102B in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________

________ ____ (Ops)

4.8.3 Close and tag out valve 1-SW-495 in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________

FINAL DRAFT

4.8.4 Place stop logs in the high level intake structure inlets to the following 96 in. circulating water lines and notify operations when each stop log is installed.

________ ____ 96"-WC-1-10 (A Waterbox)
________ ____ 96"-WC-3-10 (C Waterbox)
________ ____ 96"-WC-4-10 (D Waterbox)

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: (2. DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE DATE

NOTES: 1. 96"-WC-2-10 will not be stop logged in this phase of work in order to maintain service water supply to the component cooling heat exchangers and the charging pump service water system.

2. 96"-WC-1-10 should not be stop logged until the bearing cooling system is no longer required.

________ ____ 4.8.5 Upon dewatering, perform an inspection of the stop log supports (trash rack supports) to ensure no structural degradation exists.

4.8.6 Install 96 inch blanks in the high level intake structure upstream of the following 96 inch lines. Blank installation shall be in accordance with drawing S-8610-1-S-001. Notify Operations when each blank is installed.

________ ____ 96"-WC-1-10 (A Waterbox)

________ ____ 96"-WC-3-10 (C Waterbox)

NOTE: A 96 inch blank is not required for the "D" waterbox line.

________ ____ (Ops) 4.8.7 Remove Unit 1 discharge tunnel vacuum priming system from service in accordance with OP-48.4.

________ ____ 4.8.8 Complete Confined Area Entry Permit, Attachment I, in accordance with SOP No. 8.4.10S, for entry into the manway located in the yard south of the vacuum priming house as shown on drawing 11448-FC-5C.

FINAL DRAFT

________ ____ (Security Shift Supv) 4.8.9 Notify Security Shift Supervisor (X 346) to post security officer as required for opening of yard manway referenced in the preceding step.

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: (2
DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________	____	4.8.10	After the vacuum priming system has been out of service for approximately 10 minutes, open the manway.
________ (H.P.)	____	4.8.11	Health Physics to enter manway and survey work areas and determine if any special precautions for access are required. Issue RWP as required.
________	____	4.8.12	Provide temporary lighting and ventilation to the discharge tunnel as required.
________	____	4.8.13	When the flow and the water level in the discharge tunnel are negligible, as observed from the manhole, dewater the tunnel.

4.9 Collect and Divert Flow From 8"-WBTD-2-WI

________ (Ops)	____	4.9.1	Stop flow from line 1½"-LW-24-152 (radioactive liquid waste effluent) and reduce flow from line 3"-WS-89-136 (Units 1 and 2 charging pump service water combined discharge) to minimum.
________	____	4.9.2	Fabricate and install temporary sump.
________	____	4.9.3	Place two submersible pumps in temporary sump and route discharge hose from one pump to the discharge canal. Install one section of hose on the second pump.

NOTE: Only one pump is required. The second pump is a backup to be used if the first fails.

FINAL DRAFT

________ (Ops)	____	4.9.4	Restore flows from 1½"-LW-24-152 and 3"-WS-89-136 to normal.
________	____	4.9.5	Operate pump, as required, to maintain diversion of liquid wastes to the discharge canal.

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DESIGN CHANGE NO.: (2
DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (3

SIGNATURE DATE

______ ____
(H.P.)

4.9.6 Health Physics to survey sump area determine if additional precautions are necessary.

4.10 Valve Replacement Phase I

NOTES:

1. This phase involves replacing valves while the A, C, and D waterbox lines are stop logged and the discharge tunnel is drained.

2. The following valve must be replaced during this phase. (While the 'D' waterbox is stop logged).

   MOV-CW-100D

3. The following valves can be replaced during this phase or in the next phase. Valve replacement can be accomplished in any order.

   MOV-CW-100A
   MOV-CW-100C
   MOV-SW-101A,B
   1-SW-27
   1-SW-31

______ ____
(Ops)

4.10.1 The following plant conditions should exist:

Stop logs should be installed in the high level intake structure inlet to lines 96"-WC-1-10, 96"-WC-3-10, and 96"-WC-4-10 and these lines should be drained.

96" blanks should be installed in the high level intake structure inlet to lines 96"-WC-1-10 and 96"-WC-3-10.

The Unit 1 discharge tunnel should be drained.

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FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE	
		Service water flow should be through CCW heat exchangers 1-CC-E-1A and/or 1-CC-E-1B with the discharge directed to Unit 2.
		Valve MOV-SW-102A should be open.
		Valves MOV-SW-102B and 1-SW-495 should be closed.
		4.10.2 MOV-CW-100A
________ (Ops)	____	4.10.2.1 De-energize and tag out MOV-CW-100A in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ________.
		4.10.2.2 Determinate the following cables at MOV-CW-100A.
		NOTE: Prior to determinating, field to identify all the wires of these cables to aid in the reterminating of these cables in step 4.10.2.8.
________ ________ (QC)	____ ____	1J6PL90
________ ________ (QC)	____ ____	1J6PL91
________	____	4.10.2.3 Remove Limitorque operator from valve MOV-CW-100A
________ (Security)	____	4.10.2.4 Security personnel shall be present at the worksite prior to removing the butterfly valve and expansion joint. Security shall remain at the worksite

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SIGNATURE DATE

until the replacement valve and expansion joint are installed or a blind flange is installed at the 96 inch pipe. If a blind flange is installed, security should be present during its removal.

______ ____ 4.10.2.5 Remove valve MOV-CW-100A and rubber expansion joint REJ-4. Provide support for the Amertap barrel as required.

______ ____
______ ____
(QC)
4.10.2.6 Install Replacement valve MOV-CW-100A and rubber expansion joint REJ-4.

______ ____
______ ____
(QC)
4.10.2.7 Install Limitorque operator on valve MOV-CW-100A. Torque the 1¼ inch mounting cap screws to 500 ft-lb (dry) or 380 ft-lb (lubricated).

4.10.2.8 Reterminate the following cables which were determinated in step 4.10.2.2.

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______ ____
______ ____
(QC)
1J6PL90

______ ____
______ ____
(QC)
1J6PL91

______ ____
(Ad Ops)
4.10.2.9 Test MOV-CW-100A in accordance with the Final Design Test Matrix. N/A this step if not required.

DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
______ (Ops)	____	4.10.2.10	Remove tag from MOV-CW-100A in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ____.
______ (Ad Ops)	____	4.10.2.11	Test MOV-CW-100A in accordance with the final design test matrix. N/A this step if not required.
		4.10.3	MOV-CW-100C
______ (Ops)	____	4.10.3.1	De-energize and tag out MOV-CW-100C in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ________.
		4.10.3.2	Determinate the following cables at MOV-CW-100C.
			NOTE: Prior to determinating, field to identify all the wires of these cables to aid in the reterminating of these cables in step 4.10.3.8.
______ ______ (QC)	____ ____		1J6PL98
______ ______ (QC)	____ ____		1J6PL99
______	____	4.10.3.3	Remove Limitorque operator from valve MOV-CW-100C
______ (Security)	____	4.10.3.4	Security personnel shall be present at the worksite prior to removing the butterfly valve and expansion joint. Security shall remain at the worksite

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DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: DC-86-10-1 (2

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
			until the replacement valve and expansion joint are installed or a blind flange is installed at the 96 inch pipe. If a blind flange is installed, security should be present during its removal.
________	____	4.10.3.5	Remove valve MOV-CW-100C and rubber expansion joint REJ-4. Provide support for the Amertap barrel as required.
________ ________ (QC)	____ ____	4.10.3.6	Install Replacement valve MOV-CW-100C and rubber expansion joint REJ-4.
________ ________ (QC)	____ ____	4.10.3.7	Install Limitorque operator on valve MOV-CW-100C. Torque the 1¼ inch mounting cap screws to 500 ft-lb (dry) or 380 ft-lb (lubricated).
		4.10.3.8	Reterminate the following cables which were determinated in step 4.10.3.2.
________ ________ (QC)	____ ____		1J6PL98
________ ________ (QC)	____ ____		1J6PL99
________ (Ad Ops)	____	4.10.3.9	Test MOV-CW-100C in accordance with the Final Design Test Matrix. N/A this step if not required.

FINAL DRAFT

SIGNATURE	DATE		
________ (Ops)	____	4.10.3.10	Remove tag from MOV-CW-100C in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ____.
________ (Ad Ops)	____	4.10.3.11	Test MOV-CW-100C in accordance with the Final Design Test Matrix. N/A this step if not required.
		4.10.4	MOV-CW-100D
________ (Ops)	____	4.10.4.1	De-energize and tag out MOV-CW-100D in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ________.
		4.10.4.2	Determinate the following cables at MOV-CW-100D.
		NOTE:	Prior to determinating, field to identify all the wires of these cables to aid in the reterminating of these cables in step 4.10.4.8.
________ ________ (QC)	____ ____		1H6PL156
________ ________ (QC)	____ ____		1H6PL157
________	____	4.10.4.3	Remove Limitorque operator from valve MOV-CW-100D
________ (Security)	____	4.10.4.4	Security personnel shall be present at the worksite prior to removing the butterfly valve and expansion joint. Security shall remain at the worksite

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FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
			until the replacement valve and expansion joint are installed or a blind flange is installed at the 96 inch pipe. If a blind flange is installed security should bepresent during its removal.
________	____	4.10.4.5	Remove valve MOV-CW-100D and rubber expansion joint REJ-4. Provide support for the Amertap barrel as required.
________ ________ (QC)	____ ____	4.10.4.6	Install Replacement valve MOV-CW-100D and rubber expansion joint REJ-4.
________ ________ (QC)	____ ____	4.10.4.7	Install Limitorque operator on valve MOV-CW-100D. Torque the 1¼ inch mounting cap screws to 500 ft-lb (dry) or 380 ft-lb (lubricated).
		4.10.4.8	Reterminate the following cables which were determinated in step 4.10.4.2.
________ ________ (QC)	____ ____		1H6PL156
________ ________ (QC)	____ ____		1H6PL157
________ (Ad Ops)	____	4.10.4.9	Test MOV-CW-100D in accordance with the Final Design Test Matrix. N/A this step if not required.

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DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________ (Ops)	____	4.10.4.10	Remove tag from MOV-CW-100D in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ____.
________ (Ad Ops)	____	4.10.4.11	Test MOV-CW-100D in accordance with the Final Design Test Matrix. N/A this step if not required.

4.10.5 MOV-SW-101A

SIGNATURE	DATE		
________ (Ops)	____	4.10.5.1	During the time period when valve MOV-SW-101A is removed (steps 4.10.5.5 and 4.10.5.6), the intake canal level shall be maintained at elevation 24 to 25 feet to minimize the potential seismic loads on the stop logs.
________ (Ops)	____	4.10.5.2	De-energize and tag out MOV-SW-101A in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ________.
		4.10.5.3	Determinate the following cables at MOV-SW-101A.

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NOTE: Prior to determinating, field to identify all the wires of these cables to aid in the reterminating of these cables in step 4.10.5.8.

SIGNATURE	DATE	Cable
________ ________ (QC)	____ ____	1H6PL167
________ ________ (QC)	____ ____	1H6PL168

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FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________	____	4.10.5.4	Remove Limitorque operator from valve MOV-SW-101A
________	____	4.10.5.5	Remove valve MOV-SW-101A and rubber expansion joint REJ-8.
________ ________ (QC)	____ ____	4.10.5.6	Install Replacement valve MOV-SW-101A and rubber expansion joint REJ-8.
________ ________ (QC)	____ ____	4.10.5.7	Install Limitorque operator on valve MOV-SW-101A. Torque the 3/4 inch mounting cap screws to 175 ft-lbs (dry) or 130 ft-lb (lubricated).
		4.10.5.8	Reterminate the following cables which were determinated in step 4.10.5.3.
________ ________ (QC)	____ ____		1H6PL167
________ ________ (QC)	____ ____		1H6PL168
________ (Ad Ops)	____	4.10.5.9	Test MOV-SW-101A in accordance with the Final Design Test Matrix. N/A this step if not required.
________ (Ops)	____	4.10.5.10	Remove tag from MOV-SW-101A in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ____.
________ (Ad Ops)	____	4.10.5.11	Test MOV-SW-101A in accordance with the Final Design Test Matrix. N/A this step if not required.

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DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: DC-86-10-1 (2

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE	
		4.10.6 MOV-SW-101B
______ (Ops)	____	4.10.6.1 During the time period when valve MOV-SW-101B is removed (steps 4.10.6.5 and 4.10.6.6), the intake canal level shall be maintained at elevation 24 to 25 feet to minimize the potential seismic loads on the stop logs.
______ (Ops)	____	4.10.6.2 De-energize and tag out MOV-SW-101B in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ________.
		4.10.6.3 Determinate the following cables at MOV-SW-101B.
		NOTE: Prior to determinating, field to identify all the wires of these cables to aid in the reterminating of these cables in step 4.10.6.8.
______ ______ (QC)	____ ____	1J6PL146
______ ______ (QC)	____ ____	1J6PL147
______	____	4.10.6.4 Remove Limitorque operator from valve MOV-SW-101B
______	____	4.10.6.5 Remove valve MOV-SW-101B and rubber expansion joint REJ-8.
______ ______ (QC)	____ ____	4.10.6.6 Install Replacement valve MOV-SW-101B and rubber expansion joint REJ-8.

FINAL DRAFT

SIGNATURE	DATE		
________	____	4.10.6.7	Install Limitorque operator on valve MOV-SW-101B. Torque the 3/4 inch mounting cap screws to 175 ft-lbs (dry) or 130 ft-lbs (lubricated).
________ (QC)	____		
		4.10.6.8	Reterminate the following cables which were determinated in step 4.10.6.3.
________	____		1J6PL146
________ (QC)	____		
________	____		1J6PL147
________ (QC)	____		
________ (Ad Ops)	____	4.10.6.9	Test MOV-SW-101B in accordance with the Final Design Test Matrix. N/A this step if not required.
________ (Ops)	____	4.10.6.10	Remove tag from MOV-SW-101B in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ______.
________ (Ad Ops)	____	4.10.6.11	Test MOV-SW-101B in accordance with the Final Design Test Matrix. N/A this step if not required.
		4.10.7	Replace Valve 1-SW-27
________	____	4.10.7.1	Verify valve 1-SW-25 is closed.
________	____	4.10.7.2	Remove valve 1-SW-27 and rubber expansion joint REJ-6.
________	____	4.10.7.3	Install replacement valve 1-SW-27 and rubber expansion joint REJ-6.
________ (QC)	____		

FINAL DRAFT

SIGNATURE	DATE	
________ (Ad Ops)	____	4.10.7.4 Test 1-SW-27 in accordance with the Final Design Test Matrix. N/A this step if not required.
		4.10.8 Replace valve 1-SW-31
________	____	4.10.8.1 Verify valve 1-SW-29 is closed.
________	____	4.10.8.2 Remove valve 1-SW-31 and rubber expansion joint REJ-6.
________ ________ (QC)	____ ____	4.10.8.3 Install replacement valve 1-SW-31 and rubber expansion joint REJ-6.
________ (Ad Ops)	____	4.10.8.4 Test 1-SW-31 in accordance with the Final Design Test Matrix. N/A this step if not required.

4.11 Valve Replacement Phase II

NOTES:

1. This phase involves valve replacements while the A, B, and C waterbox lines are stop logged and drained and the discharge tunnel is drained.

2. The following valve must be replaced during this phase:

   MOV-CW-100B

3. The following valves must be replaced during this phase if not already replaced in Phase I. See Phase I for replacement instructions.

   MOV-CW-100A
   MOV-CW-100C

FINAL DRAFT

SIGNATURE	DATE	
		MOV-SW-101A MOV-SW-101B 1-SW-27 1-SW-31
		4. The valve replacements in this phase can be accomplished in any order.
		4.11.1 Remove D Stop Log
________ (Ops)	____	4.11.1.1 Close, de-energize, and tag out valve MOV-CW-100D in accordance with Administrative Procedure SUADM-0-13. Tag Report No.__________
________	____	4.11.1.2 Remove stop log from line 96"-WC-4-10, and notify operations when stop log is removed.
________ (Ops)	____	4.11.2 Remove tags from the following valves in accordance with Administrative Procedure SUADM-0-13. Tag Report No. MOV-SW-102B __________ 1-SW-495 __________
________ (Ops)	____	4.11.3 Open the following valves to provide service water flow to the CCW heat exchangers and the charging pump service water system MOV-SW-102B 1-SW-495
________ (Ops)	____	4.11.4 Close, de-energize, and tag out MOV-SW-102A in accordance with Administrative Procedure SUADM-0-13. Tag Report No.__________

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DESIGN CHANGE NO.: (2
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FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________ (Ops)	____	4.11.5	Close and tag out valve 1-SW-11 in accordance with Administrative Procedure SUADM-0-13. Tag Report No.__________
		4.11.6	Install B Stop Log
________	____	4.11.6.1	Place stop logs in the high level intake structure inlet to 96 inch circulating water line 96"-WC-2-10 (B waterbox), notify operations when stop log is installed, and drain line 96"-WC-2-10.
		NOTE:	Prior to installing this stop log, the "D" waterbox stop log must be removed so that a service water supply exists to the component cooling heat exchangers and the charging pump service water system.
________	____	4.11.6.2	Upon dewatering, perform an inspection of the stop log supports (trash rack supports) to ensure no structural degradation exists.
		4.11.7	MOV-CW-100B
________ (Ops)	____	4.11.7.1	De-energize and tag out MOV-CW-100B in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ________.
		4.11.7.2	Determinate the following cables at MOV-CW-100B.
		NOTE:	Prior to determinating, field to identify all the wires of these cables to aid in the reterminating of these cables in step 4.11.7.8.
________	____		1H6PL145
________ (QC)	____		

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DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: DC-86-10-1 (2

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
______ (QC)	____		1H6PL146
______	____	4.11.7.3	Remove Limitorque operator from valve MOV-CW-100B
(Security)	____	4.11.7.4	Security personnel shall be present at the worksite prior to removing the butterfly valve and expansion joint. Security shall remain at the worksite until the replacement valve and expansion joint are installed or a blind flange is installed at the 96 inch pipe. If a blind flange is installed, security should be present during its removal.
______	____	4.11.7.5	Remove valve MOV-CW-100B and rubber expansion joint REJ-4. Provide support for the Amertap barrel as required.
______ (QC)	____	4.11.7.6	Install Replacement valve MOV-CW-100B and rubber expansion joint REJ-4.
______ (QC)	____	4.11.7.7	Install Limitorque operator on valve MOV-CW-100B. Torque the 1¼ inch mounting cap screws to 500 ft-lb (dry) or 380 ft-lb (lubricated).
		4.11.7.8	Reterminate the following cables which were determinated in step 4.11.7.2.
______ (QC)	____		1H6PL145

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DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE	
______	____	1H6PL146
______ (QC)	____	
______ (Ad Ops)	____	4.11.7.9 Test MOV-CW-100B in accordance with the Final Design Test Matrix. N/A this step if not required.
______ (Ops)	____	4.11.7.10 Remove tag from MOV-CW-100B in accordance with Administrative Procedure SUADM-0-13. Tag Report No. ________.
______ (Ad Ops)	____	4.11.7.11 Test MOV-CW-100B in accordance with the Final Design Test Matrix. N/A this step if not required.
______ (Ops)	____	4.11.7.12 Remove tags from the following valves in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
MOV-SW-102A	________
1-SW-11	________

4.12 Valve Replacement Phase III

NOTES:

1. This phase involves replacing valves while the CCW heat exchanger discharge is directed to the Uint 1 discharge tunnel.
2. The following valves must be replaced during this phase.

   1-SW-35
   1-SW-39

3. The valve replacements in this phase can be accomplished in any order.

FINAL DRAFT

DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE	
		4.12.1 Removal of Temporary Sump
______ (HP)	______	4.12.1.1 Remove temporary sump for line 8"-WBTD-2-WI from the discharge tunnel under the direction of Health Physics.
______ (HP)	______	4.12.1.2 Remove submersible pumps and discharge hoses from the discharge tunnel under the direction of Health Physics.
______	______	4.12.1.3 Verify that all miscellaneous equipment and tools have been removed from the discharge tunnel.
		4.12.2 Replace Valves 1-SW-35 and 1-SW-39
		NOTE: These valves will be replaced while a limited amount of service water flows through the Unit 1 discharge tunnel. The flow will be the CCW heat exchanger discharge. If more than this flow is established turbine building flooding might occur while valves 1-SW-35 and 1-SW-39 are being replaced due to service water back pressure from the discharge tunnel.
______ (Ops)	______	4.12.2.1 Close de-energize and tag out the following valves in accordance with Administrative Procedure SUADM-0-13.

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	Tag Report No.
MOV-CW-100A	______
MOV-CW-100B	______
MOV-CW-100C	______

DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE	
________ (Ops)	____	4.12.2.2 Establish service water flow through CCW heat exchangers 1-CC-E-1C and/or 1-CC-E-1D by tagging in and opening isolation valves in accordance with Administrative Procedure SUADM-0-13. Tag Report No. 1-CC-E-1C ________ 1-CC-E-1D ________ NOTE: As these heat exchanges are put into service the Unit 1 discharge tunnel will fill.
________ (Ops)	____	4.12.2.3 Close the following valves 1-SW-33 1-SW-37
________ (Ops)	____	4.12.2.4 Tag out the following valves in accordance with Administrative Procedure SUADM-0-13. Tag Report No. 1-SW-33 ________ 1-SW-37 ________
________	FINAL DRAFT	4.12.2.5 Remove valve 1-SW-35 and expansion joint REJ-6.
________ ________ (QC)	____ ____	4.12.2.6 Install replacement valve 1-SW-35 and expansion joint REJ-6.
________	____	4.12.2.7 Remove valve 1-SW-39 and expansion joint REJ-6.
________ ________ (QC)	____ ____	4.12.2.8 Install replacement valve 1-SW-39 and expansion joint REJ-6.

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1	DESIGN CHANGE NO.: (2 DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________	____	4.12.2.9	Remove the two 24 inch expansion joints in the 24 inch temporary discharge line downstream of the 30" x 24" tees for heat exchangers 1-CC-E-1A and 1-CC-E-1B.
________	____	4.12.2.10	Install 24 inch blind flange on the 30" x 24" tees on the discharge of CCW Heat Exchangers 1-CC-E-1A and 1-CC-E-1B.
________ (Ad Ops)	____	4.12.2.11	Test valves 1-SW-35 and 1-SW-39 in accordance with the Final Design Test Matrix. N/A this step if not required.
________ (Ad Ops)	____	4.12.2.12	Leak test the restored blind flange joints on the discharge of CCW Heat Exchangers 1-CC-E-1A and 1-CC-E-1B.
________ (Ops)	____	4.12.2.13	Remove tags from the following valves in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-33	____________
1-SW-37	____________

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4.13 Flow Restoration

NOTE: Following accomplishment of Phase III (step 4.12) flow restoration per this phase can be accomplished. Steps 4.13.2, 4.13.3, 4.13.4, and 4.13.5 can be accomplished in any sequence, but must follow step 4.13.1. See also step 4.15 for removal of the temporary 24 inch line.

SIGNATURE DATE

4.13.1 Restore Waterboxes A,B,C,D

______ ___ 4.13.1.1 Replace manway covers on all four of the condenser waterboxes and on the yard manway south of the vacuum priming house.

______ ___ (Ops) 4.13.1.2 Return condenser waterboxes A, B, C, and D to service in accordance with 1-MOP-48.2, 1-MOP-48.4, 1-MOP-48.6, and 1-MOP-48.8.

NOTE: These procedures will remove tags from the 96 inch inlet/outlet valves and position the valves as required for operations.

______ ___ (Ops) 4.13.1.3 Return discharge tunnel vacuum priming system to service in accordance with OP-48.4.

4.13.2 Stop Log and Circulating Water Blank Removal

4.13.2.1 Remove the 96 inch blanks from the high level intake structure upstream of the following circulating water lines and notify operations when the blanks have been removed:

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______ ___ 96"-WC-1-10 (A Waterbox)

______ ___ 96"-WC-3-10 (C Waterbox)

4.13.2.2 Remove stop logs at the high level intake structure upstream of the following circulating water lines and notify operations when the stop logs have been removed:

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: (2
DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE	
________	____	96"-WC-1-10 (A Waterbox)
________	____	96"-WC-2-10 (B Waterbox)
________	____	96"-WC-3-10 (C Waterbox)

4.13.3 Restore Flows to Unit 1 Discharge Tunnel

________ (Ops) ____ 4.13.3.1 Restore flow from line 4"-WCPD-39-301 to the Unit 1 discharge tunnel. Remove tags from isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.__________

________ (Ops) ____ 4.13.3.2 Restore flow from line 2"-WBC-121 to the Unit 1 discharge tunnel. Remove tags from isolating devices in accordance with Administrative Procedure SUADM-0-13.
Tag Report No.__________

________ (Ops) ____ 4.13.3.3 Restore flow from line 2"-WHD-121 to the Unit 1 discharge tunnel. Remove tags from isolating devices in accordance with Administrative Procedure SUADM-0-13.
Tag Report No.__________

________ (Ops) ____ 4.13.3.4 Restore flow from line 2"-DA-151 to the Unit 1 discharge tunnel. Remove tags from isolating devices in accordance with Administrative Procedure SUADM-0-13.
Tag Report No.__________

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DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________ (Ops)	____	4.13.3.5	Restore flow from line 3"-WCW-1-136 to the Unit 1 discharge tunnel. Remove tags from isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________
________ (Ops)	____	4.13.3.6	Restore flow from line 3"-WGCB-120-151 and 3"-WGCB-121-151 to the Unit 1 condenser water boxes. Remove tags from isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.________.
________ (Ops)	____	4.13.3.7	Restore flow to the Unit 1 discharge tunnel from the component cooling service water radiation monitoring system. Remove tags and mechanically reinstate the pumps listed below, in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-P-6A	________
1-SW-P-6B	________
1-SW-P-6C	________
1-SW-P-6D	________

________ (Ops)	____	4.13.3.8	Restore service water flow from the bearing cooling water heat exchangers to the Unit 1 discharge tunnel, line 42"-WS-11-10. Remove tags from all

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DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: DC-86-10-1 (2

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
			isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.__________.
________ (Ops)	____	4.13.3.9	Restore service water flow from the recirculation spray heat exchangers to the Unit 1 discharge tunnel, lines 30"-WS-37-10 and 30"-WS-38-10. Remove tags from all isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.__________.
________ (Ops)	____	4.13.3.10	Restore flow from condensate polisher waste to Unit 1 discharge tunnel, line 8"-CP-392-136. Remove tags from isolating devices in accordance with Administrative Procedure SUADM-0-13. Tag Report No.__________.

4.13.4 <u>Restoration of control and relay air-conditioning condenser service water return to the Unit 1 discharge tunnel</u>

SIGNATURE	DATE		
________ (Ops)	____	4.13.4.1	De-energize the equipment listed below and tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13.

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	Tag Report No.
1-VS-E-4A	__________
1-VS-P-1A	__________

DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1	DESIGN CHANGE NO.: DC-86-10-1 (2

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
______ (Ops)	____	4.13.4.2	Tag out the valves listed below .in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-347	______
1-SW-346	______
1-SW-314	______

______	____	4.13.4.3	Remove blank flange and remake the flanged joint in line 3"-WS-326-9107.
______ (Ad Ops)	____	4.13.4.4	Leak test the restored flange joint in accordance with the Final Design Test Matrix. N/A this step if not required.
______ (Ops)	____	4.13.4.5	Remove tags from the equipment below in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-314	______
1-SW-347	______
1-SW-346	______
1-VS-E-4A	______
1-VS-P-1A	______

______ (Ops)	____	4.13.4.6	Mechanically re-instate the equipment listed below in accordance with Administrative Procedure SUADM-0-13.

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DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1	DESIGN CHANGE NO.: DC-86-10-1 (2

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE			
				Tag Report No.
			1-VS-E-4A	________
			1-VS-P-1A	________
________ (Ops)	____	4.13.4.7	Verify operability of the control and relay room air conditioning system.	
		4.13.5	<u>Restoration of containment cooling service water to the Unit 1 discharge tunnel</u>	
________ (Ops)	____	4.13.5.1	De-energize the equipment listed below and tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13.	
				Tag Report No.
			1-SW-P-13A	________
			1-SW-P-13B	________
			1-CD-REF-1A	________
			1-CD-REF-1B	________
________ (Ops)	____	4.13.5.2	Mechanically isolate the equipment listed below and tag out all isolating devices in accordance with Administrative Procedure SUADM-0-13.	
				Tag Report No.
			1-SW-P-13A	________
			1-SW-P-13B	________
			1-CD-REF-1A	________
			1-CD-REF-1B	________
________ (Ops)	____	4.13.5.3	Tag out valve 1-CP-465 in accordance with Administrative Procedure SUADM-0-13.	

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DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1	DESIGN CHANGE NO.: DC-86-10-1 (2

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE		
________ (Ops)	____	4.13.5.4	Isolate flow through line 4"-WS-67-136. Make necessary valve lineups to ensure that satisfactory operation of the vacuum priming system is maintained.
________	____	4.13.5.5	Remove blank flange and remake the flanged joint in line 10"-WS-104-136.
________ (Ad Ops)	____	4.13.5.6	Leak test the restored flange joint in accordance with the Final Design Test Matrix. N/A this step if not required.
________ (Ops)	____	4.13.5.7	Remove tags from the equipment listed below in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-P-13A	________
1-SW-P-13B	________
1-CD-REF-1A	________
1-CD-REF-1B	________
1-CP-465	________

SIGNATURE	DATE		
________ (Ops)	____	4.13.5.8	Mechanically re-instate the equipment listed below in accordance with Administrative Procedure SUADM-0-13.

	Tag Report No.
1-SW-P-13A	________
1-SW-P-13B	________
1-CD-REF-1A	________
1-CD-REF-1B	________

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DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: (2
DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE	
______ (Ops)	____	4.13.5.9 Restore flow through line 4"-WS-67-136. Ensure valve lineup for the vacuum priming is returned to normal.
______ (Ops)	____	4.13.5.10 Verify the operability of the containment cooling service water system.
______ (Ops)	____	4.13.5.11 Perform a valve lineup to restore service water discharge from 1-CD-REF-1A and 1B as directed by Operations.

4.14 Functional Valve Testing

NOTES:

1) Following valve replacement and establishing CCW heat exchanger flow to the Unit 1 discharge tunnel, the 30 inch valves can be functionally tested per step 4.14.1.

2) Following stop log/96 inch blank removal and establishment of circulating water flow to the Unit 1 discharge tunnel, the 36" and 96" valves can be functionally tested per steps 4.14.2 and 4.14.3.

3) Valve tests may be conducted in any sequence.

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SIGNATURE	DATE	
______ (Ad Ops)	____	4.14.1 Perform a functional test of the following 30" valves to ensure proper "wet" operation. Testing shall be in accordance with the Final Design Test Matrix.

1-SW-27
1-SW-31
1-SW-35
1-SW-39

DESIGN CHANGE TITLE / STATION / UNIT: (1	DESIGN CHANGE NO.: (2
SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1	DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE	
________ (Ad Ops)	___	4.14.2 Perform a functional test of the following 36" valves to ensure proper "wet" operation. Testing shall be in accordance with the Final Design Test Matrix and test procedures PT 25.1 and PT 18.10P. MOV-SW-101A MOV-SW-101B
________ (Ad Ops)	___	4.14.3 Perform a functional test of the following 96" valves to ensure proper "wet" operation. Testing shall be in accordance with the Final Design Test Matrix and test procedures PT 25.1 and PT 18.10P. MOV-CW-106A MOV-CW-106B MOV-CW-106C MOV-CW-106D
		4.15 <u>Removal of Temporary 24 Inch Service Water Discharge Line</u> <u>NOTE</u>: Removal of the 24 inch temporary line can be accomplished any time after step 4.12 has been completed.
________ (Ops)	___	4.15.1 Drain and flush the 24 inch temporary line.
		4.15.2 <u>Removal of Temporary Line At Unit 2 "A" Condenser Outlet Waterbox</u>
________ (Ops)	___	4.15.2.1 Remove Unit 2 "A" condenser waterbox from service in accordance with Maintenance Operating Procedure 2-MOP-48-1.
________	___	4.15.2.2 Remove the expansion joint and piping that tie into the condenser manway.

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DESIGN CHANGE TITLE / STATION / UNIT: SERVICE WATER AND CIRCULATING WATER BUTTERFLY VALVE REPLACEMENT/SURRY/1 (1

DESIGN CHANGE NO.: (2 DC-86-10-1

FINAL DESIGN CONTROLLING PROCEDURE (SUPPLEMENT): (13

SIGNATURE	DATE	
________ (Ops)	____	4.15.2.3 Return Unit 2 "A" condenser waterbox to service in accordance with Maintenance Operating Procedure 2-MOP-48.2.
________	____	4.15.3 Remove the 24 inch temporary line from the Unit 1 and Unit 2 turbine building except for the section of piping which penetrates the wall.
________	____	4.15.4 Install blind flanges at each end of the remaining pipe at the Unit 1 and Unit 2 turbine building wall.
________ (Ops)	____	4.16 Testing complete. System has been released to Operations.
________ (Sta Eng)	____	4.17 Complete ASME Repair/Replacement follower as required by Administrative Procedure SUADM-M-27.
________ (Const Eng)	____	4.18 Complete "Form NIS-2 Owners Report of Repair or Replacement."
________ (Sta Shift Supv)	____	4.19 Notify Station Shift Supervisor that work on this procedure is complete.

Completed by: ____________
Date: ____________

5.0 REVIEW

________ (Engineering)	____	5.1 Engineering shall review this procedure to ensure that each step has been satisfactorily completed.

FINAL DRAFT

CONTROLLED
JAN 21 1988
E&C Records Management
Richmond, Virginia

Specification No.: NUS-2076
Date ________

ADDENDUM NO. 2 TO
SPECIFICATION FOR
RUBBER EXPANSION JOINTS
FOR SERVICE WATER AND CIRCULATING WATER SYSTEMS
SURRY POWER STATION
UNITS 1 AND 2

Rev. 0

Preparer	
W McCloskey	12-9-87
Reviewer	
[signature]	12/14/87
Quality Assurance	
R. Scheffer	12/18/87
Approved	
[signature]	12/18/87

FINAL DRAFT

VIRGINIA POWER

NUCLEAR SAFETY RELATED

6615-1575202-B1V

Specification No.: NUS-2076
Date: December 16, 1987

Addendum No. 2 to
Specification for

RUBBER EXPANSION JOINTS
FOR SERVICE WATER AND CIRCULATING WATER SYSTEMS

Holz Rubber Co.

Surry Power Station
Virginia Power

APPROVED

	Signature	Date
Preparer	W McCloskey	12-9-87
Lead Engr	[illegible]	12/14/87
Specialist	J E Coughlin	12-9-87
Proj Engr	[illegible]	12/16/87
Qual Assur	NA	
Matls Engr	NA	
EMD	NA	
Indep Reviewer	J E Coughlin	12-9-87
Const Dept	NA	
Env Engr	NA	

FINAL DRAFT

Stone & Webster Engineering Corporation
Boston, Massachusetts
QA Category I

6615-1575202-B1V

Specification No.: NUS-2076
Date 4/20/87

ADDENDUM NO. 1 TO SPECIFICATION FOR RUBBER EXPANSION JOINTS FOR SERVICE WATER AND CIRCULATING WATER SYSTEMS SURRY POWER STATION UNITS 1 AND 2

	Rev. 0	Rev. 1	Rev. 2
Preparer W McCloskey	4-10-87		
Reviewer J M Nicholson	4-13-87		
Quality Assurance R. Schaffer	4-20-87		
Approved MWH T B Sowers	4-20-87		

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APR 27 1987
C&C Records Manageme...

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VIRGINIA POWER

NUCLEAR SAFETY RELATED

6615-1575202-B1V

Specification No.: NUS-2076

April 14, 1987

Addendum No. 1 to
Specification for

RUBBER EXPANSION JOINTS FOR SERVICE WATER AND CIRCULATING WATER SYSTEMS

Surry Power Station
Virginia Power

APPROVED

	Signature	Date
Preparer	[signature]	4-14-87
Lead Engr	[signature]	4-14-87
Specialist	[signature]	4-14-87
Proj Engr	[signature]	4-14-87
Qual Assur	NR	—
Matls Engr	NR	—
EMD	NR	—
Indep Reviewer	[signature]	4-14-87
Const Dept	NR	—
Env Engr	NR	—

FINAL DRAFT

QA Category I

NOTE: Sections marked with an asterisk (*) were prepared by Virginia Power

6615-1575202-B1V

INSTRUCTION/CHANGE PAGE

The following information summarizes the changes to the specification as a result of this addendum No. 2 to the original issue of NUS-2076.

Each change to the specification has been incorporated into the specification on the replacement pages attached hereto. The changes are identified by marking in the right hand margin of each page, a vertical line and addendum number.

The replacement pages attached to this addendum shall be inserted into the specification and the replaced pages discarded. The addendum title page and this INSTRUCTION/CHANGE PAGE shall be filed in front of the specification title page.

Affected Page	Insert Attached Page	Reason for Change
B-3, B-5 B-7, B-9	B-3, B-5 B-7, B-9	Changed the design temperature from 240°F to 180°F due to a clarification from the vendor.
Quality Assurance Inspection Report sheet	same	Revised to document that up to 100% of the expansion joint tests will be witnessed, and the dimension checks performed.

FINAL DRAFT

INSTRUCTION/CHANGE PAGE

The following information summarizes the changes to the specification as a result of this addendum No. 1

Each change to the specification has been incorporated into the specification on the replacement pages attached hereto. The changes are identified by marking in the right hand margin of each page, a vertical line and addendum number.

The replacement pages attached to this addendum shall be inserted into the specification and the replaced pages discarded. The addendum title page and this INSTRUCTION/CHANGE PAGE shall be filed in front of the specification title page.

Affected Page	Insert Attached Page	Reason for Change
Table of Contents Sheet 2	Table of Contents Sheet 2	Deleted the word 'Bidder' from the technical data sheets.
2-1	2-1 2-1a	Added the following to the temperature section of paragraph 2.2.2 "This temperature is the surrounding environmental condition and not the internal fluid temperature." This clarifies that the accident temperature excursion is not the fluid temperature but the surrounding air temperature.
3-2	3-2	Deleted "quality class 3" from the shipping label as this designation is no longer used by Virginia Power.
6-3	6-3	Changed Virginia Power address to Innsbrook.
6-3	6-3 6-4	Added paragraph 6.4.2 to clarify 10CFR21 requirements.
A-2 through A-9	A-2 through A-5	Revised the design data sheets to delete the mechanical requirements of the expansion joints, as the actual mechanical properties will be included in the technical data sheets of Appendix B.

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Affected Page	Insert Attached Page	Reason for Change
B-1 and B-3 through B-10	B-1 and B-3 through B-10	Revised the Technical Data Sheets to include Vendor information.
D-2	D-2 D-2a	Changed paragraph D.1.1 and added paragraphs D.1.1.1 through D.1.1.4 to clarify 10CFR50 Appendix B requirements.
D-4	D-4	Changed Virginia Power address to Innsbrook.

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Specification No.: NUS-2076
Date 11/14/86

SPECIFICATION FOR
RUBBER EXPANSION JOINTS
FOR SERVICE WATER AND CIRCULATING WATER SYSTEMS
SURRY POWER STATION
UNITS 1 AND 2

Rev. 0 Rev. 1 Rev. 2

Preparer	W. McCloskey	11-3-86
Reviewer	N. E. Hanley	11-4-86
Quality Assurance	R. Schaffer	11-10-86
Approved	JLA MGDeacon	11-14-86

CONTROLLED
NOV 18 1986
E&C Records Management
Richmond, Virginia

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VIRGINIA ELECTRIC AND POWER COMPANY

NUCLEAR SAFETY RELATED
QUALITY CLASS 3

Specification for

RUBBER EXPANSION JOINTS
FOR SERVICE WATER AND CIRCULATING WATER SYSTEMS

Surry Power Station
Virginia Power

APPROVED

	Signature	Date
Preparer	W McCloskey	11-3-86
Lead Engr	[illegible]	11-
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Proj Engr	[illegible]	11-4-86
Qual Assur	N.A.	
Matls Engr	R.L. [illegible]	11-3-86
EMD	[illegible] for GPM	11-4-86

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QA Category I

Note: Sections marked with an asterisk (*) were prepared by Virginia Power

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1.1 Scope 1.11

This specification details the technical and quality assurance 1.12
requirements for the materials, fabrication, testing, inspection, 1.13
documentation, and shipment of rubber expansion joints for service in a nuclear power plant.

The expansion joints shall be installed in the circulating and service 1.14
water systems at Surry Nuclear Power Station, Units 1 and 2. The new 1.16
expansion joints will replace the following existing expansion joints:

Eight (8) - 96 in. condenser inlet expansion joints. 1.18

Eight (8) - 96 in. condenser outlet expansion joints. 1.19

Eight (8) - 30 in. component cooling water heat exchanger inlet and 1.20
outlet expansion joints.

Four (4) - 36 in. service water supply to bearing cooling water heat 1.21
exchanger expansion joints.

Two (2) - 42 in. service water supply to component cooling water 1.22
heat exchanger expansion joints.

Two (2) - 10 in. service water pump suction expansion joints. 1.23

In addition to the above expansion joints, this specification also 1.25
includes a temporary expansion joint (herein referred to as Temp Exp 1.26
JT-1). There are three (3) of these expansion joints, they are 30 in. 1.27
and are used in a line which provides a temporary service water supply 1.28
to component cooling water heat exchangers. 1.29

1.2 Project Description 1.31

The Surry Power Station, Unit Nos. 1 and 2 each have a pressurized water 1.32
reactor and turbine-generator unit nominally rated 822 megawatts gross 1.33
electrical. The facility is located in Surry County, Virginia, on a 1.35
point of land called Gravel Neck which juts into the James River. The 1.37
site comprises about 840 acres south of and adjacent to the Hog Island
State Waterfowl Refuge and is bordered by the James River on either side 1.38
of the peninsula. The coordinates are approximately 76° 42' W and 37° 1.39
10' N. The City of Richmond is about 47 miles NW of the site. The base 1.41
elevation of the site is about 26 ft based on the USGS datum.

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The site is accessible by truck and barge. There is no rail service to 1.43
the site. The station is located at the end of State Route 650 which is 1.44
approximately six (6) miles from its intersection with State Route 10. 1.45
A dock is located on the James River approximately 1.5 miles from the 1.46
main station building and is serviced by a gravel road suitable for 1.47
heavy transport. The dock is accessible from the James River channel by 1.48
low draft water craft.

1.3 Definitions 1.50

To aid in the uniform and consistent interpretation of the 1.51
specification, certain key words are defined herein. Words not included 1.53
in this section will be assumed to retain their common definition.

Various terms used herein are defined as follows: 1.54

Virginia Power - Refers to Virginia Electric and Power Company. 1.56

Bidder - A company submitting a proposal to fulfill the requirements 1.57
of this specification.

Seller - The successful Bidder for equipment as covered in this 1.58
specification (i.e., the firm to whom a contract has been awarded by 1.59
Virginia Electric and Power Company for the subject equipment).

Others - Any other vendor, contractor, architect engineer, etc, 1.60
other than the Seller herein defined.

Preliminary Drawings - Drawings issued by the Seller which have no 2.1
final approval, or certification, but on which Virginia Power/AE is 2.2
proceeding on preliminary engineering.

Certified Drawings - Drawings prepared by the Seller with all 2.3
details completed and checked in such a way that the drawing would 2.4
require no changes prior to being released for construction unless
necessitated by interface requirements of Virginia Power/AE. 2.5

Approved with Corrections as Noted, Drawings - Certified drawings 2.6
issued by the Seller which have been reviewed and commented upon by 2.7
Virginia Power/AE, but which require corrections by the Seller,
prior to his reissuance of the drawings in a form suitable for 2.8
approval by Virginia Power/AE.

Approved Drawing - Certified drawings which have been issued by the 2.9
Seller, which have been reviewed by Virginia Power/AE and with which 2.10
Virginia Power/AE has taken no exception, and has so indicated, in
order that the Seller can proceed to issue the drawings in final 2.11
certified form.

Certified Engineering Data - Engineering data in fixed and finalized 2.12
form issued by the Seller, such that Virginia Power can proceed on 2.13
design, procurement, or commitments, for auxiliary equipment, bids
for erection, or other such purpose. FINAL DRAFT 2.14

Field Service Engineer - The Seller's construction-oriented employee 2.15
who advised Virginia Power/AE and his erection contractor on 2.16
installation of equipment supplied by the Seller.

Virginia Power's Shop Inspector - Virginia Power's employee assigned 2.17
to perform various inspections in the shops of the Seller, or in the 2.19
shops of the Seller's subcontractors, to ensure that quality,

standards, and criteria, as stated in this specification, are 2.20
complied with.

Architectural Engineer (AE) - Virginia Power's architectural/ 2.21
engineering firm who provides engineering services as specified by 2.22
Virginia Power under a separate scope of supply.

Subsupplier - Any firm retained by the Seller to provide materials, 2.23
equipment and/or services relating to the fulfillment of the 2.24
requirements of this specification.

Engineers - Virginia Power Engineering personnel and/or contracted 2.25
Architectural Engineer personnel.

Verify - The act of checking from evidence or documentation. 2.26
Surveillance inspection techniques will be used to assure adequate 2.27
fabricaton and testing where inspection documentation is not a 2.28
requirement.

Witness - The presence of a Virginia Power representative at any 2.29
point in the manufacturing, fabrication, or test processes. His 2.31
observations are documented as an inspection record.

Perform - Act of the actual execution of an activity to assure 2.32
conformance with the specified requirement.

Certificate of Conformance - A signed statement attesting that the 2.33
items or services are in accordance with specified requirements and 2.34
accompanied by additional information as stipulated by the purchase
order to substantiate the statement. 2.35

1.4 Referenced Documents, Codes, and Standards 2.38

To the extent specified herein, the version and full identity of all 2.39
codes, standards, and other documents applicable to this specification 2.40
are shown below. A later version of some of the dated documents may 2.42
become mandatory under regulations that have jurisdiction. If this 2.43
develops, the newer version of each document will be identified by means
of a revision to the specification.

If there is a conflict between this specification and a referenced 2.44
document, the matter shall be referred to Virginia Power who will 2.45
clarify the matter in writing.

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The documents mentioned herein are as follows: 2.47

American National Standards Institute 2.49

ANSI B16.1	1975	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800	2.52 2.53
ANSI B16.5	1981	Pipe Flanges and Flanged Fittings	2.56
ANSI B31.1	1967	Power Piping	2.58

ANSI N45.2	1980	Requirements for Quality Assurance Program for Nuclear Power Plants
ANSI N45.2.1	1980	Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants
ANSI N45.2.2	1978	Packaging, Shipping, Receiving, and Handling of Items for Nuclear Plants
		<u>American Society for Testing and Materials</u>
ASTM A123	1984	Zinc (Hot-Galvanizing) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
		<u>Occupational Safety and Health Administration</u>
OSHA	Standard	Subpart G., Subsection 1910.95 - Occupational Noise Exposure
		<u>U.S. Nuclear Regulatory Commission</u>
10CFR50 Appendix B	1970	Code of Federal Regulations Quality Assurance Criteria
10CFR21	1985	Reports to the Commission Concerning Defects and Noncompliance
RG 1.37	1973	Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants
RG 1.38	1977	Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage, and Handling of Items Water-Cooled Power Plants

1.5 <u>Equipment and Services to be Furnished by Seller</u>
(See also Section 6.2)

The Seller shall furnish the following:

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1. Sixteen (16) - 96 in. concentric spool type rubber expansion joints with galvanized retaining rings.

2. Two (2) - 42 in. concentric spool type rubber expansion joints with galvanized retaining rings.

3. Four (4) - 36 in. concentric spool type rubber expansion joints with galvanized retaining rings.

4. Eight (8) - 30 in. concentric spool type rubber expansion joints with galvanized retaining rings. 4.7

5. Two (2) - 10 in. concentric spool type rubber expansion joints with galvanized retaining rings. 4.8

6. Three (3) - 30 in. "temporary" concentric spool type rubber expansion joints with galvanized retaining rings. 4.9

7. Documentation as required by this specification. 4.10

8. Certificate of Conformance for all equipment furnished under this specification. 4.11

9. Shipping, F.O.B. jobsite and all shipping and storage supports and coverings. 4.12

10. Certified drawings of the equipment furnished under this specification. 4.13

11. Operation and Maintenance Manuals. 4.14

1.6 <u>Equipment and Services to be Furnished by Virginia Power</u> 4.17

Virginia Power will furnish the following: 4.18

1. Off-loading and storage at the jobsite. 4.20

2. Installation of the equipment. 4.22

3. All connecting piping and required supports. 4.23

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2.0 TECHNICAL REQUIREMENTS

2.1 Function

The expansion joints will be used to allow thermal movements in the circulating water and service water piping. The expansion joints are nuclear safety related components.

2.2 Conditions of Service

2.2.1 The 96 inch expansion joints will be installed in the circulating water system. The 42 inch, 30 inch, and 10 inch expansion joints will be installed in the service water system. The fluid medium for all the expansion joints will be untreated brackish river water. The water chemistry is shown in Appendix C.

2.2.2 All expansion joints will be located in valve pits or on the ground floor of each unit's turbine building. The environmental conditions in these areas will be as follows:

	Normal	Accident
Temperature*	70-120 F	310F: 0-30 min. 310F - 130F: 30-60 min.
Pressure	14.7 psia	15.0 psia: 0-3500 sec. 15.0 psia - 14.7 psia: 3500-3600 sec.
Relative Humidity:	30-100%	100%
Radiation (total integrated 40 year dose)	260R	2500R

Add

The Seller shall provide a Certificate of Conformance that the expansion joints will be suitable for service in the environmental conditions above.

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* This temperature is the surrounding environmental condition and not the internal fluid temperatures.

Add

2.2.3 The system design and operating parameters for the expansion joints are shown in Appendix A.

2.3 Material Requirements

2.3.1 Materials shall be in accordance with ASTM requirements and supplementary requirements identified in this section. Materials not specified shall be suitable for the intended service condition.

2.3.2 Certifications shall be submitted to allow traceability of each expansion joint back to the manufacturer and date made 2.10 2.11

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as well as the order number of the rubber as each expansion joint is manufactured.

2.3.3 Certified material test reports shall be submitted for the retaining ring as part of the verification documentation.

2.3.4 The expansion joints shall be constructed of natural or synthetic rubber material and shall be reinforced with steel American Iron and Steel Institute (AISI) Alloy C1018 body rings. Reference to "rubber" expansion joints includes either natural or synthetic rubber compounds as recommended by the Seller to result in quality construction for the service intended.

2.3.5 The expansion joints shall be designed and constructed to prevent electrolytic corrosion of the expansion joint and the Purchasers equipment.

2.3.6 Products which contain asbestos are prohibited. This prohibition includes items such as packings or gaskets even though the item is encapsulated or the asbestos fibers are impregnated with binder material.

2.4 Fabrication

2.4.1 General

2.4.1.1 It is the intent of this specification that all components be of proven, dependable, long life design.

2.4.1.2 The Seller shall furnish equipment capable of continuous satisfactory operation at the design conditions specified herein by Virginia Power. The Seller's equipment shall also be capable of fulfilling all performance requirements set forth herein.

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2.4.1.3 The expansion joints are to be designed and fabricated in accordance with the codes and standards listed in Section 1.4 and with all other provisions of this specification.

2.4.1.4 Workmanship shall be first-class and shall be done by workmen skilled in their various trades. Tolerances, fits, and finish shall conform to the best modern shop practices in the manufacture of finished products of nature similar to those covered by these specifications. Like parts shall be interchangeable insofar as practicable.

2.4.1.5 The manufacturer guarantees that the rubber expansion joints will be of good design and

workmanship and will be able to achieve safely the
movements specified within this specification. 2.43

2.4.1.6 The design and construction of all equipment shall 2.44
conform to all applicable safety laws and 2.45
regulations of the Commonwealth of Virginia, as
well as other regulatory bodies having 2.46
jurisdiction at the jobsite. All local building 2.47
codes shall be strictly adhered to. It shall be 2.48
the Seller's responsibility to ascertain the above
requirements and to assure Virginia Power that 2.49
they are being met.

2.4.1.7 Each item of manufactured equipment, furnished 2.50
under this specification shall have a permanent 2.51
nameplate affixed thereto in a readily visible
place, showing the serial number, model number, 2.52
name and address of the manufacturer, rated
conditions, and other applicable pertinent data as 2.53
defined in Section 3.5.

2.4.1.8 The equipment offered shall have a history of 2.54
satisfactory performance under similar conditions. 2.55
If not, the developmental nature of that equipment 2.56
must be stated clearly in the proposal and its 2.57
advantages itemized.

2.4.1.9 Dimensions and tolerances referenced on the 2.58
drawings are controlled and shall be maintained. 2.59
The Purchaser reserves the right to check all 3.1
dimensions at the Seller's plant prior to
shipment. 3.2

2.4.1.10 All pieces of equipment supplied by the Seller 3.3
must be capable of being erected and installed 3.4
without field modification in dimensions. All 3.5
pieces should be marked and should be clearly
noted in the erection drawings and erection 3.6
procedures.

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2.4.2 <u>Technical Requirements - Mechanical</u> 3.9

2.4.2.1 The expansion joints furnished under this 3.11
specification shall be in accordance with the
applicable requirements of ANSI B31.1 and this 3.12
specification.

2.4.2.2 The expansion joints shall be designed for the 3.14
design and operating conditions listed in 3.15
Appendix A.

2.4.2.3 The expansion joints will be installed between an 3.16
in-line pipe flange and a flanged valve. These 3.18
flanges are 125 lb ANSI B16.1 flat face (sizes 3.19

30", 36", 42", and 96") and 150 lb ANSI B16.5 flat
face (size 10"). 3.20

2.4.2.4 All rubber expansion joints shall be furnished 3.21
with galvanized steel retaining rings. Sufficient 3.23
clearance shall be provided between the rubber
corrugation and retaining ring to allow for the 3.24
use of standard nuts. Bolt-holes shall be lined 3.25
so that no internal fabric is exposed. Expansion 3.26
joints shall be reinforced with steel AISI C1018
body rings. Each expansion joint shall be freshly 3.27
manufactured with no appreciable previous shelf
life. The expansion joints shall not crack, peel, 3.29
or show an evidence of deterioration throughout 3.30
the life expectancy.

2.4.2.5 The steel retaining rings shall be hot dipped 3.31
galvanized as per ASTM A123. Metal preparation 3.32
prior to hot dipping shall be in accordance with
the Seller's standard procedures. 3.33

2.4.2.6 The face to face dimensions of the expansion 3.35
joints furnished under this specification shall be 3.36
as shown below:

Line Size	Expansion Joint Length	3.39
10"	12" +1/8" -3/16"	3.41
30"	10" + 3/16" -3/16"	3.42
36"	10" +3/16" -3/16"	3.43
42"	10" +3/16" -3/16"	3.44
96"	12" +1/4" -1/4"	3.45

2.5 Technical Data Sheets 3.51

The data sheets, attached in Appendix B must be completed by the 3.53
Bidder. Upon award this data will become a part of the technical 3.55
specification and will be held as minimum requirements for the 3.56
equipment furnished.

2.6 WELDING REQUIREMENTS **FINAL DRAFT** 3.59

2.6.1 All fabrication by welding shall be done in accordance with 4.2
the requirements of ANSI B31.1 and the following paragraphs 4.3
of this section.

2.6.2 Welding Processes 4.5

2.6.2.1 The following processes are permitted. 4.3

a. Manual shielded metal arc (SMAW) 4.10

b. Gas tungsten-arc (GTAW) 4.11

c. Gas metal arc (GMAW) 4.12

2.6.3 <u>General</u> 4.16

2.6.3.1 At least two weld-layers are required on 4.18
thicknesses 1/8 to 1/4 inch on pressure retaining 4.19
components, and at least three weld-layers for
thicknesses of 1/4 inch and over. 4.20

2.6.3.2 Surfaces to be welded shall be free of moisture 4.22
prior to welding.

2.6.3.3 The root pass of single welded circumferential 4.23
butt welds accessible from one side only shall be 4.24
welded by the GTAW or GMAW process.

2.6.3.4 Peening may be used only with prior written 4.25
acceptance by the Purchaser of the method and 4.26
controls to be used. Peening of the root and 4.27
cover passes will not be permitted. The use of 4.28
pneumatic tools for slag removal is not considered
peening and is acceptable.

2.6.3.5 Welded joints shall be made by completing each 4.29
weld layer before succeeding weld layers are 4.30
deposited, unless otherwise approved for specific
application.

2.6.3.6 Prior to welding, all surfaces shall be cleaned 4.31
thoroughly by grinding, wire brushing, and/or 4.32
solvent cleaning.

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2.6.3.7 Weld cladding, hard-facing, or overlaying, if any, 4.33
will be in accordance with ANSI B31.1. 4.34

2.6.3.8 All welding procedures and changes to welding 4.35
procedures will be approved by Virginia Power 4.36
prior to use by the Seller. Obtaining procedure 4.37
approval is the responsibility of the Seller.
Initial procedure approval will be obtained in 4.38
writing from Virginia Power. Changes to 4.39
procedures which are in use may be obtained from
Virginia Power by telecommunications, if required, 4.40
and followed up with in writing.

2.6.3.9 Welding repair shall be in accordance with the 4.41
ANSI B31.1.

2.5.3.10 Preheat temperatures when recommended by the 4.42
governing code shall be considered as mandatory, 4.43
except welding may only be performed when the
metal temperature is above 50°F. 4.44

3.6.3.11 Preheat and interpass temperature shall be 4.45
determined by temperature indicating crayons, 4.46
infrared noncontact pyrometers, contact pyrometers
or other equally suitable means approved by 4.47
Virginia Power. Such devices shall meet the 4.48
requirements of USNRC Regulatory Guide 1.37 (i.e., 4.49
low sulfur, low chloride, etc.)

2.6.3.12 Preheat and interpass temperature requirements 4.50
listed above shall also apply to tack welding, 4.51
fillet welds, attachment welds, hard-surfacing,
and overlays.

2.6.3.13 Each weld shall be uniform in width and size 4.52
through its full length. In addition, the cover 4.53
pass(es) shall be free of coarse ripples, grooves,
overlaps, abrupt ridges and valleys. 4.54

2.6.3.14 Each weld layer or pass shall be visually free of 4.55
slag, inclusions, overlaps, cracks, porosity and 4.56
lack of fusion.

2.6.3.15 Elimination of defects and surface preparation of 4.57
welds by chipping, grinding or gouging shall be 4.58
done in such a manner as not to gouge, groove or
reduce the adjacent base-material thickness below 4.59
the minimum required.

2.6.3.16 Grinding of the cover pass (final weld layer) to 5.1
meet the visual criteria required by the governing 5.2
code shall not reduce the weld or base material
below the design thickness. FINAL DRAFT 5.3

2.6.3.17 Undercut shall not exceed 1/32 inch, and shall not 5.4
encroach upon the required section thickness. 5.5

2.6.3.18 Butt welds shall be flush with the base metal or 5.6
have uniform crowns.

2.6.3.19 Butt welds shall be full penetration welds, unless 5.7
otherwise specified and permitted by the 5.8
applicable governing codes.

2.6.3.20 Fillet welds shall be of the specified size with 5.9
full throat and legs of uniform size. 5.10

2.6.4 Weld Filler Metal Control 5.13

All welding materials shall be stored in a controlled 5.15
access, clean, dry area that is weathertight and is 5.16
maintained at a temperature between 40°F and 140°F.

Materials which are damaged shall be discarded. All 5.19
electrodes which are oil or water soaked, dirty, or from
which the flux has separated from the wire, shall be 5.20
discarded. Bare carbon steel and low-alloy steel wire shall 5.21
be discarded if a bloom of rust develops and cannot be 5.22
removed by light sanding. All flux-cored wire shall be 5.23
discarded if it becomes oil or water soaked. Bare and flux- 5.24
cored wire that becomes dirty can be used if it is cleaned
prior to use.

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3.0 CLEANING, PACKAGING, SHIPMENT AND STORAGE

3.1 Cleaning

3.1.1 All surfaces shall meet the cleanness requirements of ANSI N45.2.1, Class C and RG 1.37.

3.1.2 Where final cleaning is to be done by water flushing, all surfaces shall be final flushed with demineralized water.

3.1.3 Machined surfaces shall be free of rust.

3.2 Preparation for Shipment

3.2.1 Expansion joints shall be assembled prior to shipment. All equipment and materials shall be prepared for shipment in such manner as to facilitate transit, unloading and handling free from damage in accordance with ANSI N45.2.2 Level C and RG 1.38. Where necessary, heavy parts shall be mounted on skids or shall be crated, and any articles or materials that might otherwise be lost shall be boxed or wired in bundles and plainly marked or tagged with identification to match identification of each part on the Seller-supplied drawings required by this Specification. Detailed packing lists shall be provided for crated or boxed parts.

3.2.2 It shall be the responsibility of the Seller to take all precautions required to reasonably ensure arrival of all equipment and materials at the jobsite in an undamaged condition. This includes protection against deterioration such as excessive rusting of ferritic parts due to exposure to the elements while in transit or storage at the jobsite. Open ends of the expansion joints shall be suitably capped and protected from foreign matter and mechanical damage.

3.2.3 The Seller shall submit for approval by the Engineers, his expansion joint preparation for shipment and packaging procedures.

3.3 Delivery

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The Seller is responsible for all equipment delivery, FOB delivery destination point. Virginia Power will unload the equipment at the delivery point.

3.4 Shipping Label

The boxes, crates, or packages containing the equipment shall be clearly labeled or tagged with the following information:

Virginia Power P.O. No.:
Virginia Power Account No.:
Virginia Power Project Title: Circulating and Service Water Expansion Joints

Nuclear Safety-Related Add
Storage Level: C

3.5 Marking

A metal tag bearing the Purchaser's Expansion Joint identification number shall be permanently attached to each expansion joint before shipment. Expansion Joint identification numbers will be as follows:

96 in. joints (condenser inlet)	REJ-2
96 in. joints (condenser outlet)	REJ-4
30 in. joints	REJ-6
42 in. joints	REJ-7
36 in. joints	REJ-8
10 in. joints	REJ-16
30 in. joints	Temp Exp JT-1

Manufacturer's name or trademark, primary service pressure rating, size, and material designation shall be stamped on a metal plate securely attached to the expansion joint.

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4.0 TESTING REQUIREMENTS

4.1 General

4.1.1 The Seller shall be responsible that equipment furnished under this specification conforms to the procurement requirements stated and is suitable for the purpose outlined herein.

4.1.2 The Seller shall be responsible for compliance with his standard in-process test procedures in effect at time of contract award and the additonal tests invoked by this specification. The Seller shall send the test procedure and the test results to the Engineers as indicated in the Documentation Table.

4.1.3 Supplemental Tests may be invoked by a Virginia Power representative when marginal conditions are noted by the tests and inspections specified. The costs of these tests, and the effect, if any, on the delivery schedule, shall be determined prior to undertaking the test.

4.2 Mechanical Tests

Each expansion joint shall be tested to one and one-half times the rated design pressure and to a vacuum equivalent to the rated minimum operating pressure. Tests shall be maintained for a minimum period of 15 min. The acceptance criteria shall be no visible leakage through the joint and no permanent deformation.

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5.0 <u>QUALITY ASSURANCE REQUIREMENTS</u> 1.8

5.1 Quality Assurance Requirements shall be as stated in Appendix D. 1.9

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6.0 ADMINISTRATIVE 1.8

6.1 Bidder Information 1.9

The Bidder shall provide with his bid, as a minimum, all information on 1.10
the data sheets in Appendix B denoted with an "*". The data furnished 1.12
by the Bidder will upon award become a part of the technical
specification and will be held as minimum requirements for the equipment 1.13
furnished.

The Bidder shall also furnish the following: 1.14

a. Exceptions to the specification as required. 1.16

b. A firm price for the equipment, including delivery. 1.17

c. A schedule for drawing submittal after contract award. 1.18

d. Filled-in Technical Data Sheets. 1.19

e. Dimensioned outline drawings and catalog information as 1.20
required by attached Vendor Data Requirements. 1.21

f. Bidder's equipment storage requirements. 1.22

g. A list of recommended spare parts. 1.23

h. Bill of material. 1.24

i. A complete description of his proposed normal inspection 1.25
program including the tests, procedures, and applicable codes 1.26
he intends to include in the manufacturing of his equipment. 1.27
He also shall include the normal inspection procedures and 1.28
tests, etc., with which he intends to require subcontractors to 1.29
comply.

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6.2 Seller Information 1.31

6.2.1 The Seller shall furnish assembly and detailed drawings and 1.33
instruction manuals in such number and detail as necessary for 1.34
installation, operation and maintenance of the equipment. The 1.36
drawings shall further provide all information necessary for
Virginia Power to complete design details of all other systems 1.37
required to support the operation of the equipment. 1.38

6.2.2 All drawings and information submitted by the Seller shall 1.39
become the property of Virginia Power as a part of the 1.40
equipment supplied. There shall be no restrictions on Virginia 1.41
Power's right to reproduce and distribute copies of the 1.42
drawings.

All drawings shall be submitted in accordance with "Drawing and 1.44
Release Procedures" contained in special terms in the 1.45
procurement documents.

6.3 Communications

6.3.1 All correspondence from the Seller shall consist of an original plus four copies and shall contain the following subject heading:

> Title: Service Water and Circulating Water Rubber Expansion Joints
> Station & Unit No.(s): Surry Units 1 and 2
>
> Virginia Power P.O. No.: __________
> Seller P.O. No.: __________

6.3.2 All correspondence relative to the order shall be addressed to:

> Virginia Power Company
> Innsbrook
> 5000 Dominion Boulevard
> Glen Allen, VA 23060
>
> Attn: Mr. J. R. Long, III
> Supervisor - Purchasing

6.3.3 Technical correspondence, including the submittals required by the Vendor Data Requirements document shall be addressed to:

> Mr. J. A. Ahladas
> Vice President
> Power Station Engineering
> Virginia Power Company
> Innsbrook
> 5000 Dominion Boulevard
> Glen Allen, VA 23060
>
> Attn: Mr. M. Henig
> Project Engineer

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6.3.4 Notification of tests and inspections required by this specification shall be as described in the <u>Quality Assurance Requirements</u>, Appendix D of this specification.

6.4 Compliance with 10CFR21

6.4.1 The equipment provided under this specification is a basic component of a Nuclear Regulatory Commission (NRC) licensed facility or activity. Accordingly, the Seller is subject to the provisions of Part 21, Chapter 1, of Title 10 of the Code of Federal Regulations. Refer to the contract for further information.

6.4.2 Commercial grade items supplied to the Seller shall not be considered a part of a basic component until after dedication. This will occur upon receipt by Seller when the part is designated for use as a basic component.

6.5 Schedule 3.26

For all equipment provided as part of this purchase order, the Schedule, 3.27
or revision to it, as submitted to the Engineers and agreed upon by the 3.28
Seller and the Engineers before the purchase order is placed and 3.29
included with the purchase order, shall be binding on the Seller. The 3.31
Seller shall submit any requested changes to the Schedule to the
Engineers for approval. 3.32

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APPENDIX A 1.8

VIRGINIA POWER DESIGN INFORMATION 1.10

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Mark No.	REJ-2	REJ-4	1.18
Service:	Circulating Water	Circulating Water	1.19
	Condenser Inlet	Condenser Outlet	1.20
Size (in.)	96	96	1.22
Fluid	River Water	River Water	1.24
Quantity	8	8	1.26
Flange Rating, ANSI	125	125	1.36
Length, face-to-face, (in.)	12 ± 1/4	12 ± 1/4	1.38
Maximum Operating Pressure			1.40
(psig)	20	20	1.41
Minimum Operating Pressure			1.43
(psig)	0	0	1.44
Maximum Operating			1.46
Temperature (F)	95	120	1.47
Mimimum Operating			1.49
Temperature (F)	30	30	1.50
Maximum Ambient			1.52
Temperature (F)	See Section 2.2	See Section 2.2	1.53
Minimum Ambient			1.55
Temperature (F)	See Section 2.2	See Section 2.2	1.56

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Mark No.	REJ-6	REJ-7	2.3
Service:	Component Cooling Water Heat Exchanger Service Water Inlet/Outlet	Service Water Supply to Component Cooling Water Heat Exchanger	2.4 2.5 2.6 2.7
Size (in.)	30	42	2.10
Fluid	River Water	River Water	2.12
Quantity	8	2	2.14
Flange Rating, ANSI	125	125	2.16
Length, face-to-face, (in.)	10 ± 3/16	10 ± 3/16	2.18
Maximum Operating Pressure (psig)	20	20	2.20 2.21
Minimum Operating Pressure (psig)	-5	0	2.23 2.24
Maximum Operating Temperature (F)	120	95	2.26 2.27
Mimimum Operating Temperature (F)	30	30	2.29 2.30
Maximum Ambient Temperature (F)	See Section 2.2	See Section 2.2	2.40 2.41
Minimum Ambient Temperature (F)	See Section 2.2	See Section 2.2	2.43 2.44

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Mark No.	REJ-8	REJ-16	
Service:	Service Water Supply to Bearing Cooling Water Heat Exchangers	Service Water Pump Suction	
Size (in.)	36	10	2.59
Fluid	River Water	River Water	2.61
Quantity	4	2	3.2
Flange Rating, ANSI	125	125	3.12
Length, face-to-face, (in.)	10 ± 3/16	12 ± 1/8 - 3/16	3.14
Maximum Operating Pressure (psig)	20	20	3.16 3.17
Minimum Operating Pressure (psig)	0	-5	3.19 3.20
Maximum Operating Temperature (F)	95	95	3.22 3.23
Mimimum Operating Temperature (F)	30	30	3.25 3.26
Maximum Ambient Temperature (F)	See Section 2.2	See Section 2.2	3.28 3.29
Minimum Ambient Temperature (F)	See Section 2.2	See Section 2.2	3.31 3.32

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Mark No.	TEM EXP JT 1	
Service:	Service Water Supply to Component Cooling Water Heat Exchangers	
Size (in.)	30	3.44
Fluid	River Water	3.46
Quantity	3	3.48
Flange Rating, ANSI	125	3.50
Length, face-to-face, (in.)	10 ± 3/16	3.60
Maximum Operating Pressure (psig)	20	4.1 4.2
Minimum Operating Pressure (psig)	-0	4.4 4.5
Maximum Operating Temperature (F)	95	4.7 4.8
Mimimum Operating Temperature (F)	30	4.10 4.11
Maximum Ambient Temperature (F)	See Section 2.2	4.13 4.14
Minimum Ambient Temperature (F)	See Section 2.2	4.16 4.17

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APPENDIX B 1.9

TECHNICAL DATA SHEETS 1.11 | Add

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 1.13

Technical Data Sheets 1.16

The bidder shall furnish a complete set of data for the expansion 1.17
joints. The data sheets furnished by the bidder will upon award become 1.18
a part of the technical specification and will be held as minimum 1.19
requirements for the equipment furnished.

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APPENDIX B 1.13

FILL-IN DATA SHEET 1.15

Mark No.	REJ-2	REJ-4	1.18
Size	96"	96"	1.20
Manufacturer's Figure No.	*320FA/777	*320FA/777	1.22
Maximum Design Pressure, psi gauge	*80 @ 180°F	*80 @ 180°F	1.24
Minimum Design Pressure, in. Hg VAC	*29 @ 180°F	*29 @ 180°F	1.31
Maximum Design Axial Compression, in.	*7/8	*7/8	1.33
Maximum Design Axial Elongation, in.	*1/2	*1/2	1.35
Maximum Design Transverse Defl. in.	*7/16	*7/16	1.37
Axial Stiffness			1.39
Compression (lb/in.)	*10800	*10800	1.40
Elongation (lb/in.)	* 7600	* 7600	1.41
Shear Stiffness (lb/in.)	*16400	*16400	1.43
Bending Stiffness			1.46
(ft-lb/degree)	* 1640	* 1640	1.47
Design Temperature, F	* 180	* 180	1.50
Outside Diameter of Body, in.	*98-1/2	*98-1/2	1.52
Weight, lb. (with retaining rings)	* 1070	* 1070	1.54
No. of Arches	* 1	* 1	1.56
Length, Face-to-Face, in.	* 12	* 12	1.58
Materials			1.60
Carcass (tube or lining)	*EPDM	*EDPM	2.1
Carcass Fabric	*POLYESTER	*POLYESTER	2.3
Face to Flange	*EDPM/POLY	*EDPM/POLY	2.5
Arch Filler	*EDPM	*EDPM	2.7

Add 2

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Note: Stiffness rates are for unpressurized systems at a temperature of 85°F. The tolerance for these values is ±20 percent.

	REJ-2	REJ-4	
			2.13
Life Expectancy, incl. Shelf Life, yr.	*4-10	*4-10	2.14
Normal Use			2.16
No. of expansion and contraction cycles			2.17
expansion joint is designed for	*100,000	*100,000	2.18
Hydrostatic Shop Test Pressure, psig	1-1/2 x Design Pressure		2.20
Hydrostatic Test Pressure Hold Time	15 minutes		2.22

ADD. 1

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APPENDIX B 2.35

FILL-IN DATA SHEET 2.37

Mark No.	REJ-6	REJ-7	2.40	
Size	30"	42"	2.42	
Manufacturer's Figure No.	*320FA/777	*320FA/777	2.44	
Maximum Design Pressure, psi gauge	*95 @ 180°F	*90 @ 180°F	2.46	
Minimum Design Pressure, in. Hg VAC	*28 @ 180°F	*28 @ 180°F	2.53	
Maximum Design Axial Compression, in.	*5/8	*7/8	2.55	
Maximum Design Axial Elongation, in.	*7/16	*1/2	2.57	
Maximum Design Transverse Defl. in.	*7/16	*7/16	2.59	
Axial Stiffness			3.1	
Compression (lb/in.)	*3700	*5300	3.2	
Elongation (lb/in.)	*2600	*3700	3.3	
Shear Stiffness (lb/in.)	*4400	*7300	3.5	
Bending Stiffness			3.8	
(ft-lb/degree)	* 340	* 600	3.9	
Design Temperature, F	* 180	* 180	3.12	Add 2
Outside Diameter of Body, in.	* 32	* 42-1/4	3.14	
Weight, lb. (with retaining rings)	* 163	* 295	3.16	
No. of Arches	* 1	* 1	3.18	
Length , Face-to-Face, in.	* 10	FINAL DRAFT *[illegible]0	3.20	
Materials			3.22	
Carcass (tube or lining)	*EPDM	*EPDM	3.23	
Carcass Fabric	*POLYESTER	*POLYESTER	3.25	
Face to Flange	*EPDM/POLY	*EPDM/POLY	3.27	
Arch Filler	*EPDM	*EPDM	3.29	

Note: Stiffness rates are for unpressurized systems at a temperature of 85°F. The tolerance for these values is ±20 percent.

	REJ-6	REJ-7	
			3.35
Life Expectancy, incl. Shelf Life, yr.	*4-8	*4-8	3.36
Normal Use			3.38
No. of expansion and contraction cycles			3.39
expansion joint is designed for	*100,000	*100,000	3.40
Hydrostatic Shop Test Pressure, psig	1-1/2 x Design Pressure		3.42
Hydrostatic Test Pressure Hold Time	15 minutes		3.44

Add 1

FINAL DRAFT

APPENDIX B 3.57

FILL-IN DATA SHEET 3.59

Mark No.	REJ-8	REJ-16	4.2
Size	36"	10"	4.4
Manufacturer's Figure No.	*320FA/777	*320FA/777	4.6
Maximum Design Pressure, psi gauge	*90 @ 180°F	*200 @ 180°F	4.8
Minimum Design Pressure, in. Hg VAC	*27 @ 180°F	*28 @ 180°F	4.15
Maximum Design Axial Compression, in.	*7/8	*5/8	4.17
Maximum Design Axial Elongation, in.	*1/2	*7/16	4.19
Maximum Design Transverse Defl. in.	*7/16	*7/16	4.21
Axial Stiffness			4.23
Compression (lb/in.)	*4700	*2000	4.24
Elongation (lb/in.)	*3300	*1400	4.25
Shear Stiffness (lb/in.)	*5800	*1750	4.27
Bending Stiffness			4.30
(ft-lb/degree)	* 490	* 25	4.31
Design Temperature, F	* 180	* 180	4.34
Outside Diameter of Body, in.	*38-1/4	*11-3/4	4.36
Weight, lb. (with retaining rings)	* 198	* 65	4.38
No. of Arches	* 1	* 1	4.40
Length , Face-to-Face, in.	* 10	* 12	4.42
Materials			4.44
Carcass (tube or lining)	*EPDM	*EPDM	4.45
Carcass Fabric	*POLYESTER	*POLYESTER	4.47
Face to Flange	*EPDM/POLY	*EPDM/POLY	4.49
			4.50
Arch Filler	*EPDM	*EPDM	4.51

Add 2

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Note: Stiffness rates are for unpressurized systems at a temperature of 85°F. The tolerance for these values is ±20 percent.

	REJ-8	REJ-16	
			4.57
Life Expectancy, incl. Shelf Life, yr.	*4-8	*4-8	4.58
Normal Use			4.60
No. of expansion and contraction cycles			5.1
expansion joint is designed for	*100,000	*100,000	5.2
Hydrostatic Shop Test Pressure, psig	1-1/2 x Design Pressure		5.4
Hydrostatic Test Pressure Hold Time	15 minutes		5.6

Add
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APPENDIX B 5.19

FILL-IN DATA SHEET 5.21

Mark No.	Temp Exp Jt-1	5.24
Size	30"	5.26
Manufacturer's Figure No.	*320FA/777	5.28
Maximum Design Pressure, psi gauge	*95 @ 180°F	5.30
Minimum Design Pressure, in. Hg VAC	*28 @ 180°F	5.37
Maximum Design Axial Compression, in.	*5/8	5.39
Maximum Design Axial Elongation, in.	*7/16	5.41
Maximum Design Transverse Defl. in.	*7/16	5.43
Axial Stiffness		5.45
Compression (lb/in.)	*3700	5.46
Elongation (lb/in.)	*2600	5.47
Shear Stiffness (lb/in.)	*4400	5.49
Bending Stiffness		5.52
(ft-lb/degree)	* 340	5.53
Design Temperature, F	* 180	5.56 Add 2
Outside Diameter of Body, in.	* 32	5.58
Weight, lb. (with retaining rings)	* 163	5.60
No. of Arches	* 1	6.2
Length , Face-to-Face, in.	* 10	6.4
Materials	FINAL DRAFT	6.6
Carcass (tube or lining)	*EPDM	6.7
Carcass Fabric	*POLYESTER	6.9
Face to Flange	*EPDM/POLY	6.11
Arch Filler	*EPDM	6.13

Note: Stiffness rates are for unpressurized systems at a temperature of 85°F. The tolerance for these values is ±20 percent.

	Temp Exp Jt-1	6.19
Life Expectancy, incl. Shelf Life, yr.	*4-8	6.20
Normal Use		6.22
No. of expansion and contraction cycles		6.23
expansion joint is designed for	*100,000	6.24
Hydrostatic Shop Test Pressure, psig	1-1/2 x Design Pressure	6.26
Hydrostatics Test Pressure Hold Time	15 minutes	6.28

Add
1

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APPENDIX C

WATER CHEMISTRY

The James River is the source of circulating and service water for Surry Power Station. The typical James River Water Chemistry is shown on the following table.

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JAMES RIVER WATER
AT SURRY POWER STATION

(All values are ppm, except as indicated.)

(Samples taken during the period of March 1982 to September 1983, except for sulfide which was taken during June of 1986.)

Sample	Range
pH (20°C)	7.5 to 8.02
Ammonia	< 0.01 to .22
Chloride	480 to 4,049
Specific Conductivity µmhos	2,190 to 13,900
Total Evaporated Solids mg/l	1,274 to 12,804
Total Suspended Solids mg/l	37.2 to 92
Total Dissolved Solids	1,227 to 12,766
Soluble Silica as SiO_2	1.4 to 6.64
Sulfate as SO_4	78 to 865
Sulfide	.010 to .020
Aluminum	0.51 to 4.75
Calcium as Ca	14.83 to 112.5
Chromium as Cr	0.005 to < 0.05
Copper as Cu	0.01 to 0.02
Iron as Fe	1.28 to 6.53
Magnesium as Mg	37.75 to 341.87
Manganese as Mn	0.002 t[illegible]
Mercury as Hg	0.000 to < 0.002
Nickle as Ni	0.03 to < 0.14
Silica as Si	1.1 to 4.51
Sodium as Na	290 to 2,944
Zinc as Zn	0.019 to 0.12

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APPENDIX D 1.9

QUALITY ASSURANCE REQUIREMENTS 1.11

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D.1 <u>Quality Control Program</u> 1.14

D.1.1 Each bidder shall submit with his original proposal one copy of 1.16
his Quality Assurance Program covering the quality control and 1.17 Add
quality assurance measures applicable to the work. The bidders 1.18
(Sellers) program shall be in compliance with the intent of
10CFR50, Appendix B, "Quality Assurance Criteria for Nuclear 1.19
Power Plants." For fluid pressure boundary components, Section 1.20
III, ASME Boiler and Pressure Vessel Code will satisfy this 1.21
intent. Programs complying with ANSI N45.2-1977 also will 1.22
satisfy this specification requirement.

D.1.1.1 Seller will establish measures to assure that purchased 1.24
material, equipment, and services, whether purchased
directly or through contractors or subcontractors, conform 1.25 Add
to the procurement documents. These measures shall include 1.26
provision as appropriate, for source evaluation and
selection, objective evidence of quality furnished, 1.27
inspection at the source, and examination of products upon
delivery.

D.1.1.2 Selection of suppliers shall be based on evaluation of 1.28
their capability to provide items or services in accordance 1.29
with the requirements of the procurement document.

D.1.1.3 Measures for the evaluation and selection of procurement 1.30
sources, and the results therefrom shall be documented and 1.31
shall include an evaluation of the suppliers history of
providing a similar product which performs satisfactorily 1.32
in actual use. The suppliers history shall reflect current 1.33
capability.

D.1.1.4 Seller will develop an approved vendor's list applicable to 1.34
this order for pressure retaining items.

D.1.2 A program acceptable to the Engineers shall be a prerequisite 1.36
for a bidder being chosen as Seller. 1.37

D.1.3 The Seller shall implement and maintain this program carrying 1.38
out the requirements of this specification, and all proposed 1.39
major changes shall be submitted to, and approved by, the 1.40
Engineers prior to implementation.

D.1.4 The accepted Quality Assurance Program manual of the successful 1.41
bidder shall be used in the audit of the program by Virginia 1.42
Power's representative during the performance of the work 1.43
specified.

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D.1.5 Authorized representatives of Virginia Power or Engineers shall 1.44
be allowed access to the engineering offices, shops, and working 1.45
areas of the Seller and his subsuppliers at all reasonable times 1.46
for the purpose of auditing (1) the Seller's accepted Quality
Assurance Program and (2) the subsupplier's Quality Assurance 1.47
Program to the extent that such a program is required by the 1.48

Seller's Program. Such audits will include examination of 1.56
documentary evidence of activities affecting quality and will be 1.57
carried out on a planned, periodic basis during the course of
the work to verify compliance with all aspects of the program 1.58
and to determine the effectiveness thereof. 1.59

D.1.6 This specification itemizes certain key steps that shall be 2.1
witnessed/performed/verified by Virginia Power's Shop Inspector 2.3
at the appropriate times to assure equipment/material supplied 2.5
is in conformance with the requirements of this specification.
A "Certificate of Conformance" shall be submitted by the Seller 2.6
stating that the equipment is in conformance with the 2.7
requirements of this specification. The Seller will not only be 2.8
required to certify the compliance of his own actions but those 2.9
of subsuppliers he may use.

D.1.7 The Seller shall specifically ensure that a copy of this 2.10
specification with all addenda thereto, or appropriate work 2.11
instructions which include the specification requirements, are 2.12
readily available at each of his fabricating or production
locations where work covered by this specification is in 2.13
progress.

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D.2 Seller and Subsuppliers' Responsibilities

D.2.1 Should the Seller propose to purchase from other suppliers any equipment, material, or service specified herein, he shall, upon request, identify the subsuppliers for those specific components itemized by Virginia Power. If the proposed supplier(s) will custom manufacture any of the items covered by the specification completely or perform sufficient fabrication of the item(s) which require the presence of Virginia Power's Shop Inspector in the subsupplier's shop, the Seller shall identify the subsupplier(s) to Virginia Power. The Seller shall perform inspections and/or witness tests at his subsupplier facilities as required. Virginia Power's Shop Inspector may accompany the Seller during his visit. The presence of Virginia Power's Shop Inspector does not relieve the Seller of his responsibilities to meet the requirements of this specification.

D.2.2 Where applicable, the Seller shall impose on his subsuppliers the requirements of this specification. The Seller shall assure that all subsuppliers meet the applicable requirements of the specification.

D.2.3 The specification requirements for procedure submittals shall apply to subsuppliers for operations or services not performed by the Seller. The Seller shall first review subsupplier procedures to ensure compliance with specification requirements, submit these procedures, and obtain Virginia Power's approval in writing prior to the performance of the subsupplier's work. The Seller's procedures may be used at the subsupplier's facilities if the subsupplier is unable to provide his own. Proper evidence of Virginia Power's approval shall be available at the subsupplier facility.

D.2.4 The Seller shall ensure that the subsupplier is aware of all testing that he (the subsupplier) will be required to perform and identify activities that require the presence of Virginia Power's Shop Inspection. The Seller shall assure that Virginia Power's Shop Inspector has the right of access to subsupplier facilities and documents to perform inspection or witness tests.

D.2.5 It shall be the Seller's responsibility that <u>NO</u> shipment of equipment required by this specification to have a "Shipping Release Tag" (SRT) is made to the jobsite until the Shipping Release Tag has been affixed thereto or issued by Virginia Power's Shop Inspector, or a written statement has been supplied by Virginia Power's Inspector permitting shipment without attachment of the "Shipping Release Tag."

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D.3 Inspection

D.3.1 As used herein, the term "Virginia Power Shop Inspector" means Virginia Power employee or authorized representative assigned to do inspection work in the manufacturer's shop.

D.3.2 Authorized shop inspectors or other representatives of Virginia Power shall be allowed access to the engineering offices, shops, and working area of the Seller and his subsupplier at all reasonable times. These personnel shall have the right to such information as is necessary to demonstrate that engineering, procurement, and production are proceeding in accordance with the established schedules. They shall also have the right to inspect the material or equipment, or the Seller's or subsupplier's production and inspection procedures, to confirm that the requirements of this specification are being complied with. The Seller or subsupplier shall provide tools, instruments, scaffolding, etc., necessary to facilitate these inspections.

D.3.3 Inspections by Virginia Power may be required as follows:

a) At selected points in the production of subassemblies
b) At final assembly
c) During standard production tests
d) During the performance of any optional test, if purchased
e) At such other performance points as may be mutually designated

D.3.4 The Seller shall cooperate with Virginia Power's Shop Inspector in scheduling the various inspections or tests during manufacture, testing, lining, cleaning, and preparation for shipment. Within thirty (30) days of the issuance of the purchase order, the Seller shall have confirmed with Virginia Power's Shop Inspector which of the tests or inspections, the inspector is required to witness or participate, and also, the components which will require a Shipping Release Tag prior to shipment. This confirmation will normally occur during a visit by the Inspector and a QA Engineering Representative to Seller's facilities during a post-contract award conference. The visit shall be arranged by the Seller for a mutually convenient time during the 30-day period.

D.3.5 Virginia Power's Shop Inspector shall not be expected to accept less than three (3) working days notification of a performance or witness point by the Seller. Telephone notification can be made by calling the Supervisor, Vendor Surveillance at (804) 273-2877 M-F 8 am to 5 pm. Written confirmation should be sent to the following:

Add 1

Supervisor, Vendor Surveillance
Virginia Power Company
Innsbrook
5000 Dominion Boulevard
Glen Allen, Va 23060

FINAL DRAFT

D.3.6 Should Virginia Power's Shop Inspector be unable to meet an inspection commitment, the Seller will be notified, by telephone, by Virginia Power Vendor Surveillance. The resolution will be transmitted, in writing, to the Seller. The written statement will become part of the Seller's documentation package, along with the other documents required by the specification.

D.3.7 Virginia Power's Shop Inspector will ascertain through proper examination and the various tests specified or usually used for such purposes, and will verify that the material or equipment conforms to the requirements of this specification.

D.3.8 The Vendor Surveillance Inspection Report (VSIR) shall be used by Virginia Power's Shop Inspector to document the results of his inspections and shall apply to those components designated in the Virginia Power's Shop Inspection Requirements section as requiring inspection. Virginia Power's Shop Inspector and the Seller or subsupplier shall coordinate their efforts so that for each shipment the various inspections required by the Virginia Power Shop Inspector can be made at the proper time. The VSIR shall be initialed and dated by Virginia Power's Shop Inspector as each item listed thereon is verified, witnessed, or performed.

D.3.9 This Inspection Report form is not intended to limit or preclude the performance of additional tests, inspections, or documentation required by the specification codes or normally provided by the Seller or receipt inspection at the jobsite.

D.3.10 When the Virginia Power Shop Inspector or other authorized Virginia Power representative become concerned about a marginal condition found by the tests or inspections specified herein, he shall have the right to call for an appropriate supplementary test.

D.3.11 In addition, Virginia Power's Shop Inspector shall:

1. Warn the Seller at any time that he (the Inspector) notices anything that may lead to rejection of the equipment or material when it is presented later for inspection and acceptance.

2. At the appropriate time, witness or conduct the various inspections, tests, verifications, etc., as indicated on the enclosed Vendor Surveillance Inspection Report(s) and indicate that each is in conformance with the requirements of this specification by initialing and dating in the spaces provided therefor.

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3. Issue a properly completed "Shipping Release Tag" for each shipment or provide written authorization for shipment without a "Shipping Release Tag."

D.3.12 It is not intended that Virginia Power's Shop Inspector shall relieve the Seller in any way whatsoever of his obligation to maintain an adequate test, inspection, and documentation program of his own, or of any obligation under this specification.

Furthermore, the fact that Virginia Power's Shop Inspector may 4.1
inadvertently overlook a deviation from some requirement of this 4.2
specification shall not constitute a waiver of that requirement, 4.3
or of the Seller's obligation to correct the condition when it
is discovered, or of any other obligation under this 4.4
specification.

D.3.13 To the extent that approval of certain drawings or procedures is 4.5
required by this specification: 4.6

1. No production work, where indicated drawings or procedures 4.8
are used, shall be started until Virginia Power's written 4.9
approval has been attained.

2. All work shall be in accordance with the approved drawings 4.10
or procedures. Failure to comply with this requirement 4.11
will be cause for rejection of the work by Virginia Power's 4.12
Shop Inspector.

D.4 <u>Release for Shipment</u> 4.15

D.4.1 <u>Equipment/Material requiring a Virginia Power Shipping Release</u> 4.17
<u>Tag (SRT)</u>

D.4.1.1 This is defined as equipment/material designated in 4.19
Virginia Power's Shop Inspector section as requiring 4.20
inspection and the completion of a Vendor Surveillance 4.22
Inspection Report (VSIR) and shall <u>NOT</u> be shipped unless a 4.23
Shipping Release Tag (SRT) is issued or written authority 4.24
waiving this requirement is given by Manager, QA
Engineering and Vendor Surveillance. If the requirement 4.26
for a SRT is waived, it shall be shipped in accordance with
paragraph D.4.2 below, with all documents distributed in 4.27
accordance with the requirements of the specification 4.28
and/or Documentation Table. A copy of the written waiver 4.29
for the SRT must accompany the shipment.

D.4.1.2 Prior to each shipment, the Seller shall submit to Virginia 4.30
Power's Shop Inspector, when required by the Technical 4.31
Specifications, the documentation packages as required by 4.32
the specification and/or Documentation Table consisting of
the records applicable to the shipment which shall be bound 4.33
and appropriately identified for reference and use. 4.34

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D.4.1.3 Virginia Power's Shop Inspector will review the 4.35
documentation for its completeness and reproduction 4.36
quality. If satisfactory, the Inspector will issue a SRT 4.37
to the Seller. If not satisfactory, the Seller will be 4.38
promptly advised of any additional documentation required. 4.39

D.4.2 <u>Equipment/Material not designated as requiring a SRT</u> 4.42

D.4.2.1 This material may be shipped direct to the jobsite, in 4.44
accordance with the instructions below. Documentation for 4.47

items shipped by a subsupplier must be forwarded to the
Supplier for Virginia Power's Shop Inspector review. 4.48

D.4.2.2 The Seller shall affix the appropriate shipping label and 4.49
shall also attach a packing list and a copy of the 4.50
Certificate of Conformance. A copy of this packing list 4.51
shall be forwarded to Virginia Power's Shop Inspector.
Documents designated as accompanying the shipment shall be 4.52
included with the shipment.

D.4.2.3 Failure of the Seller to comply with these requirements may 4.53
be cause for rejection at the jobsite, with the material 4.55
returned to the factory, and with all additional freight 4.56
off-loading services, handling, and storage expense for the
Seller's account.

D.5 <u>Virginia Power Shop Inspection Requirements</u> 4.59

D.5.1 The following items covered by this specification shall be 5.1
inspected by Virginia Power's Shop Inspector, in accordance with 5.2
the requirements of this specification and the VSIR: 5.3

a. 10 in. rubber expansion joints 5.7
b. 30 in. rubber expansion joints 5.8
c. 36 in. rubber expansion joints 5.9
d. 42 in. rubber expansion joints 5.10
e. 96 in. rubber expansion joints 5.11

The list of components indicated above are basic components 5.15
considered key items of this procurement. Additional components 5.17
may be added to this list as a result of post-contract award
conference. 5.18

D.6 <u>Documentation</u> 5.21

D.6.1 The Seller and his subsupplier shall provide Virginia Power in 5.22
writing at the conclusion of the design, procurement, and 5.23
manufacturing phases, as applicable, and prior to shipment, a 5.26
"Certificate of Conformance" stating that all referenced
standards, specifications, Codes, and procedures have been 5.27
complied with.

D.6.2 The attached "Certificate of Conformance" form and instructions 5.28
should be utilized to fulfill the above requirements. 5.29

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D.6.3 The Seller and the Seller's subsuppliers shall maintain adequate 5.30
documentation to support the facts certified in the "Certificate 5.31
of Conformance" until such time that the applicable warranty 5.32
expires.

D.6.4 Based on the documentation requirements in the "Documentation 5.33
Table," and at the time of shipment, the Seller and/or his 5.34
subsuppliers shall submit to Virginia Power's Shop Inspector, 5.35

those documents that will accompany the shipment, each
identified, at a minimum, as follows: 5.36

1. Type of document such as mill test report, liquid penetrant 5.38
test report, certified test report, etc. 5.39

2. The specific component(s) or parts thereof, to which the 5.40
document applies.

D.6.5 If the specification does not require the presence of Virginia 5.42
Power's Shop Inspector, documents shall be distributed as 5.43
detailed in the specification and/or the Documentation Table. 5.44

D.6.6 Certified copies of test reports shall be furnished to the 5.45
Virginia Power Project Engineer each properly identified and 5.46
including a description of the tests covered and of the 5.47
materials or equipment tested. Reports shall be submitted on 5.48
all tests specified.

D.6.7 Documentation that has been forwarded with a previous shipment 5.49
need not be duplicated. However, a statement shall be forwarded 5.51
with the shipment itemizing both the specific equipment with 5.52
which shipped and the date of the shipment.

D.6.8 Virginia Power's Inspector will use the Documentation Table for 5.53
his documentation audit. A "Shipping Release Tag" will not be 5.55
issued by Virginia Power's Shop Inspector until he has completed 5.56
his documentation audit for that shipment and has confirmed that
a complete set of those documents that are applicable to the 5.57
shipment are being forwarded with that shipment, or were 5.58
submitted previously and are properly identified.

D.6.9 When the final shipment is presented to Virginia Power's Shop 5.59
Inspector for a "Shipping Release Tag," the Seller shall show to 5.60
the satisfaction of Virginia Power's Shop Inspector that all 6.1
documentation itemized or indicated by the specification has
been distributed in accordance with the Documentation Table. 6.2

D.6.10 Documents submitted by the Seller shall clearly identify 6.3
Virginia Power (the Purchaser), station and unit, purchase order 6.4
number, Virginia Power's job order number, equipment description 6.5
and specification identification, and the manufacturer's name
and address. 6.6

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D.6.11 Documentation to be transmitted with a shipment, after review by 6.7
Virginia Power's Shop Inspector, shall be adequately packaged, 6.8
protected, and secured so as to assure that it will arrive with 6.9
the shipment in an undamaged condition.

D.6.12 All document copies listed in the Documentation Table shall be 6.10
of a quality capable of yielding hard copy reproductions with 6.11
every line, charter, and letter clearly legible, and usable for 6.12
further reproduction.

D.7 Nonconformances 6.15

D.7.1 Nonconformances from specification requirements, approved 6.16
drawings and applicable federal, state, and local codes/- 6.18
standards invoked by this specification shall not be accepted 6.19
until approved by Virginia Power - Power Station Engineering 6.20
(PSE). Nonconformances to be reported and approved by Virginia 6.21
Power are those uncorrectable nonconformances which are 6.22
considered to be conditions which cannot be corrected within the 6.23
specification requirements by rework or replacement. When such 6.24
a condition exists, the supplier shall initiate the "Supplier
Nonconformance Report - SNCR," which identifies the 6.25
nonconformance and the supplier's proposed disposition. 6.26
Additionally, the supplier shall (1) segregate the nonconforming 6.27
item to prevent any further processing which may result in a 6.28
change of the nonconformance as identified, (2) make SNCR 6.29
available to Virginia Power - Vendor Surveillance
Representative's (if present) review to assure the 6.30
nonconformance is completely identified and accurately stated,
and (3) properly disposition and transmit SNCR to Virginia Power 6.31
- Purchasing Supervisor Expediting, by the most expeditious 6.32
means. SNCR may be telecopied followed by direct transmittal of 6.33
original. Supplier shall provide technical specification if 6.34
recommended disposition is "Accept-As-Is" or "Repair." 6.35

D.7.2 Supplier shall promptly document and notify Virginia Power of 6.36
all nonconformances from the specification. Further engineering 6.38
and/or manufacturing after detection of nonconformances, prior
to Virginia Power's approval, shall be at the Supplier's risk. 6.39
No departure from the specification shall be binding on any 6.40
party until a revision to the specification has been issued by 6.41
Virginia Power - Power Station Engineering.

D.7.3 The Supplier Nonconformance Report - SNCR and instructions are 6.42
included in this specification, and provide the method by which 6.43
the Supplier will obtain a documented response and approval from 6.44
Virginia Power when nonconformances are identified. The use of 6.45
the SNCR will pertain only to work at the Supplier's and/or
subsupplier's shops. 6.46

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DOCUMENTATION TABLE

Title	VPE	VSI	S	ERM	Schedule
	Distribution and No. of Copies				
Seller's QA Program Manual	(Note 1)				With Bid/proposal
Technical Data Sheets					With Bid/proposal
Virginia Power Certificate of Conformance		1	1		With Shipment
Certified Drawings	1(A)		3		Per Specification
Certified Material Test Reports		1	1		With Shipment
Weld and Weld Repair Procedures and Procedure Qualifications	1(A)				Per Specification
Welder Qualification	(Available for Verification)				
Hydrostatic Pressure Test Procedures	1(A)				Per Specification
Hydrostatic Pressure Test Report	1	1	1		With Shipment
Preparation for Shipping Procedures	1(A)		1		Per Specification
Installation and Maintenance Manuals	5		3	1	With Shipment

Note 1 Submitted to: Attention: Supervisor, Quality Assurance Engineering (To be returned with/without comments after review, if desired)

VPE - Virginia Power Project Engineer
VSI - Virginia Power Shop Inspector
S - Shipment
ERM - Engineering Record Management

FINAL DRAFT

All documents listed shall be available in manufacturer's files, available for review/verification by Virginia Power Shop Inspector.

Items marked (A) must be approved prior to start of work.

No. 97883014

Vepco
QUALITY ASSURANCE
VENDOR SURVEILLANCE INSPECTION REPORT

ITEM/COMPONENT RUBBER EXPANSION JOINTS

P.O. NUMBER ______ REPORT NUMBER ______ SHEET 1 OF 1

PROJECT Surry - Expansion Joint Replacement	J.O. NO. CAT. NO. I
VENDOR/LOCATION	MARK NO. REJ-2, 4, 6, 7, 8, 16 Temp Exp. Jt-1
DRAWING NO.	
CONTACT: TELEPHONE:	CHANGE ORDER NO.
SUBVENDOR/LOCATION	SUBCONTRACT NO.
SPECIFICATION: NUS-2076 ADDENDUM:	VENDOR SHOP NO.

W - WITNESS V - VERIFY P - PERFORM

	INSPECTION AND DOCUMENT RECORD	RECORD REQ'D IN VENDOR FILE	A/E APP. REQ'D	Action Req'd	DEVIATIONS/TEST PARAMETER/ APPROVAL/ETC	Ref. No.	BY	DATE
1	QA Program Approval	X		V	Per Spec. Section 5.0			
2	Cert. Material Test Report	X		V	Per Spec. Section 2.3 (Note 1)			
3	Reports (Batch Identification)	X		V	Per Spec. Section 2.3 (Note 2)			
4	Weld & Weld Repair Proc.	X	X	V	Per Spec. Section 2.6			
5	Welder Qualifications	X		V	Per Spec. Section 2.6			
6	Weld. Mat. Control	X		V	Per Spec. Section 2.6			
	[illegible]drostatic Test Procedures	X	X	V	Per Spec. Section 4.0			
	[illegible]drostatic Test Reports	X		* W	Per Spec. Section 4.0			
9	Approved Drawings	X	X	V				
10	Visual Dimensional Check	X		* P	Per Approved Certified Dwgs.			
11								
12	Nameplate Inspection			P	Per Spec. Section 3.5			
13	VA POWER Cert. of Conformance	X		X				
14	Prep. for Shipment	X	X	V	Per Spec. Section 3.2			
15	Documentation Audit			P				
16	Shipping Release Tag			P				
17								
18					FINAL DRAFT			
19								
20								

DISCUSSION

* Random up to 100%

1. Steel retaining rings
2. Certifications furnished shall allow traceability of each expansion joint back to the manufacturer and date as well as order number of the rubber as each expansion joint is manufactered.

DOCUMENTATION CERTIFICATION:

SIGNATURE ON THIS DOCUMENT, WHEN CHECKED HERE ( ), CERTIFIES THAT ALL SURVEILLANCE ACTIONS INITIALLED ABOVE HAVE BEEN ACCOMPLISHED WITH SATISFACTORY RESULTS, AND THAT REQUIRED DOCUMENTATION HAS BEEN REVIEWED AND ACCEPTED IN ACCORDANCE WITH THE REQUIREMENTS OF THE PURCHASE SPECIFICATION.

DISTRIBUTION

DATE	SIGNATURE	SRT NO.

INSTRUCTION FOR COMPLETING VIRGINIA POWER'S CERTIFICATE OF CONFORMANCE

The vendor shall complete the lines numbered below in duplicate:

Line No.	Instructions
1.	Surry Power Station - (Include unit identification, as applicable).
2.	Vendor's Name
3.	Vendor's Address
4.	Name of component or service performed.
5.	Mark number of component as required.
6.	The specification number, revision and dated, including title appearing on specification.
7.	Purchase order number plus any change orders as applicable.
8.	Job order number as applicable. Surry Unit 1 - Surry Unit 2 - and J.O. No.
9.	Vendor's job number or shop number.
10.	Approved fabrication drawings and latest revisions.
11.	All vendor deviations from the specification with approval letters, etc., to verify acceptance of deviation.
12.	QA Manager, or equivalent, responsible vendor representative.

FINAL DRAFT

VIRGINIA ELECTRIC AND POWER COMPANY

CERTIFICATE OF CONFORMANCE

PROJECT NAME (1)

SELLER (2) ADDRESS (3)

ITEM OR SERVICE (4) MARK NO. (5)

SPECIFICATION NO. AND TITLE (6)

PURCHASE ORDER NO. (7) J.O. NO. (8)

SELLER IDENTIFYING NO. (9) DRAWING NO. (10)

DEVIATIONS FROM SPECIFICATION REQUIREMENTS: (IF NONE, SO STATE)
ATTACH COPIES OF DEVIATION APPROVAL DOCUMENTS.

1. (11)
2.
3.
4.
5.
6.

The Seller, including his subsuppliers, hereby certifies that the item or service supplied on this order complies with the above listed specifications, drawings, applicable codes, standards, and procedures. The Seller certifies that all deviations from specification requirements are listed above and that deviation approval documents are attached.

SIGNATURE (12)
QUALITY ASSURANCE MANAGER
OR EQUIVALENT

FINAL DRAFT

VIRGINIA ELECTRIC AND POWER COMPANY

CERTIFICATE OF CONFORMANCE

PROJECT NAME ______________________________

SELLER ______________ ADDRESS ______________

ITEM OR SERVICE ______________ MARK NO. ______________

SPECIFICATION NO. AND TITLE ______________________________

____

PURCHASE ORDER NO. ______________ J.O. NO. ______________

SELLER IDENTIFYING NO. ______________ DRAWING NO. ______________

DEVIATIONS FROM SPECIFICATION REQUIREMENTS: (IF NONE, SO STATE)
ATTACH COPIES OF DEVIATION APPROVAL DOCUMENTS.

1. ______________ 4. ______________

2. ______________ 5. ______________

3. ______________ 6. ______________

The Seller, including his subsuppliers, hereby certifies that the item or service supplied on this order complies with the above listed specifications, drawings, applicable codes, standards, and procedures. The Seller certifies that all deviations from specification requirements are listed above and that deviation approval documents are attached.

SIGNATURE ______________________________
QUALITY ASSURANCE MANAGER
OR EQUIVALENT

FINAL DRAFT

SUPPLIER NONCONFORMANCE INSTRUCTIONS FOR PREPARATION

Block No.	Information	By Whom
1	Supervisor Expediting (Name)	Supplier
2	Name & Address of Supplier	Supplier
3	SNCR Number from Log	Vendor Surveillance
4	Project i.e. Surry Unit 1	Supplier
5	Vepco Purchase Order Number	Supplier
6	Supplier Shop Order Number	Supplier
7	Quality Assurance Category I, II, III	Supplier
8	Identify Equipment i.e. Sump Pump Mk#RH-2-C	Supplier
9	Specification Number	Supplier
10	Identify Related Report if Applicable	Vendor Surveillance
11	State Problem Description in Detail	Supplier
12	State Recommended Solution	Supplier
13/14	Initiator Signs and Dates	Supplier
15	Date Approval Required	Supplier
16/17	Sign & Date after Review for Accuracy	Vendor Surveillance
18/19	Sign & Date to acknowledge Receipt	Purchasing
20/21	Check Appropriate Block-Sign & Date	QAE
22/23	Check Appropriate Block-Sign & Date	Resp. Engr.
24	Check Appropriate Block if Applicable	Engr.

FINAL DRAFT

Block No.	Information	By Whom
25/26	Sign & Date	Lead Engr.
27/28	Sign & Date	Chief Engr.
29/30	Sign & Date when Rework/Repair, etc. Completed and Verified	Vendor Surveillance
31/32	Sign & Date to Close SNCR	Mgr. QAEGVS
	If Suppliers Disposition is not approved complete 33-47	
33	Vepco's Recommended Disposition	Resp. Engr.
34/35	Sign & Date	Resp. Engr.
36/37	Sign & Date	Lead Engr.
38/39	Sign & Date	Chief Engr.
40/41	Check Appropriate Block-Sign & Date	QAE
42/43	Sign & Date if Concur	Supplier
44/45	Sign & Date when Rework/Repair Completed and Verified	Vendor Surveillance
46/47	Sign & Date to Close SNCR	

FINAL DRAFT

VIRGINIA ELECTRIC AND POWER CO.
SUPPLIER NONCONFORMANCE REPORT

TO: VEPCO PURCHASING ATT: 1	FROM 2		SNCR # 3
ADJECT 4	P.O. # 5	S.O.# 6	QA CAT 7

SUBJECT 8	SPEC # 9	RELATED REPORT 10

PROBLEM DESCRIPTION

11

RECOMMENDED DISPOSITION (Include Technical Justification, if Use As Is or Repair)

12

INITIATOR (TITLE) 13	DATE 14	REQUIRED DATE 15	VENDOR SURVEILLANCE REVIEW 16	DATE 17
PURCHASING 18	DATE 19	QUALITY ASSURANCE ENGINEERING CONDITION ADVERSE TO QUALITY 20 YES ☐ NO ☐		DATE 21

DOCUMENT CHANGE 24				
☐ DWG ____	DISPOSITION APPROVED 22 YES ☐ NO ☐ DISCIPLINE ENGR.	DATE 23	DISPOSITION VERIFIED 29	DATE 30
☐ SPEC. ____ ☐ PROCEDURE ____	LEAD ENGINEER 25	DATE 26	QAE & VS (SNCR CLOSED) 31	DATE 32
☐ OTHER ____	CHIEF ENGINEER 27	DATE 28		

VEPCO COMMENT (If Supplier Disposition is not Approved)

33

FINAL DRAFT

DISPOSITION BY DISCIPLINE ENGINEER 34	DATE 35	LEAD ENGINEER 36	DATE 37	DISPOSITION VERIFIED 44	DATE 45
SUPPLIER CONCURRENCE 42	DATE 43	CHIEF ENGINEER 38	DATE 39	QAE & VS (SNCR CLOSED) 46	DATE 47

QUALITY ASSURANCE ENGINEERING CONDITION ADVERSE TO QUALITY 40 YES ☐ NO ☐	DATE 41

VIRGINIA ELECTRIC AND POWER CO.
SUPPLIER NONCONFORMANCE REPORT

TO: VEPCO PURCHASING ATT:	FROM		SNCR #
PROJECT	P.O. #	S.O.#	QA CAT
SUBJECT		SPEC. #	RELATED REPORT

PROBLEM DESCRIPTION

RECOMMENDED DISPOSITION (Include Technical Justification, if Use As Is or Repair)

INITIATOR (TITLE)	DATE	REQUIRED DATE	VENDOR SURVEILLANCE REVIEW	DATE
PURCHASING	DATE	QUALITY ASSURANCE ENGINEERING CONDITION ADVERSE TO QUALITY YES ☐ NO ☐		DATE

DOCUMENT CHANGE	DISPOSITION APPROVED YES ☐ NO ☐ DISCIPLINE ENGR.	DATE	DISPOSITION VERIFIED	DATE
☐ DWG ____	LEAD ENGINEER	DATE	QAE & VS (SNCR CLOSED)	DATE
☐ SPEC. ____ ☐ PROCEDURE ____ ☐ OTHER ____	CHIEF ENGINEER	DATE		

VEPCO COMMENT (If Supplier Disposition is not Approved).

FINAL DRAFT

DISPOSITION BY DISCIPLINE ENGINEER	DATE	LEAD ENGINEER	DATE	DISPOSITION VERIFIED	DATE
SUPPLIER CONCURRENCE	DATE	CHIEF ENGINEER	DATE	QAE & VS (SNCR CLOSED)	DATE

QUALITY ASSURANCE ENGINEERING CONDITION ADVERSE TO QUALITY YES ☐ NO ☐	DATE

EXPANSION JOINTS
NON-METALLIC JOINTS · COUPLINGS · CONNECTORS · DAMPENERS
FOR PIPING SYSTEMS
INDUSTRIAL AND PROCESS PIPING · AIR CONDITIONING SYSTEMS
POWER PLANTS · HEATING–MARINE–WATER–SEWAGE SYSTEMS

HOLZ HR RUBBER

INSTALLATION INSTRUCTIONS

EXPANSION JOINTS and VIBRATION DAMPENERS

Pre-Installation Check List:

1. **Compare the requirements of the system** to ensure the temperature pressure, vacuum, media and movements are not beyond or different from the recommendations of Holz Rubber Company for the expansion joints provided.
2. **Remeasure the opening** to ensure the face to face is accurate. Any variance from the specified opening will reduce the total allowable movements by the amount of variance.
3. **Align the piping** so the system misalignment does not exceed ⅛". If the system cannot be aligned to within ⅛", an offset expansion joint should be used.
4. **Check anchors, supports and alignment guides** to ensure proper design. The Holz non-metallic expansion joints and vibration dampeners are not designed to support the weight of the piping system. If the system is not properly supported or anchored, control rods must be installed. See reverse side for instructions.
5. **Clean companion metal flanges** of all foreign material. Be sure metal flanges do not have more than a 1/16" raised face.

Installation:

1. **Apply lubricant** consisting of a thin film of graphite dispersed in water or glycerine to the rubber flanges. No other lubricant or gasket is required.
2. **Install part** between mating flanges, inserting the bolts from the arch side of the flange. Washers must be used over splits in the retaining rings. Tighten bolts alternately around the joint until all nuts are tight and the rubber flanges bulge slightly.
3. **Inspect cover** for any accidental cuts or gouges. The protective cover should be repaired with rubber cement prior to system start-up.
4. **Re-Tighten bolts** after seven days of operation and periodically thereafter. Rubber parts will take a set after a period of compression. Loosening of the bolts and breakage of the seal may occur, if this procedure is not followed.

General Precautions:

1. **Spare parts** should be stored in a cool, dark, dry place in a flat position. (Do not store on flange edges.)
2. **System tests** should not exceed 150% of the rated working pressure of the expansion joints. Systems should not be operated above the rated pressure or temperature of the expansion joints.
3. **Insulating** over expansion joints is not recommended. If insulation is required, insulation should be designed for easy removal so the periodic inspection procedure can be maintained.
4. **Welding** should not take place in the vicinity of the expansion joints. If welding occurs frequently above the expansion joint, a shield should be installed. Contact Holz for shield information.
5. **If underground installation** is necessary, a protective shield over the expansion joint should be provided. Back filling directly onto the expansion joints is not recommended.

HOLZ RUBBER COMPANY, INC. • 1129 SO. SACRAMENTO STREET, LODI, CALIFORNIA 95240 • TELEPHONE (209) 368-7171 • TELEX 359453

NOTES:

1. HOLZ STYLE 320FA/777, EPDM FILLED ARCH, FLANGED EXPANSION JOINT WITH ANSI 125/150 lb DRILLING.
2. ALL EXPANSION JOINT MOUNTING HOLES TO BE LINED WITH EPDM TO PREVENT EXPOSED FABRIC.
3. RETAINING RINGS 3/8 THK. HOT-DIPPED GALVANIZED PER ASTM A-123, CERTIFICATION REQUIRED.
4. ALL MATERIALS TO BE CERTIFIED, TEST REPORTS AND HYDRO TEST CERT. ARE REQUIRED ON ALL JOINTS. VACUUM TEST CERTS. ARE REQUIRED FOR TAG No.'s. REJ-6 AND REJ-16 ONLY.
5. ALL EXPANSION JOINT COMPOUND, BATCH TEST REPORTS AND FULL TRACEABILITY BY BATCH NUMBER, MFG. DATE (QTR/YR.) ORDER NUMBER, JOINT MFG'R. DATE (MTH, DAY, YR.) ARE REQUIRED.

COVER SHEET

REF DWG'S No. A-9354 SHEET 2 OF 6 - REV. "A"
A-9354 SHEET 3 OF 6 - REV. "A"
A-9354 SHEET 4 OF 6 - REV. "A"
A-9354 SHEET 5 OF 6 - REV. "A"
A-9354 SHEET 6 OF 6 - REV. "A"

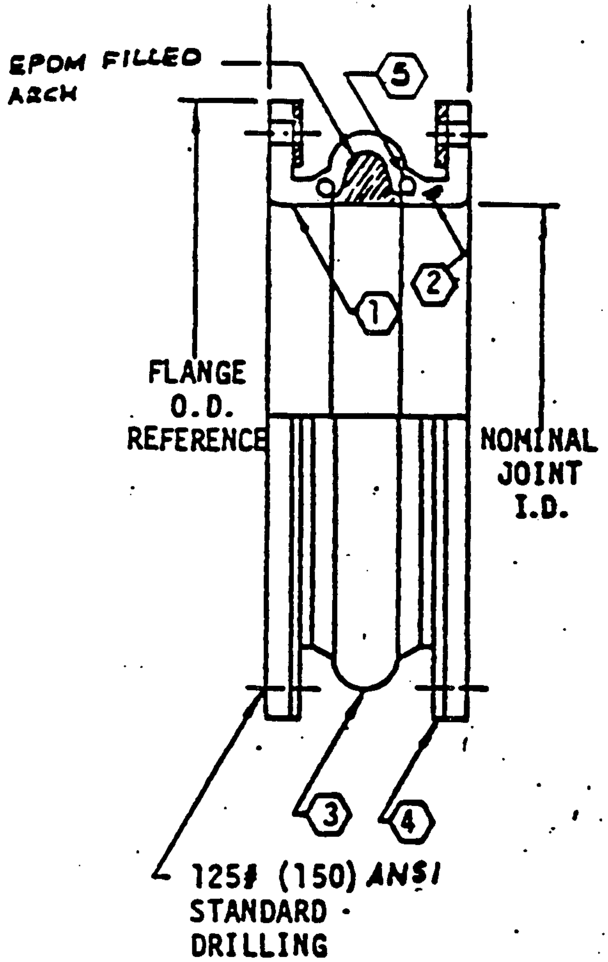
REVISIONS

LTR	DESCRIPTION	DATE	BY	CKD
A	REVISED SEE RECORD PRINT	7-13-87	ACH	TC

CUSTOMER: HENRY PRATT Co.
P.O. No. U-03104
S.O. No. E26467
QUOTE No. FD.8701-02
JOB: VIRGINIA ELECTRIC AND POWER Co.
SURRY POWER STATION, UNITS 1 AND 2; SURRY, VA.
RUBBER EXPANSION JOINTS - SERVICE WATER AND CIRC. WATER.
ENG'R: STONE AND WEBSTER, BOSTON, MA., SPEC. No. NUS-2076-ADDM. No. 1.

NEWCO HOLZ RUBBER COMPANY, INC.

Drawn by: A.C. Mames	Date: 7-2-87	Drawing Num A-9354
CHK BY	7-6-87	SHT. 1 of 6 REV.



				MOVEMENTS			
HYDRO TEST 15 MINUTES	NOMINAL JOINT ID	F/F	FLANGE OD REFERENCE	COMPR.	EXTEN.	LATERAL	ANGULAR
135 PSIG	36"	10"	46"	9/16"	9/32"	1/4"	.97°

MATERIALS
Tube Elastomer: (1) EPDM
Reinforcement: (2) POLYESTER
Cover Elastomer: (3) EPDM
Retaining Rings: (4) ASTM-A36 C.S. GALV.
BODY RINGS: (5) 1018 C.S.

			EXP. JOINT DESIGN
Pressure (psig)			90@180°F
Vacuum (in. Hg)			-0-
Maximum Temp. (°F)			180°F

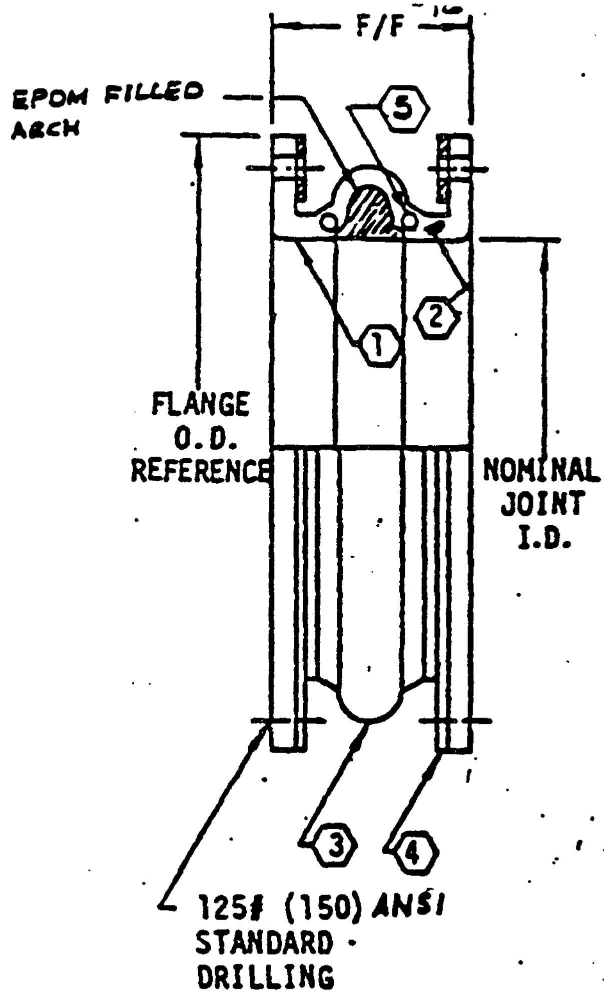
NOTE: These units must be anchored or installed with control units to assure maximum rated joint movements will not be exceeded.

QTY	TAG No.
2	SERVICE WATER SUPPLY TO BC HEAT EXCHANGE UNIT-1, REJ-8
2	SERVICE WATER SUPPLY TO BC HEAT EXCHANGE UNIT-2, REJ-8

REF DWG A-9354, SHEET 1 OF 6
REV. "A"

NEWCO HOLZ RUBBER COMPANY, INC.

Drawn by: A.C. Mames	Date: 7.2.87	Drawing No. A-9354
CHK BY TC	7-2-87	SHT. 4 of 6



HYDRO TEST 15 MINUTES	NOMINAL JOINT ID	F/F	FLANGE OD REFERENCE	MOVEMENTS COMPR.	EXTEN.	LATERAL	ANGULAR
135 PSIG	42"	10"	53"	9/16"	9/32"	1/4"	.83°

MATERIALS

Tube Elastomer: (1) EPDM
Reinforcement: (2) POLYESTER
Cover Elastomer: (3) EPDM
Retaining Rings: (4) ASTM-A36 C.S. GALV.
Body Rings: (5) 1018 C.S.

			EXP. JOINT DESIGN
Pressure (psig)			90 @ 180°F
Vacuum (in. Hg)			- 0 -
Maximum Temp. (°F)			180°F

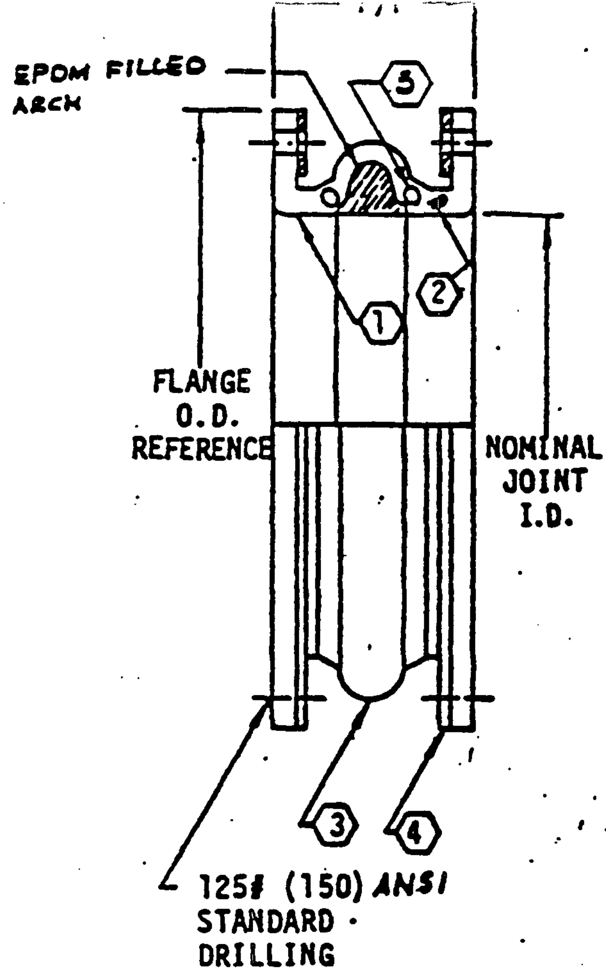
NOTE: These units must be anchored or installed with control units to assure maximum rated joint movements will not be exceeded.

QTY	TAG No.
2	SERVICE WATER SUPPLY TO CC HEAT EXCHANGE UNIT-1, REJ-7

REF DWG A-9354, SHEET 1 OF 6 REV. "A"

NEWCO HOLZ

Drawn by: A.C. Mones	Date: 7-2-87	Drawing Num. A-9354
CHK BY TC	7-2-87	SHT. 3 of 6 REV.



HYDRO TEST 15 MINUTES	NOMINAL JOINT ID	F/F	FLANGE OD REFERENCE	MOVEMENTS COMPR.	EXTEN.	LATERAL	ANGULAR
120 PSIG	96"	12"	113¼"	9/16	9/32"	¼"	.37°

MATERIALS
Tube Elastomer: (1) EPDM
Reinforcement: (2) POLYESTER
Cover Elastomer: (3) EPDM
Retaining Rings: (4) ASTM-A36 C.S. GALV.
BODY RINGS: (5) 1018 C.S.

			EXP. JOINT DESIGN
Pressure (psig)			80 @ 180°F
Vacuum (in. Hg)			- 0 -
Maximum Temp. (°F)			180°F

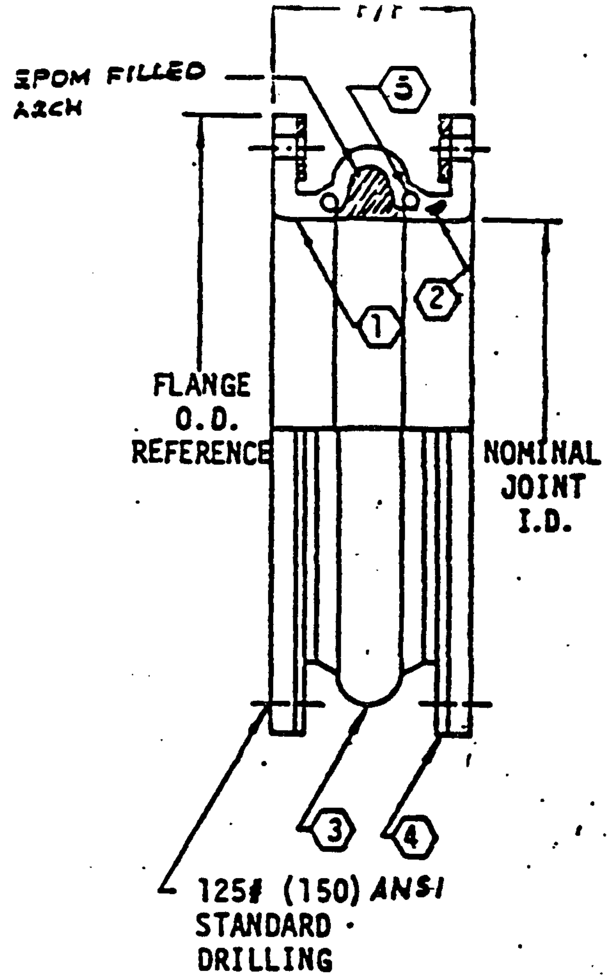
NOTE: These units must be anchored or installed with control units to assure maximum rated joint movements will not be exceeded.

QTY	TAG No.
4	COND. INLET, UNIT-1 REJ-2
4	COND. OUTLET, UNIT-1 REJ-4
4	COND. INLET, UNIT-2 REJ-2
4	COND. OUTLET, UNIT-2 REJ-4

REF DWG A-9354, SHEET 1 OF 6
REV. "A"

NEWCO HOLZ RUBBER COMPANY, INC.

Drawn by: A.C. Mames	Date: 7-2-87	Drawing Number: A-9354
CHK BY TC	7-2-87	SHT. 2 of 6



HYDRO TEST 15 MINUTES	NOMINAL JOINT ID	F/F	FLANGE OD REFERENCE	MOVEMENTS COMPR.	EXTEN.	LATERAL	ANGULAR
143 PSIG	30"	10"	38 3/4"	1/2"	1/4"	1/4"	0.9°
VACUUM TEST 15 MIN.	8 PCS						
-5 PSIG OR 10" Hg	REJ-6 ONLY						

MATERIALS

Tube Elastomer: (1) EPDM

Reinforcement: (2) POLYESTER

Cover Elastomer: (3) EPDM

Retaining Rings: (4) ASTM-A36 C.S. GALV.

Body Rings: (5) 1018 C.S.

			EXP. JOINT DESIGN
Pressure (psig)			95 @ 180°F
Vacuum (in. Hg)			10" Hg
Maximum Temp. (°F)			180° F

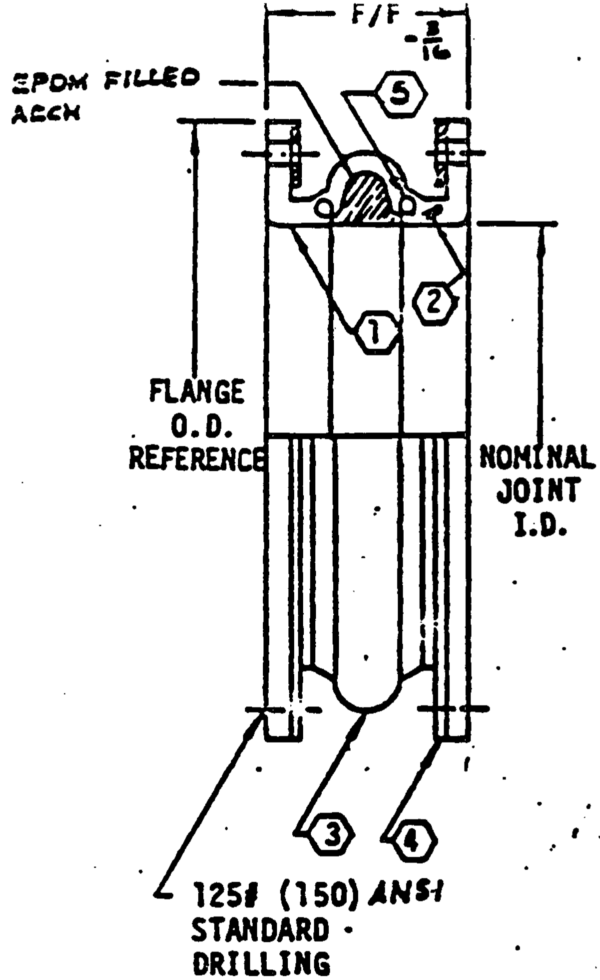
NOTE: These units must be anchored or installed with control units to assure maximum rated joint movements will not be exceeded.

QTY	TAG NO.
8	COMPONENT COOLING WATER HEAT EXCHANGE INLET AND OUTLET UNIT-1, REJ-6.
3	TEMPORARY EXPANSION JOINT-TEM. EXP. JT. 1

REF DWG A-9354, SHEET 1 OF 6 REV. "A"

NEWCO HOLZ RUBBER COMPANY, INC.

Drawn by: A.C. Mouses	Date: 7-2-87	Drawing Nu[mber] A-9354
CHK BY TC	7-2-87	SHT. 5 of 6



HYDRO TEST 15 MINUTES	NOMINAL JOINT ID	F/F	FLANGE OD REFERENCE	MOVEMENTS COMPR.	EXTEN.	LATERAL	ANGULAR
300 PSIG	10"	12"	16"	3/8"	3/16"	1/4"	2.25°
VACUUM TEST 15 MIN.							
-5 PSIG OR 10" Hg							

MATERIALS

Tube Elastomer: 1 EPDM

Reinforcement: 2 POLYESTER

Cover Elastomer: 3 EPDM

Retaining Rings: 4 ASTM-A36 C.S. GALV.

Body Rings: 5 1013 C.S.

			EXP. JOINT DESIGN
Pressure (psig)			200 @ 180°F
Vacuum (in. Hg)			10" Hg
Maximum Temp. (°F)			180°F

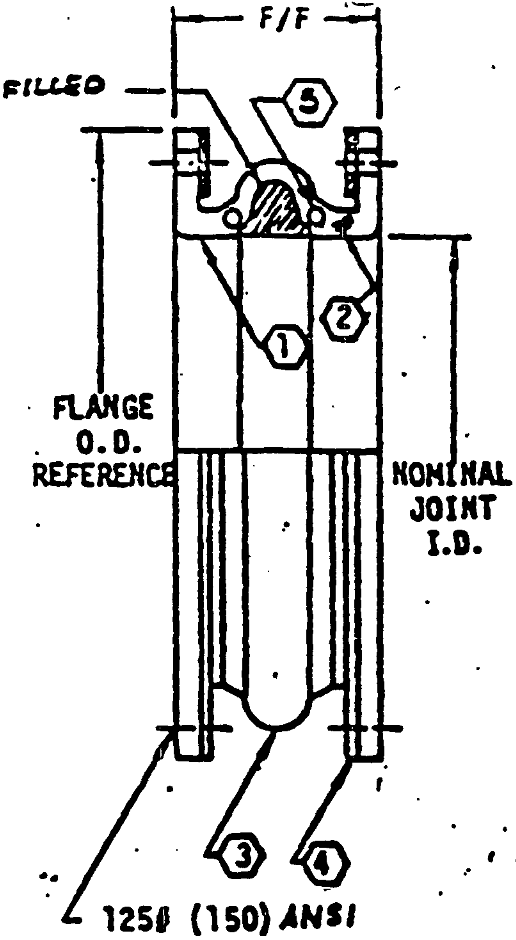
NOTE: These units must be anchored or installed with control units to assure maximum rated joint movements will not be exceeded.

QTY	TAG No.
2	SERVICE WATER PUMP SUCTION UNIT-2, REJ-16

REF DWG A-9354, SHEET 1 OF 6
REV. "A"

NEWCO HOLZ RUBBER COMPANY, INC.

Drawn by: A.C. Moses	Date: 7-2-87	Drawing Number A-9354
CHK BY TC	7-2-87	SHT. 6 of 6 REV



CERTIFIED FOR FABRICATION 9/11/87

HYDRO TEST 15 MINUTES	NOMINAL JOINT ID	F/F	FLANGE OD REFERENCE	MOVEMENTS COMPR.	EXTEN.	LATERAL		VACUUM TEST	T...
143 PSIG	30"	10"	38 3/4"	5/8"	7/16"	7/16"		10" Hg @ 15 MIN.	BE...
143 PSIG	30"	10"	38 3/4"	5/8"	7/16"	7/16"		N.R.	J...

MATERIALS
Tube Elastomer: (1) EPDM
Reinforcement: (2) POLYESTER
Cover Elastomer: (3) EPDM
Retaining Rings: (4) ASTM-A36 C.S. GALV.
Body Rings: (5) 1018 C.S.

			EXP. JOINT DESIGN
Pressure/Temp (psig) (°F)			95 @ 180°F
Vacuum (In. Hg)			10" Hg
Maximum/Exc Temp.			1 HR @ 310 °F

QTY	TAG NO.
8	COMPONENT COOLING WATER HEAT EXCHANGE INLET AND OUTLET UNIT-1, REJ-6.
3	TEMPORARY EXPANSION JOINT-TEM. EXP. JT. 1

REF DWG A-9354, SHEET 1 OF 6
REV. "B"

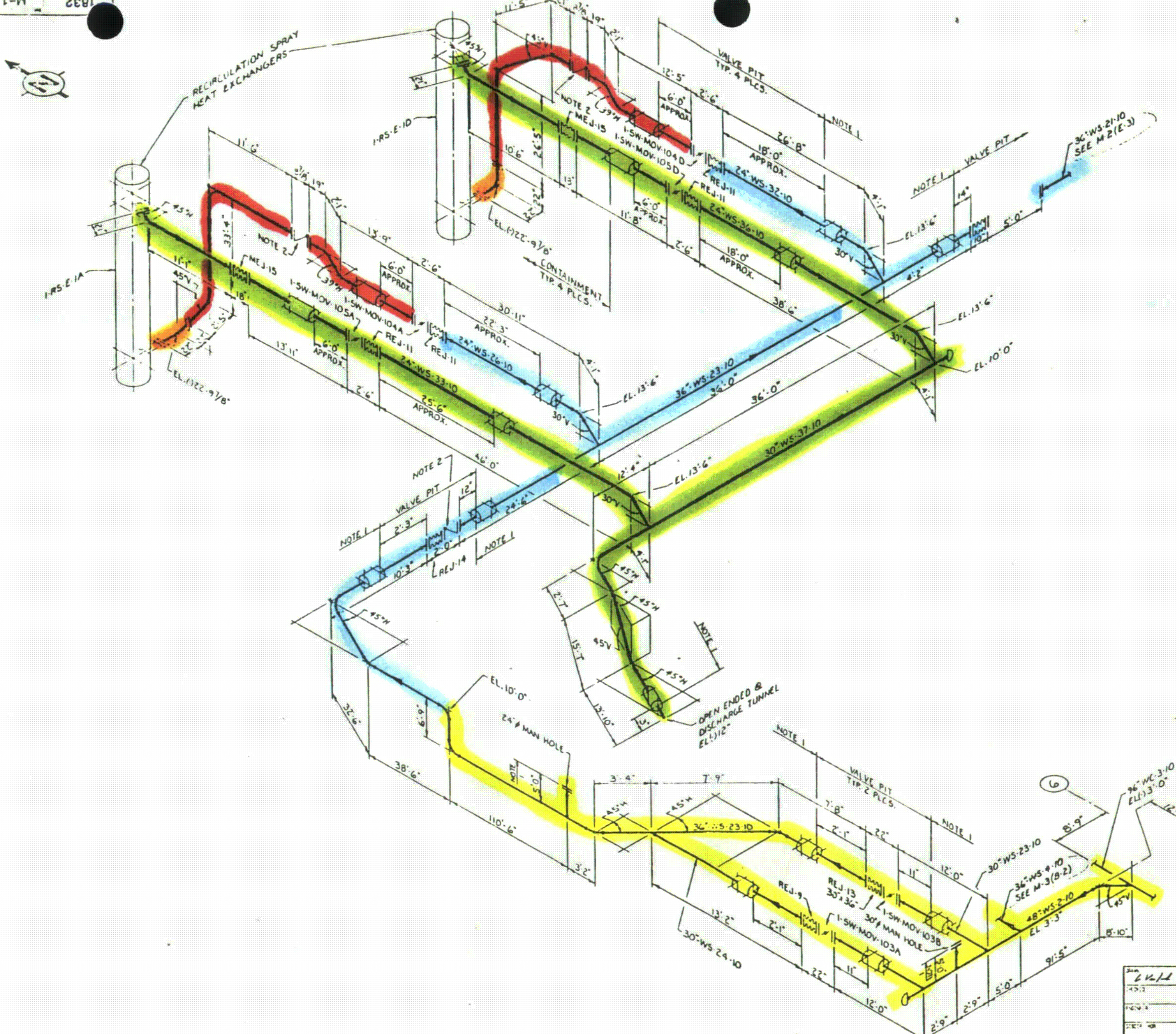
NEWCO HOLZ RUBBER COMPANY, INC.

5 of 6
REV. B

Drawn by: A.C. Morgan | Date: 7-2-87 | Drawing No. A-9354
CHK BY | 7-2-87

SURRY UNIT 1 & 2 SERVICE WATER SYSTEM PIPE COATING STATUS as of 7/9/91	
	Pipe has been cleaned, inspected, weld repaired (as necessary), and CHESTERTON coated. **JOB COMPLETE!**
	Pipe has been cleaned and inspected. Future outages will reclean, reinspect, weld repair (as necessary) and CHESTERTON coat.
	Pipe has been cleaned and inspected. Future outages will replace 24" non-functional check valves with spool pieces. Unit 2 piping has been weld repaired, but will be reinspected prior to CHESTERTON coating.
	Pipe has been inspected only. Future outages will clean, inspect, weld repair (as necessary) and CHESTERTON coat.
	Pipe has NOT been inspected. Future outages will clean, inspect, weld repair (as necessary) and CHESTERTON coat.

<u>NOTE:</u> CHESTERTON coating products are approved for use in the Circulating and Service Water Systems. CHESTERTON Abrasion Control Liquid 855 and Putty 858 are Multifunctional Epoxys that are 100% solids. This 100% solids feature reduces sags and voids since there are no solvents.



NOTES:

1) NON-ACCESSIBLE; PIPING IS ENCASED/BURIED
2) NON-FUNCTIONAL: CHECK VALVE INTERNALS HAVE BEEN REMOVED
3) PIPING HIGHLIGHTED (▬▬) TO BE COATED DURING 1992 OUTAGE
4) PIPING NOT HIGHLIGHTED TO BE COATED DURING 1990 OUTAGE

THE INFORMATION SHOWN ON THIS DRAWING HAS BEEN REPRODUCED FROM THE FOLLOWING VIRGINIA POWER DRAWINGS:

11448-FM-071A SH. 3	CIRCULATING AND SERVICE WATER SYSTEM DIAGRAM
11448-FP-4A,B,C & D	SERVICE WATER LINES

FOR PIPE AND FITTING MATERIALS SEE VIRGINIA POWER SPECIFICATION NUS-19, "SPECIFICATION FOR WELDED STEEL CIRCULATING WATER PIPING".

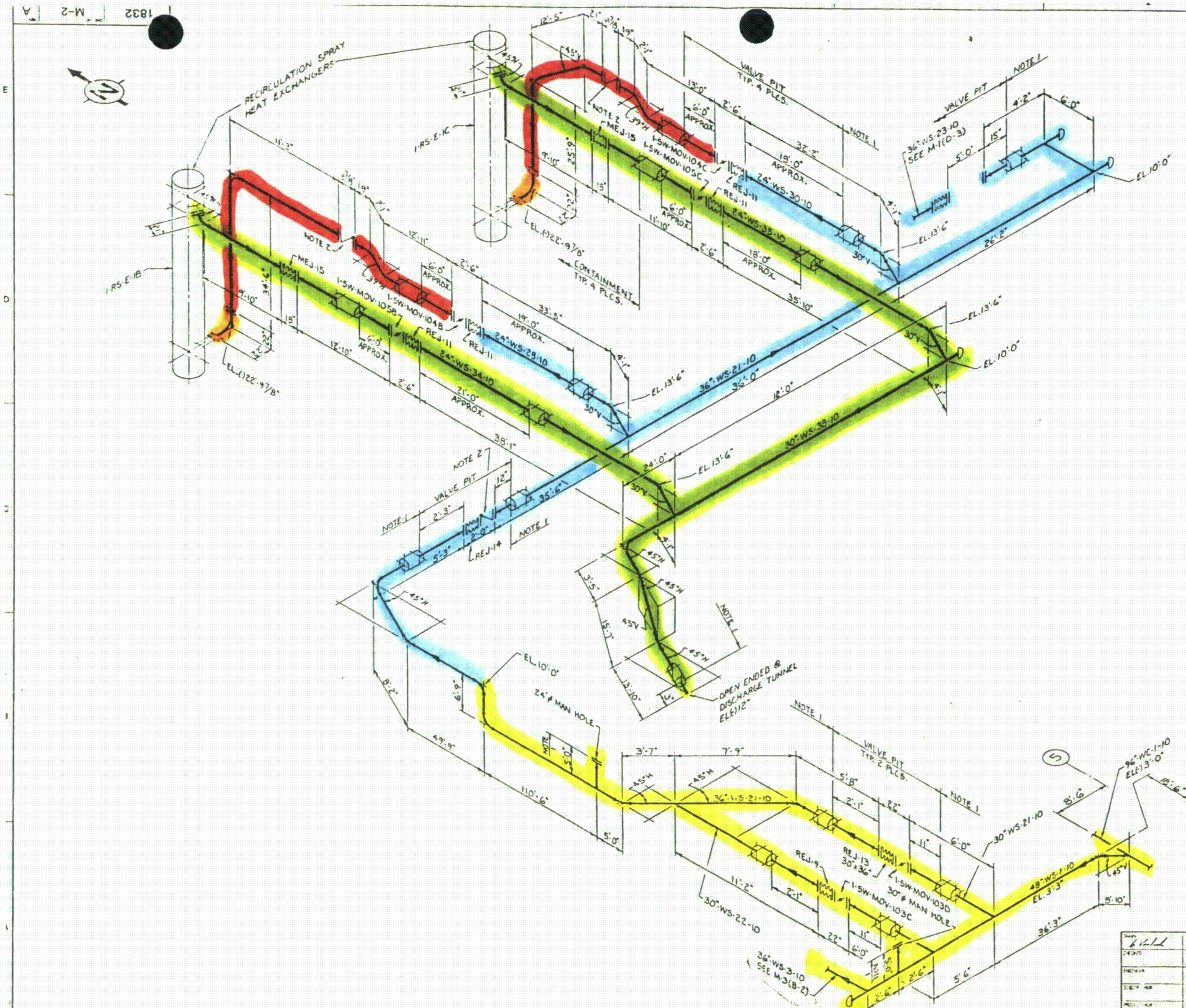
ISSUED FOR REFERENCE ONLY
DCP-90-26-1

VIRGINIA POWER | SURRY UNIT 1

PIPING ISOMETRIC
SERVICE WATER SUPPLY & RETURN
RECIRCULATION SPRAY HEAT EXCHANGERS

NUS CORPORATION

JOB NO	DRAWING NO	REV
1832	8-9036-1-M-600	A
SCALE NONE	SHEET 1 OF 1	



NOTES:

1) NON-ACCESSIBLE; PIPING IS ENCASED/BURIED
2) NON-FUNCTIONAL; CHECK VALVE INTERNALS HAVE BEEN REMOVED
3) PIPING HIGHLIGHTED (▬▬) TO BE COATED DURING 1992 OUTAGE
4) PIPING NOT HIGHLIGHTED TO BE COATED DURING 1990 OUTAGE

THE INFORMATION SHOWN ON THIS DRAWING HAS BEEN REPRODUCED FROM THE FOLLOWING VIRGINIA POWER DRAWINGS:

11448-FM-071A SH. 3&3 CIRCULATING AND SERVICE WATER SYSTEM DIAGRAM

11448-FP-4A, B, C & D SERVICE WATER LINES

FOR PIPE AND FITTING MATERIALS SEE VIRGINIA POWER SPECIFICATION NUS-29, "SPECIFICATION FOR WELDED STEEL CIRCULATING WATER PIPING".

ISSUED FOR REFERENCE ONLY
DCP-90-26-1

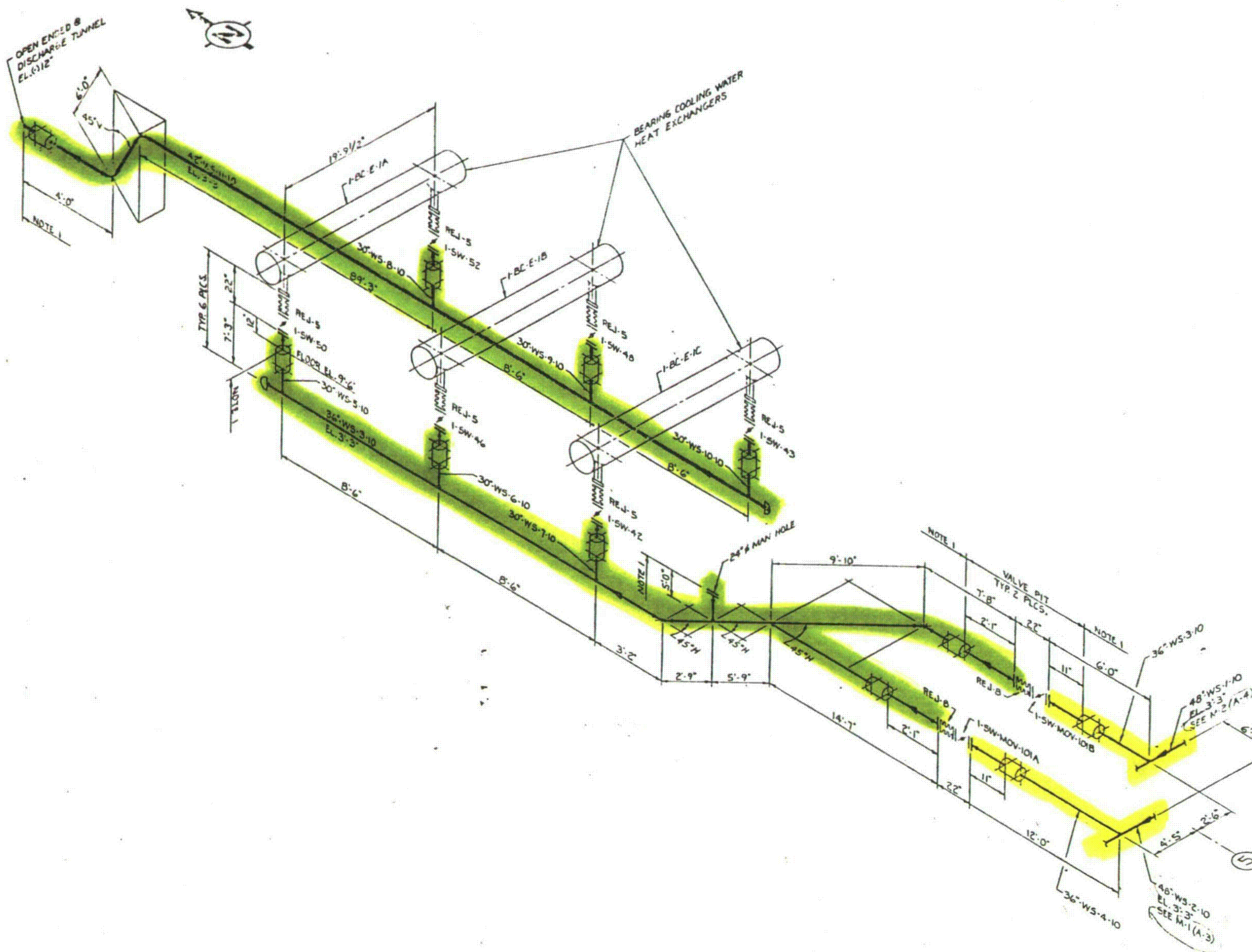
VIRGINIA POWER | SURRY UNIT 1

PIPING ISOMETRIC
SERVICE WATER SUPPLY & RETURN
RECIRCULATION SPRAY HEAT EXCHANGERS

NUS CORPORATION

1832 | 8-9026-1-M-801 | A

SCALE NONE



NOTES:

1) NON ACCESSIBLE; PIPING IS ENCASED/BURIED
2) PIPING HIGHLITED (▬▬) TO BE COATED DURING 1992 OUTAGE.
3) PIPING NOT HIGHLITED TO BE COATED DURING 1990 OUTAGE.

THE INFORMATION SHOWN ON THIS DRAWING HAS BEEN REPRODUCED FROM THE FOLLOWING VIRGINIA POWER DRAWINGS:

11448-FM-071A SH. 2&3	CIRCULATING AND SERVICE WATER SYSTEM DIAGRAM
11448-FP-4A,B,C & D	SERVICE WATER LINES

FOR PIPE AND FITTING MATERIALS SEE VIRGINIA POWER SPECIFICATION NUS-29, "SPECIFICATION FOR WELDED STEEL CIRCULATING WATER PIPING".

REVISIONS

A ISSUED FOR REFERENCE ONLY DCP-90-26-1

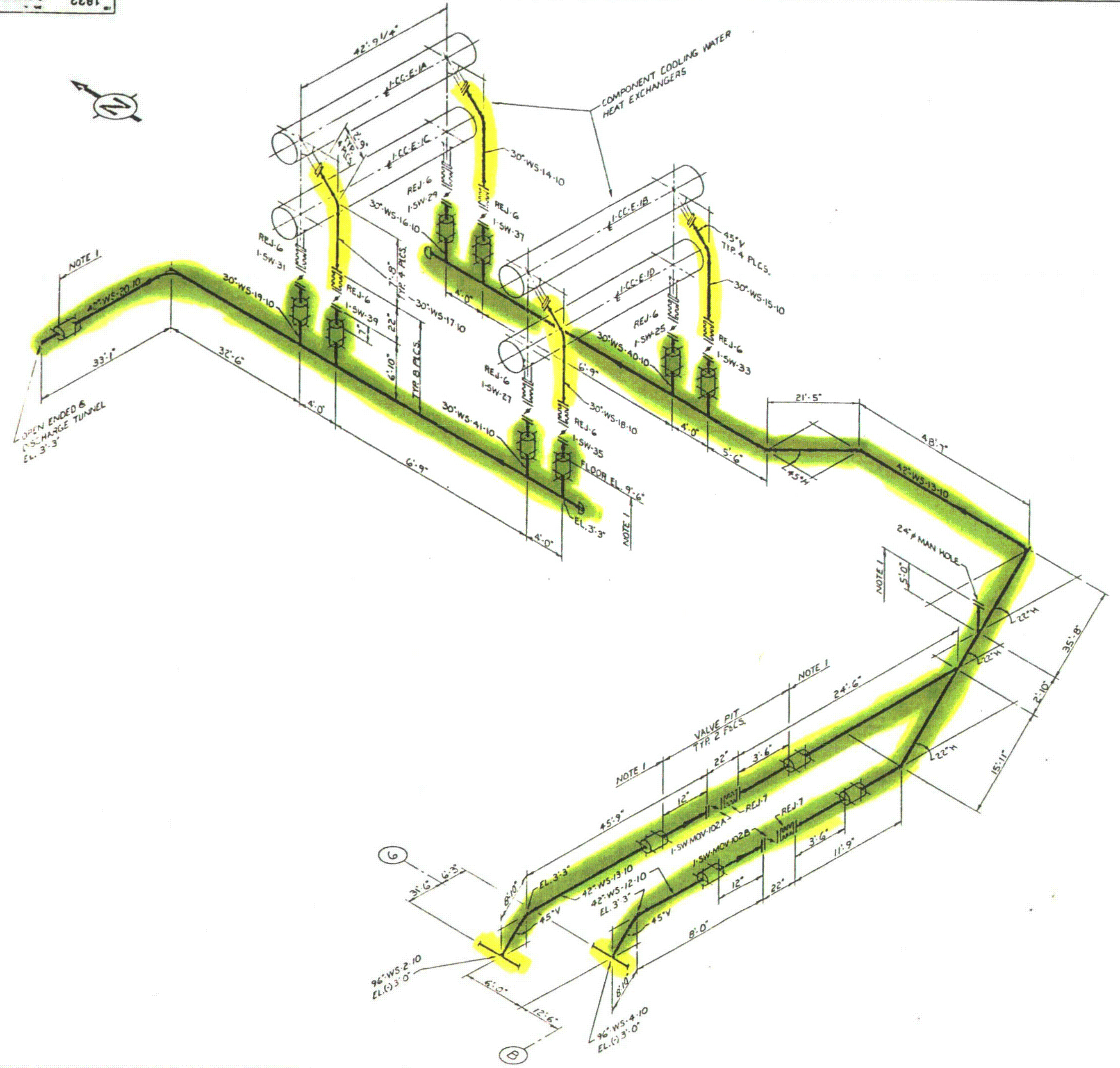
OUTSTANDING DCN'S

ISSUED FOR REFERENCE ONLY
DCP-90-26-1

VIRGINIA POWER | SURRY UNIT 1

PIPING ISOMETRIC
SERVICE WATER SUPPLY & RETURN
BEARING COOLING WATER HEAT EXCHANGERS

NUS CORPORATION | JOB NO. 1832 | SCALE NONE | DRAWING NO. S-9026-1-M-602 | SHEET 1 OF 1 | REV. A



NOTES:
1) NON-ACCESSIBLE: PIPING IS ENCASED/BURIED
2) PIPING HIGHLITED (▬▬) TO BE COATED DURING 1992 OUTAGE.
3) PIPING NOT HIGHLITED TO BE COATED DURING 1990 OUTAGE.
4) PIPING HIGHLITED (▬▬) IS NOT PART OF THIS DCP.

THE INFORMATION SHOWN ON THIS DRAWING HAS BEEN REPRODUCED FROM THE FOLLOWING VIRGINIA POWER DRAWINGS:

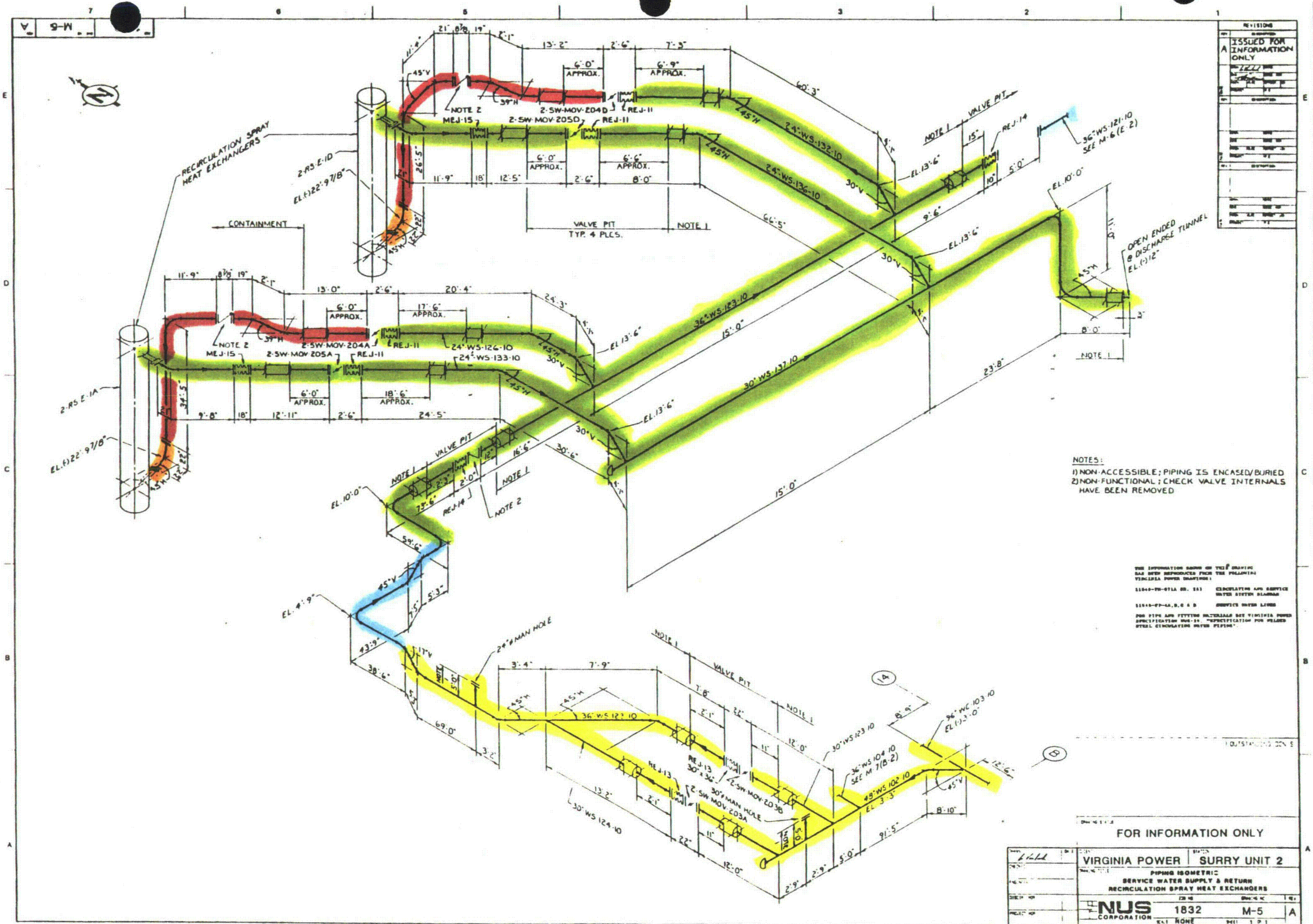
11448-FM-071A SH. 2&3 — CIRCULATING AND SERVICE WATER SYSTEM DIAGRAM

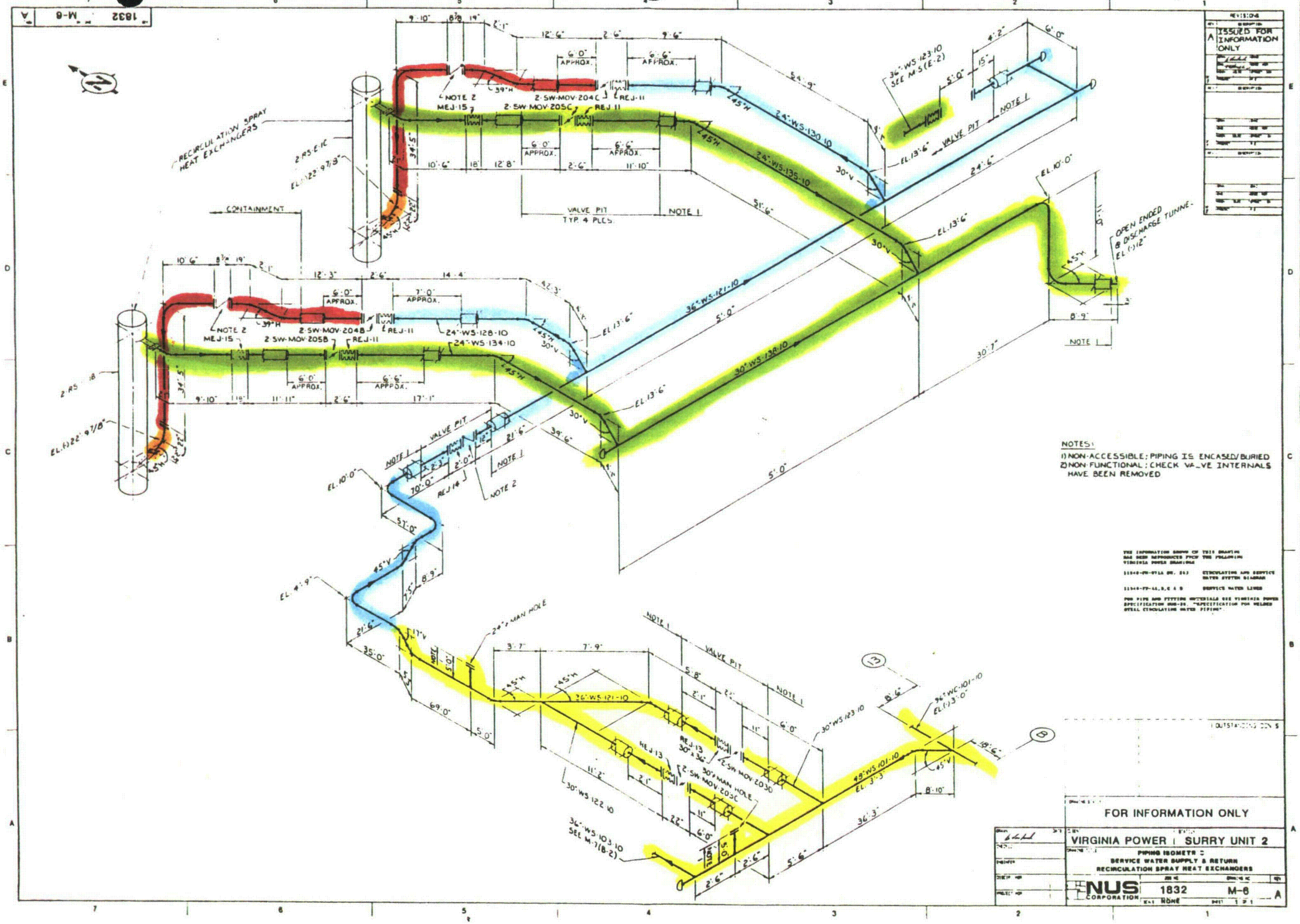
11448-FP-4A,B,C & D — SERVICE WATER LINES

FOR PIPE AND FITTING MATERIALS SEE VIRGINIA POWER SPECIFICATION NUS-39, "SPECIFICATION FOR WELDED STEEL CIRCULATING WATER PIPING".

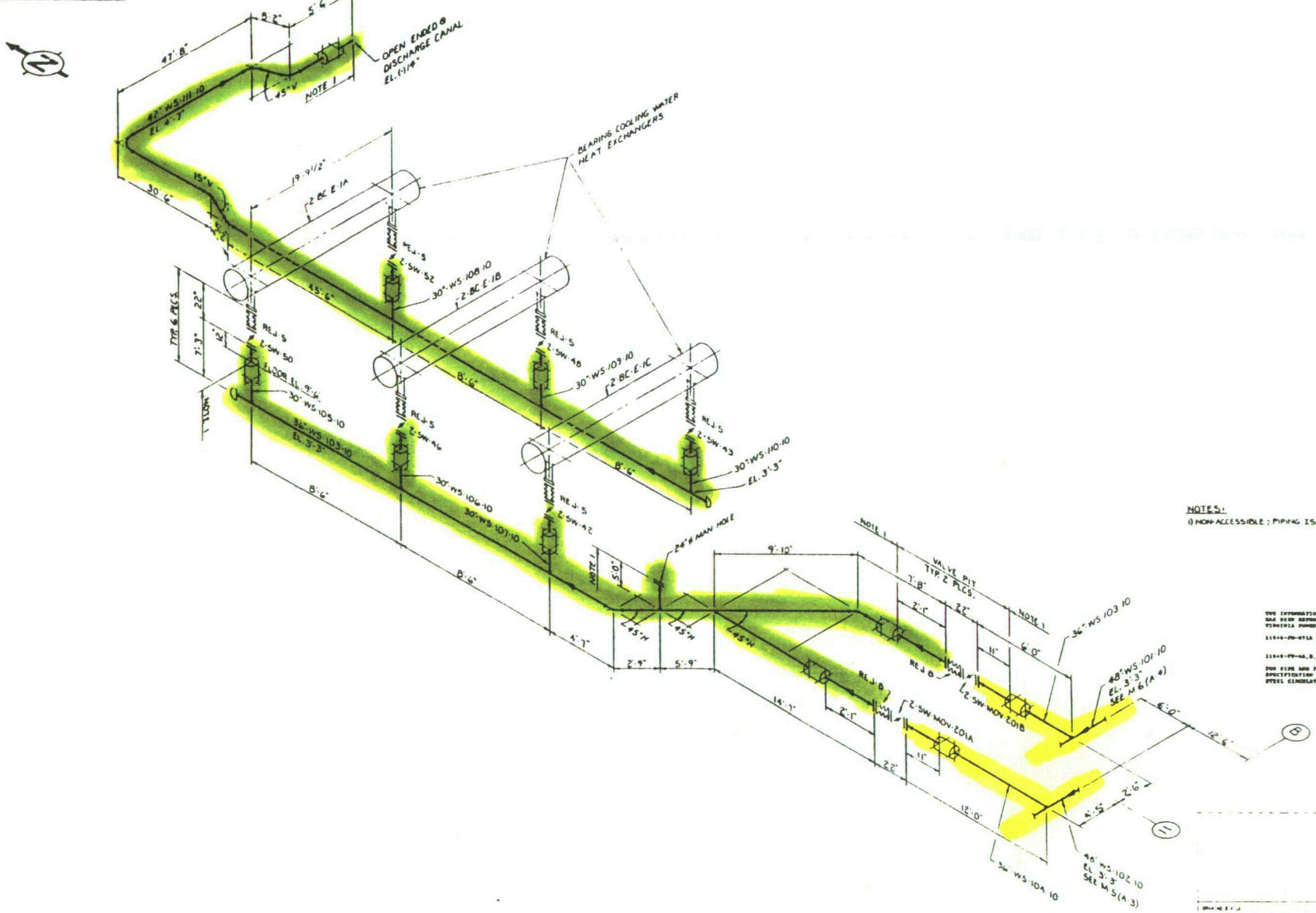
ISSUED FOR REFERENCE ONLY
DCP-90-26-1

VIRGINIA POWER	SURRY UNIT 1
PIPING ISOMETRIC SERVICE WATER SUPPLY & RETURN COMPONENT COOLING WATER HEAT EXCHANGERS	
NUS CORPORATION	1832
SCALE NONE	8-9026-1-M-803 A
	SHEET 1 OF 1


RECIRCULATION SPRAY HEAT EXCHANGERS
2-RS-E-1D
2-RS-E-1A
EL.(-)22'-9 7/8"
CONTAINMENT
VALVE PIT
TYP. 4 PLCS.
NOTE 1
NOTE 2
2-SW-MOV-204D
2-SW-MOV-205D
2-SW-MOV-204A
2-SW-MOV-205A
2-SW-MOV-203A
2-SW-MOV-203B
MEJ-15
REJ-11
REJ-14
REJ-13
24"-WS-132-10
24"-WS-136-10
24"-WS-126-10
24"-WS-133-10
36"-WS-123-10
30"-WS-137-10
36"-WS-121-10
SEE M-6 (E-2)
36"-WS-104-10
SEE M-7(B-2)
48"-WS-102-10
96"-WC-103-10
30"-WS-124-10
30"-WS-123-10
24"Ø MAN HOLE
30"Ø MAN HOLE
OPEN ENDED
@ DISCHARGE TUNNEL
EL.(-)12"
NOTES:
1) NON-ACCESSIBLE; PIPING IS ENCASED/BURIED
2) NON-FUNCTIONAL; CHECK VALVE INTERNALS HAVE BEEN REMOVED
REVISIONS
A ISSUED FOR INFORMATION ONLY
FOR INFORMATION ONLY
VIRGINIA POWER
SURRY UNIT 2
PIPING ISOMETRIC
SERVICE WATER SUPPLY & RETURN
RECIRCULATION SPRAY HEAT EXCHANGERS
NUS CORPORATION
1832
M-5
A
NONE



ISSUED FOR INFORMATION ONLY
RECIRCULATION SPRAY HEAT EXCHANGERS
CONTAINMENT
VALVE PIT
TYP. 4 PLCS.
NOTE 1
NOTE 2
MEJ-15
REJ-11
REJ-13
REJ-14
2-SW-MOV-204C
2-SW-MOV-205C
2-SW-MOV-204B
2-SW-MOV-205B
2-SW-MOV-203D
2-SW-MOV-205C
24"-WS-130-10
24"-WS-135-10
24"-WS-128-10
24"-WS-134-10
36"-WS-121-10
30"-WS-138-10
36"-WS-123-10
SEE M-5(E-2)
36"-WS-121-10
30"-WS-123-10
30"-WS-122-10
36"-WS-103-10
SEE M-7(B-2)
48"-WS-101-10
36"-WC-101-10
24" ⌀ MAN HOLE
30" ⌀ MAN HOLE
OPEN ENDED
@ DISCHARGE TUNNEL
NOTES:
1) NON-ACCESSIBLE; PIPING IS ENCASED/BURIED
2) NON-FUNCTIONAL; CHECK VALVE INTERNALS HAVE BEEN REMOVED
FOR INFORMATION ONLY
VIRGINIA POWER | SURRY UNIT 2
PIPING ISOMETRIC
SERVICE WATER SUPPLY & RETURN
RECIRCULATION SPRAY HEAT EXCHANGERS
NUS CORPORATION
1832
M-6
A
NONE
1 OF 1



NOTES:
1) NON-ACCESSIBLE; PIPING IS ENCASED/BURIED

ISSUED FOR INFORMATION ONLY

FOR INFORMATION ONLY

VIRGINIA POWER | SURRY UNIT 2

PIPING ISOMETRIC
SERVICE WATER SUPPLY & RETURN
BEARING COOLING WATER HEAT EXCHANGERS

NUS CORPORATION

1832 | M-7 | A

SCALE NONE