SEABROOK STATION

MODERATE ENERGY LINE BREAK STUDY

PREPARED BY

UNITED ENGINEERS & CONSTRUCTORS INC.

FOR

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE
MANCHESTER, NEW HAMPSHIRE

JUNE 1984

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MODERATE ENERGY LINE BREAK STUDY
TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

7.0 ILLUSTRATIONS

MODERATE ENERGY LINE BREAK STUDY

1.0 INTRODUCTION

In accordance with the requirements of 10CFR50, Appendix A, General Design Criteria for Nuclear Power Plants (Reference A), structures, systems and components important to safety must be capable of performing their safety-related functions under environmental conditions resulting from normal operation, maintenance, testing and postulated accidents.

One type of postulated accident which could result in an abnormal or severe environmental condition, affecting essential systems or components, is a rupture or crack in a line carrying moderate energy fluid in close proximity to systems or components important to safety at locations outside containment. (Ref. B)

The purpose of this study is to evaluate the effects of such a moderate energy line break on those systems or components important to the safety of the Seabrook plant. Each of these systems or components has been compiled and included in Tables 4.1 through 4.8 of Section 6 and is also illustrated in Figures 4.1 through 4.8 of Section 8.

This study considered primarily the flooding and spray impingement effects resulting from the rupture of moderate energy lines. Complete immersion in conductive fluids could render many electrical and some mechanical components inoperable due to degradation of insulation, bearing lubrication, etc. The method chosen for the analysis was to consider each major building individually. In evaluating the effects of flooding, all moderate energy lines in a given area were reviewed and the line whose failure would result in the most severe flooding rate was selected to be considered the subject of the limiting failure.

In accordance with the requirements of Reference R, the following criteria were used:

1. Cracks were postulated in all moderate energy fluid system piping and branch runs exceeding a nominal pipe size of one inch. These cracks were postulated individually at locations that resulted in the most severe environmental consequences.
2. Fluid flow from a crack was based on a circular opening of area equal to that of a rectrangle one half pipe diameter in length and one half pipe wall thickness in width.
3. The flow from the crack was assumed to result in an environment that wetted all unprotected components within the compartment, with consequent flooding in the compartment and communicating compartments. Flooding effects were generally determined on the basis of a conservatively estimated time period required to effect corrective action.

Rupture of moderate energy lines containing gaseous fluids such as compressed air or nitrogen was not considered because the results of these breaks would not cause failure of systems important to safety.

In evaluating the effects of liquid spray, unless the component is located away from all moderate energy lines, the component was assumed to be subjected to spray impingement, regardless of the moderate energy line source. It is concluded on a general basis that spray impingement from a MELB does not adversely affect the capability of components from performing their safety function because of the protective features specified when the components were purchased. These features include drip-proof motors, enclosures for electrical components which are either water proof or water shedding, water proof or water shedding instrument and control components, water shedding HVAC fan and filter housings, and water proof and water shedding electrical junction and pull boxes - some with drip shields.

Spray impingement will not be discussed in greater detail in the building sub-sections unless particular measures have been taken to protect essential components from MELB sprays.

In evaluating the capability of essential safe shutdown components to remain operable in the presence of a MELB, the following assumptions were made:

a. Valve and pump bodies, piping, and pressure vessels cannot be affected by water or water spray or by immersion, since they are carbon steel or stainless steel forgings or castings which are designed to act as fluid pressure boundaries.

b. All safety-related motors used in this plant, other than those supplied by the NSSS, must meet the requirements of UE&C Specification 9763-128-1, and are either drip-proof or totally enclosed. Drip-proof motors are protected by housings from falling water or falling objects, and cooling air intakes are protected by baffles to prevent ingestion of solid objects or water spray. Heavy spray, directed into the air intakes, could be drawn into the motor, and if permitted to remain for long periods of time, could eventually cause deterioration of the motor insulation and lubrication, thereby shortening motor life. Short-term or immediate failure of the motor as a result of water spray is not a credible event. (Ref. C)

c. Complete immersion due to flooding is considered to render motors inoperable because of degradation of insulation and bearing lubrication, and because of possible short circuiting of internal circuitry.

d. Pneumatic and hydraulic valve operators will not be rendered inoperable by direct moderate-energy water spray because their solenoid valves and position switches are covered by NEMA-12 enclosures, which are water-resistant. Pneumatic diaphragms and pistons are enclosed in water-tight housings, and hydraulic pistons are enclosed in closed hydraulic systems which are sealed against the entry of water.

e. Complete immersion of pneumatic operators is considered to render them inoperable by covering the discharge vent and possibly filling the low-pressure chamber with water.

f. Solenoid valves are not affected by moderate energy spray or complete immersion because their coils are potted with epoxy or polyster resins which are impervious to water, and because they are enclosed in water-tight housings. (Ref. F)

g. Safety class limit switches used for Seabrook are enclosed in NEMA-12 housings, and their function will not be affected by moderate energy spray. Complete immersion in water is considered to render them inoperable because the weatherproof housings are not designed to exclude water under pressure.

h. Switches mounted on cabinets or panels with watershed design are not affected by moderate energy spray. Complete immersion is considered to render them inoperable. (Ref. H, J)

Water shed design means that a cap or cover is used to deflect falling water away from openings in the cabinet. If direct spray is a credible event, it is considered in the design of the cover.

i. Instrument racks are designed with NEMA-12 housings and are not susceptible to damage due to moderate energy spray. (Ref. E)

j. Essential dampers, pneumatic operators, pilot valves, thermal switches and fans are enclosed in NEMA-12 housings and are not considered to be affected by moderate energy spray. (Ref. D)

k. Cables enclosed in conduit or in cable trays are not considered to be affected by moderate energy spray or immersions because their waterproof insulation is unbroken by splices.

l. Motor control centers, terminal boards and other devices which contain electrical terminations are not considered to be waterproof, and direct moderate energy spray or immersion are considered to render them inoperable due to short circuiting, unless special protection is provided.

m. Flooding of one RHR vault would not affect the equipment in the other vault, since pipe penetrations between the vaults are sealed to prevent leaks into the other vault.

2.0 REFERENCES

A. 10CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

B. Branch Technical Position ASB3-1, Protection Against Postulated Piping Failures in Fluid Systems Outside Containment (NUREG-0800).

C. UE&C Specification 9763-128-1, Rev. 4, Alternating Current Induction Motors.

D. UE&C Specification 9763-248-13, Rev. 6, Actuators for Dampers and Valves.

E. UE&C Specification 9763-171-1, Rev. 4, Instrument Racks.

F. UE&C Specification 9763-173-7, Rev. 1, Solenoid Valves.

G. UE&C Specification 9763-174-1, Rev. 9, Electronic Transducers.

H. UE&C Specification 9763-252-14, Rev. 3, Pressure Switches.

I. UE&C Specification 9763-252-16, Rev. 8, Differential Pressure Instrumentation.

J. UE&C Specification 9763-252-17, Rev. 2, Temperature Switches.

K. SD-1, Rev. 6, System Design Description for Condensate, Feedwater, ad Heater Drain System.

L. SD-23, Rev. 4, System Design Description for the Primary Component Cooling Water System (CC).

M. SD-24, Rev. 4, System Design Description for Station Service Water System.

N. SD-52, Rev. 7, Fire Protection System.

O. SD-57, Rev. 6, Plant Storm Drainage System.

P. Letter SB-12677, dated January 19, 1982, MELB Study Equipment Requirements.

Q. UE&C Specification 9763-006-249-7, Rev. 3, Wall and Floor Penetration Sealant.

R. Branch Technical Position MEB-3-1, Postulated Rupture Locations in Fluid System Piping Inside and Outside Containment (NUREG-0800).

S. SD-10, Rev. 2, System Design Description for Diesel Generator - Mechanical Systems

3.0 DEFINITIONS

Essential systems/components - systems and components required to shutdown the reactor and mitigate the consequences of a postulated piping failure without offsite power.

Moderate energy line - a line that during normal plant condition is either in operation or maintained pressurized above atmospheric pressure under conditions where both of the following conditions are met:

A. Maximum operating temperature is 200°F or less, and

B. Maximum operating pressure is 275 psig or less.

4.0 ANALYSIS

4.1 RHR, Containment Spray and Safety Injection Equipment Vaults

(Refer to Table 4.1 and Figure 4.1)

There are two RHR, containment spray, and safety injection equipment vaults. They extend from a roof elevation of 25'6" to an elevation of (-)61' where the sumps are located. Each floor elevation in the vaults contains grating such that liquid from a line break or crack will fall through the grating and accumulate at the (-)61' elevation with little or no accumulation elsewhere.

Separating the two vaults is a 30-inch concrete wall with a total of fifteen penetrations. All fifteen penetrations are above the maximum flood level resulting from the worst case moderate energy line break in either vault. Six of the penetrations carry pipes, all of which are sealed to sleeves embedded in the concrete wall. The seals are designed to withstand a pressure differential of approximately 3 psi, and tested at 4.5 psid.

There are seven spare penetration sleeves which penetrate the same wall; these are sealed by means of a 1/4-inch thick carbon steel plate seal welded to each end of the sleeves.

The two remaining penetrations are passageways between the vaults at Elevations (-)31'10" and 3'2". Each of these passageways is equipped with a door. Both doors are well above the maximum flood level resulting from the worst case moderate energy line break in either vault. Although not designed to be a watertight door, the spray and flooding effects due to a line break above the doors will not result in significant passage of water beyond the door because of the physical location of piping in relation to the doorway and because of the floor grating which will drain water to lower elevations in the building. Thus, a MELB in one vault will not result in flooding or spray impingement effects in the other vault.

The following drawings were used in evaluating the effects of moderate energy pipe breaks in the vault areas:

Piping Drawings

9763-F-805060, Rev. 10
805061, Rev. 13
805078, Rev. 06
805200, Rev. 12
805201, Rev. 13
805202, Rev. 12
805203, Rev. 10
805204, Rev. 12
805205, Rev. 13
805206, Rev. 11
805207, Rev. 09
805545, Rev. 03
805563, Rev. 14
805565, Rev. 07

Electrical Drawings

9763-F-310761, Rev. 14
310762, Rev. 14
310763, Rev. 23
310781, Rev. 08
310782, Rev. 11

Instrumentation Drawings

9763-F-500331, Rev. 07

Arrangement Drawings

9763-F-805060, Rev. 11
805078, Rev. 7

Mechanical Services Drawings

9763-F-604112, Rev. 05
604121, Rev. 09
604122, Rev. 10

Structural Drawings

9763-F-101510, Rev. 16
101530, Rev. 13
101534, Rev. 11
101547, Rev. 07
101558, Rev. 06

4.1.1 Flooding

The vault area contains moderate energy lines in the following systems:

- Chemical and Volume Control
- Containment Spray
- Primary Component Cooling
- Residual Heat Removal
- Safety Injection
- Sample
- Vent
- Fire Protection

Of the above systems, those with the highest potential leak rates are the Primary Component Cooling Water System and the Residual Heat Removal System.

The largest lines in the vault area are the 20-inch component cooling lines which operate under a head of 200 feet of water. The calculated crack area for these lines would result in a leak rate of 85 cubic feet per minute.

Since each vault contains grating at each floor elevation, any line break will result in water falling through the grating and accumulating at the (-)61 foot elevation. No credit is taken for the operation of the vault area non-Class 1E sump pumps, thus the water level in the affected vault would rise at the rate of approximately 0.1 foot per minute. After about 1.4 minutes, the Component Cooling Water System head tank Class 1E low-low level alarm would be activated by the loss of component cooling water. Since the vault sump level alarm also is not Class 1E, no credit can be taken for using it as a flood warning device in the Control Room. Allowing a reaction time of 30 minutes for isolation of the leakage, the water in the affected vault would reach a height of 3-3/4 feet, which would result in a loss of function of the containment spray pump in that vault. However, the containment spray is not required to mitigate this MELB. In addition, the redundant containment spray pump in the other vault would not be affected because the vaults are completely separated. The RHR pump motor is located above the (-)55'-0" elevation, and would not be affected by flooding in this case.

Loss of inventory in one component cooling water train will not result in the loss of the ability to achieve and maintain cold shutdown because a redundant component cooling water train is available to take up the loads.

There is one RHR pump suction line in each vault. These lines are connected directly to the reactor coolant piping of Loops 1 and 4, with two interlocked motor-operated isolation valves in each line. These valves are opened by the operator during reactor cooldown for the establishment of RHR cooling. Flow in these lines is continuously monitored when they are in use. Any change in RHR flow rate or pressure, or pressurizer level would alert the operator that a leak existed.

The RHR lines are used during reactor heat-up and cooldown. Since they operate as high energy lines during only short operational periods, and qualify as moderate energy lines for the major portion of the plant operational life, through-wall leakage cracks have been postulated to occur during start-up and shutdown, and have been included in this study. These lines are assumed to be in operation at the maximum MELB temperature of 200°F and a pressure of 275 psig when the line break occurs. Ruptures of the 14-inch and 16-inch portions of the RHR suction line need not be postulated because stresses in these portions are less than $0.41(1.2S_h + S_A)$ and are exempted from crack postulation by BTP MEB 3-1 of NUREG 0800.

The postulated crack in the 12" RHR line would result in a flow of 95 cfm of reactor coolant into the vault area. The Control Room operator would be notified of a problem by a low level alarm in both the Pressurizer and the Reactor Vessel. Assuming 30 minutes for operator response, the water level in the affected vault would rise about 4'-2".

Since the RHR pump motors are located above the (-)55'-0" elevation, they would not be flooded by this event. Reactor cooling would continue at a reduced rate, using the other RHR loop maintaining subcriticality in the core.

Instrument racks IR-14, IR-15 and IR-23 are located on elevation 3'-2" in the stairwell area. The only equipment that is required for safe shutdown in these racks is RH-HY-606-1 mounted in rack

IR-14 above elevation 5'-8". This is a solenoid operated valve and will not be affected by a rupture of any of the small cold water lines in the stairwell area. Flooding to this elevation is not a credible event.

4.2 **Primary Auxiliary Building**

(Refer to Table 4.2 and Figure 4.2)

The PAB has full or partial floor levels at the following elevations: (-)26'-0:, (-)6'-0", 2'-0", 7'-0", 25'-0", 53'-0" and 81'-0". See Fig. 4.2 for arrangement of this building. No single elevation is sealed off from any other since there are equipment hatches, piping and electrical chases, HVAC duct openings and floor drains generally located on all elevations. All of the approximately sixty floor drains drains in the building except three, drain to the single sump at El. (-)26'-0".

The three exceptions are in the northwest corner of the building at El's 25'-0" and 53'-0" in the area of the Component Cooling Water Heat Exchangers. These three floor drains are connected to a single 3" pipe which penetrate the building exterior wall and terminates in a normally closed valve. Initial leakage in this area would be held up in a curbed area surrounding the PCCW heat exchangers. The contents will be sampled and examined. If radioactive, the contents will be directed to the radioactive liquid waste system. Otherwise it will be disposed of in the yard storm drainage system.

The following drawings were used in evaluating the effects of a moderate energy line break in the PAB.

Piping Drawings

9763-F-805136, Rev. 04
805138, Rev. 03
805210, Rev. 08
805211, Rev. 14
805213, Rev. 13
805215, Rev. 11

9763-F-805216, Rev. 08
805217, Rev. 11
805218, Rev. 09
805219, Rev. 08
805220, Rev. 08
805221, Rev. 11
805222, Rev. 13

9763-F-805223, Rev. 11
805224, Rev. 13
805227, Rev. 10
805228, Rev. 10
805229, Rev. 08
805230, Rev. 05
805231, Rev. 10

9763-F-805232, Rev. 07
805235, Rev. 09
805236, Rev. 09
805237, Rev. 05
805238, Rev. 07
805239, Rev. 09
805240, Rev. 07
805241, Rev. 08
815214, Rev. 11

9763-F-805242, Rev. 05
805243, Rev. 07
805244, Rev. 04
805246, Rev. 07

Arrangement Drawings

9763-F-805061, Rev. 13
805062, Rev. 13
805063, Rev. 12
805064, Rev. 13
305065, Rev. 13
805066, Rev. 12
805069, Rev. 8

Electrical Drawings

9763-F-310761, Rev. 14
310762, Rev. 14
310763, Rev. 23
310764, Rev. 14
310765, Rev. 17
310766, Rev. 18

P & I Diagrams

9763-F-804959, Rev. 01
804992, Rev. 06
804993, Rev. 07

Structural Drawings

9763-F-101511, Rev. 12
101512, Rev. 13
101513, Rev. 12
101535, Rev. 18
101536, Rev. 11
101549, Rev. 09
101550, Rev. 09
101551, Rev. 17
101552, Rev. 13
101625, Rev. 10
102966, Rev. 01
102972, Rev. 00

Instrumentation Drawings

9763-F-500175, Rev. 06
500176, Rev. 05
500177, Rev. 03
500179, Rev. 06
500183, Rev. 02

Electrical Drawings	Mechanical Services
9763-F-310767, Rev. 14	9763-F-604109, Rev. 07
310768, Rev. 13	604110, Rev. 10
310781, Rev. 08	604111, Rev. 07
310784, Rev. 15	604118, Rev. 04
310785, Rev. 14	604119, Rev. 07
310786, Rev. 16	604120, Rev. 05
310787, Rev. 17	604121, Rev. 09
310788, Rev. 13	604122, Rev. 10

4.2.1 Flooding

The Primary Auxiliary Building contains moderate energy piping in the following systems:

Chemical and Volume Control
Containment Spray
Demineralized Water
Hydrogen Gas
Mechanical Seal
Nitrogen Gas
Primary Component Cooling
Reactor Make-up Water
Resin Sluicing
Service Air
Service Water
Spent Fuel Cooling and Clean-up
Vent
Waste Process - Gaseous
Waste Process - Liquid
Fire Protection

Preliminary calculations were made to determine leak rates from a crack in the largest line in each of the above systems in the Primary Auxiliary Building. The two lines with the potential of highest leak rates are the 24" Service Water line and the 24" Primary Component Cooling Water line.

Rupture of the 24-inch Primary Component Cooling Water line at an elevation of 46'-0" would result in a flow of 103 cubic feet per minute which would activate the CC head tank redundant Class 1E low-low level alarms in about 1-1/4 minutes. Since there are approximately 25 floor drains at El. 25'-0", even if 50% of them were plugged, the floor drainage system is large enough to carry the 103 cfm to the sump at (-)26'-0" without backing up. The water would reach the sump in seconds and take approximately 1-1/4 minutes to fill the sump and energize the Class 1E redundant high level alarms. The water would then rise above the (-)26'-0" level at a rate of approximately 0.1 ft./min. At El. (-) 26'-0", the structural wall between the Primary Auxiliary Building and the mechanical penetration area outside the Containment Building consists of a metal partition with a door. This partition is designed to withstand a pressure differential of 0.5 psi or a head of approximately 1 ft. of water. Thus, if the operator did not recognize and isolate the failed pipe within minutes following the two level alarms, water would begin leaking through the partition into the mechanical penetration area. The water would gravitate to a pit at El. (-) 34'-6" where a floor drain would carry it to the sump in one of the two R.H.R. Equipment Vaults at El. (-) 61'-0".

Should the break not be isolated for 30 minutes (considered a reasonable maximum time) approximately 3100 $ft.^3$ (23,000 gal.) of PCC water would be deposited in the RHR Vault. This would be approximaterly 4'-6" deep at El. (-)61'-0". This would cause the Containment Spray Pump of one of the two redundant loops to be inoperable. However, since it is not required to mitigate this accident, there is no safety problem involved.

Should the floor drain at El. (-)34'-6" in the mechanical penetration area outside the Containment Building be plugged, the water would reach a depth of 3'-7" feet in 30 minutes. No components essential to plant safety would be submerged at that level.

As the water leaked out of the PCCW System, the general level (elevation) of the water in the system would drop, reducing the available NPSH. When the required NPSH was reached and passed, the PCCW Pump would start to cavitate. Also, since the heat removal capability of the system decreased, system temperatures would rise as flows decreased, and would be so noted in the control room. The unit would have to be shut down while shifting major loads to the redundant PCCW loop.

A crack in a 24" Service Water line at El. 63'-1-5/8" would produce a flow of 88.4 CFM or approximately 660 gpm. Initially, the flooding would be confined to the curbed area at the northwest corner of the PAB at El. 53'-0'. Some water would flow down through the annuli in the floor around the two Component Cooling Heat Exchangers to El. 25'-0". In 5 to 7 minutes the water would overflow the 6" curb surrounding this area. Floor drains would immediately carry the water to the sump at El. (-)26'-0". Within two minutes, one or both redundant Class 1E sump high level alarms would notify the operator of a problem. Should the flow through the crack continue for 30 minutes, flooding would be similar to that with Component Cooling Water; however, with a slightly lower rate and less total water. This flooding situation would also not compromise the operating capability of any safety related components.

The loss of 660 gpm or 6% of the total Service Water flow would result in a drop in line pressure of about 12%. This drop in pressure would not be great enough to cause a Tower Actuation signal, since the TA signal is actuated at approximately 50% of pump full load discharge pressure. Isolation of one loop would result in an extended cool-down time, but one service water loop is capable of supplying 100% of the flow required for all accident conditions.

If the non-safety related sump pumps in the sumps in either or both sumps in the PAB or RHR Vault operate during either of the above flooding conditions, the PCC Water or Service Water would be pumped to the Floor Drain Tank(s) in the Waste Process Building. Should one or both of these fill and overflow, the excess would flow to one of the two sumps at El. 31-0" in the WPB through the floor drainage system. No safety related components nor systems would be affected.

4.3 Control Building

(Refer to Table 4.3 and Fig. 4.3)

The Control Building contains three floor elevations as follows:

El. 75'-0" - Control Room plus offices

El. 50'-0" - Cable spreading room plus HVAC equipment room

El. 21'-6" - 480 Volt switchgear, sub-station and battery rooms

Refer to Fig. 4.3 for arrangement of the Control Building.

The only moderate energy piping in the Control Building are the fire protection piping and the potable water piping. The fire protection piping provides water to the hose stations in the stairwells of the Control Building and Diesel Generator Building. The potable water system supplies water to the washrooms and HVAC equipment room.

The following drawings were used in evaluating the effects of moderate energy pipe breaks in the Control Building:

Structural Drawings	Electrical Drawings
9763-F-101341, Rev. 02	9763-F-310431, Rev. 22
101346, Rev. 10	310442, Rev. 22
101351, Rev. 10	310443, Rev. 18
101352, Rev. 07	310444, Rev. 22
101610, Rev. 10	310451, Rev. 18
101611, Rev. 11	310452, Rev. 16
	310455, Rev. 07
	310456, Rev. 09
	310457, Rev. 11
	310458, Rev. 09
	310459, Rev. 10
	310460, Rev. 06
	310461, Rev. 06
	310462, Rev. 07
	310463, Rev. 08
	310464, Rev. 05
	310471, Rev. 03

Arrangement Drawings	Mechanical Services
9763-F-500090, Rev. 15	9763-F-604091, Rev. 06
310452, Rev. 19	604092, Rev. 11
310451, Rev. 21	604093, Rev. 12
500091, Rev. 6	604094, Rev. 06
310431, Rev. 22	604095, Rev. 08
	604099, Rev. 09
	604166, Rev. 01
	604100, Rev. 07

4.3.1 Flooding

During normal plant operation, the Control Room is continuously staffed, and any evidence of flooding from the potable water piping in the washrooms and HVAC equipment room would immediately be noticed and investigated and prompt corrective action taken.

Rupture of the potable water lines in the Control Building washrooms would result in a flow of approximately 2.6 cubic feet per minute. There is one 2-1/2 inch floor drain in each washroom. Assuming only one drain is functional, the maximum flood level in the washrooms, in the event of a rupture of the potable water line, is approximately one half of an inch. Water would drain to the yard storm drainage system.

The Control Room is capable of sustaining a flood water level of at least 4 inches without damage to essential equipment. All sections of the Main Control Board have an inside base which is 4 inches high, effectively requiring all MCB components to be at least 4 inches above the floor. The component parts of all other panels and racks in the Control Room are likewise located above the floor level.

Drainage from the Control Room is available through the door of the Turbine Building, through the stairway leading out of the building, and by way of the floor drains in the washrooms.

Flooding of the Control Room from the Turbine Building has a very low probability for the following reason: the passageway to the Turbine Building consists of a double door airlock leading to a fifty foot long corridor and office complex. Beyond that is an open stairwell, with no piping in the area for a distance of approximately fifty feet.

Flooding from the Control Room to the Cable Spreading Room directly below is not possible because all openings are sealed against a maximum pressure difference of 3 psi. The Cable Spreading room (El. 50'-0") has a normally dry water deluge system for fire protection, therefore, flooding from a pipe break is not considered in that area.

The HVAC Equipment Room on El. 50'-0" of the Control Building has a 2" potable water line which supplies water to humidifiers and a 6" fire protection header which supplies water to the fire protection system in the adjacent Diesel Generator Building. A crack in the latter line would produce a leak of approximately 24 CFM or approximately 180 gpm.

There are three - 3" floor drains in this area which drain through a common 3" line to the storm sewer system. If this common line were 100% plugged, the water would flow out of the equipment room, even if the door were closed, across the floor of the cable spreading room to two 6" floor drains on the east side of the room. Either one or both of these drains would carry the 180 gpm of water away without significant build-up on the floor of the cable spreading room.

One of the 6" drains drops straight down and empties onto the floor of the train "A" electrical tunnel at El. 0'-0". The other 6" drain drops straight down and empties onto the floor of the train "B" electrical tunnel at El. (-) 20'-0". The scenario would now be the same as that in Section 4.5. All the water in both tunnels would gravitate to the sump in the "B" train electrical tunnel. A Class 1E level alarm would notify the operator of a problem. Should the leak continue for 30 minutes, the level of water in the "B" train electrical tunnel would reach approximately 3". This would not cause failure of any components required for safe shut down.

All other floor openings in the cable spreading room and HVAC equipment room are sealed so the water cannot escape to the electrical equipment room below.

On loss of water from the 6" fire protection supply line, one or both fire protection jockey pumps would start automatically. These, however, would not maintain system pressure (130 psig). Should the main fire pump (motor driven) start automatically at 100 psig, a non-Class 1E alarm on the Main Control Board should also alert the operator.

Flooding from the Heater Bay through the doorway in the North wall of the Cable Spreading Room is impossible since the floor of the Heater Bay in the area of the door consists of grating.

The A and B Switchgear and Battery Rooms at El. 21'-6" contain no moderate energy lines. Flooding of this area through the doorway from the adjacent Heater Bay of the Turbine Building is virtually impossible because the nearest piping is approximately 65 feet away., Closer to the door is a battery room and a 480 volt substation. In addition, there are two 4" flow drains within 50 feet of the doorway.

4.4 Diesel Generator Building

(Refer to Table 4.4 and Figure 4.4)

The Diesel Generator Building, adjacent to the Control Building has three floor levels. The Fuel Oil Storage Tanks are located at (-) 16'-0" elevation. The engines and generators are at the 21'-6" level, and the day tanks, exhaust silencers, expansion tanks, and HVAC equipment are at the 51'-6" elevation (See Figure 4.4).

The off-engine moderate energy lines in the D.G. Building are demineralized water, potable water, fire mains, and engine jacket cooling water.

On-engine moderate energy lines are lube oil, fuel oil, and cooling water.

Each diesel generator system has four separate dry-type deluge fire protection systems associated with it.

Since the diesels and their auxiliaries are housed in separate concrete rooms, a moderate energy line break in one unit would not impair the start-up and operation of its redundant twin.

Drawings used in this evaluation are as follows:

Mechanical Drawings	Electrical Drawings
9763-F-202264, Rev. 08	9763-F-310524, Rev. 18
202265, Rev. 11	310525, Rev. 09
202266, Rev. 09	310534, Rev. 07
202268, Rev. 03	310535, Rev. 06
202269, Rev. 07	310536, Rev. 03
202270, Rev. 06	310537, Rev. 10

Mechanical Drawings	Electrical Drawings
9763-F-202271, Rev. 09	9763-F-310358, Rev. 08
202272, Rev. 07	310359, Rev. 07
202273, Rev. 07	
202274, Rev. 04	**Structural Drawings**
202275, Rev. 06	
	9763-F-101382, Rev. 14

Mechanical Services	Arrangement Drawings
9763-F-604102, Rev. 07	9763-F-202068, Rev. 7
604104, Rev. 11	202069, Rev. 10
604105, Rev. 07	202070, Rev. 10
604107, Rev. 07	
604146, Rev. 05	

4.4.1 Flooding

The largest moderate energy line associated with the diesels is the 10" diesel component cooling water line. This line enters the building below grade and below the operating floor at El. 21'-6". It reduces to 8" in diameter and rises through the operating floor to the nozzle on the engine skid. Should a crack occur in the 10" portion, the leakage would be approximately 32 CFM or 240 gpm. Since the expansion tank on this closed cooling loop and the sump at El. (-) 16'-0" have level alarms which are not Class 1E, it is assumed that the operator would not be alerted immediately. The volume of the closed cooling loop is approximately 400 $ft.^3$ or 3000 gal. Should the loop drain completely, in approximately 12.5 minutes, the floor at El. (-) 16'-0" would be covered by approximately 3" of water.

Should the break occur in the 8" portion of the loop above the operating floor at El. 21'-6", the leakage would be approximately 22.5 CFM or 168 gpm. If the single 4" floor drain is open, the leaking water will fill the sump at El. (-) 16'-0" and overflow on the floor. Should the leak continue, the loop would be empty in 18 minutes and there would be approximately 3" of water on the floor.

If the floor drain at El. 21'-6" were plugged, the water would not quite fill the trench system at El. 21'-6". Existing six inch high curbs around the doorways would prevent this water from entering the adjacent compartment housing the redundant diesel generator.

On loss of cooling water several low pressure alarms would register at the appropriate diesel engine control board. In addition, non-Class 1E trouble alarm would register on the Main Control Board. Following procedures, the redundant diesel would be placed in service. Should the alarm not function, or if the operator took no action, the diesel engine could possibly overheat and fail; in any case, the redundant unit would be available.

While each diesel and its auxiliaries are covered by dry delulge fire protection systems, a 6" fire main enters each half of the diesel building at El. 14'-6", below grade, in the fuel storage tank compartment. The deluge valves are located on a platform at El. (-) 8'-6" in the southwest and northwest corners of the building, respectively.

If one of the 6" fire mains should have a crack, the leakage flow would be approximately 26 $ft.^3$/min. or 195 gpm. Should this go undetected for eight hours, 12,480 $ft.^3$ of water would collect in the fuel oil storage tank room at El. (-) 16'-0". This would cause failure of the Fuel Oil Transfer Pump. If the pump were running when the pipe break took place, the operator would be notified of the problem by low level alarm in Day Tank and no flow in F.O. Transfer Pump discharge to Day Tank, and could take appropriate action to start the other diesel.

Following the latter pipe break and loss of fire protection water, one or both fire protection jockey pumps would start automatically with a drop in fire main pressure. What follows is similar to that in the Control Building with break in the 6" fire main at El. 50'-0". If the main motor driven fire pump starts automatically, a non-Class 1E alarm would notify the operator. Otherwise, the flow could continue for eight hours, and the 12,480 $ft.^3$ of water at El. (-) 16'-0" would reach a level of approximately 8'.

Regarding the on-engine moderate energy lines, the cooling water loss has been discussed above. A break in a fuel oil or lube oil pipe would produce a limited amount of liquid at the (-) 16'-0" level, but would not prevent the start-up and operation of the redundant diesel. The capacity of the Fuel Oil Day Tank is 1500 gallons while the total lube oil system holds approximately 2500 gallons. A variety of instrumentation would notify the operator in case of a rupture in either system. The resultant fuel oil or lube oil would be held up in either the sump at El. 16'-0" or on the floor at El. 21'-6". The 6" curbs around the critical doors in each redundant compartment at El. 21'-6" would prevent the oil from getting to the other compartment. Any liquid in the sump at El. (-) 16'-0" would eventually be pumped to an underground oil-water separator vault.

4.5 Emergency Feedwater Pump House

(Refer to Table 4.5 and Figure 4.5)

The Emergency Feedwater Pump House is a one story structure whose concrete floor elevation is 27'-0". It is located directly to the north of the Containment and Containment Enclosure Buildings. It houses the two Emergency Feedwater Pumps, associated piping and valves and HVAC equipment.

The moderate energy lines in this building are the 8" E.F. Pump suction lines, a 4" fire protection line which feeds the F.P. standpipe in the adjoining stairtower and the 4", 6" and 8" E.F. Pump discharge lines. Although high energy during operation, the latter are considered moderate energy at 275 PSI because of the pumps' short operating times.

The following drawings were used to evaluate this area:

Mechanical Drawings	Structural Drawings
9763-F-202296, Rev. 05	9763-F-101660, Rev. 09
202297, Rev. 05	101661, Rev. 04
202298, Rev. 05	101611, Rev. 11
202265, Rev. 05	101627, Rev. 11
202076, Rev. 03	101632, Rev. 08
604142, Rev. 03	101650, Rev. 10
604100, Rev. 07	101652, Rev. 06
	101653, Rev. 08
Arrangement Drawings	101662, Rev. 02
	101664, Rev. 05
9763-F-202065, Rev. 03	101665, Rev. 05

4.5.1 Flooding

The line which would cause the greatest amount of leakage, should a crack occur, would be the 8" discharge header at 275 psi. The leakage would be 93 cfm or approximately 696 gpm. The Emergency Feedwater Pump House has three 4" floor drains, two 4" hub drains and two 2-1/2" hub drains, all of which drain to an oil-water separator vault which is outside the building below grade. The inlet to the oil-water separator has a device which limits the inlet flow to 75 gpm, therefore, 621 gpm remain to flood the area.

With little or no build-up at El. 27'-0", the water will enter floor openings in the southwest and southeast corners of the building.

Below the opening in the southwest corner is an isolated room at El. 0'-0". As soon as the break occurred, the operator would be alerted by the Class 1E low feedwater flow alarms in the lines to the steam generator(s) being fed by the failed header. Allowing thirty minutes to isolate the break, and assuming all the water entered this area, the water would rise in the room to an elevation of approximately 11'-8". The lowest opening in that room is a pipe tunnel connected to the west Main Steam and Feedwater Pipe Chase. Its bottom elevation is 12'-0". Allowing for a higher flow or longer time to isolate, water would enter the pipe tunnel at El. 12'-0" and collect in the bottom of the Main Steam and Feedwater Pipe Chase at El. 3'-0". A water tight door to a room at the south end of the chase would prevent the water from causing failure of safety related equipment in that area. In the major portion of the chase, there are no components required for plant shutdown.

Should the water enter the floor opening at the southwest corner of the room at El. 27'-0", it would fall to a compartment below with a floor at El. 8'-2". If the water level rose to El. 10'-0", it would pass through a doorway to the adjacent Pre-Action Valve Building, which houses the deluge valves for the fire protection of the train "A" and "B" electrical tunnels. From here the water would gravitate to a compartment at the north end of the east Main Steam and Feedwater Pipe Chase. A single floor drain leads to the sump in the adjacent main portion of the MS and FW Pipe Chase. If this drain were plugged, the water would rise harmlessly in the aforementioned compartment, to an elevation of 7'-3". The lowest opening in this room is at El. 8'-0". If the drain were open to the sump, the water level would rise only a few inches in this main portion of the pipe chase, where there are no components required for shutdown.

The 8" E.F. Pump suction lines are exempt from pipe break or crack considerations in accordance with NUREG 0800, BTP MEB 3-1, Section B.2.C.(1) for both lines, $0.4\ (1.2S_h + S_A) = 16,622$ PSI.

For line 4081 ASME III Sect. ND Eq. (9 + 10) = 8319 PSI.

For line 4082 ASME III Sect. ND Eq. (9 + 10) = 6954 PSI.

For each line, the summation is at the most highly stressed mode.

4.6 Service Water Pumphouse (Refer to Table 4.6 and Figure 4.6)

The Service Water Pumphouse is adjacent to the Circulating Water Pumphouse and houses the Service Water Pumps, the Service Water Screen Wash Pumps, the Travelling Screens and the hot water unit heaters. The moderate energy lines are the 24" Service Water lines, the 6" Screen Wash lines, the service air and instrument air lines, and a 3/4" potable water line. Note that the electrical switchgear room and the HVAC fan room are not affected by moderate energy line breaks.

The following drawings were used in evaluating this area:

Mechanical Drawings	Mechanical Services
9763-F-202507, Rev. 01	9763-F-202418, Rev. 03
202508, Rev. 01	202419, Rev. 04
202419, Rev. 02	604459, Rev. 11
202576, Rev. 04	
202499, Rev. 07	**General Arrangements**
	9763-F-202476, Rev. 04
	202477, Rev. 02
	202478, Rev. 04

4.6.1 Flooding

The moderate energy line which would produce the highest leak rate on failure is the 24" service water line. Rupture of this line would produce a leak rate of 92 cfm or approximately 685 gpm. The S.W. Pumphouse has eight 4" floor drains at El. 21'-0" operating floor and four 4" floor drains in the pit at El. 4'-0" running north and south along the west side of the pumphouse. In addition, there is one 4" drain in the trench which runs the length of the pit.

Since most of the service water piping is in the pit on the west side of the building, a break in a service water pipe would cause flooding in the pit, assuming two of the four drains were plugged. Since there are no safety related components in this pit, flooding would be no problem. Should the pit overflow to the operating floor at El. 21'-0", half of the 8 hub drains and half of the 10 floor drains would limit the water depth to 2" or less. No safety related components would be affected.

The loss of 685 gpm from one service water loop would not activate the Tower Actuation signal since the line pressure would drop approximately 12%, which is far less than the 50% required for a TA signal. Should the operator not note the drop in pressure and/or rise in temperature of the Primary Component Cooling Heat Exchanger service water discharge, the leak could continue for eight hours before isolation.

4.7 Main Steam and Feedwater Pipe Chases

(Refer to Table 4.7 and Figure 4.7)

These two chases, one on the East and the other on the West side of the Containment and Containment Enclosure structures each basically contain the Safety and Code Class 2 portions of two main steam and two main feedwater lines outside the Containment Building. The East chase also contains portions of the following moderate energy lines:

Emergency Feedwater

Instrument Air

Service Air

The West chase contains portions of the following moderate energy lines:

Emergency Feedwater

Instrument Air

Service Air

Demineralized Water

As stated previously, failure of instrument air or service air lines is not considered to cause a failure of safety related structures, systems, or components in the area.

The following drawings were used in evaluating this area:

Structural Drawings

9763-F-101624, Rev. 05
101625, Rev. 10
101626, Rev. 13
101627, Rev. 12
101628, Rev. 08
101629, Rev. 06
101630, Rev. 08
101631, Rev. 07
101632, Rev. 07
101633, Rev. 04
101634, Rev. 08
101657, Rev. 09
101658, Rev. 09
101659, Rev. 01
102071, Rev. 03
101650, Rev. 10

General Arrangements

9763-F-202063, Rev. 05
202064, Rev. 05

Mechanical Drawings

9763-F-202236, Rev. 05
202237, Rev. 04
202238, Rev. 03
202239, Rev. 05
202240, Rev. 05
202241, Rev. 03
202242, Rev. 06
202243, Rev. 06
202244, Rev. 05
202245, Rev. 04
202246, Rev. 05
202247, Rev. 04
202248, Rev. 03
202249, Rev. 07
202250, Rev. 07
202251, Rev. 06
202252, Rev. 05
202253, Rev. 04
202254, Rev. 04
202255, Rev. 07
202256, Rev. 04
604165, Rev. 07

4.7.1 Flooding

A break in the 4" Emergency Feedwater pump discharge pipe would produce a flow of 27 cfm or approximately 203 gpm, calculated at 275 psig. The operator who would be monitoring the operation of the EFW pumps at this time would see the following indications of the problem: EFW pump low discharge pressure and low flow to steam generator(s). Allowing 30 minutes for operator action and break isolation, 6090 gallons would flood El. 3'-0" of the West chase (the smaller of the two chases) to a depth of 9-3/8"

The corresponding elevation of water in the East MS and FW pipe chase would be 8". Water-tight doors to compartments at the south end of each of the two chases at El. 3'-0" would prevent the water from causing failure of safety related electrical equipment in those areas. There are no components required for plant shutdown in either pipe chase which would be rendered inoperable following this event.

Each chase has a sump containing two non-Class 1E sump pumps. Normally, these would carry away any water present to the storm drainage system.

4.8 Containment Enclosure Ventilation Fan Room

See Figure 4.8, Sketch of this area and Table 4.8, list of essential components.

The Containment Enclosure Ventilation Fan Room is at El. 21'-6" southwest of the Containment Building between the Primary Auxiliary Building and the Fuel Storage Building. It houses redundant Containment Enclosure Fan Cooling Units, redundant Containment Enclosure Return Fans and redundant Containment Enclosure Emergency Exhaust Filter Units. The moderate energy lines in this area are the two redundant 10" Primary Component Coolant Water supply and return lines to and from the Fuel Storage Building, the redundant 4" PCCW lines to and from the Fan Cooler Units and a 3/4" demineralized water line.

The following drawings were used in evaluating this area:

Nuclear Drawings	Structural Drawings	Mechanical Service Dwgs.
9763-F-805270, Rev. 07	9763-F-101619, Rev. 09	9763-F-604110, Rev. 10
805271, Rev. 07		604115, Rev. 05
805372, Rev. 07	General Arrangement	
805053, Rev. 08	9763-F-805053, Rev. 09	

4.8.1 Flooding

A through-wall crack in the 10" PCCW line would produce a flow of 43 CFM (323 gpm). Six floor and hub drains would carry the water to the sump at El. (-)26'-0" in the Primary Auxiliary Building. The first alarm in the Control Room would be the low level alarm from the PCCW head tank in approximately 2-1/2 minutes following the break. The low-low level alarm would be activated about 20 seconds later.

At about the same time, 3 minutes following the break, the Class 1E high level alarm in the PAB sump would be indicated.

Allowing 30 minutes for isolation, a total of 1290 $ft.^3$ would be released. Should all the water be drained to PAB El. (-)26'-0", it would be approximately 1' 1-1/2" deep. It would not all drain to the PAB sump since some water would overflow into the Containment Purge System isolation valve pit at the northeast corner of the building. From here it would drain to El. (-)30'-0" in the annulus between the Containment structure and the Containment Enclosure wall. In either case, the flooding would not jeopardize the operation of systems or components necessary for plant shut-down.

Some of the flood water at El. (-)26'-0" of the PAB probably would leak through the metal partition separating the PAB from the Containment mechanical penetration area. As in Section 4.2, this water would gravitate to El. (-)34'-6" in the Containment mechanical penetration area and then drain to the sump at El. (-)61'-0" in train A RHR Vault. It's maximum depth would be approximately 1'-8-1/2". This would make the Containment Spray Pump in Train A inoperable but would not prevent the plant from attaining a safe shutdown.

At the north end of the Containment Enclosure Ventilation Fan Room, a door leads to a stairwell which decends to the electrical and I&C equipment room at the south end of the east Main Steam and Feedwater Pipe Chase. A 6" curb around the door at El. 21'-6" prevents water from entering the stairwell.

All the floor and hub drains at El. 21'-6" are connected to the PAB sump through a common 4" line. Should this be plugged, all the water would enter the aforementioned Containment Purge isolation valve pit at the northeast corner of the building where it would not cause problems.

At the south end of the building is a door which leads to two additional doors. One leads to the exterior of the building and the other to the interior of the Fuel Storage Building. Leakage past any of all of these doors would cause no problems.

4.9 Miscellaneous Areas

4.9.1 Fuel Storage Building, Waste Process Building, and Tank Farm - While these buildings contain no systems or components required for plant shutdown they are in someway connected to buildings that do. The Fuel Storage Building is connected to the Containment Enclosure Ventilation Fan Room indirectly through two doors, normally closed, at El. 21'-6". The FSB has moderate energy lines at El. 21'-6", however, in case of a break in one of them, there could be no water build-up because of 2 floor drains and grating which would carry any leakage to lower elevations in the FSB.

The Waste Process Building is separated from the PAB by the Tank Farm. Piping tunnels and the personnel tunnel connect the WPB and Tank Farm to the PAB. The tunnels have individual sumps with non-class 1E pumps. However, should there be a pipe break in a tunnel and no alarm, the water would either gravitate to the WPB where it could do no harm or to the PAB at El's. 15'-0", 5'-0" or (-) 6'-0". From any of these elevations it would flow through floor drains or floor openings to El. (-) 26'-0" and the sump with redundant Class 1E level alarms.

Each tank in the tank farm, including Safety Class and Non-Safety Class tanks, is surrounded by a Seismic Category I dike, sized to contain the contents of the tank should it fail.

4.9.2 Circulating Water System

NRC staff Request for Information No. ~~420~~ 410.23 requested discussion of the effects of the failure of the non-safety related circulating water piping and non-safety related portion of the station service water system on the safety related station service water system or other safety related systems or components. The project response indicated that the Circulating Water pipe does not run in the vicinity of any station service water pipe. However, certain nonsafety related service water piping does run adjacent to Safety Class 3 SW pipe above and below ground. Since they have the same configuration as the non-safety related pipe, they will experience the same stress levels in the event of an SSE. In addition, analysis indicates that water jets from a postulated crack in the non-seismic Category I piping would not cause sufficient erosion to compromise the support of adjacent safety related piping.

Flow from the Service Water discharge atmospheric vent has essentially an unrestricted path to the open areas outside the PAB which dump into the storm drainage system.

4.9.3 Stairwells

The following buildings have stairwells containing moderate energy fire protection standpipes with strategically located hose reels:

Diesel Generator Building - Each of the two stairwells C

and D has a standpipe with a 6" supply. Each stairwell serves the diesel fuel oil tank room, therefore a leak in the supply pipe or standpipe would spill on the floor at El. (-) 16'-0". This MELB is discussed in Section 4.4 on Diesel Generator Building.

Emergency Feedwater Pump Room - Stairwell "A" serving this building and the electrical tunnels below has a standpipe with a 4" supply. Should a crack in this line occur, the leak would be approximately 15 cfm or 110 gpm. The water would gravitate to the "B" train electrical tunnel at El. (-) 26'-0" and the sump at the base of the stairwell. The flooding scenario which would follow is similar to that described in Section 4.5.1, with approximately 1/5 the water leakage rate.

RHR Equipment Vault - The stairwell in each vault has a tandpipe with a 4" supply line. Should a through-wall crack appear in one of these lines, the leakage would be approximately 15 cfm or 110 gpm. Should the sump pump and level alarm not function (non-Class 1E) the water level would rise about 1/4" per hour.

Since just one of the two redundant vaults involved and since the problem would be discovered before any safety related components ar- involved, no safety problem exists.

Primary Auxiliary Building - Both stairwells (#1 and #2) in the PAB have fire protection standpipes. No. 1 stairwell is founded at El. (-) 26'-0" with the lowest portion of the standpipe being at (-) 6'-0". A leak in the 4" standpipe or supply line would amount to 15 cfm or 110 gpm. The water would fall through the stairwell structure to the base mat at El. (-) 26'-0" and the sump with redundant Class 1E level alarms. Only 450 ft^3 would collect in the first half hour and this would not cause any safety problem.

Stairwell No. 2 is founded at the 7'-0" elevation. It also has a 4" standpipe and 4" supply line. A 15 cfm leak would flow across the floor at El. 7'-0" and enter 1 or more of the 17 floor drains at the level. These lead to the sump at El. (-) 26'-0" and the redundant Class 1E level alarms. Thus this failure would cause no safety problem.

Control Building - The stairwell serving the Control Building has a fire protection standpipe fed by a 6" line. Leakage would be approximately 26 cfm or 200 gpm. The water would fall to the base of the stairwell at El. 21'-6". At this point there are two doors - one to the exterior of the building and one to electrical equipment room which is the first floor of the Control Building. Since these doors are not water-tight, leakage will occur under and around them. "As-built" clearances below the doors are not known at this time. However, if the clearance at the bottom of each door is 1/2", approximately 100 gpm will pass below each door with a head or build-up of about 1 1/2 inches of water on the floor. Water entering the train "A" electrical equipment room (maximum depth 1/2") will be carried away by a 4" floor drain to the storm sewer. Should the floor drain be partially or completely blocked, the water would run by the two doors to the train "B" room and another 4" floor drain.

Conceivably, the water could also leave the train "B" room by two more doorways, one to the Turbine Building Heater bay (and more floor drains) and the second to the non-essential switchgear room. From here it would pass below double doors to the exterior of the building. Nowhere in any of the three electrical equipment rooms would the water become deep enough to make any shut-down components inoperable.

5.0 CONCLUSIONS

5.1 In general, the study revealed that there is no pipeline of moderate energy in the Seabrook plant whose failure by a through-wall crack and resulting spraying and flooding would prevent the plant from achieving a safe shutdown.

5.2 The major redundant systems and components required to shut the plant down are located in the RHR, Containment Spray and Safety Injection Vaults. A major flood in either redundant vault will not prevent the systems and components in the other vault from bringing the plant to a safe shutdown. A single failure of any moderate energy line cannot cause flooding of both vaults.

5.3 The Primary Auxiliary Building has many large and small moderate energy lines with the 24" Service Water and 24" Primary Component Cooling Water lines predominating. Water from a crack in either of these two systems will not cause flooding at any elevation except the lowest in the building (-)26'-0". One or both Class 1E level alarms in the sump at this elevation will warn the operator of a potential flooding condition. Should a flooding condition start, the water would leak through the metal partition separating the PAB from the Containment piping penetration area. From here, the water would enter a floor drain at El. (-)34'-6" and drain to the sump in Train "A" RHR vault. While it may cause some flooding here, Train "B" systems are available for plant shut-down.

5.4 The Control Building complex has a very low probability for flooding conditions to exist. The only moderate energy line in the Control Room itself is a small potable water line which is located in the area of two floor drains. The Cable Spreading Room has no moderate energy lines but it has two 6" floor drains to carry away the water in the unlikely event of the fire protection deluge system activation. The electrical equipment room at grade has no moderate energy lines, but could possibly be exposed to water coming in under the outside door from the fire protection piping in the adjoining stairwell. This would be removed by a floor drain in each train area.

5.5 The Diesel Generator Building has several on and off-engine moderate energy lines. As with the RHR vaults, the flooding of one diesel generator area will not result in flooding its redundant twin. Thus, while one side of the building could be flooded with up to 10' of water at El. (-)16'-0", with the Fuel Oil Transfer Pump inoperable, the other diesel train is intact and available for plant shut-down.

5.6 The Emergency Feedwater Pumphouse is not subject to flooding and subsequent component or system failure by any conceivable failure of a moderate energy line in that area.

5.7 Likewise the Service Water Pumps and other safety related components in the Service Water Pumphouse are not subject to failure due to flooding resulting from a service water or any other moderate energy line break.

5.8 A watertight door at the south end of each Main Steam and Feedwater Pipe Chase would prevent Class 1E electrical components from being inundated and subsequently failing if the Emergency Feedwater Pump discharge line failed in either chase. Minor flooding of the order of one foot from this break would not cause failure of any safety related components in the area.

5.9 In the Containment Enclosure Ventilation Fan Room, flooding is prevented following a leak in a PCCW line through the floor drains and/or the gravitation of the water to El. (-)30'-0" in the annulus between the Containment Building and the Containment Enclosure Building.

5.10 Failure of moderate energy lines in buildings which do not contain systems or components required for safe shut-down cannot cause failure of systems or components required for safe shut-down and which are located in adjacent buildings.

5.11 Several stairwells in the various buildings of the plant contain fire protection stand pipes and hose reels. In no case would a crack in one of these moderate energy lines cause a failure of safe shut-down equipment within that or adjoining building.

6.0 LIST OF TABLES

Table No. 4.1

RHR CONTAINMENT SPRAY & SAFETY INJECTION EQUIPMENT VAULTS

Essential Components

El. (-)61'-0", (-)50'-0", (-)31'-10", (-)9'-0", 3'-2"

Equipment I.D.	Description	Elevation
RH-P-8A	Pump	Motor El. (-)55'-0"
RH-P-8B	Pump	Motor El. (-)55'-0"
RH-FCV-618	Flow Control Valve	El. (-)37'-8"
RH-RCV-619	Flow Control Valve	El. (-)37'-8"
RH-ZS-618	Position Switches	El. (-)37'-8"
RH-ZS-619	Position Switches	El. (-)37'-8"
RH-FY-618-1	Solenoid Pilot Valve	El. (-)37'-8"
RH-FY-619-1	Solenoid Pilot Valve	El. (-)37'-8"
RH-HY-606-1	Solenoid Pilot Valve	El. (-)24'-9"
RH-HY-607-1	Solenoid Pilot Valve	El. (-)24'-9"
RH-ZS-606	Position Switch	El. (-)24'-9"
RH-ZS-607	Position Switch	El. (-)24'-9"
RH-HCV-606	Flow Control Valve	El. (-)24'-9"
RH-HCV-607	Flow Control Valve	El. (-)24'-9"
CBS-V2	Motorized Valve	El. (-)15'-0"
CBS-V5	Motorized Valve	El. (-)15'-0"
CC-V-145	Motorized Valve	El. 6'-0"
CC-V-272	Motorized Valve	El. 6'-0"
CC-ZS-145	Position Switch	El. 6'-0"
CC-ZS-272	Position Switch	El. 6'-0"

Table No. 4.2

PRIMARY AUXILIARY BUILDING ESSENTIAL COMPONENTS

El. (-)26'-0", (-)6'-0", 7'-0", 25'-0", 42'-0", 53'-0"

Equipment I.D.	Description	Elevation
CS-P-2A	Pump	El. 10'-6"
CS-P-2B	Pump	El. 10'-6"
CC-P-11A	Pump	El. 28'-0"
CC-P-11B	Pump	El. 28'-0"
CC-P-11C	Pump	El. 28'-0"
CC-P-11D	Pump	El. 28'-0"
CS-P-3A	Pump	El. 26'-4"
CS-P-3B	Pump	El. 26'-4"
CS-V-426	Valve	El. 27'-0"
CS-ZS-426	Position Switch	El. 27'-0"
PAH-FN-42A	Fan	El. 42'-0"
PAH-FN-42B	Fan	El. 42'-0"
PAH-DP-43A	Damper	El. 42'-0"
PAH-DP-43B	Damper	El. 42'-0"
PAH-FY-43A	Solenoid Pilot Valve	El. 42'-0"
PAH-FY-43B	Solenoid Pilot Valve	El. 42'-0"
PAH-ZS-43A	Solenoid Pilot Valve	El. 42'-0"
PAH-ZS-43B	Solenoid Pilot Valve	El. 42'-0"
CC-TV-2171-1	Valve	El. 41'-0"
CC-TV-2171-2	Valve	El. 41'-0"
CC-TY-2171-1	Solenoid Pilot Valve	El. 41'-0"
CC-TY-2171-2	Solenoid Pilot Valve	El. 41'-0"
CC-TY-2172-1	Solenoid Pilot Valve	El. 41'-0"
CC-TY-2172-2	Solenoid Pilot Valve	El. 41'-0"
CC-ZS-2171-1	Solenoid Pilot Valve	El. 41'-0"
CC-ZS-2171-2	Solenoid Pilot Valve	El. 41'-0"
CC-ZS-2172-1	Solenoid Pilot Valve	El. 41'-0"
CC-ZS-2172-2	Solenoid Pilot Valve	El. 41'-0"
CS-LCV-112B	Valve	El. 53'-0"
CS-LCV-112C	Valve	El. 53'-0"
CC-E-17A	Heat Exchanger	El. 53'-0"
CC-E-17B	Heat Exchanger	El. 53'-0"
CC-TV-2271-1	Valve	El. 41'-0"
CC-TV-2271-2	Valve	El. 41'-0"
CC-TY-2271-1	Solenoid Pilot Valve	El. 41'-0"
CC-TY-2271-2	Solenoid Pilot Valve	El. 41'-0"
CC-TY-2272-1	Solenoid Pilot Valve	El. 41'-0"
CC-TY-2272-2	Solenoid Pilot Valve	El. 41'-0"
CC-ZS-2271-1	Solenoid Pilot Valve	El. 41'-0"
CC-ZS-2271-2	Solenoid Pilot Valve	El. 41'-0"
CC-ZS-2272-1	Solenoid Pilot Valve	El. 41'-0"
CC-ZS-2272-2	Solenoid Pilot Valve	El. 41'-0"
CS-LT-7446	Level Transmitter	El. 25'-0"
CS-LT-7464	Level Transmitter	El. 25'-0"

Table No. 4.2 (cont.)

El. (-)26'-0", (-)6'-0", 7'-0", 25'-0, 42'-0, 53'-0"

Equipment I.D.	Description	Elevation
SW-V-16	Valve	El. 53'-0"
SW-V-18	Valve	El. 53'-0"
DE-E-42A	Heat Exchanger	El. 53'-0"
DG-E-42B	Heat Exchanger	El. 53'-0"
CC-TK-19A	CC Head Tank	El. 65'-9"
CC-TK-19B	CC Head Tank	El. 65'-9"
CS-V-142	Valve	El. (-)17'-9" (Pipe Tunnel)
CS-V-112D	Valve	El. 20'-0" (Tank Farm)
CS-V-112E	Valve	El. 20'-0" (Tank Farm)
CS-V-847	Valve	El. (-)17'-9" (Radioactive Tunnel)
CS-V-846	Valve	El. (-)17'-9" (Radioactive Tunnel)
SI-V-138	Valve	El. (-)17'-9" (Radioactive Tunnel)
SI-V-139	Valve	El. (-)17'-9" Radioactive Tunnel to be Deleted
CC-LT-2172-1	Level Transmitter	El. 53'-0"
CC-LT-2172-2	Level Transmitter	EL. 53'-0"
CC-LT-2172-3	Level Transmitter	El. 53'-0"
CC-LT-2192-1	Level Transmitter	El. 53'-0"
CC-LT-2192-2	Level Transmitter	El. 53'-0"
CC-LT-2192-3	Level Transmitter	El. 53'-0"
CC-LT-2272-1	Level Transmitter	El. 53'-0"
CC-LT-2272-2	Level Transmitter	El. 53'-0"
CC-LT-2272-3	Level Transmitter	El. 53'-0"
CC-LT-2292-1	Level Transmitter	El. 53'-0"
CC-LT-2292-2	Level Transmitter	El. 53'-0"
CC-LT-2292-3	Level Transmitter	El. 53'-0"
WLD-LS-6269	Level Switch	El. (-)26'-0"
PAH-DP-357	Damper	El. 25'-0"
PAH-DP-358	Damper	El. 25'-0"

Table No. 4.3

CONTROL BUILDING ESSENTIAL COMPONENTS

El. 21'-6", 50'-0", 75'-0"

Equipment I.D.	Description	Elevation
CBA-FN-19	Supply Air Fan	Motor El. 51'-6"
CBA-FN-20	Ret. Air Fan	Motor El. 51'-6"
CBA-FN-21A	Exh. Fan	Motor El. 51'-6"
CBA-FN-21B	Exh. Fan	Motor El. 51'-6"
CBA-FN-32	Supply Air Fan	Motor El. 51'-6"
CBA-FN-33	Supply Air Fan	Motor El. 51'-6"
CBA-DP-24A	Damper	El. 58'-0"
CBA-ZY-24A	Sol. Valve	El. 58'-0"
CBA-DP-24F	Damper	El. 58'-0"
CBA-ZY-24F	Sol. Valve	El. 58'-0"
CBA-DP-24B	Damper	El. 66'-2"
CBA-ZY-24B	Sol. Valve	El. 66'-2"
CBA-DP-24E	Damper	El. 66'-2"
CBA-ZY-24E	Sol. Valve	El. 66'-2"
CBA-DP-24C	Damper	El. 69'-10"
CBA-ZY-24C	Sol. Valve	El. 69'-10"
CBA-DP-24D	Damper	El. 69'-10"
CBA-ZY-24D	Sol. Valve	El. 69'-0"
E-5	Elect. Bus	El. 21'-6"
E-6	Elect. Bus	El. 21'-6"
HV-4	Battery	El. 21'-6"
HV-5	Battery	El. 21'-6"
HV-6	Battery	El. 21'-6"
HV-7	Battery	El. 21'-6"
DC Bus 11A	DC Switchgear	El. 21'-6"
DC Bus 11B	DC Switchgear	El. 21'-6"
DC Bus 11C	DC Switchgear	El. 21'-6"
DC Bus 11D	DC Switchgear	El. 21'-6"
MMCP-12	SSPS Train A	El. 21'-6"
MMCP-13	SSPS Train B	El. 21'-6"

TABLE NO. 4.4

DIESEL GENERATOR BUILDING ESSENTIAL COMPONENTS

El. (-)16'-0", 21'-6", 51'-6"

Equipment I.D.	Description	Elevation
DAH-DP-16A	Damper	El. 53'-0"
DAH-DP-16B	Damper	El. 53'-0"
DAH-ZS-16A	Position Switch	El. 53'-0"
DAH-ZS-16B	Position Switch	El. 53'-0"
DAH-FY-16A	Solenoid Pilot Valve	El. 53'-0"
DAH-FY-16B	Solenoid Pilot Valve	El. 53'-0"
DAH-FN-26A	Exhaust Fan	El. 53'-0"
DAH-FN-26B	Exhaust Fan	El. 53'-0"
DAH-FN-25A	Supply Fan	El. 53'-0"
DAH-FN-25B	Supply Fan	El. 53'-0"
DAH-FY-15A	Solenoid Pilot Valve	El. 53'-0"
DAH-FY-15B	Solenoid Pilot Valve	El. 53'-0"
DAH-ZS-15A	Positions Switch	El. 53'-0"
DAH-ZS-15B	Positions Switch	El. 53'-0"
DAH-DP-15A	Damper	El. 53'-0"
DAH-DP-15B	Damper	El. 53'-0"
DG-1A	Diesel Generator	El. 21'-6"
DG-1B	Diesel Generator	El. 21'-6"
TK-45A	D.G. Starting Air Receiver	El. 21'-6"
TK-45B	D.G. Starting Air Receiver	El. 21'-6"
TK-45C	D.G. Starting Air Receiver	El. 21'-6"
TK-45D	D.G. Starting Air Receiver	El. 21'-6"
TK-26A	D.G. Fuel Oil Storage Tank	El. (-)16'-0"
TK-26B	D.G. Fuel Oil Storage Tank	El. (-)16'-0"
P-38A	D.G. Fuel Oil Transfer Pump	El. (-)16'-0"
P-38B	D.G. Fuel Oil Transfer Pump	El. (-)16'-0"
TK-78A	D.G. Fuel Oil Day Tank	El. 55'-6"
TK-78B	D.G. Fuel Oil Day Tank	El. 55'-6"
TK-46A	D.G. PCCW Expansion Tank	El. 67'-6"
TK-46B	D.G. PCCW Expansion Tank	El. 67'-6"

TABLE NO. 4.5

EMERGENCY FEEDWATER PUMP HOUSE ESSENTIAL COMPONENTS

El. 27'-0"

Equipment I.D.	Description	Elevation
FW-FT-4214-2	Flow Transmitter	El. 27'-0"
FW-FT-4214-4	Flow Transmitter	El. 27'-0"
FW-FT-4214-5	Flow Transmitter	El. 27'-0"
FW-FT-4424-2	Flow Transmitter	El. 27'-0"
FW-FT-4424-4	Flow Transmitter	El. 27'-0"
FW-FT-4424-5	Flow Transmitter	El. 27'-0"
FW-FT-4234-2	Flow Transmitter	El. 27'-0"
FW-FT-4234-4	Flow Transmitter	El. 27'-0"
FW-FT-4234-5	Flow Transmitter	El. 27'-0"
FW-FT-4244-2	Flow Transmitter	El. 27'-0"
FW-FT-4244-4	Flow Transmitter	El. 27'-0"
FW-FT-4244-5	Flow Transmitter	El. 27'-0"
FW-FV-4214B	SG. A Emerg. FW. Cont. Valve	El. 28'-3"
FW-FV-4224B	SG. B Emerg. FW. Cont. Valve	El. 28'-3"
FW-FV-4234B	SG. C Emerg. FW. Cont. Valve	El. 28'-3"
FW-FV-4244B	SG. D Emerg. FW. Cont. Valve	El. 28'-3"
FW-FV-4214A	SG. A Emerg. FW. Cont. Valve	El. 31'-3"
FW-FV-4224A	SG. B Emerg. FW. Cont. Valve	El. 31'-3"
FW-FV-4234A	SG. C Emerg. FW. Cont. Valve	El. 31'-3"
FW-FV-4244A	SG. D Emerg. FW. Cont. Valve	El. 31'-3"
EPA-TSH-5430	Temperature Switch	El. 32'-0"
EPA-TSH-5431	Temperature Switch	El. 32'-0"
FW-P-37B	Emerg. FW. Pump	El. 30'-6"
FW-P-37A	Emerg. FW. Pump	El. 30'-6"
EPA-FN-47A	Fan	El. 40'-0"
EPA-FN-47B	Fan	El. 40'-0"
FW-PI-4209	Pressure Indicator	El. 27'-0"
FW-PI-4208	Pressure Indicator	El. 27'-0"

TABLE NO. 4.6

SERVICE WATER PUMP HOUSE ESSENTIAL COMPONENTS

El. 21'-0"

Equipment I.D.	Description	Elevation
SW-P-41A	Pump	El. 21'-0"
SW-P-41B	Pump	El. 21'-0"
SW-P-41C	Pump	El. 21'-0"
SW-P-41D	Pump	El. 21'-0"
SWA-FN-40A	Fan	El. 22'-0"
SWA-FN-40B	Fan	El. 22'-0"
SWA-TSH-5614-1	Temp Switch	El. 22'-0"
SWA-TSH-5614-2	Temp Switch	El. 22'-0"
SWA-TSH-5615-1	Temp Switch	El. 22'-0"
SWA-TSH-5515-2	Temp Switch	El. 22'-0"
SW-V2	Valve	El. 23'-6"
SW-V22	Valve	El. 23'-6"
SW-V29	Valve	El. 23'-6"
SW-V31	Valve	El. 23'-6"
SW-V4	Valve	El. 70'-5" (Tank Farm)
SW-V5	Valve	El. 70'-5" (Tank Farm)

TABLE NO. 4.7

MAIN STEAM & FEEDWATER PIPE CHASES ESSENTIAL COMPONENTS

El. 3'-0", 12'-0", 20'-0", 26'-6", 42'-0"

Equipment I.D.	Description	Elevation
MS-V-86	M.S. Isolation Valve	El. 28'-0"
MS-ZS-86A	Position Switch	El. 28'-0"
MS-ZS-86B	Position Switch	El. 28'-0"
MS-ZS-204	Position Switch	El. 28'-0"
MS-V-204	Bypass Valve	El. 28'-0"
MS-FY-89A-1	Solenoid Pilot Valve	El. 28'-0"
MS-FY-89B-1	Solenoid Pilot Valve	El. 28'-0"
MS-FY-102A-1	Solenoid Pilot Valve	El. 28'-0"
MS-FY-102B-1	Solenoid Pilot Valve	El. 28'-0"
MS-FY-117A-1	Solenoid Pilot Valve	El. 28'-0"
MS-FY-117B-1	Solenoid Pilot Valve	El. 28'-0"
MS-V-88	M.S. Isolation Valve	El. 28'-0"
MS-ZS-88A	Position Switch	El. 28'-0"
MS-ZS-88B	Position Switch	El. 28'-0"
MS-ZS-205	Position Switch	El. 28'-0"
MS-V-205	Bypass Valve	El. 28'-0"
MS-FY-89A-2	Solenoid Pilot Valve	El. 28'-0"
MS-FY-89A-2	Solenoid Pilot Valve	El. 28'-0"
MS-FY-102A-2	Solenoid Pilot Valve	El. 28'-0"
MS-FY-102B-2	Solenoid Pilot Valve	El. 28'-0"
MS-FY-117A-2	Solenoid Pilot Valve	El. 28'-0"
MS-FY-117B-2	Solenoid Pilot Valve	El. 28'-0"
MS-V-90	M.S. Isolation Valve	El. 28'-0"
MS-FY-89A-3	Solenoid Pilot Valve	El. 28'-0"
MS-FY-89B-3	Solenoid Pilot Valve	El. 28'-0"
MS-FY-102A-3	Solenoid Pilot Valve	El. 28'-0"
MS-FY-102B-3	Solenoid Pilot Valve	El. 28'-0"
MS-FY-117A-3	Solenoid Pilot Valve	El. 28'-0"
MS-FY-117B-3	Solenoid Pilot Valve	El. 28'-0"
MS-ZS-90A	Position Switch	El. 28'-0"
MS-ZS-90B	Position Switch	El. 28'-0"
MS-ZS-206	Position Switch	El. 28'-0"
MS-ZS-206	Bypass Valve	El. 28'-0"
MS-V-92	M.S. Isolation Valve	El. 28'-0"
MS-FY-89A-4	Solenoid Pilot Valve	El. 28'-0"
MS-FY-89B-4	Solenoid Pilot Valve	El. 28'-0"
MS-FY-102A-4	Solenoid Pilot Valve	El. 28'-0"
MS-FY-102B-4	Solenoid Pilot Valve	El. 28'-0"
MS-FY-117A-4	Solenoid Pilot Valve	el. 28'-0"

TABLE NO. 4.7 (Cont'd.)

MAIN STEAM & FEEDWATER PIPE CHASES ESSENTIAL COMPONENTS

El. 3'-0", 12'-0", 20'-0", 26'-6", 42'-0"

Equipment I.D.	Description	Elevation
MS-FY-117B-4	Solenoid Pilot Valve	El. 28'-0"
MS-ZS-92A	Position Switch	El. 28'-0"
MS-ZS-92B	Position Switch	El. 28'-0"
MS-PT-3178	Pressure Trans.	El. 28'-0"
MS-PT-3174	Pressure Trans.	El. 28'-0"
SB-V-9	Valve	El. 3'-0"
SB-V-10	Valve	El. 3'-0"
SB-V-11	Valve	El. 3'-0"
SB-V-12	Valve	El. 3'-0"
SB-FY-1900A	Solenoid Valve	El. 3'-0"
SB-FY-1900B	Solenoid Valve	El. 3'-0"
SB-FY-1901A	Solenoid Valve	El. 3'-0"
SB-FY-1901B	Solenoid Valve	El. 3'-0"
SB-FY-1902A	Solenoid Valve	El. 3'-0"
SB-FY-1902B	Solenoid Valve	El. 3'-0"
SB-FY-1903A	Solenoid Valve	El. 3'-0"
SB-FY-1903B	Solenoid Valve	El. 3'-0"
MS-PT-3173	Pressure Trans.	El. 28'-0"
MS-PT-3179	Pressure Trans.	El. 28'-0"
MS-V-127	Valve	El. 28'-0"
MS-V-128	Valve	El. 28'-0"
MS-PV-3001	Valve	El. 28'-0"
MS-PV-3002	Valve	El. 28'-0"
MS-PV-3003	Valve	El. 28'-0"
MS-PV-3004	Valve	El. 28'-0"

TABLE NO. 4.8

CONTAINMENT ENCLOSURE ESSENTIAL COMPONENTS

El. 21'-6"

Equipment I.D.	Description	Elevation
EAH-FN-5A	Fan	El. 21'-6"
EAH-FN-5B	Fan	El. 21'-6"
EAH-AC-2A	Air Cooler	El. 21'-6"
EAH-AC-2B	Air Cooler	El. 21'-6"
EAH-ZS-3A	Position Switch	El. 21'-6"
EAH-ZS-3B	Position Switch	El. 21'-6"
EAH-DP-3A	Damper	El. 21'-6"
EAH-DP-3B	Damper	El. 21'-6"
EAH-ZS-37B	Position Switch	El. 36'-0"
EAH-FY-37B	Solenoid Pilot Valve	El. 36'-0"
EAH-DP-37B	Damper	El. 36'-0"
EAH-ZS-37A	Position Switch	El. 37'-8"
EAH-FY-37A	Solenoid Pilot Valve	El. 37'-8"
EAH-DP-37A	Damper	El. 37'-8"
EAH-ZS-25A	Position Switch	El. 44'-3"
EAH-ZS-25B	Position Switch	El. 44'-3"
EAH-DP-25A	Damper	El. 44'-3"
EAH-DP-25B	Damper	El. 44'-3"
EAH-FN-31A	Fan	El. 44'-3"
EAH-FN-31B	Fan	El. 44'-3"