GPU Nuclear

TECHNICAL DATA REPORT

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PROJECT: TMI-1
EQUIPMENT QUALIFICATION FOR
SBLOCA RADIATION ENVIRONMENTS

DEPARTMENT/SECTION E&D/CONSULTING ENG.

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DOCUMENT TITLE: METHODOLOGY AND LIST OF ELECTRICAL COMPONENTS REQUIRING RADIATION QUALIFICATION FOR SBLOCA MITIGATION

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ABSTRACT:

Statement of Problem:

GPUN had been requested by the NRC (Reference No. 1) to review and affirm the completeness of the list (Reference No. 3) of electrical components which are required to mitigate postulated small break loss-of-coolant accidents (SBLOCA) with a loss of main feedwater and which are located in a harsh radiological environment. The list of such components are to be in compliance with 10CFR50.49(b)(1) and (b)(2) utilizing the applicable guidance contained in NRC's May 25, 1984 letter (Reference No. 2), for a SBLOCA with postulated radiation levels associated with large break LOCAs in accordance with the DOR Guidelines.

The purpose of this report is to document the methodology and basis for the affirmation of completeness of the electrical component list which meets the forestated requirements.

Common type electrical components such as power, control and instrument cable, terminal blocks, electrical penetration assemblies, and heat shrink tubing will be qualified and need not be addressed by this report.

Summary of Key Results

The list of electrical components submitted by Reference No. 3 is complete with the exception of the following:

1 - New instrumentation which was installed, subsequent to the referenced submittal, for the purpose of segregating the indicated plant parameters from the ICS/NNI systems.

2 - Replacement of a component and assigning it a new identifying number (PS-745 A, B, C).

3 - The reactor incore thermocouples were recognized to be required for SBLOCA mitigation as a result of the development of the B&W ATOG document.

4 - The pressurizer spray valves which may be required for long term boron precipitation control.

Appendix "A" provides a complete list of electrical components which are required for SBLOCA mitigation and are located in a postulated harsh radiological environment. Components requiring qualification for these conditions are identified.

Conclusion

This report provides the methodology for electrical component identification and basis for affirming the completeness of the list of electrical components to be evaluated for their radiation qualification in accordance with the stated requirements.

Recommendations

1 - It is recommended that this report be reviewed by TMI-1 operations in order to ensure that the operators recognize the qualifications and limitations of the components which may be called upon to mitigate a postulated SBLOCA.

2 - Specific procedural guidance must be incorporated to justify not qualifying MV tank level indication (MV-14-DPT), HPI flow indication MV-23-DPT 1, 2, 3, 4) and seal injection flow indication (MV-42-DPT). Refer to specific instruments (Appendix "A" and Appendix "C" for guidance.

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1.0 INTRODUCTION

The UCS contention regarding the radiation qualification levels to which electrical equipment located in containment and auxiliary building whose operation is necessary to mitigate small break loss of coolant accidents (SBLOCA) and loss of main feedwater transients was ruled to be a valid contention by the Atomic Safety and Licensing Appeals Board (ASLAB). The contention essentially stated that such electrical equipment must be qualified for radiation levels associated with large break LOCAs in accordance with the Division of Operating Reactors (DOR) guidelines.

As a result of the ASLAB ruling, the NRC Commissioners directed the NRC staff to certify that the TMI-1 electrical equipment which is required to mitigate such an event is qualified with respect to radiation in accordance with the DOR guidelines. GPUN has been requested (Ref. No. 1) to review the list of equipment falling within the scope of the NRC Commission's order, using the applicable guidance from the Commissions (Ref. No. 2) May 25, 1984 letter to GPUN and prepare for an audit of the environmental qualification files for such components.

This report provides the basis and list of electrical equipment falling within the scope of the NRC Commission's order, utilizing the applicable guidance of the May 25, 1984 letter.

Appendix "A" of this report is a list of electrical components which are required to mitigate such an event and are located in areas which are postulated to provide a harsh radiological environment. The list identifies the components requiring qualification for harsh radiological environments and the degree of radiological exposure for which such qualification is required.

The body of this report, in conjunction with the remarks in Appendix "A" provide the methodology used to identify components that must be environmentally qualified.

2.0 METHOD

The methodology utilized to generate the list of safety-related electrical equipment as defined in paragraph (b) (1) of 10CFR50.49 which is required to remain functional during or following a SBLOCA with a loss of main feedwater, to mitigate the event, included a review of the following TMI-1 documents:

1 - Final Safety Analysis Report (FSAR)

2 - Technical Specifications & Manuals

3 - Normal Operating & Abnormal Transient Procedures

4 - System Flow Diagrams

5 - Piping Drawings

6 - Electrical Distribution & Elementary Wiring Diagrams

The foregoing documents identify the systems, the system operating modes, auxiliary support systems, and components which are required to perform the following mitigating functions following a SBLOCA with a loss of main feedwater.

1 - Emergency Reactor Shutdown (Reactor Reactivity Control)

2 - Containment (Reactor Building) Isolation

3 - Reactor Core Cooling and Heat Removal

4 - Containment (Reactor Building) Heat Removal

5 - Prevention of Radioactive Material Release to the Environment

Each of these functions is discussed individually and in greater detail in subsequent sections.

2.1 Definition of Scope and Assumptions

A small break loss of coolant accident (SBLOCA) shall be defined as a break within the reactor coolant system (RCS) boundary which does not exceed the flow area of the largest RCS connecting pipe cross sectional area, namely the core flood (DF) nozzle on the reactor vessel. This 0.44 ft^2 break is the largest break which does not exhibit large break LOCA symptoms (i.e., continuous depressurization to LPI injection).

The control room operator is assumed to respond to the event in accordance with the Abnormal Transient Procedures (ATPs) and operator training. Subsequent to the initial period of the event, the resources of the emergency response organization are available to provide any required assistance.

The radiological environment which has been utilized for this evaluation is presented in TDR-282 and TDR-121 (Ref. No.'s 4 & 5) with equipment locations identified by the same area designations.

As a result of the postulated event and the defined limits for a SBLOCA, the reactor building (RB) pressure does not reach 30 psig. Thus, the reactor building spray system is not initiated, nor is a 30 psig RB pressure containment isolation signal generated.

The defined SBLOCA event does not result in core fuel failure or conditions which would result in hydrogen generation in excess of 4% by volume. Thus, the postulated radiological conditions are conditions for environmental qualification of electrical components which would be required to mitigate such an event while such environmental conditions existed. Therefore, it is assumed that in accordance with the criteria for containment isolation, the radiological conditions would not permit the operator to re-open containment isolation valves once they have been closed and that the hydrogen recombiner system will remain isolated during the event.

The radiological conditions in the Auxiliary Building are assumed to be the same as the normal operating conditions until the borated water storage tank (BWST) has been depleted of its inventory and the decay heat removal pump suction is switched to the reactor building sump. The plant ATPs require specific operator actions to align system valves and system operating modes in preparation for RB sump recirculation. Concurrently, electrical components within the auxiliary building which will not be required to change state (i.e., motor operated valves) after RB sump recirculation has been initiated will be properly aligned prior to commencing such an operating mode.

The radiological environment in the Auxiliary Building, after RB circulation has commenced, is based on radioactivity emitted by the recirculated fluid within the piping systems. It is assumed that the integrity of these piping systems is maintained during this event with no radiological releases within the Auxiliary Building.

The postulated loss of main feedwater either concurrently or independently of a SBLOCA does not affect the methodology and list of mitigating system/components requiring electrical component qualification since the mitigating EFW for either event is addressed by the SBLOCA mitigating systems. Thus, the event will henceforth be identified only as a SBLOCA.

Implicit in this evaluation, is the assumption that there may also exist a concurrent loss-of-offsite-power (LOOP) and that redundancy of safety-related components be provided for possible single failure of such components.

Appendix "A" of this report does not list all safety related auxiliary equipment which are required to perform a safety function during or following a SBLOCA, but which are clearly identifiable by inspection of the plant general arrangement drawings to be located in a non-harsh environment. These items are contained in the auxiliary support systems identified in Section 2.2.

2.2 Systems Identification and SBLOCA Scenario

The systems required for mitigation of a SBLOCA were identified by a review of the plant Abnormal Transient Procedures (ATPs) in conjunction with an understanding of the symptoms associated with a SBLOCA and a review of the containment isolation system. The SBLOCA cannot be defined by a single scenario. It can, however, be defined by associated symptoms. The TMI-1 ATOG (Reference No 8) described both the plant response for various LOCAs and the mitigating systems. The ATPs are likewise designed to address correct operator actions in a prioritized fashion to the plant response symptoms rather than specific scenarios. Since the ATPs address symptoms and responses for all postulated events, extractions were made from these procedures of the steps appropriate for the SBLOCA. These steps are presented in Appendix "B" as a procedural logic for SBLOCA mitigation.

This logic provides for the identification of the general systems and some specific components which are required in order to perform the SBLOCA mitigating functions identified in Section 2.1 The support auxiliary systems, the system interfaces, the required instrumentation and electrical auxiliary devices are identified by a review of the specific system flow diagrams, component specifications, manuals and drawings and the elementary wiring diagrams.

The following systems provide for the performance of one or more of the required mitigating functions:

1 - Reactor Protection System
2 - Nuclear Instrumentation (Neutron Monitors)
3 - Engineered Safeguards Actuation System
4 - Containment Isolation System
5 - Reactor Coolant System Instrumentation
6 - High Pressure Injection (HPI) System
7 - Core Flood System
8 - Low Pressure Injection System
9 - Emergency Feedwater and Atmospheric Steam Dump Systems
10 - Reactor Building Emergency Cooling System
11 - Vital and ES Electric Power Systems

The cooling water support systems are generally located in non-harsh radiological areas. Components within these cooling water systems which are not clearly identifiable to be either

located in a non-harsh environment and/or to be non-electrical in nature were listed in Appendix "A". All other such auxiliary support systems including the river water supply systems are located in non-harsh environments. This includes all of the electrical components in the following systems:

1 - Decay Heat Closed Cooling Water System

2 - Nuclear Services Closed Cooling Water System

3 - Intermediate Closed Cooling Water System

4 - Auxiliary Building HVAC System

5 - Control Building HVAC System

6 - Vital and ES Power and Control Systems and Relays

These mitigating and mitigating support systems encompass all of the systems required to mitigate a SBLOCA.

2.3 Reactivity Control

Reactivity control is obtained by the insertion of the reactor control rods and injection of borated water. Verification of the reactor control rod insertion and reactor shutdown is accomplished by the incore intermediate range power monitoring system.

The reactor control rods are inserted by the Reactor Protection System (RPS) as a result of abnormal RCS pressure and/or temperature conditions or directly as a result of a loss-of-offsite-power (LOOP). A SBLOCA would cause abnormal pressure/temperature conditions that would actuate the RPS to trip the reactor. A reactor trip signal removes power from the control rod drive mechanism, as would a LOOP, and would allow these rods to fall to the reactor shutdown position.

The purpose of these trip signals is to prevent the fuel from experiencing a departure from nucleate boiling (DNB) transient. Therefore core fuel failure would not yet have occurred and thus, the function of the RPS would have been complete prior to its components having been subjected to a harsh environment. Therefore, the RPS components meet the criteria of 10CFR50.49 for exception and do not need to be environmentally qualified.

Likewise, the incore intermediate range power monitoring system performs its function prior to being subjected to a harsh environment and is excepted for environmental qualification.

Boron injection during a SBLOCA is accomplished by the LPI and/or HPI systems which inject water from the borated water storage tank into the RCS. The LPI and HPI systems are discussed and addressed in Section 2.5.

2.4 Containment Integrity and Radiation Release Control

2.4.1 Containment Isolation

The containment isolation system has been designed on the basis of diverse and redundant isolation signals. The initiating signals which are anticipatory of postulated fuel failure are the reactor trip and 1600 psig RCS pressure isolation signals. Most of the containment isolation valves receive one of these isolation closure signals. These valves would then be closed prior to being subjected to the harsh postulated radiation from a SBLOCA. These valves would remain closed during the remainder of the event unless a failure of their electrical components would result in re-opening the valve. In order to satisfy the single failure criteria, these isolation valves may not be allowed to re-open due to such failure. Since motor operated valve control systems are located in non-harsh environments, motor operated valves will fail in an as-is position due to radiation. Solenoid operated valves are assumed to fail to a de-energized state. Since some containment isolation valves are air operated and their air supply is controlled by a solenoid valve, the failure mode of the isolation valve was examined in response to an assumed solenoid valve failure.

All of the powered containment isolation valves contain direct position indication in the control room. Failure of the isolation valve position indication after the valves have been initiated and indicated closed on the containment isolation status board is deemed to be acceptable since their function has been completed and at the given level of radioactivity in the reactor building would not have been re-opened either by the operator or due to the failure of the valve operator.

The intermediate closed cooling water (IC) system and nuclear services closed cooling water (NS) system containment isolation valves would not necessarily receive isolation signals which are anticipatory of postulated high radiation levels. These valves would be initiated to close if their respective piping system inside of the

containment did not remain intact as a result of the SBLOCA. Their isolation signal is generated by a concurrent 1600 psig RCS pressure signal and a low surge tank level signal. Their respective surge tank inventory may not be immediately depleted to the low level set point, however, their isolation signal would be initiated within two (2) hours of the SBLOCA event. Thus, they must be functional at that time and must, therefore, be radiologically qualified.

The reactor coolant pumps (RCP) seal return containment isolation valves MU-V-25 and 26 do not receive an isolation signal which is anticipatory of postulated high radiation levels. These valves would be isolated by the operator in response to a high radiation monitor alarm on the seal return piping in the Auxiliary Building. The RCP seal return water remains relatively clean while the seal injection water source is from the BWST. If seal injection is not available due to the failure of the supplying HPI pump or the switch to RB sump recirculation has been made, then the radiation monitor will alarm before the monitor is outranged and fails due to radiation. Since the inside containment isolation valve will have been subjected to a harsh postulated radiological environment and the outside valve will have been exposed to the effects of the contaminated fluid, these valves must still be qualified to function and provide their respective closed position indication.

All containment isolation valves, including their position indicating devices, must as a minimum, be qualified for their normal harsh radiological environment.

Specific remarks regarding the qualification needs for each containment isolation valve are provided in Appendix "A".

2.4.2 Prevention of Radioactive Release to the Environment

Prevention of radioactive material release is provided by properly maintaining containment integrity. Containment integrity is provided by ensuring that the reactor building pressure and temperature limits are not exceeded and containment isolation is implemented.

Containment isolation has been addressed in Section 2.4.1 and is accomplished by the containment isolation system and operator guidelines, designed to prevent releases, for re-opening isolation valves.

The containment heat removal function to mitigate the energy release within the reactor building and prevent a rise of pressure/temperature within the building is addressed in Section 2.4.3. The energy release due to the largest SBLOCA only result in RB pressures less than 30 psig and temperatures below the RB design temperature.

The pressure response of the TMI-1 reactor building was evaluated using the CONTEMPT computer code and blowdown data for a 0.5ft^2 LOCA as presented in Table 6.2-22 if the TMI-2 FSAR. This break size is at the low end of the large break LOCA spectrum. This analysis results in a peak pressure of 31 psig. The pressure response for the 0.44 ft^2 core flood line break will be less than 30 psig because: 1) the core pressure level at TMI-1 is only 2535 MW(t); 2) the break area is 12% smaller than the analyzed break (hence break flow will be reduced); and 3) the CF line break results in RCS pressure being held up, so that the stored energy in the RCS is released over a much longer period of time than the 0.5 ft^2 LOCA.

Hydrogen release, in excess of 4% by volume, has not been postulated since a mitigated SBLOCA will not result in fuel failure.

Thus, containment integrity is maintained and provides the required prevention of radioactive material release to the environment.

2.4.3 Containment Heat removal

The reactor building emergency cooling system is initiated by the anticipatory 1600 psig RCS pressure ES signal. With the exception of the RB Fans located inside of containment, as listed in the miscellaneous section of Appendix "A", all other electrical components required to operate and control this system to provide the required RB cooling function are located in either the Intermediate Building or the Intake Structure Building which do not contain a harsh radioactive environment. Thus, the only components which require qualification for the postulated harsh radiological environment are the RB fan motors.

2.5 Reactor Core Cooling and Heat Removal

The SBLOCA consists of a break spectrum as described by the TMI-1 ATOG (Reference No. 8), which produce definable symptoms. The symptom which is common to the entire spectrum is the loss of

reactor coolant inventory. Since the reactor coolant is the primary medium for reactor heat transfer, sufficient inventory must be maintained in the reactor core to absorb the core decay heat and to provide for a means of removing this heat from the reactor core region.

The systems which provide makeup water injection to the RCS water inventory are the high pressure injection (HPI) system, core flood (CF) system and the low pressure injection (LPI) system. These injection systems initially take borated water from the BWST for their injection supply. The borated water also performs the secondary function of reducing the core reactivity. Once the BWST inventory is depleted, these injection systems are re-aligned to draw water, which has exited the break, from the RB sump. The HPI pumps do not draw their water directly from the RB sump at this point, but rather receive their supply from the LPI pump discharge. This mode of operation is called the "piggy back" mode.

The means available for decay heat removal and core cooling are dependent on the SBLOCA symptoms. Therefore, the system that provides this function will also depend on the symptoms of the SBLOCA.

The TMI-1 ATOG (Reference No. 8) described both the plant response for various SBLOCAs and the mitigating systems for core heat and RCS heat removal. These guidelines also address mitigating actions beyond the single failure criteria. Such additional actions have not been addressed by this report on the basis that they exceed the stated requirements.

In order to identify the electrical components required to perform or prevent the performance of the core cooling and heat removal function, we have reviewed the ATPs, operating procedures, system flow diagrams, training material and elementary wiring diagrams for components that are called upon to function, system interfaces and control logic that maybe in a harsh radiological environment and could interfere with the performance of the function if it failed in any given state. The components that were thus identified and evaluated are shown in Appendix "A".

The instrumentation which would be required by the operator to perform the core cooling and RCS heat removal were also identified, including the RCS and OTSG instrumentation which is independent of the ICS/NNI systems and added subsequent to the submittal of Reference No. 3.

Instrumentation was reviewed by considering whether sufficient redundancy existed in indication so that failure of non-qualified instrumentation would not mislead the operator and that for the scenarios described the operator would have the required indications.

The review of the systems operating modes and identified components included the application of the concept of failure as a result of the event and single failure of safety related components independently of the event.

2.6 Electrical Systems Interactions

The electrical systems interactions for failure of electrical components which have not been qualified for harsh radiological environments, on electrical components which are required for SBLOCA mitigation has been accomplished. This been accomplished by a review of the TMI-1 electrical wiring diagrams, (Reference No. 10 & 11) with the following results:

1 - All M. O. valves identified in Appendix "A" have dedicated over current protection devices and contain no interfacing devices that could impact their operation.

2 - All solenoid valves are individually fused and have no other electrical devices other than limit switches that could impact their operation. These limit switches are identified as part of the valve and are radiologically qualified.

3 - The pumps identified do not contain any electrical devices other than those identified and qualified which could interface with the operation of these pumps.

4 - The identified air handling fan motors do not contain any electrical devices which, if not qualified, could interfere with their operation.

5 - Instrumentation

The effect of non-qualified instrumentation failure on safety-related instrumentation power supplies has been evaluated by GAI (Reference No. 11). This evaluation concluded that their failure could not result in a failure of the safety-related instrumentation power supplies or affect the operation of components required for SBLOCA mitigation.

Certain instrumentation identified in Appendix "A", requiring radiation qualification receive their power from ICS/NNI

power. While the ICS/NNI power is not safety-related, it does have diesel backed power and failure of an ICS/NNI power supply is indicated in the control room.

Each such radiation qualified instrument has its power supply identified on the control room panel, therefore, the operator will be aware of an ICS/NNI power supply failure and could then rely on other qualified instrumentation for the required indication. Where such instrumentation provides an automatic control function, the means for qualified manual control and indication are available in the control room.

3.0 RESULTS

The results of this evaluation are presented in Appendix "A", wherein each electrical component which is located within a harsh radiological environment and which is required to mitigate a SBLOCA has been identified and indicated to require qualification for the harsh environment to which it may be subjected.

The reactor incore thermocouples, which had not been included on the list submitted by Reference No. 3, provide verification of operation within the Pressurized Thermal shock (PTS) limits and verification of adequate core cooling and sub-cooling margin. Recognition of this item is as a result of development of the B&W ATOG document since the Reference No. 3 submittal.

4.0 CONCLUSIONS

This report provides a complete list and the basis for affirming the completeness of the list of items which require qualification to radiation levels associated with large break LOCAs in order to mitigate the spectrum of the SBLOCA in compliance with 10CFR50.49(b)(1) and (b)(2), has been prepared in accordance with the applicable NRC (Reference No. 2) guidance and is responsive to the NRC (Reference No. 1) request.

5.0 RECOMMENDATIONS

1 - It is recommended that this report be reviewed by TMI-1 operations in order to ensure that the operators recognize the qualifications and limitations of the components which may be called upon to mitigate a postulated SBLOCA.

2 - Specific procedural guidance must be incorporated to justify not qualifying MU tank level indication (MU14DPT), HPI flow indication MU23DPT 1, 2, 3, 4) and seal injection flow indication (MV-42-DPT). Refer to specific instruments (Appendix "A" and Appendix "C" for guidance.

6.0 REFERENCES

1 - NRC (D. G. Eisenhaut) letter to GPUN (H. D. Hukill) dated August 8, 1984

2 - NRC (D. G. Eisenhaut) letter to GPUN (H. D. Hukill) dated May 25, 1984

3 - GPUN (H. D. Hukill) letter, LIL-161 dated May 18, 1981, to NRC Office of NRR (J. F. Stolz)

4 - GPUN Technical Data Report, TDR-282, Rev. 4 "TMI-1 Qualified Equipment Locations and Environments"

5 - GPUN Technical Data Report, TDR-121, Rev. 4 "Design Review of Plant Shielding and Radiation Qualification for Post Accident Operations Outside Containment

6 - GPUN Technical Data Report, TDR-083, Rev. 3 "Evaluation of Containment Isolation Signals"

7 - GPUN Calc. No. C-1101-220-5450-013, Revision 0 "TMI-1 Estimate of the Potential for Nitrogen Gas Entrainment in the RCS during CF Discharge"

8 - B&W Technical Document No. 74-1124158-00, "TMI-1 Abnormal Transient Operating Guidelines," Part II, Vol. 2, Appendix F.

9 - GPUN Technical Data Report, TDR-269, Revision 0 "Nuclear Services Closed Cooling Water System Pump Runout Capability Test"

10 - EDS Nuclear Report No. 02-0370-1060, Vol. V, Environmental Qualification of Class 1E Electrical Equipment Report

11 - Gilbert/Commonwealth (GAI) letter (No. GAI/TMI-ICS/11077) dated 9/10/84 to GPUN

APPENDIX "A"

APPENDIX A

AT TMI- I
ASSESSMENT OF ELECTRICAL COMPONENTS REQUIRING RADIATION QUALIFICATION FOR SBLOCA MITIGATION

NOTES:

1. Radiological Environment Code

   H-1* = Harsh normal operating environment dose.

   H-1 = Harsh operating environment, normal operating dose plus SBLOCA postulated dose.

   H-2 = Harsh environment only after component completed its operating function but its failure due to radiation could result in unacceptable consequences.

   H-3 = Component may be required to operate within 2 hours after the reactor trip in a harsh environment after which the component function is not required, and its failure would not result in unacceptable consequences.

   H-4 = Harsh environment only after component completed its operating function or component function is not required in a harsh environment, and its failure would not result in unacceptable consequences.

   M = Component is located in a mild or low radiological environment.

2. Radiation Qualification Requirement Code

   Y = Component needs to be qualified for its identified radiological environment.

   N = Component is exempted from radiological qualification if it's located in a mild environment or meets the H-4 environment code criteria.

3. Location

   RB = Reactor Building

   Aux. Bldg. = Auxiliary Building area identified in TDR-282 and TDR-121.

   Int. Bldg. = Intermediate Building

OMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
H-V-1 B&C	RBI Valve(s) for RB Purge Exhaust & Supply	RB	Y	H-1*	Motor operated valves, normally closed.
V 1&2 & LS/ H-V-1D	RBI Valve(s) for RB Purge Supply	Interm Bldg	N	M	SV is normally de-energized to close AH-V-1D. Failure of solenoid due to radiation keeps AH-V-1A closed in its RBI state.
V 1&2 & LS/ H-V-1A	RBI Valve(s) for RB Purge Exhaust	Aux Bldg (A-13)	Y	H-1*	SV is normally de-energized to close AH-V-1A. Failure of solenoid due to radiation keeps AH-V-1D closed in its RBI state.
DL-V-303	RBI Valve(s)for RCDT Liquid to WDL System	RB	Y	H-1*	Motor operated valve, normally closed.
V & LS/ DL-V-304	RBI Valve(s) for RCDT Liquid to WDL System	Aux Bldg (A-13)	Y	H-1*	SV is de-energized to close WDL-304. WDL-304 is normally closed. Failure of solenoid due to radiation keeps WDL-304 closed in its RBI state.
DL-V-534	RBI Valve(s) for RB Sump to Aux Bldg Sump	Aux Bldg (A-1)	Y	H-1*	SV is de-energized to close WDL-534. WDL-534 is normally closed. Failure of solenoid due to radiation keeps WDL-534 closed in its RBI state.
DL-V-535	RBI Valve(s) for Sump to Aux Bldg Sump	Aux Bldg (A-1)	Y	H-1*	SV is de-energized to close WDL-535. WDL-535 is normally closed. Failure of solenoid due to radiation keeps WDL-535 closed in its RBI state.
C-V-2	RBI Valve(s) for ICCW Return	RB	Y	H-3	If IC system line inside RB breaks, then line break isolation signal will not be initiated until IC surge tank drops. Valve may thus be required to operate in the post accident radiological environment.

OMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
V & LS/ C-V-3	RBI Valve(s) for ICCW Return (Solenoid Valve & Limit Switches)	Aux Bldg (A-9)	Y	H-2	If valve isolation is required due to IC system line break, the valve will have only been subjected to mild radiation within the time before its closure. SV is energized to close IC-V-3. Failure of SV would fail IC-V-3 open. If IC system line inside RB breaks, then line break isolation signal will not be initiated until IC surge tank drops. Valve may thus be required to operate in the post accident radiological environment. Therefore, SV & LS need to be radiologically qualified.
V & LS/ C-V-4 & 6	RBI Valve(s) for ICCW Supply to CRDM & Other IC Supplied Services Solenoid Valve & Limit Switches	Outside of Aux Bldg area (A-13)	N	M	If IC system line inside RB breaks, then line break isolation signal will not be initiated until IC surge tank drops. Valve may thus be required to operate in the post accident radiological environment. Valve is located in a mild radiological environment for the entire post LOCA accident period. SV is energized to close the respective IC-V-4 & IC-V-6 valves.
B-V-2A & B-V-7	RBI Valve(s) for Norm Cooling Water Return for RB Coolers	Int Bldg	N	M	Motor operated, normally open, RBI valves. Close on RBI 1600# RCS pressure.
V & LS/ M-V-1, 2, 3&4	RBI Valve(s) for RB Air Sample	Int Bldg	N	M	SV is normally de-energized to close CM-V-1/2/3/4. Failure of solenoid due to radiation keeps these valves in their RBI state. Valves are not required to be re-opened unless RM-A-2 containment iodine and gas radiation monitor is to be used. Even if a containment air sample is taken, the integrated radiological dose is less the 1×10^4 rads, and valves are therefore exempt from qualification.
DG-V-3	RBI Valve(s) for RCDT Vent to WDG System	RB	Y	H-1*	Motor operated valve, normally open, closes on RBI isolation signal. This valve does not need to be re-opened for SBLOCA mitigation.
V & LS/ DG-V-4	RBI Valve(s) for RCDT Vent to WDG System	Aux Bldg (A-13)	Y	H-1*	This solenoid operated valve is de-energized to close the valve. Failure of the solenoid due to radiation keeps WDG-V-4 in its closed RBI state. The magnetic valve position switches are only required to confirm the initial valve closing.

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
NS-V-35	RBI Valve(s) for NS Cooling Water Return from RCP Motors	RB	Y	H-3	Motor operated valve. If NS system line inside RB breaks, then line break isolation signal will not be initiated until NS surge tank level drops. Valve may thus be required to operate in the post accident radiological environment.
NS-V-15 & NS-V-4	RBI Valve(s) for NS cooling water supply and return for RCP Motors	Aux Bldg (A-13)	Y	H-3	Motor operated RBI valves. Since a SBLOCA will not yield a 30 psig RBI signal, valves may be initiated to close on a line break isolation signal. A line break signal, if received, would occur while the Aux Bldg is still not contaminated. Therefore if valves are required to function, they will do so in a normal radiological environment while the HPI water source is the BWST. Since the valves are located in a normally high radiation area, they need to be qualified to function after receiving normal integrated radiation dose.
SV & LS/ MU-V-18	RBI Valve(s) for Normal RCS Makeup	Aux Bldg (A-7)	Y	H-1	SV is energized to close MU-V-18. Failure of SV results in MU-V-18 re-opening. MU check valves prevent reverse flow from RCS if MU-V-18 re-opened and MU or HPI pump is not operating. Failure of MU-V-18 in the open position may result in HPI pump runout. Therefore, MU-V-18 solenoid valve needs to be qualified for the SBLOCA postulated radiological environment. LS is not required after valve is confirmed closed by 1600 # RCS pressure isolation signal, but its failure could de-energize the SV.
SV & LS/ MU-V-3	RBI Valve(s) for RCS Letdown Containment Isolation Valve	Aux Bldg (A-7)	Y	H-1	SV is energized to close MU-V-3. SV failure due to radiation would de-energize and fail MU-V-3 open. If MU-V-2A or B failed to close due to "LOOP" and one failed D/G, then MU-V-3 failing open is unacceptable. Therefore, it needs radiation qualification. The LS should also be qualified even though they are only required to confirm the initial valve closing.

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
MU-V-2A & 2B	RBI Valve(s) for RCS Letdown Containment Isolation Valve	RB (Letdown Clr. Room)	Y	H-1*	Motor operated RBI valves. RCS letdown is not required to mitigate a SBLOCA. RCS letdown may only be initiated after a LOCA if RCS fluid is not significantly contaminated due to core fuel failure. If fuel failure did not result due to the transient, then the valve operator would not have been exposed to the RB radiation levels and therefore may be exempt from radiation qualification.
SV & LS/ CA-V-189	RBI Valve(s) for Reclaimed Water	Aux Bldg (A-7)	Y	H-1*	SV is de-energized to close CA-V-189. Failure of solenoid due to radiation closes CA-V-189 to its RBI state. LS are only required to confirm initial valve closing.
CA-V-1,3,13	RBI Valve(s) for RCS Sample (PZR Wtr & Stm SP, Letdown)	RB	Y	H-1*	Motor operated valves are normally closed and are not required to operate for SBLOCA mitigation.
SV & LS/ CA-V-2	RBI Valve(s) for RCS Sample	Aux Bldg (A-13)	Y	H-1*	SV is de-energized to close CA-V-2. CA-V-2 is normally closed. Failure of solenoid due to radiation closes CA-V-2 to its RBI state. LS are only required to confirm initial valve closing.
CA-V-4A,4B	RBI Valve(s) for OTSG Sample	RB	Y	H-1*	Motor operated valves are normally closed and are not required to operate for SBLOCA mitigation.
SV & LS/ CA-V-5A,5B	RBI Valve(s) for OTSG Sample	Turb Bldg	N	M	SV & LS are not located in a radiological area and would thus not fail due to radiation.
SV & LS/ CF-V-19 A&B	RBI Valve(s) for CF Tk Makeup	Aux Bldg (A-13)	Y	H-1*	SV is de-energized to close CF-V-19 A&B. CF-V-19 A&B are normally closed. Failure of solenoid due to radiation keeps CF-V-19 A&B in their required RBI state. LS are only required to confirm initial valve closing.
CF-V-2 A&B	RBI Valve(s) for CF Tk Bleed & Sample	RB	Y	H-1*	Motor operated valves are normally closed valves and are not required to operate for SBLOCA mitigation.
SV & LS/ CF-V-20 A&B	RBI Valve(s) for CF Tk Bleed & Sample	Aux Bldg (A-13)	Y	H-1*	SV is de-energized to close CF-V-20 A&B. CF-V-20 A&B are normally closed. Failure of solenoid due to radiation keeps CF-V-20 A&B in their required RBI state. LS are only required to confirm initial valve closing.

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
MU-V-25	RCP Seal Return Isolation Inside RB	RB	Y	H-1	Motor operated valve, normally open, closes only on 30# RB pressure RBI signal. If seal return were to become highly activated, then this valve would need to be manually closed. This may occur after going to sump recirc mode. Therefore, this valve must be radiation qualified.
SV&LS/ MU-V-26	RCP Seal Return Isolation Outside RB	Aux Bldg. (A-13)	Y	H-1	SV is normally energized to keep MU-V-26 open. (See remarks for valve MU-V-25).

YSTEM: LOW PRESSURE INJECTION FUNCTION (LPI) /
PUMP SUCTION FROM RB SUMP FOR LPI MODE OR HPI PIGGYBACK MODE

OMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
H-P-1 A&B	Decay Heat Pump - Provide LPI or Supply Suction to HPI Pumps from RB Sump	Aux Bldg (A-1)	Y	H-1	The DH pumps are required to be operated for the entire SBLOCA event and must therefore be qualified for the SBLOCA postulated radiological environment.
H-V-6 A&B	RB Sump Suction Valve for DH-P-1	Aux Bldg (A-1)	Y	H-1*	Motor operated valves need to be capable of opening when DH recirculation from the RB sump is initiated. Once recirculation from the sump is initiated, the valves do not need to be operated. Thus, valves need only be qualified for the normal operation radiation environment integrated dose.
H-V-5 A&B	DH Pump Suction from BWST	Aux Bldg (A-8, A-10)	N	M	Motor operated, normally open, valves which need to be capable of being closed when the DH pumps are switched to RB sump suction. Once they have been closed, they do not need to be re-opened. Thus, they need to be qualified for their normal plant operation radiation environment integrated dose only. Since these valves are located in a normally mild radiological environment, they are exempted from radiation qualification.
S-V-2 A&B	DH Pump Suction from NaOH Tank	Aux Bldg (A-8, A-10)	N	M	Motor operated, normally closed, valves. These valves are activated to open by a 4 psig RB pressure switch as an anticipatory step to RB spray actuation. The SBLOCA does not result in a 30 psig RB pressure which would actuate the RB spray pumps. Since the RC does not initially depressurize to the point where the DH pumps can inject into the RCS, the DH pumps will operate on their minimum recirculation flow and will not draw NaOH into the DH system piping.

SYSTEM: LOW PRESSURE INJECTION FUNCTION (LPI) /
PUMP SUCTION FROM RB SUMP FOR LPI MODE OR HPI PIGGYBACK MODE (continued)

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
DH-V-4 A&B	LPI Mode Injection Valves	Aux Bldg (A-9, A-7)	Y	H-1	These motor operated valves will open automatically by either a 1600 psig RCS pressure or by a 4 psig RB pressure signal. Since valves DH-V-19A&B, used for DH flow throttling, are located in an unaccessible area after having operated in a RB sump recirculation mode, valves DH-V-4A&B need to be utilized for this throttling process. Therefore, they need to be qualified for the SBLOCA postulated radiation.
DH-V-1	DH Dropline Isolation at "B" Hot Leg	RB (Inside "D" Ring)	Y	H-1	DH-V-1, 2 & 3 are normally closed, motor operated manually controlled valves. These valves are utilized for normal operation DH removal. They may also be utilized for small break LOCA boron precipitation control. These valves need to be opened to provide a flow path to prevent boron precipitation in the core region. Valves DH-V-1 & 2 have permissive interlocks which are controlled by qualified instruments RC-3A-PT3 and RC-3A-PT4. These valves provide for one of the redundant paths, in conjunction with RC-V-3 & 4 for this function. Therefore, these valves need to be qualified for SBLOCA postulated radiation levels.
DH-V-2	DH Dropline Isolation at Containment	RB	Y	H-1	
DH-V-3	DH Dropline Isolation Outside RB	Aux Bldg (A-7)	Y	H-1	
DC-V-2 & 65 A&B	Inlet & Bypass Valves for DC System flow through DHR Cooler	Aux Bldg (A-1)	N/A	N/A	Not applicable for electrical qualification. Pneumatic (manually) regulated valves and local hydraulic flow indication (FI-26 & 27). These valves are utilized to control the amount of heat removed by the DH coolers.

OMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
S-745 AB&C	Pressure switches, trip MU/HPI pump on Low oil pressure	Aux Bldg (A-6)	Y	H-1	These switches insure that lube oil pressure is sufficient to maintain HPI/make-up pump operation. Failure of these switches under SBLOCA conditions could result in MU/HPI pump trip. These pressure switches are located in a radiologically harsh environment and therefore need to be radiologically qualified.
S-479 A,B&C S-648 A,B&C S-478 A,B&C	Start & Stop Aux. oil Pump (MU-P-2) Start & stop Aux. gear oil pump (MU-P-4) Main oil pump low pressure alarm	Aux Bldg. (A-6)	N	H-4	These pressure switches provide alarm indication of low oil pressure in the MU/HPI pump and motor and in the MU/HPI gear oil systems. They also provide start signals for the oil systems auxiliary oil pumps. The failure of these switches would not prevent the starting or operating capability of the MU/HPI pumps. Since the auxiliary oil pumps MU-P-2 & 4 are also not required for the MU/HPI pump operation and failure of these switches does not affect the MU/HPI pump operation, the switches can be exempted from SBLOCA radiation qualification.
U-P-1 A,B&C	Makeup (MU & HPI) Pumps	Aux Bldg (A-6)	Y	H-1	Make-up/HPI pumps required for accident mitigation.
U-P-2 A,B&C	Auxiliary Oil Pump for Respective MU-P-1	Aux Bldg (A-6)	N	H-4	These pumps are normally operated in conjunction with and as a backup to the main oil pumps to insure sufficient lubrication for the make up pumps motor and pump bearings. The failure of this auxiliary oil pump would jeopardize the availability of the HPI pump only if the main oil pump had failed. Failure of the auxiliary oil pump would not affect the operation of the main oil pump or the MU/HPI pump. Therefore, these pumps can be exempted from SBLOCA radiation qualification although they are located in a normally harsh environment and would also be subjected to the SBLOCA postulated radioactivity.

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
MU-P-3 A,B&C	Main Oil Pump for Respective MU-P-1	Aux Bldg (A-6)	Y	H-1	These pumps operate continuously during make-up pump operation to supply the pump motors and bearings with sufficient lubricating oil. Failures of the main oil pumps would jeopardize HPI operation. These pumps are located in a radiologically harsh environment during normal operation and during SBLOCA events with the postulated radioactivity.
MU-P-4 A,B&C	Gear Oil Pump for Respective MU-P-1	Aux Bldg (A-6)	N	H-4	These pumps provide a backup pumping capability for the gear shaft driven gear oil pump. These pumps are started by a low gear oil pressure switch. However, failure of the pressure switch or this pump does not prevent the start of the MU/HPI pump. As the MU/HPI pump starts, the gear driven oil pump will supply the required gear oil. Thus, these auxiliary gear oil pumps are not required to support or adversely affect the MU/HPI pumps if they fail during the SBLOCA event. Therefore, these pumps can be exempted from SBLOCA radiation qualification.
MU-V-12	Makeup Pump Isolation Valve Normal Suction from MU Tank	Aux Bldg (A-5)	N	H-4	This motor operated valve is normally open. If the valve operator fails due to the SBLOCA postulated radiation, it will fail as-is. Since procedure O.P. 1104-2 limits the MU tank gas pressure to prevent gas entrainment to the HPI pumps, this valve may be left open or closed during a SBLOCA. Failure of this valve due to radiation will not affect the ability to mitigate a SBLOCA. Therefore, this valve does not need to be qualified for the SBLOCA postulated radiation.

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
MU-V-16 A,B,C&D	HPI Injection Valves	Aux Bldg (A-7, A-13)	Y	H-1	Upon ES signal, these valves open to permit HPI injection flow to the RCS. HPI flow is throttled in accordance with the procedural criteria, by modulating the position of theses valves. Failure of these valves in the opened or closed position is undesirable. Therefore, these valves need to be qualified for the SBLOCA postulated radiation environment.
MU-V-14 A&B	HPI Mode, MU Pump Suction Isolation from BWST	Aux Bldg (A-8)	Y	H-1	Upon ES signal, both valves open to allow HPI pumps to take suction directly from the BWST. For "piggy back" mode of operation, these valves remain open until LPI pump operation is verified. Thereafter, the valves may be closed. Failure of the valves in either the open or closed position is undesirable.
MU-V-13 and MU-V-27&28	MU tank vent and hydrogen & nitrogen supply valves.	Aux Bldg (A-3) (A-4a)	N	H-4	These solenoid valves are normally closed and de-energized. Failure of the solenoid due to radiation would keep these valves in their normally closed state. These valves will not be required to function for SBLOCA mitigation. Therefore, they need not be qualified for exposure to radiation.

OMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
U-V-36 & 37	Common Recirc Isolation for MU Pumps back to MU Tank	Aux Bldg (A-5)	N	H-4	During normal operating conditions, these valves are open. An ES actuation of the HPI pumps close these valves in order to attain the maximum RCS injection flow. Per OP-1101-1 "Plant Limits & Precautions," these valves are required to be opened when HPI flow is throttled below 80 gpm/pump in order to provide a path for pump recirculation. For a SBLOCA in which the break is un-isolatable, the HPI pump flow will always remain above the 80 gpm/pump. Thus, these valves do not need to be re-opened from their closed ES alignment. For a SBLOCA in which the break is isolated some time during the event, the operator will turn off the HPI pumps, utilize the natural circulation cooling to control RCS pressure and temperature and may periodically restart an HPI pump to provide RCS makeup for the RCS volume shrinkage. Thus, these valves do not need to be re-opened from their closed ES alignment. Therefore, these valves do not need to be qualified for the SBLOCA postulated radiological environment. Also, these valves are located in a normally mild radiological environment. Therefore, these valves may be exempted from radiological qualification.
H-V-7 A&B	MU Pump HPI Mode Suction from RB Sump	Aux Bldg (A-8)	Y	H-1	Under conditions of normal operation, these valves are closed. For purposes of SBLOCA mitigation, it may be necessary to line up HPI and LPI for the "piggy back" mode of operation. In this event, DH-V-7 A&B will be required to open per ATP 1210-6. It may be desired to reclose these valves after having operated in a throttled HPI "piggy back" mode. Therefore, these valves need to be qualified for the SBLOCA postulated radiation.

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
DC-P-1 A&B	Decay Closed CW Pump - Supplies Cooling Water for MU-Pump (A&C)	Aux Bldg (305' Elev NW Corn) Outside Area (A-13)	N	M	The decay heat closed cooling system is an ES system. During normal operation, pumps 1A and 1B are in standby. Upon an ES signal, (1600, 500 psig RCS pressurize or 4 psig RB pressure), both pumps are started. These pumps supply motor and bearing cooling water for the make up pumps 1A and 1C, decay heat pumps 1A and 1B and building spray pumps 1A and 1B. Failure of the pumps is unacceptable. These pumps are located in a mild radiological environment during normal and SBLOCA conditions and are therefore exempted from radiation qualification.
NS-P-1 A, B&C	Nuclear Services Closed CW Pump - Supplies Clg Water for MU-Pump (B)	Aux Bldg (305' Elev NW Corn) Outside Area (A-13)	N/A	M	The nuclear services closed cooling water system is an ES system. Two pumps are normally on ES standby. For emergency operation, only one pump is required for operation. Under a loss of offsite power, two (2) pumps which have been selected to start on ES actuation would be started via loading block 3 from the diesel generator. The pumps provide cooling water to equipment that is vital for mitigating a SBLOCA. These pumps are located in a mild radiological environment during normal and SBLOCA conditions, and are therefore exempted from radiation qualification.
NS-V-56- A&B	Cooling Water Control Valve for AH-E-15 A&B	Aux Bldg. (305' Elev. NW Corn) Outside Area 13	N	M	These are non-electric operated and controlled devices. NS-V-56 A&B are pneumatic flow regulating valves which are located on the NS cooling water inlet lines to the pump cubicle air coolers for nuclear services and decay heat closed cooling systems. Both valves are controlled by thermostats located in the pump cubicles. Since the valves, controls and thermostats are located in a mild radiological environment during normal and SBLOCA conditions, and are exempted from radiation qualification.
AH-E-15 A&B	NS & DC Cooling Systems Pump Area	Aux Bldg. (305' Elev NW Corn) Outside Area 13	N	M	These ES air handling units which provide cooling for the NS and DC pump cubicles. Fan air flow is controlled by means of temperature switches and adjustable dampers located in the ducting on the discharge sides of the fans. Since the fans and control devices are located in a mild radiological area during normal and SBLOCA conditions, they are exempted from radiation qualification.

MPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
F-P-1	Turbine Driven EFW Pump	Int Bldg	N	M	All EFW system components are located in non-radiologically contaminated areas.
-P-2 A&B	Motor Driven EFW Pumps & Motors	Int Bldg	N	M	" " " " " " "
-V-2 A&B -V-13 A&B	Steam Supply to Turbine Driven EFWP	Int Bldg	N	M	" " " " " " "
-V-4 A&B	MS Atmospheric Dump Valves	Int Bldg	N	M	" " " " " " "
-V-1 A&B -V-2 A&B	EFWP Suction & Discharge Cross Connects	Int Bldg	N	M	" " " " " " "
-V-4&5	EFW Suction from River Water Pumps RR-P-1 A&B	Int Bldg	N	M	" " " " " " "
-V-10 A&B	EFW Suction from Condensate Storage Tanks	Cond Stg Tank	N	M	" " " " " " "
-V-30 A&B	EFW Flow Regulating Valves	Int Bldg	N	M	" " " " " " "
-E-24 A&B -V-55 A&B	EF Pump Area Ventilation Unit & Cooling Supply Valve Limit Switches	Int Bldg	N	M	" " " " " " "

te: *The Licensee has not taken credit for the EFW turbine and associated components for SBLOCA events.

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
CF-V-1 A&B CF-V-3 A&B	CF Tk Isolation & Vent Valves	RB	N	H-4	These are motor operated valves whose electric breakers are opened (de-energized) when the reactor is critical. The CF system is designed to inject borated water into the reactor core during a LOCA. Such an injection, if CF-V-1 could not isolate and CF-V-3 could not vent the CF tank, would result in some time delay in the ability to depressurize the RCS below 600 psig and 275°F. CF injection will not result in nitrogen injection into the RCS (Reference No. 7 calc) Therefore, these valves are exempt from radiation qualification.
NS-V-32	NS System Supply for RCP Seal Return, Waste Gas Comp & Misc Waste Evap Cooling Isolation Valve	Aux Bldg (A-8)	N	H-4	This motor operated valve was originally intended to provide means of isolating unessential cooling functions in order to prevent the runout flow with one NSCCW pump. A subsequent test reported in TDR 269 (Reference 9) indicated that this valve could be left open. Therefore, this valve is not required to be operated.
1A & 1B ES Valves CC	Breaker Cabinet for ES Components	Aux Bldg (A-15)	N	M	These breaker cabinets contain the breakers which provide the electric power for ES valves. These cabinets are located in areas which have a mild radiological environment during normal operating conditions and as a result of SBLOCA postulated radiation. They are therefore exempted from required radiation qualification.
1C ES Valves CC	Breaker Cabinet for ES Components	FHB 281' elev (TDR-121, Area XIII)	N	M	
RC-V-3	Pressuirzer Spray Block Valves	RB (on top of PZR) (inside D-rings)	Y	H-1	These valves are required to provide a second flow path to prevent boron precipitation in the core. These are required to meet the single failure and redundency criteria in conjunction with DH-V-1, 2 & 3. Therefore, these are required to be radiation qualified for SBLOCA.
RC-V-4	Auxiliary Spray Block Valve	RB 346' elev. outside D-rings	Y	H-1	
SV & LS/ MU-V-20	RCP Seal Injection Isolation Valve	Aux Bldg (A-13)	Y	H-1	SV is de-energized to close MU-V-20. This valve requires manual actuation to close or re-open the valve. Since a failure of the SV due to radiation would close the valve and RCP seal injection is desired to prevent pump seal damage, the SV & LS need to be qualified.

OMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
H-E-1 A,B&C	Rx Bldg Recirculation Unit Fan Motors	RB	Y	H-1	These RB fans, recirculate the RB air during normal and post accident conditions. They are required to operate during a SBLOCA in order to remove the heat released to the RB as a result of the SBLOCA. They must, therefore, be qualified for the SBLOCA postulated radiation in order to be able to provide the required air circulation.
S-V-52 & 53 ,B&C	Nuclear Services Cooling water Supply & Return for Cooling Water to RB Fan Motors (AH-E-1 A,B&C)	Int Bldg	N	M	The RB fans required motor and bearing cooling which is provided thru these valves. Since these valves are located in a mild normal and post LOCA environment, they are exempted from radiation qualification.
R-V-3 A,B&C R-V-4 A,B,C&D	River Water Supply & Return to Cooling Coils in RB Recirc Units (AH-E-1 A,B&C)	Int Bldg	N	M	These valves must open when river water is being utilized for RB cooling with the Emergency RB cooling coils. These valves are initiated to open by a 4 psig RB pressure ES actuation or manual initiation. Since these valves are located in mild radiological environment during normal operation and during a SBLOCA, they are exempted from radiation qualification.
C-7 R-V-6 R-V-5	Pressure Controller & Pressure Control Valves (Normal & Bypass) to Maintain RB Emergency Cooling System Pressure above 60 psig	Int Bldg	N	M	

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
Reactor Coolant System					
RC-4A-TE 2/3 RC-4B-TE 2/3	RCS Narrow Range T_{HOT} RTDs (RPS)	RB	Y	H-1	These instruments are not required for core cooling or maintaining the RCS pressure boundary. The required RCS temperature indication is provided by the Incore T/Cs. These instruments (RTDs) provide very useful indications and a benefit if qualified for SBLOCA radiation.
RC-4A-TE 1/4 RC-4B-TE 1/4	RCS T_{HOT} RTDs (indication)	RB	Y	H-1	
RC-5A-TE 2/4 RC-5B-TE 2/4	RCS Wide range T_{COLD} RTDs (Indication & RCP and PORV interlocks)	RB	Y	H-1	
RC-5A-TE 1/3 RC-5B-TE 1/3	RCS Narrow Range T_{COLD} RTDs (indication)				
TE-959 & 961	RCS Wide Range T_{COLD} RTds (indication)	RB	Y	H-1	
-----	Incore (T/C) Thermocouples	RB	Y	H-1	These instruments are required; to indicate that the core is being cooled; used to maintain the RCS within the PTS & NDT limits; indicate the core sub-cooling margin; verify the effect of LPI cooling. Therefore, these instruments need to be qualified for the SBLOCA postulated radiation.
RC-3A-PT 1/2 RC-3B-PT 1/2	RCS Narrow Range Pressure Transmitters RPS (indication)	RB	Y	H-1*	These instruments are required to perform the RPS function of tripping the reactor. After they have performed their RPS function, their indication is no longer required. Failure of these instruments could result in opening the PORV. Such a failure would increase the size of the SBLOCA to a large SBLOCA which is still within the analyzed SBLOCA case. Thus, such failure is acceptable and these instruments can be exempted from qualification for the SBLOCA postulated radiation. They must, however, be qualified for their normal operating radiation dose.

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
RC-3A-PT 3/4 RC-3B-PT 3	RCS Wide Range Pressure (ESAS) Transmitters (indication)	RB	Y	H-1	RCS (ESAS) pressure is required for initiation of the 1600 psig ES signal for reactor trip and RBI. After the RPS and RBI functions have been completed, RCS pressure is required for SBLOCA mitigation. The RCS pressure needs to be provided by either the RC-3 PTs or from the new PT-949 & 963 pressure transmitters. Thus, either set of pressure transmitters needs to be qualified for the SBLOCA postulated radiation levels. If only one set of pressure transmitters is qualified, then the operator will have to evaluate which instrument is providing erroneous indication.
PT-949	RCS Pressure (B loop) for SCM & indication	RB	Y	H-1	
PT-963	RCS Pressure (A loop) for SCM only				
TE-958 & 960	RCS Wide Range T_{HOT} RTDs for SCM & indication	RB	Y	H-1	
					These instruments are required for the SC monitor alarm function, which was added by ATOG, to ensure that the operator trip the RC pumps during a SBLOCA.
RC-1 LT 1,2&3 LT-777	Pressurizer Level Transmitters	RB	Y	H-1	The pressurizer level indication is required in order to establish if the HPI throttling criteria is being met (i.e., SCM is within acceptable range and pressurizer level is greater than zero). The pressurizer level is normally temperature compensated by RC-2-TE 1/2. If the RC-2 TE 1/2 are not qualified for the SBLOCA postulated radiation and fails either high or low, any indicated level would only have a larger but minor indication error. Therefore, pressurizer (non-temperature compensated) level transmitters RC-1-LT 1,2 & 3 and LT-777 need to be qualified for SBLOCA postulated radiation.
RC-2-TE 1/2	Pressurizer Temperature RTDs	RB	N	H-4	See RC-1-LT 1, 2 & 3 for justification for qualification exemption.

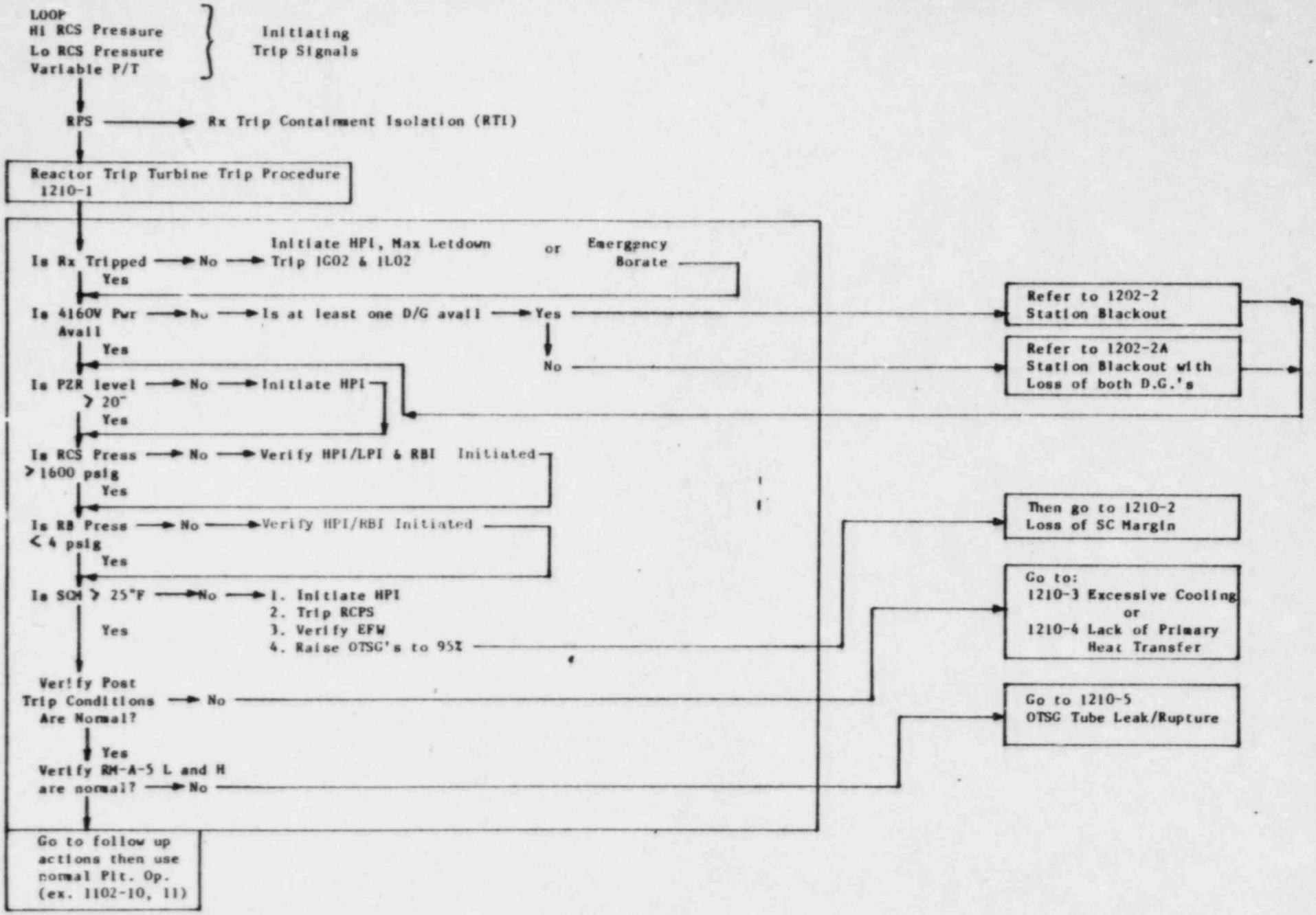
COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
Reactor Protection System					
PS-672, 673, 674, 675	RB 4 psig Pressure Switches for (RPS)	Aux Bldg (A-13)	Y	H-1*	These pressure switches provide the reactor trip signal if the reactor building pressure exceeds 4 psig. Once the reactor is tripped by these switches or any other reactor trip signal, then these pressure switches have completed their function. This function would be completed before the postulated harsh radiological environment existed in the Auxiliary Building. Thus, failure of these switches after the reactor trip is verified would not affect the mitigation of a SBLOCA. Therefore, these switches need only be qualified for the normal plant operation radiation dose to assure their proper functioning to generate the 4 psig RB pressure reactor trip signal.
Reactor Building Isolation					
NI-3&4	Intermediate Range Nuclear Instr.	RB	N/A	N/A	Only required to verify that the reactor is tripped. IEB 79-01B, Suppl 2, answer to question #12 states that qualification is not required for these instruments.
Reactor Building Isolation					
PT-282, 285, 288	RB Pressure Transmitters for (4 psig) ESAS Initiation	Aux Bldg (A-13)	Y	H-1	These pressure transmitters provide the 4 psig RB pressure RBI isolation actuation. They are required to provide the initial RBI signal for SBLOCA which yield a 4 psig RB pressure.
PT-981 & 982 A&B	RB Pressure Transmitters (C.R. indication)	Aux Bldg (A-13)	Y	H-1	These pressure transmitters provide the C. R. with RB pressure indication in order to monitor for a degradation of the event.
PS-283, 284, 286, 287, 289, 290	RB 30 psig Pressure Switches for ESAS	Aux Bldg (A-13)	N	H-1	RB pressure will not reach 30 psig, and RB spray actuation is not required. To get an inadvertent actuation, two PS on one BS pump must fail simultaneously. This is beyond failure scenario if, after a PS fails, the operator puts the BS pump in "pull to lock," an inadvertent actuation will not occur. Therefore, these pressure switches are not required to mitigate a SBLOCA.

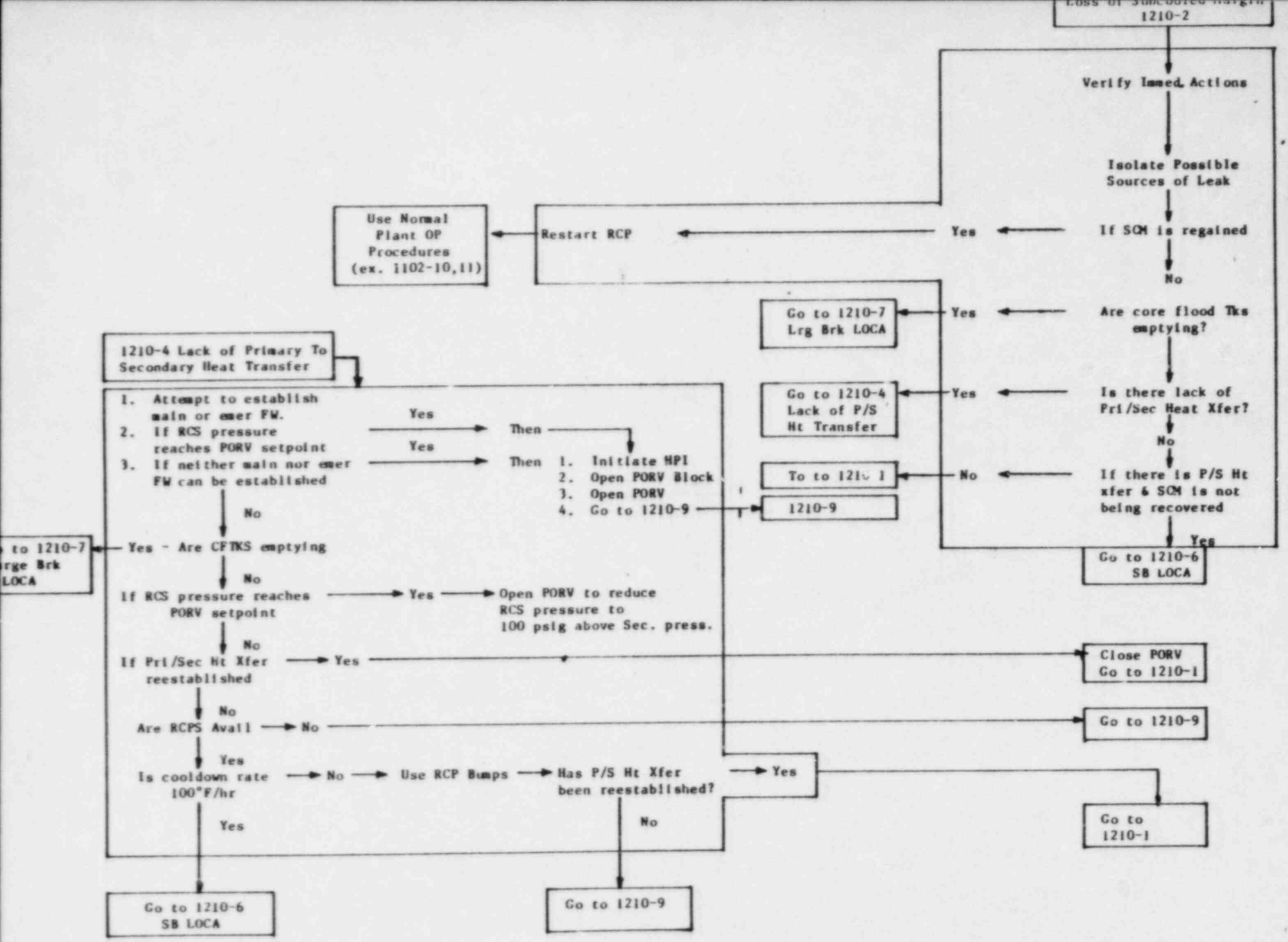
COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
Once Through Steam Generator					
SP-6A-PT 1/2 SP-6B-PT 1/2	OTSG A & B Pressure Transmitters	RB	Y	H-1	The OTSG pressure indication is required for OTSG pressure control. Since the two OTSGs operate independently of each other, redundant pressure indication is required for each OTSG. Therefore, the SP-6 A & B pressure transmitters need to be qualified for the SBLOCA postulated radiation. The PT-950 & 951 pressure transmitters are new instruments, independent of the ICS system, are qualified for the SBLOCA postulated radiation environment.
PT-950 & 951	OTSG A & B Pressure Transmitters (C.R. indication)	RB	Y	H-1	
SP-1A-LT-4&5 SP-1B-LT-4&5	OTSG Startup Range Level Instr	RB	Y	H-1	OTSG level indication is required for OTSG level control with the EFW system in order to maintain sufficient level for core cooling. Normally, the OTSG level is controlled by the start-up range level and operating range level for forced circulation and natural circulation respectively. Therefore, these level transmitters need to be qualified for the SBLOCA postulated radiation. New full range level transmitters have been added and can also be utilized to control OTSG level by providing temperature compensation based on OTSG pressure in accordance with procedure OP-1102-11. These new level transmitters are qualified for the SBLOCA postulated radiation.
SP-1A-LT-2&3 SP-1B-LT-2&3	OTSG Operating Range Level	RB	Y	H-1	
LT-775, 776 & 788, 789	OTSG A&B Full Range Level Indication	RB	Y	H-1	
Emergency Feedwater					
PT-65, 71 & 72	EFW Pumps Discharge Pressure Transmitters	Int Bldg	N	M	All EFW system components are located in non-radiologically contaminated areas and are therefore exempted from SBLOCA radiation qualification.
DPT-779, 782,788,791	EFW Flow Transmitters	Int Bldg	N	M	All EFW system components are located in non-radiologically contaminated areas and are therefore exempted from SBLOCA radiation qualification.

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
Makeup & Purification / High Pressure Injection					
MU-14-LT	MU Tank Level Indicator	Aux Bldg (A-3)	N	H-1	Redundant MU tank level indication is provided so that the operator will have indication of high and low level upon which he would isolate any remaining inlet flows. [redacted] If operator determines that indication has failed, he would isolate the tank from the system. Therefore, a failure would not adversely affect the mitigation of a SBLOCA. Therefore, these instruments need not be radiation qualified.
LT-778	MU Tank Level Indicator		N	H-1	
MU-23-DPT 1,2,3&4	HPI Flow Indication dP Transmitters	Aux Bldg (A-7, A-13)	N	H-4	The flow indication is only required for a SBLOCA which has depressurized the RCS to less than 1000 psig and only one HPI pump is operable. The flow indication is utilized by the operator to check the total HPI pump flow and verify that it is less than the 550 gpm pump runout flow. If the pump flow is greater than 550 gpm, then the pump flow must be throttled. The HPI system cavitating venturis will limit the flow to an acceptable pump flow, with seal injection flow less 10 gpm. If the operator cannot verify the total pump flow to be less than 550 gpm due to indication of flow indicator failures, then the seal injection flow will be isolated in order to protect the operating HPI pump. Therefore, failure of these flow indicators will require the operator to apply conservative actions, including isolation of a seal injection with MU-V-20. Thus, these flow indicators need not be qualified for the SBLOCA postulated radiation. See Appendix "C" for evaluation logic.
MU-42-DPT	RCP Seal Injection Flow Transmitter	Aux Bldg (A-5)	N	H-4	

TMI-1

ABNORMAL TRANSIENT PROCEDURE LOGIC FOR A SB LOCA




Loss of Subcooled Margin
1210-2
Verify Immed. Actions
Isolate Possible Sources of Leak
If SCM is regained
Yes
Restart RCP
Use Normal Plant OP Procedures (ex. 1102-10,11)
No
Are core flood Tks emptying?
Yes
Go to 1210-7 Lrg Brk LOCA
Is there lack of Pri/Sec Heat Xfer?
Yes
Go to 1210-4 Lack of P/S Ht Transfer
No
If there is P/S Ht xfer & SCM is not being recovered
No
To to 1210-1
Yes
Go to 1210-6 SB LOCA
1210-4 Lack of Primary To Secondary Heat Transfer
1. Attempt to establish main or emer FW.
2. If RCS pressure reaches PORV setpoint
3. If neither main nor emer FW can be established
Yes
Then
1. Initiate HPI
2. Open PORV Block
3. Open PORV
4. Go to 1210-9
1210-9
No
Yes - Are CFTKS emptying
to 1210-7 rge Brk LOCA
No
If RCS pressure reaches PORV setpoint
Yes
Open PORV to reduce RCS pressure to 100 psig above Sec. press.
No
If Pri/Sec Ht Xfer reestablished
Yes
Close PORV Go to 1210-1
No
Are RCPS Avail
No
Go to 1210-9
Yes
Is cooldown rate 100°F/hr
No
Use RCP Bumps
Has P/S Ht Xfer been reestablished?
Yes
Go to 1210-1
No
Yes
Go to 1210-6 SB LOCA
Go to 1210-9

COMPONENT	FUNCTION	LOCATION	RADIATION QUAL REQ'D Y/N	RADIOLOGICAL ENVIRONMENT	REMARKS
Decay Heat Removal / Low Pressure Injection					
DH 1-DPT 1&2	DH Flow Indication	DH Pump Vault	N	H-4	The DH pump flow indication is required in order to balance LPI flow thru both core flood lines for the postulated single LPI pump failure with the SBLOCA located at one of the core flood nozzles on the reactor vessel. DH 1-DPT 1 & 2 provide the control room indication which would be used unless these instruments failed. If DH 1-DPT 1 & 2 showed no change as the DH flow were being throttled, then the operator would check DPT-802 & 803 to confirm the flow and provide him with sufficient information to balance LPI flows. Therefore, only one pair of the instruments needs to be qualified for SBLOCA postulated radiation.
DPT-802, 803	DH Flow Indication (on Remote Shutdown Panel)	Aux Bldg (A-1)	Y	H-1	
LS-116 - A,B,C,D&E and/or	RB Sump Level Switches	RB	N	H-4	The RB Sump level indication is not required for SBLOCA mitigation. The RB sump will contain sufficient inventory to provide the needs of the LPI pumps once the BWST has been depleted. The level instruments are not interlocked with the LPI pumps or the RB sump isolation valves DH-V-6A&B. If it is desired to provide and inject more BWST water than the initial BWST inventory, then an approximation of the RB water level can easily be made to establish a limit on the amount of additional water that may be injected before the RB flood level for instrumentation is reached. Such action could be taken to delay the time at which recirculation from the RB sump is initiated in order to reduce potential radiation levels in the Auxiliary Building.
LT - 804 - 805 - 806 - 807	RB Sump Level Transmitters	RB	N	H-4	

1210-6
Small Break
LOCA Cooldown

Verify
- HPI Initiated
- All RCPS Off
- EFW Controlling OTSG at 95%

Verify Rx Trip Containment Isolation

If RCS Pressure < 1600 psig
- Yes → Verify & Reactivate 1600 psig & 4 psig RBI
- No

If OTSG is Avail. & P/S HT XFER Does Not Exist
- Yes → 1210-10 Bump RCPS
- No

If P/S HT XFER Can not Be Reestablished & Cooldown ≤ 100°F/HR
- Yes → Open PORV → Until P/S HT XFER Established or LPI Operation

Verify RB Emer. Cooling

Maintain RCP Services

If RCS is Solid & Subcooled & P/S HT XFER is Avail.
- Yes → Go to 1210-9 to Reestablish PZR Bubble
- No

If SCM is Regained
- Yes → Close CFV 1A/B When RCS Press ≤ 700 psig
- No

Monitor BWST Level

Prior to Going on Sump Recirc.
Open DHV64 & MUV198

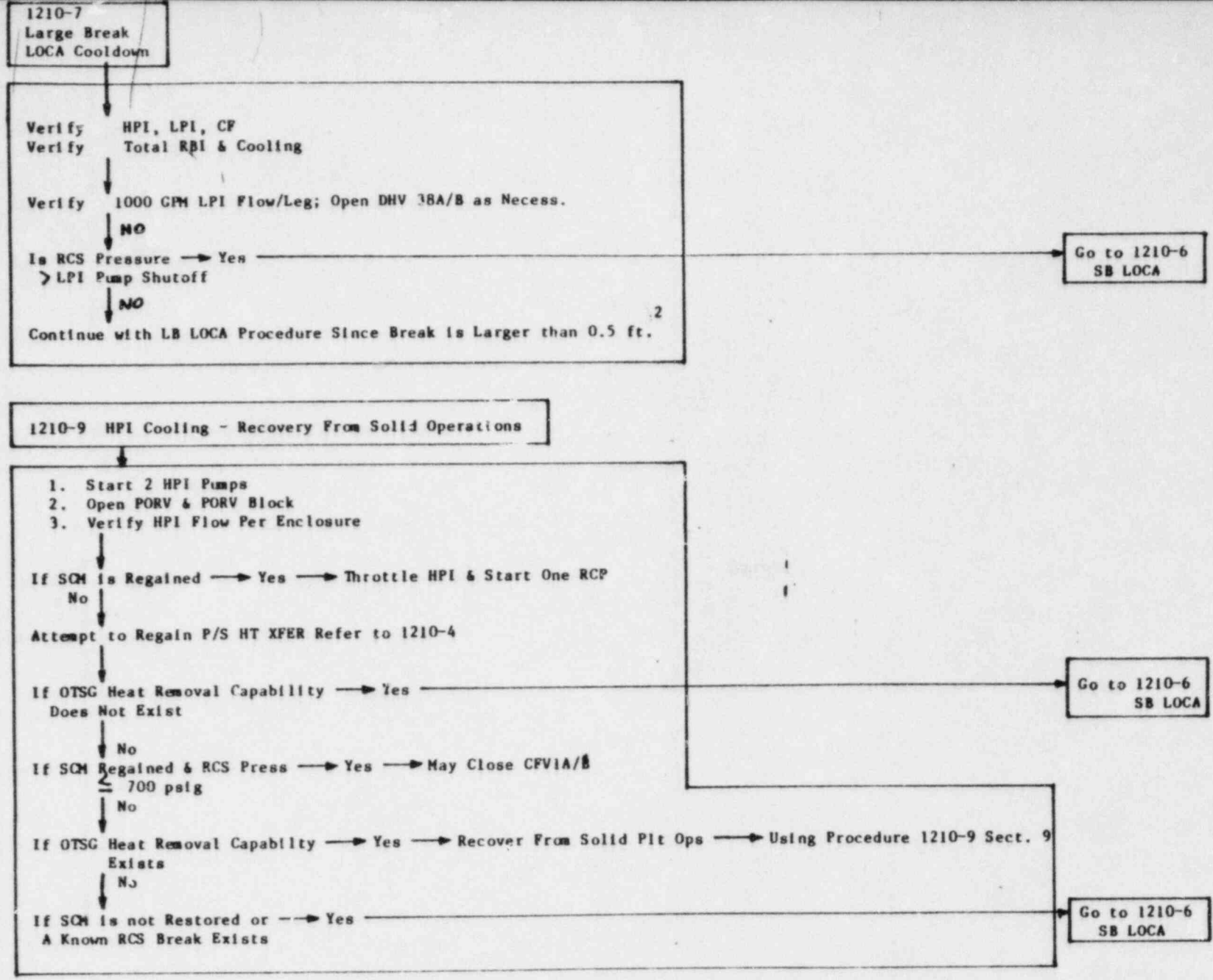
When BWST Level Reaches 3ft.
- No

Is LPI FLow Established?
- No → Go to Piggyback
  - Open DHV7A
  - Open DHV6A
  - Close DHV5A & BSV2A
  - (Open MUV14A)
  - Then do same for 'B'
- Yes → Go To LPI Sump Recirc Mode
  - Open DH-V-6
  - Close DH-V-5
  - Close BS-V-2

Stop EFW When LPI or DHR In Service

Throtile DHV19A/B or DH-V-4A/B as Necess.

If DC-V-2 & 65 are Inaccessible
Use DR-V1-A/B to Control
Cooldown Rate


1210-7
Large Break
LOCA Cooldown
Verify HPI, LPI, CF
Verify Total RBI & Cooling
Verify 1000 GPM LPI Flow/Leg; Open DHV 38A/B as Necess.
NO
Is RCS Pressure > LPI Pump Shutoff
Yes
Go to 1210-6
SB LOCA
NO
Continue with LB LOCA Procedure Since Break is Larger than 0.5 ft.2
1210-9 HPI Cooling - Recovery From Solid Operations
1. Start 2 HPI Pumps
2. Open PORV & PORV Block
3. Verify HPI Flow Per Enclosure
If SCM is Regained
Yes
Throttle HPI & Start One RCP
No
Attempt to Regain P/S HT XFER Refer to 1210-4
If OTSG Heat Removal Capability Does Not Exist
Yes
Go to 1210-6
SB LOCA
No
If SCM Regained & RCS Press ≥ 700 psig
Yes
May Close CFV1A/B
No
If OTSG Heat Removal Capability Exists
Yes
Recover From Solid Plt Ops
Using Procedure 1210-9 Sect. 9
No
If SCM is not Restored or A Known RCS Break Exists
Yes
Go to 1210-6
SB LOCA

APPENDIX "C"

JUSTIFICATION FOR NOT REQUIRING RADIATION QUALIFYING OF MU23-DPT 1, 2, 3, 4 or MU42-DPT