DESIGN RELIABILITY ASSURANCE PROGRAM PLAN

FOR THE

SYSTEM 80+ STANDARD DESIGN

DECEMBER, 1992
REV. 1

ABB COMBUSTION ENGINEERING NUCLEAR POWER
WINDSOR, CONNECTICUT

ASEA BROWN BOVERI

9212300103 921223
PDR ADOCK 05200002
A PDR

SECTION 17.3

CONTENTS

SECTION 17.3

CONTENTS

17.3 Reliability Assurance Program During Design Phase

This section presents the System 80+ Design Reliability Assurance Program (D-RAP)

17.3.1 INTRODUCTION

The System 80+ Design Reliability Assurance Program (D-RAP) is a program that will be performed by the designers during detailed design and specific equipment selection phases to assure that the important System 80+ reliability assumptions of the Probabilistic Risk Assessment (PRA) will be considered throughout the design process. The PRA evaluates the plant response to initiating events to assure that plant damage has a very low probability and risk to the public is very low. Input to the PRA includes details of the plant design and assumptions about the reliability of the plant risk-significant structures, systems and components (SSCs). The plant owner/operator will also have an Operations Reliability Assurance Program (O-RAP) that tracks equipment reliability to demonstrate that the plant is being operated and maintained with an acceptably low risk.

The D-RAP will include the design evaluation of the System 80+. It will identify relevant aspects of plant operation, maintenance, and performance monitoring of important plant SSCs for owner/operator consideration, safety of the equipment and, limited risk to the public. The policy and implementation procedures will be specified by the owner/operator.

Also included in this explanation of the D-RAP is a descriptive example of how the D-RAP will apply to one potentially important plant system, the Component Cooling Water System (CCWS). The CCWS example shows how the principles of D-RAP will be applied to other systems identified by the PRA as being significant with respect to risk.

17.3.2 SCOPE

The System 80+ D-RAP will include the design evaluation of the System 80+, and it will identify relevant aspects of plant operation, maintenance and performance monitoring of plant risk-significant SSCs. The PRA for the System 80+ and other industry sources will be used to identify and prioritize those SSCs that are important to prevent or mitigate plant transients or other events that could present a risk to the public.

17.3.3 PURPOSE

The purpose of the D-RAP is to assure that the plant safety as estimated by the PRA is maintained as the detailed design evolves throughout the implementation and procurement phases and that pertinent information is provided in the design documentation to the future owner/operator so that equipment reliability, as it affects plant safety, can be maintained through operation and maintenance during the entire plant life.

17.3.4 OBJECTIVE

The objective of the D-RAP is to identify those plant SSCs that are significant contributors to risk, as shown by the PRA or other sources, and to assure that, during the implementation phase, the plant design continues to utilize risk-significant SSCs whose reliability is commensurate with the PRA assumptions. The D-RAP will also identify key assumptions regarding any operation, maintenance and monitoring activities that the owner/operator should consider in developing its O-RAP to assure that such SSCS can be expected to operate throughout plant life with a reliability consistent with maintaining utility performance criteria described in the O-RAP.

A major factor in plant reliability assurance is risk-focused maintenance (Ref. 17.3-1). Maintenance resources are focused on those SSCs that enable the System 80+ safety-related systems to fulfill their safety-related functions. Also, Maintenance is focused on SSCs whose failure may directly initiate challenges to safety-related systems. All plant modes are considered, including equipment directly relied upon in emergency operating procedures (EOPs). Such a focus of maintenance will help to maintain an acceptably low level of risk.

17.3.5 ABB-CE ORGANIZATION FOR D-RAP

The project organization for the First Of A Kind Engineering (FOAKE) of System 80+, shown in Figure 17.3-1, is integrated and the responsibility to meet the D-RAP objectives rests with the Project Director. Regular meetings are scheduled to coordinate all the design and D-RAP activities with participation of Engineering Manager, Reliability Analysis Services, the Project Integration Manager, the Quality Assurance Manager and Regulatory Conformance Manager. During these meetings, design changes and the impact on the overall plant performance are identified, and discussions about the impact of these changes on plant risk are held. Management meetings are also held in which programmatic issues affecting the System 80+ design are discussed. The responsibilities of each organization in the D-RAP plan are as follows:

The Project Director is responsible for the programmatic aspects of the plant design as well as the overall direction of the project, certification and licensing issues. The NSSS, I&C Design Manager is responsible for the design of the nuclear steam supply system. The Regulatory Conformance Manager has the responsibility of addressing any regulatory concerns and bringing these concerns to the attention of the Project Integration Manager and Reliability Analysis Services.

The NSSS, I&C Design Engineering organization is the core of the RAP program and it is responsible for the design of the System 80+ NSSS. It is in this group where the NSSS design and drawings are developed with inputs from the mechanical, I&C, reactor, and fluid systems subgroups. It is also in this organization where the PRA models are developed as well as the Technical Specifications and plant procedures.

The Project Manager for the System 80+ PRA and is responsible for managing and integrating the D-RAP Program and has direct access to the System 80+ Project

Integration Manger and is responsible for keeping him abreast of D-RAP critical items, program needs and status. The PRA and D-RAP Project Manager or his designee will attend all of the design review and progress meetings. He has organizational freedom to:

- identify D-RAP problems;
- initiate, recommend or provide solutions to problems through designated organizations;
- verify implementation of solutions; and
- function as an integral part of the design team and final design process.

The Project Manager for the PRA and D-RAP is in the Reliability Analysis Services Department which performs reliability analyses, RAMI, risk assessments and PRAs. This group is part of ABB-CE Nuclear Services and reports to the NSSS, I&C Design Manager, through the Project Manager for the D-RAP and PRA (Figure 17.3-1). The PRA input to the D-RAP and any of the System 80+ reliability analyses will be performed in this organization and will be integrated into the System 80+ design.

The Quality Assurance organization provides quality control by performing regular audits and participating in the scheduled meetings to discuss System 80+ issues.

Organization for the O-RAP is the responsibility of the CL applicant. It is recommended that the CL applicant also have a group which coordinates all the reliability activities. This group could be in charge of keeping a living PRA during plant operation, developing a corrective actions program, performing an RCM program, and maintaining a component/system aging database. These functions could be coordinated by one or several groups depending on the organization of the staff. However, direct and frequent communication should be kept between these groups since their functions complement each other.

The CL applicant could also consider participation in the Combustion Engineering Owners Group (CEOG) and using this group to foster feedback to the designers and other owners about the design performance of the SSCs important to risk reduction.

17.3.6 SSC IDENTIFICATION/PRIORITIZATION

The PRA prepared for the System 80+ will be the primary source for identifying risk-significant SSCs that should be given special consideration during the detailed design and procurement phases and/or considered for inclusion in the O-RAP. The method by which the PRA is used to identify risk-significant SSCs is described in Chapter 19. It is also possible that some risk-significant SSCs will be identified from sources other than the PRA, such as nuclear plant operating experience, other industrial experience and relevant component failure data bases.

17.3.7 DESIGN CONSIDERATIONS

The reliability of risk-significant SSCs, which are identified by the PRA, will be evaluated at the detailed design stage by appropriate design reviews and reliability analyses. Current data bases will be used to identify appropriate values for failure rates of equipment as designed, and these failure rates will be compared with those used in the PRA. Normally, the failure rates will be similar, but in some cases they may differ because of recent design or data base changes. Whenever failure rates of designed risk-significant SSCs are significantly greater than those assumed in the PRA, an evaluation will be performed to determine if the equipment is acceptable or if it must be redesigned to achieve the appropriate reliability.

For those risk-significant SSCs, as indicated by the PRA or other sources, component redesign (including selection of a different component) will be considered as a way to reduce the Core Damage Frequency (CDF) contribution. (If the system unavailability or the CDF is acceptably low, less effort will be expended toward redesign). If there are practical ways to redesign a risk-significant SSC, it will be redesigned and the change in system fault tree results will be calculated. Following any redesign, dominant SSC failure modes will be identified so that protection against such failure modes can be accomplished by appropriate activities during plant life. The design considerations that will go into determining an acceptable, reliable design and the SSCs that must be considered for O-RAP activities are illustrated in Figure 17.3-2.

Using the PRA or other design documents, the designer will identify to the plant owner/operator the risk-significant SSCs, their associated failure modes, and reliability assumptions, including any pertinent bases and uncertainties considered in the PRA. The designer will also provide this information for the plant owner/operator to consider in developing an Operations Reliability Assurance Program (O-RAP). This information can be used by the owner/operator for establishing appropriate reliability targets and the associated maintenance practices for achieving them.

17.3.8 DEFINING FAILURE MODES

The determination of dominant failure modes of risk-significant SSCs will include historical information, analytical models and existing requirements. Many PWR systems and components have compiled a significant historical record, so an evaluation of that record comprises Assessment Path A in Figure 17.3-3. Details of Path A are shown in Figure 17.3-4.

For those SSCs for which there is not an adequate historical basis to identify critical failure modes, an analytical approach is necessary, shown as Assessment Path B in Figure 17.3-3. The details of Path B are given in Figure 17.3-5. The failure modes identified in Paths A and B are then reviewed, including the existing maintenance activities in the industry and the maintenance requirements (Assessment Path C in Figure 17.3-3). Detailed steps in Path C are outlined in Figure 17.3-6.

17.3.9 OPERATIONS RELIABILITY ASSURANCE ACTIVITIES

Once the dominant failure modes are determined for risk-significant SSCs, an assessment is required to determine suggested O-RAP activities that will assure acceptable performance during plant life. Such activities may consist of periodic surveillance inspections or tests, monitoring of SSC performance, and/or periodic preventive maintenance (Reference 17.3-1). An example of a decision tree that would be applicable to these activities is shown in Figure 17.3-7. As indicated, some SSCs may require a combination of activities to assure that their performance is consistent with the PRA.

Periodic testing of SSCs may include startup of standby systems, surveillance testing of instrument circuits to assure that they will respond to appropriate signals, and inspection of SSCs (such as tanks and pipes) to show that they are available to perform as designed. Performance monitoring, including condition monitoring, can consist of measurement of magnitude of an important variable (such as vibration or temperature), and testing for abnormal conditions (such as oil degradation or local hot spots).

Periodic preventive maintenance is an activity performed at regular intervals to preclude problems that could occur before the next preventative maintenance (PM) interval. This could be regular oil changes, replacement of seals and gaskets, or refurbishment of equipment subject to wear or age-related degradation.

Planned maintenance activities will be integrated with the regular operating plans so that they do not disrupt normal operation. Maintenance that will be performed more frequently than refueling outages must be planned so as to not disrupt operation or be likely to cause reactor scram, engineered safety feature (ESF) actuation, or abnormal transients. Maintenance, planned for performance during refueling outages, must be conducted in such a way that it will have little or no impact on plant safety, on outage length, or on other maintenance work.

17.3.10 OWNER/OPERATOR'S RELIABILITY ASSURANCE PROGRAM

The O-RAP that will be prepared and implemented by the System 80+ owner/operator will make use of the information provided by the designer. This information will help the owner/operator determine activities that should be included in the O-RAP. Examples of elements that might be included in an O-RAP are as follows:

Reliability Performance Monitoring -- Measurement of the performance of equipment to determine that it is accomplishing its goals and/or that it will continue to operate with low probability of failure.

Reliability Methodology -- Methods by which the plant/operator can compare plant data to the SSC data in the PRA.

Problem Prioritization -- Identification, for each of the risk-significant SSCs, of the importance of that item as a contributor to its system unavailability and assignment of priorities to problems that are detected with such equipment.

Root Cause Analysis -- Determination, for problems that occur regarding reliability of risk-significant SSCs, of the root causes, those causes which, after correction, will not recur to again degrade the reliability of equipment.

Corrective Action Determination -- Identification of corrective actions needed to restore equipment to its required functional capability and reliability, based on the results of problem identification and root cause analysis.

Corrective Action Implementation -- Carrying out identified corrective action on risk-significant equipment to restore equipment to its intended function in such a way that plant safety is not compromised during work.

Corrective Action Verification -- Post-corrective action tasks to be followed after maintenance on risk-significant equipment to assure that such equipment will perform its intended functions.

Plant Aging -- Some of the risk-significant equipment is expected to undergo age related degradation that will require equipment replacement or refurbishment.

Feedback to Designer -- The plant owner/operator should periodically compare performance of risk-significant equipment to that specified in the PRA and D-RAP, and, at its discretion, may send SSC performance data to plant or equipment designers in those cases that consistently show performance below that specified. The plant owner/operator should consider participation in the CEOG.

Programmatic Interfaces -- Reliability assurance interfaces related to the work of the several organizations and personnel groups working on risk-significant SSCs.

Maintenance Rule Integration -- The plant owner/operator should consider the integration or interface of the O-RAP and the requirements of 10 CFR 50.65 which require the operator to develop a maintenance program for risk significant SSCs or SSCs that could produce trips or transients.

The plant owner/operator's O-RAP will address the interfaces with construction, startup testing, operations, maintenance, engineering, safety, licensing, quality assurance and procurement of replacement equipment.

17.3.11 D-RAP IMPLEMENTATION

An example of implementation of the D-RAP is given for the Component Cooling Water System (CCWS). This system was selected as an example because it is not a front-line safety system but was found in the earlier System 80 PRA to contain risk-significant SSCs. Because of this finding, and through the D-RAP organization described in Section 17.3.5, the design was changed. The design and analytical results, as presented in this chapter, is presented only as a D-RAP example and does not necessarily correspond to the current System 80+ design.

17.3.11.1 CCWS Function

The Component Cooling Water System (CCWS) is a closed loop system that provides cooling water flow to remove heat released from plant systems, structures, and components. The CCWS functions to cool the safety-related and non-safety-related reactor auxiliary loads. Heat transferred by these components to the CCWS is rejected by the Station Service Water System (SSWS) via the CCWS heat exchangers.

17.3.11.2 Earlier CCWS Design

The System 80+ Design is an evolutionary plant and improvements were included with input from the earlier System 80 PRA. The earlier CCWS design is shown in Figure 17.3-8 and described in more detail in section 5.3.19 of Reference 17.3-2. It consisted of two independent, closed loop, safety trains. Each train contained one pump that was on standby. One of the major insights of the System 80 PRA (Section 8.2 of Reference 17.3-2) was that loss of the CCWS was a dominant cause of front-line system failure. Failure of the CCWS pumps to start and run were one of the dominant failure modes.

17.3.11.3 System Redesign

To more easily meet the desired CDF for the ALWR, the CCWS probably required a redesign as represented in Figure 17.3-9. This redesign was also helped by design review meetings where the Project Manager for the RAP and PRA discussed with the designers the PRA results, including failure modes and importance of support systems to front line safety systems. An example of an improved CCWS design is given in Figure 17.3-9 and an example of analytical results are presented in Tables 17.3-1 and 17.3-2. Details of the actual System 80+ CCWS design and reliability analysis is given in Section 6.3.3 of the System 80+ PRA and do not necessarily correspond to the example presented here.

The improved CCWS design contain two trains (only one is shown in Figure 17.3-9). Each train contains two pumps and one pump is kept running at all times. This design eliminated the important failure mode of the CCWS pump failing to start which was observed in the earlier design. Table 17.3-1 gives an example of the components importance for internal events for an ALWR. The Fussell-Vesley Importance is the fraction of the CDF that the component failure contributes to. In this example, the components in the CCWS are underlined. The first CCWS component is only ranked 59th in importance based on this measure. The SSCs in the improved CCWS meets the criteria that they have a small impact on risk (bottom of Figure 17.3-2) and can be considered for O-RAP.

17.3.11.4 Failure Mode Identification

Figure 17.3-3 gives two methods for O-RAP evaluation, using failure history or analytical methods. For this example an analytical method as represented in Figure 17.3-5 was used. Figure 17.3-10 gives an example of the upper level fault tree to analyze failure modes for Train 1 of an improved CCWS. Table 17.3-2 gives an example of the ranking of the risk significant SSCs for Train 1. There is also a second train not evaluated in this table. Because this CCWS design is an evolutionary design using standard components, a search of the operational data bases for component failure rates and operations experience is also possible using Figure 17.3-4, but was not used in this example.

Following the flow chart of Figure 17.3-5, the designer would determine more details about each failure mode, including pieceparts most likely to fail and the frequency of each failure mode category or piecepart failure. This would result in a list of the dominant failure modes to be considered for the O-RAP. ASME Section XI requirements for inspection and other mandated inspections and tests would be identified, as indicated in Figure 17.3-6.

Examples of the types of failure modes that could impact reliability of these identified components are shown in Table 17.3-3. The example is not a complete listing of the important failure modes, but is intended to indicate the types of failures that would be considered.

17.3.11.5 Identification of Maintenance Requirements

For each identified failure mode, the appropriate maintenance tasks will be identified to assure that the failure mode will be (1) avoided, (2) rendered insignificant, or (3) kept to an acceptably low probability. The type of maintenance and the maintenance frequencies are both important aspects of assuring that the equipment failure will be consistent with that assumed for the PRA. As indicated in Figure 17.3-7, the designer would consider periodic testing, performance testing or periodic preventive maintenance as possible O-RAP activities to keep failure rates acceptable.

For the CCWS, one pump in each train is in operation and all the valves are in that flow path are open. An example of the possible maintenance and testing follows and is summarized in Table 17.3-3. Minor PM on the pumps will be performed based on the recommendations of the vender (8000 hrs of operation for example) and a major overhaul would be performed every 50,000 hrs of operation. Only maintenance on one pump will be performed at a time during Modes 1 through 4. The most frequent surveillance requirement for the CCWS might be to verify that each CCW manual, power-operated or automatic valve in the flow path servicing essential equipment, that is not locked, sealed, or otherwise secured in position, is in its correct position. This test is performed every 31 days. Additionally, there is a surveillance requirement that every 18 months, it must be demonstrated that each CCW automatic valve actuates and each CCW pump starts on an actual or simulated actuation signal. Example of maintenance activities and frequencies are shown in Table 17.3-3 for each identified failure mode. The D-RAP will include documentation of the basis for each suggested O-RAP activity.

17.3.12 GLOSSARY OF TERMS AND ACRONYMS

ALWR Advanced Light Water Reactor
ASME American Society of Mechanical Engineers
CCWS Component Cooling Water System
CDF Core Damage Frequency, as calculated by the probabilistic risk assessment.
CEOG Combustion Engineering plant Owners Group.
CFR Code of Federal Regulations
CL Combined License
D-RAP Design Reliability Assurance Program, Performed by the plant designer to assure that the plant is designed so that it can be operated and maintained in such a way that the reliability assumptions of the probabilistic risk assessment apply throughout plant life.
EOP Emergency Operating Procedure
EPRI Electric Power Research Institute
ESF Engineered Safety Features
FOAKE First Of A Kind Engineering
I&C Instruments & Controls
O-RAP Operations Reliability Assurance Program -- Performed by the plant owner/operator to assure that the plant is operated and maintained safely and in such a way that the Owner/Operator O-RAP performance criteria are met.
Owner/Operator The utility, CL applicant, or other organization that owns and operates the System 80+ following construction.
PM Preventative Maintenance
PRA Probabilistic Risk Assessment -- Performed to identify and quantify the risk associated with the System 80+
PWR Pressurized Water Reactor
RAMI Reliability, Availability, Maintainability, and Inspectability
RAP Reliability Assurance Program
RCM Reliability Centered Maintenance
Risk-Significant Those structures, systems and components which are identified as contributing significantly to the system unavailability.
SSC Structures, Systems, and Components
SSWS Station Service Water System

17.3.13 REFERENCES

17.3-1 Lofgren, E. V., et al., "A Process for Risk-Focused Maintenance," SAIC. NUREG/CR-5695, March 1991

17.3-2 Finnicum, D. J., et al, "Base Line Level 1 Probabilistic Risk Assessment for the System 80 NSSS Design," ABB-CE, January, 1988.

Table 17.3-?

EXAMPLE OF COMPONENT IMPORTANCE FOR AN ALWR
FOR INTERNAL EVENTS

COMPONENT	COMPONENT DESCRIPTION	FUSSELL-VESLEY IMPORTANCE
AEFWTA2DVINDD	FAILURE OF THE DISTRIBUTION VALVES IN EFW SYS SUBTRAIN A2	1.14E-1
AEFP103INDD	FAILURE OF EFU SYSTEM TURBINE DRIVEN PUMP EFWP-103 TO START	1.12E-1
AEFP101INDD	FAILURE OF EFU SYSTEM TURBINE DRIVEN PUMP EFWP-101 TO START	1.04E-1
HPMXA4	COMMON CAUSE FAILURE OF 4 OUT OF 4 SI PUMPS	8.22E-2
EDGAINDD	DIESEL GENERATOR A DEMAND INDEPENDENT FAULTS	7.91E-2
EDGBINDD	DIESEL GENERATOR B DEMAND INDEPENDENT FAULTS	7.71E-2
HPMXA3	COMMON CAUSE FAILURE OF 2 OR MORE SI PUMPS	4.87E-2
FSSOSIAS	OPERATOR FAILS TO GENERATE SIAS	3.85E-2
FSSXSIAS	COMMON CAUSE FAILURE OF SAFETY INJECTION ACTUATION SIGNAL	3.85E-2
HPMXA1	COMMON CAUSE FAILURE OF 3 OR 4 SI PUMPS	3.55E-2
HVMXD2	COMMON CAUSE FAILURE OF 2 OF 2 HOT LEG INJECTION VALVES	3.39E-2
EDDXDG	COMMON CAUSE FAILURE OF DIESEL GENERATORS	3.33E-2
HVMXC1	COMMON CAUSE FAILURE OF 3 OR 4 DVI MOTOR VALVES	2.06E-2
HVMAGSI312	HOT LEG INJECTION MOTOR VALVE SI-312 GROUP FAILS TO OPEN	1.92E-2
HVMAGSI313	HOT LEG INJECTION MOTOR VALVE SI-313 GROUP FAILS TO OPEN	1.92E-2
HVMAGSI412	HOT LEG INJECTION MOTOR VALVE SI-412 GROUP FAILS TO OPEN	1.92E-2
HVMAGSI413	HOT LEG INJECTION MOTOR VALVE SI-413 GROUP FAILS TO OPEN	1.92E-2
HVMXC4	COMMON CAUSE FAILURE OF 4 OUT OF 4 DVI MOTOR VALVES	1.41E-2
HPMJGSIP301	SI PUMP SI-P301 GROUP FAILS TO START	1.39E-2
HPMJGSIP401	SI PUMP SI-P401 GROUP FAILS TO START	1.39E-2
APTX-EFP12	COMMOU CAUSE FAILURE OF TURBINE DRIVEU EFW PUMPS EFWP101/103	1.14E-2
DVPBADVS	ADVs ON RUPTURED SG-2 FAILS TO RECLOSE	8.07E-3
ELBX125C1E	COMMON CAUSE FAILURE OF CLASS 1-E 125 VDC BUSES	7.75E-3
EBATIIINDU	BATTERY II UNAVAILABLE	5.71E-3
CVMAMV123	CCW/CS HEAT EXCHANGER ISOLATION MOV MV-123 FAILS TO OPEN	4.90E-3
HVMOSI304	MOTOR VALVE SI-304 NOT OPEN DUE TO PRE-EXISTING ERROR	4.80E-3
EBATIINDU	BATTERY I UNAVAILABLE	4.16E-3
AEFP102INDD	FAILURE OF EFW SYSTEM MOTOR-DRIVEU PUMP EFWP-102 TO START	4.12E-3
CVMAMV124	CCW/SCS HEAT EXCHANGER ISOLATION MOV MV-124 FAILS TO OPEN	3.91E-3
JVMAGSI127	SCS MOTOR VALVE SI-127 FAILS TO OPEN	3.91E-3
GVMXA2	COMMON CAUSE FAILURE OF CTMT ISOLATION VALVES SI-144/SI-244	3.39E-3
FSERAPS	NO (EFAS) ACTUATION SIGNAL FROM ALTERNATE PROTECTION SYSTEM	3.15E-3
FSEX-EFAS	COMMON CAUSE FAILURE OF EMERGENCY FEEDWATER ACTUATION SIGNAL	3.15E-3
HPMKSIP301	SI PUMP SI-P301 FAILS TO OPERATE	3.01E-3
HPMKSIP401	SI PUMP SI-P401 FAILS TO OPERATE	3.01E-3
APMX-EFP22	COMMON CAUSE FAILURE OF MOTOR-DRIVEN EFW PUMPS EFWP-102/104	2.92E-3
HVMXC3	COMMON CAUSE FAILURE OF 2 OR MORE DVI MOTOR ISOLATION VALVES	2.10E-3
APMKEFP102	EFW SYSTEM MOTOR DRIVEN PUMP EFWP-102 FAILS TO OPERATE	2.06E-3
JVMAGSI120	SCS MOTOR VALVE SI-120 FAILS TO OPEN	1.87E-3
JVMAGSI121	SCS MOTOR VALVE SI-121 FAILS TO OPEN	1.87E-3
JVMAGSI122	SCS MOTOR VALVE SI-122 FAILS TO OPEN	1.87E-3
JVMAGSI129	SCS MOTOR VALVE SI-129 FAILS TO OPEN	1.87E-3
GVMAGSI244	CTMT SPRAY MOTOR VALVE SI-244 FAILS TO OPEN	1.51E-3
CVMAMV223	CCW/CS HEAT EXCHANGER ISOLATION MOV MV-223 FAILS TO OPEN	1.51E-3
AVCAEF214	NON-SAFETY CONDENSATE SOURCE CHECK VALVE EF-214 FAILS TO OPEN	1.50E-3
AVNAEF215	NON-SAFETY SOURCE ISO. MANUAL VALVE EF-215 CANNOT BE OPENED	1.50E-3
HVMOSI204	MOTOR VALVE SI-204 NOT OPEN DUE TO PRE-EXISTING ERROR	1.39E-3
GVMAGSI144	CTMT SPRAY MOTOR VALVE SI-144 FAILS TO OPEN	1.36E-3
GHRVCSHX1	CTMT SPRAY HEAT EXCHANGER 1 UNAVAILABLE DUE TO MAINTENANCE	1.24E-3
CPMX-CCWP44	COMMON CAUSE FAILURE OF ALL FOUR (4) CCW PUMPS (TO START)	1.16E-3
CPMX-ESWSP44	COMMON CAUSE FAILURE OF ALL FOUR (4) ESWS PUMPS (TO START)	1.16E-3
CVNOV234-235	CCW MANUAL VALVES V-234/235 FOR SI PUMP 2 N.O. DUE TO M.E.	1.14E-3
CVNOV236-237	CCU MANUAL VALVES V-236/237 FOR SI PUMP 4 U.O. DUE TO M.E.	1.14E-3
FSXX-HITEMP	COMMON CAUSE FAILURE OF CS HIGH TEMPERATURE ACTUATION SIGNAL	1.08E-3
FSSXCSAS	COMMON CAUSE FAILURE OF CONTAINMENT SPRAY ACTUATION SIGNAL	1.08E-3
HVMOSI104	MOTOR VALVE SI-104 NOT OPEN DUE TO PRE-EXISTING ERROR	1.01E-3

Table 17.3-2

EXAMPLE OF RISK-SIGNIFICANT RANKING OF SSCs FOR THE CCWS TRAIN 1

RANK*/COMPONENT NAME	DESCRIPTION
1) CVNDCC-1316	MANUAL VALVE CC-1316 FAILS TO REMAIN OPEN
2) CPBKCCWP1A	COMPONENT COOLING WATER PUMP 1A FAILS TO RUN
CPBVCCWP1B	CWP 1B UNAVAILABLE DUE TO MAINTENANCE
3) CPBJCCWP1B	CCW PUMP 1B FAILS TO START
CPBKCCWP1A	COMPONENT COOLING WATER PUMP 1A FAILS TO RUN
4) CHFLCC-1305	VALVE CC-1305 NOT OPENED DUE TO PRE-EXISTING MAINT. ERROR
CPBKCCWP1A	COMPONENT COOLING WATER PUMP 1A FAILS TO RUN
5) CHWEHX1A	CCW/SW HEAT EXCHGR. 1A FAILS WHILE OPERATING
CVMACC-107	MOV CC-107 FAILS TO OPEN
6) CHWEHX1A	CCW/SW HEAT EXCHGR 1A FAILS WHILE OPERATING
CVMACC-109	MOV CC-109 FAILS TO OPEN
7) CHWEHX1A	CCW/SW HEAT EXCHNGR 1A FAILS WHILE OPERATING
CVMASW-123	MOV SW-123 FAILS TO OPEN
8) CHWEHX1A	CCW/SW HEAT EXCHNGR 1A FAILS WHILE OPERATING
CVMASW-121	MOV SW-121 FAILS TO OPEN
9) CHFFSTBHX1B	OPERATOR FAILS TO OPEN CCW HX 1B ISO. VALVES
CHWEHX1A	CCW/SW HEAT EXCHNGR 1A FAILS WHILE OPERATING
10) CBDBCCWP1B	4.16 Kv CIRCUIT BREAKER 1B FAILS TO CLOSE
CPBKCCWP1A	COMPONENT COOLING WATER PUMP 1A FAILS TO RUN
11) CPBVCCWP1B	CCWP 1B UNAVAILABLE DUE TO MAINTENANCE
CVCDCC-1302	CHECK VALVE CC-1302 FAILS TO REMAIN OPEN
12) CBDQCCWP1A	4.16 Kv CIRCUIT BREAKER 1A TRIPS SUPRIOUSLY
CPBVCCWP1B	CCWP 1B UNAVAILABLE DUE TO MAINTENANCE
13) CPBKCCWP1A	COMPONENT COOLING WATER PUMP 1A FAILS TO RUN
CVCACC-1303	CHECK VALVE CC-1303 FAILS TO OPEN
14) CPBJCCWP1B	CCW PUMP 1B FAILS TO START
CVCDCC-1302	CHECK VALVE CC-1302 FAILS TO REMAIN OPEN
15) CBDQCCWP1A	4.16 Kv CIRCUIT BREAKER 1A TRIPS SUPRIOUSLY
CPBJCCWP1B	CCW PUMP 1B FAILS TO START
16) CPBKCCWP1A	COMPONENT COOLING WATER PUMP 1A FAILS TO RUN
CPBXDCCWP1B-2B	COMMON CAUSE DEMAND FAILURE OF CCWPs 1B, 2B
17) CPBKCCWP1A	COMPONENT COOLING WATER PUMP 1A FAILS TO RUN
CPBKCCWP1B	COMPONENT COOLING WATER PUMP 1B FAILS TO RUN
18) CHFLCC-1305	VALVE CC-1305 NOT OPENED DUE TO PRE-EXISTING MAINT. ERROR
CVCDCC-1302	CHECK VALVE CC-1302 FAILS TO REMAIN OPEN
19) CHWEHX1A	CCW/SW HEAT EXCHNGR 1A FAILS WHILE OPERATING
CHWVHX1B	CCW HX 1B UNAVAILABLE DUE TO MAINTENANCE
20) CVMACC-107	MOV CC-107 FAILS TO OPEN
CVMDCC-108	MOV CC-108 FAILS TO REMAIN OPEN

* The ranking is the order of decreasing probability for the combinations of equipment failures.

Table 17.3-3

EXAMPLE OF CCWS FAILURE MODES & O-RAP ACTIVITIES

COMPONENT	FAILURE MODE/CAUSE	RECOMMENDED MAINTENANCE	MAINTENANCE INTERVALS	BASIS
CCWS pump	fails to start, [illegible]cal	functional test pump	18 months	experience with other pumps
	fails to run, mechanical	functional test	18 months	experience with other pumps
		minor PM	8000 op.hrs	pump vendor
		major PM	50000 op.hrs	pump vendor
	leaking seals, gaskets	visual inspection	31 days	ASME Code
CCWS MOV	fails to open	functional test	31 days	experience with MOVs
manual vlv	fails to remain open	inspect vlv interior	5 yrs	corrosion experience
	left closed, op. error	functional test	after maintenance	operating experience
heat exchanger	fails, leakage	walkdown	31 days	operating experience
	fouling	monitor ΔP, ΔT	7 day trending	operating experience

Figure 17.3-1 Example of System 80+ FOAKE Functional Project Organization

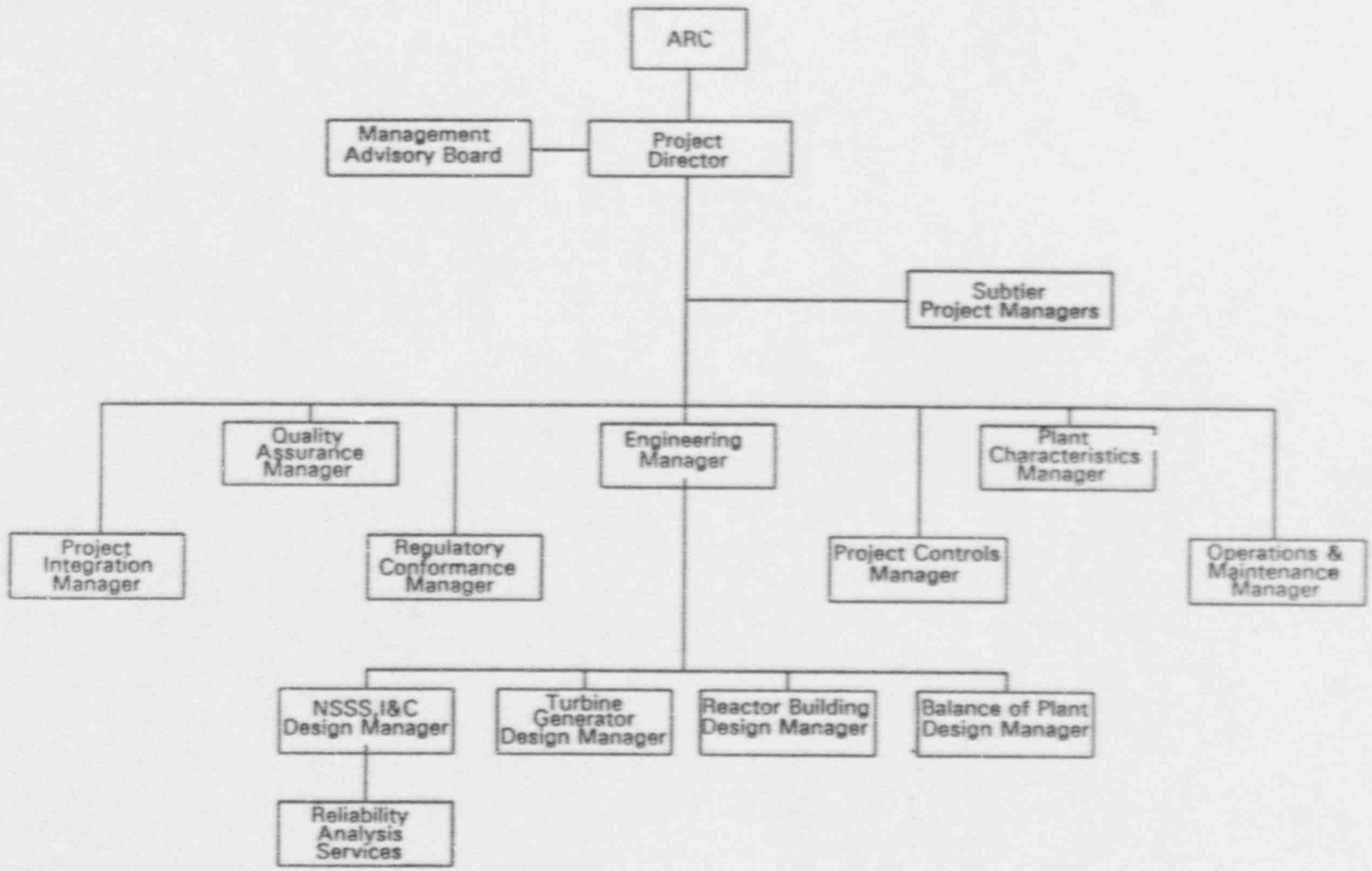


Figure 17.3-2

Design Evaluation for SSCs

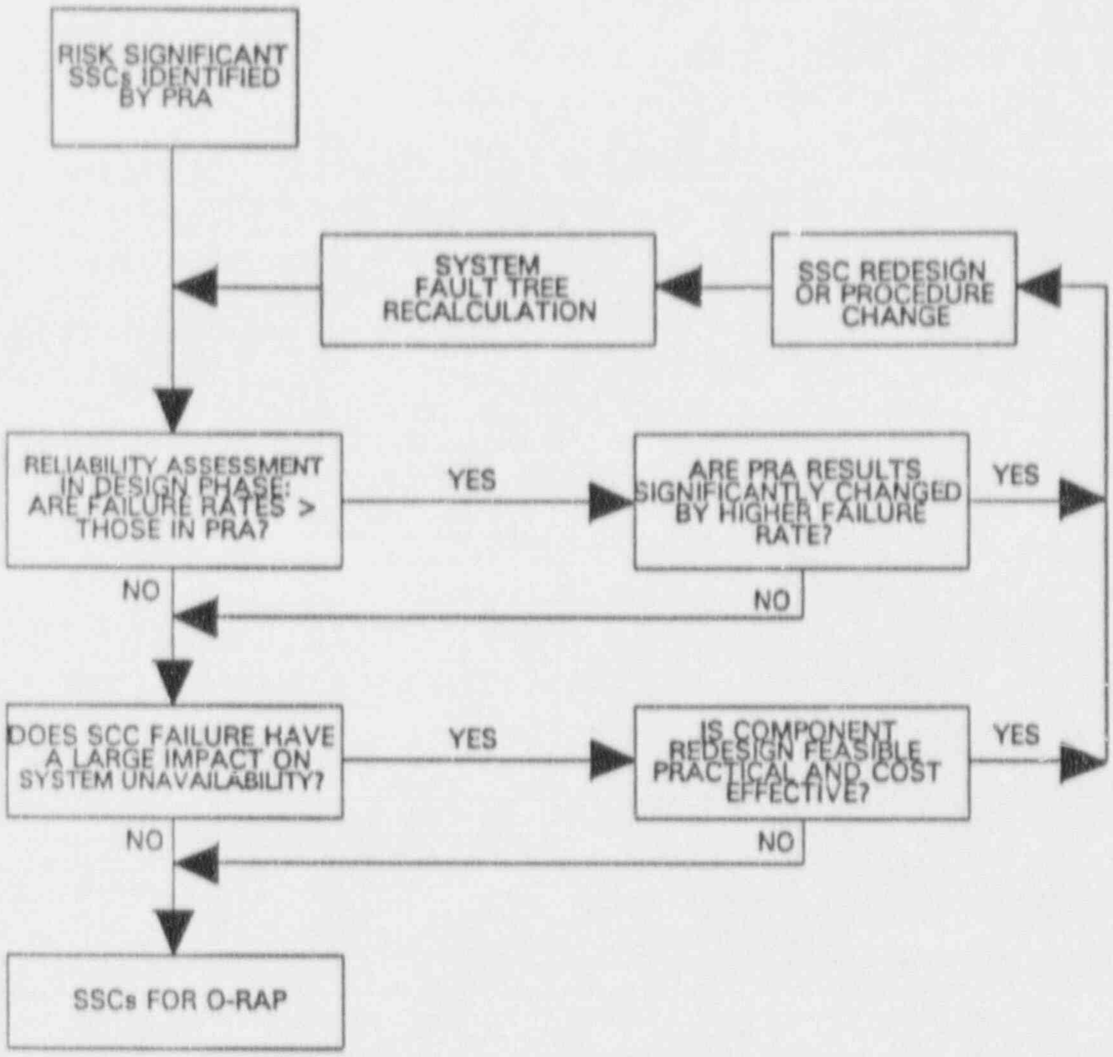


Figure 17.3-3

Process for Determining Dominant Failure Modes
of Risk-Significant SSCs

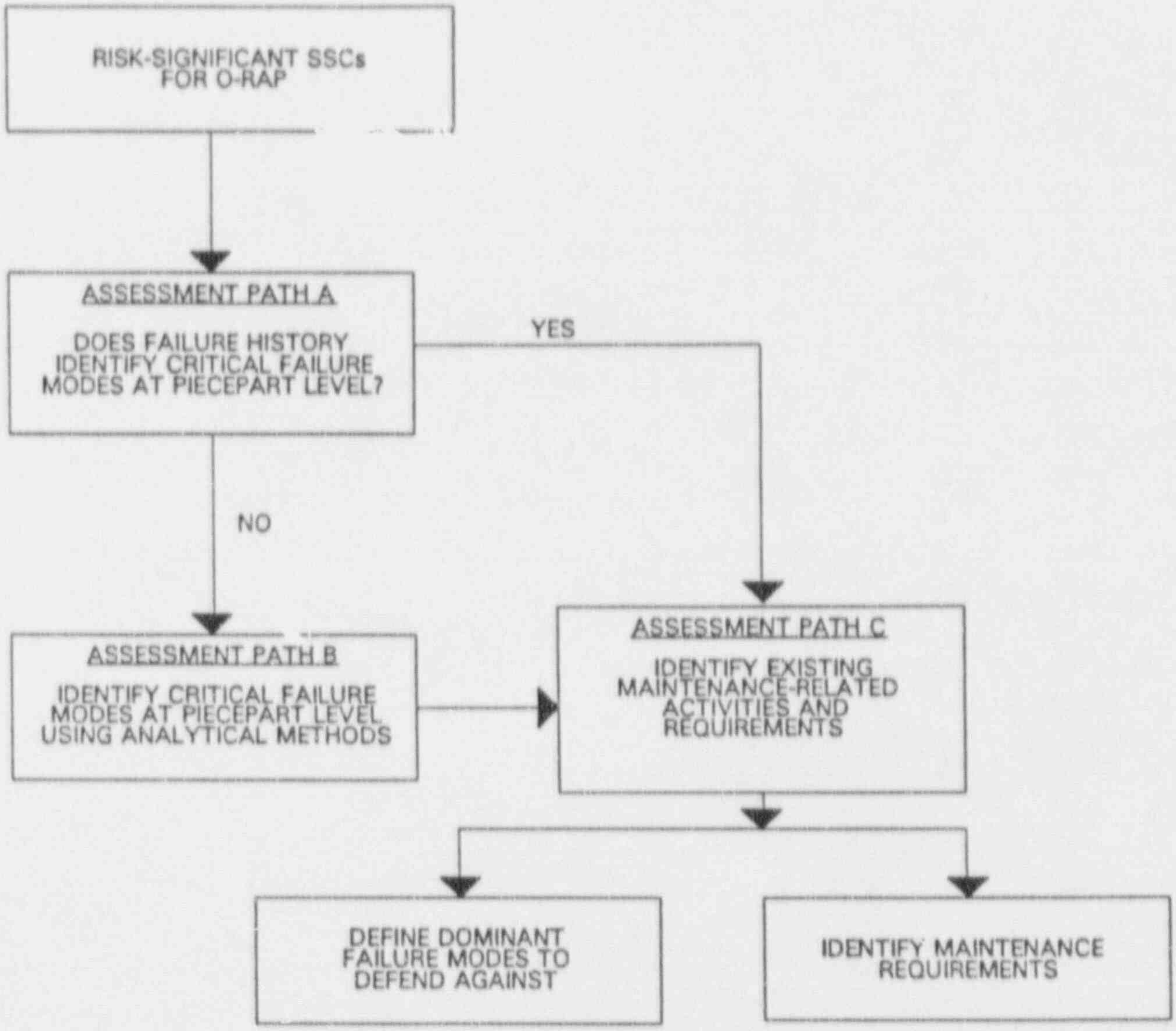


Figure 17.3-4

Use of Failure History to Define Failure Modes

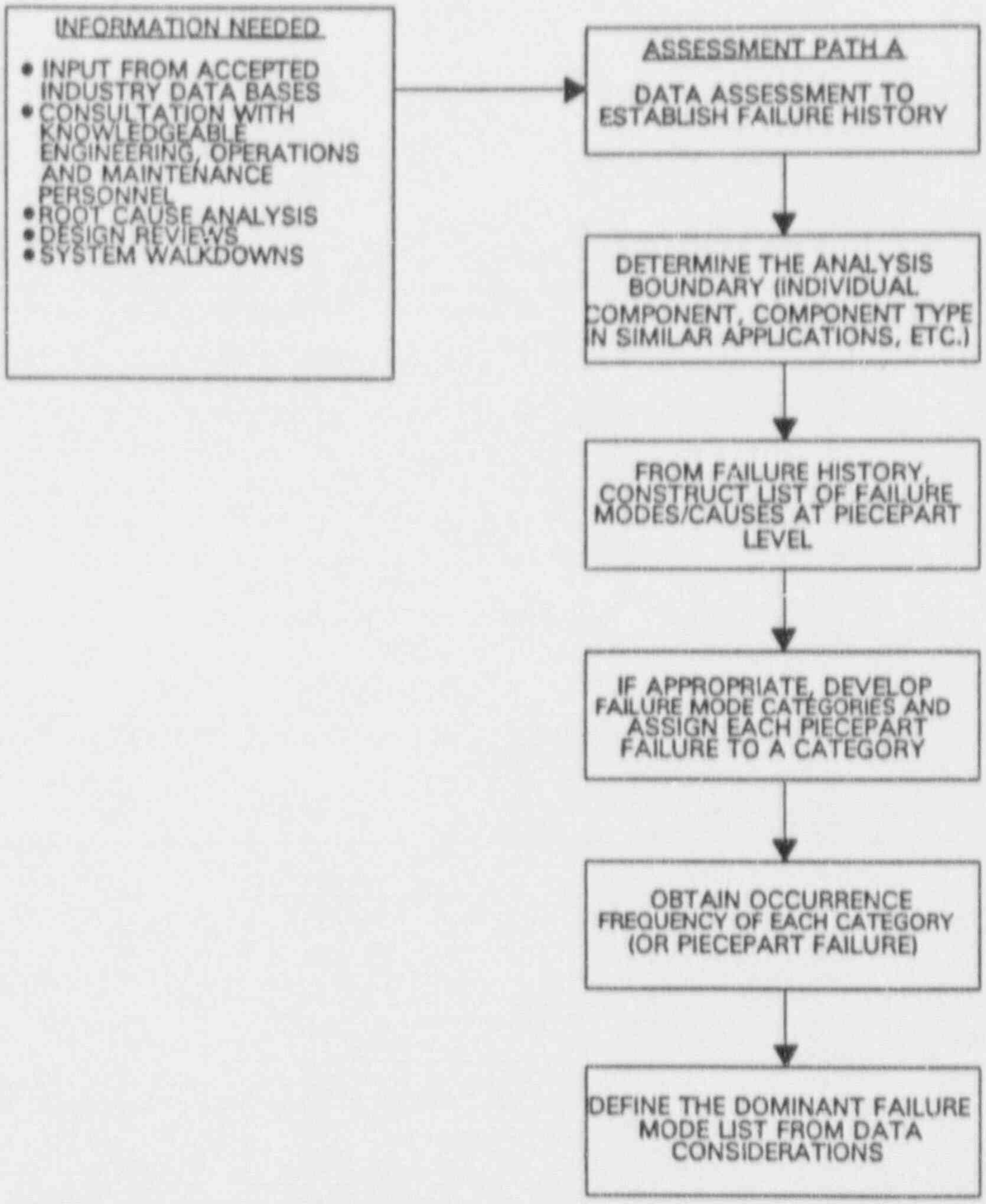


Figure 17.3-5

Analytical Assessment to Define Failure Modes

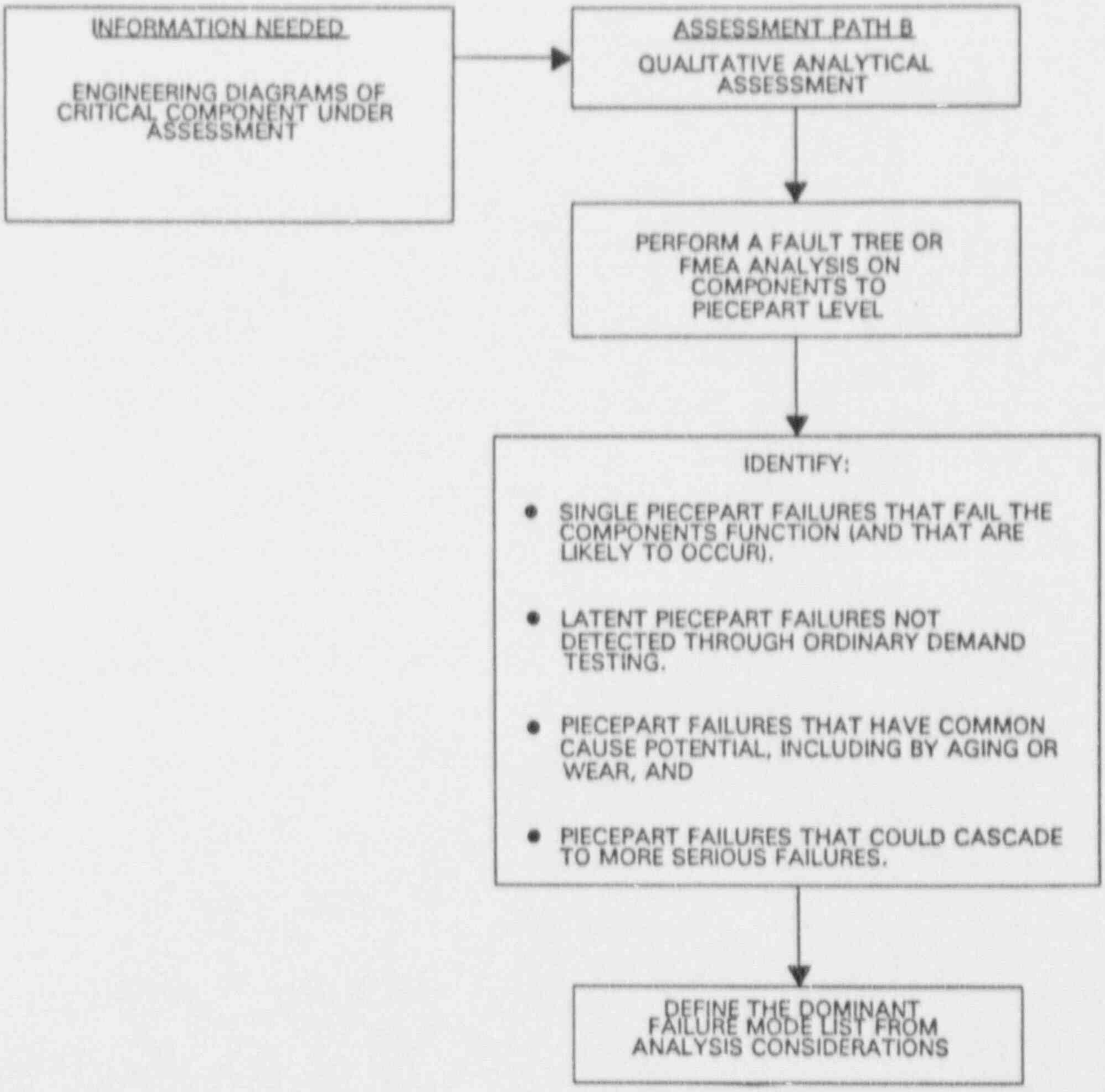


Figure 17.3-6

Inclusion of Maintenance Requirements in the Definition of Failure Modes

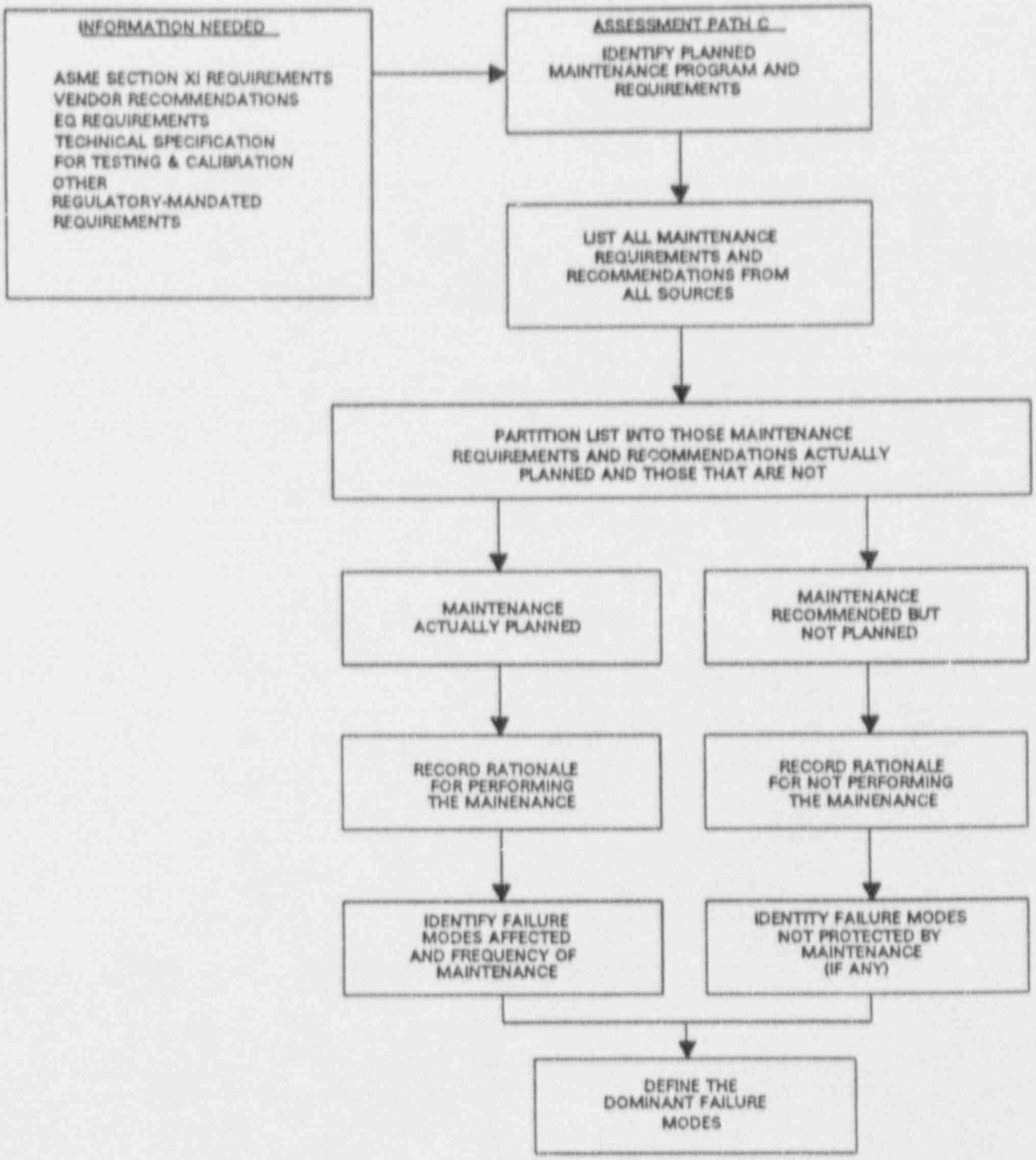


Figure 17.3-7

Identification of Risk-Significant SSC O-RAP Activities

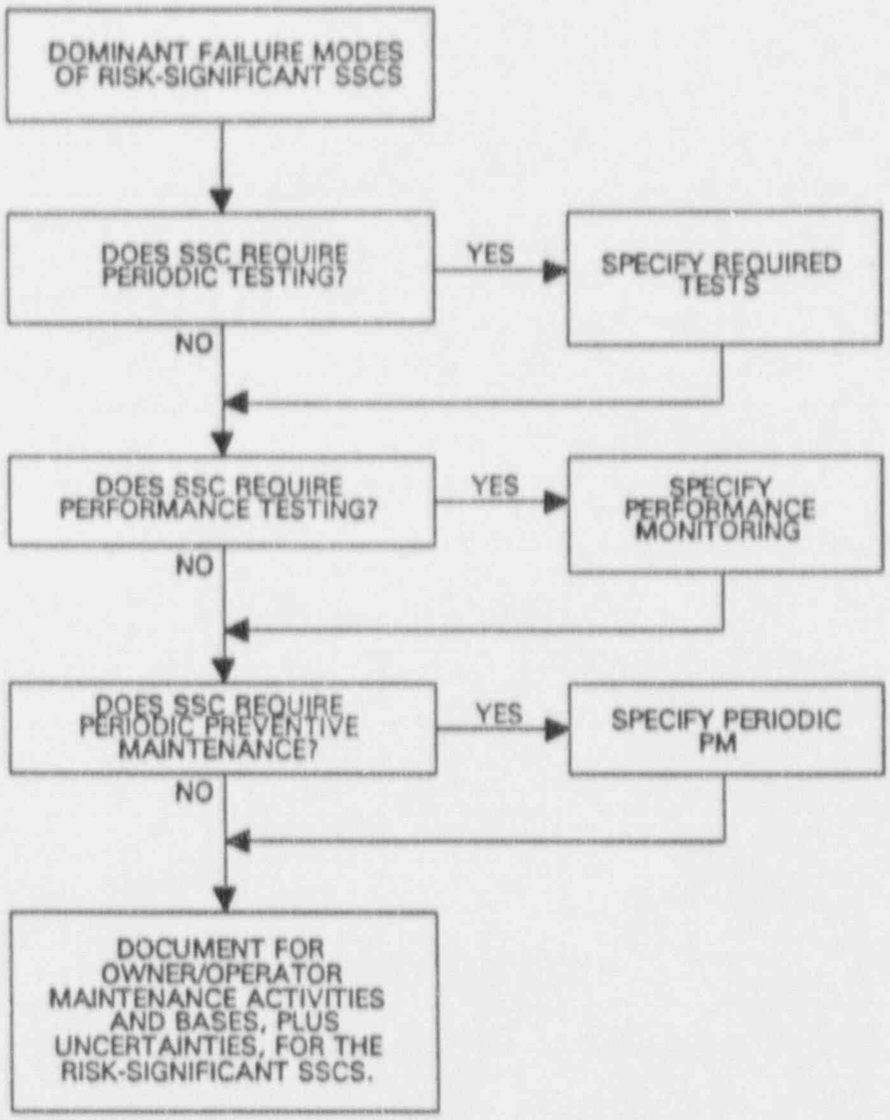


Figure 17.3-6

Example of Early CCWS Design

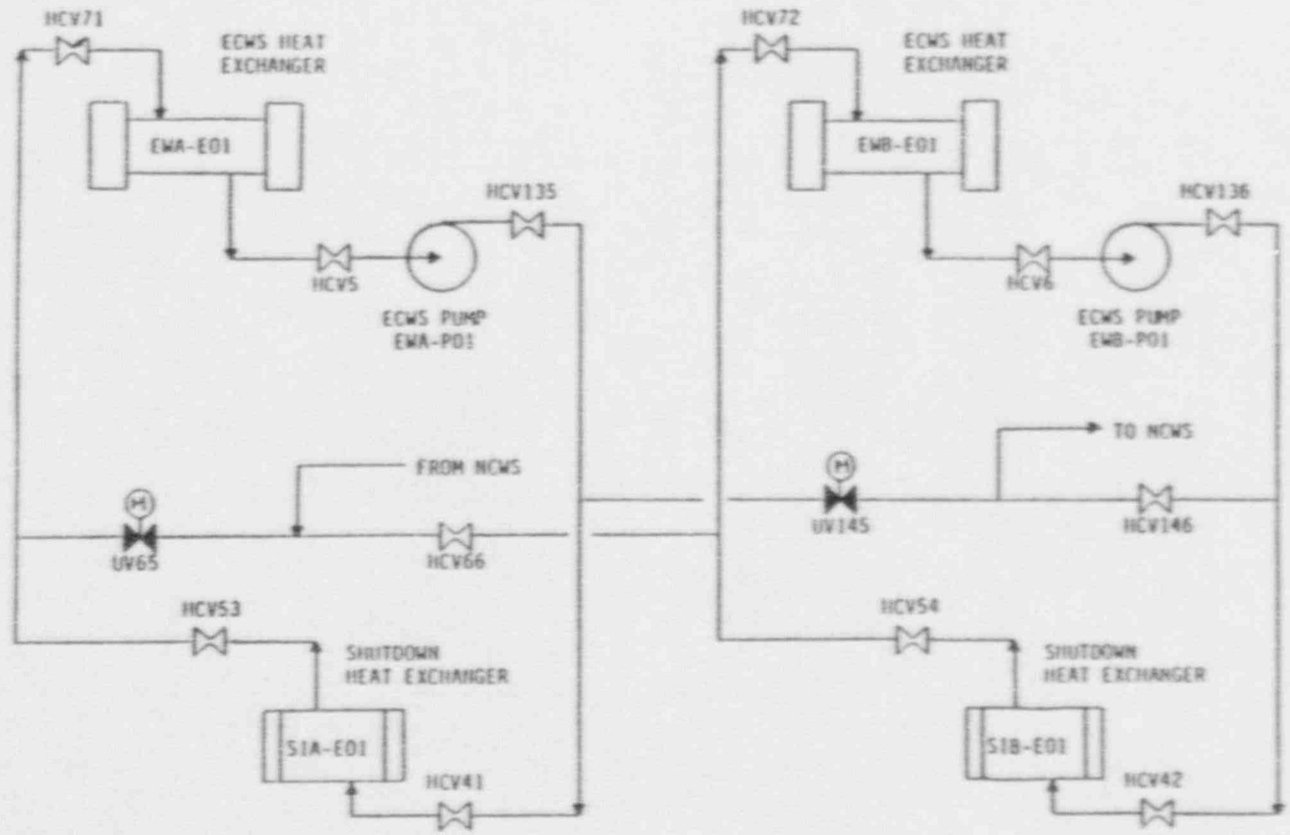


Figure 17.3-9

Example of Improved CCWS Design

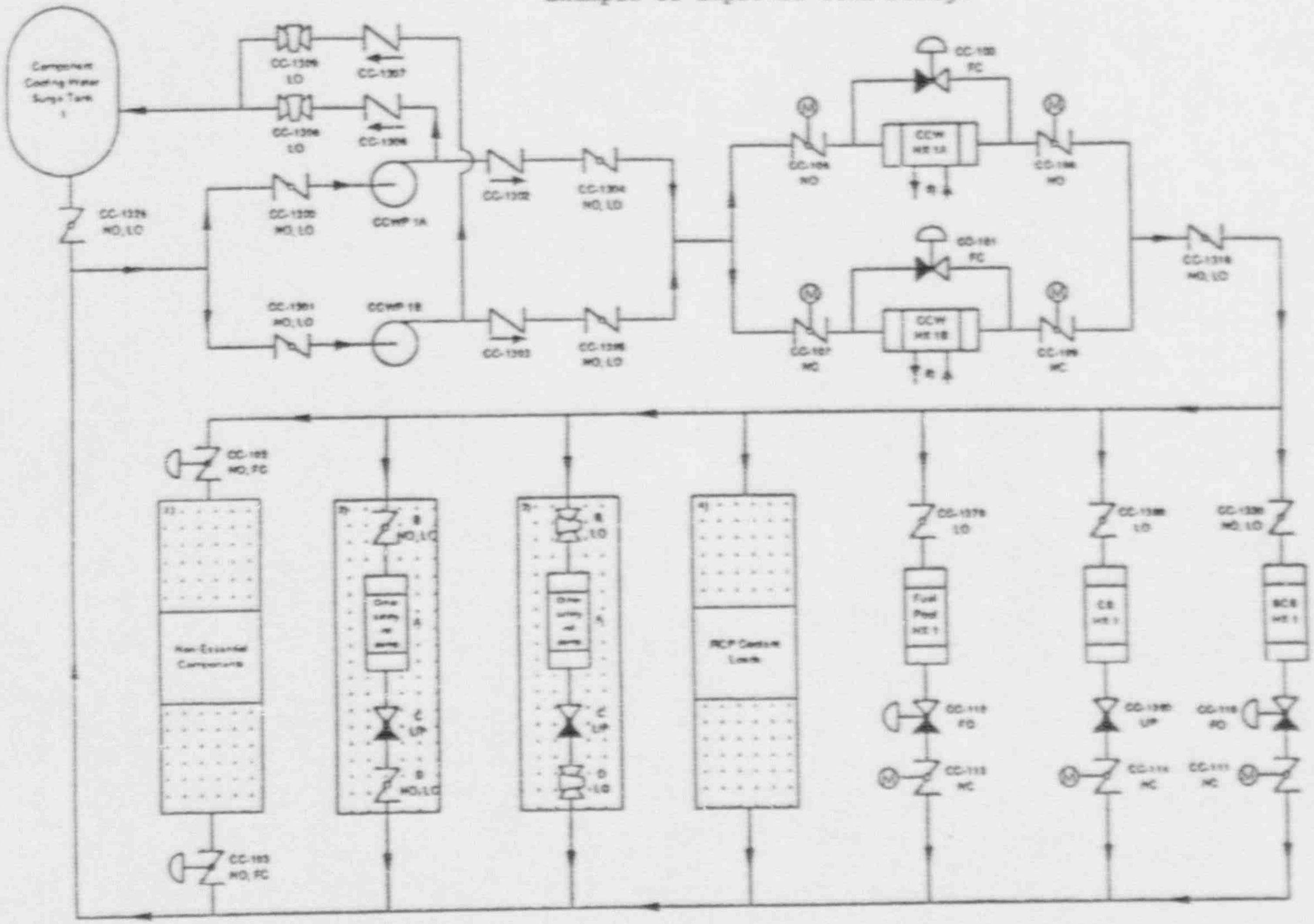
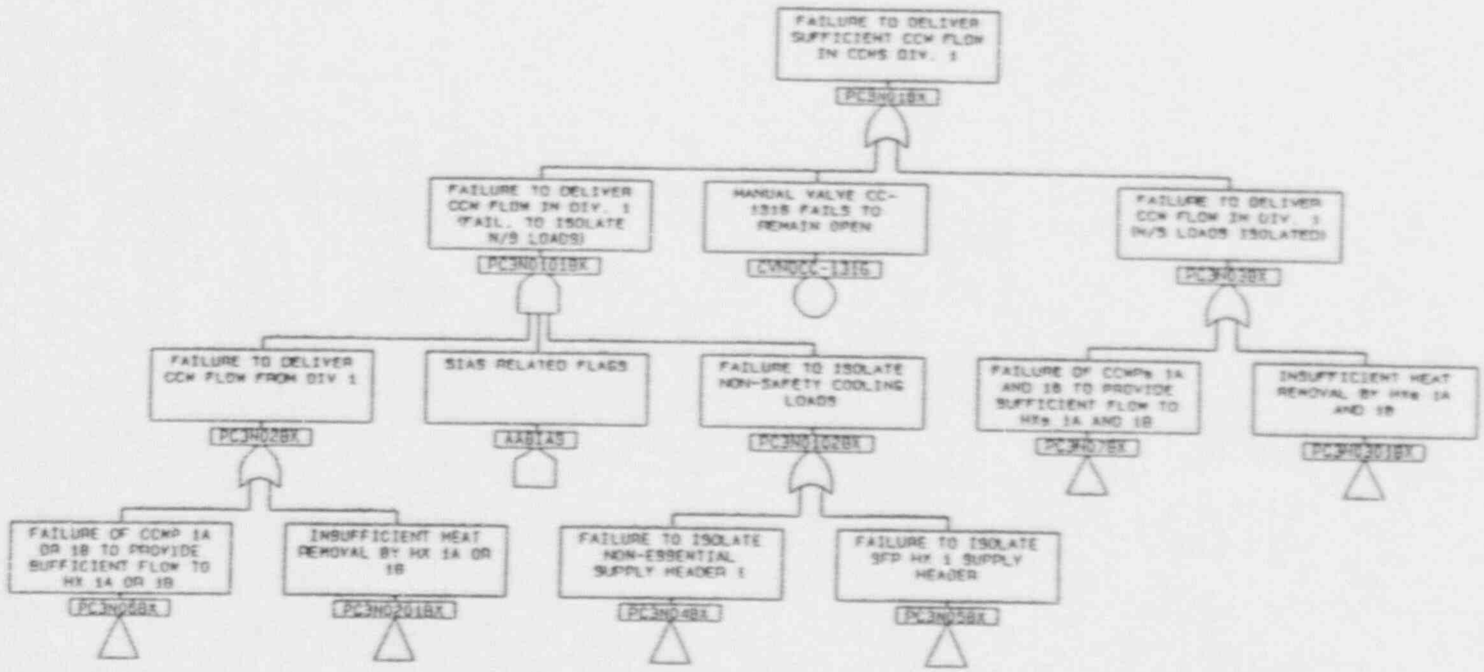


Figure 17.3-10

Example of Fault Tree for CCWS Train 1



Plant Systems Branch

NUMBER	TYPE	TITLE	BRANCH
** 03.04.2-1	COL ITEM	The COL applicant must provide a specific description of the site and the elevation for all safety-related structures, exterior accesses, equipment, and systems.	SPLB
** 03.11.7.3-1	COL ITEM	The staff will evaluate the details of a site-specific environmental qualification program.	SPLB
✓06.2.3-1	COL ITEM	The COL applicant should perform local leak rate tests on the annulus ventilation system (AVS) in accordance with Appendix J to 10 CFR 50.	SPLB
06.4-1	COL ITEM	The COL applicant for a multi-unit site must apply for the evaluation of the unit's compliance with the requirements of GDC 5.	SPLB
06.4-2	COL ITEM	The COL applicant must demonstrate that control room operators are adequately protected against the effects of toxic substances.	SPLB
06.4-3	COL ITEM	The COL applicant will need to verify that the control room habitability system is consistent with the licensing basis documentation.	SPLB
** 06.5-1	COL ITEM	The COL applicant must verify the operability of the containment spray system by using preoperational tests.	SPLB
✓09.1.1-1	COL ITEM	The COL applicant must apply for evaluation of multi-unit's ability to comply with GDC 5.	SPLB
✓09.1.2-1	COL ITEM	The applicant for a multi-unit site must apply for the evaluation of the unit's compliance with the requirements of GDC 5.	SPLB
** 09.1.3-01	COL ITEM	The COL applicant must apply for the evaluation of a multi-unit's compliance with the requirements of GDC 5.	SPLB
✓09.1.4-1	COL ITEM	The COL applicant must apply for the evaluation of multi-unit's compliance with the requirements of GDC 5.	SPLB
✓09.2.01-1	COL ITEM	The COL applicant must take appropriate measures to prevent organic fouling and inorganic buildup in the station service water system (SSWS).	SPLB
09.2.02-1	COL ITEM	The COL applicant must apply for the evaluation of a multi-unit's compliance with the requirements of GDC 5.	SPLB
✓09.2.04-1	COL ITEM	The COL applicant needs to provide potable and sanitary water system designs for staff review.	SPLB
✓09.2.05-1	COL ITEM	The COL applicant will provide an analysis to show that the function of the ultimate heat sink is not impared by ice formation.	SPLB
✓09.2.05-2	COL ITEM	The specific ultimate heat sink design is site dependent.	SPLB
09.2.09.1-1	COL ITEM	The COL applicant must apply for the review of a multi-unit's compliance with GDC 5.	SPLB
09.3.1-1	COL ITEM	The COL applicant must apply for the evaluation of the multi-unit's compliance with the requirements of GDC 5.	SPLB
✓09.5.1-1	COL ITEM	The COL applicant must provide a description of safety-grade provisions for the fire-protection systems.	SPLB
✓09.5.1.5-1	COL ITEM	The staff will perform a detailed review of the administrative controls during the COL review.	SPLB
✓09.5.4.1-1	COL ITEM	The NUREG/CR-0660 guidance on diesel operator training will be performed by the site specific applicant.	SPLB
✓09.5.4.1-2	COL ITEM	All diesel generator auxiliary support systems' test and calibration frequencies will be evaluated on a site-specific basis.	SPLB
✓09.5.4.2-1	COL ITEM	The specific diesel generator fuel storage and transfer system design criteria will be provided by the COL applicant.	SPLB
✓09.5.5-1	COL ITEM	Specific diesel generator cooling water system information will be provided by the COL applicant.	SPLB
✓09.5.5-2	COL ITEM	The COL applicant must address the prevention of gum and varnish deposits due to extended diesel generator idling.	SPLB
✓09.5.6-1	COL ITEM	The COL applicant must provide a preventive maintenance program for the diesel generators' starting air instrumentation.	SPLB
✓09.5.6-2	COL ITEM	Specific diesel generator starting air system interface requirements will be provided by the COL applicant.	SPLB
✓09.5.7-1	COL ITEM	The COL applicant must provide specific design criteria for the diesel generator lube oil system.	SPLB
✓09.5.8-1	COL ITEM	The diesel generator air flow capacity will be specified by the COL applicant.	SPLB
✓09.5.9-1	COL ITEM	The adequacy of the diesel generator building sump pump system design in regards to the maximum leakage or maximum credible pipe rupture is a plant specific interface issue.	SPLB
✓10.2-1	COL ITEM	The selection of the turbine valve operation times that meet the turbine valves closing time criteria is a COL action item.	SPLB
✓10.3-1	COL ITEM	The COL applicant must provide a program to protect against the potential occurance of steam hammer.	SPLB
10.3-2	COL ITEM	The COL applicant has to apply for the evaluation of the multi-unit's ability to comply with GDC 5.	SPLB
✓10.4.4-1	COL ITEM	The COL applicant will need to provide pressure drops between the steam generator nozzles and each system valve in order for the staff to evaluate the turbine bypass system.	SPLB
10.4.7-1	COL ITEM	The COL applicant must apply for the evaluation of a multi-unit's compliance with the requirements of GDC 5.	SPLB
✓10.4.7-2	COL ITEM	The staff will review the adequacy of the provisions for avoidance of water hammer in the condensate and feedwater systems on a site-specific basis during the COL review.	SPLB
10.4.9-1	COL ITEM	The COL applicant must apply for the evaluation of a multi-unit's compliance with the requirements of GDC 5.	SPLB
✓10.4.9-2	COL ITEM	Water hammer in the emergency feedwater piping is a COL item since the detailed design is dependent on vender supplied information.	SPLB
✓10.4.9-3	COL ITEM	The staff will evaluate the steam binding of the emergency feedwater pumps on a site-specific basis during the COL review.	SPLB

NUMBER	TYPE	TITLE	BRANCH
11.1-1	COL ITEM	The COL applicant must ensure that its application conforms with 10 CFR 50, Appendix I, ANSI N13.1 and RGs 1.21 and 4.15.	SPLB
11.4-1	COL ITEM	Site specific solid waste management system operating procedures are to be developed by the COL applicant.	SPLB
11.5-1	COL ITEM	The COL applicant must demonstrate conformance with 10 CFR 50 Appendix I, ANSI N13.1, RG 1.21 and RG 4.15.	SPLB
11.5-2	COL ITEM	The COL applicant must provide procedures in accordance with Position C of RG 4.15.	SPLB
15.3.10-1	COL ITEM	The parameters that show that failure of the boric acid storage tank is the limiting tank failure and show a minimum equivalent dilution factor of 1.438E8 must be provided.	SPLB
20.2-02	COL ITEM	The staff will review site-specific aspects of the resolution of GI-51 as part of the review of the COL application.	SPLB
20.2-03	COL ITEM	The staff will evaluate the resolution of Issue 57 during its review of the COL application.	SPLB
20.2-05	COL ITEM	The staff will evaluate the steam binding of the EFW pumps on a site-specific basis during a COL review.	SPLB
20.2-06	COL ITEM	Generic Issue 106 has not been resolved by the staff. The staff expects the COL applicant to address the resolution of this issue.	SPLB
20.2-07	COL ITEM	The site-specific design must comply with 10 CFR 50.34(f) for combustible gas control.	SPLB
20.2-08	COL ITEM	Generic Issue 130 has not been resolved by the staff. The staff expects the COL applicant to address the resolution of this issue.	SPLB
03.11.3.2.2-1	CONF ITEM	The applicant must complete the proposed changes to CESSAR Sections 3.11.2.1 and 3.11.3.2.	SPLB
05.2.5-1	CONF ITEM	The staff will confirm that the containment atmosphere monitor is designed to seismic Category I and is included in Table 11.5-3 as previously proposed by the applicant.	SPLB
06.2.3-1	CONF ITEM	The applicant should provide the design limits for annulus pressure and temperature in the CESSAR.	SPLB
06.4-1	CONF ITEM	The staff will confirm that the locations of the control room vents are included in a revision to the general arrangement drawings (CESSAR Figures 1.2-3 and 1.2-8).	SPLB
06.4-2	CONF ITEM	The staff will confirm that a future revision to the general arrangement drawings incorporates the location of the unit vent.	SPLB
06.4-3	CONF ITEM	The staff will confirm that responses to RAIs Q450-3 and Q410.116 are incorporated into the CESSAR.	SPLB
09.1.1-01	CONF ITEM	The staff will confirm that the identification of the facilities qualified as seismic Category I are incorporated into CESSAR Section 9.1.1.3.3.	SPLB
09.1.1-02	CONF ITEM	The applicant's response to RAI Q410.103(i) should be incorporated into CESSAR Section 9.1.1.3.1.1.	SPLB
09.1.1-03	CONF ITEM	Additional information on fuel rack design features and on the seismic classification of new fuel inspection area equipment should be incorporated into CESSAR Section 9.1.1.2.	SPLB
09.1.1-04	CONF ITEM	The criticality design basis described in CESSAR 9.1.1.1.A is not derived from RG 1.13. CESSAR 9.1.1.1.B must be revised to state which parts of RG 1.13 are met.	SPLB
09.1.1-05	CONF ITEM	The design basis for the storage of 121 new fuel assemblies must be incorporated into CESSAR 9.1.1.1.D.	SPLB
09.1.1-06	CONF ITEM	The applicant's commitment to comply with ANS 57.1 and ANS 57.3 must be incorporated into CESSAR 9.1.1.1.	SPLB
09.1.1-07	CONF ITEM	The restrictions limiting the lifting capacity of the overhead crane must be stated in CESSAR 9.1.1.3.1.	SPLB
09.1.1-08	CONF ITEM	The features to preclude the fall of heavy objects onto the new fuel racks must be incorporated into CESSAR 9.1.1.3.1.1.	SPLB
09.1.1-09	CONF ITEM	The applicant must clarify in CESSAR Section 9.1.1.1 what fraction of the total core is represented by the 121 new fuel assemblies.	SPLB
09.1.1-10	CONF ITEM	The applicant must clarify the design requirements for the new fuel racks for safe shutdown earthquake conditions and dropped fuel assembly conditions.	SPLB
09.1.2-01	CONF ITEM	The design features showing compliance with ANS 57.2 should be incorporated into CESSAR 9.1.2.3.	SPLB
09.1.2-02	CONF ITEM	The list of facilities should be incorporated into CESSAR Section 9.1.2.2.3.	SPLB
09.1.2-03	CONF ITEM	The justification that excessive force cannot be applied to spent fuel racks and fuel pool should appear in CESSAR Section 9.1.2.	SPLB
09.1.2-04	CONF ITEM	Portions of CESSAR Section 9.1.2.3.1.3 are missing. This error should be corrected.	SPLB
09.1.2-05	CONF ITEM	The applicant must insert material into CESSAR Section 9.1.2.2.2 concerning the restrictions of fuel storage in Region II.	SPLB
09.1.2-06	CONF ITEM	Compliance with SRP 9.1.2, Item III.2.e should be incorporated into CESSAR Sections 9.1.2 and 9.1.4.	SPLB
09.1.2-07	CONF ITEM	Discussion regarding failure of non-safety related systems and structures on spent fuel racks should appear in CESSAR Section 9.1.2.	SPLB
09.1.2-08	CONF ITEM	The applicant's response to RAI Q410.64 must be incorporated into the CESSAR.	SPLB
09.1.2-09	CONF ITEM	The applicant must explain what fraction of a full core is represented by Region II and the total spent fuel storage capacity.	SPLB
09.1.2-10	CONF ITEM	The applicant must incorporate its response to RAI Q410.66 into the CESSAR.	SPLB
09.1.3-01	CONF ITEM	The second paragraph to the applicant's response to RAI Q410.55(d)(4) should be added to CESSAR Section 9.1.3.3.3.	SPLB
09.1.3-02	CONF ITEM	The third paragraph to the applicant's response to RAI Q410.67 should be added to CESSAR Section 9.1.3.3.1.	SPLB
09.1.3-03	CONF ITEM	The applicant's response to RAI Q410.59 must be inserted into CESSAR Section 9.1.3.1.5.	SPLB
09.1.3-04	CONF ITEM	The applicant's response to RAI Q410.61 should be included in CESSAR Section 9.1.3.	SPLB
09.1.3-05	CONF ITEM	The applicant's response to RAI Q281.34 must be included in CESSAR Sections 9.1.3.3.3 and 9.1.3.2.2.5.	SPLB
09.1.3-06	CONF ITEM	The applicant's response to RAI Q410.55(d)(5) should be incorporated into CESSAR Section 9.1.3.	SPLB
09.1.3-07	CONF ITEM	The discussion of PCPS design features provided in response to RAI Q410.06b should be given in CESSAR Section 9.1.3.1.	SPLB

NUMBER	TYPE	TITLE	BRANCH
09.1.3-08	CONF ITEM	The applicant's response to RAI Q410.68 contains an acceptable revision to CESSAR Section 9.1.3.3.1.	SPLB
09.1.3-09	CONF ITEM	The CESSAR does not identify the related Figure 9.1-3.	SPLB
09.1.3-10	CONF ITEM	The applicant has not yet incorporated its response to RAI Q410.68 into the CESSAR.	SPLB
09.1.4-1	CONF ITEM	The applicant must incorporate its response to RAI Q410.107 into CESSAR Section 9.1.4.	SPLB
09.1.4-2	CONF ITEM	The applicant should incorporate its response to RAI Q410.108 into CESSAR Section 9.1.4.	SPLB
09.1.4-3	CONF ITEM	The response to RAI Q410.109 should be corrected to refer to positions C.3 and C.5 of RG 1.13.	SPLB
09.1.4-4	CONF ITEM	The applicant should verify that 2-assembly fuel carrie, design for the fuel transfer carraige includes criticality considerations.	SPLB
09.1.4-5	CONF ITEM	The response to RAI Q410.66 should be incorporated into CESSAR Section 9.1.4.3.	SPLB
09.1.4-6	CONF ITEM	The response to RAI Q410.69 should be incorporated into CESSAR Section 9.1.4.2.1.2.	SPLB
09.1.4-7	CONF ITEM	The response to RAI Q410.71 should be incorporated into CESSAR Section 9.1.4.4.	SPLB
09.1.4-8	CONF ITEM	The response to RAI Q410.73 should be incorporated into CESSAR Section 9.1.4.[illegible].1.	SPLB
09.2.06-1	CONF ITEM	The staff will confirm that a flow diagram of the condensate storage system is included in a future revision to the CESSAR.	SPLB
09.3.1-1	CONF ITEM	The staff will confirm that RAI Q410.114 response will be incorporated into a revision to the CESSAR.	SPLB
09.3.3-1	CONF ITEM	The applicant committed to incorporate information on the reactor building sump pumps and check valves in CESSAR Section 9.3.3.	SPLB
09.3.3-2	CONF ITEM	P&IDs in CESSAR Section 9.3.3 will be revised to indicate the component safety classification and to indicate check valve designation.	SPLB
09.3.3-3	CONF ITEM	CESSAR Figure 11.2-1 will be revised to agree with the text in CESSAR Section 9.3.3.	SPLB
09.4.2-1	CONF ITEM	The applicant has committed to incorporate changes in CESSAR Section 9.4.2 and Tables 8.3.1-2 and 8.3.1-3 in response to RAI Q410.117.	SPLB
09.4.4-1	CONF ITEM	The applicant has committed to incorporate its response to RAI Q410.118 into the CESSAR.	SPLB
09.4.5-1	CONF ITEM	The applicant committed to incorporate its response to RAI Q410.119 into the CESSAR.	SPLB
09.4.6-1	CONF ITEM	The applicant committed to incorporate its response to RAI Q410.120 into the CESSAR.	SPLB
09.4.8-1	CONF ITEM	The applicant has committed to provide interface requirements for the station service water pump structure ventilation system.	SPLB
09.4.9-1	CONF ITEM	The applicant has committed to incorporate its response to RAI Q410.122 into CESSAR Section 9.4.9.	SPLB
09.5.4.2-1	CONF ITEM	The applicant committed to revise CESSAR Section 9.5.4.3 to provide assurance that the fuel oil temperature would remain above the cloud point.	SPLB
10.2-1	CONF ITEM	The applicant will revise the CESSAR to include the extraction steam non-return check valves and turbine valves closing criteria.	SPLB
10.2-2	CONF ITEM	The applicant will revise the CESSAR to include the criteria that the speed governor for normal speed load-control fully closes the control and intercept valve at 105 percent.	SPLB
10.3-1	CONF ITEM	The applicant must incorporate its response to RAI Q410.2 into the CESSAR.	SPLB
10.4.5-1	CONF ITEM	The applicant has committed to provide additional information in CESSAR Section 10.4.5.	SPLB
10.4.7-1	CONF ITEM	The applicant has committed to more fully incorporate statements addressing water hammer in CESSAR Sections 10.4.7.2.5-7.	SPLB
10.4.9-1	CONF ITEM	Incorporation of the most recent PRA analysis in the chapter 10 emergency feedwater system reliability analysis is a confirmatory item.	SPLB
10.4.9-2	CONF ITEM	The applicant committed to prepare a distribution system design concerning water hammer in the emergency feedwater piping.	SPLB
11.1-1	CONF ITEM	The applicant should change the applicable CESSAR sections to show 1830 gpd (not 183 gpd) for the shim bleed rate.	SPLB
11.2-1	CONF ITEM	The applicant must incorporate changes proposed in a January 24, 1992 letter into the CESSAR.	SPLB
11.3-1	CONF ITEM	The staff will confirm that the revisions proposed in the applicant's January 24, 1992 letter are incorporated into the CESSAR.	SPLB
11.3-2	CONF ITEM	The applicant must state the filtration system components for the radwaste building exhaust.	SPLB
11.4-1	CONF ITEM	The staff will confirm that the applicant incorporates the information included in its January 24, 1992 letter into the CESSAR.	SPLB
11.5-1	CONF ITEM	The staff will confirm that the applicant's response to RAI Q410.139e is included in a revision to the CESSAR.	SPLB
20.2-01	CONF ITEM	The staff will confirm that the applicant revises CESSAR Section 9.5.10 to include the requirements of SRP Section 9.5.1 for hydrogen lines located in safety-related areas.	SPLB
09.2.04-1	INTERFACE	The potable and sanitary water systems shall be designed with no interconnections with systems containing radioactive materials.	SPLB
09.2.04-2	INTERFACE	Protection by the use of air gaps shall be provided where necessary in the potable and sanitary systems.	SPLB
09.2.08-1	INTERFACE	The turbine building cooling water system is to be located in a building that does not contain any safety-related components.	SPLB
09.2.10-1	INTERFACE	The turbine building service water system is to be located in a building that does not contain any safety-related components.	SPLB
10.4.5-1	INTERFACE	The applicant has summarized interface requirements for the condenser circulating water system.	SPLB
03.04.1-1	OPEN ITEM	The applicant needs to specify where seismic Category I structures requiring flood protection will be identified.	SPLB
03.04.1-2	OPEN ITEM	The seismic Category I diesel fuel oil storage structures are not identified as requiring flood protection in accordance with RG 1.29.	SPLB
03.05.1.3-1	OPEN ITEM	The applicant should revise the CESSAR to be consistent with the staff's turbine maintenance and inspection program.	SPLB
03.11.3.2.1-1	OPEN ITEM	CESSAR Section 3.11.2 alternate test profile is not in compliance with 10 CFR 50.49 and is therefore, unacceptable.	SPLB
03.11.3.2.1-2	OPEN ITEM	The applicant's use of IEEE 323-1983 is not acceptable to the staff.	SPLB

NUMBER	TYPE	TITLE	BRANCH
03.11.3.2.1-3	OPEN ITEM	The applicant should address the staff's concerns relative to environmental qualification of electronic components.	SPLB
03.11.3.2.1-4	OPEN ITEM	The staff does not agree that topical report CENPD-255-A Rev. 3 should be extended to include other equipment suppliers.	SPLB
05.2.5-1	OPEN ITEM	The applicant states that the maximum allowable total identified leakage will be given in the TS. RG 1.45 states that both identified and unidentified leakage should be given	SPLB
06.2.1.1.2-1	OPEN ITEM	The applicant's reliance on a possible future change in 10 CFR 100 for containment pressure margin is unacceptable.	SPLB
06.2.1.1.2-2	OPEN ITEM	The applicant must show that the external differential pressure on the primary containment due to the inadvertent actuation of containment spray provides an acceptable margin.	SPLB
06.2.1.2-1	OPEN ITEM	It is not clear that the applicant has identified all of the high energy line breaks, that LBB may not apply to, that may cause subcompartment pressurization.	SPLB
06.2.1.3-1	OPEN ITEM	The staff believes that the metal-water energy should be included as one of the energy sources that effect the containment pressure after a LOCA.	SPLB
06.2.3-1	OPEN ITEM	The applicant must justify testing HEPA filters in accordance with MIL-STD-282 vice the RG 1.52 recommended test.	SPLB
06.2.3-2	OPEN ITEM	It is not clear that the filter train will include minimum instrumentation requirements listed in SRP Table 6.5.1-1.	SPLB
06.2.3-3	OPEN ITEM	The radiant heat transfer to the secon[illegible]ry containment has not been included in the applicant's annulus building pressure analysis. The applicant should justify this.	SPLB
06.2.3-4	OPEN ITEM	The applicant should address the issue of primary containment leakage bypassing the secondary containment as it is specified in SRP 6.2.3 and BTP CSB 6-3.	SPLB
06.2.4-1	OPEN ITEM	The applicant should clearly state which standards and recommendations specified in SRP 6.2.4 will be met.	SPLB
06.2.4-2	OPEN ITEM	The applicant must provide additional information on the containment isolation valves listed in CESSAR Table 6.2.4-1.	SPLB
06.2.4-3	OPEN ITEM	The applicant does not indicate that lines connecting the containment atmosphere and the environment have radiation monitors that could isolate the lines on high radiation.	SPLB
06.2.4-4	OPEN ITEM	The containment isolation valves are designed to withstand a maximum radiation dose that is not physically reasonable (i.e., 4.0E-7 rads).	SPLB
06.2.4-5	OPEN ITEM	The applicant has not responded to RAI Q480.37(d) regarding an analysis of the radiological results of a DBA with the containment purge system initially open.	SPLB
06.2.6-1	OPEN ITEM	The containment isolation valves on piping connected to the steam generator secondary side must be leak tested with operating fluid.	SPLB
06.2.6-2	OPEN ITEM	The applicant should leak test the shutdown cooling system and the safety injection pump system containment isolation valves in accordance with 10 CFR 50 Appendix J.	SPLB
06.2.6-3	OPEN ITEM	The lack of a leak rate test for the secondary containment is not acceptable.	SPLB
06.4-1	OPEN ITEM	The applicant does not conform to the guidance of SRP 6.4 related to the control room boundary pressurization systems.	SPLB
06.5-1	OPEN ITEM	The applicant must provide additional information to allow the staff to verify that the containment spray system will cover 90 percent of the containment volume.	SPLB
06.5-2	OPEN ITEM	The calculated containment spray system pump minimum NPSH could not be compared to required NPSH since no specific pump has been selected.(ITAAC)	SPLB
06.8-1	OPEN ITEM	The hydrodynamic loads to the IRWST and SRS have not been addressed in the CESSAR.	SPLB
09.1.1-1	OPEN ITEM	The applicant should provide criticality information for the review of CESSAR Section 9.1.1.	SPLB
09.1.1-2	OPEN ITEM	SRP 9.1.1 requires criticality information to show the fuel racks with k-eff less than 0.95 w[illegible] design enrichment fuel.	SPLB
09.1.1-3	OPEN ITEM	The applicant should discuss which accidents require DOT-4 and the use of the KENO IV computer codes and the respective accuracies of these codes.	SPLB
09.1.1-4	OPEN ITEM	The applicant should explain how a 10-inch space between the top of the active fuel and the top of the rack precludes a dropped assembly criticality.	SPLB
09.1.1-5	OPEN ITEM	The applicant should confirm that flooding with unborated room-temperature water is a conservative assumption for an optimum moderation condition.	SPLB
09.1.1-6	OPEN ITEM	The applicant should discuss provisions in the design for drainage of the vault to prevent the accumulation of a fluid moderator.	SPLB
09.1.1-7	OPEN ITEM	An analysis should be performed to ensure that failure of non-seismic Category I systems cannot cause unacceptable k-eff.	SPLB
09.1.1-8	OPEN ITEM	The applicant must show how the distances between the concrete and the fuel array provide the most conservative assumptions for the criticality anaylsis.	SPLB
09.1.1-9	OPEN ITEM	The applicant must explain how cross-placement of new and spent fuel storage racks will be prevented.	SPLB
09.1.2-1	OPEN ITEM	The applicant must incorporate its response to RAI Q410.104a into CESSAR Section 9.1.2. The response should be expanded to show conformance to RG 1.13 Position C.3.	SPLB
09.1.2-2	OPEN ITEM	The applicant should discuss which analyses require the use of DOT-4 and KENO IV computer codes.	SPLB
09.1.2-3	OPEN ITEM	The applicant should submit numerical values for k-eff for all normal design and accident analyses performed for the spent fuel storage.	SPLB
09.1.2-4	OPEN ITEM	The applicant should provide the results of criticality analyses which assume a boron concentration of 0 ppm for the dropped load conditions discussed in the CESSAR.	SPLB
09.1.2-5	OPEN ITEM	The applicant must provide information which demonstrates how the spent fuel storage pool will be protected from a spent fuel storage cask drop.	SPLB
09.1.2-6	OPEN ITEM	The applicant must explain how pool leakage will be detected and discuss design features to prevent water inventory loss beyond minimum safe shielding and cooling limits.	SPLB
09.1.2-7	OPEN ITEM	The applicant must explain how fuel racks will be anchored and prevented from tipping in the pool.	SPLB
09.1.2-8	OPEN ITEM	The applicant must explain how placement of a fuel assembly in a wrong location is prevented.	SPLB

NUMBER	TYPE	TITLE	BRANCH
09.1.3-01	OPEN ITEM	The applicant's response to RAI Q410.56 regarding heat generation rate calculations is considered incomplete. Also the applicant should show how SRP 9.1.3 is met.	SPLB
09.1.3-02	OPEN ITEM	The applicant's response to RAI Q410.55(a) is considered inadequate. CESSAR Section 9.1.3 should provide the heat removal rates required to meet the design bases criteria.	SPLB
09.1.3-04	OPEN ITEM	The applicant must provide information showing the effect of nonborated makeup to the pool on criticality.	SPLB
09.1.3-05	OPEN ITEM	The applicant must provide information regarding the effect of equipment wetting on system operability.	SPLB
09.1.3-06	OPEN ITEM	The applicant must provide additional information on the system containment isolation valves.	SPLB
09.1.3-07	OPEN ITEM	The applicant must identify all automatic system functions.	SPLB
09.1.3-08	OPEN ITEM	The applicant should provide an analysis of the effect of spent fuel pool suction connection location on the pumps when the pool is at its minimum level.	SPLB
09.1.3-09	OPEN ITEM	The applicant should identify the borated makeup water source for the pool as well as the non-safety-related source of nonborated water used to makeup for evaporation losses.	SPLB
09.1.3-10	OPEN ITEM	The applicant must specify the seismic category and safety class of the purification portion of the system.	SPLB
09.1.4-1	OPEN ITEM	The applicant should commit to satisfying the PWR requirements contained in Section 5 of NUREG-0612.	SPLB
09.2.02-1	OPEN ITEM	The dual isolation valves between the essential and non-essential portions of the component cooling water system should be added to CESSAR Section 9.2.2.2.2.5.	SPLB
09.2.08-1	OPEN ITEM	The turbine building cooling water system description in CESSAR Section 9.2.8.2 does not agree totally with Figure 9.2.8-1.	SPLB
09.2.09.1-1	OPEN ITEM	The essential chill water system design does not appear to consider potential water hammer concerns.	SPLB
09.2.09.1-2	OPEN ITEM	The applicant should clearly state which portions of the essential chilled water system are safety related.	SPLB
09.2.09.1-3	OPEN ITEM	The flow diagram in CESSAR Figure 9.2.9-1 is not sufficient to show how backflow through the secured normal chilled water system pump will be prevented.	SPLB
09.2.10-1	OPEN ITEM	The applicant should provide more information regarding turbine building service water system parameters.	SPLB
09.3.1-1	OPEN ITEM	Any portion of the compressed air system designated seismic Category II should be clearly identified by the applicant.	SPLB
09.3.1-2	OPEN ITEM	The MSIV air reservoir should be shown on the main steam supply sytem diagrams or the instrument air diagrams.	SPLB
09.3.1-3	OPEN ITEM	The applicant must provide a revised copy of CESSAR Figure 9.3.1-1 to indicate safety-related portions of the compressed air system.	SPLB
09.3.1-4	OPEN ITEM	The applicant must provide revised figures for the breathing air and station air systems to include the portions of the systems that include the containment penetrations.	SPLB
09.4.1-1	OPEN ITEM	The applicant must clearly state that the ESF grade filter train will include the minimum instrumentation requirements listed in SRP Table 6.5.1-1.	SPLB
09.4.1-2	OPEN ITEM	The applicant has not provided information on the carbon adsorber efficiency for radioiodine removal.	SPLB
09.4.2-1	OPEN ITEM	The applicant's single bypass damper for the filtration system does not meet the single failure criteria necessary for preventing inadvertent release of radioactivity.	SPLB
09.4.2-2	OPEN ITEM	The applicant must justify having the fuel building ventilation system located inside a non-seismic building.	SPLB
09.4.3-1	OPEN ITEM	Yhe radwaste building ventilation system must conform with RG 1.140 in order to comply with GDC 60.	SPLB
09.4.3-2	OPEN ITEM	The radwaste building ventilation system components design parameters and flow diagram are required for staff review.	SPLB
09.4.4-1	OPEN ITEM	The diesel building ventilation system components design parameters and flow diagram, and piping and instrumentation diagram are needed for staff review.	SPLB
09.4.4-2	OPEN ITEM	The applicant must specify the elevations above ground level of the intake vents for the diesel building ventilation system.	SPLB
09.4.5-1	OPEN ITEM	CESSAR Table 3.2-1 needs to identify the system, system components and their locations regarding safety classification, seismic category and quality assurance designations.	SPLB
09.4.5-2	OPEN ITEM	The staff requires more information regarding the intake air vent of the subsphere building ventilation system.	SPLB
09.4.7-1	OPEN ITEM	The staff requires more information regarding the turbine building ventilation system.	SPLB
09.4.9-1	OPEN ITEM	The staff requires more information to review the nuclear annex ventilation system's intake vent.	SPLB
09.5.1.1-1	OPEN ITEM	The applicant must identify any deviations from the National Fire Protection Association codes and standards and describe measures taken to ensure equivalent protection.	SPLB
09.5.1.2.1-1	OPEN ITEM	The staff does not accept the concept of radiant heat shields and 6.1 m (20 ft) separation. Each such deviation inside containment must be fully justified.	SPLB
09.5.1.2.1-2	OPEN ITEM	The applicant must clearly state how the redundant shutdown trains are separated in the System 80+ design.	SPLB
09.5.1.2.2-1	OPEN ITEM	The applicant has presented insufficient material regarding passive fire protection features.	SPLB
09.5.1.2.2-2	OPEN ITEM	The applicant should provide more information regarding the HVAC system that is to be used for smoke removal.	SPLB
09.5.1.3.1-1	OPEN ITEM	The applicant must verify the staff's assumptions regarding the design and installation of fire detection capability.	SPLB
09.5.1.3.2-1	OPEN ITEM	The applicant does not adequately discuss the fire-protection water-supply system in the fire hazards analysis.	SPLB
09.5.1.3.3-1	OPEN ITEM	Details concerning pressure reducing orifices, exterior hydrants and hose houses, and electrical supervision of control and section-lizing valves need to be discussed.	SPLB

NUMBER	TYPE	TITLE	BRANCH
09.5.1.3.3-2	OPEN ITEM	The applicant must show that redundant safe shutdown equipment is adequately protected from fire and the water used to fight the fire.	SPLB
09.5.1.4.1-1	OPEN ITEM	The staff requires more information to review the emergency communications and lighting system.	SPLB
09.5.1.4.2-1	OPEN ITEM	The Fire Hazards Assessment does not discuss emergency breathing air.	SPLB
09.5.1.4.3-1	OPEN ITEM	The staff requires more information to review the curbs and drains discussed in the Fire Hazards Assessment.	SPLB
09.5.1.4.7-1	OPEN ITEM	The staff cannot determine whether or not adequate protection has been provided for safe shutdown equipment.	SPLB
09.5.1.6-1	OPEN ITEM	Several fire areas designated Category 2 by the applicant have no automatic fire suppression provided.	SPLB
09.5.1.6-2	OPEN ITEM	Some Category 2 fire areas state that automatic fire suppression is to be determined.	SPLB
09.5.1.6-3	OPEN ITEM	The applicant must provide justification for using an engineering analysis vice laboratory testing for qualifying structural members, doors, dampers, and penetration seals.	SPLB
09.5.1.6-4	OPEN ITEM	Some Category 2 fire areas state that an engineering analysis will be provided to verify automatic fire suppression is not needed.	SPLB
09.5.1.6-5	OPEN ITEM	The applicant must confirm that no penetrations exist in the 3-hour rated barriers separating safe shutdown equipment.	SPLB
10.3-1	OPEN ITEM	CESSAR Section 10 should be modified to reference the main steam valve house (MSVH) and clearly identify the equipment in the MSVHs.	SPLB
10.3-2	OPEN ITEM	The applicant must clearly identify the need to have the COL applicant provide a steam hammer dynamics program.	SPLB
10.4.1-1	OPEN ITEM	The applicant has not provided a systems drawings and component design parameters table in CESSAR Section 10.4.1.	SPLB
10.4.2-1	OPEN ITEM	CESSAR Section 10.4.2 does not provide sufficient details to conclude the staff's review of the main condenser evacuation system.	SPLB
10.4.2-2	OPEN ITEM	The vacuum pump discharge path and the monitoring capabilities associated with the path are not identified.	SPLB
10.4.2-3	OPEN ITEM	The applicant has not demonstrated conformance to RGs and standards as noted in DSER Section 10.4.2.	SPLB
10.4.3-1	OPEN ITEM	CESSAR Section 10.4.3 does not contain sufficient details to conclude the staff's review of the turbine gland sealing system.	SPLB
10.4.3-2	OPEN ITEM	The applicant has not demonstrated conformance to RGs and standards as noted in DSER Section 10.4.3.	SPLB
10.4.4-1	OPEN ITEM	The SRP states that the turbine bypass system preoperational and startup tests should conform with the recommendations of RG 1.68.	SPLB
10.4.5-1	OPEN ITEM	The staff cannot conclude that the circulating water system design meets GDC 4 requirements with respect to the effects of discharging water resulting from a system failure.	SPLB
10.4.5-2	OPEN ITEM	The normal inlet and outlet temperature and the flow capacity of the circulating water pumps is needed for the staff's review.	SPLB
10.4.7-1	OPEN ITEM	The condensate and feedwater system piping and instrument diagrams should clearly indicate where class changes occur.	SPLB
10.4.7-2	OPEN ITEM	Compliance with GDC 46 is an open item pending availability of the information regarding functional testing of the condensate and feedwater systems.	SPLB
10.4.9-2	OPEN ITEM	The 48 hour endurance test recommended in NUREG-0611 was not discussed in CESSAR Chapter 10.	SPLB
11.1-1	OPEN ITEM	CESSAR Section 11.1 requires more information to enable the staff to evaluate the radioactive waste system.	SPLB
11.1-2	OPEN ITEM	SRP Sections 11.2 and 11.3 state that the radwaste system should have the capability to process wastes based on 1 percent failed fuel.	SPLB
11.2-1	OPEN ITEM	The liquid waste management system must consider operator error. Also, the DFs for the shim bleed stream used for concentration determination may not be conservative.	SPLB
11.2-2	OPEN ITEM	The applicant must revise CESSAR Section 11.2 tables and demonstrate that normal releases to unrestricted areas will be within 10 CFR 20, Appendix B acceptable concentrations.	SPLB
11.2-3	OPEN ITEM	All aspects of RG 1.143 must be addressed by the applicant.	SPLB
11.2-4	OPEN ITEM	The disposition of the discharge flow for the shim bleed and clean waste streams must be made clear.	SPLB
11.3-1	OPEN ITEM	The applicant must explain its basis for the 1 scfm flow rate of carrier gas through the delay bed.	SPLB
11.3-2	OPEN ITEM	The applicant must show how charcoal delay beds comply with RG 1.143 Positions C.2.1.3, C.5.1.1, C.5.1.2 and C.5.1.3, and how the GWMS meets RG 1.143 Position C.6.	SPLB
11.3-3	OPEN ITEM	The applicant must provide additional information to show that the GWMS design meets GDC 3.	SPLB
11.3-4	OPEN ITEM	The four values identified by the staff in DSER Section 11.3 must be corrected.	SPLB
11.3-5	OPEN ITEM	The source term used in the charcoal delay bed system design should correspond to 1 percent failed fuel.	SPLB
11.4-1	OPEN ITEM	The applicant should provide information to show that the solid waste management system complies with RG 1.143.	SPLB
11.4-2	OPEN ITEM	The applicant should provide an explanation of how the values in CESSAR Table 11.4-2 were determined. Also the applicant should show the curie content of the waste.	SPLB
11.5-1	OPEN ITEM	CESSAR Section 11.5 should be revised to include all gaseous and liquid process streams or effluent release points that will be monitored and sampled.	SPLB
11.5-2	OPEN ITEM	Generic monitor locations should be presented in tabular form for gaseous and liquid process and effluent monitors.	SPLB
20.2-25	OPEN ITEM	The applicant should conduct tests or analyses to show that containment purge or vent valves would shut without degrading containment integrity during a LOCA.	SPLB
20.2-26	OPEN ITEM	The applicant should conduct analyses to show that containment valve operability is assured against ascending differential pressure and dynamic loading resulting from a LOCA.	SPLB

NUMBER	TYPE	TITLE	BRANCH
✓ 20.4-1	OPEN ITEM	The staff will address the applicability of Bulletins 80-03, 80-10 and 80-24, and Generic Letter 81-38 in the FSER.	CPLB

Revised

SPLB

Confirmatory Item 9.1.3-2:

The applicant will include its response to RAI Q410.67 providing an failure modes and effects analysis (FMEA) on the spent fuel pool cooling system (SFPCS) in a future Amendment to the CESSAR (as Table 9.1-3). The applicant should incorporate paragraph 3 of its response into CESSAR Section 9.1.3.3.1 to show the effect of this analysis.

Response to Confirmatory Item 9.1.3-2:

Per response to RAI Q410.67, a failure modes and effects analysis (FMEA) was developed for the spent fuel pool cooling system. This FMEA (as shown in the attachment) will be included in the next Amendment to CESSAR-DC as Table 9.1-3.

Per response to Confirmatory Item 9.1.3-8, the rewording of CESSAR-DC Section 9.1.3.3.1 from RAI Q410.68 response will be added to the next Amendment to CESSAR-DC. The revised section contains the following sentence: "Suitable redundancy is provided to ensure that this function can be achieved assuming a single failure of a component coincident with the loss of either onsite or offsite power." This provides the same information as stated in paragraph 3 of response to RAI Q410.67.

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
1	Spent Fuel Pool Cooling Heat Exchangers Heat Exchanger 1 Heat Exchanger 2	a. Plugged tubes	Corrosion or boron buildup, foreign objects in PCPS.	Reduced flow in one system. Gradual increase in temp in pool.	High pool temp alarm (T-420) in control room at 180 °F. Local temp indication (T-404/406 and T-405/407). Local flow indication (F-400/401).	Failed heat exchanger can be isolated by valve PC-212/211. Redundant heat exchanger is available through cross connection (valves PC-201 and PC-293). Redundant train is provided.	Complete plugging of all tubes is unlikely. Reduced flow would be detected long before complete plugging occurs.
		b. Insufficient heat transfer	Corrosion or boron buildup on tubes.	Reduced heat removal in one system. Gradual increase in temp in pool.	High pool temp alarm (T-420) in control room at 180 °F. Local temp indication (T-405/407).	Heat exchanger can be isolated by valve PC-212/211. Redundant heat exchanger is available through cross connection (valves PC-201 and PC-293). Redundant train is provided.	
		c. CCWS leakage	Casing crack, welding failure, manufacturing defect.	Reduced heat removal in one system. Gradual increase in temp in pool.	High pool temp alarm (T-420) in control room at 180 °F. Local temp indication (T-405/407).	Failed heat exchanger can be isolated by valve PC-212/211. Redundant heat exchanger is available through cross connection (valves PC-201 and PC-293). Redundant train is provided.	

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
		d. Cross leakage	Tube corrosion, vibration wear, manufacturing defect.	Contamination of component cooling water system. Increase in pool temp. Decrease in pool water level.	High water level alarm in CCWS surge tanks. Fuel pool low level alarm (L-420) in control room. High pool temp alarm (T-420) in control room at 180 °F. Local temp indication (T-405/407). Local flow indication (F-400/401).	Failed heat exchanger can be isolated by valve PC-212/211. Redundant heat exchanger is available through cross connection (valves PC-201 and PC-293). Redundant train is provided.	Water level in fuel pool can be returned to normal with manual makeup flow with borated water from the CVCS.
2	Spent Fuel Pool Cooling Pumps Pump 1 Pump 2	a. Fails to start	Electrical malfunction, mechanical failure or binding, loss of power.	Fuel pool temp will gradually increase.	Motor status in control room. High pool temp alarm (T-420) in control room at 180 °F. Low discharge pressure alarm (P-403/404) in control room. Local pressure indication (P-401/402). Local flow indication (F-400/401). Local temp indication (T-404/406 and T-405/407).	Redundant train is provided for continued flow for heat removal. Stand-by pump is started manually.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads.

Table 9.1-3 (Sheet 3 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
		b. Stops	Electrical malfunction, mechanical seizure, loss of power.	Loss of flow. Fuel pool temp will gradually increase.	Motor status in control room. High pool temp alarm (T-420) in control room at 180 °F. Low discharge pressure alarm (P-403/404) in control room. Local pressure indication (P-401/402). Local flow indication (F-400/401). Local temp indication (T-404/406 and T-405/407).	Redundant train is provided for continued flow for heat removal. Stand-by pump is started manually.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads.

Table 9.1-3 (Sheet 4 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
		c. Fails deliver rated flow	Excess seal leakage, mechanical malfunction.	Reduced flow. Fuel pool temp will gradually increase.	Motor status in control room. High pool temp alarm (T-420) in control room at 180 °F. Low discharge pressure alarm (P-403/404) in control room. Local pressure indication (P-401/402). Local flow indication (F-400/401). Local temp indication (T-404/406 and T-405/407).	Redundant train is provided for continued flow for heat removal. Stand-by pump is started manually.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads.
		d. Spurious startup	Electrical malfunction, spurious signal.	Pool cooling will start.	Motor status in control room. Local flow indication (F-400/401). Local pressure indication (P-401/402). Local temp indication (T-404/406 and T-405/407).	No compensation needed.	Pumps are normally started manually.

Table 9.1-3 (Sheet 5 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
3	Pump Suction Valves PC-202 PC-203	a. Fails closed	Human error, mechanical failure	Loss of flow in one train. Gradual increase in temp in pool.	High pool temp alarm (T-420) in control room at 180 °F. Low discharge pressure alarm (P-403/404) in control room. Local pressure indication (P-401/402). Local flow indication (F-400/401). Local temp indication (T-404/406 and T-405/407).	Redundant train is provided for continued flow for heat removal.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads. Valves are normally open.
		b. Fails open	Mechanical failure or binding	Isolation of cooling pump impossible.	Periodic check.	None.	Valves are normally open.
4	Pump Discharge Valves PC-206 PC-207 PC-208 PC-209	a. Fails closed	Human error, mechanical failure	Loss of flow in one train. Gradual increase in temp on pool.	High pool temp alarm (T-420) in control room at 180 °F. Low discharge pressure alarm (P-403/404). Local pressure indication (P-401/402). Local flow indication (F-400/401). Local temp indication (T-404/406 and T-405/407).	Redundant train is provided for continued flow for continued heat removal.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads. Valves are normally open.

Table 9.1-3 (Sheet 6 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
		b. Fails open	Mechanical failure or binding	Isolation of cooling pumps impossible if both valves in one train fail open.	Periodic check.	If both valves fail open, the heat exchanger inlet valves (PC-211/212) can be used to isolate pumps.	Valves are normally open.
5	Pressure Indicator Valve PC-204 PC-205	a. Fails closed	Human error, mechanical failure	Loss of local pressure indication (P-401/402).	Periodic check.	Low/high pressure alarm (P-403/404) in control room.	Valves are normally open.
		b. Fails open	Mechanical failure or binding	Isolation of pressure indicator impossible.	Periodic check.	Pump suction valves (PC-202/203) and pump discharge valves (PC-208/209) can be used to isolate pressure indicator.	Valves are normally open.
6	Pressure Switch Valve PC-200 PC-210	a. Fails closed	Human error, mechanical failure	Loss of low/high discharge pressure alarm (P-403/404) in control room.	Periodic check. Low discharge pressure alarm (P-403/404) in control room.	Local pressure indication (P-401/402).	Valves are normally open.
		b. Fails open	Mechanical failure or binding	Isolation of pressure switch impossible.	Periodic check.	Pump discharge valves (PC-208/209) and heat exchanger inlet valves (PC-211/212) can be used to isolate pressure switch.	Valves are normally open.

Table 9.1-3 (Sheet 7 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
7	Heat Exchanger Inlet Valves PC-211 PC-212	a. Fails closed	Human error, mechanical failure	Loss of one heat exchanger. Gradual temp increase in pool.	High pool temp alarm (T-420) in control room at 180 °F. High discharge pressure alarm (P-403/404) in control room. Local pressure indication (P-401/402). Local flow indication (F-400/401). Local temp indication (T-405/407).	Redundant heat exchanger is available through cross connection (valves PC-201 and PC-293). Redundant train is provided.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads. Valves are normally open.
		b. Fails open	Mechanical failure or binding	Isolation of heat exchanger impossible.	Periodic check.	Pump discharge valves (PC-208/209) can be used to isolate the heat exchanger.	Valves are normally open.
8	Heat Exchanger Outlet Valves PC-213 PC-214	a. Fails closed	Human error, mechanical failure	Loss of flow in one train. Gradual increase in temp in pool.	High pool temp alarm (T-420) in control room at 180 °F. High discharge pressure alarm (P-403/404) in control room. Local pressure indication (P-401/402). Local flow indication (F-400/401). Local temp indication (T-405/407).	Redundant heat exchanger is available through cross connection (valves PC-201 and PC-293). Redundant train is provided.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads. Valves are normally open.

Table 9.1-3 (Sheet 8 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
		b. Fails open	Mechanical failure or binding	Isolation of heat exchanger impossible.	Periodic check.	None.	Valves are normally open.
9	Cross Connection Valves PC-201 PC-293	a. Fails closed	Human error, mechanical failure or binding	Switching from one heat exchanger to the other one impossible.	Periodic check	Pool cooling is available through either train.	Valves are normally closed.
		b. Fails open	Human error, mechanical failure	None, flow will be through both heat exchangers.	Periodic check. Local flow indication (F-400 and F-401).	Cooling is available.	Valves are normally closed.
10	Flow Indicator Inlet Valves PC-301 PC-303	a. Fails closed	Human error, mechanical failure	Loss of local flow indicator (F-400/401).	Periodic check.	Local flow indication (F-400/401) possible by using the other redundant train. Redundant heat exchanger and flow indicator available through cross connection (valves PC-201 and PC-293).	Valves are normally open.
		b. Fails open	Mechanical failure or binding	Isolation of local flow indicator (F-400/401) impossible.	Periodic check.	Heat exchanger discharge valve (PC-214/213) can be used to isolate flow indicator.	Valves are normally open.

Table 9.1-3 (Sheet 9 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
11	Flow Indicator Outlet Valves PC-300 PC-302	a. Fails closed	Human error, mechanical failure	Loss of local flow indicator (F-400/401).	Periodic check.	Local flow indication (F-400/401) possible by using the other redundant train. Redundant heat exchanger and flow indicator available through cross connection (valves PC-201 and PC-293).	Valves are normally open.
		b. Fails open	Mechanical failure or binding	Isolation of local flow indicator (F-400/401) impossible.	Periodic check.	None.	Valves are normally open.
12	Pool Cooling Piping Suction Line Inlet	Inlet covered	Foreign objects in spent fuel pool.	Loss of one cooling train. Gradual increase in temp in pool.	High pool temp alarm (T-420) at 180 °F. Low discharge pressure alarm (P-403/404) in control room. Local flow indication (F-400 or F-401). Local pressure indication (P-401/402). Local temp indication (T-404/406 and T-405/407).	Redundant train is provided for continued heat removal.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads.

Table 9.1-3 (Sheet 10 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
13	Pool Cooling Piping Pump Suction Line	Break	Accident	Loss of flow in one train. Loss of coolant. Pool drained to level of suction line inlet. Temp in pool rises.	High pool temp alarm (T-420) in control room at 180 °F. Fuel pool low level alarm (L-420) in control room. Low discharge pressure alarm in control room (P-403/404). Local pressure indication (P-401/402). Local flow indication (F-400/401). Local temp indication (T-404/406 and T-405/407).	Redundant train is provided for continued heat removal. If pool drains to level of pump suction inlet, sufficient water remains to allow time to line up make up to preclude reaching the minimum shielding depth.	

Table 9.1-3 (Sheet 11 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
14	Pool Cooling Piping Pump Discharge Line	Break	Accident	Loss of flow in one train. Loss of coolant. Gradual increse in temp in pool.	High pool temp alarm (T-420) in control room at 180 °F. Fuel pool low level alarm (L-420) in control room. Local flow indication (F-400/401). Local temp indication (T-405/407). Eventually low discharge alarm (P-403/404) in control room. Eventually local pressure indication (P-401/402). Eventually local temp indication (T-404/406).	Broken pipe is isolated with valves PC-202/203 and PC-214/213. Redundant train is provided for continued heat removal. If pool drains to level of pump suction inlet, sufficient water remains to allow time to line up make up to preclude reaching the minimum shielding depth.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads. Water level in fuel pool can be returned to normal with manual make up flow with borated water from the CVCS.

Table 9.1-3 (Sheet 12 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
15	Pool Cooling Piping Cross Connection Line	Break	Accident	Loss of flow in one train. Loss of coolant. Gradual increase in temp in pool.	High pool temp alarm (T-420) in control room at 180 °F. Fuel pool low level alarm (L-420) in control room. Local flow indication (F-400/401). Local temp indication (T-405/407).	Broken pipe is isolated with valves PC-208/209 and PC-212/211. Redundant train is provided for continued heat removal. If pool drains to level of pump suction inlet, sufficient water remains to allow time to line up make up to preclude reaching the minimum shielding depth.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads. Water level in fuel pool can be returned to normal with manual make up flow with borated water from the CVCS.
16	Pool Cooling Piping Return Line	Break	Accident	Loss of flow in one train. Loss of coolant. Gradual increase in temp in pool.	High pool temp alarm (T-420) in control room at 180 °F. Fuel pool low level alarm (L-420) in control room. Eventually local flow indication (F-400/F401).	Broken pipe is isolated with valves PC-212/211 or PC-214/213. Redundant train is provided for continued heat removal. If pool drains to level of pump suction inlet, sufficient water remains to allow time to line up make up to preclude reaching the minimum shielding depth.	Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads. Water level in fuel pool can be returned to normal with manual make up flow with borated water from the CVCS.

Table 9.1-3 (Sheet 13 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
17	Pool Cooling Piping Discharge Line Sparger	Plugged nozzels	Corrosion buildup, boron buildup, foreign objects in PCPS.	Reduced flow in one train. Gradual increase in temp in pool.	High pool temp alarm (T-420) in control room at 180 °F. Local temp indication (T-404/406). Local flow indication (F-400/401).	Redundant train is provided for continued heat removal.	Complete plugging of all nozzles is unlikely. Reduced flow would be detected long before complete plugging occurs.
18	Pump Discharge Pressure Indicator P-401 P-402	a. False low pressure indication	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident low discharge pressure alarm (P-403/404) with low pressure gauge indication from P-401/402. Periodic test.	Low discharge pressure alarm (P-403/404). Redundant train is provided.	
		b. False high pressure indication	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident high discharge pressure alarm (P-403/404) with high pressure gauge indication from P-401/402. Periodic test.	High discharge pressure alarm (P-403/404). Redundant train is provided.	

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
19	Pump Discharge Pressure Switch P-403 P-404	a. False low pressure alarm	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident local low pressure gauge indication (P-401/402) with low pressure alarm from P-403/404. Periodic test.	Local pressure indication (P-401/402). Redundant train is provided.	No direct impact on system even if the operator closes one train and switches to the redundant train. Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads.
		b. False high pressure alarm	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident local high pressure gauge indication (P-401/402) with high pressure alarm from P-403/404. Periodic test.	Local pressure indication (P-401/402). Redundant train is provided.	No direct impact on system even if the operator closes one train and switches to the redundant train. Single train is sufficient to remain fuel pool temp at 180 °F for abnormal loads and 140 °F for normal loads.

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
20	Heat Exchanger Inlet Temperature Indicator T-404 T-406	a. False low temp indication	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident local low temp indication (T-405/407) or low pool temp alarm (T-420) with low temp gauge indication (T-404/406). Periodic test.	Redundant train is provided.	
		b. False high temp indication	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident local high temp indication (T-405/407) or high pool temp alarm (T-420) with high temp gauge indication (T-404/406). Periodic test.	Redundant train is provided.	A high heat exchanger inlet temp makes increased cooling necessary. A false high temp indication results in lower temp than necessary in pool.
21	Heat Exchanger Outlet Temperature Indicator T-405 T-407	a. False low temp indication	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident low pool temp alarm (T-420) with low temp gauge indication (T-405/407). Periodic test.	Spent fuel pool temp alarm (T-420). Redundant train is provided.	
		b. False high temp indication	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident high pool temp alarm (T-420) with high temp gauge indication (T-405/407). Periodic test.	Spent fuel pool temp alarm (T-420). Redundant train is provided.	A high heat exchanger outlet temp makes increased cooling necessary. A false high temp indication results in lower temp than necessary in pool.

Table 9.1-3 (Sheet 16 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
22	Heat Exchanger Outlet Flow Indicator F-400 F-401	a. False low flow indication	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident high pool temp alarm (T-420) with low flow gauge indication (F-400/401). Periodic test.	Redundant train is provided.	
		b. False high flow indication	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident low pool temp alarm (T-420) with high flow gauge indication (F-400/410). Periodic test.	Redundant train is provided.	
23	Spent Fuel Pool Temperature Indicator T-420	a. False low temp alarm	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident local low temp gauge indication (T-404/406) with low temp alarm (T-420) when pump is running. Periodic test.	Local temp indication (T-404/406) when pump is running.	
		b. False high temp alarm	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident local high temp gauge indication (T-404/406) with high temp alarm (T-420) when pump is running. Periodic test.	Local temp indication (T-404/406) when pump is running.	Low pool temp is desired.

Table 9.1-3 (Sheet 17 of 17)

Failure Mode and Effects Analysis of the Spent Fuel Pool Cooling System

No.	Name/number	Failure Mode	Cause	Effects on System	Method of Detection	Inherent Compensating Provision	Remarks
24	Spent Fuel Pool Level Switch L-420	a. False low level alarm	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident high temp alarm (T-420) in control room or local low flow indication (F-400/401) with low level alarm (L-420). Periodic test.	None.	No risk of overfilling of pool since make up is manually provided.
		b. False high level alarm	Electrical or mechanical malfunction. Setpoint drift.	No direct impact on system operation.	No coincident indication of loss of water from CCWS and CVCS with high level alarm (L-420). Periodic test.	None.	No risk of uncovering the spent fuel since the suction line inlet is situated near the normal water level.

SPLB

Open Item 5.2.5-1

The applicant states that the maximum allowable total identified leakage will be given in the TS. RG 1.45 states that both identified and unidentified leakage should be given.

ABB-CE Response

Section 16.7.12 and 16.7.14 of the CESSAR-DC, chapter 16 - Technical Specifications, provide the information required by Position C.9 of RG 1.45. Section 16.7.12 specifies limits of 1 gpm of unidentified leakage and 10 gpm of identified leakage. Section 16.7.14 specifies operability requirements for the RCS leakage detection instrumentation. Therefore, CESSAR-DC Section 5.2.5.3 will be revised in a future amendment as follows:

5.2.5.3 **Leakage Requirements**

The maximum allowable identified and unidentified leakage and the instrument availability to detect leakage is stated in the Technical Specifications, Chapter 16.

SPLB

Open Item 3.11.3.2.1-1

In CESSAR Section 3.11.2, the applicant is using an alternate test profile which allows for the substitution of testing twice at the specified service conditions as a substitute for testing once at a profile that includes margins. This approach is nonconservative; not consistent with IEEE 323-1974, NUREG-0588, or RG 1.89; and does not meet the intent of nor is it in compliance with 10 CFR 50.49. Therefore, this is an open item. To date the NRC staff has not endorsed IEEE 323-1983.

Response:

CESSAR Section 3.11.2 will be revised to reflect testing once at a profile that includes margins to be consistent with IEEE 323-1974 and to meet the intent of and to comply with 10 CFR 50.49.

SPLB

Open Item 3.11.3.2.1-2

To date the NRC staff has not endorsed IEEE 323-1983; consequently, references to this standard in its entirety, or in part, are not acceptable. Therefore, in CESSAR Section 3.11.2.1 where IEEE 323-1983 is referenced in regard to the definition of a mild environment, the staff considers this an open item (Open Item 3.11.3.2.1-2). An acceptable definition for a mild environment can be found in 10 CFR 50.49, paragraph (c).

Response:

CESSAR-DC Section 3.11.2.1 will be revised to use the definition of the mild environment in 10 CFR 50.49, and to remove reference to IEEE Std. 323-1983.

SPLB

Open Item 3.11.3.2.1-3

With the expected significant increase in the quantity and variety of electronic components in newer generation plants, the staff has increasing concerns about the efforts being made and the ability of these components to be environmentally qualified. The applicant should address the staff concerns relative to their position on the environmental qualification of electronic components.

Response:

For harsh environment, it is anticipated that equipment which has previously been qualified in accordance with the requirements of IEEE Std. 323, 1974, Regulatory Guide 1.89 Rev. 01, June 1984, IEEE Std. 344, 1975 and Regulatory Guide 1.100 Rev. C1, August 1977 will be utilized. Harsh environments are defined as environments that will experience significant changes in environmental parameters due to a postulated DBE (e.g., inside containment, radiation $\geq 10^4$ Rads TID). It is expected that no new harsh environment equipment will be required for SYS80+ beyond that which has previously been qualified for the parameter envelope of the SYS80 design. If necessary, previously qualified harsh environment equipment will be re-qualified by previous methods to plant-specific parameter envelope for situations where the plant envelope is not bounded by the previous qualification envelope. For seismic qualification, however, this equipment will be re-qualified, if necessary, to meet the requirements of IEE Std. 344 1987 and Regulatory Guide 1.100 Rev. 02, June 1988.

SPLB

Open Item 3.11.3.2.1-4

The staff does not agree that topical report CENPD-255-A Rev. 3 should be extended to include other equipment suppliers.

Response:

ABB-CE will change CESSAR-DC, Section 3.11.2 to read:

Qualification of electrical equipment of System 80+ will comply with 10CFR50.49 as described below:

(1) environmental qualification of electrical equipment located in harsh environments within Combustion Engineering's scope of supply will be in accordance with the methodologies outlined in CENPD-255-A, Rev. 3 (Reference 1);

(2) environmental qualification of electrical equipment located in mild environments within Combustion Engineering's scope of supply will be in accordance with the methodologies outlined in NPX80-IC-QG790-00[1];

(3) environmental qualification of electrical equipment outside of Combustion Engineering's scope of supply will be in accordance with IEEE 323-1974 and Regulatory Guide 1.89, Rev. 1.

Environmental qualification of mechanical equipment will comply with GDC 1 and 4 and Appendix B to 10 CFR 50 (Criteria III, "Design Control," and XVII, "Quality Assurance Records") and will include the following:

(1) identification of safety-related mechanical equipment located in harsh environments, including required operating times;

(2) identification of non-metallic subcomponents of this equipment;

(3) identification of the environmental conditions for which this equipment must be qualified;

(4) identification of non-metallic material capabilities; and

(5) evaluation of environmental effects."

Note.[1] NPX80-IC-QG790-00 has been transmitted to the staff by letter LD-92-115 dated November 24, 1992.

Open Item 9.1.3-1: SPLB

The applicants response to RAI Q410.56 regarding heat generation rate calculations is incomplete. The applicant should show how the spent fuel cooling system meets the assumed conditions given in SRP 9.1.3 Issue III H.iii and III H.iv. The applicant should incorporate the missing material into CESSAR Section 9.1.3.

Response to Open Item 9.1.3-1:

In accordance with SRP Section 9.1.3 Issue III H.iii, for abnormal conditions the spent fuel pool cooling system should have the capacity to remove the decay heat from one full core at equilibrium conditions after 150 hours decay and one refueling load at equilibrium conditions after 36 days decay without spent fuel pool bulk water boiling. Cooling system single failure need not be considered concurrent with this condition.

Since the System 80+ spent fuel pool is designed for a storage capacity greater than 1-1/3 cores, SRP Section 9.1.3 Issue III H.iv is also applicable. This section states that one additional refueling batch at equilibrium conditions, after 400 days decay, should be included in the spent fuel pool cooling requirements.

Based on the above requirements, a total decay heat load was calculated using the decay energy vs. time after shutdown curve provided in Attachment (1). This curve was previously submitted in response to NRC RAI Q410.56. The resultant spent fuel pool decay heat load for this condition is 52.65×10^6 Btu/Hr.

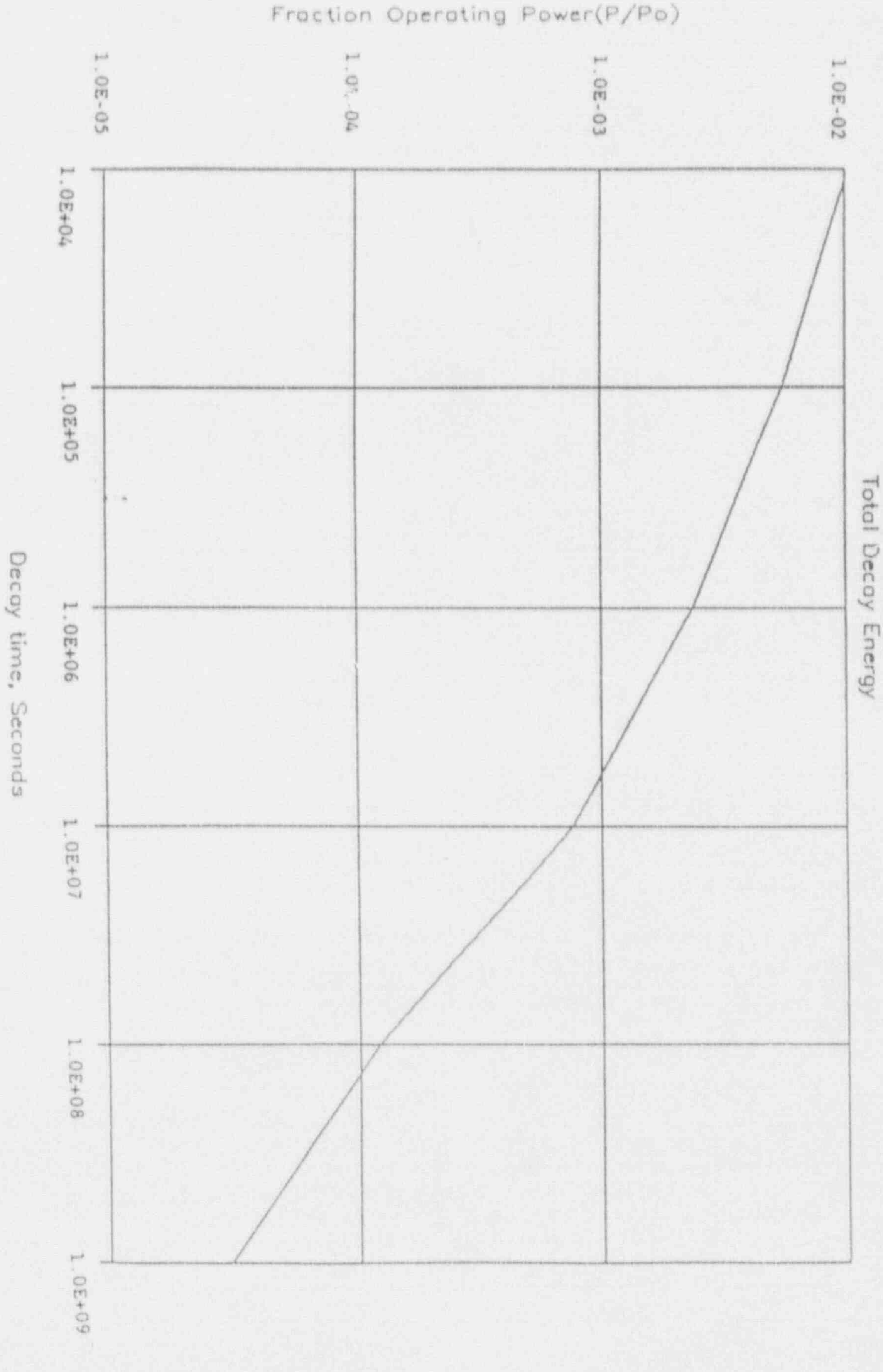
System 80+ CESSAR-DC Section 9.1.3.1.4, "System Capacity Basis", states that the System 80+ pool cooling system is designed to remove decay heat from a full core offload heat load (which is the abnormal heat load). This is equal to the normal spent fuel pool heat load, plus the addition of decay heat from a full core offload 120 hours after shutdown. The normal heat load is the decay heat which occurs when an accumulation of spent fuel equal to 10 full power years is in the spent fuel pool with the newest spent fuel batch having just been placed in the pool during refueling at 120 hours after shutdown. The resultant decay heat load calculated for this condition, using the Attachment (1) curve, is 65.27×10^6 Btu/Hr.

Section 9.1.3.1.4 also states that for the above abnormal spent fuel loading condition concurrent with normal plant operation (which is both cooling trains operating, (no single failure)) the spent fuel pool maximum bulk water temperature is 140°F.

Based on the above information, the System 80+ design meets the criteria in SRP 9.1.3 since the System 80+ cooling system is designed to remove a spent fuel pool heat load of 65.27 x 10^6 Btu/Hr, which is greater than the 52.65 x 10^6 Btu/Hr required by SRP 9.1.3. Also the System 80+ design must keep the spent fuel pool bulk water temperature $\leq$ 140°F, where in SRP 9.1.3 the pool must not bulk boil.

Per response to Open Item 9.1.3-2, the heat loads for normal and abnormal conditions stated in CESSAR-DC Section 9.1.3.1.4 have been added to this section.

Attachment (1) to
Open Item 9.1.3-1



SPLB

Open Item 9.1.3-2:

The applicant's response to RAI Q410.55(a) is inadequate. Although detailed final design information may not be available, the applicant should include in CESSAR Section 9.1.3, as a minimum, the heat removal rates required to meet the design-bases criteria for normal and abnormal conditions and the design heat removal rates for these conditions.

Response to Open Item 9.1.3-2:

The following spent fuel pool decay heat loads were determined for normal and abnormal conditions in accordance with CESSAR-DC Section 9.1.3.1.4, System Capacity Bases:

Normal Conditions - 18.60×10^6 Btu/hr
Abnormal Conditions - 65.27×10^6 Btu/hr

The above decay heat loads will be included in the second half of the first paragraph in CESSAR-DC Section 9.1.3.1.4 in the next amendment as follows:

"The normal heat load is the decay heat which occurs when an accumulation of spent fuel equal to 10 full power years is in the spent fuel pool, with the newest spent fuel batch having just been placed in the pool during refueling at 120 hours after shutdown. The resultant heat load for this condition is 18.60×10^6 Btu/hr. The full core offload heat load is equal to the normal heat load plus the addition of the decay heat from a full core offload 120 hours after shutdown. The resultant heat load for this condition is 65.27×10^6 Btu/hr. The heat load from any other combination of spent fuel within the pool will result in heat loads lower than 65.27×10^6 Btu/hr."

Each spent fuel pool heat exchanger will be sized to remove a minimum of 32.63×10^6 Btu/hr with a tube inlet temperature of 140°F. This is the worse cas scenario where both PCPS cooling trains must maintain the spent fuel pool water temperature at $\leq$ 140°F during abnormal heat load conditions.

SPLB

NRC Open Item 9.1.3-5

The applicant must provide information regarding the effect of equipment wetting on system operability.

Response to NRC Open Item 9.1.3-5

The Pool Cooling and Purification System (PCPS) contains both safety grade and non-safety grade equipment. The portion of the system providing pool cooling is designed to Safety Class 3, Seismic Category I criteria, while the portion of the system which provides pool purification is designed as non-nuclear safety and non-seismic.

The pool cooling and pool purification portions of the PCPS are located in the nuclear annex and the reactor building subsphere. The nuclear annex and reactor building subsphere are designed as Seismic Category I structures and are designed to maintain a dry environment during all floods by incorporating the following design features:

A. No exterior access openings will be lower than 1 foot above plant grade elevation

B. The finished yard grade adjacent to the safety-related structures will be maintained at least 1 foot below ground floor elevation.

C. Waterstops are used in all horizontal and vertical construction joints in all exterior walls up to the flood elevation.

D. Water seals are provided for all penetrations in exterior walls up to flood level elevation.

E. Waterproofing of walls subject to flooding is provided.

In addition, for the safety related pool cooling portion of the PCPS, redundant equipment is separated and compartmentalized so that a single flooding event does not affect the redundant heat removal loop. The reactor building subsphere, at the elevation where the pool cooling equipment is located, is physically separated such that a potential flood in one division is prevented from flooding the other division.

The arrangement of the redundant safety related pool cooling trains protects against a loss of pool cooling due to spray resulting from a nearby pipe break. The compartmentalization and separation of the cooling trains by division in the reactor building subsphere ensures that spray affecting one division does not affect the redundant heat removal loop.

Response to Open Item 9.1.3-5 (Continued)

PCPS equipment is qualified for environmental conditions which are expected for that particular components' location. The pool cooling equipment is designed to function during a LOCA or MSLB. These environmental conditions are specified in CESSAR-DC Table 3.11A-1 (Environmental Category D). Pool cooling equipment is designed to function in temperatures ranging from 55 to 104°F, with relative humidity ranging from 20 to 90%, with a limit of 8 hours operation outside the normal humidity range.

The pool purification equipment is non-safety related and design conditions are reflected in CESSAR-DC Table 3.11A-1 (Environmental Category C). The pool purification equipment is designed for normal nuclear annex environmental conditions with temperatures ranging from 55 to 104°F and relative humidity between 20 and 90%.

The environmental conditions stated above represent the minimum conditions to which PCPS equipment is designed. Additional, more restrictive environmental requirements may apply to some equipment.

SPLB

Open Item 9.1.3-6:

The applicant must provide additional information on the system containment isolation valves. This should include isolation time, valve type, inspection and testing requirements and power supplies.

Response to Open Item 9.1.3-6:

Pool Cooling and Purification System (PCPS) containment isolation valves PC-257, PC-258, PC-291 and PC-292 are part of the purification portion of the system and are located in the refueling pool inlet and discharge piping on the inside and outside of the containment. All four valves are Safety Class 2, manually operated gate valves and are normally closed during power operations. The valves are opened in the refueling mode when the pool requires filling and purification. Since the valves are manually operated, there are no isolation time or power supply requirements.

CESSAR-DC Section 9.1.3.4, "Tests and Inspection", states that for PCPS components, periodic visual inspection and preventitive maintenance are conducted using normal industry practice. The Seismic Category I portions will be inspected in accordance with ASME B&PV Code Section XI. The layout of the components of the PCPS is such that periodic testing and inservice inspection of this system are possible.

The valves are listed in Table 3.2-2 of CESSAR-DC Section 3.2, Classification of Structures, Components and Systems. In this Table, the valves location/description, safety class, seismic category and quality class are provided.

In response to this Open Item, the following section describing containment isolation for the PCPS will be added to CESSAR-DC Section 9.1.3.3:

9.1.3.3.4 System Isolation

9.1.3.3.4.1 Containment Isolation

There are two penetrations through the containment structure to accommodate PCPS piping. One penetration allows flow from the purification loop into the refueling pool. The other penetration allows flow from the refueling pool back into the purification loop.

The penetration for the purification loop to the refueling pool consists of a Safety Class 2 manually operated gate valve (PC-291) outside containment and a Safety Class 2 manually operated gate valve (PC-292) inside containment. The penetration for the refueling pool to the purification loop consists of a Safety Class 2 manually operated gate valve (PC-257) inside containment and a Safety Class 2 manually operated gate valve (PC-258) outside contaiment.

The containment isolation valves are normally closed during power operations. The valves are opened in the refueling mode when the refueling pool requires filling and purification.

SPLB

Open Item 9.1.3-7:

The applicant must identify all automatic system functions. Primary functions, such as isolation on low flow in the system or in one train, and high temperature, should be identified.

Response to Open Item 9.1.3-7:

The PCPS provides one automatic function (which is located in the purification portion of the system). Both ion exchangers are automatically bypassed on a high temperature signal to valves PC-400 and PC-401. This provides overtemperature protection for the refueling pool ion exchanger resin, in the event that the temperature of the spent fuel cooling water exceeds the temperature at which the ion removal capability of the resin is adversely affected. This is described in Amendment J of CESSAR-DC Section 9.1.3.2.2.5, Pool Demineralizers. All other valves in the PCPS are manually operated. Both the pool purification pumps and the pool cooling pumps are controlled manually.

Per ABB-CE response to Confirmatory Item 9.1.3-2, a detailed failure modes and effects analysis (FMEA) was developed for the safety-related spent fuel pool cooling system. This FMEA will be included in the next Amendment to CESSAR-DC as Table 9.1-3. This table analyzes potential failure modes that exist within the system, down to faulty instrumentation. When necessary, the table provides on an individual basis what valves need to be isolated in order to compensate certain failure modes. This includes low flow and high temperature situations.

SPLB

NRC Open Item 9.1.3-8

The applicant should provide an analysis of the effect of spent fuel pool suction connection location on the pumps when the pool is at its minimum level.

Response to NRC Open Item 9.1.3-8

The PCPS suction piping is located higher than 14 feet above the stored fuel. All other piping in the spent fuel pool or refueling pool is either located above, or has a siphon breaker hole located above the pool cooling suction piping.

The net positive suction head available (NPSHA) has been calculated for the spent fuel pool cooling pumps and the pool purification pumps. The calculations were based on the minimum pool level as stated above and the maximum pool temperature of 180°F. The maximum pool temperature is based on a single active failure in the cooling train with a full core offload with 10 years of irradiated fuel in the pool, as specified in CESSAR-DC Section 9.1.3.1.4. NPSHA for the pool cooling pumps was calculated to be 26 feet and NPSHA for the pool purification pumps was calculated to be 42 feet based on the above conditions.

SPLB

NRC Open Item 9.1.3-9

The applicant should identify in CESSAR Sections 9.1.3.1.4 and 9.1.3.2.1 the borated makeup water source for the pool, as well as the non-safety-related source of nonborated water used to make up for evaporation losses from the pool during normal operation, discussed in Section 9.1.3.2.1. Also, the applicant should identify the building housing the system, referred to in Section 9.1.3.2.1.

Response to NRC Open Item 9.1.3-9

The borated makeup water source for the spent fuel pool is the boric acid storage tank located in the CVCS. Borated water from the boric acid storage tank is delivered to the pool via a connection to the boric acid makeup pumps. The flow path from the boric acid storage tank to the spent fuel pool is shown in CESSAR-DC Figure 9.3.4-1, Sheet 2 of 4 (Area a-6), and CESSAR-DC Figure 9.1-3 (Area G-2).

The Demineralized Water Makeup System supplies normal, non-safety grade, nonborated water to the spent fuel pool to provide makeup for evaporation losses during normal operation. CESSAR-DC Section 9.2.3 provides information on the Demineralized Water Makeup System and its interfaces with other plant systems.

The pool cooling portion of the PCPS is located in the reactor building subsphere. The two cooling trains are physically separated. The nuclear annex houses the purification portion of the PCPS, with the exception of the piping and valves required within containment which enable the PCPS to purify the refueling pool. Both the nuclear annex and the reactor building subsphere are Seismic Category I structures and provide protection from the effects of natural phenomena and missiles. Refer to general arrangement drawings in CESSAR-DC Section 1.2 for the location of the spent fuel pool and individual PCPS components.

Reactor Systems Branch

NUMBER	TYPE	TITLE	BRANCH
04.2.7-1	COL ITEM	The COL applicant must perform the on-line fuel failure monitoring and post-irradiation surveillance to detect anomalies.	SRXB
06.3.7-1	COL ITEM	The COL applicant will periodically test the safety injection system in accordance with ISI requirements of ASME Section XI.	SRXB
04.2.7-1	CONF ITEM	The applicant should provide the fuel design acceptance criteria as ITAAC to be certified for System 80+ fuel design.	SRXB
04.4.6.3-1	CONF ITEM	The staff will confirm that an ITAAC is developed to include testing and calibration of the inadequate core cooling (ICC) system.	SRXB
06.3.8-1	CONF ITEM	The applicant must commit to a preoperational testing program and an ITAAC program for safety injection.	SRXB
06.7.1-1	CONF ITEM	The staff will confirm that acceptable TS are submitted for the SDS (including the RCGVS and RDS) at all operating modes.	SRXB
06.7.2-1	CONF ITEM	The applicant must provide an evaluation confirming that 1720 kPa (250 psia) criterion precludes a direct containment heating challenge.	SRXB
04.3.2-1	OPEN ITEM	The staff requires that the moderator temperature coefficient (MTC) be non-positive at all operating conditions.	SRXB
04.3.2-2	OPEN ITEM	The applicant must provide justification to show that the calculated neutron fluence complies with 10 CFR 50.61.	SRXB
04.4.4-1	OPEN ITEM	The applicant should provide a description of the software design for the digital core protection calculator and CEA calculator.	SRXB
05.4.3.1-1	OPEN ITEM	The applicant must provide the analysis demonstrating that the plant as designed is capable of achieving cold shutdown per BTP RSB 5-1.	SRXB
05.4.3.1-2	OPEN ITEM	The applicant is required to include a boron mixing test in the ITAAC program to demonstrate a satisfactory boron mixing under natural circulation.	SRXB
05.4.3.2-1	OPEN ITEM	The applicant should state that the valve position indicators for 4 isolation valves inside containment and 2 MOVs outside containment will be provided in the control room.	SRXB
05.4.3.2-2	OPEN ITEM	The applicant is requested to evaluate design and procedure improvements for overpressure protection of the shutdown cooling system.	SRXB
05.4.3.2-3	OPEN ITEM	The applicant must provide technical justifications for the deviations from BTP RSB 5-1.	SRXB
05.4.3.2-4	OPEN ITEM	The staff is reviewing the applicant's report that addresses the staff's concerns on intersystem LOCA issues. The staff will include its evaluation in the FSER.	SRXB
05.4.3.4-1	OPEN ITEM	The applicant is requested to address the durability of the SCS pump for long term operation.	SRXB
05.4.3.5-1	OPEN ITEM	The applicant submitted an interim report on May 15, 1992, addressing shutdown and low-power risk. The staff has not completed its review of this report.	SRXB
05.4.3.5-2	OPEN ITEM	The staff will review the responses to RAIs Q440.140 through Q440.151 in the FSER.	SRXB
06.3.1-1	OPEN ITEM	The applicant is requested to redesign the HPSI pumps so that they offer a wider operating range that would provide increased injection flow at lower RCS pressures.	SRXB
06.3.2-1	OPEN ITEM	The applicant must provide justification and address the intersystem LOCA concerns as stated in SECY 90-016 and RAI Q440.45.	SRXB
06.3.3-1	OPEN ITEM	The applicant should provide the design criteria for the SI minimum recirc. flow and provide pump operating data or test results demonstrating operability at low recirc. flow.	
06.7.1-1	OPEN ITEM	The applicant must submit emergency procedure guidelines on the RCGVS for staff review.	SRXB
06.7.1-2	OPEN ITEM	The applicant should specify the required flow capacity of RCGVS and provide an ITAAC.	SRXB
06.7.2-1	OPEN ITEM	The applicant must justify that the 10 minute delay in tripping the RCPs is conservative when determining the size of the RDS valves.	SRXB
06.7.2-2	OPEN ITEM	The applicant should specify the required flow capacity of RDS and provide an ITAAC.	SRXB
06.7.2-3	OPEN ITEM	The applicant must provide an evaluation showing high availability of RDS when being utilized for severe accident mitigation.	SRXB
06.7.2-4	OPEN ITEM	The applicant must submit emergency procedure guidelines on the RDS for staff review.	SRXB
15.1-1	OPEN ITEM	The applicant should provide a discussion of the doppler reactivity feedback functions, MTCs and control rod worths for the transients and accidents analyzed in the CESSAR.	SRXB
15.1-2	OPEN ITEM	The statistical convolution method has not been approved by the staff. Fuel failure must be assumed for all rods not meeting the 95/95 DNBR limit.	SRXB
15.1-3	OPEN ITEM	The applicant must provide a complete list of designs that deviate from the EPRI URD requirements and provide justification addressing the adequacy of the deviations.	SRXB
15.1-4	OPEN ITEM	The 3 second LOOP delay time may result in a failure to tranfer ECCS loads. Also the real time grid conditions may change over time and not always meet the time delay.	SRXB
15.1-5	OPEN ITEM	The applicant must provide a discussion of each of the transient and accident analyses and justify that they meet GDC 17.	SRXB
15.2.2-1	OPEN ITEM	The staff concludes that the applicant's loss of condenser vacuum analysis is not acceptable.	SRXB
15.3.1-1	OPEN ITEM	The applicant must provide a discussion of the SLB analysis calculational method that determines the peaking factor of 150 and justify the conservatism of this value.	SRXB
15.3.1-2	OPEN ITEM	The applicant must reanalyze the SLB and post-LOCA long term cooling events taking credit of only safety-grade systems.	SRXB
15.3.2-1	OPEN ITEM	If 3-second LOOP delay is not accepted by the staff, the applicant will be required to reanalyze the feedwater line break event assuming a LOOP immediately after turbine trip.	SRXB
15.3.5-1	OPEN ITEM	The applicant must justify that the valves in the letdown, instrumentation and sample lines are qualified to be isolated upon demand during letdown line break conditions.	SRXB
15.3.6-1	OPEN ITEM	The applicant must perform a sensitivity study and demonstrate that large break LOCAs with the maximum SI flow is the limiting case for System 80+.	SRXB
15.3.8-1	OPEN ITEM	The applicant should evaluate the potential benefit of mitigation features for potential containment bypass due to a steam generator tube rupture event.	SRXB

NUMBER	TYPE	TITLE	BRANCH
15.3.8-2	OPEN ITEM	The applicant must provide a technical basis for steam generator overfilling prevention during a steam generator tube rupture.	SRXB
20.1-05	OPEN ITEM	Issue A-26 will be addressed in the FSER.	SRXB
20.2-07	OPEN ITEM	The applicant should provide adequate test data to demonstrate the KSB seal integrity or provide a diverse seal injection system.	SRXB
20.2-12	OPEN ITEM	The applicant must revise the TS for LTOP by reducing the ullowable outage time for a single channel from 7 days to 24 hours in MODES 5 and 6 as stated in GL 90-06.	SRXB
20.2-13	OPEN ITEM	The staff will evaluate the applicant's shutdown risk evaluation report against the guidance provided in the staff's draft report when the applicant's report is received.	SRXB
20.2-14	OPEN ITEM	The applicant must address interfacing system LOCA requirements as discussed in SECY 90-16.	SRXB
20.3-1	OPEN ITEM	10 CFR 50.34(f) (TMI) requirements II.K.3(2) and III.D.1.1 will be addressed in the FSER.	SRXB

SRXB

Conf Item ~~4.2.7.1~~ 4.4.6.3-1

The staff will confirm that an ITAAC is developed to include testing and calibration of the inadequate core cooling (ICC) system.

Response

ITAAC for testing and calibration of the inadequate core cooling (ICC) system will be submitted to NRC separately under the System 80+ ITAAC submittal schedule.

Open Item 5.4.3.1-2

The applicant is required to include a boron mixing test in the ITAAC program to demonstrate a satisfactory mixing under natural circulation.

ABB-CE Response

A boron mixing test under natural circulation conditions will be performed during the startup test program as described in CESSAR-DC Section 14.2.12.4.23. This test is performed after fuel load, during power ascension testing, and therefore would not be part of the ITAAC program, which would be completed prior to fuel load.

SRXB

Open Item Number 6.3.3-1:

The applicant should provide the design criteria for the SI minimum recirculation flow and provide pump operating data or test results demonstrating operability at low recirculation flow.

ABB-CE's Response:

The design minimum flow rate of 85 to 105 gpm for the SIS pumps was set based on criteria for pump and system protection, include the following considerations for operation at reduced flow:

1) limiting the fluid temperature rise across the pump due to reduced efficiency
2) radial thrust limitations
3) system pressure limitations due to the higher head
4) optimizing performance
5) review of existing equipment and systems

The criteria presented above have been evaluated based on extended operation at miniflow for a minimum of 36 hours. This time is consistent with the performance requirements of the System 80 High Pressure Safety Injection Pumps and far exceeds the expected time at minimum flow operation for the spectrum of System 80+ LOCA events. The analyses presented in chapter 6 of CESSAR-DC show that RCS pressure is reduced below the corresponding pump head much sooner than 36 hours, allowing an increase in flow above minimum flow for all design bases events.

The SIS pumps have been tested at miniflow in several ABB-CE designed plants. The report from this test shows that the pumps have been operated successfully with miniflow rates as low as 35 gpm. The pump vendors at that time endorsed a related maximum life for the pump seals of 720 hours of continuous or 60 hours of intermittent use. In addition, a survey was conducted to determine the frequency and duration of the safguard pumps operation at miniflow in existing plants. The result of this survey revealed no seal problems for operating time of up to 45 hours at miniflow operation. However, since these tests and reports, the pump vendors have revised their position on the minimum recommended pump flow. They have recommended significantly higher values, but have agreed that the SIS pumps will operate satisfactorily with a minimum flow of 85 to 105 gpm.

Based on the above criteria including past performance of the HPSI pumps, the same miniflow rate has been specified for System 80+ with the operational requirement of a minimum of 36 hours. The operation of the pumps at minimum flow will be verified and is included in the draft submittal as item number 16 of ABB-CE's ITAAC.

SRXB

Open Item 6.7.2-3:

The applicant must provide an evaluation showing high availability of RDS when being utilized for severe accident mitigation.

Response to Open Item 6.7.2-3:

The issue of RDS availability for severe accident mitigation will be addressed in the Level 2 PRA report which will be issued in January.