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Revision 2

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June 2002

Emergency Diesel Generator Loading Study

Entergy Nuclear Northeast
Indian Point Unit 2

Westinghouse

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EMERGENCY DIESEL GENERATOR LOADING STUDY FOR INDIAN POINT UNIT 2

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ABSTRACT

This report provides a loading analysis for the Indian Point 2 emergency diesel generators (EDGs) for a number of loss of offsite power events requiring safety injection (SI). Limiting EDG loads for large LOCA, small LOCA, steamline break, steam generator tube rupture, and spurious SI actuation are determined. The loss of offsite power transient without SI is also analyzed. This study is updated to reflect "as-is" systems and conditions at Indian Point Unit 2 near the end of 2001.

With the possible exception of short periods during the injection phase and post-LOCA switchover to cold leg recirculation, EDG loads for the design basis events are determined to be less than 2100 kw, the two hour emergency rating for the EDGs. Short term loads during injection and switchover are within the half hour rating of 2300 kw. Longer term loads are less than or readily controllable to be less than the EDG continuous rating of 1750 kw.

EMERGENCY DIESEL GENERATOR LOADING STUDY FOR INDIAN POINT UNIT 2

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1.0 INTRODUCTION AND BACKGROUND

Emergency alternating current (a.c.) power at Indian Point Unit 2 is provided by three emergency diesel generators (EDGs), each of which has a continuous rating of 1750 kw. In the event of loss of offsite power, EDGs 21, 22, and 23 will feed the 480 V Safeguards Bus groups 5A, 2A/3A, and 6A, respectively. Table 1-1 summarizes the equipment which receives power from these buses. Associated one-line diagrams of the emergency power system are contained in Section 8.2 of the FSAR (Ref. 1-1).

For accident conditions, prior to the 1991 refueling outage, the EDGs were permitted limited operation at 1950 kw for 2 hours in any 24 hour period (Ref. 1-2). This emergency rating exceeded the continuous rating of the EDGs. This 1950 kw limit was consistent with the 2000 hour diesel overhaul limit listed in an EDG rating tabulation contained in a 1970 Con Edison memo (Ref. 1-3). This tabulation is shown below:

Maximum 1/2 Hour	2000 kw	2520 horsepower (BHP)
Peak 2000 Hour	1950 kw	2460 horsepower
Continuous	1750 kw	2200 horsepower
Maximum non-warranted	2250 kw	2800 horsepower
Stall rating *	2385 kw	2950 horsepower

The BHP to kw conversion used above assumes an averaged value of 94% for the shaft or motor efficiency of the major safeguards loads.

Early EDG loading design studies confirmed the adequacy of the EDGs at meeting various post-accident power requirements. As reported in the original Nuclear Regulatory Commission (NRC) Safety Evaluation Report (SER) (Ref. 1-4), the EDG loads following a postulated loss-of-coolant accident (LOCA) were estimated at 1813, 2210, and 2353 horsepower for the first one-half hour, for EDGs 21, 22 and 23, respectively. Limiting loads during the recirculation phase then changed to 2438, 2235, and 2043 horsepower. Referring to the above tabulation, the limiting loads (i.e., EDG 23 during injection and EDG 21 during recirculation) were less than the 1950 kw limit allowed for accident conditions.

The loads reported in the SER were consistent with EDG loading studies performed by Westinghouse in early 1970. The values reported in the SER were actually derived from tables supplied by Westinghouse in Reference 1-4.

Through the years, a number of informal loading verifications have been performed to confirm the loads on the EDGs. The overall result of these studies has been that the loads originally reported in the SER and early 1970 loading studies have remained largely unchanged. Con Edison recognized the need to re-evaluate the expected DG loading in more detail for the purpose of providing flexibility in future plant design

*GE/ALCO, the diesel manufacturer, does not recognize this stall rating. However, the diesel capacity is limited by the fuel rack adjustments.

changes. As a result, Con Edison contracted Westinghouse to perform an analysis to determine the current limiting loads on the EDGs (Ref. 1-5).

Con Edison and Westinghouse met in early March 1989 to discuss preliminary results of this EDG loading study (Ref. 1-6). It was determined that under certain conditions, the loads on the EDGs could exceed the two hour emergency rating of 1950 kw. Proposed changes to reduce the loading were discussed and a Licensee Event Report (LER) was subsequently issued in April 1989 (Ref. 1-7). This LER describes the modifications made to the recirculation switches and Emergency Operating Procedures (EOPs) during the 1989 spring refueling outage to keep the EDG loads within acceptable limits. Draft reports of the EDG loading study were then issued in June 1989 (Ref. 1-8) and August 1989 (Ref. 1-9). These reports describe the limiting EDG loads prior to and immediately following the 1989 spring outage, respectively. The pre-stretch analysis of Reference 1-9 confirmed that the modifications described in the LER would result in EDG loads less than the 1950 kw short term emergency limit and the 1750 kw longer term limit.

In late September 1989, an audit team from the NRC Region 1 met at the Indian Point Unit 2 site to review the draft EDG loading studies of References 1-8 and 1-9. With some minor exceptions, they agreed with the results and the conservative approach used in these analyses. The audit supported the conclusion that, for pre-stretch operation, the EDGs would not be loaded beyond the 1950 kw emergency limit. A presentation on the EDG loading study was then given to the NRC at the Rockville offices October 2-3, 1989. A copy of the presentations and summary of most of the site audit comments is provided in Reference 1-10.

On January 29, 1990, Con Edison obtained approval to operate Indian Point Unit 2 at the 3083.4 MWt NSSS stretch rating. Due to the higher flow and power requirements for the motor-driven auxiliary feedwater (AFW) pumps for stretch, it was necessary to eliminate some small loads on EDG 23 to accommodate this uprate in reactor power. Reference 1-11 describes these modifications. These changes were made during the spring 1990 mid-cycle outage. To make the EDG loading study as complete and current as possible, the EDG loading study report was updated to include the changes made for stretch as well as those previously made during the 1989 refueling outage. Changes and corrections made following the NRC site audit were also included. The previous EDG loading study (WCAP-12655, Rev. 0, dated July 1990) therefore bounded stretch operation immediately following the spring 1990 mid-cycle outage.

Since the completion of WCAP-12655 Rev. 0, a number of modifications have been made that impact the EDG loading study. Many of these changes were made during the 1991 refueling outage. These changes include the following:

1. Per the diesel enhancement project, the ratings on the EDGs have increased. The two hour emergency rating has increased from 1950 kw to 2100 kw. The EOPs also allow the EDG load to increase to 2300 kw for up to one half hour in any 24 hour period.

2. The power feed for CCW pump 23 has been switched with the feed for MCC 211. Thus, MCC 211 is now powered by EDG 22 and CCW pump 23 by EDG 23. As a result, each EDG now provides power to its own CCW pump.

3. A new vital MCC (26C) has been added to EDG 22.

4. Some of the "optional" loads on the MCCs previously controlled by selective loading were moved to smaller MCCs (24A, 29A, and 27A) to allow easier control by the operator.

5. A number of improvements were also made to the EOPs. Because of the electrical improvements made above, the "Blue" set of EOPs previously used to limit the loads on the EDGs could be eliminated. Also, with the increased diesel ratings, it was possible to allow the motor-driven AFW pumps to remain operable during switchover.

The above electrical modifications are described in References 1-12 through 1-15 and the increased EDG load ratings are documented in Reference 1-16.

Additional changes were made during the 1993 refueling outage. These include the following:

1. Power feeds for Switchgear Room exhaust fans 213 and 215 were changed from MCC 29 to MCC 26C (213) and MCC 29A (215).

2. EDG Building exhaust fan 318 was moved to MCC 26B and a new fan (323) was added, also to MCC 26B.

3. CRAC Booster fans 21 and 22 were replaced with higher capacity fans with increased horsepower ratings.

The above modifications are described in References 1-18 through 1-20.

In addition to the electrical modifications, a number of calculational changes have been made:

1. Large motor loads for the safeguards pumps and fan coolers have been revised based on calculated design data for motor efficiencies.

2. MOV valve loads for MCCs 26A and 26B have been revised based on their kVA rating.

3. Fan cooler power requirements for small LOCA and steamline break have been revised based on containment integrity reanalysis performed to

incorporate the SI flow balancing modification and the containment high-1 setpoint increase.

Con Edison (now Entergy) provided the necessary input for the first two items above (References 1-21, 1-22). The revised containment integrity calculations for small LOCA and steamline break are described in Reference 1-23.

The above 1991 and 1993 refueling outage modifications and calculation changes have resulted in changes to the EDG loadings previously reported in the WCAP-12655 Rev. 0 report (July 1990). A draft loading study was therefore completed to bring the document current to the end of 1994, just prior to the February 1995 outage. The Westinghouse proposal for this update is given in Reference 1-24.

After the 1995 refueling outage, additional changes were made to some of the fan cooler power requirements for large LOCA to reflect the containment high-1 setpoint increase. Revisions were also been included for steam generator refill with AFW following a large LOCA. The revised EOPs, Rev. 21 (August 1995), were also used for this update (Reference 1-17). The Westinghouse proposal to include these changes following the 1995 refueling outage is given in Reference 1-25. This revision (WCAP-12655, Rev. 1), therefore included changes to the Rev. 0 loading study to bring the EDG loading study document current to the end of 1995. The Revision 1 version of the load study was issued in May 1996.

Since the completion of WCAP-12655, Rev. 1, a number of additional changes have been made that impact the EDG loading study. Many of these were captured in the restart update performed near the end of year 2000 (References 1-26, 1-27). Changes include the following:

1. A Rev. 1B update for some miscellaneous small load changes plus shifting of some loads early in the recirculation switch sequence,

2. A significant number of pump changes (AFW, SW, SI 23, Recirc, and CCW),

3. A potential increase in fan cooler loads as a result of recent containment reanalysis,

4. A major revision to the plant Emergency Operating Procedures (EOPs, Rev. 35, including the LOCA switchover procedure ES-1.3, Transfer to Cold Leg Recirculation, and

5. Most recently, the original Model 44 SGs have been replaced with Model 44F SGs.

Since the restart update focused primarily on large LOCA as a limiting initiating event, loads for other events were not updated. To update the load study for other events and make it more complete, Con Edison approved a more comprehensive update.

The inputs used for the Revision 2 update to WCAP-12655 have been provided in References 1-28 through 1-32. Revisions to the EOPs (Ref. 1-28) are also included so that the load study reflects with reasonable accuracy the plant configuration at the end of year 2001.

Table 1-1
480 V Bus Loading Summary[1]

Description	Bus 5A EDG No. 21	Bus 2A/3A EDG No. 22	Bus 6A EDG No. 23
SI Pumps	21	22	23
Cont. Spray Pumps	21		22
RHR Pumps		21	22
Aux. FW Pumps		21	23
Cont. Fans	21/22	23/24	25
Recirc. Pumps	21		22
Service Water Pumps	21/24	22/25	23/26
CCW Pumps	21	22	23
MCCs	28/29/29A 26A/AA	24A/24/28A 21/210/211 23/25/22 26C	26B/BB 27/27A
Charging Pumps	21	22	23
Prz. Htrs.	Gp. 23	Gp. 21/22	Contr. 24
Lighting Trans	23	21/22	21
Service Air Comp.[2]	x		
M-G Set[2]		21	22
Turb. Aux. Lube[2]			x

[1] Con Edison Drawing A208088-37
[2] Equipment Not Considered In This Study (Does Not Auto-Start, Not Required per the EOPs for Design Basis Events)

2.0 OVERVIEW OF THE EMERGENCY DIESEL GENERATOR LOADING STUDY

This section describes the method and scope of the EDG loading analysis and provides an overview of the major sections that follow.

Since initial operation of Indian Point Unit 2 in the early 1970's, a number of plant modifications have been made that have an impact on the loading requirements for some of the major safety-related components. Changes in flow rates and motor efficiencies affect the corresponding horsepower requirements. Several motors and pumps at the plant have also been replaced. Since the power required for these major components is the dominant contribution to the total EDG load, an important part of this study is to consider the various changes in equipment and operating parameters to accurately but conservatively determine the expected loading for these major components during various design basis accident scenarios. Sections 3.1 and 3.2 describe these calculations for the safeguards pumps and containment fan coolers, respectively.

In addition to the major safeguards equipment, a number of smaller components, including safety-related motor operated valves (MOVs), automatically connect (are not stripped) during the Safety Injection (SI) sequence. This equipment is powered by the vital motor control centers (MCCs) 26A, 26B, and 26C (Buses 5A, 6A and 3A). Section 3.3 summarizes the loads and valve stroke times for these components.

In Section 3.4, "optional" loads are reviewed. This equipment would be added to aid in plant recovery as directed by the Emergency Operating Procedures (EOPs). Examples include restart of a charging pump (for RCP seal injection), and components powered by other non-safety related MCCs that could automatically start if the MCC is reset (note: all MCCs except 26A, 26B, 26AA, 26BB, 26C, and 211 strip on loss of offsite power).

Section 4 describes the logic associated with the auto-connected loads. The loading sequence for the injection phase of the accident is presented in Section 4.1. A description of the semi-automatic recirculation switch sequence is presented in Section 4.2. Included in Section 4.2 is a description of the recirculation switch modifications made during the 1989 and 1991 spring refueling outages. Section 4.3 describes the loss of offsite power without SI sequence.

Section 5 combines the information from Sections 3 and 4 to determine limiting EDG loads applicable to the large break loss of coolant accident (LOCA). In defining these loads, the EOPs* were reviewed to determine the sequence and approximate timing of

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* In the EOPs, the EDG loading limits are established in several or more places (e.g., ES-1.3 foldout page, ES-1.4 caution prior to Step 11, and ECA-0.0 caution prior to Step 6): The EDG load should be maintained less than 1660 kw, but may be increased to 2010 kw for maximum of 2 hrs in any 24 hour period. These limits allow for 90 kw instrument uncertainty for the continuous (1750 kw) and 2 hour emergency (2100 kw) limits when the operator manually loads equipment on the EDGs.

operator actions that would be used for recovery. The total load on each EDG includes a conservative allowance for miscellaneous losses, including frequency tolerance and bus and cable losses.

Section 5 is subdivided into six subsections. In Section 5.1, the large LOCA plant response and equipment requirements are discussed in general. Hypothetical scenarios or event time tables are then constructed for each of the four major conditions of interest. These include all EDGs operational with selected limiting single failures or equipment out of service (Section 5.2), single failure of EDG 21 (Section 5.3), single failure of EDG 22 (Section 5.4), and single failure of EDG 23 (Section 5.5). Spreadsheets are developed for each of these scenarios to track the expected EDG loads for the sequence of actions based on the EOPs. Results for large LOCA with low-head recirculation are summarized in Section 5.6. Results for large LOCA with high-head recirculation are summarized in Section 5.7.

Other accident cases are considered in Section 6. The EDG loads for small LOCA are presented in Section 6.1. To complete Section 6, the non-LOCA cases are discussed in Section 6.2. These events include the steam line break accident, the steam generator tube rupture accident, and the spurious SI event.

Section 7 includes an update to the Station Blackout and Loss of Offsite Power Without SI Study. Section 8 provides a summary, conclusions, and some recommendations for future improvements. References are then given in Section 9.

Four Westinghouse safety evaluation check lists (SECLs) are presented in Appendix A. One SECL supports a recirculation switch change (switch 2 and 3 interchange) that reduces transient peak loads during the switchover to cold leg recirculation. The other SECL supports SI pump flow degradation. Both of these changes were implemented by Con Edison (now Entergy). A third SECL justifies securing the motor-driven AFW pumps during the switchover procedure. With the enhanced diesel ratings, this action is no longer required nor performed per the EOPs. However, this SECL still provides bounding justification for reducing AFW flow to the minimum during recirculation. The fourth SECL is for the containment high-1 setpoint increase, a change implemented at the plant as a result of the change from an 18 to 24 month refueling cycle. These still remain valid for the current update.

Appendix B describes the containment pressure and temperature response analysis for large break LOCA, small break LOCA and main steam line break mass and energy release transients based upon various equipment-loading scenarios. These cases were performed and are summarized in Section 3.2.

3.0 EQUIPMENT POWER REQUIREMENTS

Power requirements for equipment automatically or manually loaded (as established in the EOPs) on the EDGs are described in this chapter. Requirements for safeguards pumps, fan cooler motors, essential motor control centers (MCCs), and non-essential equipment are documented in the following sections.

3.1 Safeguards Pumps

Power requirements based on steady-state operation have been estimated for the following safeguards pumps:

- Safety Injection (SI) Pumps
- SI Circulating Water Pumps
- Residual Heat Removal (RHR) Pumps
- Recirculation Pumps
- Containment Spray (CS) Pumps
- Service Water (SW) Pumps
- Component Cooling Water (CCW) Pumps
- Auxiliary Feedwater (AFW) Pumps

The power requirements are based on conservative assumptions for both pump flow and equipment performance (i.e., motor efficiency). The pump flowrates have been established for different system alignments, where applicable. These are based on a single failure criteria for EDGs and the related pumps. Loss of a single injecting pump results in an increased power demand for each of the remaining pump(s) due to an increased flowrate.

Once the pump operating flow is determined, vendor pump performance curves are used to estimate the brake horsepower (BHP) required to deliver the specified flow. The BHP is conservatively based on a fluid specific gravity (S.G.) of 1.0 if the fluid temperature is 200°F or less. With the BHP defined, the motor power input (i.e., EDG load) is then calculated by use of the following generalized equation:

$$\text{Motor Input Power (kw)} = \text{BHP} \cdot 0.746 \text{ kw per BHP} / \text{Motor Efficiency}$$

Provided below is a summary of major conservatisms and assumptions utilized in the determination of pump motor load requirements:

1) The lowest reported motor efficiency in the expected operating range as defined on the motor data sheet or calculated design data output is used. The calculated design efficiencies are typically 1-2 percent higher than those given in the motor data sheets. Equipment aging has an insignificant effect on the motor efficiencies, so this effect can be neglected.

2) The power requirements described in this section are based on steady-state operation. Loading sequence and resulting starting loads are not included.

Reference 3-16 documents the flowrates for the pumps (including references to the sources for the flowrates) and the calculations that support the motor power requirements for the safeguards pumps.

Table 3.1-2 summarizes the EDG power requirements for major safeguards pumps powered from the 480 volt buses. A discussion is provided for each pump of the detailed evaluations used to determine these power requirements.

3.1.1 Safety Injection Pumps

The plant is provided with three SI pumps connected in parallel. Each pump has a minimum flow recirculation line. Depending on available power and which single active failure is considered, two or three SI pumps could be operational during a design basis event. The motor power requirement is primarily dependent on pump flow, and the pump flowrates are influenced by the system backpressure against which the pumps are assumed to deliver against. For this study, motor power requirements are calculated at several RCS/containment backpressures to cover both primary and secondary system breaks.

SECL-91-231, Table 3-2-E in Appendix A gives 1659 gpm injected flow (no lines are spilling) at 0 psig RCS pressure, which gives 553 gpm/pump. Additionally, Reference 3-17 gives a maximum miniflow for the HHSI pumps as 35 gpm. The maximum pump flow for 3 pumps injecting is therefore (553+35)= 588 gpm.

For the LBLOCA, Reference 3-16 gives a pump flow of 650 gpm or higher for two pumps injecting and for recirculation. For conservatism, the maximum BHP for the strongest HHSI pump (which occurs near 650+ gpm) was used to establish the required motor power. This was based on the ongoing flow balance investigation (fall 2001), which indicated that with the current alignment HHSI pump #22 may run out passed a runout flow of 650 gpm for the two pump injecting case, and for the recirculation case. The maximum pump BHP of 435

(at S.G.=1.0) for the strongest HHSI pump, occurring at 650+ gpm, was therefore used to establish the motor power requirements for these two cases.

For SBLOCA and Non-LOCA the pump flows given in Reference 3-16 were estimated based on the current HHSI flow balance work of record, as documented in SECL-91-231 (HHSI Flows of record) in Appendix A.

In an effort to utilize the available data for the small break LOCA/non-LOCA, the minimum safeguards calculated flows documented in WCAP-12656 were used. The maximum flows were calculated by increasing the minimum flows to account for the non-conservative EDG loading modeling assumptions (see Reference 3-16).

The original vendor SI pump performance curves showed BHP at a specific gravity (S.G.) of 0.918 (300°F). Since pump operation with a higher fluid S.G. (lower fluid temperature) would require a higher BHP, the vendor BHP data were revised upward to reflect a fluid S.G. of 1.0.

As noted in Table 3.1-1, two sets of replacement frames have been procured. Motor efficiency data for both the original and replacement frames were available. For the replacement frames, the lowest motor efficiency in the expected operating range is for the replacement motor frame (data sheet for Reliance 1&2XF-883704) at the 3/4 load condition (94.3 percent). This value is used to calculate EDG power requirements for BHP above 300 and below 398. The full load efficiency of 94.5 percent is used for BHP of 398 and above.

Provided below is a discussion of the flow assumptions and calculated power requirements for the SI pumps for various design basis events.

The flow rates assumed for the SI pumps are those following installation of throttle valves at the SI pump discharge. These flow restrictions were added to improve the SI flow balancing. This change is described in the Westinghouse Safety Evaluation SECL-91-231 which is included in Appendix A. The HHSI pump flow rates, as applied for the EDG loading study, are conservatively high. The calculations of pump motor power which follow are accordingly conservative.

3.1.1.1 Large Break LOCA Injection and Recirculation

For a large break LOCA, motor power requirements are calculated with the RCS/Containment pressure at 0 psig. With three pumps operational, the maximum HHSI pump flow is calculated to be 588 gpm per pump. At this flow, the calculated motor power requirement is 339 kw per pump. With two pumps operational, the pump flow may reach 650 gpm runout flow or higher, based on ongoing flow balancing evaluations. For conservatism it is therefore assumed that the pumps will operate at the maximum BHP (flow of 650+ gpm) and require 345 kw motor power/pump. For recirculation the flow may also reach 650 gpm or

higher, and the resulting motor power requirement is 345 kw/pump.

3.1.1.2 Small Break LOCA Injection

For a small break LOCA, power requirements with RCS pressure of 1000 psig and one line spilling to 0 psig containment pressure are calculated. At a pressure of 1000 psig, the maximum HHSI flow with three pumps operational is calculated to be approximately 517 gpm per pump. At this flow, the motor power requirement 330 kw per pump. With two pumps operating, the expected pump flow is approximately 600 gpm per pump. At this flow, the motor power requirement is 339 kw per pump.

3.1.1.3 Non-LOCA Injection

For this event, pump motor power requirements are calculated with all lines injecting based on a RCS pressure of 1000 psig. With three pumps operational, the maximum HHSI pump flow is calculated to be approximately 367 gpm per pump. At this flow, the motor power requirement is 297 kw per pump. With two pumps operational, the calculated pump flow is approximately 447 gpm per pump. At this flow, the motor power requirement is 315 kw per pump.

3.1.1.4 Small Break LOCA High-Head / Hot-Leg Recirculation

The SI pumps are needed for post-LOCA recirculation to perform Hot-Leg recirculation. Depending on the break size, the pumps may also be required for high-head recirculation. In this alignment, a low-head pump (RHR or recirculation) would provide flow and NPSH to the suction of the operating HHSI pumps. For this report, the runout flow was assumed for these operating modes since the low-head pump would provide suction boost to the operating SI pumps. As such, the power requirement calculated for the large break LOCA recirculation phase is applicable (345 kw per pump).

3.1.2 SI Circulating Water Pumps

During the injection phase of a LOCA concurrent with blackout, the CCW pumps are not in operation, and the CCW system is used as a heat sink. To provide forced cooling to the SI pump coolers during this period, a small centrifugal pump is provided for each SI pump. These pumps are attached to the individual shafts of each SI pump motor and would be operational whenever a SI pump is in operation.

To maximize the EDG power requirement, the vendor performance curve runout flow (50 gpm) is considered. At this flow, the BHP is 2.8 HP. Using the SI pump motor efficiency (93.4 percent), the additional EDG power requirement for the SI pump motor is 2.2 kw per pump.

3.1.3 RHR Pumps

The plant is provided with two RHR pumps in parallel. Depending on available power and which single failure is assumed, one or two RHR pumps could be operational during a design basis event. During recirculation, the RHR pumps provide a redundant backup to the in-containment recirculation pumps. Normally, the RHR pump(s) would be shut down during the switchover to recirculation.

The RHR pump motor power requirement is dependent on pump flow which is influenced by the back pressure that the pumps deliver flow against. For this study during the injection phase, RHR pump maximum flow and motor power requirements were calculated based on 0, 10, and 20 psig RCS/containment back pressure. Reference 3-16 documents the RHR pump flow rates for different system alignments and containment pressure, the reference sources of the pump flows, and the calculation of the pump motor power requirements.

As noted in Table 3.1-1, a replacement frame was procured. Motor efficiency data are available for both the original and replacement frames. For the replacement frame, the lowest motor efficiency in the expected operating range is for the replacement motor frame. The calculated design data sheet at the one-half and full load conditions is 94.4 percent. For this report, this value was used to calculate EDG power requirements.

The following sections provide discussions of the RHR pump flow rates and the calculated power requirements for the various design basis events.

3.1.3.1 Large Break LOCA Injection

With both pumps operational and RCS pressure at 0 psig, the maximum safeguards pump flow is calculated to be 2903 gpm per pump. At this flow, the motor power requirement is 260 kW per pump. With one pump operational, the calculated pump flow is 4720 gpm. At this flow, the pump motor power requirement is 307 kW.

With RCS pressure at 20 psig, the maximum safeguards flow is calculated to be 2764 gpm per pump. At this flow, the motor power requirement is 255 kW per pump. With only one RHR pump operating, the maximum pump flow is 4508 gpm, with a motor power requirement of 303 kW. Containment analysis shows that the containment pressure for LBLOCA will not drop below 20 psig during this event. For this reason, the 20 psig case motor power requirements are conservative for this event, and are therefore listed in Table 3.1-2.

3.1.3.2 Small Break LOCA / Non-LOCA Injection

During the subject events, the RHR pump(s) would be operated on miniflow. With both pumps operating, the expected flow is approximately 215 gpm per pump (no deadheading assumed). At this flow, the power requirement is 165 kw per pump. With only one pump operating, the expected flow is approximately 430 gpm. At this flow, the power requirement is 171 kw.

3.1.3.3 Large Break LOCA Recirculation

Emergency operating procedure ES1.3 provides instructions for the alignment of low-head recirculation to establish minimum flows to the core and spray header (the containment integrity analysis does not take credit for recirculation spray). As stated previously, the RHR pumps would be manually stopped during the switchover to cold leg recirculation. The pumps provide a redundant backup to the recirculation pumps. Since the low-head system is manually aligned, the actual pump flow can not be easily calculated. As such, pump runout flow (approximately 5500 gpm) will be considered for both the one and two RHR pump operating cases. At pump runout flow, the motor power requirement is 316 kw per pump.

3.1.3.4 Small Break LOCA High-Head / Hot Leg Recirculation

As noted in Section 3.1.1.4, a low-head pump is used to deliver flow (and NPSH) to SI pumps during the recirculation phase of a LOCA. This configuration is needed since the SI pumps do not take suction directly from the containment sump. In this alignment, RHR pump flow is conservatively estimated to be approximately 1350 gpm, the runout flow of two SI pumps (675 gpm each). Note, the recirculation (i.e., miniflow) flow path is assumed to be isolated to minimize leakage outside of containment. At this flow, the pump power requirement is 202 kw .

3.1.4 Recirculation Pumps

The recirculation pumps are manually started during the switchover to containment recirculation. Emergency operating procedure ES-1.3 provides instructions for the alignment of low-head recirculation which establishes minimum flow to the core and spray header (if required).

As noted in Table 3.1-1, replacement frames have not been procured for the recirculation pumps. The lowest reported motor efficiency in the expected operating range on the original motor frame data sheet is at the one-half load condition (93.4 percent). For this report, this value is used to calculate EDG power requirements, except at runout where the full load efficiency (93.7 percent) is used.

Provided below is a discussion of the flow assumptions and calculated power requirements for the recirculation pumps for various design basis events.

3.1.4.1 Large Break LOCA Recirculation

Reference 3-16 Table 6.3 gives the maximum flow rates for recirculation mode for 5 PEGISYS LBLOCA cases representing different system alignments and single failure conditions, and the corresponding motor power requirements.

For the large LOCA cases analyzed in appendix B and discussed in Section 3.2, the containment sump temperature remained above 200°F for 10^4 seconds (2.8 hours) or longer following the accident. On this basis, 200°F fluid temperature is a conservatively low sump temperature for the initial phase of recirculation following a large break LOCA event. At this temperature, the pumped fluid SG is 0.964.

The maximum pump flow rates from Reference 3-16 are dependent on the system alignment. For 2 recirculation pumps delivering flow to two RHR heat exchangers, the flow is 3523 gpm which requires 287 kw motor power. For one pump delivering flow to one heat exchanger, the flow is 3885 gpm, which requires 294 kw. For one pump delivering flow to two heat exchangers, the flow is 4607 gpm, which requires 299 kw.

3.1.4.2 Small Break LOCA High-Head / Hot Leg Recirculation

For a small break LOCA, motor power requirements was based on a S.G. of 1.0 since the sump temperature could be less than 200°F. When containment recirc spray was active, a recirculation pump flow of 3704 gpm was calculated, with a corresponding motor power requirement of 301 kw. When containment recirc spray was not active, a pump flow of 1380 gpm is calculated, with a motor power requirement of 194 kw.

3.1.5 Containment Spray Pumps

The CS pumps are started on a Phase B actuation signal. Since the pumps take suction from only the RWST, they are not a long-term load on the EDGs. One pump, however, is kept on during the LOCA switchover procedure until the RWST is empty. Approximately 80,000-100,000 gallons are left in the RWST at the start of switchover.

Following an initiating event, containment pressure will rise and approach the design pressure of 47 psig. Spray flow and fan cooler heat removal turns around the pressure increase and reduces it over time. The CS pump flow is not dependent on the number of operating pumps since the flow paths are independent. Pump flow, however, is sensitive to containment backpressure.

For this report, CS pump motor power requirements at selected containment back pressures are calculated based on new system performance calculations (see Reference 3-16). These calculations utilized piping data and system layout reflecting the current system configuration to estimate the maximum spray flow at containment back pressures of 0 psig and 20 psig, in order to maximize the pump BHP. For a LBLOCA event, 20 psig containment pressure is conservatively low and results in conservatively high pump motor power requirements.

As shown in Table 3.1-1, replacement frames have been procured for the CS pumps. Of the two sets of frames, only motor efficiency data for the original frames were available for this study. The lowest reported motor efficiency in the expected operating range on the original motor frame data sheet is at the one-half and full load conditions (94.4 percent). For this report, this value is used to calculate EDG power requirements.

Provided below is a discussion of the flow assumptions and calculated power requirements for the CS pumps for various design basis events.

3.1.5.1 Large Break LOCA with Containment Spray Injection

For the large break LOCA cases considered (see Sections 3.2 and Appendix B), 20 psig is a conservatively low pressure above which the CS pumps will operate against prior to the operating CS pump being secured in ES-1.3. The low containment back pressure results in a higher CS pump flow, BHP, and required motor power.

The calculated CS pump flows (see Reference 3-16) reflect a 3% enhanced pump curve based on the vendor CS pump performance curves, a derated system flow resistance, and containment back pressures of 20 psig and 0 psig. The spray flow is calculated to be 3384 gpm for 20 psig containment pressure. For 0 psig containment pressure the flow is 3562 gpm.

The pump motor power requirements are based on the bounding pump performance from the vendor pump curves, and the motor efficiency data. The pump motor requirement for 0 psig containment pressure is 360 kW, and for 20 psig containment pressure 350 kW is calculated.

3.1.5.2 Small Break LOCA with Containment Spray Injection

For a small break LOCA, the containment pressure will rise more slowly and stay lower after spray is actuated (assuming the spray setpoint of 24 psig is ever reached). The CS pump motor power requirements are therefore generated at reduced containment backpressure of 0 psig. This approach is conservative

since the CS actuation does not occur until a containment post accident pressure of 24 psig is reached.

At a containment pressure of 0 psig, the CS pump flow is estimated to be approximately 3562 gpm per pump. At this flow, the motor power requirement is 360 kw per pump.

3.1.6 Service Water Pumps

The plant has six SW pumps with three on the essential header and three on the non-essential header. The pumps on the essential header are required for the injection phase of a design basis event. The non-essential pumps are required for post-LOCA recirculation.

As noted in Table 3.1-1, replacement frames have been procured for the SW pumps. However, only motor efficiency data for the original frames were available for this study. Based on the original pump motor data sheets (see Reference 3-16, page 16), 94.7 % motor efficiency was used for this calculation. Based on a review of the vendor SW pump curves, the BHP is relatively constant and is at its maximum over the pump flow range of 5000 to 7000 gpm. The SW pumps are expected to operate at flows near the maximum BHP. For this reason the maximum BHP for each of the SW pumps is determined from the pump curves.

Con Edison (now Entergy) completed a modification at the plant which added the pump strainer load directly to the pump motor power supply. The nameplate rating of the strainer and control load is 0.5 HP, and the corresponding power requirement is 0.37 kw. In order to bound the required pump motor power, pump SW#23 (which has the highest BHP) was considered for both the essential and non essential headers. The bounding value for the SW pumps (including the 0.37kw for the strainer) was 282 kw for injection and recirculation.

3.1.7 Component Cooling Water Pumps

The plant has three CCW pumps installed of which one is required for minimum safeguards. In addition, a spare pump has been procured. The BHP for this pump is bounded by the BHP for the installed pumps.

As noted in Table 3.1-1, replacement frames have been procured for the CCW pumps. Of the two sets of frames, the motor efficiency data for the replacement frames are lower, and used for this study. The reported motor efficiency for the replacement motor in the expected operating range is 92.6 percent.

CCW pump runout flow is 5500 gpm for a single pump operating (see Reference 3-16). The bounding motor power requirement for this flow is 230 kW (based on S.G.=1.0). With two CCW pumps each pump will pump 4000 gpm, which will require 213 kW for each pump motor.

As part of the UHS project, a revised operating methodology was developed to ensure CCW pump post-LOCA runout protection. The CCW system has been configured such that CCW pump header pressure is maintained above a minimum value during plant power operation. During post-LOCA recirculation, one or both RHR heat exchanger shell-side flow paths could be opened. The use of a minimum CCW pump header pressure allows total system resistance to be fixed such that a single CCW pump operates within its maximum (i.e., runout) flow capability with both RHR heat exchanger shell sides opened.

CCW pump runout flow is 5500 gpm for a single pump operating (see Reference 3-16 and CR 200106582). The bounding motor power requirement for this flow is 230 kw (based on S.G.=1.0). With two CCW pumps each pump will pump 4000 gpm, which will require 213 kw for each pump motor.

3.1.8 Auxiliary Feedwater Pumps

The plant is provided with two motor-driven AFW pumps with each pump feeding two steam generators. The pump flowpaths are separated such that pump flow is not affected by the number of operating pumps.

As noted in Table 3.1-1, replacement frames have been procured. For the Reliance VH-883732 data, the motor efficiency varies dependent on the load as given in Reference 3-16. For this report, these values are used to calculate EDG power requirements.

For the design basis loss of feedwater event, a minimum AFW flow of 380 gpm is required at stretch power (3083.4 MWt NSSS power). Taking into account uncertainties in the flow control loop (including consideration of the 24 month setpoints), Con Edison (now Entergy) determined the maximum expected AFW flow to be 467gpm per pump (Ref. 3-13 and 3-14). Note, this approach conservatively assumes that the loop uncertainties result in higher than nominal flows. Since the individual pump recirculation (i.e., miniflow) flow paths automatically close on high pump flow, the maximum expected pump flow is also 467 gpm per pump. At this flow, the motor power requirement is 387 kw. It should be noted that for the 467gpm pump flow the BHP is 495 which exceeds the motor design service factor rating (400 HP * 1.15 = 460 HP). Based on discussions Con Edison had with the motor vendor, operation at this load for a limited time period is acceptable.

Following accident recovery, operator action can be taken to reduce AFW pump flow. The following table gives motor power requirements at selected reduced pump flows based on the bounding pump (see Reference 3-16, Table B1-2):

Flow gpm	Bounding kw
467	386.6
460	385
455	383.9
440	379.6
429	376.2
420	373.4
400	367.1
350	347.6
300	328.1
250	308.6
200	281.2
150	257.8
100	232.1
85	222.7
50	200.7

Table 3.1-1
Safeguard Pumps Replacement Motor Frame Status

Motor Name	Original Frame	Replacement Frame
Safety Injection & Circulating Water[1]	509US	E5008S (1&2XF-883704) E5008S (VH-883732)
Residual Heat Removal	509UPZ	5008P20
Recirculation	588.5PH	N/A
Containment Spray	509US	5009S
Service Water	509UPH	5008P24
Component Cooling	504US	5006SX
Auxiliary Feedwater	509US	E5008S

[1]The SI circulating water pump is shaft-driven by the SI pump motor.

Table 3.1-2
EDG Power Requirements Summary

Power Design Basis Event	No. Oper. Pumps	Pump Performance Specific Gravity	Pres. (PSIG)	Data Flow (GPM)	Motor Eff. %	Motor (kW)
HH SAFETY INJECTION PUMPS						
LB LOCA - Inject.	3	1.0	0	588	94.5	339
	2	1.0	0	>=650	94.5	345
LB LOCA – Recirc.		1.0	N/A	>=650	94.5	345
SB LOCA - Inject.	3	1.0	1000	517	94.5	330
	2	1.0	1000	600	94.5	339
Non LOCA - Inject.	3	1.0	1000	367	94.3	297
	2	1.0	1000	447	94.5	315
SI CIRCULATING WATER PUMPS						
SI Pump Operation	1-3	1.0	N/A	50	93.4	2.2
RESIDUAL HEAT REMOVAL PUMPS						
LB LOCA - Inject.	2	1.0	20	2764	94.4	255
	1	1.0	20	4508	94.4	303
SB LOCA & Non LOCA - Inject. (Miniflow)	2	1.0	N/A	215	94.4	165
	1	1.0	N/A	430	94.4	171

[1] SI Pump flows and power requirements have been reduced due to installation of throttle valves (added for flow balancing). Refer to SECL-91-231 in Appendix A.
[2] The SI circulating water pump is attached to the SI pump and is shaft-driven by the SI pump motor.

Table 3.1-2 (cont)
EDG Power Requirements Summary

Power Design Basis Event	No. Oper. Pumps	Pump Performance Data Specific Gravity	Pres. (PSIG)	Flow (GPM)	Motor Eff. %	Motor (kW)
RECIRCULATION PUMPS						
LB LOCA - Recirc.	1-2	0.964[3]	0	4607	93.7	299
SB LOCA - Recirc. (with recir. spray)	1-2	1.0	0	3704	93.4	301
CONTAINMENT SPRAY PUMPS						
Phase B Actuation	1-2	1.0	20	3384	94.4	350
	1-2	1.0	0	3562	94.4	360
SERVICE WATER PUMPS						
Safeguards Actuation	1-3	1.0	N/A	5000+	94.7	282
COMPONENT COOLING WATER PUMPS						
Safeguards Actuation	1	1.0	N/A	5500	92.6	230
	2	1.0	N/A	4000	92.6	213
AUXILIARY FEEDWATER PUMPS [5]						
Safeguards Actuation	1/2	1.0	N/A	467	95.5	387
	1/2	1.0	N/A	429	95.5	376
	1/2	1.0	N/A	250	95.5	309
	1/2	1.0	N/A	85	94.8	223

[3] Specific gravity corresponds to a sump temperature of 200°F.
[4] Load includes pump strainer (0.4 kW) which is powered from the motor power supply.
[5] Operator action is needed to throttle pump flow to achieve lower loads.

3.2 Containment Fan Cooler Unit Motors

Power requirements for the containment fan cooler unit motors have been calculated as a function of steam/air density. The fan motor BHP and power inputs are calculated as described below. Note that these power requirements include the elimination of the charcoal and HEPA filers.

As analyzed in Reference 3-18, the elimination of the charcoal and HEPA filters from the system results in an increase in the fan volumetric flow rate from 64,500 CFM to 69,300 CFM under maximum design accident conditions. The static pressure of the system during design accident operating pressure and density reduces from 23.2 "WG to 18.6 "WG, and the fan brake horsepower is reduced from 310 bhp to 307.7 bhp. The maximum design accident atmospheric conditions are 271°F temperature, 47 psig pressure, and 0.175 lbm/ft^3 density.

As a result of the Reference 3-18 evaluation, the relationship between the CR fan brake horsepower (BHP) and containment density, in the accident range of 0.11 lbm/ft^3 to 0.19 lbm/ft^3 can be determined by the following equation:

$$BHP = 1758 * Density + 6.847E\text{-}14$$

The 6.847E-14 term is negligible, so the BHP for containment design pressure conditions would be BHP = 1758*(0.175) = 307.7 hp.

The containment atmosphere density is based on the calculated steam/air densities from the pressure/temperature time response of the containment integrity analyses.

Once the fan BHP is determined, the fan motor power input requirement can be calculated based on the following equation:

$$\text{Fan Motor Power Input (kw)} = \text{Fan BHP} * 0.746 / \text{Motor Efficiency (\%)}$$

Motor efficiency data from motor data sheets were not available for this project on the existing frames and replacement frames have not been procured. As such, calculated design data efficiencies were used. These efficiencies ranged from 93.8% @ 175 HP to 94.8% @ 350 HP. Except for t=0, the fan cooler motor brake HP requirements range from approximately 200 to 300 HP. The motor efficiency for this range is conservatively assumed to be 93%. For t = 0 (i.e., normal conditions), a more conservative value of 90% is used.

Tables 3.2-1a and 3.2-1b provide results for the containment pressures and fan cooler power requirements for the various large LOCA scenarios. All cases include stretch rating conditions of 3083.4 MWt (NSSS power), 95°F service water temperature and 130°F initial containment temperature. Additional details are provided as Cases 1 through 5 in Appendix B. Appendix B also has plots of these parameters, as well as containment temperature and density and sump temperature.

For all EDGs operating (Table 3.2-1a), it is assumed one fan cooler may be out of service so that 2 CS pumps and 4 fan cooler units are available for cooling. Case 1 in Appendix B (see Table 3.2-2b) corresponds to a "minimum safeguards" case (with 1 CS pump and 3 fan cooler units. This case is bounding for both the EDG 21 and the EDG 23 failure cases. Case 2 is used to represent the EDG 22 failure case (2 CS pumps, 3 fan cooler units). The fan cooler motor power requirements are based on steady-state operating conditions. No credit is taken for recirculation spray (which would lower the containment pressure and density for the long term containment response).

For the "maximum safeguards" case (first case in Table 3.2-1a), the fan cooler motor powers should be increased for a limiting single failure of one CS pump with all EDGs operating (applicable at certain times for loads on EDGs 21 and 22). This case is run explicitly (Appendix B Case 5) to determine the expected containment pressure increase. The fan cooler motor power requirements for 1 CS pump with 4 fan coolers are higher by the amounts shown in the last column of Table 3.2-1a. For example, at 30 minutes (1800 seconds), the impact of a CS pump failure would be an additional 17 kw per fan cooler, due to the higher containment pressure and density. These increases would be doubled if the EDG supplies power to two fan cooler units.

Appendix B Case 2 (EDG 22 failure) conservatively assumes (for purposes of calculating the fan cooler motor power requirements only) that containment spray is terminated at 20 minutes, i.e., at a time corresponding to a conservatively early start of switchover. In the switchover procedure EOP ES-1.3, Transfer to Cold Leg Recirculation, one CS pump is left operating until the RWST empty alarm is reached. As noted in Table 3.2-1b, Case 4 (all EDGs, with 4 CR fans) would be similar to EDG 22 failure case. The CR Fan Sensitivity results in the last column of Table 3.2-1b can be applied to Case 4 to adjust the results for the EDG 22 failure case after 20 minutes (1200 seconds). If this refinement is done for the EDG 22 failure case, the CR fan load at 30 minutes (1800 seconds) becomes 194+12 = 206 kW (versus 215 kW, a reduction of 9 kW). Likewise, the load at 60 minutes (3600 seconds) becomes 184+18 = 202 kW (versus 215 kW, a reduction of 13 kW). Long term results are then consistent with the "minimum safeguards" case (Appendix B Case 1, the first case in Table 3.2-1b).

It should be noted all large LOCA cases consider failure / unavailability of one RHR pump. This is the assumed basis for the mass and energy release rates for the limiting containment integrity case. This is conservative for containment integrity (and EDG loading) since it maximizes the steaming rate into containment (and the resulting power requirements for the fan coolers). The various cases therefore address only the different containment cooling configurations (CS pumps and fan coolers).

Tables 3.2-1a and 3.2-1b, which summarize selected containment pressures and fan cooler power requirements, provide sufficient detail to include the peaks and secondary peaks of interest for the large LOCA scenarios. When inputting the fan cooler power requirements into the EDG loading tables of Section 5, the peaks are "broadened" to avoid any potential non-conservative combination of loads on the EDGs.

Appendix B, Cases 6 and 7, describe the analysis for two main steamline break (MSLB) cases. The first (Case 6) is a regeneration of the limiting MSLB case reevaluated for restart in December 2000 (SECL-00-164, Reference 1-27). This case is run for 605 seconds and assumes maximum safeguards for containment cooling (2 CS pumps plus 5 fan coolers). The mass and energy release for this case is based on a MSLB with failure of a feedwater flow control valve to close (this maximizes the energy release into containment). Case 7 uses the same mass and energy release rates (from Case 6) but further assumes "minimum safeguards" conditions for containment cooling (1 CS pump and 3 fan coolers). Both cases have comparable containment pressures occurring at approximately the same time (350 seconds) with the peak pressure for Case 7 slightly higher (39.5 psig versus 37.5 psig). Case 7 was run for two hours (7200 seconds) with spray secured at 1500 seconds (25 minutes) to simulate operator action in the emergency procedures. (Note: in EOP E-1, Loss of Reactor or Secondary Coolant, containment spray flow can be stopped for non-LOCA events when the indicated containment pressure is less than 17 psig).

Results for the containment pressure and fan cooler power requirements for the MSLB cases are provided in Table 3.2-2. Again, additional details and plots (including other parameters, containment temperature and density, and sump temperature) are provided in Appendix B. Note that since the energy release is limited to a single SG, there is no appreciable long-term energy release to containment. Containment conditions return to normal (less than 4 psig, as per the EOPs) after approximately two hours.

In addition to large LOCA and MSLB, the fan cooler motor power requirements for the small LOCA event were determined. Cases equivalent to the 4 inch and 3 inch cold leg break described in the FSAR were analyzed for their containment response. The containment pressure and fan cooler motor power transient for the "composite" small LOCA with "minimum safeguards" (3 fan coolers, 1 CS pump) is given in Table 3.2-3. Spray actuation did not occur for the 3 inch LOCA with 3 fan coolers (Appendix B, Cases 16 and 17), and this case bounds the 4 inch LOCA later in time (after spray actuation occurs for the 4 inch case). (Note: values in Table 3.2-3 for 100 and 120 minutes are for the 3 inch LOCA).

Spray actuation did not occur for the 4 inch LOCA with 5 fan coolers (Appendix B, Cases 12 and 13) and results for this case are bounded by the composite values in Table 3.2-3. Containment pressure reaches 26.5 psig and is slowly increasing at the end of two hours for the 4 inch LOCA with 4 fan coolers (Appendix B, Cases 10 and 11). However, this is a consequence of assuming the steaming rate for the break flow does not change after 2485 seconds (41 minutes), the end of the 4" LOCA analyzed for the peak clad temperature transient. Had the mass and energy release rates for this case decreased in a more realistic manner (i.e., varied as the decay heat), it is expected that the pressure transient would turn around later in time. Therefore, the "composite" case depicted in Table 3.2-3 table remains bounding for small LOCA.

Table 3.2-4 summarizes all of the small LOCA cases, peak containment pressures, and the sump temperatures at the end of two hours. A large number of small LOCA cases were performed in Appendix B to bound the expected sump temperatures for high head recirculation. Whereas the sump temperature for the large LOCA cases generally remained above 200°F for 10^4 seconds (several hours or more) before significant cool off, small LOCA cases with SI spill modeled cooled to less than 200°F in less than 2 hours. For a given scenario, the true sump temperature should lie somewhere between the results for "no spill" and "with spill". (Note: SI spill refers to safety injection water that spills directly onto containment floor and does not first enter the RCS. If modeled, SI spill flow is higher than anticipated, so the sump will cool more than anticipated.) As can be observed, the impact of the spill flow cools the sump temperature below 200°F, especially for the smaller break size. Therefore, it is conservative to assume a specific gravity (S.G.) of 1.0 for long term recirculation following a small LOCA.

Table 3.2-1a
Containment Fan Cooler Motor Power Requirements for Large LOCA, All EDGs Operating

(Four Fan Coolers, Two CS Pumps, No Recirculation Spray)

	Appendix B Case 4, All EDGs Operating, Both CS pumps inject		Appendix B Case 5, All EDGs Operating, One CS pump fails		CS Pump Sensitivity (Case 5 – Case 4)	
Time (sec)	Containment Pressure (psig)	CR Fan Power (kw)	Containment Pressure (psig)	CR Fan Power (kw)	ΔCont. Press. (psi)	ΔFan Power (kw)
0	2.0	110	2.0	110	0.0	0
23	39.4	221	39.4	221	0.0	0
100	38.4	219	38.6	220	0.2	1
300	35.2	210	37.0	215	1.8	5
500	37.2	216	40.3	225	3.1	9
600	36.2	213	39.9	224	3.7	11
900	34.2	207	39.7	223	5.5	16
1200 *	32.9	203	39.7	224	6.8	21
1400	33.0	203	39.6	223	6.6	20
1500	32.0	200	38.3	219	6.3	19
1800	29.8	194	35.3	210	5.5	17
2400	26.4	183	30.7	196	4.3	13
3600	26.6	184	29.7	193	3.1	9
6000	21.1	167	22.8	172	1.7	5

* Note: only One CS pump is left running after 20 minutes; this pump is then stopped when the RWST empty alarm is reached.

Table 3.2-1b
Containment Fan Cooler Motor Power Requirements for Large LOCA, EDG Failure Cases

(Three Fan Coolers, One or Two CS Pumps, No Recirculation Spray)

	Appendix B Case 1, EDG 21 or 23 Failure One CS Pump Operating		Appendix B Case 2, EDG 22 Failure, 2 CS Pumps Operating		CR Fan Sensitivity (Case 5 - Case 1)	
Time (sec)	Containment Pressure (psig)	CR Fan Power (kw)	Containment Pressure (psig)	CR Fan Power (kw)	ΔCont. Press. (psi)	ΔFan Power (kw)
0	2.0	110	2.0	110	0.0	0
23	39.4	221	39.4	221	0.0	0
100	38.7	220	38.5	220	0.1	0
300	37.7	217	35.8	212	0.7	2
500	41.4	229	38.2	219	1.2	4
600	41.3	228	37.4	217	1.4	4
900	41.8	230	36.1	213	2.1	6
1200	42.5	232	35.2	210	2.8	8
1400	43.0	234	36.8	215	3.4	10
1500	41.9	230	36.7	215	3.6	11
1800	39.3	223	36.9	215	4.0	12
2400	35.2	210	37.1	216	4.5	14
3600	35.6	211	36.9	215	5.9	18
6000	30.6	196	31.3	198	7.8	24

* For EDG 22 failure (Case 2), both CS pumps are assumed stopped at 20 minutes (1200 seconds). Since Case 4 (all EDGs, with 4 CR fans) would be similar, the CR Fan Sensitivity results can be applied to Case 4 to adjust the results for the EDG 22 failure case.

Table 3.2-2
Containment Fan Cooler Motor Power Requirements for Main Steamline Break

	Appendix B Case 6, MSLB with Feedwater FCV Fails to Close (2 CS Pumps, 5 CR Fans)		Appendix B Case 7, MSLB (M&E for Case 6) Minimum Safeguards (1 CS Pump, 3 CR Fans)	
Time (sec)	Containment Pressure (psig)	CR Fan Power (kw)	Containment Pressure (psig)	CR Fan Power (kw)
0	2.0	110	2.0	110
100	21.7	167	21.7	167
200	29.9	193	30.4	194
300	35.6	210	36.9	214
350	37.5	216	39.4	222
353	37.5	216	39.5	222
400	35.6	210	38.2	218
500	32.0	199	35.8	210
600	29.2	190	34.0	205
700	NA	NA	31.8	198
900	NA	NA	28.1	187
1200	NA	NA	23.5	173
1500 *	NA	NA	19.6	161
1800	NA	NA	17.9	156
2100	NA	NA	16.3	151
2400	NA	NA	14.8	146
3000	NA	NA	12.2	139
5000	NA	NA	7.0	125
7200	NA	NA	4.5	118

* CS pump stopped per EOP E-1, Loss of Reactor or Secondary Coolant.

Table 3.2-3
Containment Fan Cooler Motor Power Requirements
for Small Break LOCA (3 Inch / 4 Inch Composite Cold Leg Break)

Time (Min)	RCS Pressure (psig)	Motor Power (kw)
1	9.7	130
5	18.8	160
10	23.8	175
15	25.4	180
20	26.0	182
30	27.4	186
40	28.1	188
50	29.0	191
60	29.8	193
64+	30.1	194
67	29.2	192
100	26.4	183
≥ 120	26.2	182

\+ One CS Pump Starts (24 psig setpoint plus 6 psi uncertainty).

Table 3.2-4
Summary of Small LOCA Cases Analyzed

Case in Appendix B	Break Size	Number of Fan Coolers	Maximum Containment Pressure (psig) #	SI Spill Modeled?	Sump Temperature (at 2 hours)
8	4 inch	3	30.15 (at 64 min)	no	225
9	4 inch	3	30.18 (at 64 min)	yes	202
10	4 inch	4	26.4 (at 2 hours)	no	222
11	4 inch	4	26.5 (at 2 hours)	yes	182
12	4 inch	5	23.0 (at 23 min)	no	216
13	4 inch	5	23.0 (at 23 min)	yes	179
14	3 inch	3	28.8 (at 2 hours)	no	211
15	3 inch	3	28.9 (at 2 hours)	yes	167
16 *	3 inch	3	26.28 (at 94 min)	no	211
17 *	3 inch	3	26.35 (at 95 min)	yes	165

* Mass and energy releases for these cases reduced in proportion to the decay heat.

Containment spray actuated at 30 psig (24 psig setpoint plus 6 psi uncertainty).

3.3 Essential Motor Control Centers

As defined in Table 1-1, Motor Control Centers (MCCs) 26A, 26B, and 26C receive power from 480 volt busses 5A, 6A, and 3A, respectively. The equipment loaded on these MCCs is essential to mitigate/monitor design basis events. As such, these MCCs remain loaded on the EDGs during automatic sequencing (per Section 4.1, these MCCs are not stripped).

Provided in Tables 3.3-1a, 3.3-1b, and 3.3-1c are listings of equipment and their respective power requirements for MCC 26A, 26B, and 26C, respectively. Some of the components are motor-operated valves (MOVs); for these, the maximum expected stroke times are provided since valve loads are present only when the valve is in motion. In general, the valve stroke times are based on design data contained in equipment specification data sheets. As noted, information provided by Con Edison in References 3-2 and 3-4 was used to update some of these loads. For plant valves, Con Edison reviewed and provided updates to some of the valve stroke times in Reference 3-3. Additional changes have been made to these loads and valve stroke times in the Rev. 1B update, as documented in Reference 3-19.

For the EDG loading study, it is important to know which components on MCCs 26A, 26B, and 26C are energized at the start of the accident. These loads were determined based on information given in the schematic diagrams for MCCs 26A and 26B (Dwg. 9321-LL-3126 and associated reference drawings), and other information confirmed with Con Edison. The loads on these vital MCCs that could be energized at approximately one minute following the start of an accident are listed in Tables 3.3-2a, 3.3-2b, and 3.3-2c. The total loads on these MCCs should be less than that indicated since some of the components do not become energized unless specific setpoints are reached or a particular piece of equipment was in use when the accident first occurs. For example, the fans, heat tracing, and some of the control room HVAC loads may not all be in operation simultaneously.

The information in Tables 3.3-2a, 3.3-2b, and 3.3-2c will be used to determine the peak injection phase loads after all the major component loads have been sequenced onto the EDGs. As noted in Section 4.1 (see Table 4.1-1), the load sequencing generally takes at least 30-40 seconds but less than 60 seconds (including the assumed 10 second EDG start time). Therefore, it is appropriate to ignore the fast acting MOVs and include only those with valve stroke times of approximately 60 seconds or longer.

When component loads are defined in hp, a conversion factor of a 0.746 kw/hp was used to convert the load to kw. Motor and/or fan efficiency corrections have not been accounted for in the conversion to kw since the loads are small in comparison to those discussed earlier for the large motors. Furthermore, in selecting motors for these smaller components, it has generally been found that the motors providing power to the smaller miscellaneous loads have excess capacity when compared to the power actually required to operate the pump or fan. For example, boric acid transfer pump 22, when operating at the higher speed, requires about 9.1 kw (based on plant measurements).

The load assumed in Tables 3.3-1b, 3.3-1c, 3.3-2b and 3.3-2c is 11.2 kw. Some of the measured or more accurately determined control room HVAC and other loads have also been confirmed to be less than those assumed.

In the evolution of the MCC 26A, 26B, and 26C tables, there have been several corrections and also some changes resulting from modifications made during the spring 1989 refueling outage, the spring 1990 mid-cycle outage, the spring 1991 refueling outage and the spring 1993 refueling outage. These corrections and changes are discussed below.

Boric Acid Pump 22 (MCC 26B)

Based on information from the Con Edison (now Entergy) operations personnel in the Generation Support group, this pump is normally left in automatic and recirculates at the lower pump speed (7.5 hp). During a boration operation, however, it could be in operation at the higher speed (15 hp). The corresponding load (11.2 kw) is conservatively assumed to be present on EDG 23.

Service Water Pump Heaters and Strainers

As described in Reference 3-8, modifications were made during the spring 1989 refueling outage so that each service water pump motor also powers its associated strainer (refer to Section 3.1.6). In Reference 1-11 (spring 1990 mid-cycle outage modifications) the 4 kw SW strainer pit heater load is also taken off MCC 26A and 26B and moved to MCC 29. These heaters are not energized (on EDG 21) when the MCCS are later reset (Ref. 1-2) (note: Con Edison (now Entergy) determined that there would be no freezing concern associated with this change).

Use For Control Room HVAC Loads (MCC 26B)

During the 1991 refueling outage, some of the redundant control room HVAC loads (CRAC backup fan and booster fan 21) were taken off MCC 26B and placed on the new MCC 26C (Ref. 1-13). The resulting HVAC loads remaining on EDG 23 that could auto-start include a 10 hp motor for the evaporator fan, the motor for booster fan 22 (auto-starts if booster fan 21 fails), and humidifier loads (3 hp humidifier and 1/3 hp booster pump).

Plant PA System

The 7.6 kw (9 kVA) PA System load is taken off MCC 26B (also a spring 1990 mid-cycle outage change described in Reference 1-11). This load is re-connected to a new static inverter from battery 22. During the 1991 refueling outage, the alternate power source for this inverter was changed from MCC 24 to MCC24A.

Lighting Panel 223 (MCC 26B)

The only essential Lighting Panel 223 loads left powered by MCC 26B are the EDG building emergency lighting (1.1 kw), the crankcase exhaust for EDG 23 (0.8 kw), and some miscellaneous valve loads for the fuel oil system (approximately 0.3 kw). The remaining loads on this lighting panel (see Dwg. A209211-0) would be powered by MCC 27. These loads on MCC 27 would not be energized. Thus, the total lighting panel 223 load energized would be that on MCC 26B, approximately 1.1+0.8+0.3 = 2.2 kw. This change for lighting panel 223 is also a spring 1990 mid-cycle outage change described in Reference 1-11.

Battery Chargers

The full battery charger load is conservatively assumed to be 25 kw. For battery chargers that are supplied by MCC's that are stripped, the load could be as high as 45 kw because of battery recharging. Battery Chargers 21, 22, and 24 are supplied by MCCs 29A, 24A and 27A, respectively. These MCCs are stripped on loss of offsite power in conjunction with an accident. The resetting of these MCCs is an immediate action step in the EOPs, and these battery chargers can be loaded onto the diesels within 5 minutes. Therefore, Battery Chargers 21, 22 and 24 are shown as being supplied by their respective diesels at 5 minutes. However, since the batteries have been discharged for 5 minutes, recharging of the batteries will result in the battery charger load being 45 kw. This load will drop and approach 25 kw in 6-7 minutes as the batteries are recharged. Therefore, the conservatism, the load for Battery Chargers 21, 22 and 24 will be assumed to be 45 kw added at 5 minutes and drop to 25 kw at 10 minutes. The load for Battery Charger 23, which is supplied by MCC 26C (which is not stripped), is 25 kw for all time intervals.

EDG 23 Auxiliaries

The EDG 23 Auxiliaries (fuel oil pump, compressor, jacket water heaters, etc.) are moved from MCC 27 to MCC 26B. Of these loads, modifications are made so that the jacket water heaters (9 kw) do not automatically load (the lube oil heaters would cut-out). Of the remaining components, the fuel oil pump (2 hp) and compressor (3 hp, later increased to 5 hp) can automatically start. However, the fuel oil pump component would not start until after approximately 20 minutes, after level in one or more of the day tanks becomes low.

Hydrogen Analyzer Heat Tracing (MCC 26AA, 26BB)

Per Reference 3-9, it is recommended that manufacturer data for the H_2O_2 analyzer heat tracing be used:

3.261 kw for Channel 1 (MCC 26AA, EDG 21)
3.120 kw for Channel 2 (MCC 26BB, EDG 23)

These are supported by plant measurements of 3.2 kw for Channel 1 and 2.7 kw for Channel 2. For simplicity, the heat tracing load for either MCC is rounded up to 3.3 kw for the EDG loading study. Another small load on MCC 26BB (0.3 kw) for transformer 2H was added by Con Edison in their update to the loading tables.

During the spring 1991 refueling outage, modifications were completed to create MCC 26C. Other modifications, including the transferring of some electrical loads, were completed during that outage or during the 1993 refueling outage. The modifications pertinent to MCCs 26A, 26B, and 26C are listed below.

Control Room HVAC Loads (MCC 26B and 26C)

As mentioned previously, the power feeds for the CRAC backup fans and booster fan 21 were transferred from MCC 26B to MCC 26C. While both are automatic loads, the 7.5 hp backup fan would not operate if the 10 hp evaporator fan was running on MCC26B (Ref. 1-13). During the 1993 outage, new 7.5 HP Carbon Filter Booster Fans replaced the 2 HP Booster Fans on MCC 26B and MCC 26C (Ref. 1-20). Dampers were replaced and small motors added as part of this modification.

EDG Ventilation System (MCC 26A, 26B and 26C)

As part of an effort to upgrade the emergency diesel generators to handle higher loads, the EDG ventilation system was modified for the increased capacity. This 1991 refueling outage modification involved replacing the two horsepower fans with five horsepower fans. Two fans, 319 and 320 were powered by MCC 26A, and two additional fans, 321 and 322, were powered by MCC 26C. A fifth "swing" fan (fan 318) was powered by MCC 26A with an alternate feed to MCC 26C if power at MCC 26A was lost (Refs. 1-12, 1-14).

During the 1993 refueling outage, additional modifications (Ref. 1-19) were made to the EDG Ventilation System by realigning fan 318 and installing a new (sixth) fan on MCC 26B. This alignment provides a 2 fan/train alignment to increase cooling redundancy by allowing maintenance requirements to take a fan out of service at any time while assuring that at least three fans will be available for any single failure (a failure of a diesel would take out 2 fans). Currently, fans 319 and 320 are powered from MCC 26A, fans 318 and 323 are powered by MCC 26B and fans 321 and 322 are powered by MCC 26C (see Reference 3-20 for details).

Wall Exhaust Fans (MCC 26C)

Wall exhaust fans 213 and 215 were transferred from MCC 29 to MCCs 26C and 29A, respectively. Fan 216 remained connected to MCC 29. Two temperature switches were also installed in the switchgear room to allow annunciator response when the temperature is high (Ref.1-18). The Rev. 38 version of the EOPs (Ref. 1-28) calls for operation of either fan 213, 215, or 216 when PAB ventilation is established. Since an annunciator may alarm early in the event, the fans on MCC 26C (213) and MCC 29A (215) are assumed manually loaded by the operator within minutes after the respective MCCs are reset.

In addition to the above changes, several others were made during the spring 1991 refueling outage to shift redundant loads or to move desired loads to the automatically energized MCC 26C. These changes are as follows: PAB exhaust fan 21, primary water makeup pump 21, BAT heaters 21, BA transfer pump 21, and spent fuel pump 21 were all transferred from MCC 27 to MCC 26C. Also, battery charger 23 was transferred from MCC 22 to MCC 26C (Refs. 1-12, 1-13).

Table 3.3-1a
MCC 26A Component Load Summary
(Con Edison Drawing 9321-F-3006-91)

Description	ID	Load (HP)	Load (kw)	Stroke Time (sec)
15 kVA Transf (Alt Feed)	23	N/A	10.0+	N/A
Spray Recirc. Stop Valve	889A	0.75	0.6	120
SI Pump 22 Stop Valve	851A	1.0	0.7	55
Accumulator Stop Valve	894A/C	7.5	5.6*	10
SI Branch Stop Valve	856A/C/F	1.6	1.2	12
Press. PORV Stop Valve	536	0.6	0.4	16
RCP CCW Supply Iso. Valve	797	1.9	1.4	15
RHRS Suction Stop Valve	730	5.0	3.7	240
RCP TB CCW Out. Iso. Valve	625	2.0	1.5	13
RHX Outlet Stop Valve	746	10.3	7.7	11
RCP CCW Return Iso. Valve	784	1.3	1.0	10
RHX Inlet Isolation Valve	745B	1.6	1.2	120
RHX CCW Supply Iso. Valve	822A	1.6	1.2	150
Recirc. Pump Iso. Valve	1802A	1.0	0.7	114
Elec. Tunnel Exhaust Fan	21	10	7.4	N/A
BA Heat Tracing (Nor)	N/A	N/A	16.8**	N/A
Hydrogen Recombiner	21	15+200w	11.4	N/A
Miniflow Iso. Valve	842	0.75	0.6	120
Reactor Vent Valve	3100	0.33	0.25	120
BFP Discharge Valve	BFD2-21	19.2	14.3	60
SI Pump Suct. Iso. Valve	887A	1.6	1.2	120
EDG Bldg. Vent Fans	319,320	5	3.7*	N/A
EDG Crankcase Exhaust Nor.	21	0.5	0.4	N/A
Aux CCW Pump	21	5.0	3.7	N/A
RHRS Control Valve	640	0.75	0.6	10
Recirc. Stop Valve	888A	1.0	0.7	12
Cont. Sump Stop Valve	885A	4.0	3.0	117
CS Pump Stop Dich. Valves	866A/C	0.75	0.6*	15
RWST Discharge Valve	1810	1.6	1.2	14
Radiation Monitor	EPX3	N/A	15***	N/A
HVAC Dist.	EPV21	N/A	7.5++	N/A

Table 3.3-1a (cont)
MCC 26A Component Load Summary

Description	ID	Load (HP)	Load (kw)	Stroke Time (sec)
Seal Water Ret. Line Valve	222	0.7	0.5	10
VCT Discharge Valve	112C	0.5	0.4	10
RHR Pump Iso. Valve	744	7.8	5.8	16
MCC 26AA:				
Misc MOVs	---	---	1.0+++	N/A
H2/O2 Anlyz. Heat Tracing	Chan 1	N/A	3.3	N/A

* The load is on a per component basis.
** See Calculation FEX-00008-00.
*** See Dwg. # C235288.
+ Load is 10KVA static inverter, unity power factor is assumed for conservatism.
++ See Mod.# MPE-87-15561-E Rev. 4
+++ Provided by Con Edison in References 3-2 or 3-4.

Note: General updates to this table have been made per Reference 3-19.

Table 3.3-1b
MCC 26B Component Load Summary
(Con Edison Drawing 9321-F-3006-91)

Description	ID	Load (HP)	Load (kw)	Stroke Time (sec)
Spray Recirc. Stop Valve	889B	0.75	0.6	120
SI Pump 22 Stop Valve	851B	1.0	0.7	55
Accumulator Stop Valve	894B/D	7.5	5.6*	10
SI Branch Stop Valve	856B/D/E	1.6	1.2*	12
Press. PORV Stop Valve	535	1.6	1.4	16
RCP CCW Supply Iso. Valve	769	1.9	1.4	15
RHRS Suction Stop Valve	731	5.0	3.7	240
RCP TB CCW Out. Iso. Valve	789	1.6	1.2	15
RHX Outlet Stop Valve	747	10.3	7.7	11
RCP CCW Return Iso. Valve	786	1.1	0.8	10
RHX Inlet Isolation Valve	745A	1.6	1.2	11
RHX CCW Supply Iso. Valve	822B	1.0	0.7	150
Recirc. Pump Iso. Valve	1802B	1.0	0.7	114
Elec. Tunnel Exhaust Fan	22	10	7.4	N/A
Emerg. Boration Valve	333	0.5	0.4	45
BA Heat Tracing (Emg-Man)	N/A	N/A	16.8***	N/A
Hydrogen Recombiner	22	15+200w	11.4	N/A
Miniflow Iso. Valve	843	0.75	0.6	120
Reactor Vent Valve	3101	0.33	0.25	13
BA Transfer Pump (2 speeds)	22	7.5/15	5.6/11.2	N/A
BFP Discharge Valve	BFD2-22	19.2	14.3	60
Cont. Sump Iso. Valve	1805	2.0	1.5	10
SI Pump Suct. Iso. Valve	887B	1.6	1.2	120
RHR Pump Recirc. to RWST	883	3.0	2.2	120
Aux CCW Pump	22	5.0	3.7	N/A
RHRS Control Valve	638	0.75	0.6	10
Recirc. Stop Valve	888B	1.0	0.7	12
Cont. Sump Stop Valve	885B	4.0	3.0	117
CS Pump Stop Dich. Valves	866B/D	0.75	0.6*	15
RHR Pump Suct. Stop Valve	882	3.0	2.2	20
EDG Bldg. Vent Fans	318,323	5.0	3.7*	N/A

Table 3.3-1b (cont)
MCC 26B Component Load Summary

Description	ID	Load (HP)	Load (kw)	Stroke Time (sec)
Lighting Panel 223: **				
DG Bldg Emg Lights	N/A	N/A	1.1	N/A
EDG Crankcase Exhaust	23	N/A	0.8	N/A
Eng Aux Control Panel	N/A	N/A	0.3	N/A
EDG 23 Support Loads: **				
Fuel Oil Pump	23	2.0	1.5	N/A
Air Compressor (Man)	23	5.0	3.7	N/A
Jacket Water Heaters (Man)	23	N/A	9.0	N/A
Lube Oil Heaters (Man)	23	N/A	12.0	N/A
CRAC, Humidifier, and Fans:				
Evap Fan Motor (1 Auto)	N/A	10	7.5	N/A
AC Motor (Man)	N/A	15/7.5	11.2/5.6	N/A
Boost Fan Motor (1 Auto)	22	7.5	5.6	N/A
CRAC Dampers (.15 + .06 kw)	N/A	N/A	0.21	N/A
Transf. for 0.75 hp Motor	N/A	2 kVA	1.0	N/A
Bypass Fan(Off if Evap On)	N/A	0.75	0.6	N/A
Humidifier (May be On)	N/A	3.0	2.2	N/A
Booster Pump (May be On)	N/A	0.33	0.25	N/A
MCC 26BB:				
Misc MOVs	---	---	1.0+	N/A
H2/O2 Anlyz Heat Tracing	Chan 2	N/A	3.3	N/A
Transf. 2H	N/A	N/A	0.3	N/A

*The load is on a per component basis.
+ Provided by Con Edison in References 3-2 or 3-4.
** Change made during the spring 1990 mid-cycle outage (Reference 1-11)
*** See Calculation FEX-00008-00.

Note: General updates to this table have been made per Reference 3-19.

Table 3.3-1c
MCC 26C Component Load Summary
(Con Edison Drawing B248513-10)

Description	ID	Load (HP)	Load (kw)	Stroke Time (sec)
PAB Exhaust Fan	21	125	93	N/A
Battery Charger	23	N/A	25	N/A
Boric Acid Transfer Pump	21	15/7.5	11.2/5.6	N/A
DG Exhaust Fan	22	N/A	0.5 kVA	N/A
EDG Bldg. Vent Fans	321,322	5	3.7*	N/A
BAT Heaters	21	N/A	15	N/A
Spent Fuel Pump	21	100	75	N/A
CRAC Backup Fan	N/A	7.5	5.6	N/A
CRAC Booster Fan	21	7.5	5.6	N/A
CRAC Dampers	N/A	N/A	0.08	N/A
Motor for Dampers	N/A	0.17	0.15	N/A
Pri. Water Makeup Pump	21	20	15	N/A
Wall Exhaust Fan	213	2	1.5	N/A

* Load is on a per component basis.

Table 3.3-2a
Automatic Loads for MCC 26A

Components	Load (kw)	Man/Auto	Loads at One Minute
MCC 26A Loads			
MOVs:			
MOV-822A	0.7	A	0.7
MOV-894A	5.6	A	
MOV-894C	5.6	A	
MOV-866A	0.6	A	
MOV-866C	0.6	A	
MOV-851A	0.7	A	0.5*
MOV-744	5.8	A	
MOV-746	7.7	A	7.7
MOV-887A	0.4	A	
MOV-784	1.0	A	
FCV-625	1.5	A	
HCV-640	0.6	M	
BFP-2-21	14.3	A	14.3
MOV-1802A	0.7	M	
MOV-889A	0.6	M	
MOV-842	0.6	M	
HCV-3100	0.25	M	
MOV-1810	1.2	M	
CCW Boost Pmp 21 (5)	3.7	A	3.7
Elec Tun Exh Fan 21	7.4	A	7.4
H2 Recomb 21	11.4	M	
DG Exh Fan 21 (nor)	0.5	A	0.5
EDG Bldg Vent Fans 319,320	7.5	A	7.5
EPX3	15	A	15
EPV21	7.5	A	7.5
BA Ht Trace (nor)	16.8	A	16.8
XMFR 23 (Inv 21)(max)	15	M/A	
MCC 26AA Loads			
Misc MOVs	1	A	1
H2/O2 Anlyz Ht Trc 1	3.3	A	3.3
---	---	---	---
Total Load on MCC 26A			85.9 kw

*These Loads Are Energized on MCC 26A Only If There Are Other Component Failures (e.g., EDG 23 Fails to Start).

Table 3.3-2b
Automatic Loads on MCC 26B

Components	Load (kw)	Man/Auto	Loads at One Minute
MCC 26B Loads MOVs:			
MOV-822B	0.7	A	0.7
MOV-894B	5.6	A	
MOV-894D	5.6	A	
MOV-866B	0.6	A	
MOV-866D	0.6	A	
MOV-851B	0.5	A	0.5*
MOV-882	2.2	M	
MOV-887B	0.4	A	
MOV-747	7.7	A	7.7
MOV-786	0.8	A	
MOV-789	1.2	A	
HCV-638	0.6	M	
BFP-2-22	14.3	A	14.3
MOV-1802B	0.7	A	
MOV-889B	0.6	M	
MOV-843	0.6	M	
HCV-3101	0.25	M	
CC Boost Pmp 22 (5)	3.7	A	3.7
Elec Tun Exh Fan 22	7.4	A	7.4
BA Heat Trace (Emg)	16.8	M	
H2 Recomb 22	11.4	M	
CRAC, Humidifier, & Fans (10+3+.33 hp)	9.9	A	9.9
CRAC Booster Fan 22, Dampers & Motors	6.8	A	6.8**
DG 23 Support Loads (6.5+21kW)			
Fuel Oil Pmp (2)	1.5	A	
Compressor (5)	3.7	A	3.7
Lighting Panel 223:			
DG Exh Fan 23	0.8	A	0.8
DG Bldg Emg Lights	1.1	A	1.1
Eng Aux Cntr Pnl	0.3	A	0.3
BA Trans Pmp 22 (7.5/15)	11.2	A	11.2
EDG Bldg Vent Fans 318,323	7.5	A	7.5
MCC 26BB Loads			
Misc MOVs	1	A	1
H2/O2 Anlyz Ht Trc 2	3.3	A	3.3
TRANSF. 2H	0.3	A	0.3
Total Load on MCC 26B			80.2

* These loads are energized on MCC 26B only if there are other component failures (e.g., EDG 21 Fails to Start).

** These loads are energized on MCC 26B only if CRAC Booster Fan 21 fails to start.

Table 3.3-2c
Automatic Loads on MCC 26C

Components	Load (kw)	Man/Auto	Loads at One Minute
MCC26C Loads			
DG Exhaust Fan 22	0.8	A	0.8
PAB Exhaust Fan 21	93	M	
EDG Bldg Vent Fans 321,322	7.5	A	7.5
Battery Charger 23	25	A	25
CRAC Backup Fan	5.6	M	
CRAC Booster Fan 21			
Dampers & Motors	5.8	A	5.8
BA Transfer Pump 21	11.2	A	11.2
BAT Heaters	15	M	
Spent Fuel Pump	87.7	M	
Pri. Water Make-up Pump	15	M	
Wall Exhaust Fan 213	1.5	M	
---	---	---	---
Total Load on MCC 26C			50.3 kw

3.4 Non-Essential Equipment

In addition to the required loads described in the previous three sections, the EOPs allow the operator to manually load various "optional" equipment to aid in plant recovery. In the original EDG loading study (WCAP-12655, Rev. 0) equipment most important for recovery early in the accident was selectively loaded on the MCCs or 480 V buses according to instructions in the "Blue" set of EOPs, specifically EOP ES-0.5. In the revised EOPs, a "Blue" set no longer exists. Much of the "optional" equipment has been placed on smaller MCCs (MCCs 24A, 27A and 29A) and energized early in EOP E-0. Additional "optional" equipment (redundant feedwater isolation valves) is contained on MCC 211. This small MCC is designed to remain energized in the event of a reactor trip with loss of offsite power. Tables 3.4-1 through 3.4-4 give the loads on these MCCs. Additional details are explained below.

1. In addition to energizing certain MCCs, the operator starts one charging pump early in EOP E-0. The speed is increased to a maximum to limit the temperature of the gyrol fluid drive oil (maximum speed is required until backup cooling or CCW can be placed in service).

2. In the same step of EOP E-0, the operator verifies that MCCs 26A, 26B, and 26C are energized. If offsite power is not available (as assumed for the EDG loading study), the operator energizes only the small MCCs noted above (MCCs 24A, 27A and 29A) plus any of the automatic ones (MCCs 26A, 26B, 26C and 211) that did not remain loaded.

3. Normal lighting loads can be significant, so these loads are not added to EDGs 21, 22, and 23. Operators are dispatched to establish a backup power supply for lighting transformer 23 to aid in plant recovery. This does not affect the load on the EDGs.

4. The EOP E-0 procedure is structured so that a CCW and non-essential SW pump are not started as part of the immediate actions of EOP E-0. For large LOCA, these pumps would later be started in the ES-1.3 switchover procedure. For small LOCA and non-LOCA events, these pumps may later be started provided there is sufficient loading capacity on one or more of the EDGs.

Some additional information on some of the larger or more significant optional loads is given below.

<u>Charging Pumps</u>

Although not crucial for large LOCA, a charging pump is desirable for cooling the RCP seals for less severe accidents where RCP thermal barrier cooling would be lost if SI occurs and the CCW pumps are not automatically sequenced onto the emergency buses. The operator is directed to start one charging pump early in EOP

E-0 to prevent the back-flow of hot RCS water that would otherwise cause the seals to heat-up (see Section 10.1.1 of Reference 3-6). For a LOCA, the operator stops the charging pump prior to adding loads via Recirc Switch 2 while performing the switchover actions of EOP ES-1.3, Transfer to Cold Leg Recirculation.

Since charging pump operation is important for these other transients, it is included as one of the more essential optional loads. As described below, the charging pump power requirements have been calculated for maximum flow conditions over the range of possible discharge pressures.

As indicated above, the charging pump is started early in the EOP E-0 procedure. The speed is adjusted to provide maximum flow to limit the temperature of the gyrol fluid drive oil until CCW or backup cooling can be established (Reference 3-10). Therefore, only the case of full rated flow (98 gpm) and corresponding main shaft speed of approximately 208 rpm has been considered. Full flow is generally conservative since the brake horsepower of the pump is directly proportional to the flow or the speed. The curve defining the power requirement for the EDG must also appropriately account for the mechanical and volume efficiencies of the pump, the efficiency of the gyrol speed controller, and the motor efficiency of the charging pump motor.

The charging pump power requirement for full flow conditions, as a function of pump developed pressure, is shown in Figure 3.4-1 (curve provided in Reference 3-11). The pump developed pressure is approximately the same as the pump discharge pressure since the elevation difference between the top of the RWST and the RCS cold legs is only approximately 60 ft (equivalent to approximately 25 psi). Line losses between the RWST and the charging pump would make the two pressures more nearly equal.

As noted from Figure 3.4-1, the power requirement previously assumed in Reference 1-8 at 2500 psig (150 kw) remains conservative for very small LOCA and non-LOCA events (where RCS pressure remains comparatively high). For other cases, the power requirements can be reduced due to the nature of the transient. These cases are discussed below.

For a design basis SG tube rupture following SI termination, the RCS pressure will be near the ruptured SG pressure, i.e., less than 1100 psig if controlled below the lowest SG safety valve set-pressure. Assuming a delta p of 250 psi to account for line losses, the charging pump discharge pressure would be approximately 1350 psig. Referring to Figure 3.4-1, a charging pump power requirement of only 80 kw can be justified for a design basis SG tube rupture following SI termination.

For design basis small LOCAs, RCS pressure will stabilize at approximately 1150 psia (i.e., above the SG pressure) for a brief period of time. This time decreases as the break size increases. For the 4" diameter break (see Figure 6.1-1), this period lasts until approximately 400 seconds (6.7 minutes). For the 6" diameter break

(Reference 5-1), this time is reduced to approximately 150 seconds (2.5 minutes). As the break size increases, the small LOCA will "act" more like a large LOCA in terms of RCS and containment pressure response. Since the charging pump is assumed to be started early in the transient (within the 1-5 minute time interval), it will be conservative to assume RCS pressure remains high (i.e., 1150 psia) to bound the intermediate sized LOCA cases. Thus, allowing for 250 psi line losses, the charging pump power requirement for intermediate and small LOCA can be evaluated at 1400 psi in Figure 3.4-1. At this pressure, the charging pump power requirement is 81 kw. Using results for section 3.2 for the containment fan coolers, it is possible to justify a lower power requirement for the charging pumps for large LOCA. This is based on the following argument. During the 1 to 5 minute period for the 4" break, the containment fan cooler motors can be estimated to be operating at 160 kw (from Table 3.2-3). If RCS pressure is reduced faster (as for large LOCA), the power requirement for the charging pumps can be relaxed to 50 kw (at 350 psi in Figure 3.4-1). The fan cooler power requirements can be estimated at about 220 kw (Table 3.2-1a or Table 3.2-1b) for the large LOCA situation. The power increase for one fan cooler more than offsets the decrease in power for the charging pump. Thus, since each EDG has at least one fan cooler, a power requirement of 50 kw can be assumed for the charging pump for large LOCA.

As noted above, the charging pump discharge pressure was estimated given a known RCS pressure assuming line losses of 250 psi. If the normal charging line isolates at the start of the accident and only the seal injection lines are open, the flow losses would be based on seal injection flow of approximately 25 gpm per RCP. Conservatively assuming all this flow is directed down the RCP shaft across the labyrinth seal (i.e., ignoring the seal injection flow), the delta p between the RCP inlet injection point and the cold leg is estimated to be quite low on the order of 10 psi (estimate based on calculations used in support of Reference 3-6). Based on discussions with the plant site, losses in the remaining piping are expected to be on the order of 100-200 psi. Thus, the 250 psi delta-p assumed is expected to be conservatively high for the intended application.

Pressurizer Heaters

For non-LOCA events, it is desirable to have 150 kw of pressurizer heaters to control RCS pressure during the hot standby period or during a subsequent natural circulation cooldown. This value is noted in the Technical Specifications (Section 3.1.A) and is consistent with a generic study performed for the Westinghouse Owners Group (Ref. 3-7). Upon closer review of Reference 3-7, it is evident that 150 kw is a conservative value to be used as a guideline for maintaining RCS pressure following a loss of offsite power event. The heater power from two individual heater banks (i.e., 139 kw based on Ref. 3-12, Westinghouse Sketch ED-SK-329412) will be adequate to overcome expected pressurizer heat losses and maintain RCS pressure control (each heater is rated at 69.24 kw).

The minimum desired heater capacity (i.e., 139 kw) is less than the capacity of each of the four heater groups. Thus, some of the individual heater breakers for the heater group energized could be locally opened before the heater group is energized if the operator needs to manage loads on the EDGs to keep loads below the 2100/1750 kw limits. Future EOP revisions could consider limiting the pressurizer heater loads in this manner if it becomes desirable to add additional optional loads. However, for the non-LOCA tables (which follow in Section 6.2), this pressurizer heater load stripping is not assumed since this action is not necessary to reduce the EDG loads to acceptable values.

MCC 211

During the 1991 refueling outage, power feeds for CCW pump 23 were exchanged with the feeds for MCC 211. This resulted in MCC 211 being powered by EDG 22. In addition, the automatic trip feature of MCC 211 was removed. Thus, MCC 211 will remain energized in the event of a reactor trip. MCC 211 contains redundant main and bypass feedwater isolation valves. While the stroke times for these MOVs are small, they would be required to operate at the beginning of the accident to provide additional isolation of the feedwater system.

Other "Non-Essential" Required Loads

As noted in Tables 3.4-1 through 3.4-3 and 3.3-1C, MCC 29A (EDG 21), MCCs 24A and 26C (EDG 22), and MCC 27A (EDG 23) each supply power to a 25 kVA battery charger. Per FSAR Section 8.2, these become required loads after approximately 2 hours. As explained on Section 3.3, the loads due to battery chargers 21 (MCC 29A), 22 (MCC 24A), and 24 (MCC 27A) are assumed to be 45 kw (high recharging rate) when their MCCs are reset. After 10 minutes, this load is reduced to 25 kw. Battery charger 23 (on MCC 26C) remains energized and its load is assumed to be 25 kw.

MCCs 24A and 29A also supply power to the 75 hp instrument air compressors and associated support loads. These compressor(s) would operate intermittently to re-establish instrument air when the receiver pressure falls below approximately 100 psi. Instrument air compressors are not required for large LOCA since nitrogen bottles provide an adequate back-up supply for required components (mostly valves) used during the post-accident recovery. For other accident scenarios (e.g., those in which the RCS is to be cooled down and depressurized), a higher volume of instrument air would be needed and the instrument air compressor (or the station air compressor) would eventually be required.

MCCs 24A and 29A also provide power to two of the three sets of EDG auxiliaries (starting air compressor and fuel oil pumps). MCC 26B, one of the vital MCCs not stripped, supplies power to the third set of EDG auxiliary loads. The 5 hp air compressor would not be needed if the associated EDG is operating. However, the air compressors for EDGs 21 and 22 would automatically start and operate briefly (minutes) to re-establish starting air pressure once MCCs 24A and 29A are reset. As

noted in Section 3.3, the EDG 23 air compressor now powered by MCC 26B would also automatically start. Per FSAR Section 8.2.3.2 (and Systems Description 10.0 Section 5.1), at least one of the fuel oil pumps would need to be operable by approximately 30 minutes to replenish the day tank(s). One or more of the fuel oil pumps would begin operating based on low level in the EDG fuel oil day tanks at approximately 15-20 minutes.

The remaining optional loads consist of ventilation fans for the PAB and fuel storage building on MCC 27A, and a spent fuel pump on MCC 27A. A number of main turbine and BFP support loads on MCCs 22, 23, and 25 do not get energized for loss of offsite power events. However, emergency pumps will be powered by the batteries to protect this equipment. The other support loads requiring ac power can be energized if conditions stabilize and loadings can be easily controlled by the operator.

In the next two sections of this load study, the required and optional loads will be compiled to determine the limiting EDG loads for the Indian Point Unit 2 design basis events.

Table 3.4-1
Loads on MCC 24A #
(Con Ed Dwg. A249956-15)

BRK NO.	DESCRIPTION	FUSE/BKR RATING (AMP)	RATING (HP)	APPROX LOAD (kw)**	RESET AUTO/MAN	REMARKS
2A	RAD. MONITOR R-45 DIST. PANEL	50		1.60		
3C	INSTR. AIR COMPRESSOR 22	150	75.00	56.00	A*	Auto if Press <100 psi
3M	INST. AIR CLSED COOL RECR. PUMP 22	15	1.50	1.10	A*	
2E	BATTERY CHARGER 22	80	25 kVA	45.00	A	High Recharging Load When MCC Reset
5H	TO 480/120 VAC XFORMER 24/INVTR 22	50	15 kVA	10.00	M	Alternate Feed
6DL	DIESEL GEN 22 COMPRESSOR	70	5.00	3.70	A*	Brief Operation to Resupply Starting Air
	FUEL OIL PUMP		2.00	1.50	A+	Auto at Approx. 20 Min.
	JACKET WATER & LUBE OIL HEATERS		21 kw	21.00	A+	Expect off if DG Running

Notes:

This MCC creation outlined in reference 1-12.
* Equipment may auto start when pressure, level, temperature, etc. call for contact closure.
+ Potential A* equipment not expected to auto start due to other circumstances.
** Equipment loads in kw estimated using the nameplate hp ratings multiplied by the 0.746 conversion factor (except for battery charger).

Table 3.4-2
Loads on MCC 27A #
(Con Ed Dwg. 9321-F-3005-72)

BRK NO.	DESCRIPTION	FUSE/BKR RATING (AMP)	RATING (HP)	APPROX LOAD (kw)**	RESET AUTO/MAN	REMARKS
3A	PLANT VENT SAMPLE STATION COMPRESSOR	15	2.00	1.50	A	
3J	PAB EXHAUST FAN 22	225	125.00	93.00	M	
4E	BATTERY CHARGER 24	80	25 kVA	45.00	A	High Recharging Load When MCC Reset
4J	SPENT FUEL PUMPS	225	100.00	75.00	M	Not Required for Several Hours or Longer
5E	TRANSF. .22480/120V ALT. TO INVTR. 24	30	15 kVA	15.00	M	
5J	FUEL STORAGE BLDG. EXHAUST FAN	225	100.00	75.00	A	
6L	PAB SUPPLY FAN	150	50.00	37.50	M	May Run with Purge Fan

Notes:

This MCC creation outlined in reference 1-12.
* Equipment may auto start when pressure, level, temperature, etc. call for contact closure.
+ Potential A* equipment not expected to auto start due to other circumstances.
** Equipment loads in kw estimated using the nameplate hp ratings multiplied by the 0.746 conversion factor (except for battery charger).

Table 3.4-3
Loads on MCC 29A #
(Con Ed Dwg. A249955-07)

BRK NO.	DESCRIPTION	FUSE/BKR RATING (AMP)	RATING (HP)	APPROX LOAD (kw)**	RESET AUTO/MAN	REMARKS
3E	DIESEL GEN 21 COMPRESSOR	60	5.0	3.7	A*	Brief Operation to Resupply Starting Air
	FUEL OIL PUMP		2.00	1.50	A+	Auto at Approx. 20 min
	JACKET WATER & LUBE OIL HEATERS		21 kw	21.00	A+	Expect Off if DG Running
3C	INST. AIR CLSED COOL RECR. PMP 21	15	1.50	1.10	A*	
3G	WALL EXHAUST FAN 215	15	2.00	1.50	M	Operator starts if 480v SWGR Room Temp. is high.
3J	BATTERY CHARGER 21	80	25 kVA	45.00	A	High Recharging Load When MCC Reset
3L	INSTR. AIR COMPRESSOR 21	150	75.00	56.00	A*	Auto if Press < 100 psi
3A	480/120 TRANSF 21/IVTR 23	60	15 kVA	15.00	A	

Notes:

This MCC creation outlined in reference 1-12.
* Equipment may auto start when pressure, level, temperature, etc. call for contact closure.
+ Potential A* equipment not expected to auto start due to other circumstances.
** Equipment loads in kw estimated using the nameplate hp ratings multiplied by the 0.746 conversion factor (except for battery charger).

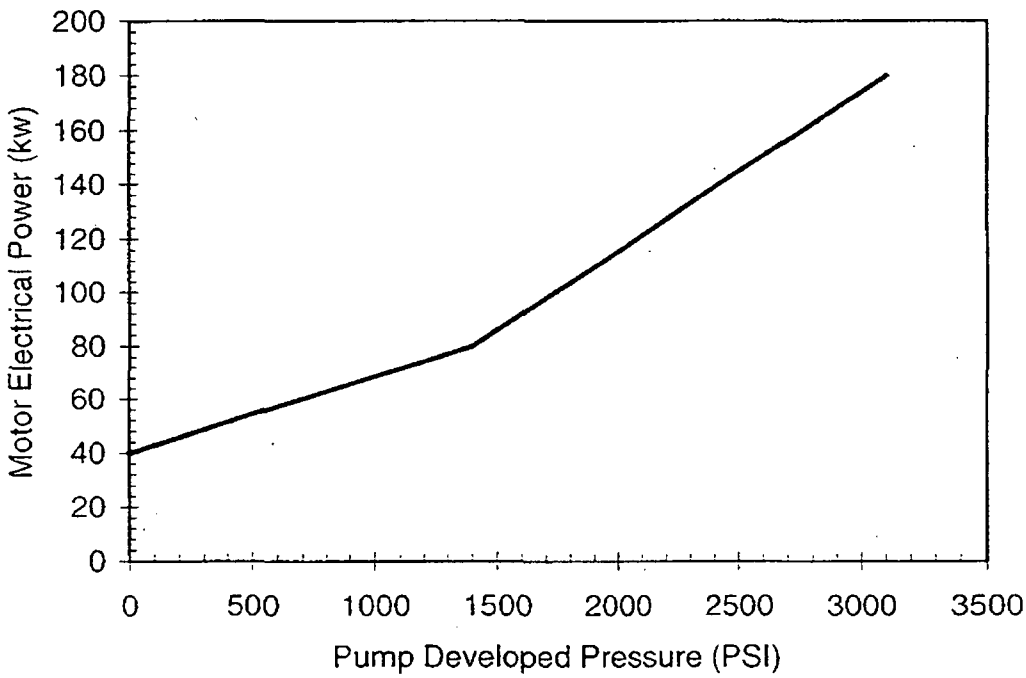
Table 3.4-4
Loads on MCC 211 *
(Con Ed Dwg. A208241-16)

BRK NO.	DESCRIPTION	RATING (HP)	APPROX LOAD (kw)**	RESET AUTO/MAN
1C	21 SG FW BYPASS VALVE #BFD-90	1.60	1.2	A
1F	22 SG FW BYPASS VALVE #BFD-90-1	1.60	1.2	A
1J	23 SG FW BYPASS VALVE #BFD-90-2	1.60	1.2	A
1M	24 SG FW BYPASS VALVE #BFD-90-3	1.60	1.2	A
2C	21 SG MAIN FW VALVE #BFD-5	6.60	4.9	A
2F	22 SG MAIN FW VALVE #BFD-5-1	6.60	4.9	A
2J	23 SG MAIN FW VALVE #BFD-5-2	6.60	4.9	A
2M	24 SG MAIN FW VALVE #BRD-5-3	6.60	4.9	A

Notes:
* Equipment loads in kw estimated using nameplate hp ratings multiplied by the 0.746 conversion factor.

Figure 3.4-1
Charging Pump Motor Power Versus Pump Pressure

Motor Power vs. Pump Pressure
Pump Speed: 208 RPM
Pump Flow: 98 GPM



Note: Power levels shown in this curve are conservative levels intended only for evaluating the adequacy of the power supply. This curve is applicable only for the identified speed and flow.

4.0 LOGIC FOR AUTOMATIC EQUIPMENT LOADING

This section describes the automatic safety injection sequence (SIS) and recirculation switch logic. Section 4.1 describes the injection phase. Section 4.2 describes the recirculation phase. Section 4.3 describes the automatic loading for a loss of offsite power event without SI actuation.

4.1 Safety Injection Sequence

Table 4.1-1 provides a summary of major safeguards equipment loaded during the safety injection sequence. Details of safeguards equipment loaded during the safety injection sequence are provided in Table 4.1-2.

The following information was used to develop the start times for safety injection sequencing of equipment automatically loaded during an accident.

1. At Time = 0 seconds, the following events occur simultaneously:
   - an "S" signal is generated
   - a safety injection signal with blackout is generated
   - a signal to start the diesel generators is generated

2. For a blackout condition, all loads are stripped off the 480 volt buses, except MCC 26A/26AA, MCC 26B/26BB, MCC 26C, and MCC 211.

   Reference documents:

   1. Consolidated Edison Drawing A225100, Emergency Generator Starting Logic (Ref. 4-1)

   2. FSAR Section 8.2, ELECTRICAL SYSTEM DESIGN, Sub-section 8.2.3.4 (Ref. 4-5)

   3. For MCC 26C, see References 4-14 and 4-15.

   4. For MCC 211, see Reference 4-17.

3. The emergency diesel generators are capable of starting and load sequencing within 10 seconds after the initial start signal. In addition, the starting system is redundant for each emergency diesel generator.

   Reference document:

   1. FSAR Section 8.2, ELECTRICAL SYSTEM DESIGN, Sub-section 8.2.3.1 (Ref. 4-5)

4. EDG output breaker 52/EG1 (52/EG2 & 52/EG3) closure is enabled by voltage permissive relay CVX/EDG21 (CVX/EDG22 & CVX/EDG23) in $\leq$ 10 seconds.

   Reference document:

   1. Consolidated Edison Drawing A225100, Emergency Generator Starting Logic (Ref. 4-1)

5. The emergency diesel generators have the capability of being fully loaded within 30 seconds after the start of load sequencing.

   Reference document:

   1. FSAR Section 8.2, ELECTRICAL SYSTEM DESIGN, Sub-section 8.2.3.1 (Ref. 4-5)

Table 4.1-1
Safety Injection Major Equipment Loading Summary

MCC or Bkr. I. D.	Component Energized	EDG 21# Bus 5A	EDG 22# Bus 2A	EDG 22# Bus 3A	EDG 23# Bus 6A
MCC 26A/AA	**	10			
52/SI1	SI Pump 21	13			
52/SW1 or SW4	+SW Pump 21 or 24	25			
52/CRF1	CR Fan 21	30			
52/CRF2	CR Fan 22	35			
52/CS1	CS Pump 21	40 ++			
MCC26C (1)	**			10	
MCC211 (2)	**			10	
52/SI2A	SI Pump 22		13*		
52/RHR1	RHR Pump 21			18	
52/SW2A or SW5B	+SW Pump 22 or 25		25*		
52/CRF4	CR Fan 24			30	
52/CRF3	CR Fan 23		35		
52/AF1	AFW Pump 21			40	
52/SI2B	SI Pump 22			50	
52/SW5A or SW2B	+SW Pump 25 or 22			55	
MCC 26B/BB	**				10
52/SI3	SI Pump 23				13
52/RHR2	RHR Pump 22				18
52/SW3 or SW6	+SW Pump 23 or 26				25 ++
52/CRF5	CR Fan 25				30 ++
52/AF3	AFW Pump 23				35 ++
52/CS2	CS Pump 22				40 ++

+ Only pump on essential header will start: SW Pump 21, 22, and 23 or SW Pump 24, 25 and 26.
++ Timing changes and elimination of the early CS pump start time are documented in References 4-20 and 3-19.
* Pump will be given another automatic start signal if not running.
** Miscellaneous pump, valve and fan motors.
# All times are in seconds and are based on a 10 second delay for diesel startup and contact closure of the EDG output breakers.
(1) References: 4-14, 4-15, and 4-8.
(2) References: 4-17 and 4-8.

Table 4.1-2
Safety Injection Equipment Loading

Equip I.D.	Time (sec)	EDG No.	Bus No.	Description	Notes
CCBP1	10	21	5A	MCC 26A	(Ref. 4-2 and 4-7)
746	10	21	5A	MCC 26A	(Ref. 4-2 and 4-7)
822A	10	21	5A	MCC 26A	(Ref. 4-2 and 4-7)
BFD-2-21	10	21	5A	MCC 26A	(Ref. 4-4 and 4-7)
52/MCC6A	10	21	5A	Not stripped	(Ref. 4-8)
52/SI1	13	21	5A	SI Pump 21	(Ref. 4-2 and 4-8)
52/CC1	16	21	5A	CCW Pump 21	Automatically loaded for loss of offsite power without SI, not automatically loaded for loss of offsite power with SI. (Ref. 4-2 and 4-8)
52/SW1 or	25	21	5A	SW Pump 21	(Ref. 4-2 and 4-8)
52/SW4	25	21	5A	SW Pump 24	(Ref. 4-2 and 4-8)
52/CRF1	30	21	5A	CR Fan 21	(Ref. 4-2 and 4-8)
52/CRF2	35	21	5A	CR Fan 22	(Ref. 4-2 and 4-8)
52/CS1	40	21	5A	CS Pump 21	(Ref. 4-2, 4-8, 4-20 and 3-19)

Table 4.1-2 (cont)
Safety Injection Equipment Loading

Equip I.D.	Time (sec)	EDG No.	Bus No.	Description	Notes
866A	10	21	5A	MCC 26A	(Ref. 4-2 and 4-7)
866C	10	21	5A	MCC 26A	(Ref. 4-2 and 4-7)
851A	133	21	5A	MCC 26A	Includes 120 second time delay. (Ref. 4-2, 4-6 and 4-7)
52/SI2A	13	22	2A	SI Pump 22*	52/SI2A can be closed provided that 52/SI2B is open. (Ref. 4-2 and 4-8)
52/MCC6C	10	22	3A	Not Stripped	Ref. 4-14 and 4-15)
52/RHR1	18	22	3A	RHR Pump 21	(Ref. 4-2 and 4-8)
52/CC2	19	22	2A	CCW Pump 22	Automatically loaded for loss of offsite power without SI, not automatically loaded for loss of offsite power with SI. (Ref. 4-2 and 4-8)
52/SW2A or	25	22	2A	SW Pump 22*	52/SW2A can be closed provided that both 52/SW2B is open and selector switch 43 is in position 1, 2, 3. (Ref. 4-2 and 4-8)
52/SW5B	25	22	2A	SW Pump 25*	52/SW5B can be closed provided that both 52/SW5A is open and selector switch 43 is in position 4, 5, 6. (Ref. 4-2 and 4-8)

* Pump will be given another automatic start signal if not running.

Table 4.1-2 (cont)
Safety Injection Equipment Loading

Equip I.D.	Time (sec)	EDG No.	Bus No.	Description	Notes
52/CRF4	30	22	3A	CR Fan 24	(Ref. 4-2 and 4-8)
52/CRF3	35	22	2A	CR Fan 23	(Ref. 4-2 and 4-8)
52/AF1	40	22	3A	AFW Pump 21	(Ref. 4-2 and 4-8)
52/SI2B	50	22	3A	SI Pump 22	52/SI2B can be closed provided that 52/SI2A is open. (Ref. 4-2 and 4-8)
52/SW5A or	55	22	3A	SW Pump 25	52/SW5A can be closed provided that both 52/SW5B is open and selector switch 43 is in position 1, 2, 3. (Ref. 4-2 and 4-8)
52/SW2B	55	22	3A	SW Pump 22	52/SW2B can be closed provided that both 52/SW2A is open and selector switch is in position 4, 5, 6. (Ref. 4-2 and 4-8)
CCBP2	10	23	6A	MCC 26B	(Ref. 4-2 and 4-7)
747	10	23	6A	MCC 26B	(Ref. 4-2 and 4-7)
822B	10	23	6A	MCC 26B	(Ref. 4-2 and 4-7)
BFD-2-22	10	23	6A	MCC 26B	(Ref. 4-4 and 4-7)
52/MCC6B	10	23	6A	Not stripped	(Ref. 4-8)
52/SI3	13	23	6A	SI Pump 23	(Ref. 4-2 and 4-8)
52/RHR2	18	23	6A	RHR Pump 22	(Ref. 4-2 and 4-8)

Table 4.1-2 (cont)
Safety Injection Equipment Loading

Equip I.D.	Time (sec)	EDG No.	Bus No.	Description	Notes
52/CC3	21	23	6A	CCW Pump 23	Automatically loaded for loss of offsite power without SI, not automatically loaded for loss of offsite power with SI. (Ref. 4-2, 4-8, 4-16 and 4-17)
52/CS2	40	23	6A	CS Pump 22	(Ref. 4-2, 4-8, 4-20 and 3-19)
52/SW3 or	25	23	6A	SW Pump 23	52/SW3 can be closed provided that selector switch 43 is in position 1, 2, 3. (Ref. 4-2, 4-8, 4-20 and 3-19)
52/SW6	25	23	6A	SW Pump 26	52/SW6 can be closed provided that selector switch 43 is in position 4, 5, 6. (Ref. 4-2, 4-8, 4-20 and 3-19)
52/CRF5	30	23	6A	CR Fan 25	(Ref. 4-2, 4-8, 4-20 and 3-19)
52/AF3	35	23	6A	AFW Pump 23	(Ref. 4-2, 4-8, 4-20 and 3-19)
851B	133	23	6A	MCC 26B	Includes 120 second time delay. (Ref. 4-2, 4-6 and 4-7)
866B	10	23	6A	MCC 26B	(Ref. 4-2 and 4-7)
866D	10	23	6A	MCC 26B	(Ref. 4-2 and 4-7)

4.2 Switchover to SI Recirculation Phase

4.2.1 Introduction

In this section the methodology developed to perform the switchover from the injection phase to the recirculation phase following a LOCA is described. When in the injection phase any operating Emergency Core Cooling System (ECCS) or CS pump takes suction from the RWST. In the recirculation phase, water is supplied from the recirculation sump or (as a backup) the containment sump.

To accomplish the switchover to recirculation, an eight switch sequence was developed. The switchover sequence is initiated when the RWST level decreases to less than 9.24 feet.

Although the recirculation switches described below are manually operated, each automatically initiates certain operations. An indicating lamp for each switch is provided to show the operator when the operations of a given switch have been performed and when he should proceed to the next operation. The indicating lamps are adjacent to the switches. Should an individual component fail to respond, the operator can take manual corrective action. All switches and lamps are on the Safeguards Panel.

4.2.2 Operational Sequence of Recirculation Switches

Operation of the recirculation switches is detailed in Reference 1-17 in EOP ES-1.3, "Transfer to Cold Leg Recirculation." Performance Test PT-R13A, "Recirculation Switches," (Ref. 4-12) also describes the actions of these switches. The description which follows incorporates the changes summarized in Reference 1-7 which were made during the spring 1989 refueling outage. Some additional changes were made to recirculation switches 2 and 5 during the 1991 refueling outage. These are described in Reference 4-19.

4.2.2.1 Switch One

Switch one is intended to remove and isolate unnecessary loads from the EDGs. When the operator closes switch one, SI pump 22 is automatically tripped provided SI pumps 21 and 23 are both running. If SI pump 22 is tripped, its suction valves (887A and 887B) are automatically closed.

If both CS pumps are operating, closing switch one automatically stops CS pump 21 and closes the pump discharge valves 866A and 866B. As explained in Reference 1-7, CS pump 21 is secured to reduce the load on EDG 21 during switchover. If CS pump 22 is not operating, however, CS pump 21 would continue to run.

The CS pump discharge valves will not shut unless the Containment Spray Signal has been reset. The Containment Spray Signal is reset in EOP ES-1.3 prior to operation of switch one.

4.2.2.2 Switch Three

As explained in Reference 1-7, switch three is operated before switch 2 to reduce some transient loads on the EDGs during the switchover sequence. Justification for this modification is provided in one of the SECLs of Appendix A and in a follow-up phone conversation with the NRC (Ref. 4-13).

When switch three is closed, both RHR pumps are automatically tripped and valves 744 and 882 are closed (if these valves are not energized, at this time, they are energized and closed later in ES-1.3). This removes additional unnecessary loads from EDGs 22 and 23. The recirculation pumps inside containment (which are started by switches four and five) are used for long term cooling.

4.2.2.3 Switch Two

Switch two establishes cooling flow to the RHR heat exchangers. When switch two is closed, one CCW pump and one non-essential (NE) SW pump receive signals to automatically start. Manual start of the CCW pump could be necessary since these pumps could be placed in PULLOUT to prevent undesired startup during SI reset. The order of priority for starting the CCW pumps is pump 22 followed by pump 21 and then pump 23. Thus, if CCW pump 22 is unavailable, CCW pump 21 is started. If CCW pumps 22 and 21 are both unavailable, CCW pump 23 is started.

Per References 1-17 and 4-19, the order of priority for starting the NE SW pump via recirculation switch two has been changed to "2-3-1" if pumps 21, 22, and 23 are on the non-essential header or to "5-6-4" if pumps 24, 25, and 26 are on the non-essential header.

4.2.2.4 Switch Four

Cold leg recirculation through the low head safety injection lines is initiated once switch four is closed. Closing this switch results in the automatic starting of recirculation pump 21 as well as the automatic opening of the discharge valves 1802A and 1802B. If recirculation pump 21 fails to start, the operator is directed to manually start recirculation pump 22. After switch four is closed, the operating recirculation pump takes suction from the recirculation sump and injects through the RHR heat exchangers into the RCS cold legs.

4.2.2.5 Switch Six

Upon completion of recirculation switch four, Step 10 of EOP ES-1.3 essentially checks to see if at least 600 gpm flow is being delivered to the core (by checking if low-head flow indications are greater than 600 gpm, plus uncertainties). This is used to determine if low or high-head recirculation is required. If both flow criteria for low-head injection given in ES-1.3 Step 10 are not met, then switch six is used to establish a high-head recirculation flow path with the recirculation pump supplying fluid to the suction of the SI pumps. Closing switch six will automatically close the RHR heat exchanger valves 746 and 747 to stop injection flow through the low head injection lines to the RCS cold legs, and automatically open valves

888A and 888B to provide a flow path from the recirculation pump discharge to the high head SI pump suction. The SI pumps then inject into the RCS cold legs.

Closing switch six also automatically closes SI pump test line valves 842 and 843.

4.2.2.6 Switch Seven

If either of the flow criteria for low head injection given in ES-1.3 Step 10 are met, then switch seven is closed. Closing switch seven automatically trips both running SI pumps. With sufficient flow through the low head injection lines, the SI pumps are no longer required for core cooling.

4.2.2.7 Switch Eight

When switch eight is closed, SI pump suction valve 1810 is automatically closed (if this valve is not energized, at this time, it is energized and closed later in ES-1.3). This isolates the SI pumps from the RWST. At this time, the SI pumps are either being fed by the recirculation pumps (see Section 4.2.2.5) or are tripped (see Section 4.2.2.6).

Closing switch eight also results in the CS pump test line valve 1813 automatically closing.

4.2.2.8 Switch Five

Switch five performs no action unless all three EDGs are operational (or offsite power is available). If all three EDGs are functional, switch five establishes additional cooling capability (beyond minimum requirements) by automatically starting a second NE SW pump, starting a second CCW pump, and starting recirculation pump 22 (if it is not already running). The order of priority for starting the second NE SW pump is pump 23 (or 26) followed by 21 (or 24). As with switch number two, manual (versus auto) start of one of the remaining CCW pumps (21 or 23) could be required to complete switch 5. To avoid transfer of a high heat load to the CCW system, the operator is directed to stop one of the recirculation pumps if only one CCW or one NE SW pump is running after switch five is performed.

Because switch five establishes additional cooling (beyond minimum requirements), this switch is not required and is not used until operation of the remaining recirculation switches is complete.

4.2.3 Recirculation Spray

After completion of switch eight, one CS pump (left operating by switch one) will continue to deplete the RWST. When the RWST level drops to the 2 ft empty alarm setpoint, the operator is to manually trip the CS pump. After this, they may establish recirculation spray by diverting some of the recirculated water to the RHR spray header through MOV-889B (or 889A). For low-head recirculation, the RHR discharge valves HCV-638 and/or 640 are adjusted to control the low-head and recirculation spray flows. High-head recirculation is established if the specified low-head and spray flows can not be established. If RHR spray is to be operated and the system is aligned for high-head recirculation, one of the spray

header valves is simply opened and then high-head recirculation flow is verified.

4.2.4 Technical Specifications Related to Switchover

Technical Specifications currently allow operation with any one (of three) non-essential service water pumps out of service for an extended period of time. To conservatively account for this scenario, the loading tables of sections 5 and 6 assume the backup service water pump (next in firing order) will be powered at the same time the primary pump is loaded. Thus, if the primary pump is out of service, the load would automatically be transferred to the EDG which powers the backup pump

4.3 Loss of Offsite Power Without SI Sequence

If there is no accident, the SI pumps, RHR pumps, CS pumps, and CR fans are not immediately required for core cooling and containment heat removal. Therefore, this equipment is not sequenced onto the EDGs if loss of offsite power without SI occurs. Without the additional safeguards loads, the EDGs have sufficient capacity for running the CCW pumps, which supply cooling to the RCP seals and other equipment. The AFW pumps can also start earlier in the sequence.

Table 4.3-1 shows the timing sequence for the major equipment loads for loss of offsite power without SI. MCCs 26A, 26B, and 26C and MCC 211 remain energized at the assumed EDG start time of 10 seconds (refer to Section 4.1). However, MOVs that change position with the SI signal do not change position if there is no accident. This also applies to the feedwater pump discharge valves (BFD valves) on MCCs 26A / 26B and the redundant main and bypass feedwater isolation valves on MCC 211.

Table 4.3-1
Loss of Offsite Power without SI Major Equipment Loading Summary

MCC or Bkr. I. D.	Component Energized	EDG 21# Bus 5A	EDG 22# Bus 2A	EDG 22# Bus 3A	EDG 23# Bus 6A
MCC 26A/AA	**	10			
52/CC1	CCW Pump 21	16			
52/SW1 or SW4	+SW Pump 21 or 24	25			
MCC26C	**			10	
MCC211	**			10	
52/CC2	CCW Pump 22		19		
52/SW2A or SW5B	+SW Pump 22 or 25		25*		
52/AF1	AFW Pump 21			30	
52/SW5A or SW2B	+SW Pump 25 or 22			55	
MCC 26B/BB	**				10
52/CC3	CCW Pump 23				21
52/SW3 or SW6	+SW Pump 23 or 26				25
52/AF3	AFW Pump 23				30

\+ Only pump on essential header will start: SW Pump 21, 22, and 23 or SW Pump 24, 25 and 26.
* Pump will be given another automatic start signal if not running.
** Miscellaneous pump, valve and fan motors.
\# All times are in seconds and are based on a 10 second delay for diesel startup and contact closure of the EDG output breakers.

5.0 EMERGENCY DIESEL GENERATOR LOADINGS FOR LARGE BREAK LOCA

In this section, the EDG loadings for large LOCA are presented. Section 5.1 describes the general RCS response and equipment requirements for large LOCA. In Sections 5.2 through 5.5, the EDG loading transients are determined for the various limiting failure cases. A summary for large LOCA with low-head recirculation is presented in Section 5.6. High-head recirculation is considered in Section 5.7.

5.1 General Equipment Requirements for Large LOCA

The large break LOCA imposes a challenging load for the EDGs due to the required operation of much of the safeguards equipment for extended periods of time. This section briefly describes the large LOCA event and the equipment required for mitigation of the accident.

5.1.1 SI, RHR, and Recirculation Pumps

The licensing basis for Indian Point Unit 2 assumes a minimum of two SI pumps and one RHR pump operate during the initial phase of the accident to refill the vessel (core recovery) to satisfy the clad temperature and metal-water reaction limits specified in 10CFR50.46. The RCS rapidly depressurizes to containment pressure, so these pumps reach run-out or maximum flow conditions near the beginning of the accident. Based on UFSAR Table 14.3-1, this blowdown time for large LOCA is typically about 30 seconds. Additional discussion related to the large LOCA safety analysis can be found in Section 14.3 of the UFSAR (Reference 5-5).

After the level in the RWST reaches the low-level setpoint (9.24 ft), the system is aligned for cold leg recirculation per EOP ES-1.3, Transfer to Cold Leg Recirculation. The time for this transition is approximately 20 minutes if all safeguards pumps are running (longer if less than full safeguards equipment is operating). Per the description given in Section 4.2, two SI pumps are left operating while the RHR pump(s) are stopped and the makeup source is switched to the recirculation sump. During this switchover, the injection flow from the two SI pumps will be at least 750 gpm (or 105 lbm /sec (see Appendix A, Table 4-5 of SECL-91-231). This exceeds the boil-off requirement by approximately a factor of two (see EOP ECA-1.1, Rev. 34, Figure ECA11-1). This ensures that the core will remain covered during switchover if there are any delays in re-establishing low-head SI flow (refer to Appendix A, SECL-89-744).

After switchover, one (of two) recirculation pumps aligned to the recirculation sump and discharging through one (of two) RHR heat exchangers will be adequate for makeup and long term cooling following the large LOCA event. As back-up to the recirculation pumps, the RHR pump(s) can be operated in the recirculation mode. Following verification of adequate recirculation flow in EOP ES-1.3, the SI pumps are stopped via Recirculation Switch No. 7.

Longer term (i.e., after 24 hours), the system is aligned for hot leg recirculation for

boron precipitation concerns using EOP ES-1.4. This mode of operation is established by opening the SI hot leg injection valves (MOV-856B and 856F), opening the SI to RHR heat exchanger suction valves (MOV-888A and 888B), and restarting two SI pump(s) to establish hot leg recirculation. The above alignment makes use of the automatic features of Recirc Switches 6 (turn ON) and 7 (turn OFF) to open the 888A/B valves and restart the SI pumps. If SI pump 22 is to be used, it will also be necessary to place Recirculation Switch No. 1 in the OFF position and open the SI pump 22 suction valves MOV-887A and 887B. After hot leg recirculation for 24 hours, the EOPs again direct the operators to align cold leg recirculation (within ES-1.4 instructions). Since the time into the accident is now more than 2 days, the operations manager is consulted for further instructions.

5.1.2 Containment Spray Pumps and Cooling Fans

The large LOCA ECCS calculations described briefly in the previous sub-section assumed minimum RCS injection / core flow but maximum containment cooling based on operation of both containment spray (CS) pumps and 5 containment recirculation (CR) fans. For the ECCS acceptance model, low containment back-pressure is conservative since it minimizes the RCS injection flow from the RHR and SI pumps. For containment integrity and EDG loading concerns, however, minimum containment cooling requirements are important.

A recent containment integrity analysis for large LOCA is based on operation of one CS pump and 3 CR fans. As summarized in Section 3.2, Table 3.2-1b (or Case 1 of Appendix B), the peak containment pressure based on 3083.4 MWt NSSS power and other limiting conditions was found to be 43.0 psig at 1400 sec. (More precisely, the time is reported as 1399 seconds in Appendix B). High initial containment temperature of 130°F and a high service water temperature of 95°F are assumed in this analysis. The peak pressure is significantly less than the containment design pressure of 47 psig.

After switchover to recirculation, one CS pump continues to operate until the level in the RWST reaches the empty alarm level (2 feet). This would occur at approximately 30 minutes if all safeguards equipment operates prior to switchover. For the limiting case analyzed, however, the spray pump continues to inject until somewhat later (2354 seconds = 39 minutes, based on the minimum safeguards conditions assumed). After the spray pump is secured, the 3 CR fans are adequate for containment cooling, capable of reducing containment pressure to less than 50% of the peak value within 24 hours.

In the current version of ES-1.3 (Rev. 36), the operator is directed to establish recirculation spray after securing the CS pump. However, since operation of the CR fans without recirculation spray is adequate for long term containment cooling, the EDG loading study will conservatively assume (by maximizing the fan cooler power required) that recirculation spray is not established when determining the fan cooler loads. The study will then remain bounding if recirculation spray is eliminated in a future revision to ES-1.3 (Note: for dose considerations, containment spray is required for 3.5 hours

following a LOCA. The EDG load study conservatively assumes the recirculation pumps operate at high flows as needed to provide recirculation spray.)

5.1.3 Component Cooling and Service Water Pumps

Post-accident requirements for the component cooling and service water systems can be found in FSAR Sections 9.3 and 9.6, respectively. Requirements for each system are briefly described here.

During the injection phase of the accident, there is no immediate need to operate a component cooling pump. Safety related components that do require component cooling during injection have auxiliary pumps to provide this function and /or rely on the component cooling water volume as a heat sink. Auxiliary component cooling pumps provide cooling water for the recirculation pump motor coolers to protect them from the harsh containment environment. Bearings for each SI pump are also cooled by a smaller auxiliary pump connected directly to the SI pump shaft. If a charging pump is operated, studies have indicated that it will operate for an extended period of time without CCW cooling provided the charging pump operates at full flow (Ref. 3-10). At reduced flow, the pump is less efficient and this will cause the speed control unit to heat up within about one minute. Therefore, in EOP E-0, the operator is instructed to operate the charging pump at maximum speed. If CCW cooling to the charging pumps is not in service, the operator is directed to establish backup cooling using city water (per SOP 4.1.2).

During recirculation, one CCW pump and one non-essential service water pump are required for cooling one (or both) RHR heat exchangers. This assumes that only one recirculation pump is operated. A second CCW pump and non-essential service water pump are needed if a second recirculation pump is operated. Additional details on the various "ultimate heat sink" (UHS) configurations can be found in References 5-6 and 5-7. Note that the EOPs currently require a second CCW pump be operated if the river water temperature exceeds 85°F. In view of the recent UHS work (specifically Cases 3, 4, 8, and 4b in References 5-6 and 5-7), the second pump is no longer required if only one recirculation pump operates. This would allow the EOPs to be changed to resolve a low probability EDG overloading concern identified in CRS 200105357.

Essential service water provides cooling to the EDGs and containment fan coolers. Three service water pumps operate on the essential header. A minimum of two essential service water pumps are required during the accident.

5.1.4 Auxiliary Feedwater Pumps

The AFW flow requirements had been considered in detail in the original EDG loading study (WCAP-12655, Rev. 0), since it was desirable to secure the motor-driven pumps during switchover to reduce the loads on EDGs 22 and 23. For this reason, requirements for large and small LOCA and non-LOCA events are described. A safety

evaluation for stopping the motor driven AFW pumps during switchover is given in Appendix A. A presentation to the NRC was also made on this issue (Reference 1-10).

For large LOCA, AFW is not required for decay heat removal since safety injection and break flow will adequately maintain vessel inventory and provide for core decay heat removal. However, in EOP E-1, Loss of Reactor or Secondary Coolant, the operator is instructed to maintain the total feed flow greater than some minimum value until level in at least one steam generator is confirmed to be on span in the narrow range. For stretch-rated conditions (3083.4 MWt NSSS power), the minimum feed flow requirement currently in the EOPs is 400 gpm (this allows for 20 gpm uncertainty in excess of the 380 gpm minimum feed flow requirement). Note that the SG level step in EOP E-1 is a continuous action step, i.e., the operator could reduce feed flow at some later time or step in E-1 provided the level criterion is satisfied.

The minimum feed flow requirement mentioned above is established by the loss of main feedwater transient described in Chapter 14 of the FSAR. Since E-1 must apply for secondary breaks and very small LOCAs where the SGs are important for decay heat removal, it is appropriate that the SG level step be included. For large LOCAs and even for small LOCA several inches in diameter, however, the feed flow restriction is conservative. For these cases, the motor-driven AFW pumps could be secured (or flow reduced) to reduce the loading on EDGs 22 and 23, particularly during the recirculation phase of the accident when the operator is performing the recirculation switch sequence directed in ES-1.3, Transfer to Cold Leg Recirculation.

For this Revision 2 update, it is assumed the operator reduces AFW flow from the motor-driven AFW pumps to the minimum recirculation value (85 gpm), instead of stopping the pump completely, when indicated level reaches 26% in the narrow range. This is the indication required for level to be on span and above the top of the SG U-tubes for adverse containment conditions. For normal containment conditions, this uncertainty is only 9%[#] (Note: in the Indian Point Unit 2 EOPs, adverse containment conditions are assumed if the containment pressure is greater than 4 psig or if containment radiation levels exceed 10^5 R/hr. Based on the results in Section 3.2, adverse containment conditions based on the containment pressure criterion clearly apply.)

Expected SG Level Response for Large LOCA

At full power operation, the mixture mass in each SG is calculated to be approximately 77,000 lbm (Section 6.3 of Reference 5-8). This is based on current operating parameters of 3083.4 MWt NSSS power, Model 44F SGs, loop average temperature of approximately 559°F, and initial narrow range level of 49%. A 3% variation in narrow range level (from 46% to 52%) causes the SG liquid mass to change approximately 2.4%, with higher level corresponding to higher mass and vice versa. For the remaining

[#] This EOP setpoint will change to 10% in a future revision to the EOPs (Rev. 39). The 26% value for adverse containment will also increase to 27%.

sensitivities investigated (tube plugging up to 10%, feedwater temperature decreased 4°F, blowdown flow at zero and several times nominal, and Tavg 3°F higher or lower), results change by less than 500 lbm (0.65%). Therefore, for purposes of determining the SG refill times, the approximate "base estimate" liquid mass of 77,000 lbm will be assumed. If the plant is operated at higher levels in the future (as proposed for the Model 44F SGs), the liquid mass would be higher and refill time reduced. The refill time would also be reduced if the turbine-driven AFW pump is operated (as instructed early in EOP E-0). In the evaluation that follows, the impact of the T-D AFW pump is not considered (conservative).

In the post-trip response for large LOCA, the SGs will not steam since the break removes all the decay and sensible energy. Instead, the SGs will remain near saturated conditions at approximately 500°F (approximate initial temperature) for several minutes and subsequently depressurize to RCS conditions since they remain higher in temperature and pressure than the primary. The secondary pressure in the SG of the broken loop could depressurize somewhat faster than the others for a cold side break downstream of the SG.

To determine whether or not the operator would reduce AFW flow prior to switchover, the principal sources of uncertainties comprising the 26% level requirement will be reviewed. They are approximately as listed below:

9%	Uncertainties associated with normal containment conditions
8%	Approximate amount reading could be high due to reference leg heatup
8%	Environmental allowance of the DP transmitters
1%	Miscellaneous (includes IR degradation)
26%	Total SG NR level requirement for adverse containment conditions

A more exact tally of these contributions is provided in the SG EOP Set-point calculations for SG level (Reference 5-9).

Of the above contributions, only the reference leg heatup portion causes the reading to be predictably high, given that the event is a LOCA or high energy line break that heats up containment to around 250°F. The remaining contributions are for the most part random. The environmental allowance is added absolutely (instead of statistically combined by the square-root sum of the squares method) to be conservative. This uncertainty contribution could be positive, negative, or (if the instrumentation is accurate) close to zero.

Based on the above description, an indicated narrow range level of 26% would correspond to 18% actual level, adjusting only for the reference leg heatup effect for large LOCA. The time to refill the SG can then be determined based on the time to refill to 18% NR at the assumed flowrate of 400 gpm.

Based on the expected density at 500°F and volume of 2238 ft^3 (water volume at 18% narrow range for a Model 44F SG), the SG liquid mass would have to be increased to

109,500 lbm to meet the heat sink level criterion for adverse containment. Based on a flow of 400 gpm (approximately 27.6 lbm/sec to each of two SGs), it takes 19.6 minutes to reach 18% actual (26% indicated) on the narrow range, starting from the initial liquid mass of 77,000 lbm (these results are documented on page 24 of Reference 5-8). Therefore, after 20 minutes, it is reasonable to assume operator reduces AFW flow to the minimum recirculation value of 85 gpm.

Table 5.1-1 summarizes the estimated times to switchover for the large LOCA scenarios of interest. Also included are approximate times at which recirculation switches would be operated. The flowrates assumed for the RWST draindown are based on those obtained in Section 3.1, excluding mini-flow (note: this table was taken from Table 6-6 of Reference 5-8). Results indicate that in all cases, switchover occurs after an elapsed time of 20 minutes, i.e., after SG level indicates on span (26% NR).

Simulator results for the four cases are similar but typically have slightly longer times to switchover. A combination of the calculated / simulator times in Table 5.1-1 will be used in the large LOCA loading spreadsheets described in the sections which follow.

Expected SG Level Response for Small LOCA

For a small LOCA, the reference leg heat-up would not be as high (containment temperature significantly less than 240 F). Depending on the break size, some secondary inventory would also be relieved through the atmospheric relief valves (or safety valves) until safety injection matches break flow and is sufficient for removing decay heat.

Results for the 6" small LOCA described in Reference 5-1 are not significantly different from the large break from the standpoint of AFW flow requirements. By 500 seconds, the RCS pressure was less than 300 psia and the break flow and SI flow (approximately 100 lbm/sec for both) was capable of removing decay heat and maintaining vessel inventory. Since the 6" break transient demonstrated that AFW was not required at a comparatively early time, the smaller 3" and 4" diameter break cases are considered in more detail.

The 3" and 4" break cases in the FSAR (Reference 5-5) have been analyzed out to 3000 seconds (50 minutes) and 2500 seconds (41 minutes), respectively. For the 4" break, the balance between break flow and SI flow, which matches or exceeds decay heat, occurs at around 900 seconds (15 minutes) (when the two flows are approximately 78.8 lbm/sec). For the 3" break, this balance occurs somewhat later, at approximately 1550 seconds (26 minutes). For "better estimate" decay heat and SI flows, shorter times would be anticipated. Considering the SG refill trends (Table 6-4 of Reference 5-8) and the times at which break flow and SI flow remove decay heat, the expected time to reach 26% NR level would be around 30 to 40 minutes for a small LOCA. (The smaller time would be applicable to the larger of the two break cases).

For the 3" and 4" break cases, RCS pressure remains at or above the shutoff head pressure of the low-head SI (RHR) pumps for a prolonged period of time. Therefore, the minimum switchover time can be estimated assuming operation of 3 SI pumps and 2 CS pumps (in the FSAR analysis, only 2 SI pumps are considered). Using maximum SI and CS flows, and considering spray actuation at the 24 psig set-point, an "early" spray actuation time of ~10 to 15 minutes is determined for the 4" break (see also Table 3.2-3). The earliest time to switchover is estimated to be 40 to 45 minutes for this case. For spray actuation at 30 psig (at approximately 65 minutes), switchover is delayed until about 105 minutes. Thus, for these smaller break sizes, the operator would be able to reduce AFW flow to the minimum recirculation value prior to ES-1.3 entry. For long term cooling and EDG loads, these cases are generally more limiting than large LOCA since SI pumps must be operated in addition to the recirculation (or RHR) pumps. For large LOCA, the recirculation pumps are sufficient for core cooling and the SI pumps can be stopped.

Summary and Conclusion

Based on this evaluation, it can be concluded that the motor-driven AFW pumps can be reduced to minimum recirculation flow for any small or large LOCA of interest upon entry into ES-1.3. At the presentation noted above (Reference 1-10), the NRC accepted stopping the motor-driven AFW pumps during switchover as an interim solution for limiting the loads on EDG 22 and 23 in the original loading study (WCAP-12655, Rev. 0). Since these pumps are safety-related, they indicated their expectation that these pumps remain on during after switchover once the EDG ratings were increased.

Based on current operating conditions, calculations support reducing AFW flow at approximately 20 minutes for large LOCA. This is the time calculated to reach the indicated 26% narrow range level for adverse containment conditions. After this time, the operator could reduce flow to the minimum recirculation value and maintain SG narrow range level on span as directed in the EOPs. This time coincides with the time to switchover for the large LOCA scenario with all EDGs operating. Times to switchover would be somewhat longer for EDG failure cases (Table 5.1-1).

For small LOCA (4" or 3" break cases), the time at which narrow range level reaches the indicated 26% value would be 30 to 40 minutes. Since AFW flow is not required for decay heat removal at these times, flow can also be reduced. The earliest switchover times for these cases exceeds 40 minutes, so the action can be accomplished during the injection phase prior to recirculation.

AFW Flow Rates and Power Requirements

Per Reference 1-30, the AFW flow controllers for the motor-drive AFW pumps are set to deliver between 200 - 205 gpm per line with an accuracy of $\pm$9.59 gpm. For the maximum setting, the AFW flow delivered would be 410 + 2*9.59 = 429 gpm. Referring

to Section 3.1, the power requirement at this flow rate is 376 kw.

The expected flow rate for minimum recirculation flow is approximately 85 gpm per Reference 1-32. Again referring to Section 3.1, the power requirement at this flow rate is 223 kw.

5.1.5 Miscellaneous Losses

These are treated the same as assumed in the EDG load study update done for the 2000 restart (page 11 of Reference 1-26).

Including bus and cable losses (ranging from 82 to 87 kw) and frequency fluctuations of up to 0.5% (60 Hz $\pm$ 0.3 Hz), which add 1.5% (or 35 kw at the 2300 kw rating), the following miscellaneous loss are included:

EDG 21: 117 kw EDG 22: 122 kw EDG23: 119 kw

These loads are not precise and constant in time, but are judged to be conservative and appropriate for this load study. These are used for large LOCA as well as small LOCA and other transients analyzed in Sections 6.0 and 7.0.

Table 5.1-1
Summary of RWST Switchover and Recirculation Switch Times for Large LOCA
(all times are in minutes from the initiation of the accident)

Switchover Actions:	All EDGs Operating	EDG 21 Fails	EDG 22 Fails	EDG 23 Fails
RWST Switchover (Note 1)	20 (22)	34 (30)	22 (24)	35 (38)
Recirc Switches 1 and 3	22	36	24	37
Recirc Switch 2	24	38	26	39
Recirc Switch 4	25 (26)	39 (33)	27 (28)	40 (41)
Recirc Switch 7	27	41	29	42
Recirc Switch 8	28	42 (35)	30 (32)	43 (43)
Recirc Switch 5 (Note 2)	31 (30)	NA	NA	NA
RWST Empty Alarm	33	50	36	51
Isolate/Vent Accumulators	45 (46)	62 (57)	48 (43)	63 (63)

Notes:

1. Maximum flow rates from the safeguards pumps have been used in determining the switchover times. Times for all EDGs operating would be delayed by approximately one minute if one SI or one RHR pump fail or 6 minutes if one CS pump fails.
2. Switch 5, which aligns a second cooling train, is performed only if all 480V busses are energized.
3. Results informally provided based on simulator tests are provided in parentheses ( ).

5.2 Large LOCA with All Emergency Diesel Generators Operating

Table 5.2-1 is a time table of events describing the large LOCA transient with all EDGs operating. Revision 38 of the Indian Point Unit 2 EOPs (Ref. 1-28) plus information presented in previous sections of this report was used to construct this scenario. The times used for manual actions are based on times that should be typical for performing the actions in the EOPs. These times can be confirmed by the operations staff and /or with Indian Point 2 specific simulations for large LOCA. The exact timing of the manual actions is not critical. The order in which the recirculation switches are performed is important, so this relative timing must be preserved.

To be conservative, optional loads that could be added (per E-0 Step 6) are assumed to be loaded before switchover. This equipment includes instrument air compressors, battery chargers (required after about 2 hours) plus other component loads listed in Table 5.2-1. During the semi-automatic switchover procedure, it has been assumed that each switch takes 1 to 2 minutes to complete. Since many of the valves operated during switchover have a stroke time of approximately 2 minutes (see Section 3.3), a 2 minute time delay for each switch was usually assumed. Note that based on SECL 89-744 in Appendix A, Recirculation Switch 3 is performed before Switch 2.

The time table of events in Table 5.2-1 was used to define the EDG loads for the all EDGs operating case. The loading "spreadsheets" for this scenario are provided in Tables 5.2-2a (EDG 21), 5.2-2b (EDG 22) and 5.2-2c (EDG 23). At the bottom of each spreadsheet, the total EDG loads are provided. The total EDG load includes the effect of one non-essential service water pump out of service. As noted in section 4.2, Indian Point Unit 2 Technical Specifications allow one non-essential service water pump to be out of service at any time. Should the preferred pump be out of service, the backup pump (next in firing order) would be required to operate. Thus, the spreadsheets conservatively account for this by loading the backup pump when the preferred pump is loaded. Below the total EDG loads, the EDG loads for limiting single failures are given. Also included is the limiting single failure assumed at the various times during the accident.

Tables 5.2-2a, 2b, and 2c show acceptable results (loads < 2100 kw) excluding limiting single failures. With the single limiting failure, the loads on EDG 23 may surpass the 2100 kw 2-hour limit, but do not exceed the 2300 kw half-hour limit.

The limiting load for this case is the switchover phase load for EDG 23 (with failure of RC Pump 21). The maximum load is calculated to be 2176 kw. However, this load is reduced to 1822 kw within several minutes, once the SI pumps are stopped.

During the injection phase, the next most limiting load on EDG 23 is 2135 kw (if RHR Pump 21 fails). Since this injection phase load exceeds 2100 kw for only ~20 minutes, the loads are well within the 2-hr and half-hour ratings of the EDGs.

Table 5.2-1
Time Table of Events
Large LOCA with All Diesel Generators Operating

Event	Time (min)
Large LOCA with Loss of Offsite Power, SI and Containment Spray Actuation	0
All Diesels Start, Major Equipment Sequences Onto 480 V Buses per Description in Section 4.1	0-1
Other Miscellaneous Equipment on MCCs 26A, 26B, 26C, and 211 Load Automatically: Control Room A.C.-Incident Mode Cable Tunnel Exhaust Fans (Auto-Temp) EDG Support Loads (Emg. Lighting, Vent and Exhaust Fans) MOV Loads for Valves Moving to Safeguards Positions	0-1
Operators Directed to Emergency Operating Procedure (EOP) E-0, Reactor Trip or Safety Injection, Step 1	1
Operators Verify Reactor Trip, Turbine Trip, and SI Actuation	3
MCCs 24A, 27A, and 29A reset per EOP E-0 The following components are loaded automatically:	4

EDG 21, Bus 5A

MCC 29A

Inst. Air Comp. 21 (and Support Loads)	60 kw
Battery Charger 21	45 kw
EDG 21 Auxiliaries (Compressor)	4 kw
Additional EDG 21 Load =	109 kw

EDG 22, Buses 2A /3A

MCC 24A

EDG 22 Auxiliaries (Compressor)	4 kw
Inst. Air. Comp. 22 (and Support Loads)	60 kw
Battery Charger 22	45 kw
Radiation Monitor 45	2 kw
Additional EDG 22 Load =	111 kw

Table 5.2-1 (page 2)
Time Table of Events
Large LOCA with All Diesel Generators Operating

Event		Time (min)
EDG 23, Bus 6A:		
MCC 27A		
Battery Charger 24	45 kw	
Additional EDG 23 Load =	45 kw	
Operator Starts a Charging Pump at Maximum Speed, Verifies Flow Path From RWST, and Dispatches Operator to Establish Backup Cooling per SOP 4.1.2		4
Control Room Operators Continue with Immediate Actions of EOP E-0		5-10
Transition to EOP E-1, Loss of Reactor or Secondary Coolant		12
Operator Resets SI and Containment Spray, Places CCW Pumps in PULLOUT		16
Establish PAB Ventilation per EOP E-1 - Operator Establishes Portable Ventilation per AOI 27.1.9 (high EDG 22 and 23 loads). Operator Confirms Operation of Switchgear Room Exhaust Fan		18
Initiate Evaluation of Plant Status (per E-1)		19
SG NR Levels Indicate >26%- Operator Reduces AFW Flow (action assumed completed 3 minutes later)		20
RWST Level Less Than 9.24 ft - Transition to ES-1.3, Transfer to Cold Leg Recirculation		20
Operator Dispatches NPO to Open CCW Hx SW Outlet Valves, Verifies or Completes SI and Spray Reset		21

Table 5.2-1 (page 3)
Time Table of Events
Large LOCA with All Diesel Generators Operating

Event	Time (min)
Perform No. 1 and No. 3 Recirculation Switch Sequence: SI Pump 22 Stops Valves 887A and 887B Close CS Pump 21 Stops Valves MOV-866A and 866B Close RHR Pumps 21 and 22 Stop Valves MOV-882 and 744 Close	22
Operator confirms SW alignment and stops charging pumps	23
Perform No. 2 Recirculation Switch Sequence: Non-Essential SW Pump 22 (or 25) Starts (If SW Pump 22 /25 Out of Service, Pump 23 /26 Starts) CCW Pump 22 Started Manually	24
Perform No. 4 Recirculation Switch Sequence: Recirc Pump 21 Starts Valves MOV-1802A and 1802B Open	26
Operator continues with ES-1.3 assuming low-head recirculation:	
Perform No. 7 Recirculation Switch Sequence: SI Pumps 21 and 23 Stop	28
Perform No. 8 Recirculation Switch Sequence: Valve MOV-1810 Closes (if energized) CS Test Line Valve 1813 Closes	29
Operator Confirms All EDGs Operating (Allows Recirc. Switch 5)	30
Perform No. 5 Recirculation Switch Sequence: Non-Essential SW Pump 23 (or 26) Starts (If SW Pump Out of Service, Pump 21 /24 Starts) CCW Pump 21 Started Manually Recirc Pump 22 Starts	31

Table 5.2-1 (page 4)
Time Table of Events
Large LOCA with All Diesel Generators Operating

Event	Time (min)
After No. 5 Recirculation Switch, the Following Major Equipment may be Operating:	31
Bus 5A: (EDG 21) — CR Fans 21 and 22; Essential SW Pumps 24 (or 21); Non-ESS SW Pump 21 (or 24), if other SW Pump Out of Service; Recirc Pump 21; CCW Pump 21; Selected Equip. on MCCs 26A, 26AA, and 29A	
Bus 2A /3A: (EDG 22) — CR Fans 23 and 24; Non-Ess Service Water Pump 22 (or 25); Essential SW Pumps 25 (or 22); CCW Pump 22; AFW Pump 21 (at recirc flow); Selected Equipment on MCCs 24A, and 26C	
Bus 6A: (EDG 23) — CR Fan 25; CS Pump 22; Essential SW Pump 26 (or 23); Non-Ess SW Pump 23 (or 26); Recirc Pump 22; AFW Pump 23 (at recirc flow); Selected Equip. on MCCs 26B, 26BB, and 27A	
Other Valves Close by Manual or Local Operator Action: MOV-743, MOV-1870, MOV-842, MOV-843	29-32
RWST Level Reaches 2.0 ft, Operator Aligns Spray to Recirculation per ES-1.3: CS Pump 22 is Stopped; Valves MOV-866C and 866D Closed; Valve MOV-746 or MOV-747 Closed; Valve MOV-889B Opened	33

Table 5.2-1 (page 5)
Time Table of Events
Large LOCA with All Diesel Generators Operating

Event	Time (min)
Operator Confirms Core Flow and Recirc Spray Requirements	35
Recirculation Water pH Verified to be in Proper Range (otherwise a charging pump and BA transfer pump are operated to raise or lower pH)	40
Operators Isolate Accumulators by Closing Discharge Valves 894A-894D	45
Valves HCV-3100 and 3101 Opened to Vent the Upper Head	48
Operator Establishes PAB Ventilation on EDG 22 (less loaded than EDG 23 if limiting single failures taken into account)	50
End of Transient Modeled	60
Operator Continues Efforts to Energize AC 480 V Busses from Offsite Power	

Table 5.2-2a Large LOCA With All EDGs Operating - Loads on EDG 21

06/24/02

Bus 5A Loading - EDG 21

			Time in Minutes									Recirculation Switch Sequence No. 1&3				No. 2		No. 4		No. 7&8		No. 5				Recirc Spray									
Equipment	Max kW	Man/Auto	1	*	5	*	10	*	15	*	20	*	22	*	24	*	25	*	27	*	30	*	31	*	32	*	34	*	38	*	45	*	48	*	60
SI Pmp 21 (400)	345	A	345		345		345		345		345		345		345		345		345	-345	0		0		0		0		0		0		0		0
SI Cir Wtr Pmp 21	2.2	A	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2	-2.2	0		0		0		0		0		0		0		0
CS Pmp 21 (400)	350	A	350		350		350		350		350	-350	0		0		0		0		0		0		0		0		0		0		0		0
CR Fan 21 (350)	250	A	221	-5	216		216	-9	207	-4	203		203		203	-3	200		200	-6	194		194		194		194		194		194	-10	184		184
CR Fan 22 (350)	250	A	221	-5	216		216	-9	207	-4	203		203		203	-3	200		200	-6	194		194		194		194		194		194	-10	184		184
RC Pmp 21 (350)	303	M			0		0		0		0		0		0		0	287	287		287		287		287		287		287		287		287		287
Ess SW Pmp 24 (350)	282	A	282		282		282		282		282		282		282		282		282		282		282		282		282		282		282		282		282
NE SW Pmp 21 (350)	282	M			0		0		0		0		0		0		0		0		0	282	282		282		282		282		282		282		282
CCW Pmp 21 (250)	230	M			0		0		0		0		0		0		0		0		0	213	213		213		213		213		213		213		213
Chg Pmp 21 (200)	150	M	50		50		50		50		50		50	-50	0		0		0		0		0		0		0		0		0		0		0
Srv Air Comp (125)	93	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Pzr Htrs 23	485	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Ltg Bus 23 (120/208V)	135	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Ltg Bus 23 (480V-Emg)	100.	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MCC 26A Loads																																			
MOVs:																																			
MOV-822A	0.7	A	0.7	-0.7	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-894A	5.6	A			0		0		0		0		0		0		0		0		0		0		0		0		0		0	5.6	5.6	-5.6	0
MOV-894C	5.6	A			0		0		0		0		0		0		0		0		0		0		0		0		0		0	5.6	5.6	-5.6	0
MOV-866A	0.6	A			0		0		0		0	0.6	0.6	-0.6	0		0		0		0		0		0		0		0		0		0		0
MOV-866C	0.6	A			0		0		0		0		0		0		0		0		0		0		0	0.6	0.6	-0.6	0		0		0		0
MOV-851A	0.7	A			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-744	5.8	A			0		0		0		0	5.8	5.8	-5.8	0		0		0		0		0		0		0		0		0		0		0
MOV-746	7.7	A	7.7	-7.7	0		0		0		0		0	0	0		0		0		0		0		0	7.7	7.7	-7.7	0		0		0		0
MOV-887A	0.4	A			0		0		0		0	0.4	0.4	-0.4	0		0		0		0		0		0		0		0		0		0		0
HCV-640	0.6	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
BFP-2-21	14.3	A	14.3	-14.3	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-1802A	0.7	M			0		0		0		0		0		0		0	0.7	0.7	-0.7	0		0		0		0		0		0		0		0
MOV-889A	0.6	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-842	0.6	M			0		0		0		0		0		0		0		0		0		0	0.6	0.6	-0.6	0		0		0		0		0
HCV-3100	0.25	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	0.25	0.25
MOV-1810	1.2	M			0		0		0		0		0		0		0		0	1.2	1.2	-1.2	0		0		0		0		0		0		0
CCW Boost Pmp 21 (5)	3.7	A	3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7
Elec Tun Exh Fan 21	7.4	A	7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4
DG Exh Fan 21 (nor)	0.5	A	0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5
EDG Bldg. Vent Fan 319,321	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
BA Ht Trace (nor)	16.8	A	16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8
XMFR 23 (Inv 21)(max)	10	M/A			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
EPX3	15	A	15		15		15		15		15		15		15		15		15		15		15		15		15		15		15		15		15
EPV21	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
MCC 26AA																																			
Misc MOVs	1	A	1		1		1		1		1		1		1		1		1		1		1	0.2	1.2	-0.2	1		1		1		1		1
H2/O2 Anlyz Ht Trc 1	3.3	A	3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3
MCC 29A																																			
DG 21 Support Loads																																			
Fuel Oil Pmp (2)	1.5	A			0		0		0	1.5	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
Compressor (5)	3.7	A		3.7	3.7	-3.7	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Bat Charger 21 (Max)	45	A		45	45		45	-20	25		25		25		25		25		25		25		25		25		25		25		25		25		25
Inst Air Comp 21 (75)	56	A		56	56		56		56		56		56		56		56		56		56		56		56		56		56		56		56		56
I.A. Cool Pmp 21 (3)	2.2	A		2.2	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2
Wall Exh Fan 215 (2)	1.5	M		1.5	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
Misc. Loss (Max)	117	A	117		117		117		117		117		117		117		117		117		117		117		82		82		82		82		82		82
Total EDG 21 Load:			1674		1749		1746		1708		1701		1358		1301		1295		1583		1224		1718		1684		1691		1683		1683		1674		1663
Total EDG 21 Load with Single Failure			1674		1749		1764		1742		1743		1750		1693		1683		1971		1606		2100		2066		1723		1715		1715		1698		1687
Single Failure Assumed:			CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump

Table 5.2-2b Large LOCA With All EDGs Operating - Loads on EDG 22

06/24/02

Bus 2A/3A Loading - EDG 22

Time in Minutes

											Recirculation Switch Sequence No. 1&3				No. 2		No. 4	
Equipment	Max kW	Man/Auto	1	*	5	*	10	*	15	*	20	*	22	*	24	*	25	*
SI Pmp 22 (400)	345	A	345		345		345		345		345	-345	0		0		0	
SI Cir Wtr Pmp 22	2.2	A	2.2		2.2		2.2		2.2		2.2	-2.2	0		0		0	
RHR Pmp 21 (400)	316	A	255		255		255		255		255	-255	0		0		0	
AFW Pmp 21 (400)	387	A	376		376		376		376		376		376	-153	223		223	
CR Fan 23 (350)	250	A	221	-5	216		216	-9	207	-4	203		203		203	-3	200	
CR Fan 24 (350)	250	A	221	-5	216		216	-9	207	-4	203		203		203	-3	200	
Ess SW Pmp 25 (350)	282	A	282		282		282		282		282		282		282		282	
NE SW Pmp 22 (350)	282	M			0		0		0		0		0		0	282	282	
CCW Pmp 22 (250)	230	M			0		0		0		0		0		0	230	230	
Chg Pmp 22 (200)	150	M	50		50		50		50		50		50	-50	0		0	
Pzr Htr 21	554	M			0		0		0		0		0		0		0	
Pzr Htr 22	485	M			0		0		0		0		0		0		0	
Ltg Tran 21 (Nor)	150	M			0		0		0		0		0		0		0	
Ltg Tran 22	150	M			0		0		0		0		0		0		0	
Ltg Bus 23 (480V-Nor)	100	M			0		0		0		0		0		0		0	
MCC 211																		
MOV'S																		
BFD-90	1.2	A	1.2	-1.2	0		0		0		0		0		0		0	
BFD-90-1	1.2	A	1.2	-1.2	0		0		0		0		0		0		0	
BFD-90-2	1.2	A	1.2	-1.2	0		0		0		0		0		0		0	
BFD-90-3	1.2	A	1.2	-1.2	0		0		0		0		0		0		0	
BFD-5	5	A	5	-5	0		0		0		0		0		0		0	
BFD-5-1	5	A	5	-5	0		0		0		0		0		0		0	
BFD-5-2	5	A	5	-5	0		0		0		0		0		0		0	
BFD-5-3	5	A	5	-5	0		0		0		0		0		0		0	
MCC 24A																		
DG 22 Support Loads																		
Fuel Oil Pmp (2)	1.5	A			0		0		0	1.5	1.5		1.5		1.5		1.5	
Compressor (5)	3.7	A		3.7	3.7	-3.7	0		0		0		0		0		0	
XMFR 24 (Inv 22)(max)	15	M/A			0		0		0		0		0		0		0	
Inst Air Comp 22 (75)	56	A		56	56		56		56		56		56		56		56	
I.A. Cool Pmp 22 (3)	2.2	A		2.2	2.2		2.2		2.2		2.2		2.2		2.2		2.2	
Bat Charger 22 (Max)	45	A		45	45		45	-20	25		25		25		25		25	
Radiation Monitor 45	1.6	A		1.6	1.6		1.6		1.6		1.6		1.6		1.6		1.6	
MCC 26C																		
DG Exhaust Fan 22	0.8	A	0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8	
PAB Exhaust Fan 21 (125)	93	M	0		0		0		0		0		0		0		0	
EDG Bldg Vent Fan 320,322	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5	
Battery Charger 23	25	A	25		25		25		25		25		25		25		25	
CRAC Backup Fan (7.5)	5.6	A	0		0		0		0		0		0		0		0	
CRAC Booster Fan 21 (7.5), Dampers & Motors	5.8	A	5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8	
BA Trans Pump 21 (15)	11.2	A	11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2	
BAT Heaters 21	15	M	0		0		0		0		0		0		0		0	
Spent Fuel Pump 21 (100)	75	M	0		0		0		0		0		0		0		0	
Wall Exhaust Fan 213 (2)	1.5	M	0	1.5	1.5		1.5		1.5		1.5		1.5		1.5		1.5	
Misc. Loss (Max)	122	A	122		122		122		122		122		122		122		122	
Total EDG 22 Load:			1949		2025		2021		1983		1976		1374		1171		1677	
Total EDG 22 Load with Single Failure:			1997		2073		2069		2031		2024		1721		1518		2024	
Single Failure Assumed:			RHR Pump		RHR Pump		RHR Pump		RHR Pump		RHR Pump		SI Pump		SI Pump		SI Pump	

	No. 7&8		No. 5				Recirc Spray										
Equipment	27	*	30	*	31	*	32	*	34	*	38	*	45	*	48	*	60
SI Pmp 22 (400)	0		0		0		0		0		0		0		0		0
SI Cir Wtr Pmp 22	0		0		0		0		0		0		0		0		0
RHR Pmp 21 (400)	0		0		0		0		0		0		0		0		0
AFW Pmp 21 (400)	223		223		223		223		223		223		223		223		223
CR Fan 23 (350)	200	-6	194		194		194		194		194		194	-10	184		184
CR Fan 24 (350)	200	-6	194		194		194		194		194		194	-10	184		184
Ess SW Pmp 25 (350)	282		282		282		282		282		282		282		282		282
NE SW Pmp 22 (350)	282		282		282		282		282		282		282		282		282
CCW Pmp 22 (250)	230		230	-17	213		213		213		213		213		213		213
Chg Pmp 22 (200)	0		0		0		0		0		0		0		0		0
Pzr Htr 21	0		0		0		0		0		0		0		0		0
Pzr Htr 22	0		0		0		0		0		0		0		0		0
Ltg Tran 21 (Nor)	0		0		0		0		0		0		0		0		0
Ltg Tran 22	0		0		0		0		0		0		0		0		0
Ltg Bus 23 (480V-Nor)	0		0		0		0		0		0		0		0		0
MCC 211																	
MOV'S																	
BFD-90	0		0		0		0		0		0		0		0		0
BFD-90-1	0		0		0		0		0		0		0		0		0
BFD-90-2	0		0		0		0		0		0		0		0		0
BFD-90-3	0		0		0		0		0		0		0		0		0
BFD-5	0		0		0		0		0		0		0		0		0
BFD-5-1	0		0		0		0		0		0		0		0		0
BFD-5-2	0		0		0		0		0		0		0		0		0
BFD-5-3	0		0		0		0		0		0		0		0		0
MCC 24A																	
DG 22 Support Loads																	
Fuel Oil Pmp (2)	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
Compressor (5)	0		0		0		0		0		0		0		0		0
XMFR 24 (Inv 22)(max)	0		0		0		0		0		0		0		0		0
Inst Air Comp 22 (75)	56		56		56		56		56		56		56		56		56
I.A. Cool Pmp 22 (3)	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2
Bat Charger 22 (Max)	25		25		25		25		25		25		25		25		25
Radiation Monitor 45	1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6
MCC 26C																	
DG Exhaust Fan 22	0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8
PAB Exhaust Fan 21 (125)	0		0		0		0		0		0		0		0	93	93
EDG Bldg Vent Fan 320,322	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
Battery Charger 23	25		25		25		25		25		25		25		25		25
CRAC Backup Fan (7.5)	0		0		0		0		0		0		0		0		0
CRAC Booster Fan 21 (7.5), Dampers & Motors	5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8
BA Trans Pump 21 (15)	11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2
BAT Heaters 21	0		0		0		0		0		0		0		0		0
Spent Fuel Pump 21 (100)	0		0		0		0		0		0		0		0		0
Wall Exhaust Fan 213 (2)	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
Misc. Loss (Max)	122		122		122		122		122		122		122		122		122
Total EDG 22 Load:	1677		1665		1648		1648		1648		1648		1648		1628		1721
Total EDG 22 Load with Single Failure:	2024		1697		1680		1680		1680		1680		1680		1652		1745
Single Failure Assumed:	SI Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump		CS Pump

Table 5.2-2c Large LOCA With All EDGs Operating - Loads on EDG 23

06/24/02

Bus 6A Loading - EDG 23			Time in Minutes									Recirculation Switch Sequence No.1&3				No. 2
Equipment	Max kW	Man/Auto	1	*	5	*	10	*	15	*	20	*	22	*	24	*
SI Pmp 23 (400)	345	A	345		345		345		345		345		345		345	
SI Cir Wtr Pmp 23	2.2	A	2.2		2.2		2.2		2.2		2.2		2.2		2.2	
CS Pmp 22 (400)	350	A	350		350		350		350		350		350		350	
RHR Pmp 22 (400)	316	A	255		255		255		255		255	-255	0		0	
AFW Pmp 23 (400)	387	A	376		376		376		376		376		376	-153	223	
CR Fan 25 (350)	250	A	221	-5	216		216	-9	207	-4	203		203		203	-3
RC Pmp 22 (350)	303	M			0		0		0		0		0		0	
Ess SW Pmp 26 (350)	282	A	282		282		282		282		282		282		282	
NE SW Pmp 23 (350)	282	M			0		0		0		0		0		0	282
Chg Pmp 23 (200)	150	M	50		50		50		50		50		50	-50	0	
Trb Aux Lub (150)	112	M			0		0		0		0		0		0	
Pzr Htr Cntrl Gp	277	M			0		0		0		0		0		0	
Ltg Tran 21 (Emg)	150	M			0		0		0		0		0		0	
CCW Pmp 23	230	M			0		0		0		0		0		0	
MCC 26B Loads																
MOVs:																
MOV-822B	0.7	A	0.7	-0.7	0		0		0		0		0		0	
MOV-894B	5.6	A			0		0		0		0		0		0	
MOV-894D	5.6	A			0		0		0		0		0		0	
MOV-866B	0.6	A			0		0		0		0	0.6	0.6	-0.6	0	
MOV-866D	0.6	A			0		0		0		0		0		0	
MOV-851B	0.7	A			0		0		0		0		0		0	
MOV-882	2.2	M			0		0		0		0	2.2	2.2	-2.2	0	
MOV-887B	0.4	A			0		0		0		0	0.4	0.4	-0.4	0	
MOV-747	7.7	A	7.7	-7.7	0		0		0		0		0		0	
HCV-638	0.6	M			0		0		0		0		0		0	
BFP-2-22	14.3	A	14.3	-14.3	0		0		0		0		0		0	
MOV-1802B	0.7	A			0		0		0		0		0		0	
MOV-889B	0.6	M			0		0		0		0		0		0	
MOV-843	0.6	M			0		0		0		0		0		0	
HCV-3101	0.25	M			0		0		0		0		0		0	
CC Boost Pmp 22 (5)	3.7	A	3.7		3.7		3.7		3.7		3.7		3.7		3.7	
Elec Tun Exh Fan 22	7.4	A	7.4		7.4		7.4		7.4		7.4		7.4		7.4	
BA Heat Trace (Emg)	16.8	M			0		0		0		0		0		0	
CRAC Humidifier	2.2	A	2.2		2.2		2.2		2.2		2.2		2.2		2.2	
CRAC Fan (10)	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5		7.5	
CRAC Boost Fan 22 (7.5), Dampers & Motors	6.8	A			0		0		0		0		0		0	
DG 23 Support Loads																
Fuel Oil Pmp (2)	1.5	A			0		0		0	1.5	1.5		1.5		1.5	
Compressor (5)	3.7	A	3.7	-3.7	0		0		0		0		0		0	
Lighting Panel 223:																
DG Exhaust Fan 23	0.8	A	0.8		0.8		0.8		0.8		0.8		0.8		0.8	
DG Bldg Emg Lights	1.1	A	1.1		1.1		1.1		1.1		1.1		1.1		1.1	
Eng Aux Cntr Pnl	0.3	A	0.3		0.3		0.3		0.3		0.3		0.3		0.3	
BA Trans Pmp 22 (7.5/15)	11.2	A	11.2		11.2		11.2		11.2		11.2		11.2		11.2	
EDG Bldg Vent Fan 318,323	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5		7.5	
MCC 26BB Loads																
Misc MOVs	1	A	1		1		1		1		1		1		1	
H2/O2 Anlyz Ht Trace 2	3.3	A	3.3		3.3		3.3		3.3		3.3		3.3		3.3	
Transf 2H (45KVA)	0.3	A	0.3		0.3		0.3		0.3		0.3		0.3		0.3	
MCC 27A Loads																
Bat Charger 24 (Max)	45	A		45	45		45	-20	25		25		25		25	
XFMR 22 (Inv 24)(max)	15	M			0		0		0		0		0		0	
PAB Exhaust Fan 22 (125)	93	M			0		0		0		0		0		0	
PAB Supply Fan (50)	37	M			0		0		0		0		0		0	
Spent Fuel Pump 22 (100)	75	M			0		0		0		0		0		0	
Misc. Loss (Max)	119	A	119		119		119		119		119		119		119	
Total EDG 23 Load:			2073		2087		2087		2058		2055		1803		1597	
Total EDG 23 Load with Single Failure:			2121		2135		2135		2106		2103		1851		1618	
Single Failure Assumed:			RHR Pump		RHR Pump		RHR Pump		RHR Pump		RHR Pump		RHR Pump		CS Pump	

		No. 4		No. 7&8		No. 5				Recirc Spray									
Equipment	25	*	27	*	30	*	31	*	32	*	34	*	38	*	45	*	48	*	60
SI Pmp 23 (400)	345		345	-345	0		0		0		0		0		0		0		0
SI Cir Wtr Pmp 23	2.2		2.2	-2.2	0		0		0		0		0		0		0		0
CS Pmp 22 (400)	350		350		350		350		350	-350	0		0		0		0		0
RHR Pmp 22 (400)	0		0		0		0		0		0		0		0		0		0
AFW Pmp 23 (400)	223		223		223		223		223		223		223		223		223		223
CR Fan 25 (350)	200		200	-6	194		194		194		194		194		194	-10	184		184
RC Pmp 22 (350)	0		0		0	287	287		287		287		287		287		287		287
Ess SW Pmp 26 (350)	282		282		282		282		282		282		282		282		282		282
NE SW Pmp 23 (350)	282		282		282		282		282		282		282		282		282		282
Chg Pmp 23 (200)	0		0		0		0		0		0		0		0		0		0
Trb Aux Lub (150)	0		0		0		0		0		0		0		0		0		0
Pzr Htr Cntrl Gp	0		0		0		0		0		0		0		0		0		0
Ltg Tran 21 (Emg)	0		0		0		0		0		0		0		0		0		0
CCW Pmp 23	0		0		0		0		0		0		0		0		0		0
MCC 26B Loads																			
MOVs:																			
MOV-822B	0		0		0		0		0		0		0		0		0		0
MOV-894B	0		0		0		0		0		0		0		0	5.6	5.6	-5.6	0
MOV-894D	0		0		0		0		0		0		0		0	5.6	5.6	-5.6	0
MOV-866B	0		0		0		0		0		0		0		0		0		0
MOV-866D	0		0		0		0		0	0.6	0.6	-0.6	0		0		0		0
MOV-851B	0		0		0		0		0		0		0		0		0		0
MOV-882	0		0		0		0		0		0		0		0		0		0
MOV-887B	0		0		0		0		0		0		0		0		0		0
MOV-747	0		0		0		0		0		0		0		0		0		0
HCV-638	0		0		0		0		0		0	0.6	0.6	-0.6	0		0		0
BFP-2-22	0		0		0		0		0		0		0		0		0		0
MOV-1802B	0	0.7	0.7	-0.7	0		0		0	7.7	7.7	-7.7	0		0		0		0
MOV-889B	0		0		0		0		0		0		0		0		0		0
MOV-843	0		0		0		0	0.6	0.6	-0.6	0		0		0		0		0
HCV-3101	0		0		0		0		0		0		0		0		0	0.25	0.25
CC Boost Pmp 22 (5)	3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7
Elec Tun Exh Fan 22	7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4
BA Heat Trace (Emg)	0		0		0		0		0		0		0		0		0		0
CRAC Humidifier	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2
CRAC Fan (10)	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
CRAC Boost Fan 22 (7.5), Dampers & Motors	0		0		0		0		0		0		0		0		0		0
DG 23 Support Loads																			
Fuel Oil Pmp (2)	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
Compressor (5)	0		0		0		0		0		0		0		0		0		0
Lighting Panel 223:																			
DG Exhaust Fan 23	0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8
DG Bldg Emg Lights	1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1
Eng Aux Cntr Pnl	0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3
BA Trans Pmp 22 (7.5/15)	11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2
EDG Bldg Vent Fan 318,323	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
MCC 26BB Loads																			
Misc MOVs	1		1		1		1	0.2	1.2	-0.2	1		1		1		1		1
H2/O2 Anlyz Ht Trace 2	3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3
Transf 2H (45KVA)	0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3
MCC 27A Loads																			
Bat Charger 24 (Max)	25		25		25		25		25		25		25		25		25		25
XFMR 22 (Inv 24)(max)	0		0		0		0		0		0		0		0		0		0
PAB Exhaust Fan 22 (125)	0		0		0		0		0		0		0		0		0		0
PAB Supply Fan (50)	0		0		0		0		0		0		0		0		0		0
Spent Fuel Pump 22 (100)	0		0		0		0		0		0		0		0		0		0
Misc. Loss (Max)	119		119		119		119		119		119		119		119		119		119
Total EDG 23 Load:	1876		1877		1523		1810		1811		1468		1460		1460		1461		1450
Total EDG 23 Load with Single Failure:	1895		2176		1822		2023		2024		1681		1673		1673		1674		1663
Single Failure Assumed:	CS Pump		RC Pump		RC Pump		CCW Pump		CCW Pump		CCW Pump		CCW Pump		CCW Pump		CCW Pump		CCW Pump

5.3 Large LOCA with Failure of Emergency Diesel Generator 21

Table 5.3-1 is a time table of events describing the large LOCA transient with failure of EDG 21. The EDG loading spreadsheets for this EDG failure case are given in Tables 5.3-2a (EDG 22) and 5.3-2b (EDG 23). The times used for manual actions are similar to those assumed previously for all the EDGs operating case (Section 5.2) except that the time to switchover and RWST depletion are both delayed approximately 10 to 15 minutes (with loss of SI pump 21 and CS pump 21, the RWST would not be depleted as fast). As with the all EDGs operating case, the spreadsheets have conservatively assumed that one non-essential service water pump may be out of service.

The injection phase loads for both EDGs are generally the same or lower than the limiting loads calculated in the previous Section 5.2 for all EDGs operating. The limiting load for this case is on EDG 23 during switchover (2193 kw) and is slightly less than before for the all EDGs operating case (with limiting failure of recirculation pump 21) and is still below the 2300 kw half-hour limit. The switchover loads on EDG 22 show acceptable results (loads < 2100 kw).

Table 5.3-1
Time Table of Events
Large LOCA with Emergency Diesel Generator 21 Failure

Event	Time (min)
Large LOCA with Loss of Offsite Power, SI and Containment Spray Actuation	0
Diesels 22 and 23 Start, Major Equipment Sequences Onto Energized 480 V Buses per Description in Section 4.1	0-1
Other Miscellaneous Equipment on MCCs 26B, 26C, and 211 Load Automatically: Control Room A.C. - Incident Mode Cable Tunnel Exhaust Fan (Auto-temp) EDG Support Loads (Emg. Lighting, Vent and Exhaust Fans) MOV Loads for Valves Moving to Safeguards Positions	0-1
Operators Directed to Emergency Operating Procedure (EOP) E-0, Reactor Trip or Safety Injection, Step 1	1
Operators Verify Reactor Trip, Turbine Trip, and SI Actuation	3
Operator Starts Charging Pump 22 or 23 at Maximum Speed, Verifies Flow Path From RWST, and Dispatches Operator to Establish Backup Cooling per SOP 4.1.2	4
MCCs 24A and 27A, are reset per EOP E-0 The following components are loaded automatically:	4

EDG 21, Bus 5A: None

EGD 22, Buses 2A /3A

MCC 24A

EDG 22 Auxiliaries (Compressor)	4 kw
Inst. Air Comp. 22 (and Support Loads)	60 kw
Battery Charger 22	45 kw
Radiation Monitor 45	2 kw
Additional EDG 22 Load =	111 kw

Table 5.3-1 (page 2)
Time Table of Events
Large LOCA with Emergency Diesel Generator 21 Failure

Event		Time (min)
EDG 23, Bus 6A:		
MCC 27A		
Battery Charger 24	45 kw	
Additional EDG 23 Load=	45 kw	
Control Room Operators Continue with Immediate Actions of E-0		5-10
Transition to EOP E-1, Loss of Reactor or Secondary Coolant		15
Operator Resets SI and Containment Spray, Places CCW Pumps in PULLOUT		16
Establish PAB Ventilation per EOP E-1 – Portable Ventilation Established since EDG 22 and 23 Load Exceeds 1860 kw, Operator Confirms Operation of Switchgear Room Exhaust Fan		20
Initiate Evaluation of Plant Status (per E-1)		20
SG NR Levels Indicate >26%, Operator Reduces AFW Flow		21
RWST Level Less Than 9.24 ft - Transition to ES-1.3, Transfer to Cold Leg Recirculation.		30
Operator Dispatches NPO to Open CCW Hx SW Outlet Valves, Verifies or Completes SI and Spray Reset		31
Perform No. 1 and No. 3 Recirculation Switch Sequence: No Actions Since Equipment on Bus 5A Not Operational: SI Pump 22 Continues to Inject (SI Pump 21 Not Running) CS Pump 22 Continues to Inject (CS Pump 21 Not Running) RHR Pumps 21 and 22 Stop Valve MOV-882 Closes		32

Table 5.3-1 (page 3)
Time Table of Events
Large LOCA with Emergency Diesel Generator 21 Failure

Event	Time (min)
Operator confirms SW alignment and stops charging pumps	33
Perform No. 2 Recirculation Switch Sequence: Non-Essential SW Pump 22 (or 25) Starts (If SW pump 22 /25 out of service, pump 23 /26 starts) CCW Pump 22 Started Manually	34
Perform No. 4 Recirculation Switch Sequence: Recirc Pump 22 Starts Valve MOV-1802B Opens	36
Operator continues with ES-1.3 assuming low-head recirculation:	
Perform No. 7 Recirculation Switch Sequence: SI Pumps 22 and 23 Stop	38
Perform No. 8 Recirculation Switch Sequence: Valve MOV-1810 Closes (No Power to MCC 26A - Valve Locally Closed later) CS Test Line Valve 1813 Closes	39
Recirculation Switch No. 5 Not Performed (due to EDG 21 Failure).	40
After No. 8 Recirculation Switch, the Following Major Equipment may be Operating:	40

Bus 5A: None

Bus 2A /3A: (EDG 22)
- CR Fans 23 and 24
- Essential SW Pumps 25 (or 22)
- Non-Ess Service Water Pump 22 (or 25)
- CCW Pump 22
- AFW Pump 21 (at recirc flow)
- Selected Equipment on MCC 24A

Table 5.3-1 (page 4)
Time Table of Events
Large LOCA with Emergency Diesel Generator 21 Failure

Event	Time (min)
Bus 6A: (EDG 23) CS Pump 22 CR Fan 25 Non-Ess Service Water Pump 23 (or 26), if 22 /25 Out of Service Essential SW Pumps 26 (or 23) Recirc Pump 22 AFW Pump 23 (at recirc flow) Selected Equipment on MCCs 27A, 26B, and 26BB	
Other Valves Close by Manual or Local Operator Local Action: MOV-743 MOV-744 (Local Action Req'd) MOV-1810 (Local Action Req'd) MOV-1870 (Local Action Req'd) MOV-842 (Local Action Req'd) MOV-843	39-42
RWST Level Reaches 2.0 ft, Operator Aligns Spray to Recirculation per ES-1.3: CS Pump 22 is Stopped Valve MOV-866D Closed Valve MOV-889B Opened	48
Operator Confirms Core Flow and Recirc Spray Requirements	50
Recirculation Water pH Verified to be in Proper Range (otherwise a charging pump and BA transfer pump are operated to raise or lower pH)	55
Operators Isolate Accumulators by Closing Discharge Valves 894B and 894D (894A and 894C not operable, so these accumulators would be vented)	58

Table 5.3-1 (page 5)
Time Table of Events
Large LOCA with Emergency Diesel Generator 21 Failure

Valve HCV-3101 Opened to Vent the Upper Head	62
Operator Establishes PAB Ventilation on EDG 23 (less loaded than EDG 22)	65
End of Transient Modeled	70

Table 5.3-2a Large LOCA with Failure of EDG 21 - Loads on EDG 22

6/24/02

Bus 2A/3A Loading - EDG 22

Equipment	Max kW	Man / Auto	Time in Minutes 1	5	10	15	20	30	32	34	35	37	39	40	45	50	55	60	70
								Recirculation Switch Sequence No.1&3		No. 2	No. 4	No. 7	No. 8		Recirc Spray				
SI Pmp 22 (400)	345	A	345	345	345	345	345	345	345	345	345	345 -345	0	0	0	0	0	0	0
SI Cir Wtr Pmp 22	2.2	A	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2 -2.2	0	0	0	0	0	0	0
RHR Pmp 21 (400)	316	A	219	219	219	219	219	219 -219	0	0	0	0	0	0	0	0	0	0	0
AFW Pmp 21 (400)	387	A	376	376	376	376	376 -153	223	223	223	223	223	223	223	223	223	223	223	223
CR Fan 23 (350)	250	A	221	221	9 230	230	4 234 -11	223	223	223	223	223	223	-12 211	211	211	211	211	211
CR Fan 24 (350)	250	A	221	221	9 230	230	4 234 -11	223	223	223	223	223	223	-12 211	211	211	211	211	211
Ess SW Pmp 25 (350)	282	A	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282
NE SW Pmp 22 (350)	282	M		0	0	0	0	0	0	0 282	282	282	282	282	282	282	282	282	282
CCW Pmp 22 (250)	230	M		0	0	0	0	0	0	0 230	230	230	230	230	230	230	230	230	230
Chg Pmp 22 (200)	150	M	50	50	50	50	50	50	50 -50	0	0	0	0	0	0	0	0	0	0
Pzr Htr 21	554	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pzr Htr 22	485	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ltg Tran 21 (Nor)	150	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ltg Tran 22	150	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ltg Bus 23 (480V-Nor)	100	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCC 211-MOV Loads																			
BFD-90	1.2	A	1.2 -1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-90-1	1.2	A	1.2 -1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-90-2	1.2	A	1.2 -1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-90-3	1.2	A	1.2 -1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-5	5	A	5 -5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-5-1	5	A	5 -5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-5-2	5	A	5 -5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-5-3	5	A	5 -5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCC 24A Loads																			
DG 22 Support Loads																			
Fuel Oil Pmp (2)	1.5	A		0	0	0	0 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Compressor (5)	3.7	A	3.7	3.7 -3.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
XMFR 24 (Inv 22)(max)	15	M/A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inst Air Comp 22 (75)	56	A	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
I.A. Cool Pmp 22 (3)	2.2	A	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Bat Charger 22 (Max)	45	A	45	45	45	-20 25	25	25	25	25	25	25	25	25	25	25	25	25	25
Radiation Monitor 45	1.6	A	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
MCC 26C Loads																			
DG Exhaust Fan 22	0.8	A	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
PAB Exh Fan 21 (125)	93	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EDG Bldg Vent Fan 320,322	7.5	A	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Bat Charger 23	25	A	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
CRAC Backup Fan (7.5)	5.6	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CRAC Boost Fan 21 (7.5), Dampers & Motors	5.8	A	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
BA Trans Pmp 21 (15)	11.2	A	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
BAT Htrs 21	15	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spent Fuel Pump 21 (100)	75	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wall Exhaust Fan 213 (2)	1.5	M	0 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Misc. Loss (max)	122	A	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122
Total EDG 22 Load:			1913	1999	2013	1993	2001	1827	1608	1558	2070	2070	1723	1699	1699	1699	1699	1699	1699

Table 5.3-2b Large LOCA with Failure of EDG 21 - Loads on EDG 23

6/24/02

Bus 6A Loading - EDG 23

Time in Minutes

Recirculation Switch Sequence

Equipment	Max kW	Man/Auto	1	*	5	*	10	*	15	*	20	*	30	*	32	*	34	*	35	*	37	*	39	*	40	*	45	*	50	*	55	*	60	*	70
													No.1& 3				No. 2				No. 4				No. 7				No. 8				Recirc Spray		
SI Pmp 23 (400)	345	A	345		345		345		345		345		345		345		345		345		345	-345	0		0		0		0		0		0		0
SI Cir Wtr Pmp 23	2.2	A	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2	-2.2	0		0		0		0		0		0		0
CS Pmp 22 (400)	350	A	350		350		350		350		350		350		350		350		350		350		350		350		350	-350	0		0		0		0
RHR Pmp 22 (400)	319	A	219		219		219		219		219		219	-219	0		0		0		0		0		0		0		0		0		0		0
AFW Pmp 23 (400)	387	A	376		376		376		376		376	-153	223		223		223		223		223		223		223		223		223		223		223		223
CR Fan 25 (350)	250	A	221		221	9	230		230	4	234		234	-11	223		223		223		223		223	-12	211		211		211		211		211		211
RC Pmp 22 (350)	303	M			0		0		0		0		0		0		0		0	294	294		294		294		294		294		294		294		294
Ess SW Pmp 26 (350)	282	A	282		282		282		282		282		282		282		282		282		282		282		282		282		282		282		282		282
NE-SW Pmp 23 (350)	282	M			0		0		0		0		0		0		0	282	282		282		282		282		282		282		282		282		282
CCW Pmp 23 (250)	230	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Chg Pmp 23 (200)	150	M	50		50		50		50		50		50		50	-50	0		0		0		0		0		0		0		0		0		0
Trb Aux Lub (150)	112	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Pzr Htr Cntrl Gp	277	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Ltg Tran 21 (Emg)	150	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MCC 26B Loads																																			
MOVs:																																			
MOV-822B	0.7	A	0.7	-0.7	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-894B	5.6	A			0		0		0		0		0		0		0		0		0		0		0		0		0		0	5.6	5.6	-5.6	0
MOV-894D	5.6	A			0		0		0		0		0		0		0		0		0		0		0		0		0		0	5.6	5.6	-5.6	0
MOV-866B	0.6	A			0		0		0		0		0	0.6	0.6	-0.6	0		0		0		0		0		0		0		0		0		0
MOV-866D	0.6	A			0		0		0		0		0		0		0		0		0		0		0		0	0.6	0.6	-0.6	0		0		0
MOV-851B	0.7	A	0.7	-0.7	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-882	2.2	M			0		0		0		0		0	2.2	2.2	-2.2	0		0		0		0		0		0		0		0		0		0
MOV-887B	0.4	A			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-747	7.7	A	7.7	-7.7	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
HCV-638	0.6	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
BFP-2-22	14.3	A	14.3	-14.3	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-1802B	0.7	A			0		0		0		0		0		0		0		0	0.7	0.7	-0.7	0		0		0		0		0		0		0
MOV-889B	0.6	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-843	0.6	M			0		0		0		0		0		0		0		0		0		0		0	0.6	0.6	-0.6	0		0		0		0
HCV-3101	0.25	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	0.25	0.25
CC Boost Pmp 22 (5)	3.7	A	3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7
Elec Tun Exh Fan 22	7.4	A	7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4
BA Heat Trace (Emg)	16.8	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
CRAC Booster Fan 22 (7.5).	6.8	A			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Dampers & Motors																																			
CRAC Fan (10)	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
CRAC Humidifier (3+.33)	2.5	A	2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5		2.5
DG 23 Support Loads																																			
Fuel Oil Pmp (2)	1.5	A			0		0		0		0	1.5	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
Compressor (5)	3.7	A	3.7	-3.7	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Lighting Panel 223:																																			
DG Exhaust Fan 23	0.8	A	0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8
DG Bldg Emg Lights	1.1	A	1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1
Eng Aux Cntr Pnl	0.3	A	0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3
BA Trans Pmp 22 (7.5/15)	11.2	A	11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2
EDG Bldg Vent Fan 318,323	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
MCC 26BB Loads																																			
Misc MOVs	1	A	1		1		1		1		1		1		1		1		1		1		1		1	0.2	1.2	-0.2	1		1		1		1
H2/O2 Anlyz Ht Trc 2	3.3	A	3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3
Transf 2H (45KVA)	0.3	A	0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3
MCC 27A Loads																																			
Bat Charger 24 (Max)	45	A		45	45		45	-20	25		25		25		25		25		25		25		25		25		25		25		25		25		25
XFMR 22 (Inv 24)(max)	15	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
PAB Exh Fan 22 (125)	93	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	93	93
PAB Supply Fan (50)	37	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	37	37
Spent Fuel Pump 22(100)	75	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Misc. Loss (max)	119	A	119		119		119		119		119		119		119		119		119		119		119		119		119		119		119		119		119
Total EDG 23 Load:			2038		2056		2065		2045		2049		1897		1670		1617		1899		2194		1846		1834		1835		1485		1484		1495		1614

5.4 Large LOCA with Failure of Emergency Diesel Generator 22

The time table of events for this scenario is provided in Table 5.4-1. The loading spreadsheets for EDGs 21 and 23 are given in Tables 5.4-2a and 5.4-2b, respectively.

The loads for EDG 21 remain below the 2100 kw 2-hour emergency limit except for the short period of time following completion of Recirculation Switch No. 4, which starts Recirc Pump 21. The load reaches 2129 kw for a brief period of time (up to ~3 minutes) until SI Pump 21 is stopped via Recirculation Switch No. 7.

The limiting load for this case is 2147 kw and occurs on EDG 23 during the injection phase. Since this injection phase load exceeds 2100 kw for only ~20 minutes, the loads are well within the 2-hour and half-hour ratings of the EDG.

As noted on Table 5.4-2a, the long term load on EDG 21 can be reduced to below 1750 kw (1660 kw including uncertainties) by EDG load management, e.g., operation of either the recirc pump (299 kw), CCW pump (230 kw), or NE-SW pump (282 kw) on EDG 23. A non-essential SW pump is already considered on EDG 23 since the spreadsheets consider the possibility that one SW pump on the non-essential header can be out of service (as allowed per Technical Specifications). Addition of either the recirc pump or CCW pump will result in acceptable long term loads on EDG 23.

Table 5.4-1
Time Table of Events
Large LOCA with Emergency Diesel Generator 22 Failure

Event	Time (min)
Large LOCA with Loss of Offsite Power, SI and Containment Spray Actuation	0
Diesels 21 and 23 Start, Major Equipment Sequences Onto Energized 480 V Buses per Description in Section 4.1	0-1
Other Miscellaneous Equipment on MCCs 26A and 26B Load Automatically: Control Room A.C. - Incident Mode Cable Tunnel Exhaust Fans (Auto-temp) EDG Support Loads (Emg. Lighting, Vent and Exhaust Fans) MOV Loads for Valves Moving to Safeguards Positions	0-1
Operators Directed to Emergency Operating Procedure (EOP) E-0, Reactor Trip or Safety Injection, Step 1	1
Operators Verify Reactor Trip, Turbine Trip, and SI Actuation.	3
Operator Starts Charging Pump 21 or 23 at Maximum Speed, Verifies Flow Path From RWST, and Dispatches Operator to Establish Backup Cooling per SOP 4.1.2	4
MCCs 27A and 29A are reset per EOP E-0. The following components are loaded automatically:	4

EDG 21, Bus 5A

MCC 29A

Inst. Air Comp 21 (and Support Loads)		60 kw
Battery Charger 21	45 kw	
EDG 21 Auxiliaries (Compressor)		4 kw
Additional EDG 21 Load =		109 kw

EDG 22, Buses 2A /3A: None

EDG 23, Bus 6A:

Battery Charger 24	45 kw	
Additional EDG 23 Load =		45 kw

Table 5.4-1 (page 2)
Time Table of Events
Large LOCA with Emergency Diesel Generator 22 Failure

Event	Time (min)
Control Room Operators Continue with Immediate Actions of E-0	5-10
Operator Starts Turbine Driven AFW Pump to Supply AFW to SGs Nos. 21 and 22	10
Operators Verify Remainder of Automatic Actions in E-0	10-15
Transition to EOP E-1, Loss of Reactor or Secondary Coolant	15
Operator Resets SI and Containment Spray, Places CCW Pumps in PULLOUT	16
Establish PAB Ventilation per EOP E-1 - Portable Ventilation Established since EDG 23 load exceeds 1860 kw, Operator Confirms Operation of Switchgear Room Exhaust Fan	20
Initiate Evaluation of Plant Status (per E-1)	20
SG NR Levels Indicate >26% in SGs Nos. 23 and 24, Operator Reduces AFW Flow	21
RWST Level Less Than 9.24 ft - Transition to ES-1.3, Transfer to Cold Leg Recirculation.	22
Operator Dispatches NPO to Open CCW Hx SW Outlet Valves, Verifies or Completes SI and Spray Reset	23
Perform No. 1 and No. 3 Recirculation Switch Sequence: SI Pump 22 - already stopped Valves 887A and 887B Close CS Pump 21 Stops Valves MOV-866A and 866B Close RHR Pump 22 Stops Valves MOV-882 and 744 Close	24
Operator confirms SW alignment and stops charging pumps	25

Table 5.4-1 (page 3)
Time Table of Events
Large LOCA with Emergency Diesel Generator 22 Failure

Event	Time (min)
Perform No. 2 Recirculation Switch Sequence: Non-Essential SW Pump 23 (or 21) Starts (If SW Pump 23 /26 Out of Service, Pump 21 /24 Starts) CCW Pump 21 Started Manually	26
Perform No. 4 Recirculation Switch Sequence: Recirc Pump 21 Starts Valves MOV-1802A and 1802B Open	28
Perform No. 7 Recirculation Switch Sequence: SI Pumps 21 and 23 Stop	29
Perform No. 8 Recirculation Switch Sequence: Valve MOV-1810 Closes (if energized) CS Test Line Valve 1813 Closes	31
Recirculation Switch No. 5 Not Performed (due to EDG 22 Failure)	32
After No. 8 Recirculation Switch, the Following Major Equipment may be Operating:	32

Bus 5A: (EDG 21)
- CR Fans 21 and 22
- Essential SW Pumps 24 (or 21)
- Non-ESS SW Pump 21 (or 24), if 23 /26 out of service
- Recirc Pump 21
- CCW Pump 21
- Selected Equipment on MCCs 29A, 26A, and 26AA

Bus 2A /3A: (EDG 22)
- None

Bus 6A: (EDG 23)
- CS Pump 22
- CR Fan 25
- Essential SW Pumps 26 (or 23)
- Non-Ess SW Pumps 23 (or 26)
- AFW Pump 23 (at recirc flow)
- Selected Equipment on MCCs 27A, 26B, and 26BB

Table 5.4-1 (page 4)
Time Table of Events
Large LOCA with Emergency Diesel Generator 22 Failure

Event	Time (min)
Other Valves Close by Manual or Local Operator Action: MOV-743 MOV-1870 MOV-842 MOV-843	32-35
RWST Level Reaches 2.0 ft, Operator Aligns Spray to Recirculation per ES-1.3: CS Pump 22 is Stopped Valves MOV-866C and 866D Closed Valve MOV-746 or MOV-747 Closed Valve MOV-889B Opened	36
Operator Confirms Core Flow and Recirc Spray Requirements	40
Recirculation Water pH Verified to be in Proper Range (otherwise a charging pump and BA transfer pump are operated to raise or lower pH)	44
Operators Isolate Accumulators by Closing Discharge Valves 894A-894D	46
Valves HCV-3100 and 3101 Opened to Vent the Upper Head	48
Operator Establishes PAB Ventilation on EDG 23	50
End of Transient Modeled	60

Table 5.4-2a Large LOCA with Failure of EDG 22 - Loads on EDG 21

06/24/02

Bus 5A Loading - EDG 21

Equipment	Max	Man/Auto	Time in Minutes 1 *	5 *	10 *	15 *	22 *	24 *	26 *	27 *	29 *	30 *	32 *	35 *	40 *	44 *	48 *	60
							Recirculation Switch Sequence No. 1 & 3		No. 2	No. 4	No. 7	No. 8		Recirc Spray				
SI Pmp 21 (400)	345	A	345	345	345	345	345	345	345	345	345 -345	0	0	0	0	0	0	0
SI Cir Wtr Pmp 21	2.2	A	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2 -2.2	0	0	0	0	0	0	0
CS Pmp 21 (400)	350	A	350	350	350	350	350 -350	0	0	0	0	0	0	0	0	0	0	0
CR Fan 21 (350)	250	A	221	221	221 -8	213 -2	211	211	211	211	211	211 -5	206	206	206	206	206 -4	202
CR Fan 22 (350)	250	A	221	221	221 -8	213 -2	211	211	211	211	211	211 -5	206	206	206	206	206 -4	202
RC Pmp 21 (350)	303	M		0	0	0	0	0	0	0 299	299	299	299	299	299	299	299	299
Ess SW Pmp 24 (350)	282	A	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282
NE SW Pmp 21 (350)	282	M		0	0	0	0	0	0	282 282	282	282	282	282	282	282	282	282
CCW Pmp 21 (250)	230	M		0	0	0	0	0	0	230 230	230	230	230	230	230	230	230	230
Chg Pmp 21 (200)	150	M	50	50	50	50	50	50	-50 0	0	0	0	0	0	0	0	0	0
Srv Air Comp (125)	93	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pzr Htrs 23	485	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ltg Bus 23 (120/208V)	135	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ltg Bus 23 (480V-Emg)	100	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCC 26A Loads																		
MOVs:																		
MOV-822A	0.7	A	0.7 -0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-894A	5.6	A		0	0	0	0	0	0	0	0	0	0	0	0	0 5.6	5.6 -5.6	0
MOV-894C	5.6	A		0	0	0	0	0	0	0	0	0	0	0	0	0 5.6	5.6 -5.6	0
MOV-866A	0.6	A		0	0	0	0 0.6	0.6 -0.6	0	0	0	0	0	0	0	0	0	0
MOV-866C	0.6	A		0	0	0	0	0	0	0	0	0	0	0 0.6	0.6 -0.6	0	0	0
MOV-851A	0.7	A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-744	5.8	A		0	0	0	0 5.8	5.8 -5.8	0	0	0	0	0	0	0	0	0	0
MOV-746	7.7	A	7.7 -7.7	0	0	0	0	0	0	0	0	0	0	0 7.7	7.7 -7.7	0	0	0
MOV-887A	0.4	A		0	0	0	0 0.4	0.4 -0.4	0	0	0	0	0	0	0	0	0	0
HCV-640	0.6	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFP-2-21	14.3	A	14.3 -14.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-1802A	0.7	M		0	0	0	0	0	0	0 0.7	0.7 -0.7	0	0	0	0	0	0	0
MOV-889A	0.6	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-842	0.6	M		0	0	0	0	0	0	0	0	0	0 0.6	0.6 -0.6	0	0	0	0
HCV-3100	0.25	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0 0.25	0.25
MOV-1810	1.2	M		0	0	0	0	0	0	0	0	0 1.2	1.2 -1.2	0	0	0	0	0
CCW Boost Pmp 21 (5)	3.7	A	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Elec Tun Exh Fan 21	7.4	A	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
DG Exh Fan 21 (nor)	0.5	A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
EDG Bldg Vent Fan 319,321	7.5	A	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
BA Ht Trace (nor)	16.8	A	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8
XMFR 23 (Inv 21)(max)	10	M/A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EPX3	15	A	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
EPV21	7.5	A	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
MCC 26AA Loads																		
Misc MOVs	1	A	1	1	1	1	1	1	1	1	1	1	1 0.2	1.2 -0.2	1	1	1	1
H2/O2 Anlyz Ht Trc 1	3.3	A	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
MCC 29A Loads																		
DG 21 Support Loads																		
Fuel Oil Pmp (2)	1.5	A		0	0	0 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Compressor (5)	3.7	A	3.7	3.7 -3.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bat Charger 21 (Max)	45	A	45	45	45 -20	25	25	25	25	25	25	25	25	25	25	25	25	25
Inst Air Comp 21 (75)	56	A	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
I.A. Cool Pmp 21 (3)	2.2	A	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Wall Exhaust Fan 215 (2)	1.5	M	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Misc. Loss (Max)	117	A	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
Total EDG 21 Load:			1674	1759	1756	1720	1717	1374	1317	1829	2129	1781	1772	1772	1779	1771	1782	1763

* This long term load can be reduced below 1750 kw by load management.

Table 5.4-2b Large LOCA with Failure of EDG 22 - Loads on EDG 23

06/24/02

Bus 6A Loading - EDG 23

Equipment	Max kW	Man/Auto	Time in Minutes 1	5	10	15	22	24	26	27	29	30	32	35	40	44	48	60
							Recirculation Switch Sequence No. 1 & 3		No. 2	No. 4	No. 7	No. 8		Recirc Spray				
SI Pmp 23 (400)	345	A	345	345	345	345	345	345	345	345	345 -345	0	0	0	0	0	0	0
SI Cir Wtr Pmp 23	2.2	A	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2 -2.2	0	0	0	0	0	0	0
CS Pmp 22 (400)	350	A	350	350	350	350	350	350	350	350	350	350	350	350 -350	0	0	0	0
RHR Pmp 22 (400)	316	A	303	303	303	303	303 -303	0	0	0	0	0	0	0	0	0	0	0
AFW Pmp 23 (400)	387	A	376	376	376	376 -153	223	223	223	223	223	223	223	223	223	223	223	223
CR Fan 25 (350)	250	A	221	221	221 -8	213 -2	211	211	211	211	211	211 -5	206	206	206	206	206 -4	202
RC Pmp 22 (350)	303	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ess SW Pmp 26 (350)	282	A	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282
NE SW Pmp 23 (350)	282	M		0	0	0	0	0	0 282	282	282	282	282	282	282	282	282	282
CCW Pmp 23 (250)	230	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chg Pmp 23 (200)	150	M	50	50	50	50	50	50 -50	0	0	0	0	0	0	0	0	0	0
Trb Aux Lub (150)	112	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pzr Htr Cntrl Gp	277	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lght Tran 21 (Emg)	150	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCC 26B Loads																		
MOVs:																		
MOV-822B	0.7	A	0.7 -0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-894B	5.6	A		0	0	0	0	0	0	0	0	0	0	0	0	0 5.6	5.6 -5.6	0
MOV-894D	5.6	A		0	0	0	0	0	0	0	0	0	0	0	0	0 5.6	5.6 -5.6	0
MOV-866B	0.6	A		0	0	0	0 0.6	0.6 -0.6	0	0	0	0	0	0	0	0	0	0
MOV-866D	0.6	A		0	0	0	0	0	0	0	0	0	0	0 0.6	0.6 -0.6	0	0	0
MOV-851B	0.7	A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-882	2.2	A		0	0	0	0 2.2	2.2 -2.2	0	0	0	0	0	0	0	0	0	0
MOV-887B	0.4	A		0	0	0	0 0.4	0.4 -0.4	0	0	0	0	0	0 7.7	7.7 -7.7	0	0	0
MOV-747	7.7	A	7.7 -7.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCV-638	0.6	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFP-2-22	14.3	A	14.3 -14.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-1802B	0.7	A		0	0	0	0	0	0	0	0.7 0.7 -0.7	0	0	0	0	0	0	0
MOV-889B	0.6	M		0	0	0	0	0	0	0	0	0	0	0 0.6	0.6 -0.6	0	0	0
MOV-843	0.6	M		0	0	0	0	0	0	0	0	0	0	0.6 0.6 -0.6	0	0	0	0
HCV-3101	0.25	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0 0.25	0.25
CC Boost Pmp 22 (5)	3.7	A	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Elec Tun Exh Fan 22	7.4	A	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
BA Heat Trace (Emg)	16.8	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CRAC Booster Fan 22 (7.5), Dampers & Motors	6.8	A	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
CRAC Fan (10)	7.5	A	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
CRAC Humidifier (3+.33)	2.5	A	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
DG 23 Support Loads																		
Fuel Oil Pmp (2)	1.5	A		0	0	0 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Compressor (5)	3.7	A	3.7 -3.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lighting Panel 223:																		
DG Exhaust Fan 23	0.8	A	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
DG Bldg Emg Lights	1.1	A	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Eng Aux Cntr Pnl	0.3	A	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
BA Trans Pmp 22 (7.5/15)	11.2	A	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
EDG Bldg Vent Fan 318,323	7.5	A	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
MCC 26BB Loads																		
Misc MOVs	1	A	1	1	1	1	1	1	1	1	1	1	1	0.2 1.2 -0.2	1	1	1	1
H2/O2 Anlyz Ht Trc 2	3.3	A	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Transf 2H	0.3	A	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
MCC 27A Loads																		
Bat Charger 24 (Max)	45	A	45	45	45 -20	25	25	25	25	25	25	25	25	25	25	25	25	25
XFMR 22 (Inv 24)(max)	15	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAB Exh Fan 22 (125)	93	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0 93	93
PAB Supply Fan (50)	37	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0 37	37
Spent Fuel Pump 22 (100)	75	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Loss (Max)	119	A	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119
Total EDG 23 Load:			2128	2147	2147	2119	1965	1665	1612	1894	1895	1547	1542	1543	1201	1192	1203	1318

5.5 Large LOCA with Failure of Emergency Diesel Generator 23

The time table of events for this final large LOCA scenario is provided in Table 5.5-1. The loading spreadsheets for EDGs 21 and 22 are given in Tables 5.5-2a and 5.5-2b, respectively.

Again, the loads for both diesel generators are reasonable. For EDG 21, the highest load occurs after Recirculation Switch 4. This peak load is 2268 kw, which is still below the half-hour limit. Note that in the previous loading study (WCAP-12655, Rev. 0), Technical Specification / administrative control limits prevented addition of the non-essential SW pump (previously 272 kw) on this EDG. This administrative control has been removed, and thus the non-essential service water pump was added on the spreadsheet. EDG 22 shows acceptable results with a peak load of 2059 kw during the injection phase and 2076 kw during the recirculation phase.

As noted on Table 5.5-2a, the long term load on EDG 22 can be reduced to below 1750 kw by EDG load management, e.g., operation of the CCW pump (230 kw) on EDG 21, if the non-essential SW pump (282 kw) remains powered by EDG 22. (The spreadsheets consider the NE SW load on either EDG 21 or 22 to allow for the possibility that any one SW pump on the non-essential header can be out of service, as allowed per Technical Specifications). One fan cooler (211 kw) can also be secured on EDG 22 since each EDG (21 and 22) supplies power to two fan cooler units.

Table 5.5-1
Time Table of Events
Large LOCA with Emergency Diesel Generator 23 Failure

Event	Time (min)
Large LOCA with Loss of Offsite Power, SI and Containment Spray Actuation	0
Diesels 21 and 22 Start, Major Equipment Sequences Onto Energized 480 V Buses per Description in Section 4.1	0-1
Other Miscellaneous Equipment on MCCs 26A, 26C, and 211 Load Automatically: Cable Tunnel Exhaust Fan 21 (Auto-temp) EDG Support Loads (Vent and Exhaust Fans 21 and 22) Boric Acid Heat Tracing MOV Loads for Valves Moving to Safeguards Positions	0-1
Operators Directed to Emergency Operating Procedure (EOP) E-0, Reactor Trip or Safety Injection, Step 1	1
Operators Verify Reactor Trip, Turbine Trip, and SI Actuation.	3
Operator Starts Charging Pump 21 at Maximum Speed, Verifies Flow Path From RWST, and Dispatches Operator to Establish Backup Cooling per SOP 4.1.2	4
MCCs 24A, 29A, and 211 reset per EOP E-0 Note: MCC 211 not stripped, reset not required	4

The following components are loaded automatically when MCCs reset:

EDG 21, Bus 5A:

MCC 29A:

Inst. Air Comp. 21 (and Support Loads)	60 kw
Battery Charger 21	45 kw
EDG 21 Auxiliaries (Compressor)	4 kw
Additional EDG 21 Load =	109 kw

Table 5.5-1 (page 2)
Time Table of Events
Large LOCA with Emergency Diesel Generator 23 Failure

Event		Time (min)
EDG 22, Buses 2A /3A:		
MCC 24A		
EDG 22 Auxiliaries (Compressor)	4 kw	
Inst. Air Comp. 22 (and Support Loads)	60 kw	
Battery Charger 22	45 kw	
Radiation Monitor 45	2 kw	
Additional EDG 22 Load =	111 kw	
EDG 23, Bus 6A: None		
Control Room Operators Continue with Immediate Actions of E-0		5-10
Operator Starts Turbine Driven AFW Pump to Supply AFW to SGs Nos. 23 and 24		10
Operators Verify Remainder of Automatic Actions in E-0		10-15
Transition to EOP E-1, Loss of Reactor or Secondary Coolant		15
Operator Resets SI and Containment Spray, Places CCW Pumps in PULLOUT		16
Establish PAB Ventilation per EOP E-1 – Portable Ventilation Established Since EDG 22 Load Exceeds 1860 kw, Operator Confirms Operation of Switchgear Room Exhaust Fan		20
Initiate Evaluation of Plant Status (per E-1)		20
SG NR Levels Indicate >26% in SGs Nos. 21 and 22, Operator Reduces AFW Flow		21
RWST Level Less Than 9.24 ft - Transition to ES-1.3, Transfer to Cold Leg Recirculation.		35
Operator Dispatches NPO to Open CCW Hx SW Outlet Valves, Verifies or Completes SI and Spray Reset		36

Table 5.5-1 (page 3)
Time Table of Events
Large LOCA with Emergency Diesel Generator 23 Failure

Event	Time (min)
Perform No. 1 and No. 3 Recirculation Switch Sequence: No Actions Since Equipment on Bus 6A Not Operational: SI Pump 22 Continues to Inject (SI Pump 23 Not Running) CS Pump 21 Continues to Inject (CS Pump 22 Not Running) Valve MOV-866C Closes (MOV-866D not powered) RHR Pump 21 Stops Valve MOV-744 Closes	36
Operator confirms SW alignment and stops charging pumps	38
Perform No. 2 Recirculation Switch Sequence: Non-Essential SW Pump 22 (or 25) Starts CCW Pump 22 Started Manually	39
Perform No. 4 Recirculation Switch Sequence: Recirc Pump 21 Starts Valve MOV-1802A Opens	40
Operator continues with ES-1.3 assuming low-head recirculation:	
Perform No. 7 Recirculation Switch Sequence: SI Pumps 21 and 22 Stop	42
Perform No. 8 Recirculation Switch Sequence: Valve MOV-1810 Closes (if energized) CS Test Valve 1813 Closes	44
Recirculation Switch No. 5 Not Performed (due to EDG 23 Failure)	45
After No. 8 Recirculation Switch, the Following Major Equipment will be Operating:	45

Bus 5A: (EDG 21)
- CR Fans 21 and 22
- Essential SW Pumps 24 (or 21)
- Non-Ess SW Pumps 21 (or 24), if 22 /25 Out of Service
- Recirc Pump 21
- CS Pump 21
- Selected Equipment on MCCs 29A, 26A, and 26AA

Table 5.5-1 (page 4)
Time Table of Events
Large LOCA with Emergency Diesel Generator 23 Failure

Event	Time (min)
Bus 2A /3A: (EDG 22) CR Fans 23 and 24 Essential SW Pumps 25 (or 22) Non-Ess SW Pumps 22 (or 25) CCW Pump 22 AFW Pump 21 Selected Equipment on MCC 24A	
Bus 6A: (EDG 23) None	
Other Valves Close by Operator or Local Action: MOV-743 (Local Action Req'd) MOV-1870 MOV-842 MOV-843 (Local Action Req'd)	44-48
RWST Level Reaches 2.0 ft, Operator Aligns Spray to Recirculation per ES-1.3: CS Pump 21 is Stopped Valve MOV-866A Closed Valve MOV-889A Opened	50
Operator Confirms Core Flow and Recirc Spray Requirements	55
Recirculation Water pH Verified to be in Proper Range (otherwise a charging pump and BA transfer pump are operated to raise or lower pH)	60
Operators Isolate Accumulators by Closing Discharge Valves 894A and 894C (894B and 894D not operable, so these accumulators would be vented)	63
Valve HCV-3100 Opened to Vent the Upper Head	65
Operator Establishes PAB Ventilation on EDG 22	68
End of Transient Modeled	70

Table 5.5-2a Large LOCA With Failure of EDG 23 - Loads on EDG 21

06/24/02

Bus 5A Loading - EDG 21

Equipment	Max kW	Man/Auto	Time in Minutes 1	5	10	20	30	35	37	39	40	42	43	45	50	52	60	65	70
								Recirculation Switch Sequence No. 1 &3		No. 2	No. 4	No. 7	No. 8		Recirc Spray				
St Pmp 21 (400)	345	A	345	345	345	345	345	345	345	345	345	345 -345	0	0	0	0	0	0	0
St Cir Wtr Pmp 21	2.2	A	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2 -2.2							
CS Pmp 21 (400)	350	A	350	350	350	350	350	350	350	350	350	350	350	350	350 -350	0	0	0	0
CR Fan 21 (350)	250	A	221	221	9 230	4 234	234 -11	223	223	223	223	223 -12	211	211	211	211	211	211	211
CR Fan 22 (350)	250	A	221	221	9 230	4 234	234 -11	223	223	223	223	223 -12	211	211	211	211	211	211	211
RC Pmp 21 (350)	303	M		0	0	0	0	0	0	0	0 294	294	294	294	294	294	294	294	294
Ess SW Pmp 24 (350)	282	A	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282
NE SW Pmp 21 (350)	282	M		0	0	0	0	0	0	0 282	282	282	282	282	282	282	282	282	282
CCW Pmp 21 (250)	230	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chg Pmp 21 (200)	150	M	50	50	50	50	50	50	50 -50	0	0	0	0	0	0	0	0	0	0
Srv Air Comp (125)	93	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pzr Htrs 23	485	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ltg Bus 23 (120/208V)	135	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ltg Bus 23 (480V-Emg)	100	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCC 26A Loads																			
MOVs:																			
MOV-822A	0.7	A	0.7 -0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-894A	5.6	A		0	0	0	0	0	0	0	0	0	0	0	0	0	0 5.6	5.6 -5.6	0
MOV-894C	5.6	A		0	0	0	0	0	0	0	0	0	0	0	0	0	0 5.6	5.6 -5.6	0
MOV-866A	0.6	A		0	0	0	0	0	0	0	0	0	0	0	0	0.6 0.6 -0.6	0	0	0
MOV-866C	0.6	A		0	0	0	0	0	0.6 0.6 -0.6	0	0	0	0	0	0	0	0	0	0
MOV-851A*	0.7	A	0.7 -0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-744	5.8	A		0	0	0	0	0	5.8 5.8 -5.8	0	0	0	0	0	0	0	0	0	0
MOV-746	7.7	A	7.7 -7.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-887A	0.4	A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCV-640	0.6	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFP-2-21	14.3	A	14.3 -14.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOV-1802A	0.7	M		0	0	0	0	0	0	0	0 0.7	0.7 -0.7	0	0	0	0	0	0	0
MOV-889A	0.6	M		0	0	0	0	0	0	0	0	0	0	0	0	0.6 0.6 -0.6	0	0	0
MOV-842	0.6	M		0	0	0	0	0	0	0	0	0	0	0	0.6 0.6 -0.6	0	0	0	0
HCV-3100	0.25	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 0.25	0.25
MOV-1810	1.2	M		0	0	0	0	0	0	0	0	0	0 1.2	1.2 -1.2	0	0	0	0	0
CCW Boost Pmp 21 (5)	3.7	A	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Elec Tun Exh Fan 21	7.4	A	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
DG Exh Fan 21 (nor)	0.5	A	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
EDG Bldg Vent Fan 319,321	7.5	A	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
BA Ht Trace (nor)	16.8	A	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8
XMFR 23 (Inv 21)(max)	10	M/A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EPX3	15	A	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
EPV21	7.5	A	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
MCC 26AA Loads																			
Misc MOVs	1	A	1	1	1	1	1	1	1	1	1	1	1	1 0.2	1.2 -0.2	1	1	1	1
H2/O2 Anlyz Ht Trc 1	3.3	A	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
MCC 29A Loads																			
DG 21 Support Loads																			
Fuel Oil Pmp (2)	1.5	A		0	0	0	0 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Compressor (5)	3.7	A	3.7	3.7 -3.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bat Charger 21 (Max)	45	A	45	45	45 -20	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Inst Air Comp 21 (75)	56	A	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
I.A. Cool Pmp 21 (3)	2.2	A	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Wall Exhaust Fan 215 (2)	1.5	M	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Misc. Loss (Max)	117	A	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
Total EDG 21 Load:			1674	1759	1774	1762	1762	1741	1748	1691	1973	2268	1896	1897	1897	1547	1546	1557	1546

Table 5.5-2b Large LOCA With Failure of EDG 23 - Loads on EDG 22

06/24/02

Bus 2A/3A Loading - EDG 22

Equipment	Max kW	Man/Auto	Time in Minutes 1 *	5 *	10 *	20 *	30 *	Recirculation Switch Sequence No. 1 & 3 35 *	37 *	39 *	No. 2 40 *	No. 4 42 *	No. 7 43 *	No. 8 45 *	Recirc Spray 50 *	52 *	60 *	65 *	70
SI Pmp 22 (400)	345	A	345	345	345	345	345	345	345	345	345	345 -345	0	0	0	0	0	0	0
SI Cir Wtr Pmp 22	2.2	A	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2 -2.2							
RHR Pmp 21 (400)	316	A	272	272	272	272	272	272 -272	0	0	0	0	0	0	0	0	0	0	0
AFW Pmp 21 (400)	387	A	376	376	376	376 -153	223	223	223	223	223	223	223	223	223	223	223	223	223
CR Fan 23 (350)	250	A	221	221	9 230	4 234	234 -11	223	223	223	223 -12	211	211	211	211	211	211	211	211
CR Fan 24 (350)	250	A	221	221	9 230	4 234	234 -11	223	223	223	223 -12	211	211	211	211	211	211	211	211
Ess SW Pmp 25 (350)	282	A	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282	282
NE SW Pmp 22 (350)	282	M		0	0	0	0	0	0	0 282	282	282	282	282	282	282	282	282	282
CCW Pmp 22 (250)	230	M		0	0	0	0	0	0	0 230	230	230	230	230	230	230	230	230	230
Chg Pmp 22 (200)	150	M	50	50	50	50	50	50	50 -50	0	0	0	0	0	0	0	0	0	0
Pzr Htr 21	554	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pzr Htr 22	485	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ltg Tran 21 (Nor)	150	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ltg Tran 22	150	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ltg Bus 23 (480V-Nor)	100	M		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCC 211-MOV Loads																			
BFD-90	1.2	A	1.2 -1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-90-1	1.2	A	1.2 -1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-90-2	1.2	A	1.2 -1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-90-3	1.2	A	1.2 -1.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-5	5	A	5 -5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-5-1	5	A	5 -5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-5-2	5	A	5 -5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BFD-5-3	5	A	5 -5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCC 24A Loads																			
DG 22 Support Loads																			
Fuel Oil Pmp (2)	1.5	A		0	0	0	0 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Compressor (5)	3.7	A	3.7	3.7	-3.7 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
XMFR 24 (Inv 22)(max)	15	M/A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inst Air Comp 22 (75)	56	A	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
I.A. Cool Pmp 22 (3)	2.2	A	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Bat Charger 22 (Max)	45	A	45	45	45 -20	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Radiation Monitor 45	1.6	A	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
MCC 26C Loads																			
DG Exhaust Fan 22	0.8	A	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
PAB Exh Fan 21 (125)	93	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93 93
EDG Bldg Vent Fan 320,322	7.5	A	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Batt Charger 23	25	A	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
CRAC Backup Fan (7.5)	5.6	A	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
CRAC Booster Fan 21 (7.5), Dampers & Motors	5.8	A	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
BA Trans Pmp 21 (15)	11.2	A	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
BAT Htrs 21	15	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spent Fuel Pump 21 (100)	75	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wall Exhaust Fan 213 (2)	1.5	M	0 1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Misc. Loss (Max)	122	A	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122
Total EDG 22 Load:			1972	2057	2071	2059	1906	1886	1614	1564	2076	2052	1705	1705	1705	1705	1705	1705	* 1798

* This long term load can be reduced below 1750 kw by load management.

5.6 Summary of Results for Large LOCA with Low-Head Recirculation

In the previous sections, Sections 5.2 through 5.5, limiting loads for large LOCA have been determined. The all EDGs operating case, with and without limiting single failure and EDG failure cases were analyzed. For long term cooling, it is assumed that the operator aligns low-head recirculation (using Recirc switch 7), i.e., the break is large enough that the recirculation pump(s) provide sufficient flow for core cooling. Therefore, the high-head SI pumps and stopped. Summarized below are some of the key results from this effort.

- For all EDGs operating and no failures, all EDG loads are less than 2100 kw, i.e., none of the loads exceed the 2-hour emergency rating for the EDG.

- During the injection phase of the accident, all EDG loads remain less than 2100 kw with the following exceptions:

  - All EDGs Operating, Load on EDG 23 (with RHR pump 21 failure) – The injection phase load reaches 2135 kw due primarily to high flow operation of RHR pump 22. The duration of time that the load exceeds 2100 kw is ~ 20 minutes (i.e., until the operator reduces flow from the AFW pump 23).

  - EDG 22 Failure, Load on EDG23 - The injection phase load reaches a similar peak load of 2147 kw, again due primarily to high flow operation of RHR pump 22. The duration of time this load also exceeds 2100 kw is for ~ 20 minutes (i.e., until the operator reduces flow from the AFW pump 23).

  - All other injection phase loads have ~ 20 kw margin or more to the 2100 kw limit. Note that none of the loads approach the 2300 kw half-hour limit.

- During the recirculation phase of the accident, the following peak loads occur:

  - All EDGs Operating, Load on EDG 23 (with Recirc pump 21 failure) - The load reaches 2176 kw for several minutes following operation of Recirc Switch 4. The load is subsequently reduced (to 1822 kw) when Switch 7 is operated to stop SI pump 23.

  - EDG 21 Failure, Load on EDG 23 – The load reaches 2193 kw, again for several minutes following operation of Recirc Switch 4. The load is then reduced (to 1845 kw) when Switch 7 is operated to stop SI pump 23.

  - EDG 22 Failure, Load on EDG21 - The load reaches 2129 kw for

several minutes following operation of Recirc Switch 4. The load is subsequently reduced (to 1781 kw) when Switch 7 is operated to stop SI pump 21.

- EDG 23 Failure, Load on EDG 21 – The load reaches 2268 kw, again for several minutes following operation of Recirc Switch 4. The load is then reduced (to 1896 kw) when Switch 7 is operated to stop SI pump 21. Note that this is the highest load calculated. The margin to 2300 kw is 32 kw.

- All EDGs Operating, Load on EDG 21 (with CS pump 22 failure). The load reaches 2100 kw following operation of Recirc Switch 5 (which adds a redundant cooling train). The load stays at approximately this value for several minutes, until CS pump 21 is stopped and recirculation spray is aligned.

- All loads on EDG 22 remain less than 2100 kw throughout switchover to recirculation. However, the load on this EDG typically increases above 2000 kw following Recirc Switch 2 if any failure occurs that requires SI pump 22 to continue to operate (i.e., SI pump 21 or 23 failure or EDG 21 or 23 failure). The limiting loads for this situation are 2076 kw (for failure of EDG 23) and 2070 kw (for failure of EDG21).

All the above loads are well within the 2100 kw 2-hour and 2300 kw half-hour ratings for the EDGs. Long-term loads (after recirc spray is aligned) are typically less than or controllable to less than the 1750 kw continuous rating. Therefore, these loads are considered acceptable.

In view of the high loads following recirculation switch 2 (for EDG 22) or 4 (for EDG 21 or 23), the impact of high head recirculation will be investigated. This is done in the next section.

5.7 Large LOCA With High-Head Recirculation

Large LOCA is limiting for the injection phase and initial portion of the recirculation phase of the accident. Longer term, it is conservative to assume the operator aligns to high-head recirculation with the recirculation pump(s) feeding the suction of 2 SI pumps. The loading spreadsheets in the pervious sections have been completed assuming low-head recirculation (SI pumps tripped by switch 7). Expected loads for high-head recirculation (switch 6 performed after switch 4) have been developed and compiled in Tables 5.7-1, 5.7-2, and 5.7-3. A high load for recirc typically occurs after switches 2 and 4 (which are performed sequentially), so loads are compiled starting from recirculation switch 4. In addition to the high loads after switch 4, another peak can occur after switch 5. This switch is performed only if all EDGs are operating. This switch effectively adds a redundant cooling train (recirculation, non-essential SW and CCW pumps).

High-head recirculation tends to be limiting since the SI pumps operate at high flow (for large LOCA). With recirc spray included, the recirculation pumps also operate at high flow. Therefore, with the addition of the SI pumps, high-head recirculation is more limiting than low-head recirculation. Because of the high flow conditions for the SI pumps, the loads bound small LOCA. High-head recirculation is also the alignment used for hot leg recirculation (EOP ES-1.4), so it should be analyzed to ensure long term loadings on the EDGs will be acceptable.

Peak loads in Tables 5.7-1, 5.7-2, and 5.7-3 are all less than 2300 kw, so none of them exceed the half-hour rating.

For the next most limiting loads, note that none of the cases have prolonged operation between 2100 and 2300 kw (exceeding ½ hour) if some optional loads are shed. For example, if the PAB fan or instrument air compressor (IAC) loads are removed from EDG 22 (these are optional and/or redundant loads), the loads on EDG 22 decrease 93 kw (for the PAB fan) or 57 kw (for the IAC). Either load reduction is sufficient to decrease the loads on EDG 22 below 2100 kw. Likewise, removal of the IAC from EDG 21 will reduce its load below 2100 kw for the long term (recirc spray) period. It is also possible to reduce the load on EDG 22 by operation of the non-essential SW pump or CCW pump on another EDG. The non-essential SW pump is "double-counted" in these tables to allow any SW pump to be out of service (OOS) per Technical Specifications. Based on these considerations, it is unlikely the load on any EDG will exceed the 2100 kw rating for more than ½ hour.

Long term loads will next be considered to demonstrate capability to reduce the loading to less than the 1750 kw continuous rating. It is sufficient to consider only the EDG failure cases for this effort. For the all EDGs running cases, the redundant cooling train can be eliminated and resulting loads managed between the 3 EDGs. Thus, the 2 EDG cases will be more limiting.

For EDG 21 failure, refer to Tables 5.7-1 and 5.7-3. If the AFW pump on EDG 22 remains operating but the non-essential SW pump and one CR fan are stopped, the load on EDG 22 becomes 2139 – 282 – 211 = 1646 kw. The non-essential SW pump is already considered on EDG 23, but its AFW pump (23) can be stopped since AFW 21 is operating. One CR fan on EDG 22 and one CR fan on EFDG 23 will be left operating. This should be adequate for containment cooling long term, with or without recirc spray. Stopping AFW 23 on EDG 23 results in a load of 1840 – 223 = 1617 kw. Thus, the resulting loads on EDGs 22 and 23 become 1646 kw and 1617 kw, respectively, both of which are well below the continuous rating of 1750 kw.

For EDG 22 failure, refer to Tables 5.7-1 and 5.7-3. The load on EDG 23 is already low (1550 kw) and includes a non-essential SW pump. By dropping the non-essential SW pump and one CR fan on EDG 21 results in a load of 2121 – 282 – 206 = 1633 kw. An alternate scheme would be to operate the non-essential SW pump on EDG 21 and CCW pump on EDG 23. The PAB exhaust and supply fan (93 + 37 = 130 kw) can also be included on EDG 23. The resulting loads are 2121 – 230 – 206 = 1685 kw on EDG 21 and 1550 – 282 + 230 + 130 = 1628 kw on EDG 23. Again, this represents an acceptable set of results.

For EDG 23 failure, refer to Tables 5.7-1 and 5.7-2. One CR fan can be secured on each of the operating EDGs and the non-essential SW pump can be operated on EDG 21. For this situation, the long term loads become 1901 – 211 = 1690 kw on EDG 21 and 2145 – 282 – 211 = 1652 kw on EDG22. Again, both EDG loads are well below the continuous rating of 1750 kw.

For each of the EDG failure cases discussed above, there are multiple ways to achieve an acceptable long term loading scheme such that each EDG can operate long term at loads well below 1750 kw. It is reasonable to assume the operator will have sufficient time to achieve this without operating near the 2100 kw emergency rating for more than two hours. Based on these considerations, the loads on the EDGs will remain within acceptable limits.

Table 5.7-1. Limiting High-Head Recirculation Phase Loads for Large LOCA – EDG 21

EDG 21 Loads	After Recirc Switch 4	After Recirc Switch 6	After Recirc Spray (Includes Switch 5 for All EDGs case)	Remarks
All EDGs Operating w/ limiting failure				
SI Pump 21	347	347	347	
CS Pump 21	350	350		Limiting failure
CR Fans 21&22	438	438	420	
Recirc Pump 21	287	188	291	
Ess.SW Pump	282	282	282	
Non-Ess.SW Pmp			282	SW 23/26 OOS
CCW Pump 21			213	
MCC 26A/AA	64	72	74	
MCC 29A	86	86	86	
Bus/Cable Loss	117	117	117	
Total Load (kw)	1971	1880	2112	
EDG 21 Loads, EDG 22 Fails				
SI Pump 21	347	347	347	
CS Pump 21				
CR Fans 21&22	422	422	412	
Recirc Pump 21	299	188	291	
Ess.SW Pump	282	282	282	
Non-Ess.SW Pmp	282	282	282	SW 23/26 OOS
CCW Pump 21	230	230	230	
MCC 26A/AA	64	72	74	
MCC 29A	86	86	86	
Bus/Cable Loss	117	117	117	
Total Load (kw)	2129	2026	2121	
EDG 21 Loads, EDG 23 Fails				
SI Pump 21	347	347	347	
CS Pump 21	350	350		
CR Fans 21&22	446	446	422	
Recirc Pump 21	294	188	291	
Ess.SW Pump	282	282	282	
Non-Ess.SW Pmp	282	282	282	SW 22/25 OOS
CCW Pump 21				
MCC 26A/AA	64	72	74	
MCC 29A	86	86	86	
Bus/Cable Loss	117	117	117	
Total Load (kw)	2268	2170	1901	

Table 5.7-2. Limiting High-Head Recirculation Phase Loads for Large LOCA – EDG 22

EDG 22 Loads	After Recirc Switch 4	After Recirc Switch 6	After Recirc Spray (Includes Switch 5 for All EDGs case)	Remarks
All EDGs Operating w/ limiting failure				
SI Pump 22	347	347	347	Limiting failure
AFW Pump 21	223	223	223	
CR Fans 23&24	400	388	388	
Ess.SW Pump	282	282	282	
Non-Ess.SW Pmp	282	282	282	
CCW Pump 22	230	230	213	
MCC 26C (w/o PAB)	52	52	52	
PAB Fan		93	93	
MCC 24A	86	86	86	
Bus/Cable Loss	122	122	122	
Total Load (kw)	2024	2105	2088	
EDG 22 Loads, EDG 21 Fails				
SI Pump 22	347	347	347	
AFW Pump 21	223	223	223	
CR Fans 23&24	446	446	422	
Ess.SW Pump	282	282	282	
Non-Ess.SW Pmp	282	282	282	
CCW Pump 22	230	230	230	
MCC 26C (w/o PAB)	52	52	52	
PAB Fan		93	93	
MCC 24A	86	86	86	
Bus/Cable Loss	122	122	122	
Total Load (kw)	2070	2163	2139	
EDG 22 Loads, EDG 23 Fails				
SI Pump 22	347	347	347	
AFW Pump 21	223	223	223	
CR Fans 23&24	422	422	422	
Ess.SW Pump	282	282	282	
Non-Ess.SW Pmp	282	282	282	
CCW Pump 22	230	230	230	
MCC 26C (w/o PAB)	58	58	58	
PAB Fan		93	93	
MCC 24A	86	86	86	
Bus/Cable Loss	122	122	122	
Total Load (kw)	2052	2145	2145	

Table 5.7-3. Limiting High-Head Recirculation Phase Loads for Large LOCA – EDG 23

EDG 23 Loads	After Recirc Switch 4	After Recirc Switch 6	After Recirc Spray (Includes Switch 5 for All EDGs case)	Remarks
All EDGs Operating w/ limiting failure				
SI Pump 23	347	347	347	
CS Pump 22	350	350		
AFW Pump 22	223	223	223	
CR Fan 25	200	194	194	
Recirc Pump 21	299	188	291	Limiting failure
Ess.SW Pump	282	282	282	
Non-Ess.SW Pmp	282	282	282	SW 22/25 OOS
CCW Pump 23			213	Limiting failure
MCC 26B/BB	49	58	60	
MCC 27A	25	25	25	
Bus/Cable Loss	119	119	119	
Total Load (kw)	2176	2068	2037	
EDG 23 Loads, EDG 21 Fails				
SI Pump 23	347	347	347	
CS Pump 22	350	350		
AFW Pump 22	223	223	223	
CR Fan 25	223	223	211	
Recirc Pump 22	294	188	291	
Ess.SW Pump	282	282	282	
Non-Ess.SW Pmp	282	282	282	SW 22/25 OOS
MCC 26B/BB	49	58	60	
MCC 27A	25	25	25	
Bus/Cable Loss	119	119	119	
Total Load (kw)	2194	2097	1840	
EDG 23 Loads, EDG 22 Fails				
SI Pump 23	347	347	347	
CS Pump 22	350	350		
AFW Pump 22	223	223	223	
CR Fan 25	211	211	206	
Recirc Pump 22				
Ess.SW Pump	282	282	282	
Non-Ess.SW Pmp	282	282	282	
MCC 26B/BB	56	64	66	
MCC 27A	25	25	25	
Bus/Cable Loss	119	119	119	
Total Load (kw)	1895	1903	1550	

6.0 EMERGENCY DIESEL GENERATOR LOADINGS FOR OTHER ACCIDENT CASES

In Section 5.0, EDG loadings for large LOCA were described in considerable detail. In this section, small LOCA EDG loadings are considered in Section 6.1. Non-LOCA cases are then described in Section 6.2.

6.1 Emergency Diesel Generator Loadings for Small LOCA

In this section, EDG loadings for small LOCA are described. A limiting 3" to 4" diameter LOCA case with composite failures is analyzed. For reasons explained, this case serves as a bounding case.

The EDG loads for the small (3" to 4" diameter) LOCA are determined in a conservative manner, considering composite failures. For example, all EDGs are assumed to operate but the CR fans operate at a high power characteristic of minimum containment safeguards (1 CS pump, 3 CR fans). Limiting single failures are also considered during the switchover to recirculation. For example, both CS pumps remain operating following operation of Recirc switch 1, both recirculation pumps operate following operation of Recirc switch 4, and SI pump 22 is left on following operation of Recirc switch 1. Any one non-essential SW pump is also allowed out of service, so the next pump in firing order is assumed to start via Recirc switch 2 and 5. Because of these composite failure assumptions, any potential EDG over-load condition will become evident.

This case is considered as a "representative worst case" small LOCA. This is because the break is small enough to require high-head recirculation (RCS pressure near the shut-off head pressure of the RHR or recirculation pumps) but large enough to require containment spray if only 3 CR fans are operating. Figures 6.1-1 and 6.1-2 (taken from the FSAR) show the RCS pressure transient for these two small LOCAs.

Referring to Section 3.2 and Table 3.2-3, spray actuation occurs for the 4" LOCA case; for the 3" LOCA, spray is not required, but containment pressure remains near the spray actuation setpoint. The time to switchover for this case is calculated to be 105 minutes (Reference 5-8), assuming injection from two SI pumps and one spray pump (CS pump is started at 64 minutes when containment pressure reaches 30 psig, 24 psig setpoint with 6 psi uncertainty applied).

For small LOCA, as in the large LOCA cases, the operator would be directed to EOP E-1 (from E-0) upon diagnosis of high containment radiation and possibly increasing containment sump level and pressure. Prior to switchover (ES-1.3), the operator may also transition to ES-1.2, Post-LOCA Cooldown and Depressurization. If and when the RWST reaches the low level switchover setpoint (9.24 ft), the operator would transition to ES-1.3 based on a caution in ES-1.2. If the ES-1.2 transition is taken before switchover occurs, the operator could start the following optional equipment in addition to the charging pump and automatic MCC loads added per EOP E-0.

1. PAB ventilation may be established if the load on EDG 22 or 23 is less than 1860 kw.

2. Additional charging pumps may be started.

3. A CCW pump may be started if the load on any EDG is less than 1760 kw (EDG with least load would likely be selected).

4. A non-essential SW pump may be started if the load on any EDG is less than 1730 kw (again, the EDG with the least load would be selected).

In the scenario analyzed, charging pumps are started on each EDG. A CCW pump is also started on EDG 21. These are the only additional significant loads that are added prior to the transition to ES-1.3.

Table 6.1-1 describes the significant events for this 3" to 4" small LOCA transient with composite failures. The EDG loading spreadsheets for this case are given in Tables 6.1-2a (EDG 21), 6.1-2b (EDG 22), and 6.1-2c (EDG 23).

The times used for early manual actions are similar to those assumed for the large LOCAs. For the 4" small LOCA case, RCS pressure will approach the shutoff head pressure of the RHR pump (approximately 200 psig). This is high enough to prevent significant flow from the RHR pump but low enough to <u>not</u> allow the pump to be stopped per the EOPs (i.e., less than 340 psig for adverse containment).

Prior to switchover, the operator may transition to ES-1.2, Post-LOCA Cooldown and Depressurization. Because the RCS is saturated, actions performed in ES-1.2 would be minimal. Capacity permitting, however, the operator could add a CCW pump and possibly a non-essential service water pump while in ES-1.2. For this scenario, CCW pump 21 is added, however, a non-essential service water pump can not be added on any EDG because of the anticipated load increase if containment spray actuates (on EDGs 21 and 23). The operator is then directed to ES-1.3 when RWST level reaches 9.24 ft.

In ES-1.3, recirculation switches 1 through 4 are completed as described before for large LOCA. However, since low-head flow is small, the system is aligned to high-head recirculation using recirculation Switch 6 (one recirculation pump supplies the suction of two high-head pumps). Switch 5 is also completed, which adds a second and redundant cooling train. After 135 minutes transient time, most of the actions in ES-1.3 would be complete (including stopping the CS pump). Once hot leg temperatures reach 350°F, the accumulators are isolated to prevent nitrogen injection.

As evident in the spreadsheets, all EDG loads are generally less than 2100 kw, the 2-hour rating for the EDG. There are two exceptions - the loads on EDGs 21 and 23 following operation of Switch 5 (which establishes a redundant cooling train). The load

on EDG 21 reaches 2300 kw. However, it gets this high primarily because of the composite failure, i.e., it is assumed CS pump 22 (on EDG 23) is not running (following Recirc Switch 1), the non-essential SW pump on EDG 23 is out of service, and further assumes a high calculated flow through the recirc pump. (Note: at the time of this high load, two recirc pumps are supplying 2 SI pumps but not recirc spray. The power requirement is based on 1380 gpm from a single pump instead of two recirc pumps. The power reduction if operating at half this flow is estimated to be 10 kw. There is also margin in the CR fans and other equipment loads that could be identified to help further reduce this peak load.) The corresponding peak load on EDG 23 is 2266 kw. This high load is caused by failure of a CCW pump on another EDG and also the high calculated load for the recirculation pump. These peak transient loads last less than 10 minutes and are well within the 2300 kw half-hour rating for the EDGs. The loads prior to switch 5 operation are all considerably less than 2100 kw.

Referring to Section 5.1.5, the miscellaneous losses do include a conservative allowance for frequency tolerance. Therefore, the short term calculated loads close to 2300 kw would be acceptable. Note that these high loads (> 2200 kw) occur only after completion of Switch 5, which establishes a second (redundant) cooling train. If the EDG load indication is reading high, the operator may elect to not perform Switch 5 and thereby avoid overloading that EDG. This would be acceptable since the redundant cooling train is not needed for accident recovery. If the reading is low and the operator performs Switch 5, it is unlikely the actual load would exceed 2300 kw since the EOPs restrict the amount of optional loads the operator is allowed to place on the EDGs.

Long term, the small LOCA high-head recirculation loads are bounded by those determined for large LOCA in Tables 5.7-1, 5.7-2, and 5.7-3. Using EDG load management load similar to that discussed in Section 5.7, it is possible to demonstrate that the load on any EDG can be decreased below the continuous rating of 1750 kw and still satisfy the minimum core and containment cooling requirements, assuming any credible limiting single failure.

It should also be noted that although the calculated loads exceed 1750 kw at the end of the 140 minute (2.33 hour) small LOCA transient, the amount of time that the EDG load exceeds 1750 kw is much less than 2 hours (120 minutes) for any EDG. Referring to Table 6.1-1 and the spreadsheets Tables 6.1-2a, -2b, and –2c, these times are estimated to be 140 – 64 = 76 minutes for EDGs 21 and 23 and 140 – (109-40) = 71 minutes for EDG 22. Therefore, there is considerable time left (~120-76 = 44 minutes) to implement the load management strategy explained in Section 5.7 to reduce loads to below the 1750 kw continuous rating.

Based on consideration of the above loading limits, the loads for small LOCA are acceptable.

Table 6.1-1
Time Table of Events
Small 3" to 4" LOCA with Composite Failures

Event	Time (min)
Small LOCA with Loss of Offsite Power and SI Actuation (Containment Spray Actuation Delayed)	0
All Diesels Start, Major Equipment Sequences Onto Energized 480 V Buses per Description in Section 4.1	0-1
Other Miscellaneous Equipment on MCCs 26A, 26B, and 26C, and 211 Load Automatically: Control Room A.C. - Incident Mode Cable Tunnel Exhaust Fans (Auto-temp) EDG Support Loads (Emg. Lighting, Vent and Exhaust Fans) MOV Loads for Valves Moving to Safeguards Positions	0-1
Operators Directed to Emergency Operating Procedure (EOP) E-0, Reactor Trip or Safety Injection, Step 1	1
Operators Verify Reactor Trip, Turbine Trip, and SI Actuation.	3
MCCs 27A, 24A, and 29A Reset per EOP E-0	4

The Following Components Automatically Load When MCCs Reset:

EDG 21, Bus 5A:

MCC 29A:	
Inst. Air Comp. 21 (and Support Loads)	60 kw
Battery Charger 21	45 kw
EDG 21 Auxiliaries (Compressor)	4 kw
Additional EDG 21 Load =	109 kw

EDG 22, Buses 2A/3A:

MCC 24A:	
Inst. Air Comp. 22 (and Support Loads)	60 kw
Battery Charger 21	45 kw
EDG 22 Auxiliaries (Compressor)	4 kw
Radiation Monitor 45	2 kw
Additional EDG 22 Load =	111 kw

Table 6.1-1 (cont.)
Time Table of Events
Small 3" to 4" LOCA with Composite Failures

Event	Time (min)
EDG 23, Bus 6A: MCC 27A: Battery Charger 24 — 45 kw Additional EDG 23 Load = 45 kw	
Operator Starts Charging Pump at Maximum Speed, Verifies Flow Path From RWST, and Dispatches Operator to Establish Backup Cooling per SOP 4.1.2 (E-0)	4
Control Room Operators Continue with Immediate Actions of E-0	5-10
Operators Verify Remainder of Automatic Actions in E-0	10-15
Transition to EOP E-1, Loss of Reactor or Secondary Coolant	20
Establish PAB Ventilation per EOP E-1 – Operator Establishes Portable Ventilation per AOI 27.1.9 Operator Confirms Operation of Switchgear Room Exhaust Fan	30
SG Narrow Range Levels Indicate >29%, Operators Reduce AFW Flow per E-1 (Continuous Action) or ES-1.2	40
Initiate Evaluation of Plant Status (per E-1)	45
Operators Performing Actions in ES-1.2 - May Include Cooldown If Cold Leg Temperature Limits Permit. SI Pumps Not Stopped Since RCS Remains Close to Saturation	50-111
Operator Starts CCW Pump 21 per E-1 or ES-1.2 EDG Load is Less Than 1760 kw	55
Containment Spray Actuated When Pressure Reaches 30 psig (24 psig setpoint plus 6 psi uncertainty)	64
RWST Level Less Than 9.24 ft - Transition to ES-1.3, Transfer to Cold Leg Recirculation	104

Table 6.1-1 (cont.)
Time Table of Events
Small 3" to 4" LOCA with Composite Failures

Event	Time (min)
Operator Dispatches NPO to Open CCW Hx SW Outlet Valves, Verifies or Completes SI and Spray Reset	105
Perform No. 1 and No. 3 Recirculation Switch Sequence: SI Pump 22 – Stops (assumed to keep running) Valves 887A and 887B Close CS Pump 21 Stops (assumed to keep running) Valves MOV-866A and 866B Close RHR Pumps 21 and 22 Stop Valves MOV-882 and 744 Close	106
Operator confirms SW alignment and stops charging pumps	108
Perform No. 2 Recirculation Switch Sequence: Non-Essential SW Pump 22 (or 25) Starts (SW 23/26 Starts if 22/25 Out of Service) CCW Pump 22 Started Manually (CCW Pump 21 left running)	109
Perform No. 4 Recirculation Switch Sequence: Recirc Pump 21 Starts (Recirc Pump 22 also assumed to start) Valves MOV-1802A and 1802B Open	110
Continue with ES-1.3 assuming high-head recirculation: (transition based on low injection flow):	
Perform No. 6 Recirculation Switch Sequence: Valves MOV-746 and 747 Close Valves MOV-888A and 888B Open (Establishes HH Recirc) Valves MOV-842 and 843 Close	113
Perform No. 8 Recirculation Switch Sequence: Valve MOV-1810 Closes (if energized) CS Test Line Valve 1813 Closes	115
Operator Confirms All EDGs Operating (Allows Recirc. Switch 5)	116

Table 6.1-1 (cont.)
Time Table of Events
Small 3" to 4" LOCA with Composite Failures

Event	Time (min)
Perform No. 5 Recirculation Switch Sequence: Non-Essential SW Pump 23 (or 26) Starts (If SW Pump Out of Service, Pump 21 /24 Starts) CCW Pump 21 Started Manually Recirc Pump 22 Starts	118
Bus 5A: CR Fans 21 and 22 (EDG 21) Essential SW Pumps 24 (or 21) Non-ESS SW Pump 21 (or 24), if other SW Pump Out of Service SI Pump 21 Recirc Pump 21 CCW Pump 21 Selected Equip. on MCCs 26A, 26AA, and 29A CS Pump 21 (if 22 fails)	
Bus 2A /3A: CR Fans 23 and 24 (EDG 22) Non-Ess Service Water Pump 22 (or 25) Essential SW Pumps 25 (or 22) SI Pump 22 CCW Pump 22 AFW Pump 21 (at recirc flow) Selected Equipment on MCCs 24A, and 26C	
Bus 6A: CR Fan 25 (EDG 23) CS Pump 22 Essential SW Pump 26 (or 23) Non-Ess SW Pump 23 (or 26) SI Pump 23 Recirc Pump 22 AFW Pump 23 (at recirc flow) Selected Equip. on MCCs 26B, 26BB, and 27A CCW Pump 23 (if 21 or 22 fail)	
Other Valves Close by Manual or Local Operator Action: MOV-743 MOV-1870 MOV-842 MOV-843	119-122

Table 6.1-1 (cont.)
Time Table of Events
Small 3" to 4" LOCA with Composite Failures

Event	Time (min)
RWST Level Reaches 2.0 ft, Operator Aligns Spray to Recirculation per ES-1.3: CS Pump 22 (and 21) Stopped Valves MOV-866C and 866D Close Valve MOV-889B is Opened	125
Recirculation Water ph Verified to be in Proper Range, (otherwise a charging pump and BA transfer pump are operated to raise or lower ph)	130
Operators Isolate Accumulators by Closing Discharge Valves 894A-894D	134
End of Transient	140

Table 6.1-2a Small 3" to 4" LOCA With Composite Failures - Loads on EDG 21

06/24/02

Bus 5A Loading - EDG 21

Time in Minutes

Recirculation Switch Sequence

Equipment	Max kW	Man/Auto	1	*	5	*	10	*	30	*	60	*	105	*	107	*	109	*	110	*	113	*	116	*	118	*	124	*	126	*	130	*	135	*	140
													No. 1&3				No. 2		No. 4		No. 6&8		No. 5				Recirc Spray								
SI Pmp 21 (400)	345	A	339		339		339	6	345		345		345		345		345		345		345		345		345		345		345		345		345		345
SI Cir Wtr Pmp 21	2.2	A	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2
CS Pmp 21 (400)	350	A			0		0		0		0	350	350		350		350		350		350		350		350		350	-350	0		0		0		0
CR Fan 21 (350)	250	A	130	30	160	15	175	11	186	8	194	-11	183		183		183		183		183		183		183	-1	182		182		182		182	-10	172
CR Fan 22 (350)	250	A	130	30	160	15	175	11	186	8	194	-11	183		183		183		183		183		183		183	-1	182		182		182		182	-10	172
RC Pmp 21 (350)	303	M			0		0		0		0		0		0		0		0	194	194		194		194		194	107	301		301		301		301
Ess SW Pmp 24 (350)	282	A	282		282		282		282		282		282		282		282		282		282		282		282		282		282		282		282		282
NE SW Pmp 21 (350)	282	M			0		0		0		0		0		0		0		0		0		0	282	282		282		282		282		282		282
CCW Pmp 21 (250)	230	M			0		0		0	230	230		230		230		230		230		230		230	-17	213		213		213		213		213		213
Chg Pmp 21 (200)	150	M	81		81		81		81		81		81		81	-81	0		0		0		0		0		0		0		0		0		0
Srv Air Comp (125)	93	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Pzr Htrs 23	485	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Ltg Bus 23 (120/208V)	135	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Ltg Bus 23 (480V-Emg)	100	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
											0																								
MCC 26A Loads											0																								
MOVs:											0																								
MOV-822A	0.7	A	0.7	-0.7	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-894A	5.6	A			0		0		0		0		0		0		0		0		0		0		0		0		0		0	5.6	5.6	-5.6	0
MOV-894C	5.6	A			0		0		0		0		0		0		0		0		0		0		0		0		0		0	5.6	5.6	-5.6	0
MOV-866A	0.6	A			0		0		0		0		0	0.6	0.6	-0.6	0		0		0		0		0		0		0		0		0		0
MOV-866C	0.6	A			0		0		0		0		0		0		0		0		0		0		0		0	0.6	0.6	-0.6	0		0		0
MOV-888A	0.7	M			0		0		0		0		0		0		0		0		0	0.7	0.7	-0.7	0		0		0		0		0		0
MOV-744	5.8	A			0		0		0		0		0	5.8	5.8	-5.8	0		0		0		0		0		0		0		0		0		0
MOV-746	7.7	A	7.7	-7.7	0		0		0		0		0		0		0		0		0	7.7	7.7	-7.7	0		0		0		0		0		0
MOV-887A	0.4	A			0		0		0		0		0	0.4	0.4	-0.4	0		0		0		0		0		0		0		0		0		0
HCV-640	0.6	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
BFP-2-21	14.3	A	14.3	-14.3	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-1802A	0.7	M			0		0		0		0		0		0		0		0	0.7	0.7	-0.7	0		0		0		0		0		0		0
MOV-889A	0.6	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-842	0.6	M			0		0		0		0		0		0		0		0		0		0		0	0.6	0.6	-0.6	0		0		0		0
HCV-3100	0.25	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MOV-1810	1.2	M			0		0		0		0		0		0		0		0		0	1.2	1.2	-1.2	0		0		0		0		0		0
CCW Boost Pmp 21 (5)	3.7	A	3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7
Elec Tun Exh Fan 21	7.4	A	7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4
DG Exh Fan 21 (nor)	0.5	A	0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5
EDG Bldg. Vent Fan 319.321	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
BA Ht Trace (nor)	16.8	A	16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8		16.8
XMFR 23 (Inv 21)(max)	10	M/A			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
EPX3	15	A	15		15		15		15		15		15		15		15		15		15		15		15		15		15		15		15		15
EPV21	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
MCC 26AA																																			
Misc MOVs	1	A	1		1		1		1		1		1		1		1		1		1		1		1		1		1		1		1		1
H2/O2 Anlyz Ht Trc 1	3.3	A	3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3
MCC 29A																																			
DG 21 Support Loads																																			
Fuel Oil Pmp (2)	1.5	A			0		0		0		0	1.5	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
Compressor (5)	3.7	A		3.7	3.7	-3.7	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Bat Charger 21 (Max)	45	A		45	45		45	-20	25		25		25		25		25		25		25		25		25		25		25		25		25		25
Inst Air Comp 21 (75)	56	A		56	56		56		56		56		56		56		56		56		56		56		56		56		56		56		56		56
I.A. Cool Pmp 21 (3)	2.2	A		2.2	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2
Wall Exh Fan 215 (2)	1.5	M		1.5	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
Misc. Loss (Max)	117	A	117		117		117		117		117		117		117		117		117		117		117		117		117		117		117		117		117
Total EDG 21 Load:			1167		1312		1339		1347		1593		1922		1929		1841		1841		2036		2045		2300 +		2299 +		2056		2055 *		2066 *		2035 *

+ These short term high loads occur as a result of unlikely composite failures. Refer to Section 6.1 for load margin and additional discussion.

* The long term EDG load can be reduced below 1750 kw by load management. Refer to Section 5.7 for more details.

Table 6.1-2b Small 3" to 4" LOCA With Composite Failures - Loads on EDG 22

06/24/02

Bus 2A/3A Loading - EDG 22

Equipment	Max kW	Man/Auto	Time in Minutes 1	*	5	*	10	*	30	*	60	*	105	*	107	*	109	*	110	*	113	*	116	*	118	*	124	*	126	*	130	*	135	*	140
													Recirculation Switch Sequence No. 1&3				No. 2		No. 4		No. 6&8		No. 5				Recirc Spray								
SI Pmp 22 (400)	345	A	339		339		339	6	345		345		345		345		345		345		345		345		345		345		345		345		345		345
SI Cir Wtr Pmp 22	2.2	A	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2
RHR Pmp 21 (400)	316	A	171		171		171		171		171		171	-171	0		0		0		0		0		0		0		0		0		0		0
AFW Pmp 21 (400)	387	A	376		376		376		376	-153	223		223		223		223		223		223		223		223		223		223		223		223		223
CR Fan 23 (350)	250	A	130	30	160	15	175	11	186	8	194	-11	183		183		183		183		183		183		183	-1	182		182		182		182	-10	172
CR Fan 24 (350)	250	A	130	30	160	15	175	11	186	8	194	-11	183		183		183		183		183		183		183	-1	182		182		182		182	-10	172
Ess SW Pmp 25 (350)	282	A	282		282		282		282		282		282		282		282		282		282		282		282		282		282		282		282		282
NE SW Pmp 22 (350)	282	M			0		0		0		0		0		0		0	282	282		282		282		282		282		282		282		282		282
CCW Pmp 22 (250)	230	M			0		0		0		0		0		0		0	230	230		230		230	-17	213		213		213		213		213		213
Chg Pmp 22 (200)	150	M	81		81		81		81		81		81		81	-81	0		0		0		0		0		0		0		0		0		0
Pzr Htr 21	554	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Pzr Htr 22	485	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Ltg Tran 21 (Nor)	150	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Ltg Tran 22	150	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Ltg Bus 23 (480V-Nor)	100	M			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
MCC 211																																			
MOV'S																																			
BFD-90	1.2	A	1.2	-1.2	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
BFD-90-1	1.2	A	1.2	-1.2	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
BFD-90-2	1.2	A	1.2	-1.2	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
BFD-90-3	1.2	A	1.2	-1.2	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
BFD-5	5	A	5	-5	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
BFD-5-1	5	A	5	-5	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
BFD-5-2	5	A	5	-5	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
BFD-5-3	5	A	5	-5	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
											0																								
MCC 24A											0																								
DG 22 Support Loads											0																								
Fuel Oil Pmp (2)	1.5	A			0		0		0		0	1.5	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
Compressor (5)	3.7	A		3.7	3.7	-3.7	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
XMFR 24 (Inv 22)(max)	15	M/A			0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Inst Air Comp 22 (75)	56	A		56	56		56		56		56		56		56		56		56		56		56		56		56		56		56		56		56
I.A. Cool Pmp 22 (3)	2.2	A		2.2	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2
Bat Charger 22 (Max)	45	A		45	45		45	-20	25		25		25		25		25		25		25		25		25		25		25		25		25		25
Radiation Monitor 45	1.6	A		1.6	1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6		1.6
MCC 26C																																			
DG Exhaust Fan 22	0.8	A	0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8
PAB Exhaust Fan 21 (125)	93	M	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
EDG Bldg Vent Fan 320,322	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
Battery Charger 23	25	A	25		25		25		25		25		25		25		25		25		25		25		25		25		25		25		25		25
CRAC Backup Fan (7.5)	5.6	A	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
CRAC Booster Fan 21 (7.5), Dampers & Motors	5.8	A	5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8		5.8
											0																								
BA Trans Pump 21 (15)	11.2	A	11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2
BAT Heaters 21	15	M	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Spent Fuel Pump 21 (100)	75	M	0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0
Wall Exhaust Fan 213 (2)	1.5	M	0	1.5	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
											0																								
Misc. Loss (Max)	122	A	122		122		122		122		122		122		122		122		122		122		122		122		122		122		122		122		122
Total EDG 22 Load:			1708		1854		1880		1888		1751		1730		1559		1478		1990		1990		1990		1973		1971		1971		1971 *		1971 *		1951 *

* The long term EDG load can be reduced below 1750 kw by load management. Refer to Section 5.7 for more details.

Table 6.1-2c Small 3" to 4" LOCA With Composite Failures - Loads on EDG 23

06/24/02

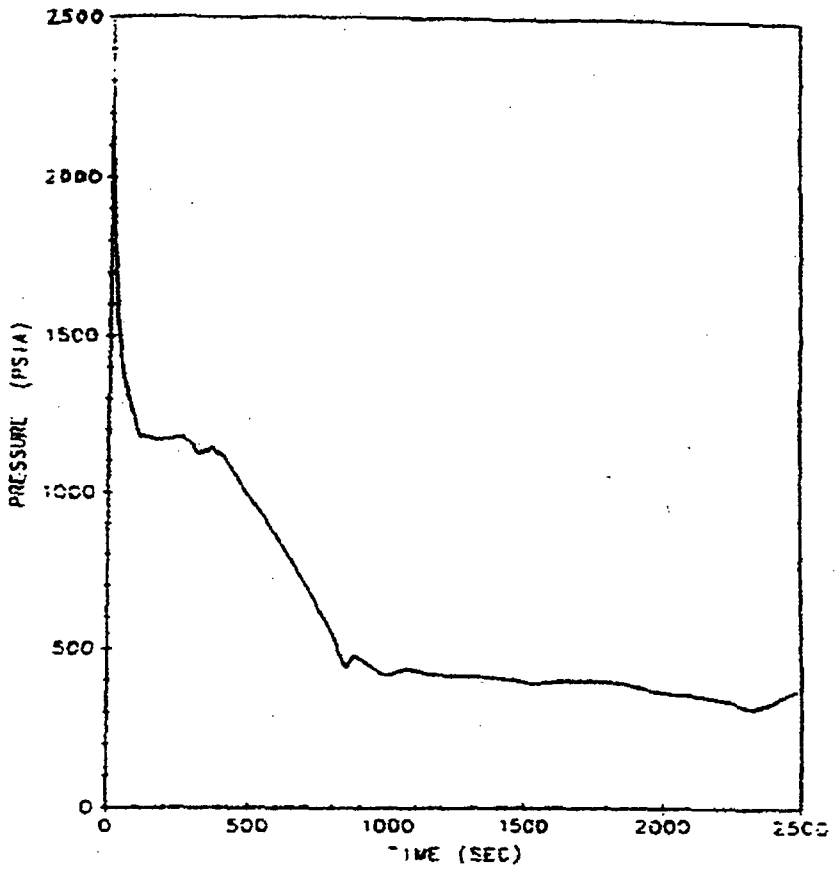
Bus 6A Loading - EDG 23 — Time in Minutes

Equipment	Max kW	Man/Auto	1	*	5	*	10	*	30	*	60	*	105	*
													Recirculation Switch Sequence No. 1&3	
SI Pmp 23 (400)	345	A	339		339		339	6	345		345		345	
SI Cir Wtr Pmp 23	2.2	A	2.2		2.2		2.2		2.2		2.2		2.2	
CS Pmp 22 (400)	350	A			0		0		0		0	350	350	
RHR Pmp 22 (400)	316	A	171		171		171		171		171		171	-171
AFW Pmp 23 (400)	387	A	376		376		376		376	-153	223		223	
CR Fan 25 (350)	250	A	130	30	160	15	175	11	186	8	194	-11	183	
RC Pmp 22 (350)	303	M			0		0		0		0		0	
Ess SW Pmp 26 (350)	282	A	282		282		282		282		282		282	
NE SW Pmp 23 (350)	282	M			0		0		0		0		0	
Chg Pmp 23 (200)	150	M	81		81		81		81		81		81	
Trb Aux Lub (150)	112	M			0		0		0		0		0	
Pzr Htr Cntrl Gp	277	M			0		0		0		0		0	
Ltg Tran 21 (Emg)	150	M			0		0		0		0		0	
CCW Pmp 23	230	M			0		0		0		0		0	
MCC 26B Loads														
MOVs:														
MOV-822B	0.7	A	0.7	-0.7	0		0		0		0		0	
MOV-894B	5.6	A			0		0		0		0		0	
MOV-894D	5.6	A			0		0		0		0		0	
MOV-866B	0.6	A			0		0		0		0		0	0.6
MOV-856D	0.6	A			0		0		0		0		0	
MOV-888B	0.7	M			0		0		0		0		0	
MOV-882	2.2	M			0		0		0		0		0	2.2
MOV-887B	0.4	A			0		0		0		0		0	0.4
MOV-747	7.7	A	7.7	-7.7	0		0		0		0		0	
HCV-638	0.6	M			0		0		0		0		0	
BFP-2-22	14.3	A	14.3	-14.3	0		0		0		0		0	
MOV-1802B	0.7	A			0		0		0		0		0	
MOV-889B	0.6	M			0		0		0		0		0	
MOV-843	0.6	M			0		0		0		0		0	
HCV-3101	0.25	M			0		0		0		0		0	
CC Boost Pmp 22 (5)	3.7	A	3.7		3.7		3.7		3.7		3.7		3.7	
Elec Tun Exh Fan 22	7.4	A	7.4		7.4		7.4		7.4		7.4		7.4	
BA Heat Trace (Emg)	16.8	M			0		0		0		0		0	
CRAC Humidifier	2.2	A	2.2		2.2		2.2		2.2		2.2		2.2	
CRAC Fan (10)	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5	
CRAC Boost Fan 22 (7.5),	6.8	A			0		0		0		0		0	
Dampers & Motors											0		0	
DG 23 Support Loads											0		0	
Fuel Oil Pmp (2)	1.5	A			0		0		0		0	1.5	1.5	
Compressor (5)	3.7	A	3.7	-3.7	0		0		0		0		0	
Lighting Panel 223:											0		0	
DG Exhaust Fan 23	0.8	A	0.8		0.8		0.8		0.8		0.8		0.8	
DG Bldg Emg Lights	1.1	A	1.1		1.1		1.1		1.1		1.1		1.1	
Eng Aux Cntr Pnl	0.3	A	0.3		0.3		0.3		0.3		0.3		0.3	
BA Trans Pmp 22 (7.5/15)	11.2	A	11.2		11.2		11.2		11.2		11.2		11.2	
EDG Bldg Vent Fan 318,323	7.5	A	7.5		7.5		7.5		7.5		7.5		7.5	
											0		0	
MCC 26BB Loads											0		0	
Misc MOVs	1	A	1		1		1		1		1		1	
H2/O2 Anlyz Ht Trace 2	3.3	A	3.3		3.3		3.3		3.3		3.3		3.3	
Transf 2H (45KVA)	0.3	A	0.3		0.3		0.3		0.3		0.3		0.3	
MCC 27A Loads														
Bat Charger 24 (Max)	45	A		45	45		45	-20	25		25		25	
XFMR 22 (Inv 24)(max)	15	M			0		0		0		0		0	
PAB Exhaust Fan 22 (125)	93	M			0		0		0		0		0	
PAB Supply Fan (50)	37	M			0		0		0		0		0	
Spent Fuel Pump 22 (100)	75	M			0		0		0		0		0	
Misc. Loss (Max)	119	A	119		119		119		119		119		119	
Total EDG 23 Load:			1573		1622		1637		1634		1489		1829	

Equipment	107	*	109	*	110	*	113	*	116	*	118	*	124	*	126	*	130	*	135	*	140
				No. 2		No. 4		No. 6&8		No. 5				Recirc Spray							
SI Pmp 23 (400)	345		345		345		345		345		345		345		345		345		345		345
SI Cir Wtr Pmp 23	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2
CS Pmp 22 (400)	350		350		350		350		350		350		350	-350	0		0		0		0
RHR Pmp 22 (400)	0		0		0		0		0		0		0		0		0		0		0
AFW Pmp 23 (400)	223		223		223		223		223		223		223		223		223		223		223
CR Fan 25 (350)	183		183		183		183		183		183	-1	182		182		182		182	-10	172
RC Pmp 22 (350)	0		0		0	194	194		194		194		194	107	301		301		301		301
Ess SW Pmp 26 (350)	282		282		282		282		282		282		282		282		282		282		282
NE SW Pmp 23 (350)	0		0	282	282		282		282		282		282		282		282		282		282
Chg Pmp 23 (200)	81	-81	0		0		0		0	213	213		213		213		213		213		213
Trb Aux Lub (150)	0		0		0		0		0		0		0		0		0		0		0
Pzr Htr Cntrl Gp	0		0		0		0		0		0		0		0		0		0		0
Ltg Tran 21 (Emg)	0		0		0		0		0		0		0		0		0		0		0
CCW Pmp 23	0		0		0		0		0		0		0		0		0		0		0
MCC 26B Loads																					
MOVs:																					
MOV-822B	0		0		0		0		0		0		0		0		0		0		0
MOV-894B	0		0		0		0		0		0		0		0		0	5.6	5.6	-5.6	0
MOV-894D	0		0		0		0		0		0		0		0		0	5.6	5.6	-5.6	0
MOV-866B	0.6	-0.6	0		0		0		0		0		0		0		0		0		0
MOV-856D	0		0		0		0		0		0		0	0.6	0.6	-0.6	0		0		0
MOV-888B	0		0		0		0	0.7	0.7	-0.7	0		0		0		0		0		0
MOV-882	2.2	-2.2	0		0		0		0		0		0		0		0		0		0
MOV-887B	0.4	-0.4	0		0		0		0		0		0		0		0		0		0
MOV-747	0		0		0		0	7.7	7.7	-7.7	0		0		0		0		0		0
HCV-638	0		0		0		0		0		0		0		0		0		0		0
BFP-2-22	0		0		0		0		0		0		0		0		0		0		0
MOV-1802B	0		0		0	0.7	0.7	-0.7	0		0		0		0		0		0		0
MOV-889B	0		0		0		0		0		0		0	0.6	0.6	-0.6	0		0		0
MOV-843	0		0		0		0		0		0	0.6	0.6	-0.6	0		0		0		0
HCV-3101	0		0		0		0		0		0		0		0		0		0		0
CC Boost Pmp 22 (5)	3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7		3.7
Elec Tun Exh Fan 22	7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4		7.4
BA Heat Trace (Emg)	0		0		0		0		0		0		0		0		0		0		0
CRAC Humidifier	2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2		2.2
CRAC Fan (10)	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
CRAC Boost Fan 22 (7.5),	0		0		0		0		0		0		0		0		0		0		0
Dampers & Motors																					
DG 23 Support Loads																					
Fuel Oil Pmp (2)	1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5		1.5
Compressor (5)	0		0		0		0		0		0		0		0		0		0		0
Lighting Panel 223:																					
DG Exhaust Fan 23	0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8		0.8
DG Bldg Emg Lights	1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1		1.1
Eng Aux Cntr Pnl	0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3
BA Trans Pmp 22 (7.5/15)	11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2		11.2
EDG Bldg Vent Fan 318,323	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5
MCC 26BB Loads																					
Misc MOVs	1		1		1		1		1		1		1		1		1		1		1
H2/O2 Anlyz Ht Trace 2	3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3		3.3
Transf 2H (45KVA)	0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3		0.3
MCC 27A Loads																					
Bat Charger 24 (Max)	25		25		25		25		25		25		25		25		25		25		25
XFMR 22 (Inv 24)(max)	0		0		0		0		0		0		0		0		0		0		0
PAB Exhaust Fan 22 (125)	0		0		0		0		0		0		0		0		0		0		0
PAB Supply Fan (50)	0		0		0		0		0		0		0		0		0		0		0
Spent Fuel Pump 22 (100)	0		0		0		0		0		0		0		0		0		0		0
Misc. Loss (Max)	119		119		119		119		119		119		119		119		119		119		119
Total EDG 23 Load:	1661		1577		1859		2054		2061		2266 +		2266 +		2023		2022 *		2033 *		2012 *

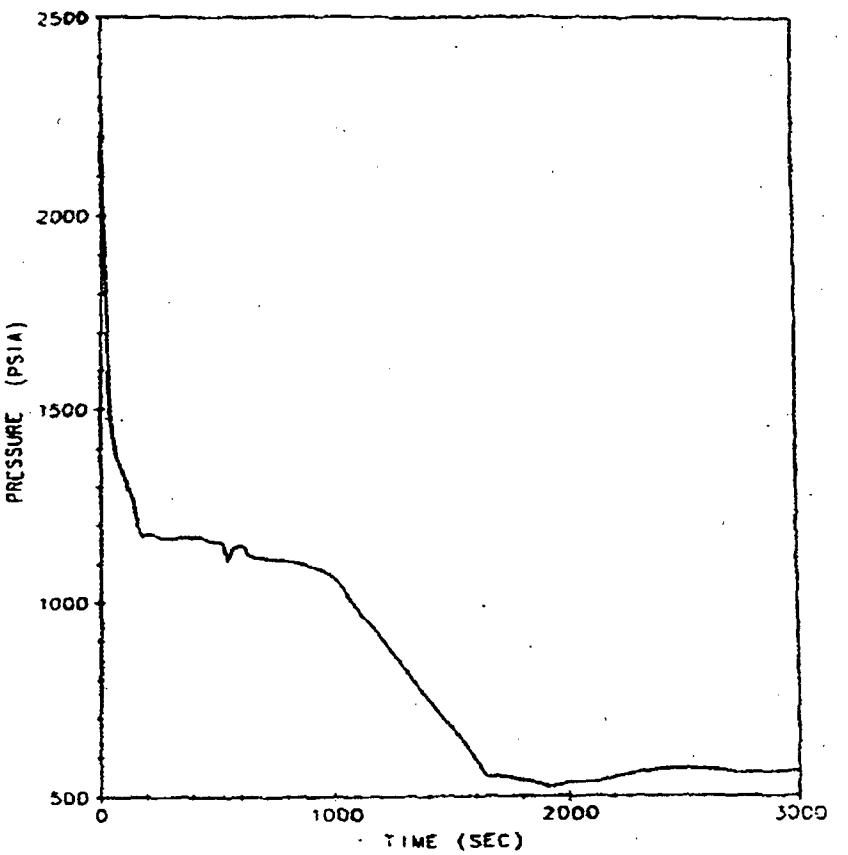
\+ These short term high loads occur as a result of unlikely composite failures. Refer to Section 6.1 for load margin and additional discussion.

* The long term EDG load can be reduced below 1750 kw by load management. Refer to Section 5.7 for more details.



CONSOLIDATED EDISON INDIAN POINT UNIT No. 2	
UFSAR FIGURE 14.3-65 4.0" SMALL BREAK LOCA RCS PRESSURE	
MIC. No. 2001MB1246	REV. No. 16A

Figure 6.1-1 RCS Pressure for the 4" Small Break LOCA



CONSOLIDATED EDISON INDIAN POINT UNIT No. 2	
UFSAR FIGURE 14.3-54 3.0" SMALL BREAK LOCA RCS PRESSURE	
MIC. No. 2001MB1235	REV. No. 16A

Figure 6.1-2 RCS Pressure for the 3" Small Break LOCA

6.2 Emergency Diesel Generator Loadings for Non-LOCA Transients

In this section three non-LOCA transients with SI are discussed. These are steamline break, steam generator tube rupture (SGTR) and spurious safety injection signal (SIS). Although the EOPs used for these three events differ, many of the equipment requirements end up being about the same, at least from the standpoint of EDG operation.

For a steamline break the following EOPs and POP would be used:

E-0, Reactor Trip or Safety Injection (Rev. 38)
E-2, Faulted Steam Generator Isolation (Rev. 34)
E-1, Loss of Reactor or Secondary Coolant (Rev. 36)
ES-1.1, SI Termination (Rev. 36)
POP 3.2, Plant Recovery from Reactor Trip

For a SGTR the following EOPs would be used:

E-0, Reactor Trip or Safety Injection (Rev. 38)
E-3, Steam Generator Tube Rupture (Rev. 36)
ES-3.1, Post SGTR Cooldown Using Backfill, or alternate cooldown and depressurization procedure ES-3.2 or ES-3.3 (all are Rev. 34)

For a spurious SIS the following EOPs and POP would be used:

E-0, Reactor Trip or Safety Injection (Rev. 38)
ES-1.1, SI Termination (Rev. 36)
POP 3.2, Plant Recovery from Reactor Trip

For the design basis accidents (and for spurious SIS), the usual minimum set of safeguards equipment would start following safety injection actuation. The required equipment is similar to that previously listed for LOCA, i. e., 2 SI pumps, 1 RHR pump, 2 essential header SW pumps, 3 CR fans and one motor driven AFW pump. For secondary break inside containment, 1 CS pump would also be required to operate until containment pressure decreases to less than 17 psig per EOP E-1 instructions.

Figures 6.2-1 and 6.2-2 show the RCS pressure and pressurizer water volume transients for a design basis steamline break performed as a part of the Stretch Rating Study (Reference 6-1). The containment pressure transient representative for this case is given in Table 3.2-2.

For the large secondary break design basis event, the operator would typically be able to diagnose the event within 10 minutes and satisfy the criteria for SI termination in E-1 within about 30 minutes. To satisfy these criteria for the secondary break, the operator would need to start one charging pump in EOP E-0 or E-1. After the faulted SG

blowdown has stopped and cooldown shrink has been terminated, RCS pressure would start to increase and pressurizer level would return on span. These conditions (along with subcooling greater than uncertainties, RCS pressure greater than the shutoff head pressure of the HHSI pumps, plus reestablishment of secondary heat sink) satisfy the requirements for SI termination.

The SI and RHR pumps would then be stopped in ES-1.1 (the RHR pumps may have also been stopped prior to this in E-1). Per EOP E-1 instructions, containment spray would be stopped after containment pressure is reduced to less than 17 psig. For the design basis secondary break this would occur at approximately 20 to 40 minutes after event initiation (see Table 3.2-2). For this evaluation, we assume spray is secured at 30 minutes.

The RCS subcooling required in E-1 to terminate SI is 26°F with adverse containment conditions. The RCS is only slightly subcooled (<15°F) at 300 seconds into the transient. However, at 600 seconds (10 minutes), subcooling exceeds 50°F, which is sufficient for SI termination. RCS pressure must also be greater than 1690 psig in order to terminate SI with an adverse containment environment. Based on Figure 6.2-1, this condition is met therefore SI and spray can be terminated at 30 minutes.

For the SGTR accident, the SI termination criteria would be satisfied in EOP E-3 following operator actions to identify and isolate the ruptured SG, cooldown the RCS by approximately 50°F (typically) using the intact SGs atmospheric steam dump valves, and then depressurize the RCS using one pressurizer PORV. For the design basis (i. e., double ended) SGTR analysis in the FSAR, it was assumed SI would be terminated within 30 minutes after event initiation. For the EDG loading study, load changes are summarized between a hypothetical 15 minute end of injection phase and 40 minute start of SGTR recovery phase. The RHR pump would be stopped midway through the E-3 procedure (this is now done after SI termination). A charging pump would be started following the initial cooldown, if not already operating per E-0, Step 5. After the EOP E-3 SI termination criteria are satisfied, the SI pumps would be stopped. The criteria for SI termination in EOP E-3 are pressurizer level on span, RCS subcooling greater than uncertainties, RCS pressure stable or increasing, plus establishment of a secondary heat sink.

For the spurious SIS the operator would typically be able to diagnose the event within 10 minutes and terminate SI within about 15 minutes. Since the SI termination criteria (which are the same as those for the secondary break) are immediately met following the spurious SIS, the operator would go directly from EOP E-0 to EOP ES-1.1 and stop the SI and RHR pumps.

Following SI termination in ES-1.1 or E-3 (and stopping of the CS pump for the secondary break), the required major equipment left operating are the essential SW pumps, the CR fans, the motor driven AFW pump, and one charging pump. The EOPs also direct the operator to start a service water pump on the non-essential header and also to start a CCW pump (provided concurrent CS pump operation does not cause an

EDG loading problem). This set of equipment clearly represents a less limiting set of loads than that described for LOCA. The equipment requirements for SGTR, spurious SIS or secondary break are essentially identical after the SI, RHR and CS pumps are stopped. For post-secondary break recovery in ES-1.1, pressurizer heaters, charging flow, letdown, and AFW would be controlled to maintain hot standby conditions. Per ES-1.1, unnecessary equipment would be shut down. ES-1.1 also allows the operator to place the main turbine and main boiler feed pump turbines on turning gear after their shafts stop. The operator would then transition to the appropriate shutdown procedure, POP 3.2. For post-SGTR recovery with backfill, a similar set of equipment would be operated (i.e., charging, letdown, pressurizer heaters and AFW). The plant would then be cooled down to cold shutdown using the SG atmospheric steam dump valves and later the RHR system. For recovery after spurious SIS, POP 3.2 is exercised. A set of equipment similar to that for the SGTR would be required (i. e., charging, letdown, pressurizer heaters and AFW). The SG atmospheric steam dump valves and RHRS would also be used to cool down the plant to cold shutdown.

It is possible that SI termination for secondary break or SGTR may not be accomplished before the 30 or 40 minutes noted previously. This would be particularly true for a small (less than design basis) SGTR where additional time may be required to identify which of the steam generators contains the rupture. The EDG loading should therefore account for the possibility that the SI pumps may be operating for longer than 30 minutes, possibly as long as one or two hours until a clear indication on the SG narrow range level instrumentation appears to confirm which SG has the rupture.

The EDG loads for each of these three non-LOCA transients are described below. For many of the loads, certain equipment is redundant (i.e., on two or more EDGs) to allow for the possibility of equipment unavailability. The loading tables for these events were constructed in this manner to allow for possible equipment failures and/or for components to be allowed out of service per the Technical Specifications. Even with this redundancy, it is possible to load additional optional equipment to aid in plant recovery.

In the current (Rev. 38) version of the EOPs (Ref. 1-28), there is a step in the E-3 SGTR procedure and the ES-1.1 SI termination procedure that directs the operator to reset (normal) lighting. This step also instructs the operator to reset other MCCs in addition to those already energized (i.e., MCCs 26A/AA, 26B/BB, 26C, 211, 24A, 27A, and 29A). The normal lighting loads when lighting is reset in these procedure steps is assumed to be as follows:

Lighting Transformer 21 - 150 kw (normal supply-EDG 22, emergency-EDG 23)
Lighting Transformer 22 - 130 kw (EDG 22)
Lighting Transformer 23 - 100 kw (EDG 21)

The load for transformer 21 is simply based on the "kVA" rating of the transformer. For transformers 22 and 23 (both rated at 225 kVA), credit is taken for a more detailed estimate based on the expected power requirements for the various lighting panels (see

Table 3.4-2 of WCAP-12655, Rev.0). An additional 10% has been added to account for possible lighting loads added over the years.

In addition to the lighting loads, the following other MCCs would be energized (note: MCCs 28 and 28A are reset if containment conditions are normal and the containment sump level is less than 44' 3"):

EDG 21:	EDG 22:	EDG 23:
MCC 29	MCC 21,22	MCC 27
MCC 28	MCC 23,24	
	MCC 25,28A	
	MCC 210	

Loads for many of these MCCs, before the creation of MCCs 24A, 27A, 29A, and 26C, are described in Section 3.4 of WCAP-12655 Rev. 0. For purposes of constructing loading tables for the transients described in this section, it will be assumed that the operator controls the total addition of automatic loads from these other MCCs to approximately 100 kw per EDG. Additional BOP support loads on MCCs 22 and 25 (e.g., bearing oil pump, MBFP oil console main oil pump, etc.,) will also be accounted for separately since EDG 22 powers considerably more equipment than the others. Note that when this reset lighting/reset MCC step is encountered in the EOPs, the accident will have been mitigated and the operator will be able manage loads on the EDGs without difficulty.

Steamline Break

For this transient, the operator initially follows E-0, E-2, and E-1. As discussed previously, after the faulted SG blowdown has stopped and cooldown shrink has been terminated, plant conditions are assumed to be sufficient to meet the criteria to terminate SI and stop containment spray within 30 minutes. Therefore, following through the EOPs, two time-based loading summaries (columns) can be used to determine the EDG loadings during this transient:

1. E-0, E-2, E-1:
   Auto loads,
   Add a charging pump,
   Auto MCC reset loads.

2. ES-1.1:
   Stop SI (and RHR) pumps,
   Stop CS pumps,
   Add a CCW pump and non-essential SW pump (if not already on and EDG loading permits),
   Add pressurizer heaters (if loading permits),
   Add normal lighting and other MCC loads.

Place main turbine and BFP turbines on turning gear.

The EDG loading tables for steamline break with the above two columns are provided in Tables 6.2-1a, -1b, and -1c. Inputs to these tables were taken from Tables 3.1-2, 3.3-2a, 3.3-2b, 3.3-2c and 3.4-1 through 3.4-3. Power requirements for the fan cooler motors were determined from Table 3.2-2. As can be noted, the EDG loads are typically less than 2100 kw during the first 30 minutes of the transient. Following SI and spray termination, the peak transient loads on either EDG 21 or EDG 22 may exceed 2100 kw if additional loads such as a non-essential service water pump, a CCW pump, or pressurizer heaters are assumed. However, any combination of two EDGs can power a minimum of additional loads (for example, one CCW pump, one NE SW pump, and pressurizer heaters) without exceeding 2100 kw on either EDG as shown below:

EDG 21 & 22 Operating	EDG 21 & 23 Operating	EDG 22 & 23 Operating
Drop CCW 21 from EDG 21	Drop CCW 21 from EDG 21	Drop CCW 22 from EDG 22
AND	OR	
Drop NE SW 22 from EDG 22	Drop PZR Htrs from EDG 21	

All EDG loads remain well below the 2300 kw ½ hour rating throughout the transient. In the longer term (e.g., after 2 hours) individual EDG loads are controllable to establish less than 1750 kw.

Steam Generator Tube Rupture

For this event, EOPs E-0 and E-3, Steam Generator Tube Rupture, are used. Long term, it is assumed that the operator uses ES-3.1, Post-SGTR Cooldown with Backfill. EDG loads for the other post-SGTR recovery procedures (ES-3.2 and ES-3.3) would be similar. Following the EOPs, it is possible to use three columns to summarize the SGTR loads:

1. E-0, E-3:
   Auto loads,
   Add a charging pump,
   Auto MCC reset loads.

2. E-3:
   Stop SI pumps,
   Add PAB Ventilation
   Stop RHR pumps,
   Add a CCW pump and non-essential SW pump (if EDG loading permits),
   Add pressurizer heaters,
   Add Normal Lighting and other MCC loads.

3. ES-3.1
   Loads are the same as the end of E-3 except AFW is assumed throttled.

The EDG loading tables for SG tube rupture are provided in Tables 6.2-2a, -2b, and 2c. As with steamline break, inputs to these tables were taken from Tables 3.1-2, 3.2-1, 3.3-2a, 3.3-2b, 3.3-2c and 3.4-1 through 3.4-3. It should be noted that in column 2, the load for the SI pumps is shown as zero even though the SI pumps may be running during part of this time interval. Since the power required for the loads assumed added later in E-3 (after SI termination) exceed the power requirement for the SI pump, the loadings will be bounded by displaying the results as provided in these tables. The EDG loads for SG tube rupture are less than 2100 kw. Long term loads are controllable to less than 1750 kw with EDG load management.

Spurious SI Actuation

The EDG loads for spurious SI with SI termination (ES-1.1) are very similar to those found for SGTR. Three columns are again used to describe the EDG loading:

1. E-0
   Auto loads,
   Add a charging pump,
   Add MCC reset loads.

2. ES-1.1:
   Stop RHR and SI pumps,
   Add a CCW pump and non-essential SW pump (if EDG loading permits),
   Add pressurizer heaters,
   Add normal lighting and other MCC loads
   Add PAB ventilation,
   Place main turbine and BFP turbines on turning gear.

3. ES-1.1 after 40 min:
   Throttle AFW.

The EDG loading tables for spurious SI actuation are provided in Tables 6.2-3a, -3b, and -3c. Loads for EDG 22 and EDG 23 remain less than 2100 kw throughout the transient. For EDG 21, loading may exceed 2100 kw if additional loads such as a non-

essential service water pump, a CCW pump, or pressurizer heaters are assumed. However, as discussed for the steamline break, any combination of two EDGs can power a minimum of additional loads (for example, one CCW pump, one NE SW pump, and pressurizer heaters) without exceeding 2100 kw on either EDG. Long term loads are controllable to less than 1750 kw with EDG load management.

Conclusion for Non-LOCA Transients

The calculated EDG loads for the non-LOCA transients are typically less than the two hour EOP limit of 2100 kw, with certain exceptions when additional loads such as non-essential service water pumps, CCW pumps, or pressurizer heaters are assumed. In those cases, it may be necessary to split the additional loads between the operating EDGs in order to maintain loading below 2100 kw during the first two hours of the transient. Successful EDG load management may be required by the operator for long term loads to ensure that an overload situation does not occur on any of the EDGs. This load management could involve selectively loading the CCW and non-essential SW pump on separate diesels to ensure a more balanced loading situation. The loading tables compiled in this section used at least two CCW and two non-essential SW pumps for redundancy and conservatism. An attachment to EOP E-3 and ES-1.1 should be considered to direct the operator on MCC automatic loads (similar to Tables 3.4-1, -2, -3, and -4) while they are being energized. Alternatively, Attachment 2 to these EOPs could be expanded to include information on the maximum expected load increase for each MCC as it is reset.

Table 6.2-1a
Steamline Break
Maximum EDG 21 Loading (kw)

EOPs Followed:	**E-0, E-2 and E-1 Injection (0-30 min)**	**ES-1.1 After SI / Spray Termination (>30 min)**
SI Pump 21	315	0
CS Pump 21	350	0
CR Fans 21&22	444	312[1]
Ess SW Pump 24	282	282
NE SW Pump 21	0	282
CCW Pump 21	0	230
Przr Htrs 23	0	485
Chg Pump 21	150	150
MCC 26A & 26AA	86	65
OPTIONAL EQUIPMENT		
MCC 29A	86	86
Other MCCs	0	~100[2]
Lighting Transf 23	0	100[2]
Misc Losses	117	117
Total EDG Load (kw)	1830	~2209[3]

Notes:

(1) One of these CR fans can be secured after normal containment conditions are established.

(2) Lighting and other MCC loads are assumed added after CS pump is turned off.

(3) Loads are readily controllable to limit EDG load to less than 2100 kw.

Table 6.2-1b
Steamline Break
Maximum EDG 22 Loading (kw)

EOPs Followed:	E-0, E-2 and E-1 Injection (0-30 min)	ES-1.1 After SI / Spray Termination (>30 min)
SI Pump 22	315	0
RHR Pump 21	171	0[1]
AFW Pump 21	376	309[1,4]
CR Fans 23&24	444	312[2]
Ess SW Pump 25	282	282
NE SW Pump 22	0	282
CCW Pumps 22	0	230
Chg Pump 22	150	150
MCC 26C	52	52
OPTIONAL EQUIPMENT		
MCC 24A	86	86
Lighting Transf 22	0	130[3]
Other MCCs	0	~100[3]
Bearing Oil Pump or Turning Gear Oil Pump	0	56
MBFP Oil Pump 21 or 22	0	45
Turning Gear Motors (turbine and MBFPs)	0	38
Misc Losses	122	122
Total EDG Load (kw)	1998	~2194

Notes:

(1) The AFW pump can be stopped if RHR is placed in service for cooldown.
(2) One of these CR fans can be secured after normal containment conditions are established.
(3) Lighting and other MCC loads are assumed added after CS pump is turned off.
(4) Flow would be throttled to maintain SG NR level within control band. The loading shown corresponds to 250 gpm.

Table 6.2-1c
Steamline Break
Maximum EDG 23 Loading (kw)

EOPs Followed:	**E-0, E-2 and E-1 Injection (0-30 min)**	**ES-1.1 After SI / Spray Termination (>30 min)**
SI Pump 23	315	0
CS Pump 22	350	0
RHR Pump 22	171	0[1]
AFW Pump 23	376	309[1,2]
CR Fan 25	222	156
Ess SW Pump 26	282	282
NE SW Pump 23	0	0
CCW Pump 23	0	230
Prz Htr Cont Gp	0	277
Charging Pump 23	150	150
MCC 26B & 26BB	80	48
OPTIONAL EQUIPMENT		
MCC 27A	25	155
Lighting Transf 21	0	150[3]
Other MCCs	0	~100[3]
Misc Losses	119	119
Total EDG Load (kw)	2090	~1976

Notes:

(1) The AFW pump can be stopped if RHR is placed in service for cooldown.
(2) Flow would be throttled to maintain SG NR level within control band. The loading shown corresponds to 250 gpm.
(3) Lighting and other MCC loads are assumed added after CS pumps are turned off

Table 6.2-2a
Steam Generator Tube Rupture
Maximum EDG 21 Loading (kw)

EOPs Followed:	E-0 and E-3 Injection (0-15 min)	E-3 SI Termination (15-40 min)	ES-3.1, Post-SGTR Recovery (>40 min)
SI Pump 21	315	0	0
CS Pump 21	0	0	0
CR Fans 21&22	220	220	220(1)
Ess SW Pump 24	282	282	282
NE SW Pump 21	0	282	282
CCW Pump 21	0	230	230
Przr Htrs 23	0	485	485(2)
Chg Pump 21	150	80	80(3)
MCC 26A & 26AA	86	65	65
OPTIONAL EQUIPMENT			
MCC 29A	86	86	86
Lighting Transf 23	0	100	100
Other MCCs	0	~100	~100
Misc Losses	117	117	117
Total EDG Load (kw)	1256	~2047	~2047

Notes:

(1) One of these CR fans can be secured after normal containment conditions are established.
(2) One pressurizer heater group from any EDG may be energized to control the RCS and ruptured SG pressures, provided the 2100 kw limit is not exceeded.
(3) With RCS pressure reduced to the ruptured SG pressure, the charging pump discharge pressure is expected to be less than 1400 psig.

Table 6.2-2b
Steam Generator Tube Rupture
Maximum EDG 22 Loading (kw)

EOPs Followed:	E-0 and E-3 Injection (0-15 min)	E-3 SI Termination (15-40 min)	ES-3.1, Post-SGTR Recovery (>40 min)
SI Pump 22	315	0	0
RHR Pump 21	171	0	0[1]
AFW Pump 21	376	376	309[1,4]
CR Fans 23&24	220	220	220[2]
Ess SW Pump 25	282	282	282
NE SW Pump 22	0	282	282
CCW Pumps 22	0	230	230
Chg Pump 22	150	80	80[3]
MCC 26C	52	52	52
OPTIONAL EQUIPMENT			
MCC 24A	86	86	86
Bearing Oil Pump or Turning Gear Oil Pump	0	56	56
MBFP Oil Pump 21 or 22	45	45	45
Turning Gear Motors (turbine and MBFPs)	0	38	38
Lighting Transf 22	0	130	130
Other MCCs	0	~100	~100
Misc Losses	122	122	122
Total EDG Load (kw)	1819	~2099	~2032

Notes:

(1) See note (1) in Table 6.2-2c.
(2) One of these CR fans can be secured after normal containment conditions are established.
(3) With RCS pressure reduced to the ruptured SG pressure, the charging pump discharge pressure is expected to be less than 1400 psig.
(4) Flow would be throttled to maintain SG NR level within control band. The loading shown corresponds to 250 gpm.

Table 6.2-2c
Steam Generator Tube Rupture
Maximum EDG 23 Loading (kw)

EOPs Followed:	E-0 and E-3 Injection (0-15 min)	E-3 SI Termination (15-40 min)	ES-3.1, Post-SGTR Recovery (>40 min)
SI Pump 23	315	0	0
CS Pump 22	0	0	0
RHR Pump 22	171	0	0(1)
AFW Pump 23	376	376	309(1,4)
CR Fan 25	110	110	110
Ess SW Pump 26	282	282	282
NE SW Pump 23	0	0(2)	0
CCW Pump 23	0	230	230
Przr Htr Cont Gp	0	277	277
Charging Pump 22	150	80	80(3)
MCC 26B & 26BB	80	48	48
OPTIONAL EQUIPMENT			
MCC 27A	25	155	155
Lighting Trans. 21	0	150	150
Other MCCs	0	~100	~100
Misc Losses	119	119	119
Total EDG Load (kw)	1628	~1927	~1860

Notes:

(1) The AFW pump can be stopped if RHR is placed in service for cooldown. During the backfill process, however, it may still be necessary to operate an AFW pump periodically to maintain a high level in the ruptured SG. Sufficient optional loads (including one or more CR fans) could be stopped to limit the EDG loadings for this situation.

(2) A NE SW pump may be added if the EDG loading is less than 1800 kw.

(3) With RCS pressure reduced to the ruptured SG pressure, the charging pump discharge pressure is expected to be less than 1400 psig.

(4) Flow would be throttled to maintain SG NR level within control band. The loading shown corresponds to 250 gpm.

Table 6.2-3a
Spurious SI Actuation
Maximum EDG 21 Loading (kw)

EOPs Followed:	**E-0 Injection (0-15 min)**	**ES-1.1 SI Termination (15-40 min)**	**ES-1.1 Longer Term (>40 min)**
Pump 21	315	0	0
CS Pump 21	0	0	0
CR Fans 21&22	220	220	220(1)
Ess SW Pump 24	282	282	282
NE SW Pump 21	0	282	282
CCW Pump 21	0	230	230
Przr Htrs 23	0	485	485(2)
Chg Pump 21	150	150	150
MCC 26A & 26AA	86	65	65
OPTIONAL EQUIPMENT			
MCC 29A	86	86	86
Lighting Transf 23	0	100	100
Other MCCs	0	~100	~100
Misc Losses	117	117	117
Total EDG Load (kw)	1256	~2117	~2117

Notes:

(1) One of these CR fans can be secured after normal containment conditions are established.

(2) One pressurizer heater group from any EDG may be energized for RCS pressure control provided the 2100 kw limit is not exceeded.

Table 6.2-3b
Spurious SI Actuation
Maximum EDG 22 Loading (kw)

EOPs Followed:	**E-0 Injection (0-15 min)**	**ES-1.1 SI Termination (15-40 min)**	**ES-1.1 Longer Term (>40 min)**
SI Pump 22	315	0	0
RHR Pump 21	171	0	0(1)
AFW Pump 21	376	376	309(1,4)
CR Fans 23&24	220	220	220(2)
Ess SW Pump 25	282	282	282
NE SW Pump 22	0	0(3)	0
CCW Pumps 22	0	230	230
Chg Pump 22	150	150	150
MCC 26C	52	52	52
OPTIONAL EQUIPMENT			
MCC 24A	86	86	86
Bearing Oil Pump or Turning Gear Oil Pump	0	56	56
MBFP Oil Pump 21 or 22	45	45	45
Turning Gear Motors (turbine and MBFPs)	0	38	38
Lighting Transf 22	0	130	130
Other MCCs	0	~100	~100
Misc Losses	122	122	122
Total EDG Load (kw)	1819	~1887	~1820

Notes:

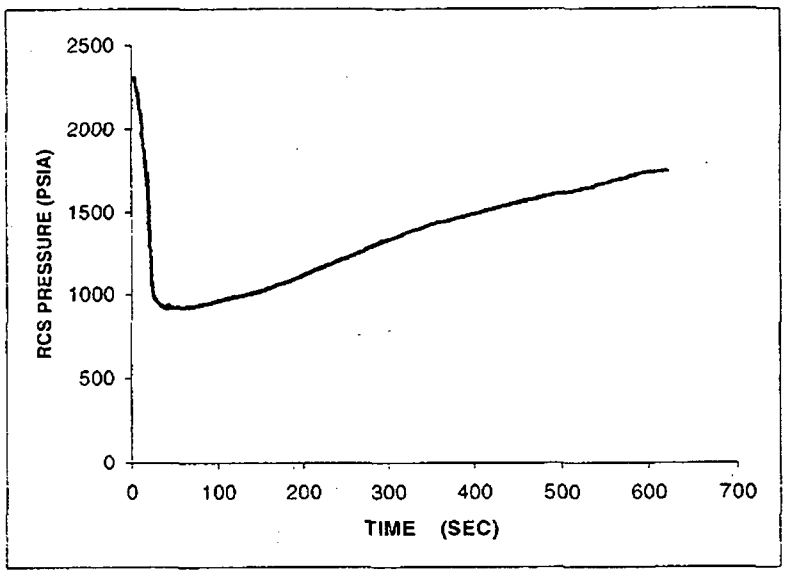
(1) The AFW pump can be stopped if RHR is placed in service for cooldown.
(2) One of these CR fans can be secured after normal containment conditions are established.
(3) A NE SW pump may be added if the EDG loading is less than 1800 kw.
(4) Flow would be throttled to maintain SG NR level within control band. The loading shown corresponds to 250 gpm.

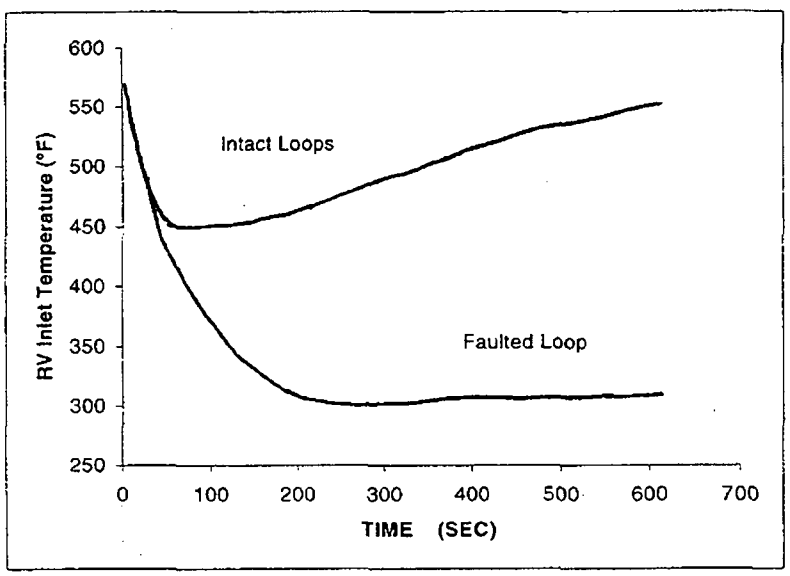
Table 6.2-3c
Spurious SI Actuation
Maximum EDG 23 Loading (kw)

EOPs Followed:	E-0 Injection (0-15 min)	ES-1.1 SI Termination (15-40 min)	ES-1.1 Longer Term (>40 min)
SI Pump 23	315	0	0
CS Pump 22	0	0	0
RHR Pump 22	171	0	0(1)
AFW Pump 23	376	376	309(1,3)
CR Fan 25	110	110	110
Ess SW Pump 26	282	282	282
NE SW Pump 23	0	282	282
CCW Pump 23	0	0(2)	0
Przr Htr Cont GP	0	277	277
Charging Pump	150	150	150
MCC 26B & 26BB	80	48	48
OPTIONAL EQUIPMENT			
MCC 27A	25	155	155
Lighting Trans 21	0	150	150
Other MCCs	0	~100	~100
Misc Losses	119	119	119
Total EDG Load (kw)	1628	~2049	~1982

Notes:

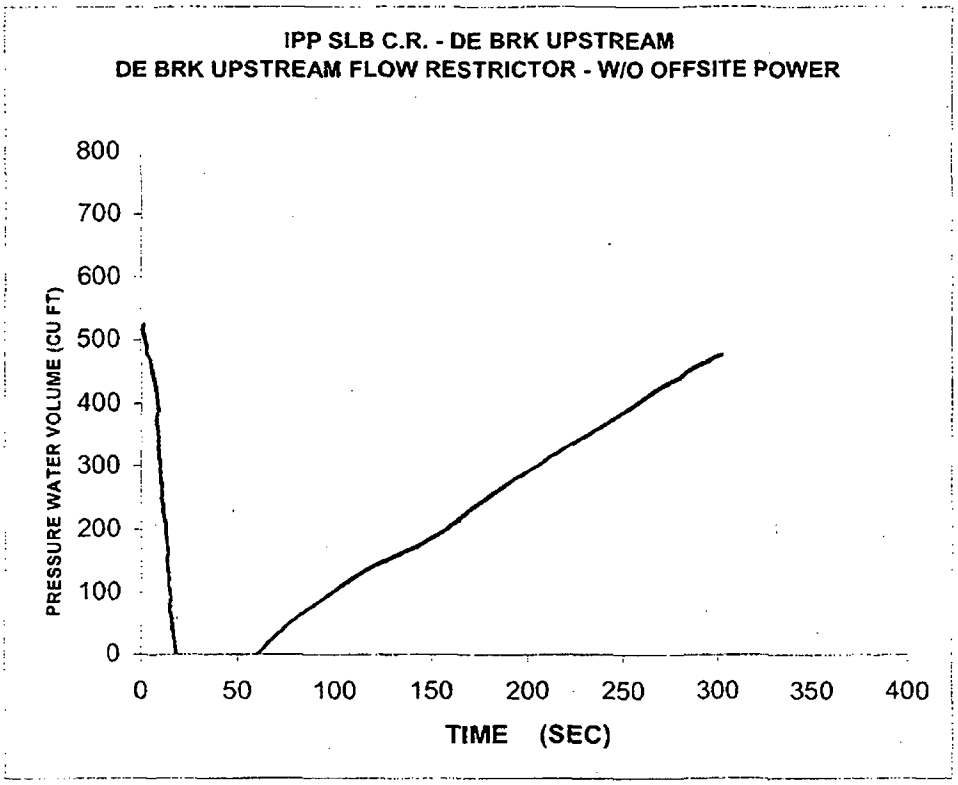
(1) The AFW pump can be stopped if RHR is placed in service for cooldown.
(2) A CCW pump may be added if the EDG loading is less than 1850 kw.
(3) Flow would be throttled to maintain SG NR level within control band. The loading shown corresponds to 250 gpm.





(From Reference 6-1)

Figure 6.2-1: Reactor Coolant Pressure, Reactor Vessel Inlet Temperature vs. Time for Steamline Break.



(Used in Steamline Break Analysis described in Reference 6-1)

Figure 6.2-2: Pressurizer Water Volume vs. Time for Steamline Break

7.0 STATION BLACKOUT AND LOSS OF OFFSITE POWER WITHOUT SI

7.1 Background

In previous sections of this report, limiting loads on the EDGs were determined for accident conditions for various design basis accident conditions with Safety Injection (SI). An example scenario considered would be large LOCA with loss of offsite power and 2 of 3 EDGs operating, i.e., only limiting single failures were considered.

For recovery from a station blackout at Indian Point Unit 2, it is desirable to have the capability to supply power to the equipment needed for recovery using only 1 of 3 EDGs. In determination of the 8 hour station blackout coping duration, the assumption of 1 of 3 EDGs (versus 2 of 3) has been made in the NRC Safety Evaluation of the Indian Point Nuclear Generating Unit 2, Response to the Station Blackout Rule, dated November 21, 1991 (Reference 7-2). In their SER, the NRC refers to a "draft" EDG load list compiled in June 1990, prior to the EDG enhancement project. However, the SER assumes increased EDG loading capability resulting from the EDG enhancement project to demonstrate acceptable recovery for both hot and cold shutdown conditions. Because the "draft" load list had never been officially documented and since it reflected a plant configuration that existed prior to the 1991 refueling outage (i.e., before addition of MCCs 24A, 26C, 29A, and 27A), Con Edison authorized Westinghouse to perform a EDG load study for station blackout recovery using a single EDG (Reference 7-1).

Results for loss of offsite power with a single EDG available are provided in this section. This section is essentially the same as WCAP-126255, Rev. 1, Supplement 1 (Ref. 7-1) except it has been updated to reflect various load changes in Section 3 and EOP changes (Ref. 1-28). It should be noted that for the Station Blackout SER, a gas-turbine generator is credited as an alternate source of AC power at the end of one hour. No credit is taken for the gas turbine alternate AC power source since the intent of this report is to demonstrate recovery capability using any single EDG.

7.2 Cases Considered

For hot standby recovery, it is assumed the reactor is initially operating at full power prior to loss of offsite power. Two situations or cases are then credible here:

Case 1. Loss of offsite power occurs, only one EDG starts

Case 2. Complete loss of AC power occurs (station blackout), one EDG is recovered.

To demonstrate capability to recover for cold shutdown conditions, a third case is included:

Case 3. Natural circulation cooldown to cold shutdown conditions, only one EDG is used for recovery.

Conditions at the end of hot standby (from Cases 1 and 2) are used to define the initial conditions for Case 3.

7.3 Emergency Operating Procedures

The EDG loading analysis for this section is based on the Indian Point Unit 2 Emergency Operating Procedures, Rev. 38 (Reference 1-28). An overview of the EOP actions is provided for each of the above cases.

In the first case, the operator is directed to Emergency Operating Procedure (EOP) E-0, Reactor Trip or Safety Injection. Since it is assumed an accident has not occurred (SI not actuated), the operator is directed to EOP ES-0.1, Reactor Trip Response, soon after entry into E-0 (from Step 3 of E-0). A timetable of events for this case is provided in Table 7-1.

In the second case, no EDG initially operates so the operator follows the instructions in EOP ECA-0.0, Loss of All AC Power. A single EDG is then recovered after performing the initial actions in ECA-0.0 (e.g., major equipment loads placed in PULLOUT). A time of 30 minutes is arbitrarily selected as the time at which power is restored using a single EDG. This time frame is considered reasonable since it is comparable to but less than the time at which a gas turbine would be credited as an alternate AC (ACC) power source (i.e., 60 minutes). Since SI is not assumed to be required, the operator is directed to ECA-0.1, Loss of All Power Recovery Without SI Required, after verification that a service water (SW) pump on the essential header has started. A timetable of events for this case is provided in Table 7-2.

The times used in the development of Tables 7-1 and 7-2 are not necessarily absolute or required times for operator actions. They are considered typical times that reflect the sequence of actions taken in the EOPs and the order in which equipment is added onto the assumed operating EDG.

Note that at the end of each of Tables 7-1 and 7-2 (i.e., at the end of ES-0.1 and ECA-0.1), the operator would be directed to EOP ES-0.2, Natural Circulation Cooldown. Assuming this transition occurs at approximately one hour for either case, the ES-0.2 timetable applicable for the transition from hot standby to cold shutdown is provided in Table 7-3. Again, the times used in Table 7-3 reflect the sequence of operator actions and order in which the loads on the operating EDG changes. They are representative but not absolute times. Note that the time scale has been changed from "minutes" (in Tables 7-1 and 7-2) to "hours" in Table 7-3.

7.4 EDG Loads During Hot Standby

EDG loading spreadsheets corresponding to the Table 7-1 (ES-0.1) scenario and the Table 7-2 station blackout (ECA-0.1) scenario have been developed for each single EDG assumed started. Table 7-1a describes the loading on EDG 21 for the Table 7-1 scenario; Tables 7-1b and 7-1c describe the loadings on EDGs 22 and 23, respectively, again for the Table 7-1 scenario. Likewise, Tables 7-2a, 7-2b, and 7-2c describe the loads on EDGs 21, 22, and 23, respectively, for the limited duration station blackout case.

7.4.1 *Major Equipment Loads*

Since there is no accident (SI not actuated), the SI and RHR pumps do not operate. The containment pressure and temperature are also expected to remain in normal range, so the CS pump does not operate. The Containment Recirculation (CR) fan loads (when manually started) are based on normal containment density. Without SI actuation, the CCW pump on the operating EDG automatically starts (see Section 4.1 or 4.3). Equipment loadings for the MD-AFW pumps, SW pumps, CCW pumps, and CR fans are as previously determined in Section 3. Maximum component loads are conservatively assumed unless otherwise indicated (e.g., loads due to the CR fans are based on normal containment density).

7.4.2 Other Component Loads

Following reactor trip and during hot standby, the charging pump is conservatively assumed to operate at full flow (98 gpm). The RCS/pressurizer pressure is assumed to decrease below and subsequently recover to normal operating pressure (2235 psig). At these conditions, the power requirement for the charging pump is 150 kW, as determined in Section 3.4. The maximum flow rate (98 gpm) is several times higher than that required to compensate for RCP seal leak-off (typically 2 to 5 gpm per RCP) plus any identified and unidentified RCS leakage allowed per Indian Point Unit 2 Technical Specifications (10 gpm identified and 1 gpm unidentified). If the RCP seals heat due to loss of seal cooling for a limited period of time (Case 2), the RCP seal leak-off flow rate may increase to greater than 5 gpm per RCP; however, this leakage is expected to be limited to approximately 21 gpm per RCP (less for silicon nitride seals), based on WCAP-10541, Rev. 2, and WCAP-10541, Rev. 2, Supplement 2 (References 7-5 and 7-6). At the assumed maximum flow rate of 98 gpm, a single charging pump would still have sufficient capacity to compensate for the increased RCP seal leak-off plus allowed leakage per Technical Specifications (21*4 + 10 + 1 = 95 gpm).

Also as described in Section 3.4, the pressurizer heater requirement sufficient to compensate for pressurizer heat losses and maintain system pressure for natural circulation cooling is 139 kW (i.e., two heater "banks" or six elements). Attachment 1 of ES-0.1 provides guidance on the number of heater banks in each heater group. It is expected that the operator would energize only one or two banks, as required, and not the entire heater group, to control RCS pressure. It is also anticipated that the operator would exercise similar caution to avoid overload of the AC power source when using pressurizer heaters in ECA-0.1.

When the operating EDG supplies power to the 480 V bus(es), the vital MCCs that automatically load on the bus become energized (MCC 26A for EDG 21, MCCs 26C plus 211 for EDG 22, and MCC 26B for EDG 23). Automatic loads on these MCCs are the same as those previously determined in Section 3.3 except that the safeguards valves do not change position and the CCW booster pumps do not start (since a CCW pump is started). Abbreviated lists of these miscellaneous equipment loads, including those that potentially start, are provided in the applicable spreadsheet tables (Tables 7-1a, 7-1b, 7-1c, 7-2a, 7-2b, and 7-2c). These loads have been updated per recent calculations performed by Con Edison (Reference 7-7).

For Cases 1 and 2, it is also assumed that certain MCCs are reset that supply power to some equipment important, but not necessarily vital, for the recovery (MCC 29A for EDG 21, MCC 24A for EDG 22, and MCC 27A for EDG 23). The operator may be allowed to energize additional MCCs (e.g., in ES-0.1, Step 1), however, it is assumed that only these smaller MCCs are reset until directed to explicitly operate a component on another MCC. (Note: if all MCCs were reset, EDG 22 could potentially over-load).

The station batteries supply adequate emergency lighting (for up to 2 hours), until normal lighting can be restored or the batteries can be recharged by the battery chargers. Again, the operator may be allowed to reset normal lighting (e.g., in ES-0.1, Step 1), but it is assumed only the normal lighting in the CCR building is reset at that time. The CCR lighting is provided by Lighting Panel No. 220 (19.62 kW), as shown on Con Edison Drawing 9321-F-3040 (Reference 7-8). The normal supply for the CCR lighting is from the 120/208V Lighting Bus 23 (Lighting Transformer 23 on Bus 5A, EDG21) and the alternate supply is from Lighting Transformer 22 (Bus 3A, EDG 22).

In addition to the above loads, various fans and EDG support loads operate as required. Instrument air compressors (on MCC 29A/EDG 21 or MCC 24A/EDG 22) operate to re-supply air for various functions (e.g., letdown, if established, or atmospheric steam dump valves - these steam dump valves have nitrogen back-up and can be operated manually for cooldown; however, they are not needed to maintain hot standby conditions since the SG safety valves operate to control SG pressure and RCS temperature). Finally, miscellaneous losses (bus and cable losses, and increased frequency loads) are also assumed based on previous results used for the large LOCA scenarios (see Section 5.1.5). Although not precise for this study, these miscellaneous losses are expected to be representative but conservative.

7.4.3 Limiting Loads During Hot Standby

The EDG loads for Case 1 (ES-0.1) are provided in Tables 7-1a, 7-1b, and 7-1c. Typically, these loads are higher than the corresponding loads for Case 2 (ECA-0.1) in Tables 7-2a, 7-2b, and 7-2c, for the following reasons:

- Major equipment loads are automatically sequenced onto each operating EDG in ES-0.1. In ECA-0.1 (and ECA-0.0), loads are selectively added.

- Initially in ES-0.1, the operator is directed to reset lighting and all MCCs (except MCCs 28 and 28A). As analyzed here, only the lighting for the CCR Building plus MCCs 29A, 24A, or 27A are reset to limit the number of non-essential loads.

- In ES-0.1, the operator is directed to establish PAB ventilation if adequate capacity exists on EDG 22 or 23 (EDG load < 1860 kW prior to addition of the PAB fans - this allows margin for ~ 100 kW uncertainty on the EDG watt-meter without exceeding the 2100 kW emergency rating of the diesel).

Limiting loads on EDG 21, after addition of the pressurizer heaters and non-essential SW pump, are 1590.4 kW (ES-0.1, Case 1 - Table 7-1a) and 1480.2 kW (ECA-0.1, Case 2 - Table 7-2a). Both of these loads are considerably less than the continuous rating of the EDG, 1750 kW. The two cases differ by the addition of CCR lighting, the sump pump, plus two (versus one) CR fans for Case 1 (19.6 + 5.6 + 110 = 135.2 kW). The only additional load included for Case 2 is the alternate supply for the static inverters (10 + 15 = 25 kW), a load not included for Case 1 (normal supply from the station batteries is available). Thus, the Case 1 load is higher by the amount 135.2 - 25 = 110.2 kW (1590.4 - 1480.2 = 110.2 kW). Operation of the turbine-driven AFW pump plus portable ventilation for the PAB would be needed for the EDG 21 cases since this EDG does not supply power to a PAB exhaust fan and motor-driven AFW pump.

Since EDG 22 does supply power to a MD-AFW pump and PAB exhaust fan, in addition to loads like those on EDG 21, the load on EDG 22 is higher, roughly by the amount of power required for these two additional components (376 kW for the MD-AFW pump at full flow applicable to both cases, and 93 kW for the PAB exhaust fan, added for Case 1 only). The peak loads on EDG 22 during hot standby are more precisely 2057.3 kW for ES-0.1 (Case 1, Table 7-1b) and 1839.1 kW for ECA-0.1 (Case 2, Table 7-2b). Both loads are less than the 2-hour emergency rating of 2100 kW. As shown in Tables 7-1b and 7-2b, the operator could secure the MD-AFW pump and operate the TD-AFW pump as a means to limit the load on EDG 22 to less than the continuous rating of 1750 kW. The limiting load on EDG 22 then becomes 1681.3 kW (Case 1), approximately 70 kW less than the continuous rating.

EDG 23 supplies power to a MD-AFW pump and a PAB exhaust (and supply) fan (93 + 37 = 130 kW). Since the associated 480 V bus (6A) has only one CR fan, the limiting loads on EDG 23 for hot standby are less than those of EDG 22. For Case 1 (ES-0.1), the peak load on EDG 23 is 1893.9 kW (Table 7-1c). For ECA-0.1 (Case 2), the PAB fans are not loaded but the backup supply for inverter 24 is (15 kW). Thus, the limiting load for this case is 1893.9 - 130 + 15 = 1778.9 kW (Table 7-2c). To reduce the longer term loading to less than the 1750 kW continuous rating (with ~ 100 kW margin for uncertainties), the TD-AFW pump can be used (MD-AFW pump stopped), as illustrated in the bottom row and last two columns of Tables 7-1c and 7-2c.

7.5 EDG Loads Added During Cooldown To Cold Shutdown

EDG loading spreadsheets corresponding to the Table 7-3 (ES-0.2) scenario have been developed for each single EDG assumed operating. These results are provided in Table 7-3a (for EDG 21), Table 7-3b (for EDG 22), and Table 7-3c (for EDG 23). As explained previously, the loads for Case 2 are less than those of Case 1 since the EDG loads are selectively added in ECA-0.1. Therefore, as a starting point for the Case 3 cooldown scenario, the EDG loads at the end of the ES-0.1 (Case 1) scenario were used. Since the operator is directed to reset lighting and MCCs and add ventilation equipment in Steps 1 through 3 of ES-0.2, the EDG loads become nearly the same, regardless of the EOP used prior to ES-0.2 entry.

7.5.1 Major Equipment Loads

For EDG 22 or 23 cases, the MD-AFW pump is assumed to be secured for the cooldown since the TD-AFW pump is available and capable of operation until the RHR System can be aligned for service. Major equipment loads are otherwise assumed to be maximum loads as previously determined for hot standby conditions. It is also conservatively assumed that two CR fans operate (EDG 21 or EDG 22 cases) throughout the natural circulation cooldown scenario. Prior to addition of the RHR pump, one of these redundant CR fans is stopped to allow the EDG load to remain less than the continuous limit of 1750 kW.

Allowing for a maximum cooldown rate of 25°F/hr, it is anticipated that the RHR System can be placed in service (hot leg temperature < 350°F) as early as 12 hours. Allowing for reasonable delays, including an upper head soak time of 8 hours if CRDM fans are not operational, it is assumed RHR is placed in service between 15 and 20 hours. A redundant CR fan, the CRDM fans, and/or the PAB fans are stopped to allow addition of the RHR pump onto the operating EDG. Per Section 3.1.3.1, the power requirement for this component is conservatively assumed to be 307 kW, based on maximum density (62 lbm/ft^3, or Specific Gravity =1.0) and high flow rate (4720 gpm, actual flow rate expected to be < 4000 gpm). Since Bus 5A does not supply power to an RHR pump, one or more of the 480 V cross-ties would be closed to allow EDG 21 to supply power to an RHR pump. (Note: once the RCS temperature is below 350°F, the Indian Point Unit 2 Technical Specifications allow closure of these cross-ties).

7.5.2 Other Component Loads

The initial power requirement for the charging pump (150 kW) is conservatively based on nominal RCS pressure (2235 psig) and full charging flow (98 gpm). As the RCS pressure decreases, the power full flow power requirement decreases to approximately 80 kW (at RCS pressures ~ 1000 to 1200 psig) and finally to 60 kW (at RCS pressures less than 400 psig). This latter value is used when RHR is placed in service.

Throughout the transient, the pressurizer heater input is also held constant at 139 kW (two banks/six heater elements). Note that if a steam bubble is to be maintained after placing RHR in service and during cold shutdown, most likely this could be achieved with only one of the two pressurizer heater banks (i.e., 68.3 kW). This would then make available 68 kW for other desired loads (e.g., bus cross-tie of an instrument air compressor if EDG 23 is the only operating EDG, or operation of the SFP pump to limit heatup of the spent fuel pool).

Note that in Table 7-3, the only significant loads added in ES-0.2 after Step 3 are the CRDM fans (about 90 kw) and the RHR pump (after cooldown and depressurization to RHR conditions). The CRDM fans are added prior to cooldown (EDG 21 and 22 cases) and stopped to reduce the load on the EDG prior to adding the RHR pump.

Since EDG 23 does not provide power to an instrument air compressor, cooldown would need to be accomplished locally and by manual operation using nitrogen back-up instead of the normal air supply. A description of the actions performed to accomplish nitrogen back-up to the atmospheric steam dump valves is given in Section 4.4 of

Reference 7-9. Similar local actions may be needed to control flow from the TD-AFW pump.

7.5.3 Limiting Loads For Cooldown To Cold Shutdown

The limiting loads for each EDG can be obtained from the associated spreadsheet provided in Tables 7-3a, 7-3b, and 7-3c. These loads are as follows:

EDG 21: 1697.4 kW, after RHR placed in service

EDG 22: 1771.3 kW, prior to cooldown, after CRDM fans started
1695.3 kW, after RHR placed in service

EDG 23: 1604.9 kW, after RHR placed in service

All of the above loads, with the exception of the hot standby load on EDG 22, are less than the continuous rating for the EDG, i.e., 1750 kW.

The load on EDG 22 (1771.3 kW), prior to and at the start of the cooldown, is controllable to less than 1750 kW by various means, including securing one or more CRDM fans, securing one CR fan, operating the turbine-driven AFW pump instead of the motor-driven AFW pump, or operating the motor-driven AFW pump at reduced flow (~250 gpm), as needed for decay heat removal and cooldown of the RCS.

7.6 Summary And Conclusions

This section addresses the EDG loading and plant capability to recover from a station blackout event at Indian Point Unit 2 using a single EDG. By restricting the lighting and MCCs that are reset in the EOPs (ECA-0.0, ECA-0.1, ES-0.1, and ES-0.2), it is feasible to bring the plant to hot standby conditions without exceeding the 2-hour emergency rating of the EDGs (2100 kW). Use of the TD-AFW pump instead of the MD-AFW pump ensures that the load on any EDG assumed for recovery will be less than the continuous rating of the EDG, 1750 kW.

By shedding redundant CR fans or non-essential fan loads (e.g., use portable ventilation instead of PAB exhaust fans), it is possible to provide the necessary AC power to achieve (or maintain) cold shutdown using a single EDG without exceeding its continuous rating of 1750 kW.

Table 7-4 provides for each EDG a summary of the resulting limiting hot shutdown (HSD) loads, with and without credit for operation of the TD-AFW pump for decay heat removal. These loads are the same as the limiting ones listed in the last columns of Tables 7-1a, 7-1b, and 7-1c. The corresponding loads at the time RHR is placed in service for cooldown to cold shutdown (CSD) are also provided for each EDG. These loads are the same as those provided in the last columns of Tables 7-3a, 7-3b, and 7-3c. Since some of the support loads are not redundant on all three EDGs (e.g., cable tunnel exhaust fans, instrument air compressor), notes have been added to the table to explain provisions for satisfying the support function, if necessary. Also shown in Table 7-4 for comparison is the HSD load referred to in the Reference 7-2 SER (from the June 8, 1990 draft) along with the CSD load obtained by adding a conservatively high RHR

pump load of 332 kW to the HSD load. Although the basis for the loadings differ somewhat for the more recent calculations (assumed higher charging flows, pressurizer heater loads, additional loads for bus and cable losses and frequency fluctuations), the total EDG loadings (per the SER) are comparable to those analyzed in this section.

This assessment is based on Revision 38 of the Indian Point Unit 2 EOPs. Recognizing that the operator has a certain degree of flexibility in addition of optional loads used during the recovery, the following EDG load management techniques were assumed following the loss of offsite power event for the scenarios developed in this section:

- In Step 1 of ES-0.1 and ES-0.2, the operator restricts the normal lighting to the CCR Building on Lighting Panel 220 (approximately 20 kW). Emergency lighting would also be supplied by the station batteries.

- Also in Step 1 of ES-0.1 and ES-0.2, the MCCs reset are the vital MCCs that automatically load (MCCs 26A, 26B, 26C, and 211) plus several small MCCs important for recovery (MCCs 24A, 29A, and 27A).

- The operator limits the number of pressurizer heaters on any EDG to 139 kW (i.e., two banks, or six individual heater elements). Attachment 1 to ES-0.1 permits the operator to energize individual heaters instead of the entire heater bank.

These actions can be considered either as potential changes to the EOPs or as EDG load management training issues for loss of offsite power or station blackout recovery. Based on this assessment, the EDG loadings for station blackout recovery using a single EDG are acceptable for both hot and cold shutdown conditions.

Table 7-1 Time Table of Events for Loss of Offsite Power Without Safety Injection One EDG Starts, ES-0.1 (Rev. 36) Recovery Actions Considered

Description	Time (min)
Loss of offsite power, one EDG automatically starts, operator refers to EOP E-0, Reactor Trip or Safety Injection, Step 1.	0
Operator verifies reactor trip and turbine trip. SI not actuated and not required; transition to ES-0.1, Reactor Trip Response, Step 1.	2
Operator performs actions in ES-0.1, Step 1: Start one charging pump on energized bus (Step 1.f) Reset lighting on energized bus (reset only for CCR) (Step 1.g.) Reset MCCs on energized bus, except MCCs 28 and 28A (Step 1.h) (only MCCs 29A, 24A, or 27A reset)	2 - 5
Operator performs verifications in Steps 2 through 6 of ES-0.1.	5 - 8
Pressurizer heaters energized to increase pressure to 2235 psig (Step 7)	10
Operator performs Steps 8 and 9 of ES-0.1: Verifies 400 gpm AFW flow, CCW and Essential SW pumps. FCUs (CR Fans) and non-essential SW pump also started at this time.	12
Operator aligns/starts ventilation systems per Step 10 of ES-0.1 Add PAB ventilation (EDG 22 or 23 running) Confirm fans 213, 215, or 216 running	14
Containment conditions normal, reset MCCs 28 and 28A Sump pumps 29 or 210 operate (EDGs 21 or 22).	15
Operator performs remaining actions in ES-0.1. Stabilizes plant, prepares for natural circulation cooldown to RHR (transition to EOP ES-0.2, Natural Circulation Cooldown, Step 1).	15-20

Table 7-1a. Loss of Offsite Power Loads on EDG 21 (using ES-0.1)

Bus 5A Loading - EDG 21

Equipment	Max kW	Man/Auto	Time in Minutes 1	*	5	*	10	*	15	*	20
SI & Cir Wtr Pmp 21 (400)	345	M			0		0		0		0
CS Pmp 21 (400)	320	M			0		0		0		0
CR Fan 21 (350)	250	M	0		0		0	110	110		110
CR Fan 22 (350)	250	M	0		0		0	110	110		110
RC Pmp 21 (350)	303	M			0		0		0		0
E SW Pmp 24 (350)	282	A	282		282		282		282		282
NE SW Pmp 21 (350)	282	M			0		0	282	282		282
CCW Pmp 21 (250)	230	A	230		230		230		230		230
Chg Pmp 21 (200)	150	M		150	150		150		150		150
Srv Air Comp (125)	93	M			0		0		0		0
Pzr Htrs 23	485	M			0	139	139		139		139
Ltg Bus 23 (120/208V)(CCR Only)	135	M		19.6	19.6		19.6		19.6		19.6
Ltg Bus 23 (480V-Emg)	100	M			0		0		0		0
MCC 26A											
MOV-822A	0.7	A			0		0		0		0
MOV-744	5.8	A			0		0		0		0
MOV-746	7.7	A			0		0		0		0
HCV-640	0.6	M			0		0		0		0
BFP-2-21	14.3	A	14.3	-14.3	0		0		0		0
Elec Tun Exh Fan 21	7.4	A	7.4		7.4		7.4		7.4		7.4
H2 Recomb 21	11.4	M			0		0		0		0
DG Exh Fan 21 (nor)	0.5	A	0.5		0.5		0.5		0.5		0.5
EDG Bldg. Vent Fan 319,321	7.5	A	7.5		7.5		7.5		7.5		7.5
BA Ht Trace (nor)	16.8	A	16.8		16.8		16.8		16.8		16.8
XMFR 23 (Inv 21)(max)	15	M/A			0		0		0		0
EPX3	30	A	15		15		15		15		15
EPV21	15	A	7.5		7.5		7.5		7.5		7.5
MCC 26AA											
Misc MOVs	1	A	1		1		1		1		1
H2/O2 Anlyz Ht Trc 1	3.3	A	3.3		3.3		3.3		3.3		3.3
MCC 29A											
DG 21 Support Loads											
Fuel Oil Pmp (2)	1.5	A			0		0		0	1.5	1.5
Compressor (5)	3.7	A		3.7	3.7	-3.7	0		0		0
Bat Charger 21 (Max)	45	A		45	45		45	-20	25		25
Inst Air Comp 21 (75)	56	A		56	56		56		56		56
I.A. Cool Pmp 21 (1.5)	2.2	A		2.2	2.2		2.2		2.2		2.2
Wall Exh Fan 215 (2)	1.5	M		1.5	1.5		1.5		1.5		1.5
XMFR 21 (Inv 23)(max)	15	M/A			0		0		0		0
MCC 28											
Sump Pump 29 (7.5)	5.6	A			0		0	5.6	5.6		5.6
CRDM Fans (4 at 30 hp)	90	M			0		0		0		0
Misc. Loss (Max)	117	A	117		117		117		117		117
Total EDG 21 Load (kW):			702.3		966		1101.3		1588.9		1590.4

Table 7-1b. Loss of Offsite Power Loads on EDG 22 (using ES-0.1)

Bus 2A/3A Loading - EDG 22 — Time in Minutes

Equipment	Max kW	Man/Auto	1	*	5	*	10	*	15	*	20
SI & Cir Wtr Pmp 22 (400)	345	M			0		0		0		0
RHR Pmp 21 (400)	316	M			0		0		0		0
AFW Pmp 21 (400)	387	A	376		376		376		376		376
CR Fan 23 (350)	250	M	0		0		110	110	110		110
CR Fan 24 (350)	250	M	0		0		110	110	110		110
E SW Pmp 25 (350)	282	A	282		282		282		282		282
NE SW Pmp 22 (350)	282	M			0		0	282	282		282
CCW Pmp 22 (250)	230	M	230		230		230		230		230
Chg Pmp 22 (200)	150	M		150	150		150		150		150
Pzr Htr 21	554	M			0		0		0		0
Pzr Htr 22	485	M			0	139	139		139		139
Ltg Tran 21 (Nor)	150	M			0		0		0		0
Ltg Tran 22 (CCR Only)	150	M		19.6	19.6		19.6		19.6		19.6
Ltg Bus 23 (480V-Nor)	100	M			0		0		0		0
MCC 211											
MOVs BFD-90, -1,-2,-3	4.8	A	4.8		4.8	-4.8	0		0		0
MOVs BFD-5, -1,-2,-3	20	A	20		20	-20	0		0		0
MCC 26C											
DG Exhaust Fan 22	0.8	A	0.8		0.8		0.8		0.8		0.8
PAB Exh Fan 21 (125)	93	M	0		0		0	93	93		93
EDG Bldg Vent Fan 320,322	7.5	A	7.5		7.5		7.5		7.5		7.5
Battery Charger 23	25	A	25		25		25		25		25
CRAC Backup Fan (7.5)	5.6	A	0		0		0		0		0
CRAC Boost.Fan 21 (7.5), Dampers & Motors	5.8	A	5.8		5.8		5.8		5.8		5.8
BA Trans Pump 21 (15)	11.2	A	11.2		11.2		11.2		11.2		11.2
BAT Heaters 21	15	M	0		0		0		0		0
Spent Fuel Pmp 21 (100)	75	M	0		0		0		0		0
Wall Exhaust Fan 213 (2)	1.5	M		1.5	1.5		1.5		1.5		1.5
MCC 24A											
DG 22 Support Loads											
Fuel Oil Pmp (2)	1.5	A			0		0		0	1.5	1.5
Compressor (5)	3.7	A		3.7	3.7	-3.7	0		0		0
XMFR 24 (Inv 22)(max)	15	M/A			0		0		0		0
Inst Air Comp 22 (75)	56	A		56	56		56		56		56
I.A. Cool Pmp 22 (1.5)	2.2	A		2.2	2.2		2.2		2.2		2.2
Bat Charger 22 (Max)	45	A		45	45		45	-20	25		25
Radiation Monitor 45	1.6	A		1.6	1.6		1.6		1.6		1.6
MCC 28A											
Sump Pump 210 (7.5)	5.6	A			0		0	5.6	5.6		5.6
CRDM Fans (4 at 30 hp)	90	M			0		0		0		0
Misc. Loss (Max)	122	A	122		122		122		122		122
Total EDG 22 Load (kW):			1085.1		1364.7		1475.2		2055.8		2057.3
Total EDG 22 Load, without MD-AFW (use TD-AFW) (kW):									1679.8		1681.3

Table 7-1c. Loss of Offsite Power Loads on EDG 23 (using ES-0.1)

Bus 6A Loading - EDG 23 — Time in Minutes

Equipment	Max kW	Man/Auto	1	*	5	*	10	*	15	*	20
SI & Cir Wtr Pmp 23 (400)	345	M			0		0		0		0
CS Pmp 22 (400)	350	M			0		0		0		0
RHR Pmp 22 (400)	316	M			0		0		0		0
AFW Pmp 23 (400)	387	A	376		376		376		376		376
CR Fan 25 (350)	250	M						110	110		110
RC Pmp 22 (350)	303	M			0		0		0		0
E SW Pmp 26 (350)	282	A	282		282		282		282		282
NE SW Pmp 23 (350)	282	M			0		0	282	282		282
CCW Pmp 23	230	A	230		230		230		230		230
Chg Pmp 23 (200)	150	M		150	150		150		150		150
Trb Aux Oil Pmp (150)	112	M			0		0		0		0
Pzr Htr Cntrl Gp	277	M			0	139	139		139		139
Ltg Tran 21 (Emg)	150	M			0		0		0		0
MCC 26B											
MOV-822B	0.7	A			0		0		0		0
MOV-882	2.2	M			0		0		0		0
MOV-747	7.7	A			0		0		0		0
HCV-638	0.6	M			0		0		0		0
BFP-2-22	14.3	A	14.3	14.3	0		0		0		0
Elec Tun Exh Fan 22	7.4	A	7.4		7.4		7.4		7.4		7.4
BA Heat Trace (Emg)	16.8	M			0		0		0		0
H2 Recomb 22	11.4	M			0		0		0		0
CRAC Humidifier (3+.33)	2.5	A	2.2		2.2		2.2		2.2		2.2
CRAC Fan (10)	7.5	A	7.5		7.5		7.5		7.5		7.5
CRAC Boost Fan 22 (7.5), Dampers & Motors	6.8	A	6.8		6.8		6.8		6.8		6.8
DG 23 Support Loads											
Fuel Oil Pmp (2)	1.5	A			0		0		0	1.5	1.5
Compressor (5)	3.7	A		3.7	3.7	-3.7	0		0		0
Lighting Panel 223:											
DG Exhaust Fan 23	0.8	A	0.8		0.8		0.8		0.8		0.8
DG Bldg Emg Lights	1.1	A	1.1		1.1		1.1		1.1		1.1
Eng Aux Cntr Pnl	0.3	A	0.3		0.3		0.3		0.3		0.3
BA Trans Pmp 22 (7.5/15)	11.2	A	11.2		11.2		11.2		11.2		11.2
EDG Bldg Vent Fan 318,323	7.5	A	7.5		7.5		7.5		7.5		7.5
MCC 26BB											
Misc MOVs	1	A	1		1		1		1		1
H2/O2 Anlyz Ht Trace 2	3.3	A	3.3		3.3		3.3		3.3		3.3
Transf 2H (45KVA)	0.3	A	0.3		0.3		0.3		0.3		0.3
MCC 27A											
Bat Charger 24 (Max)	45	A		45	45		45	-20	25		25
XFMR 22 (Inv 24)(max)	15	M			0		0		0		0
PAB Exhaust Fan 22 (125)	93	M			0		0	93	93		93
PAB Supply Fan (50)	37	M			0		0	37	37		37
Spent Fuel Pump 22 (100)	75	M			0		0		0		0
Misc. Loss (Max)	119	A	119		119		119		119		119
Total EDG 23 Load (kW):			1070.7		1255.1		1390.4		1892.4		1893.9
Total EDG 23 Load, without MD-AFW (use TD-AFW) (kW):									1516.4		1517.9

Table 7-2. Time Table of Events for Loss of Offsite Power Without Safety Injection Delayed Start for One EDG, ECA-0.1 (Rev. 34) Recovery Actions Considered

Description	Time (min)
Loss of all AC Power (loss of offsite power, EDGs fail to start) Operator refers to EOP ECA-0.0, Loss of All AC Power, Step 1.	0
Operator verifies reactor trip, turbine trip, and RCS isolation. Turbine-driven AFW pump delivers flow to all SGs.	2
Operator attempts to restore AC power to any 480V bus. Major equipment loads placed in PULLOUT position per ECA-0.0, Step 7. (SI, CS, MD-AFW, CCW, and RHR pumps; also FCUs, turning gear oil pump, bearing oil pump, and turbine aux. oil pump.)	2 - 5
Operator performs other limited actions in ECA-0.0. (equipment isolation, DC load shedding, SG depressurizations)	5 - 29
One EDG recovered. Transition to Step 26 of ECA-0.0. Stabilize SG pressures (Step 26) Essential SW pump aligned and running on energized bus (Step 27) Vital MCCs energized on energized bus (Step 28) (26A - EDG 21; 26C and 211 - EDG 22, or 26B - EDG 23)	30
Other MCCs important for recovery energized per Step 28 of ECA-0.0 (29A on EDG 21; 24 and 24A on EDG 22, 27A on EDG 23) Also, static inverters aligned to alternate supply. (21-MCC26A, 23-MCC29A, 22-MCC24A, 24-MCC27A)	32 - 34
Operator confirms RCS subcooling > uncertainties, PRZR level on span. Transition ECA-0.1, Loss of All AC Power Recovery Without SI Required, Step 1	35
Operator confirms RCP seal isolation and Phase A not actuated. Step 3 of ECA-0.1 then performed for energized bus/EDG: Start one SW pump on non-essential header (Step 3.b) Start one CCW pump on energized bus (Step 3.c) Start one charging pump on energized bus (Step 3.d) Start FCUs (CR Fans), as necessary, on energized bus (Step 3.e)	37 - 40
Operator confirms SI flow not required, adjusts charging flow (max. assumed).	40
Operator starts motor-driven AFW pump (EDGs 22 or 23), per Step 7	42
Operator performs Steps 8 through 14 in ECA-0.1	43 - 47

Table 7-2. Time Table of Events for Loss of Offsite Power Without Safety Injection (Cont.) Delayed Start for One EDG, ECA-0.1 (Rev. 34) Recovery Actions Considered

Description	Time (min)
Pressurizer heaters energized to establish PRZR pressure control (Step 15)	48
Operator performs remaining actions in ECA-0.1 Stabilizes plant, prepares for natural circulation cooldown to RHR (transition to EOP ES-0.2, Natural Circulation Cooldown, Step 1)	50 - 60

Table 7-2a. Loss of Offsite Power Loads on EDG 21 (using ECA-0.1)

Bus 5A Loading - EDG 21 — Time in Minutes

Equipment	Max kW	Man/Auto	30	*	35	*	40	*	45	*	50
SI & Cir Wtr Pmp 21 (400)	345	M			0		0		0		0
CS Pmp 21 (400)	350	M			0		0		0		0
CR Fan 21 (350)	250	M			0	110	110		110		110
CR Fan 22 (350)	250	M			0		0		0		0
RC Pmp 21 (350)	303	M			0		0		0		0
E SW Pmp 24 (350)	282	A	282		282		282		282		282
NE SW Pmp 21 (350)	282	M			0	282	282		282		282
CCW Pmp 21 (250)	230	A			0	230	230		230		230
Chg Pmp 21 (200)	150	M			0	150	150		150		150
Srv Air Comp (125)	93	M			0		0		0		0
Pzr Htrs 23	485	M			0		0		0	139	139
Ltg Bus 23 (120/208V)(CCR Only)	135	M			0		0		0		0
Ltg Bus 23 (480V-Emg)	100	M			0		0		0		0
MCC 26A											
MOV-822A	0.7	A			0		0		0		0
MOV-744	5.8	A			0		0		0		0
MOV-746	7.7	A			0		0		0		0
HCV-640	0.6	M			0		0		0		0
BFP-2-21	14.3	A	14.3	-14.3	0		0		0		0
Elec Tun Exh Fan 21	7.4	A	7.4		7.4		7.4		7.4		7.4
H2 Recomb 21	11.4	M			0		0		0		0
DG Exh Fan 21 (nor)	0.5	A	0.5		0.5		0.5		0.5		0.5
EDG Bldg. Vent Fan 319,321	7.5	A	7.5		7.5		7.5		7.5		7.5
BA Ht Trace (nor)	16.8	A	16.8		16.8		16.8		16.8		16.8
XMFR 23 (Inv 21)(max)	15	M/A		10	10		10		10		10
EPX3	30	A	15		15		15		15		15
EPV21	15	A	7.5		7.5		7.5		7.5		7.5
MCC 26AA											
Misc MOVs	1	A	1		1		1		1		1
H2/O2 Anlyz Ht Trc 1	3.3	A	3.3		3.3		3.3		3.3		3.3
MCC 29A											
DG 21 Support Loads											
Fuel Oil Pmp (2)	1.5	A			0		0		0	1.5	1.5
Compressor (5)	3.7	A		3.7	3.7	-3.7	0		0		0
Bat Charger 21 (Max)	45	A		45	45		45	-20	25		25
Inst Air Comp 21 (75)	56	A		56	56		56		56		56
I.A. Cool Pmp 21 (1.5)	2.2	A		2.2	2.2		2.2		2.2		2.2
Wall Exh Fan 215 (2)	1.5	M		1.5	1.5		1.5		1.5		1.5
XMFR 21 (Inv 23)(max)	15	M/A		15	15		15		15		15
MCC 28											
Sump Pump 29 (7.5)	5.6	A			0		0		0		0
CRDM Fans (4 at 30 hp)	90	M			0		0		0		0
Misc. Loss (Max)	117	A	117		117		117		117		117
Total EDG 21 Load (kW):			472.3		591.4		1359.7		1339.7		1480.2

Table 7-2b. Loss of Offsite Power Loads on EDG 22 (using ECA-0.1)

Bus 2A/3A Loading - EDG 22			Time in Minutes								
Equipment	Max kW	Man/Auto	30	*	35	*	40	*	45	*	50
SI & Cir Wtr Pmp 22 (400)	345	M			0		0		0		0
RHR Pmp 21 (400)	316	M			0		0		0		0
AFW Pmp 21 (400)	387	A			0		0	376	376		376
CR Fan 23 (350)	250	M			0	110	110		110		110
CR Fan 24 (350)	250	M			0		0		0		0
E SW Pmp 25 (350)	282	A	282		282		282		282		282
NE SW Pmp 22 (350)	282	M			0	282	282		282		282
CCW Pmp 22 (250)	230	M			0	230	230		230		230
Chg Pmp 22 (200)	150	M			0	150	150		150		150
Pzr Htr 21	554	M			0		0		0		0
Pzr Htr 22	485	M			0		0		0	139	139
Ltg Tran 21 (Nor)	150	M			0		0		0		0
Ltg Tran 22 (CCR Only)	150	M			0		0		0		0
Ltg Bus 23 (480V-Nor)	100	M			0		0		0		0
MCC 211											
MOVs BFD-90, -1,-2,-3	4.8	A	4.8		4.8	-4.8	0		0		0
MOVs BFD-5, -1,-2,-3	20	A	20		20	-20	0		0		0
MCC 26C											
DG Exhaust Fan 22	0.8	A	0.8		0.8		0.8		0.8		0.8
PAB Exh Fan 21 (125)	93	M	0		0		0		0		0
EDG Bldg Vent Fan 320,322	7.5	A	7.5		7.5		7.5		7.5		7.5
Battery Charger 23	25	A	45		45		45	-20	25		25
CRAC Backup Fan (7.5)	5.6	A	0		0		0		0		0
CRAC Boost.Fan 21 (7.5), Dampers & Motors	5.8	A	5.8		5.8		5.8		5.8		5.8
BA Trans Pump 21 (15)	11.2	A	11.2		11.2		11.2		11.2		11.2
BAT Heaters 21	15	M	0		0		0		0		0
Spent Fuel Pmp 21 (100)	75	M	0		0		0		0		0
Wall Exhaust Fan 213 (2)	1.5	M		1.5	1.5		1.5		1.5		1.5
MCC 24A											
DG 22 Support Loads											
Fuel Oil Pmp (2)	1.5	A			0		0		0	1.5	1.5
Compressor (5)	3.7	A		3.7	3.7	-3.7	0		0		0
XMFR 24 (Inv 22)(max)	15	M/A		10	10		10		10		10
Inst Air Comp 22 (75)	56	A		56	56		56		56		56
I.A. Cool Pmp 22 (1.5)	2.2	A		2.2	2.2		2.2		2.2		2.2
Bat Charger 22 (Max)	45	A		45	45		45	-20	25		25
Radiation Monitor 45	1.6	A		1.6	1.6		1.6		1.6		1.6
MCC 28A											
Sump Pump 210 (7.5)	5.6	A			0		0		0		0
CRDM Fans (4 at 30 hp)	90	M			0		0		0		0
Misc. Loss (Max)	122	A	122		122		122		122		122
Total EDG 22 Load (kW):			499.1		619.1		1362.6		1698.6		1839.1
Total EDG 22 Load, without MD-AFW (use TD-AFW) (kW):									1322.6		1463.1

Table 7-2c. Loss of Offsite Power Loads on EDG 23 (using ECA-0.1)

Bus 6A Loading - EDG 23

Equipment	Max kW	Man/Auto	Time in Minutes 30	*	35	*	40	*	45	*	50
SI & Cir Wtr Pmp 23 (400)	345	M			0		0		0		0
CS Pmp 22 (400)	350	M			0		0		0		0
RHR Pmp 22 (400)	316	M			0		0		0		0
AFW Pmp 23 (400)	387	A			0		0	376	376		376
CR Fan 25 (350)	250	M			0	110	110		110		110
RC Pmp 22 (350)	303	M			0		0		0		0
E SW Pmp 26 (350)	282	A	282		282		282		282		282
NE SW Pmp 23 (350)	282	M			0	282	282		282		282
CCW Pmp 23	230	A			0	230	230		230		230
Chg Pmp 23 (200)	150	M			0	150	150		150		150
Trb Aux Oil Pmp (150)	112	M			0		0		0		0
Pzr Htr Cntrl Gp	277	M			0		0		0	139	139
Ltg Tran 21 (Emg)	150	M			0		0		0		0
MCC 26B											
MOV-822B	0.7	A			0		0		0		0
MOV-882	2.2	M			0		0		0		0
MOV-747	7.7	A			0		0		0		0
HCV-638	0.6	M			0		0		0		0
BFP-2-22	14.3	A	14.3	-14.3	0		0		0		0
Elec Tun Exh Fan 22	7.4	A	7.4		7.4		7.4		7.4		7.4
BA Heat Trace (Emg)	16.8	M			0		0		0		0
H2 Recomb 22	11.4	M			0		0		0		0
CRAC Humidifier (3+.33)	2.5	A	2.2		2.2		2.2		2.2		2.2
CRAC Fan (10)	7.5	A	7.5		7.5		7.5		7.5		7.5
CRAC Boost Fan 22 (7.5), Dampers & Motors	6.8	A	6.8		6.8		6.8		6.8		6.8
DG 23 Support Loads											
Fuel Oil Pmp (2)	1.5	A			0		0		0	1.5	1.5
Compressor (5)	3.7	A		3.7	3.7	-3.7	0		0		0
Lighting Panel 223:											
DG Exhaust Fan 23	0.8	A	0.8		0.8		0.8		0.8		0.8
DG Bldg Emg Lights	1.1	A	1.1		1.1		1.1		1.1		1.1
Eng Aux Cntr Pnl	0.3	A	0.3		0.3		0.3		0.3		0.3
BA Trans Pmp 22 (7.5/15)	11.2	A	11.2		11.2		11.2		11.2		11.2
EDG Bldg Vent Fan 318,323	7.5	A	7.5		7.5		7.5		7.5		7.5
MCC 26BB											
Misc MOVs	1	A	1		1		1		1		1
H2/O2 Anlyz Ht Trace 2	3.3	A	3.3		3.3		3.3		3.3		3.3
Transf 2H (45KVA)	0.3	A	0.3		0.3		0.3		0.3		0.3
MCC 27A											
Bat Charger 24 (Max)	45	A		45	45		45	-20	25		25
XFMR 22 (Inv 24)(max)	15	M		15	15		15		15		15
PAB Exhaust Fan 22 (125)	93	M			0		0		0		0
PAB Supply Fan (50)	37	M			0		0		0		0
Spent Fuel Pump 22 (100)	75	M			0		0		0		0
Misc. Loss (Max)	119	A	119		119		119		119		119
Total EDG 23 Load (kW):			464.7		514.1		1282.4		1638.4		1778.9
Total EDG 23 Load, without MD-AFW (use TD-AFW) (kW):									1262.4		1402.9

Table 7-3. Time Table of Events for Natural Circulation Cooldown to RHR Entry Conditions One EDG Operates, ES-0.2 (Rev. 34) Recovery Actions Considered

Description	Time (hours)
Operator transition from ES-0.1 or ECA-0.1 to Step 1 of EOP ES-0.2, Natural Circulation Cooldown	1
Operator performs actions in ES-0.2, Step 1: Reset lighting on energized bus (reset only for CCR) (Step 1.h) Reset MCCs, except MCCs 28 and 28A (Step 1.i) (only MCCs 29A, 24A, or 27A reset)	1 - 2
Containment conditions normal, reset MCCs 28 and 28A (Step 2) Sump pumps 29 or 210 operate (EDGs 21 or 22)	1 - 2
Operator aligns/starts ventilation systems per Step 3 of ES-0.2 Add PAB ventilation (EDGs 22 or 23) Confirm fan 213, 215, or 216 running	1 - 2
Operator performs Steps 4 through 7 of ES-0.2: Attempts to restart RCP, Boration using boric acid transfer pumps plus charging (B.A. transfer pumps running on EDGs 22 and 23)	1 - 2
Operator energizes CRDM fans on MCCs 28 or 28A (EDGs 21 or 22) (Step 8) (approx. load ~90 kw total, 4 fans @ 30 hp per fan)	1 - 2
Operator initiates < 25°F/hr cooldown to cold shutdown (Step 9)	1 - 2
RCS cooldown and depressurization to < 350°F (Steps 10 through 22)	2 - 15
RCS pressure < 1000 psig, accumulators isolated or vented (Step 18)	~ 8
Operator depressurizes RCS to < 370 psig (RHR cut-in) (Step 22)	~ 15
RHR System placed in service, continue cooldown to cold shutdown (TD-AFW pump operated as necessary to refill SGs, MD-AFW pump secured)	~ 15 - 20

Table 7-3a. Loss of Offsite Power Loads on EDG 21 (using ES-0.2)

Bus 5A Loading - EDG 21			Time in Hours								
Equipment	Max kW	Man/Auto	1	*	2	*	10	*	15	*	20
SI & Cir Wtr Pmp 21 (400)	345	M	0		0		0		0		0
CS Pmp 21 (400)	350	M	0		0		0		0		0
CR Fan 21 (350)	250	M	110		110		110		110		110
CR Fan 22 (350)	250	M	110		110		110		110	-110	0
RC Pmp 21 (350)	303	M	0		0		0		0		0
E SW Pmp 24 (350)	282	A	282		282		282		282		282
NE SW Pmp 21 (350)	282	M	282		282		282		282		282
CCW Pmp 21 (250)	230	A	230		230		230		230		230
Chg Pmp 21 (200)	150	M	150		150	-70	80	-20	60		60
Srv Air Comp (125)	93	M	0		0		0		0		0
Pzr Htrs 23	485	M	139		139		139		139		139
Ltg Bus 23 (120/208V)(CCR Only)	135	M	19.6		19.6		19.6		19.6		19.6
Ltg Bus 23 (480V-Emg)	100	M	0		0		0		0		0
RHR 21 or 23 (via Cross-ties)	316	M	0		0		0		0	307	307
MCC 26A											
MOV-822A	0.7	A	0		0		0		0		0
MOV-744	5.8	A	0		0		0		0		0
MOV-746	7.7	A	0		0		0		0		0
HCV-640	0.6	M	0		0		0		0		0
BFP-2-21	14.3	A	0		0		0		0		0
Elec Tun Exh Fan 21	7.4	A	7.4		7.4		7.4		7.4		7.4
H2 Recomb 21	11.4	M	0		0		0		0		0
DG Exh Fan 21 (nor)	0.5	A	0.5		0.5		0.5		0.5		0.5
EDG Bldg. Vent Fan 319,321	7.5	A	7.5		7.5		7.5		7.5		7.5
BA Ht Trace (nor)	16.8	A	16.8		16.8		16.8		16.8		16.8
XMFR 23 (Inv 21)(max)	15	M/A	0		0		0		0		0
EPX3	30	A	15		15		15		15		15
EPV21	15	A	7.5		7.5		7.5		7.5		7.5
MCC 26AA											
Misc MOVs	1	A	1		1		1		1		1
H2/O2 Anlyz Ht Trc 1	3.3	A	3.3		3.3		3.3		3.3		3.3
MCC 29A											
DG 21 Support Loads											
Fuel Oil Pmp (2)	1.5	A	1.5		1.5		1.5		1.5		1.5
Compressor (5)	3.7	A	0		0		0		0		0
Bat Charger 21 (Max)	45	A	25		25		25		25		25
Inst Air Comp 21 (75)	56	A	56		56		56		56		56
I.A. Cool Pmp 21 (1.5)	2.2	A	2.2		2.2		2.2		2.2		2.2
Wall Exh Fan 215 (2)	1.5	M	1.5		1.5		1.5		1.5		1.5
XMFR 21 (Inv 23)(max)	15	M/A	0		0		0		0		0
MCC 28											
Sump Pump 29 (7.5)	5.6	A	5.6		5.6		5.6		5.6		5.6
CRDM Fans (4 at 30 hp)	90	M	0	90	90		90		90	-90	0
Misc. Loss (Max)	117	A	117		117		117		117		117
Total EDG 21 Load (kW):			1590.4		1680.4		1610.4		1590.4		1697.4

Table 7-3b. Loss of Offsite Power Loads on EDG 22 (using ES-0.2)

Bus 2A/3A Loading - EDG 22			Time in Hours								
Equipment	Max kW	Man/Auto	1	*	2	*	10	*	15	*	20
SI & Cir Wtr Pmp 22 (400)	345	M	0		0		0		0		0
RHR Pmp 21 (400)	316	M	0		0		0		0	307	307
AFW Pmp 21 (400)	387	A	0		0		0		0		0
CR Fan 23 (350)	250	M	110		110		110		110		110
CR Fan 24 (350)	250	M	110		110		110		110	-110	0
E SW Pmp 25 (350)	282	A	282		282		282		282		282
NE SW Pmp 22 (350)	282	M	282		282		282		282		282
CCW Pmp 22 (250)	230	M	230		230		230		230		230
Chg Pmp 22 (200)	150	M	150		150	-70	80	-20	60		60
Pzr Htr 21	554	M	0		0		0		0		0
Pzr Htr 22	485	M	139		139		139		139		139
Ltg Tran 21 (Nor)	150	M	0		0		0		0		0
Ltg Tran 22 (CCR Only)	150	M	19.6		19.6		19.6		19.6		19.6
Ltg Bus 23 (480V-Nor)	100	M	0		0		0		0		0
MCC 211											
MOVs BFD-90, -1,-2,-3	4.8	A	0		0		0		0		0
MOVs BFD-5, -1,-2,-3	20	A	0		0		0		0		0
MCC 26C											
DG Exhaust Fan 22	0.8	A	0.8		0.8		0.8		0.8		0.8
PAB Exh Fan 21 (125)	93	M	93		93		93		93	-93	0
EDG Bldg Vent Fan 320,322	7.5	A	7.5		7.5		7.5		7.5		7.5
Battery Charger 23	25	A	25		25		25		25		25
CRAC Backup Fan (7.5)	5.6	A	0		0		0		0		0
CRAC Boost.Fan 21 (7.5), Dampers & Motors	5.8	A	5.8		5.8		5.8		5.8		5.8
BA Trans Pump 21 (15)	11.2	A	11.2		11.2		11.2		11.2		11.2
BAT Heaters 21	15	M	0		0		0		0		0
Spent Fuel Pmp 21 (100)	75	M	0		0		0		0		0
Wall Exhaust Fan 213 (2)	1.5	M	1.5		1.5		1.5		1.5		1.5
MCC 24A											
DG 22 Support Loads											
Fuel Oil Pmp (2)	1.5	A	1.5		1.5		1.5		1.5		1.5
Compressor (5)	3.7	A	0		0		0		0		0
XMFR 24 (Inv 22)(max)	15	M/A	0		0		0		0		0
Inst Air Comp 22 (75)	56	A	56		56		56		56		56
I.A. Cool Pmp 22 (1.5)	2.2	A	2.2		2.2		2.2		2.2		2.2
Bat Charger 22 (Max)	45	A	25		25		25		25		25
Radiation Monitor 45	1.6	A	1.6		1.6		1.6		1.6		1.6
MCC 28A											
Sump Pump 210 (7.5)	5.6	A	5.6		5.6		5.6		5.6		5.6
CRDM Fans (4 at 30 hp)	90	M	0	90	90		90		90	-90	0
Misc. Loss (Max)	122	A	122		122		122		122		122
Total EDG 22 Load (kW):			1681.3		1771.3		1701.3		1681.3		1695.3

Table 7-3c. Loss of Offsite Power Loads on EDG 23 (using ES-0.2)

Bus 6A Loading - EDG 23

Time in Hours

Equipment	Max kW	Man/Auto	1	*	2	*	10	*	15	*	20
SI & Cir Wtr Pmp 23 (400)	345	M	0		0		0		0		0
CS Pmp 22 (400)	350	M	0		0		0		0		0
RHR Pmp 22 (400)	316	M	0		0		0		0	307	307
AFW Pmp 23 (400)	387	A	0		0		0		0		0
CR Fan 25 (350)	250	M	110		110		110		110		110
RC Pmp 22 (350)	303	M	0		0		0		0		0
E SW Pmp 26 (350)	282	A	282		282		282		282		282
NE SW Pmp 23 (350)	282	M	282		282		282		282		282
CCW Pmp 23	230	A	230		230		230		230		230
Chg Pmp 23 (200)	150	M	150		150	-70	80	-20	60		60
Trb Aux Oil Pmp (150)	112	M	0		0		0		0		0
Pzr Htr Cntrl Gp	277	M	139		139		139		139		139
Ltg Tran 21 (Emg)	150	M	0		0		0		0		0
MCC 26B											
MOV-822B	0.7	A	0		0		0		0		0
MOV-882	2.2	M	0		0		0		0		0
MOV-747	7.7	A	0		0		0		0		0
HCV-638	0.6	M	0		0		0		0		0
BFP-2-22	14.3	A	0		0		0		0		0
Elec Tun Exh Fan 22	7.4	A	7.4		7.4		7.4		7.4		7.4
BA Heat Trace (Emg)	16.8	M	0		0		0		0		0
H2 Recomb 22	11.4	M	0		0		0		0		0
CRAC Humidifier (3+.33)	2.5	A	2.2		2.2		2.2		2.2		2.2
CRAC Fan (10)	7.5	A	7.5		7.5		7.5		7.5		7.5
CRAC Boost Fan 22 (7.5), Dampers & Motors	6.8	A	6.8		6.8		6.8		6.8		6.8
DG 23 Support Loads											
Fuel Oil Pmp (2)	1.5	A	1.5		1.5		1.5		1.5		1.5
Compressor (5)	3.7	A	0		0		0		0		0
Lighting Panel 223:											
DG Exhaust Fan 23	0.8	A	0.8		0.8		0.8		0.8		0.8
DG Bldg Emg Lights	1.1	A	1.1		1.1		1.1		1.1		1.1
Eng Aux Cntr Pnl	0.3	A	0.3		0.3		0.3		0.3		0.3
BA Trans Pmp 22 (7.5/15)	11.2	A	11.2		11.2		11.2		11.2		11.2
EDG Bldg Vent Fan 318,323	7.5	A	7.5		7.5		7.5		7.5		7.5
MCC 26BB											
Misc MOVs	1	A	1		1		1		1		1
H2/O2 Anlyz Ht Trace 2	3.3	A	3.3		3.3		3.3		3.3		3.3
Transf 2H (45KVA)	0.3	A	0.3		0.3		0.3		0.3		0.3
MCC 27A											
Bat Charger 24 (Max)	45	A	25		25		25		25		25
XFMR 22 (Inv 24)(max)	15	M	0		0		0		0		0
PAB Exhaust Fan 22 (125)	93	M	93		93		93		93	-93	0
PAB Supply Fan (50)	37	M	37		37		37		37	-37	0
Spent Fuel Pump 22 (100)	75	M	0		0		0		0		0
Misc. Loss (Max)	119	A	119		119		119		119		119
Total EDG 23 Load (kW):			1517.9		1517.9		1447.9		1427.9		1604.9

Table 7-4 Summary and Comparison of Hot Shutdown and Cold Shutdown EDG Loads for Recovery from a Station Blackout Event at Indian Point Unit 2 Using a Single EDG

Equipment	6/8/90 Draft		EDG 21		EDG 22		EDG 23	
	HSD	CSD	HSD	CSD	HSD	CSD	HSD	CSD
MCC 24A&28A	a	a	0	0	91.9	91.9	0	0
MCC 26A/AA	a	a	59	59	0	0	0	0
MCC 26B/BB	a	a	0	0	0	0	50.9	50.9
MCC 26C (note d)	a	a	0	0	144.8	51.8	0	0
MCC 27A (note d)	a	a	0	0	0	0	155	25
MCC 29A&28	a	a	91.8	91.8	0	0	0	0
Instrument Air & Support	59.1	59.1	c	c	c	c	f	f
Service Water (2)	554	554	564	564	564	564	564	564
Aux. Feedwater Pump	300 (e)	300 (e)	0	0	376	0	376	0
RHR Pump	0	332	0	307 (g)	0	307	0	307
Charging Pump	50	50	150	60	150	60	150	60
Fan Cooler(s)	123	123	220	110	220	110	110	110
Component Cooling Pump	228	228	230	230	230	230	230	230
Battery Charger	50	50	c	c	c	c	c	c
Lighting	150	150	19.6	19.6	19.6	19.6	0	0
Pressurizer Heaters	69	69	139	139	139	139	139	139
EDG Support and Lighting	7.9	7.9	c	c	c	c	c	c
Cable Tunnel Fan	7.4	7.4	c	c	h	h	c	c
Ventilation - PAB	130	130	c	c	c	c	c	c
- CCR	11.4	11.4	i	i	c	c	c	c
Misc. Losses	b	b	117	117	122	122	119	119
TOTAL EDG LOAD (kW)	1739.8	2071.8	1590.4	1697.4	2057.3	1695.3	1893.9	1604.9
TOTAL w/o AFW Pump	1439.8	1771.8	same	same	1681.3	same	1517.9	same

Notes for Table 7-4

a - A specific component load is listed.

b - Miscellaneous losses (bus, cable, and frequency fluctuations) were not considered in prior calculations.

c - Component is part of an MCC load.

d - PAB ventilation fans are assumed turned off during cooldown to cold shutdown.

e - AFW flow is considered throttled to ~ 250 gpm after NR level is on span in the SGs.

f - Capability exists to locally operate SG atmospheric steam relief valves.

g - Operation of 480V bus cross-ties is required to place RHR in service (below 350°F).

h - Temperature limits determined to be acceptable without cable tunnel fan for > 8 hrs (Ref. 7-10).

i - CCR temperatures acceptable (<120°F) per station blackout submittal (Ref. 7-11).

8.0 SUMMARY AND CONCLUSIONS

This report provides a diesel generator loading analysis for a number of loss of offsite power events requiring safety injection. Limiting EDG loads for large LOCA, small LOCA, steamline break, SG tube rupture, and spurious SI actuation are determined. In addition, a section on station blackout / loss of offsite power without SI is included.

Significant plant and EOP modifications have been factored into this study. Some of these changes had been incorporated into previous versions of this report, WCAP-12655, Rev. 0, dated July 1990, and Rev. 1, dated May 1996. For Rev. 0, these modifications include changes to the recirculation switches as described in an LER (Ref. 1-7) and increased component power requirements for the stretch rating (3083.4 MWt NSSS power). For Rev. 1, changes have been included to reflect modifications made during the 1991 and 1993 spring refueling outages, the increased loading capabilities of the EDGs due to the diesel enhancement program, a number of calculational changes, and Rev. 21 of the EOPs (August 1995). The Rev. 1 update, therefore, reflects the Indian Point Unit 2 Plant near the end of 1995.

For Rev. 2, modifications include the Rev. 1B update for miscellaneous small loads, streamlining of the LOCA switchover procedure EOP ES-1.3 (updated to Rev. 36), plus a number of pump changes and replacements, revised fan cooler loads, and steam generator replacement (Model 44F). The loading study closely reflects the plant near the end of 2001.

The EDG loading validation for Rev. 2, based on these up-to-date changes, demonstrates that most EDG loads for the above events will be less than 2100 kw, the two hour emergency rating for the diesel generators. In a few instances during the injection phase of the accident, the loads on EDG 23 for large LOCA may surpass the 2100 kw two hour emergency rating but remain well below the 2300 kw half hour limit. The peak injection phase load as described in Section 5.6 is 2147 kw.

During recirculation, short-term transient loads may also exceed 2100 kw, but still have reasonable margin to the 2300 kw half-hour rating. The limiting large LOCA load as described in Section 5.6 is 2268 kw (load on EDG 21, with EDG 23 failure). A similar high load on EDG 23 is 2176 kw (for EDG 21 failure). Both of these loads are transient ones lasting only a few minutes (the time take between Recirculation Switch 4 and completion of Recirculation Switch 7).

Large LOCA with high head recirculation is evaluated in Section 5.7. Generally this configuration bounds small LOCA and is the one used for long term cooling (in ES-1.4, Transfer to Hot Leg Recirculation). Transient loads remain acceptable and have adequate margin to the 2300 kw half-hour rating and the 2100 kw two-hour rating.

Longer-term EDG loads are also determined for both low-head and high-head recirculation, high-head recirculation being more limiting. These loads are typically less than the diesel generator continuous rating of 1750 kw. Operator actions are required in some cases to limit the EDG loads to meet this more restrictive long-term EDG

loading limit. These actions consist primarily of load balancing between EDGs and/or elimination of certain optional loads. Since the operator would have adequate time to evaluate the longer-term loads, he would be able to readily control them to be less than the 1750 kw continuous rating limit.

In Section 6.1, a very conservative small LOCA with composite failures is evaluated. In an extreme situation, the load can approach the 2300 kw limit. However, generally the small LOCA loads will be bounded by large LOCA.

For the remaining events with SI (steamline break, SGTR, and spurious SI), EDG loads are within the appropriate limits during the initial phase of the accident. Long term, they are controllable to less than the 1750 kw continuous rating.

Finally, note that for the design basis loss of offsite power events with SI, recovery using any 2 of 3 EDGs (or other limiting single failure) is possible without exceeding the EDG loading limits. In Section 7, for station blackout / loss of offsite power with SI, it is demonstrated that plant recovery using a single EDG is possible without exceeding the EDG loading limits.

9.0 REFERENCES

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E-0	REACTOR TRIP OR SAFETY INJECTION	38	3/19/01
ES-0.0	REDIAGNOSIS	34	8/25/00
ES-0.1	REACTOR TRIP RESPONSE	36	12/21/00
ES-0.2	NATURAL CIRCULATION COOLDOWN	34	8/25/00
ES-0.3	NATURAL CIRCULATION COOLDOWN WITH STEAM VOID IN VESSEL (WITH RVLIS)	34	8/25/00
ES-0.4	NATURAL CIRCULATION COOLDOWN WITH STEAM VOID IN VESSEL (WITHOUT RVLIS)	34	8/25/00
E-1	LOSS OF REACTOR OR SECONDARY COOLANT	36	12/21/00
ES-1.1	SI TERMINATION	36	12/21/00
ES-1.2	POST LOCA COOLDOWN AND DEPRESSURIZATION	36	12/21/00
ES-1.3	TRANSFER TO COLD LEG RECIRCULATION	36	12/21/00
ES-1.4	TRANSFER TO HOT LEG RECIRCULATION	36	12/21/00
E-2	FAULTED STEAM GENERATOR ISOLATION	34	8/25/00
E-3	STEAM GENERATOR TUBE RUPTURE	36	12/21/00
ES-3.1	POST-SGTR COOLDOWN USING BACKFILL	34	8/25/00
ES-3.2	POST-SGTR COOLDOWN USING BLOWDOWN	34	8/25/00
ES-3.3	POST-SGTR COOLDOWN USING STEAM DUMP	34	8/25/00
ECA-0.0	LOSS OF ALL AC POWER	37	7/31/01
ECA-0.1	LOSS OF ALL AC POWER RECOVERY WITHOUT SI REQUIRED	34	8/25/00
ECA-0.2	LOSS OF ALL AC POWER RECOVERY WITH SI REQUIRED	34	8/25/00
ECA-1.1	LOSS OF EMERGENCY COOLANT RECIRCULATION	34	8/25/00

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3-17 Letter from S. M. Ira (Westinghouse) to Diane Storrick (Westinghouse), Verification of Additional Input Data, IPP-00-390, December 9, 2000 (this letter attaches Con Edison letter W-008 from James J. Tuohy to S. M. Ira, dated December 8, 2000).

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4-3 Consolidated Edison Drawing A225105, Safeguards Actuation Logic Diagram. (UFSAR Figure 7.2-12, Rev. 16A) (Note: This reference is no longer used.)

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APPENDIX A

SAFETY EVALUATION CHECKLISTS

This appendix presents four Westinghouse Safety Evaluation Checklists (SECLs) used as part of the EDG loading study. These SECLs are briefly described below and then presented in their entirety. These SECLs were implemented except for the first one (stopping the AFW pumps during switchover). In the revised study, flow from the motor-driven AFW pumps is reduced to minimum recirculation flow when levels are on span in the narrow range (i.e., the symptoms allow this action to occur). The other 3 SECLs have been implemented at the plant. Some of the analyses or timing of actions are not up to date, however, this not impact the overall conclusions and acceptance of the change.

The first SECL is entitled "Safety Evaluation for Securing the Motor-Driven AFW Pumps during the Post-LOCA Switchover" (SECL-89-743, pages A-2 through A-6). This SECL provides justification for stopping the motor-driven AFW pumps during the switchover to cold leg recirculation. Prior to the EDG enhancement program, this action was performed to avoid a potential overload on EDGs 22 and 23 during the recirculation switch sequence. This action is no longer required nor performed in Rev. 38 of the EOPs (Ref. 1-28), used for this updated loading study (WCAP-12655, Rev. 2). This SECL is included for completeness. However, the action to stop the motor-driven AFW pumps during switchover is no longer performed in the EOPs.

The second SECL, "Changes in Switch Sequences for Cold Leg Recirculation Switchover" (SECL-89-744, Rev. 1, pages A-7 through A-13), provides justification for performing recirculation switches 2 and 3 in reverse order. This change has been implemented and is still in effect. Some of the safety analyses referenced in this SECL have been updated. However, for purposes of justifying operation of recirculation switch 3 prior to switch 2, the SECL can still be considered valid.

The third Westinghouse SECL is "High Head Safety Injection Flow Changes Safety Evaluation" (SECL-91-231, pages A-14 through A-62). This SECL provides justification for reducing the flow from the high head SI pumps as a result of installing throttle valves (for flow balancing) in the discharge piping for these pumps. This change has been implemented and its impact on the EDG loading study is given on pages 2 and 43 of the SECL (pages A-55 and A-56).

The fourth Westinghouse SECL is entitled "Increase in the Containment Pressure High ESF Safety Analysis Limit (SAL) Setpoint to 10 psig" (SECL-92-339, Rev. 2, pages A-63 through A-78). This SECL describes the changes to various safety analyses due to an increase in containment pressure uncertainties (resulting from increased surveillance time due to fuel cycle extension to 24 months). This change has been implemented.

SECL NO. 89-743
Customer Reference No(s).

Westinghouse Reference No(s).

WESTINGHOUSE NUCLEAR SAFETY
SAFETY EVALUATION CHECK LIST

1.) NUCLEAR PLANT(S) : Indian Point Unit 2

2.) SUBJECT (TITLE): Safety Evaluation for Securing the Motor-Driven AFW Pumps Pump during the Post-LOCA Switchover

3.) The written safety evaluation of the revised procedure, design change or modification required by 10CFR50.59 (b) has been prepared to the extent required and is attached. If a safety evaluation is not required or is incomplete for any reason, explain on Page 2.

Parts A and B of this Safety Evaluation Check List are to be completed only on the basis of the safety evaluation performed.

CHECK LIST - PART A - 10CFR50.59(a)(1)

(3.1) Yes X No___ A change to the plant as described in the FSAR?
(3.2) Yes X No___ A change to procedures as described in the FSAR?
(3.3) Yes___ No X A test or experiment not described in the FSAR?
(3.4) Yes___ No X A change to the plant technical specifications? (See note on Page 2.)

4.) CHECK LIST - Part B - 10CFR50.59(a)(2) (Justification for Part B answers must be included on Page 2.)

(4.1) Yes___ No X Will the probability of an accident previously evaluated in the FSAR be increased?
(4.2) Yes___ No X Will the consequences of an accident previously evaluated in the FSAR be increased?
(4.3) Yes___ No X May the possibility of an accident which is different than any already evaluated in the FSAR be created?
(4.4) Yes___ No X Will the probability of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
(4.5) Yes___ No X Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
(4.6) Yes___ No X May the possibility of a malfunction of equipment important to safety different than any already evaluated in the FSAR be created?
(4.7) Yes___ No X Will the margin of safety as defined in the bases to any technical specifications be reduced?

SECL NO. 89-743

NOTES:

If the answers to any of the above questions are unknown, indicate under 5.) REMARKS and explain below.

If the answers to any of the above questions in Part A (3.4) or Part B cannot be answered in the negative, based on the written safety evaluation, the change review would require an application for license amendment as required by 10CFR50.59(c) and submitted to the NRC pursuant to 10CFR50.90.

5.) REMARKS:

The following summarizes the justification based upon the written safety evaluation[1], for answers given in Part A (3.4) and Part B of this SECL.

See the Attached Safety Evaluation

[1]Reference to documents containing written safety evaluation:

FOR FSAR UPDATE

Section:_____ Pages:_____ Tables:_____ Figures:_____

Reason for/Description of Change:

See the Attached Safety Evaluation

SAFETY EVALUATION APPROVAL LADDER:

Prepared by (Nuclear Safety): Alex Ball, Jr. Date: 5/19/89

Nuclear Safety Group Manager: [illegible] Date: 5/19/89

ATTACHMENT TO SECL-89-743

BACKGROUND

Westinghouse is currently reviewing the Indian Point Unit 2 diesel loadings with the objective of reducing the diesel loads. To address diesel loading considerations, it has been proposed that the motor-driven Auxiliary Feedwater (AFW) pumps be secured at the time of switchover to cold leg recirculation.

The areas considered in this review/evaluation for determining the effects of this recommendation on Indian Point 2 are as follows:

- LOCA, non-LOCA, and Steam Generator Tube Rupture analyses
- Containment Integrity analysis
- Radiological effects
- Technical Specifications
- Mechanical and Fluid systems

Contained below are the results of evaluations addressing this change.

BASES

Large Break LOCA

For the large break LOCA transient, the heat transfer from the primary to the secondary is not required to mitigate the consequences of the postulated accident. Since a secondary side heat sink is not required for this event, securing of the motor-driven AFW pumps at the time of switchover to cold leg recirculation does not adversely affect the results of the large break LOCA analysis or cause any regulatory or design limit to be exceeded and is thus acceptable with respect to large break LOCA.

Small Break LOCA

For the small break LOCA, use of heat transfer from the primary to the secondary is required to mitigate the consequences of the postulated event. However, at some point during the transient following depressurization of the Reactor Coolant System, the primary thermodynamic conditions and flow from the ECCS will provide sufficient primary heat removal capability so that a secondary heat sink is no longer required. Examination of the NOTRUMP small break LOCA analysis for Indian Point 2 has shown that the need for a secondary heat sink is eliminated well prior to the time of switchover for break sizes as small as a 4 inch equivalent diameter. For these cases, the proposed change is acceptable.

For smaller breaks, for which switchover will be much later (at a lower core decay heat level) but at a much higher primary pressure and lower break flow rate (heat sink required), a conservative evaluation was performed to assess the acceptability of the proposed change. Based on this evaluation, it was determined that while securing the motor-driven

AFW pumps during the switchover sequence may result in some net reduction in secondary mass, a heat sink will still be available as required for these smaller breaks. The extremely slow transient behavior in terms of clad heat-up and boil-off capability in the primary system suggest that a reduced efficiency of the heat sink due to a lower secondary mass will not result in a more limiting small break LOCA scenario than those analyzed in the NOTRUMP analysis. Therefore, securing of the motor-driven AFW pumps at the time of switchover to cold leg recirculation does not adversely affect the results of the small break LOCA analysis or cause any regulatory or design limit to be exceeded and is acceptable with respect to small break LOCA.

Other LOCA Related Accidents

The proposed change to the availability or sequencing of equipment during the switchover to cold leg recirculation will not affect the results of the analyses of hot leg switchover to prevent potential boron precipitation, post-LOCA long term core cooling or LOCA hydraulic forces. The hot leg switchover and post-LOCA long term core cooling calculations do not consider the specifics of switchover to cold leg recirculation, and assume that a successful switchover has occurred. For the LOCA hydraulic forces calculation, the peak forcing functions will be experienced within the first few seconds following the rupture, substantially before initiation of the switchover procedure.

Non-LOCA/ SGTR

The non-LOCA and Steam Generator Tube Rupture accident analyses were reviewed and it has been determined that they are not impacted by this change because this is for post-LOCA only and that recirculation switchover will not occur.

Containment Integrity Analysis

The containment integrity analyses are described in Chapter 14 of the FSAR and considers Short Term and Long Term Mass and Energy Release Analyses for Postulated Loss-of-Coolant Accidents (LOCA's), Containment Response Analyses following a LOCA and Subcompartment Pressure Transient Analyses.

For the Short Term Mass and Energy Release and Subcompartment Pressure Analyses a change in the Auxiliary Feedwater (AFW) flowrate would have no effect on the calculated results, since the short duration of the transient ($\leq$ 3 seconds) does not consider AFW flow.

The long term mass and energy release and containment pressure response calculation following a LOCA are performed to ensure that the peak containment pressure remains below the design limit. A review of the containment integrity analysis has been completed to determine the effect of the motor-driven auxiliary feedwater pumps being tripped during the post-LOCA switchover on the conclusions derived in the analyses. Sensitivity analyses reveal that a AFW pump trip has an insignificant

effect on the mass and energy releases and resultant peak calculated containment pressure and temperature.

Therefore, the effect of the AFW pumps being tripped will have an insignificant impact on the containment integrity response calculations and will not compromise the conclusions or pressure margin derived in the current limiting safety analyses.

Radiological Impact of AFW Termination on LOCA

The radiological consequences of a small break LOCA are not specifically evaluated in the FSAR, but are indicated as being bound by those of the large break LOCA. The large break LOCA is not affected by the AFW termination, since no heat removal from the secondary side is required.

For the small break LOCA following AFW termination, the steam generator water level is expected to fall below the primary-to-secondary leakage sites. Hence, leaking reactor coolant is assumed to bypass the secondary coolant, i.e., neither mixing with the secondary coolant nor partitioning is assumed to occur, resulting in a direct activity leakage path to the environment. An evaluation has been performed, and the results confirm that the radiological consequences of a small break LOCA, with steam generator tube uncovery, are still bounded by the large break LOCA, and are within a small fraction of the 10 CFR 100 dose guidelines.

CONCLUSION

The LOCA, non-LOCA, Steam Generator Tube Rupture and Containment Integrity Accident analyses have been reviewed for the impact of this safety evaluation and it has been determined that tripping the motor-driven AFW pumps during the recirculation switchover for small and large break LOCA will not affect any of the accident analysis results. Also, the Technical Specifications and Mechanical and Fluid Systems were reviewed and it has been determined that they are not impacted.

Based upon the above evaluation, it has been determined that the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report is not increased; the possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report will not be created; and the margin of safety is not reduced. Therefore, the implementation of this recommendation will not adversely impact safe plant operations at Indian Point 2 and will not result in an unreviewed safety question as defined in the criteria of 10CFR50.59.

SECL-89-744, Rev. 1
July 23, 1990

WESTINGHOUSE NUCLEAR SAFETY
SAFETY EVALUATION CHECK LIST

1.) NUCLEAR PLANT(S) : Indian Point Unit-2

2.) SUBJECT (TITLE): Changes in Switch Sequences for Cold Leg Recirculation Switchover

3.) The written safety evaluation of the revised procedure, design change or modification required by 10CFR50.59 (b) has been prepared to the extent required and is attached. If a safety evaluation is not required or is incomplete for any reason, explain on Page 2.

Parts A and B of this Safety Evaluation Check List are to be completed only on the basis of the safety evaluation performed.

CHECK LIST - PART A - 10CFR50.59(a)(1)

(3.1)	Yes___	No X	A change to the plant as described in the FSAR?
(3.2)	Yes X	No___	A change to procedures as described in the FSAR?
(3.3)	Yes___	No X	A test or experiment not described in the FSAR?
(3.4)	Yes___	No X	A change to the plant technical specifications? (See note on Page 2.)

4.) CHECK LIST - Part B - 10CFR50.59(a)(2) (Justification for Part B answers must be included on Page 2.)

(4.1)	Yes___	No X	Will the probability of an accident previously evaluated in the FSAR be increased?
(4.2)	Yes___	No X	Will the consequences of an accident previously evaluated in the FSAR be increased?
(4.3)	Yes___	No X	May the possibility of an accident which is different than any already evaluated in the FSAR be created?
(4.4)	Yes___	No X	Will the probability of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
(4.5)	Yes___	No X	Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
(4.6)	Yes___	No X	May the possibility of a malfunction of equipment important to safety different than any already evaluated in the FSAR be created?
(4.7)	Yes___	No X	Will the margin of safety as defined in the bases to any technical specifications be reduced?

NOTES:

If the answers to any of the above questions are unknown, indicate under 5.) REMARKS and explain below.

If the answers to any of the above questions in Part A (3.4) or Part B cannot be answered in the negative, based on the written safety evaluation, the change review would require an application for license amendment as required by 10CFR50.59(c) and submitted to the NRC pursuant to 10CFR50.90.

5.) REMARKS:

The following summarizes the justification based upon the written safety evaluation[1], for answers given in Part A (3.4) and Part B of this SECL.

See the Attached Safety Evaluation

[1]Reference to documents containing written safety evaluation:

FOR FSAR UPDATE

Section: _____ Pages: _____ Tables: _____ Figures: _____

Reason for/Description of Change:

See the Attached Safety Evaluation

SAFETY EVALUATION APPROVAL LADDER:

Prepared by (Nuclear Safety): R. R. Laubham Date: 7-24-90

Nuclear Safety Group Manager: S. D. Ruppecht Date: 7-24-90

BACKGROUND

Indian Point Unit 2 has a semi-automatic sequence of eight switches that help the operator accomplish the realignment from injection to recirculation during the post-LOCA recovery phase of an accident. A brief description of the switches is provided below and additional details are in Chapter 6 of the FSAR.

Switch 1: Ensures two and only two high-head SI pumps continue to inject, still aligned to the RWST (the switch actually stops SI pump 22 provided SI pumps 21 and 23 are both running). Switch 1 also stops one of the containment spray (CS) pumps if both are operating.

Switch 2: Starts one component cooling pump and one non-essential service water pump. These pumps are needed for cooling the water from the recirculation sump (heat exchanged in one or both of the RHR heat exchangers).

Switch 3: Trips both RHR pumps.

Switch 4: Starts one recirculation pump (takes water from the recirculation sump and directs it to one or both RHR heat exchangers).

If offsite power is available or all diesel generators are operating, Switch 5 will start a second CCW pump, a second non-essential SW pump, and the second recirculation pump (if a diesel fails, this additional equipment would not be operated).

Switches 6 or 7 align for high-head or low-head recirculation (but not both). For small LOCAs, Switch 6 aligns for high-head recirculation (recirculation pumps feed the SI pump suction). For low-head recirculation, Switch 7 stops the SI pumps; flow from the RHR heat exchanger remains aligned as it was originally, i.e., directly feeding the cold legs.

Switch 8 then causes two valves to close: the spray pump test line valve and the SI pump suction valve from the RWST.

In the current design, the CCW pump and non-essential SW pump started via Switch 2 will normally be powered by different 480 V busses or diesel generators. For certain limiting failure conditions (e.g., failure of DG 21), both pumps started by Switch 2 would be powered by diesel 22 (a load of approximately 500 kw for both pumps). Furthermore, SI pump 22 (approximately 350 kw) would remain operating after Switch 1. The resulting load on DG 22 is potentially too high until the RHR pump (300 kw) powered by DG 22 is stopped by Switch 3.

To reduce the transient load on DG 22, Consolidated Edison requested that Westinghouse investigate the possibility of interchanging the order or actions of Switches 2 and 3, i.e., effectively performing Switch 3 before Switch 2. (The EOPs would most likely simply direct the operator to perform and verify Switch 3 actions before Switch 2, if the logic so permits). Note that with this change, there would be a longer period of time without low-head flow between the time the RHR pumps are stopped and the time the recirculation pumps are started. However, it is important to emphasize that two SI pumps will still be injecting from the RWST during this time period.

Per discussions with the Consolidated Edison, the maximum delay expected between the time the RHR pumps are stopped and the time the recirculation pumps are started is five minutes. For the DG 21 failure case of primary interest, switchover would not be reached for approximately 20 minutes (for a large LOCA); however, to bound the case where there are no failures, the time to switchover should be reduced to about 15 minutes. Thus, for the bounding scenario, the following time table of events should be considered:

Event	Time (minutes)
Large LOCA, Limiting Set of Safeguards Equipment Available	0
Start of Recirculation: 2 SI Pumps Left Operating RHR Pump(s) Stopped	15
One CCW Pump and One Non-Ess. SW Pump Started	15-20
One Recirculation Pump Started	20

To address diesel loading considerations, it has been proposed that a modification to the switchover switch sequence be made for Indian Point 2. This modification will result in an extended period of operation (up to 5 minutes) during recirculation in which pumped ECCS flow will be limited to that of 2 High Head Safety Injection (HHSI) pumps.

The areas considered in this review/evaluation for determining the effects of this recommendation on Indian Point 2 are as follows:

- LOCA, non-LOCA, and Steam Generator Tube Rupture analyses
- Containment Integrity analysis
- Mechanical and Fluid Systems
- Radiological effects
- Technical Specifications

Contained below are the results of evaluations addressing these changes.

BASES

Large Break LOCA

An evaluation was performed to address the effects of an extended period of flow with only 2 HHSI pumps during switchover for Indian Point 2. This evaluation was based on conservative assumptions relative to transient behavior, HHSI flow, and time required to begin and complete the switchover procedure. The evaluation demonstrated that the vessel inventory remained high throughout the switchover procedure and that an adequately high level of heat transfer from the fuel cladding to the fluid was maintained. Based on this evaluation, it was determined that the extended period of delivery from 2 HHSI only during the switchover period would not result in any significant cladding heat-up and that the proposed change would not result in a scenario which could be more limiting than that analyzed in the Large Break LOCA (BASH) analysis to be used as the licensing basis for Indian Point 2 beginning with Cycle 10 operation. In addition, the combined effects of the proposed change in conjunction with securing the motor-driven AFW pumps during the switchover procedure (previously evaluated per SECL-89-743) were evaluated. From this evaluation, it was determined that the combined effects will be no more limiting than the conservative evaluation of the singular effects for each independent change. Therefore, the proposed change is acceptable and will not cause any regulatory or design limit to be exceeded with respect to Large Break LOCA.

Small Break LOCA

An evaluation was performed to address the effects of an extended period of flow with only 2 HHSI pumps during switchover for Indian Point 2. This evaluation was based on conservative assumptions relative to transient behavior, HHSI flow, and time required to begin and completed the switchover procedure. The evaluation considered the small break cases included in the small break LOCA analysis with NOTRUMP for Indian Point 2, as well as bounding scenarios for break cases not analyzed in the NOTRUMP spectrum. Calculations of bounding cases demonstrated that the core would remain covered throughout the switchover procedure. Based on this evaluation, it was determined that the extended period of delivery from 2 HHSI only during the switchover period would not result in any significant cladding heat-up and that the proposed change would not result in a scenario which could be more limiting than that analyzed in the small break LOCA (NOTRUMP) analysis to be used as the licensing basis for Indian Point 2 beginning with Cycle 10 operation. In addition, the combined effects of the proposed change in conjunction with securing the motor-driven AFW pumps during the switchover procedure (SECL-89-743) were evaluated. From this evaluation, it was determined that the combined effects will be no more limiting than the conservative evaluation of the singular effects for each independent change. Therefore, the proposed change is acceptable and will not cause any regulatory or design limit to be exceeded with respect to small break LOCA.

Other LOCA Related Accidents

The proposed change to the availability or sequencing of equipment during the switchover to cold leg recirculation will not affect the results of the analyses of hot leg switchover to prevent potential boron precipitation, post-LOCA long term core cooling or LOCA hydraulic forces. The hot leg switchover and post-LOCA long term core cooling calculations do not consider the specifics of switchover to cold leg recirculation, and assume that a successful switchover has occurred. For the LOCA hydraulic forces calculation, the peak forcing functions will be experienced within the first few seconds following the rupture, substantially before initiation of the switchover procedure.

Non-LOCA/SGTR

The non-LOCA and Steam Generator Tube Rupture accident analyses were reviewed and it has been determined that they are not impacted by this change because this is for post-LOCA only and that recirculation switchover will not occur.

Containment Integrity Analysis

The containment integrity analyses are described in Chapters 14 of the FSAR and considers Short Term and Long Term Mass and Energy Release Analyses for Postulated Loss-of-Coolant Accidents (LOCA's); Containment Response Analyses following a LOCA or Steamline Break Inside Containment and Subcompartment Pressure Transient Analyses.

For the Short Term Mass and Energy Release and Subcompartment Pressure Analyses a change in the recirculation switch sequence would have no effect on the calculated results, since the short duration of the transient ($\leq$ 3 seconds) does not consider safety injection flow.

For the Main Steamline Break Containment Response analysis, RHR pump flow is not considered due to the fact that the primary does not depressurize low enough to allow Low Head Safety Injection flow to initiate. Thus stopping the RHR pump delivery for a period following the accident would not affect this analysis for Containment Integrity.

The long term mass and energy release and containment pressure response calculation following a LOCA does take credit for the safety injection, including that from the RHR pump, supplied to the Reactor Coolant System. The limiting safeguards case for containment integrity is the minimum safeguards case. The proposed change in the recirculation switch sequence would result in essentially the limiting analyzed design base case for containment integrity, and therefore no change in the base assumptions. Thus, the conclusions presented in the current Indian Point Unit 2 FSAR will remain valid as related to the containment integrity analyses.

Mechanical and Fluid Systems

During ECCS injection, the safety injection pumps and the recirculation pumps are cooled by safety injection circulating water pumps (driven by the safety injection pump shafts) and auxiliary component cooling pumps, which circulate CCW through the pump coolers. During this time, the CCW pumps may not be operating (following a design basis accident, with off-site power), and thus, the CCWS slowly heats up, absorbing the pump heat.

When ECCS switchover is reached, and Switch 2 is operated, CCW cooling is established, and the CCWS provides cooling to these ECCS pumps.

Delaying the time when the CCW pumps are started, by delaying the initiation of Switch 2, will cause the CCW temperature to increase further before CCW cooling is established.

The design basis calculation performed to determine the CCWS heatup rate resulted in the CCWS temperature increasing from its initial temperature of 95°F, to 116°F in 4 hours. Based on this heatup rate, delaying CCW cooling another 5 minutes will cause the CCWS temperature to increase by an additional 0.44°F. This is considered to be insignificant, and will have no effect on the ability of the auxiliary component cooling pumps or the CCWS to provide cooling to the safety injection and recirculation pumps during ECCS injection.

Therefore, delaying the initiation of CCW cooling at the time of ECCS switchover (a 5 minute delay is assumed) by revising the recirculation switch sequencing will not increase the probability of a malfunction of equipment important to safety previously evaluated in the FSAR.

CONCLUSION

The LOCA, non-LOCA, Steam Generator Tube Rupture and Containment Integrity Accident analyses have been reviewed for the impact of this safety evaluation and it has been determined that changing the recirculation switch sequence will not affect any of the accident analysis results. Also, the Technical Specifications and radiological doses were reviewed and it has been determined that they are not impacted.

Based upon the above evaluation, it has been determined that the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report is not increased; the possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report will not be created; and the margin of safety is not reduced. Therefore, the implementation of this recommendation will not adversely impact safe plant operations at Indian Point 2 and will not result in an unreviewed safety question as defined in the criteria of 10CFR50.59.

WESTINGHOUSE

NUCLEAR SAFETY EVALUATION CHECKLIST

1) NUCLEAR PLANT(S): INDIAN POINT UNIT 2

2) CHECK LIST APPLICABLE TO: HIGH HEAD SAFETY INJECTION FLOW CHANGES
(Subject of Change) SAFETY EVALUATION

3) The written safety evaluation of the revised procedure, design change or modification required by 10 CFR 50.59 has been prepared to the extent required and is attached. If a safety evaluation is not required or is incomplete for any reason, explain on Page 2.

Parts A and B of this Safety Evaluation Check List are to be completed only on the basis of the safety evaluation performed.

CHECK LIST - PART A - 10 CFR 50.59 (a) (1)

(3.1) Yes X No___ A change to the plant as described in the FSAR?
(3.2) Yes___ No X A change to procedures as described in the FSAR?
(3.3) Yes___ No X A test or experiment not described in the FSAR?
(3.4) Yes___ No X A change to the plant technical specifications (See note on Page 2)

4) CHECK LIST - PART B - 10 CFR 50.59 (a) (2) (Justification for Part B answers must be included on page 2.)

(4.1) Yes___ No X Will the probability of an accident previously evaluated in the FSAR be increased?
(4.2) Yes___ No X Will the consequences of an accident previously evaluated in the FSAR be increased?
(4.3) Yes___ No X May the possibility of an accident which is different than any already evaluated in the FSAR be created?
(4.4) Yes___ No X Will the probability of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
(4.5) Yes___ No X Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
(4.6) Yes___ No X May the possibility of a malfunction of equipment important to safety different than any already evaluated in the FSAR be created?
(4.7) Yes___ No X Will the margin of safety as defined in the bases to any technical specification be reduced?

If the answers to any of the above questions are unknown, indicate under 5) REMARKS with an explaination.

If the answer to question 3.4 of Part A or any of the questions in Part B cannot be answered in the negative, based on written safety evaluation, the change review would require an application for license amendment as required by 10 CFR 50.59(c) and submitted to the NRC pursuant to 10 CFR 50.90.

5) REMARKS:

The answers given in Sections 3 and 4, Parts A and B of the Safety Evaluation Checklist are based on the attached safety evaluation.

(1) Reference to document(s) containing written safety evaluation:

SAFETY EVALUATION IS ATTACHED

FOR FSAR UPDATE

Section:_____ Pages:_____ Tables:_____ Figures:_____

Reason for / Description of Change:

Recommended FSAR changes are not included with this safety evaluation.

SAFETY EVALUATION APPROVAL LADDER:

Prepared by: R.R.Laubham Date: 6/26/91
R.R.Laubham
Operating Plant Licensing II

Reviewed by: J.J. DeBlasio Date: 6/26/91
J.J.DeBlasio
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Approved by: Date: 6/26/91
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SECL-91-231

INDIAN POINT UNIT 2

HIGH HEAD SAFETY INJECTION FLOW CHANGES SAFETY EVALUATION

June 1991

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INDIAN POINT UNIT 2

HIGH HEAD SAFETY INJECTION FLOW CHANGES SAFETY EVALUATION

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INDIAN POINT UNIT 2

HIGH HEAD SAFETY INJECTION FLOW CHANGES SAFETY EVALUATION

1.0 BACKGROUND

The purpose of this safety evaluation is to assess two optional changes to the Indian Point Unit 2 (IP2) nuclear power station High Head Safety Injection (HHSI) system flow balancing criteria, and the associated changes to the HHSI flows used in the various plant safety analyses, to ensure that the changes will not adversely affect the safety analyses and, therefore, safe plant operation.

During the current IP2 Cycle 10/11 refueling outage, Con Edison has installed variable orifices (throttle valves) in the discharge piping of the HHSI pumps to facilitate balancing the pumps during system testing. Per Con Edison's authorization, Westinghouse had previously developed revised flow balancing acceptance criteria for use in confirming HHSI line balancing and ensuring system performance. Two flow balancing criteria ranges were developed to enable Con Edison to select one criteria range that they would find most suitable to apply. These ranges, which were initially identified to Con Edison on May 17, 1990, are:

Case #	Allowable HHSI Pump Head Deviation	Total Header Flow (gpm)
1	+3% - -7%	570 - 585
2	+0% - -5%	565 - 590

Section 3 provides more detail concerning the proper application of these criteria. Section 3 and section 4 also identify certain items that Con Edison must confirm to ensure the validity of the supporting HHSI system performance analyses and this safety evaluation.

As of this time, the HHSI lines have been balanced, and the full-flow test has been performed verifying HHSI system performance. This report documents a safety evaluation of the effect of the subject flow balancing criteria revisions on HHSI system performance and, hence, on the flow data used in the various IP2 safety analyses.

Several years ago, as part of the IP2 Stretch Power Rating Program (reference 9), revised minimum and maximum safeguards injection flows for the HHSI system were calculated as a function of Reactor Coolant System (RCS) pressure. The results of those calculations employed the

original system performance assumptions and were used as the basis for revised safety analyses performed in support of the Cycle 10 fuel reload and the stretch power (3083.4 MWt NSSS power) licensing amendment. Since those revised safety analyses, several generic potential safety issues have been identified which can impact the flow performance capability of the HHSI system. These issues are:

(1) Excessive suction boost during recirculation

(2) Imbalance in the cold leg injection lines

(3) Flow measurement bias/uncertainty in HHSI branch line flow orifices

These issues were all previously identified within Westinghouse and communicated to all utilities including Con Edison. The revised HHSI system flow balancing criteria was developed in consideration of the above three issues.

The evaluations and conclusions addressed by this safety evaluation represent the result of individual reviews performed by Westinghouse in areas which include Loss-of-Coolant Accident (LOCA) Analyses, Non-LOCA Transient Analyses, Containment Integrity Analyses, Instrumentation and Control, Technical Specifications, Mechanical and Fluid Systems, Steam Generator Tube Rupture Accident Analysis, Radiological Assessment, and Emergency Operating Procedures. Since only the LOCA, Non-LOCA, Containment Integrity, Mechanical and Fluid Systems, SGTR, and Radiological Assessment areas were determined to be potentially impacted by the affect of the revised HHSI flow balancing criteria, the scope of this safety evaluation was limited to these areas. Con Edison will evaluate the affect of the subject change to HHSI flows on the Emergency Diesel Generator (EDG) loading analysis to ensure that the EDG loads remain acceptable.

The principal conclusion of this safety evaluation is that the changes to the IP2 HHSI flows employed in related plant safety analyses that are associated with the subject revisions to the HHSI flow balancing criteria will not involve a change to plant technical specifications, will not represent an unreviewed safety question and, therefore, will not adversely affect safe plant operation.

2.0 LICENSING BASIS

This evaluation was performed according to the regulations set forth in Title 10 of the Code of Federal Regulations, Part 50, (10 CFR 50.59). This regulation allows the holder of a license authorizing operation of a nuclear power facility the capacity to evaluate changes to the plant and/or procedures, and tests or experiments not described in the Final Safety Analysis Report (FSAR) (reference 1). Furthermore, prior Nuclear Regulatory Commission (NRC) approval is not required to implement the change provided that it does not involve an unreviewed safety question or result in a change in the plant technical specifications. It is, however, the obligation of the licensee to maintain a record of the change or modification to the facility to the extent that such a change impacts the FSAR. 10 CFR 50.59 further stipulates that these records shall include a written safety evaluation which provides the basis for the determination that the subject condition (a change in the HHSI safety analyses flows) does not involve an unreviewed safety question. This document supports the requirement for a written safety evaluation.

The determination by this safety evaluation that the subject change in the IP2 HHSI safety analyses flows does not involve an unreviewed safety question was made based on individual evaluations performed against pertinent licensing-basis acceptance criteria for IP2. These acceptance criteria are:

(a) The LOCA Analyses safety evaluation (section 4.1) demonstrates compliance with the Peak Clad Temperature (PCT) limit of 2200°F as specified in 10 CFR 50.46 b(1), and was performed consistent with the requirements of 10 CFR 50, Appendix K. The analyses also demonstrate compliance with other 10 CFR 50.46 criteria paraphrased as follows:

- The total cladding oxidation must be less than 17% of the total cladding thickness prior to oxidation.
- The total hydrogen generated must be less than 1% of the hypothetical amount that would be generated if all the cladding were to react with water or steam.
- The core must remain amenable to cooling.
- The core temperature must be maintained acceptably low, and decay heat must be removed for the period of time required by the long-lived radioactivity remaining in the core.

(b) The Non-LOCA Analysis safety evaluation (section 4.2) demonstrates that the minimum DNBR will not violate the current limit value.

(c) The SGTR Analyses and Radiological Dose Consequences safety evaluation (section 4.3) demonstrates that the SGTR offsite dose increases are small (less that 0.5 rem), and that the total dose is very low, being below the NRC definition of a "small fraction" of the 10 CFR 100 exposure guideline. This "small fraction" is defined as 10% of the guideline value (30 rem thyroid and 2.5 rem whole body), and is the smallest of the exposure limits defined by the NRC in Standard Review Plan, NUREG-0800, Section 15.6.3, "Radiological Consequences of Steam Generator Tube Failure". This acceptance criteria is consistent with that applied by the NRC in their Safety Evaluation Report (SER) of the Stretch Core Power Uprating to 3071.4 MWt (reference 2). The SGTR analysis performed in support of the Stretch Power Uprating is still the current SGTR analysis of record for IP2.

(d) The Containment Integrity Accident Analyses safety evaluation (section 4.4) demonstrates that the peak calculated containment pressure is expected to be less than the containment design value of 47 psig which was stated in reference 3, and which was used as an acceptance criteria by the NRC in their Stretch Core Power Uprating SER (reference 2). Reference 3 documents the current licensing basis containment analysis.

(e) The Mechanical and Fluid Systems safety evaluation demonstrates that the subject revisions to the HHSI balancing criteria will not adversely affect HHSI system and pump operability based on an IP2 HHSI pump runout limit of 650 gpm when suction is taken from the Refueling Water Storage Tank (RWST), and an extended runout limit of 675 gpm during high head recirculation.

3.0 HHSI SYSTEM ANALYSIS AND REVISED BALANCING CRITERIA

The following sections present general background information needed to establish the bases of the HHSI system performance analysis supporting this safety evaluation. The information includes an overview of Safety Injection System (SIS) post-accident operation, the performance analysis objectives, the modelling and methodology, key assumptions, and a summary of the revised calculated Emergency Core Cooling System (ECCS) flows.

3.1 System Post-Accident Operation

The active portion of the IP2 SIS is comprised of low head and high head subsystems. The HHSI system is comprised of three HHSI pumps (#'s 21, 22, & 23) which provide flow though a common pump header to two HHSI discharge headers. All three HHSI pumps receive a start signal on a Safety Injection (SI) signal and are initially aligned to take suction from the RWST. Each header can deliver flow to the RCS via two cold leg (normally opened) and one hot leg (normally closed) branch lines. Overall flow in each of the headers is limited by pump discharge orifices, and branch lines flows can be "balanced" by the use of HHSI branch line throttle valves (856A through F).

The system was designed such that, with a single active failure, two of the three HHSI pumps would be available to deliver ECCS flow. Each pump would deliver flow to one of two discharge headers. The two HHSI discharge headers are physically isolated from each other via check valves 852A/B (located in the common pump discharge header) when the two outer HHSI pumps (#'s 21 & 23) are running. With the failure of either one of the two outer HHSI pump to start (#'s 21 or 23), and with HHSI pump #22 running, the two HHSI discharge headers are automatically isolated via a closure of either valve 851A or 851B, as appropriate.

The closure of either valve 851A or 851B maintains the system design feature of one pump per discharge header, and maximizes flow delivered to the RCS when a branch lines delivers flow to the containment as a result of an RCS pressure boundary break. The maximum closing stroke time for these isolation valves is 120 seconds following receipt of a closure signal.

The low head subsystem is comprised of two SI recirculation pumps and two Residual Heat Removal (RHR) pumps which normally deliver flow to the RCS cold legs via one or two RHR heat exchangers. Following SI actuation, both RHR pumps are automatically started and initially take suction from the RWST.

When the low level setpoint in the RWST is reached, the SIS is manually realigned to support cold leg recirculation following a LOCA. During this switchover from injection to recirculation, the RHR pumps are normally shut down. This is done to prevent sump fluid from being recirculated (and potentially leaked) outside containment (the RHR pumps are physically located outside of containment). To provide low head flow, one or two SI recirculation pumps (located inside containment) would be used to circulate sump flow back to the RCS.

For a Large-Break LOCA, sump flow would be directed to the RCS cold legs via the low head subsystem. For smaller breaks which result in RCS pressures above the shutoff head of the SI recirculation pump, sump flow would be directed to the RCS cold legs via the HHSI cold leg branch lines. In this high head recirculation alignment, a portion of the recirculated sump flow can also be directed to the containment spray headers for containment pressure reduction, as appropriate. The RHR pumps are also capable of taking suction from a separate sump inside containment and providing redundant backup to the SI recirculation pumps for long-term cooling.

At approximately 24 hours following a LOCA, the SIS is switched over to hot leg recirculation. In this realignment, the low head safety injection (LHSI) recirculation system would be realigned to deliver flow to two HHSI pumps (if the system was not already aligned for high head recirculation). The RHR heat exchanger discharge isolation valves (746 & 747) would normally be closed to isolate flow to the LHSI cold leg injection lines, and valves 888A/B would be opened to allow LHSI flow and Net Positive Suction Head (NPSH) to be directed to the common suction header of the HHSI pumps.

To deliver hot leg recirculation flow, one of the two HHSI cold leg branch line isolation valves would be closed and the corresponding hot leg branch line isolation valve would be opened on each HHSI discharge header. The hot leg valve is interlocked with the corresponding cold leg valves on each header (that is, one cold leg valve must be closed prior to opening the hot leg valve).

During recirculation, the SIS has capability to perform core cooling following a single active failure. Also, to accommodate a passive failure, the SIS design includes an alternative flow path from the discharge header of the RHR pumps to the suction piping of HHSI pump #22. The HHSI pump #22 suction piping is provided with two power operated isolation valves in series (887A/B) which can be used to isolate the common HHSI pump suction header (where the leak/break could be postulated) from the alternate suction flow path.

To facilitate detection of loss of flow in the normal supply line, a pressure instrument and low pressure alarm is provided in the HHSI pump suction header (alarm at about 75 psig). In this configuration, only HHSI pump #22 would be available for continued high head recirculation. To provide adequate pump runout protection, one of the two HHSI pump discharge headers would have to be isolated to provide pump runout protection (MOV 851A or 851B would have to be closed).

In this modified alignment, one RHR pump would feed one HHSI pump which, in turn, would deliver "hot" recirculated sump flow to the RCS via a hot leg and cold leg branch lines from a single HHSI discharge header. Note, the IP2 SIS design does not provide for hot leg flow to the RCS using the LHSI system alone.

3.2 System Performance Analysis Objectives

The objectives of the HHSI system performance analysis were:

(1) Develop revised balancing criteria for the IP2 HHSI system. The three potential safety issues identified in section 1 were factored into this effort.

(2) Analyze the revised HHSI system performance, and to calculate revised HHSI system flows to be used in the safety analyses and evaluations documented herein.

A key consideration used in the hydraulic analysis was a HHSI pump runout limit of 675 gpm. The previous maximum HHSI pump runout flow limit had been 650 gpm (see reference 4). The limiting system alignment for runout protection was identified as LOCA high head recirculation alignment with the HHSI pumps taking suction from either the SI recirculation or RHR pumps. With either LHSI pump delivering flow to only the HHSI pumps, total pump flow would be low and the discharge pressure of the LHSI pump could approach its shutoff head. Conservatively neglecting piping friction losses from the discharge of the LHSI pump to the suction of the HHSI pumps, the HHSI pump suction pressure was estimated to be 215 psig. This compares to a normal HHSI pump suction pressure of about 10-25 psig when aligned to the RWST.

The discharge pressure of the HHSI pump is dependent on overall system resistance and available pump suction pressure. At a given pump flow, higher the pump suction boost results in higher the pump discharge pressure. For the fixed resistance (i.e., "throttled") HHSI system, the net effect of higher pump suction pressure is higher pump flow.

To address higher suction boost to the HHSI pumps during high head recirculation, the existing HHSI flow balancing range for IP2 had to be shifted downward to lower flows.

3.3 Modelling and Methodology

Provided below is an overview of the approach used to develop both sets of balancing criteria and to calculate the associated HHSI system flows:

(1) The HHSI system hydraulic model used for the Stretch Core Power uprating program was updated to reflect the replacement of the fixed pump discharge orifices with variable orifices. Resistance was also added to the piping network to better estimate header pressures, and revised pump head criteria were developed.

(2) Using the revised hydraulic model, a maximum allowable header balancing flow in the RWST suction alignment (test condition), which would yield a total pump flow of 675 gpm during the high head recirculation alignment with maximum suction boost, was calculated. The allowable ranges for HHSI pump head, RWST elevation, and HHSI pump miniflow capacity were used to set this maximum allowable analysis flow. This flow was then appropriately reduced to account for branch line flow measurement uncertainty.

(3) A minimum allowable header balancing flow was then determined based on a balancing window size defined by Con Edison.

(4) Using the step 2 & 3 criteria, allowable branch line imbalance, and branch line flow measurement uncertainty, the hydraulic model was conservatively "flow balanced" to established branch line resistances at the zero (0) psig RCS pressure test condition.

(5) Using the branch line resistances from step 4, the hydraulic model was used to calculate minimum and maximum delivered RCS flow as a function of RCS pressure. The flows were calculated over the operating range of the pump with and without one line spilling to containment pressure. The calculated flows conservatively reflect the allowable ranges in HHSI pump and miniflow capacity and RWST elevation (suction boost).

3.4 Key Inputs/Assumptions

A summary of key inputs and assumptions used to set the revised HHSI flow balance criteria and/or to perform the analysis include:

(1) HHSI Branch Line Flow Measurement Uncertainty.

A ± 7 gpm measurement uncertainty was defined by Con Edison for the cold and hot leg flow measurements. This uncertainty was based on calibration results for replacement branch line flow measurement orifices which were procured, tested, and installed in the system prior to the flow balance test.

(2) HHSI Branch Line Flow Measurement Indicated Imbalance.

A 10 gpm maximum indicated flow imbalance criterion was defined by Con Edison when two cold leg injection line throttle valves are set on each header. This imbalance, combined with flow measurement uncertainty, was used to define the maximum variation in branch line flows. In general, larger differences in branch line flows would tend to lower the injection line flow with one branch line spilling to containment pressure. The spilling fraction increases significantly as the relative pressure difference between the injection and spilling line pressures increases.

(3) HHSI Pump Suction Head Due to RWST Water Elevation (the tank is physically located above the RCS cold legs).

The plant elevation of the RWST water level was assumed to be anywhere between 80 and 120 ft. The plant elevation of the centerline of the RCS cold legs is 62 ft.

(4) HHSI Pump Miniflow Capacity.

The analysis considered flows between 25 to 35 gpm when one pump is operated near shutoff conditions on miniflow only. This range does not include measurement error. The actual pump miniflow corrected for uncertainty must be within this range to validate this analysis.

(5) HHSI Pump Discharge Orifice.

The plant was previously provided with a fixed orifice located at the discharge of each HHSI pump. The function of each orifice was to provide pump runout protection. The plant has replaced these orifices with variable orifices to facilitate balancing the HHSI pump developed head. This balancing flexibility was added since both headers also have to be balanced with the middle HHSI pump (#22). The variable resistance was assumed to be set initially for each pump with the cold leg branch line throttle valves in their full open position. Subsequent readjustment of the pump variable orifice to increase header total flow (i.e. reduce orifice resistance) is acceptable during the cold leg throttle valve adjustment phase of the flow balance.

(6) HHSI Pump Developed Head.

Two sets of minimum and maximum HHSI pump head curves were considered. The first set considers +3% to -7% of the vendor head consistent with ASME Section XI criteria. The second set considers +0% to -5% of the vendor head consistent with the analysis of record. The enhancement/degradation was taken at each point on the pump curve rather than using the pump design head as a reference point.

The original vendor certified head/flow curve for each HHSI pump was used to define pump head at 50 gpm intervals over the entire operating range of the pump. A composite curve (enveloping the highest and lowest values of all three original vendor head/flow curves) was then defined. The analysis pump head curves were then developed by applying the allowable percent variations from the appropriate composite curve. Table 3-1 presents a summary of the HHSI pump head/flow data used for this project.

From table 3-1, note that the maximum composite pump head curve was used as the upper bound for the +0% to -5% head criterion. For the system flow balance and performance analysis, the HHSI pumps are allowed to operate anywhere within either head criterion. The actual pump performance, considering measurement uncertainty, must be within the applicable pump head criteria presented in table 3-1. At a minimum, the pump developed head at miniflow and at full flow must be checked (when tested).

3.5 Results

3.5.1 Revised Balancing Criteria

The two optional revised HHSI flow balancing criteria developed for the IP2 HHSI system are provided in this section. Con Edison will select the particular criteria that they will adhere to in their full-flow testing.

GENERAL CRITERIA

- The uncertainty associated with the HHSI hot and cold leg branch line flow measurement shall be ≤ +/- 7 gpm.

- The HHSI pump miniflow shall be within 30 gpm ± 5 gpm with one pump operating near shutoff conditions on miniflow alone. The specified miniflow range does not account for measurement uncertainty. The indicated flow must be corrected for measurement uncertainty before comparison to the specified range.

- Only one HHSI pump feeding one HHSI discharge header shall be used to flow balance each header. Valve 851A or 851B shall be manually closed, as appropriate, to isolate the two HHSI discharge headers. The acceptance criteria for each header shall be met when both the appropriate HHSI pump (#21 or #23) and HHSI pump #22 feed the same header separately.

- The HHSI pump variable orifice shall be set first with the cold leg branch line throttle valves fully opened and the hot leg isolation valve fully closed. Next, the cold leg branch line throttle valves shall be set. Finally, the hot leg branch line throttle valve shall be set. During the hot leg branch line flow balance, the cold leg branch line throttle valve on the same header shall <u>not</u> be repositioned. The positions of the cold and hot leg valves shall be recorded for future reference and controlled to prevent valve movement from the established throttled position for each valve.

- The HHSI pump total developed head shall be maintained within either one or the other allowable head range (not a combination of both).

HHSI FLOW BALANCING CRITERIA

(1) COLD LEG INJECTION LINES

- The cold leg injection lines on each header shall be throttled to within a 10 gpm indicated flow imbalance.

- The cold leg injection lines on each header shall be throttled such that the sum of the indicated flows in the two cold legs are within either of the following two balancing ranges:

  - 570 gpm to 585 gpm considering a +3% to -7% allowable HHSI pump head range

  OR

  - 565 gpm to 590 gpm considering a +0% to -5% allowable HHSI pump head range

(2) HOT LEG INJECTION LINES

- The hot leg injection line flow shall be throttled to achieve a minimum 250 gpm indicated flow with only one cold leg injection line opened. This criteria shall be met with both cold legs isolated separately on each header.

- The sum of the hot and cold leg flow on each header shall be less than or equal to the following:

  - 585 gpm considering a +3% / -7% allowable HHSI pump head range

  OR

  - 590 gpm considering a +0% / -5% allowable HHSI pump head range

3.5.2 Revised System Performance

Using the criteria presented in section 3.5.1, HHSI flows based on the RWST suction alignment were calculated for the following conditions:

CASE A Non-LOCA Event (Minimum Safeguards) considering two degraded HHSI pumps in operation and all lines injecting. This case is also applicable to the LOCA Containment Integrity event.

CASE B Large Break/Small Break LOCA Event (Minimum Safeguards) with two degraded HHSI pumps in operation, one line spilling to zero pressure (0 psig), and with HHSI header isolation (valve 851A or 851B closed, as appropriate).

CASE C Large Break/Small Break LOCA Event (Minimum Safeguards) with two degraded HHSI pumps in operation, one line spilling to zero pressure (0 psig), and without HHSI header isolation (HHSI pump #22 operating with valves 851A/B open).

CASE D Large Break LOCA Event (Minimum Safeguards) with three degraded HHSI pumps in operation, one line spilling to zero pressure (0 psig), and without HHSI header isolation (valves 851A/B open).

CASE E Large Break LOCA/SGTR Events (Maximum Safeguards) with three enhanced HHSI pumps in operation and all lines injecting.

CASE F Non-LOCA Event (Minimum Safeguards) with three degraded HHSI pumps in operation and all lines injecting. This case is also applicable to the LOCA Containment Integrity event.

For the LOCA Minimum Safeguards events, separate cases were analyzed regarding the status of valves 851A/B. This was done to address loss of injection flow with HHSI pump #22 operating and the header isolation valve (851A or 851B) opened. The maximum time in which the HHSI headers would be interconnected was conservatively set at 130 seconds. This time considers the delay in the generation of the valve closure signal, and the valve stroke time needed to fully close.

The above six cases were calculated for both sets of HHSI pump head criteria (See table 3-1). Comparison of the two sets of HHSI flows showed that the larger HHSI pump head range (+3% to -7%) provided the most conservative injection flows. As such, the safety evaluation was based on this limiting set of flows to conservatively bound the affects of both pump head ranges.

Table 3-2 (parts A through F) provides the sets of revised calculated HHSI flows as a function of RCS pressure for each of the identified cases. Included with this table are summaries of key system assumptions/inputs for both the current (existing) and revised hydraulic flow analyses.

In addition to the cold leg injection flows, the minimum delivered flow during the hot leg recirculation alignment was also calculated. These flows were needed to verify that delivered flows under three separate break scenarios would be adequate to remove decay heat and to control boric acid solubility in the core. The three subject conditions are listed below:

(1) Large Cold Leg Break - Define minimum hot leg injection flow at zero RCS pressure with a cold leg injection line spilling. A single failure should be postulated, as appropriate, to minimize delivered hot leg flow.

(2) Large Hot Leg Break - Define minimum delivered injection flow at zero RCS pressure with a hot leg injection line spilling. A single failure should be postulated, as appropriate, to minimize delivered flow (hot and cold leg flow).

(3) Small Hot Leg Break - Define minimum delivered injection flow at the S/G secondary side safety valve setpoint with a hot leg injection line spilling. The spill assumption should be to RCS or containment pressure depending on the location of the hot leg injection line connection to the RCS pressure boundary. A single failure should be postulated, as appropriate, to minimize delivered flow (hot and cold leg flow).

To allow evaluation of system performance in this alignment, the HHSI balancing criteria included flow requirements for the hot leg branch lines. Section 3.5.1 identifies the hot leg balancing criteria used for this analysis. Note that a minimum indicated hot leg flow of 250 gpm was specified. This value was based on the minimum measured hot leg flow that Con Edison has already used to set up one of the HHSI discharge headers.

The minimum delivered flows for each of the three subject cases under limiting active and passive failure assumptions were defined. In general, the existing cold leg calculated flows were used as a basis. Provided below is an overview of the assumed system conditions and the minimum calculated flows for each case:

(1) Large Cold Leg Break - With this event, minimum flow delivered to the RCS via hot leg lines is of interest at zero (0) psig RCS/containment pressure. With the IP2 design, a single active failure in the power supply to a hot leg branch line power operated isolation valve would prevent the valve from opening.

With this failure, hot leg flow could only be delivered from one HHSI discharge header. If the break was a failure in a hot leg injection line, or was a passive failure during recirculation in the LHSI supply line to the HHSI pumps, then hot leg flow would be delivered from one HHSI pump to a single hot leg line.

Considering measurement error and the allowable range of HHSI pump head, a minimum delivered hot leg flow of 234 gpm was calculated with one HHSI pump feeding one HHSI discharge header. This flow was calculated using a conservatively low suction boost (equivalent to the elevation head difference between the RWST bottom and the RCS cold leg centerline).

(2) Large Hot Leg Break - With this event, minimum flow delivered to the RCS via all non-spilling lines is of interest at zero RCS/containment pressure. For this criterion, the spilling of a hot leg branch line would assume to occur. To minimize total delivered flow, the highest credible hot leg flow has to be assumed. Although a maximum hot leg flow is not included in the balancing criteria, the sum of the hot and cold leg flows was limited to the cold leg injection line header balancing criteria. This criterion would allow hot leg flow to be as high as cold leg branch line flow.

With this configuration, the cold leg injection phase flows provided in table 3-2 were used to estimate the minimum delivered flow with one line spilling (hot leg line). As shown in table 3-2 (Case C), a minimum flow of 768 gpm is delivered. This minimum flow assumes a single active failure of a HHSI pump. Credit is not taken for the isolation of the two HHSI discharge headers via valve 851A or 851B.

Using the individual calculated header flows from this case, the delivered RCS flow with one HHSI pump feeding one header was used to evaluate the passive failure condition. With one injection line and one spilling line, delivered flow to the RCS is greater than 234 gpm. As such, the Criterion 1 minimum delivered flow is limiting with respect to this criterion.

(3) Small Hot Leg Break - With this event, minimum flow delivered to the RCS via all non-spilling lines is of interest. RCS pressure is assumed to be stuck at the steam generator safety valve setpoint (the plant has taken no actions to depressurize since the event). For this criterion, the spilling of a hot leg branch line would be assumed to occur.

Unlike Criterion 2, however, a significant pressure differential would exist between RCS and containment pressure. At IP2, the two hot leg injection lines tie directly into the RCS pressure boundary. As such, the hot leg branch line would spill to containment pressure. Using the approach used for Criterion 2, the table 3-2 presented cold leg injection phase flows were used to estimate the minimum delivered flow with one injection line (hot leg) spilling. From table 3-2 (Case C), a minimum flow of only 14 gpm can be delivered at 1100 psig RCS pressure with one line spilling. This minimum flow assumes a single active failure of a HHSI pump and does not take credit for the functional operability of valve 851A or 851B to physically isolate the two HHSI discharge headers. Assuming the HHSI discharge headers are physically isolated, the minimum injection phase flow was calculated to be 206 gpm (See table 3-2, Case B).

In the high head alignment, the HHSI pump miniflow recirculation line back to the RWST is isolated to prevent sump fluid from being directed to the atmospheric tank. Taking credit for miniflow isolation, the minimum delivered flow at the above conditions was calculated to be 226 gpm. Only minimal suction boost was consider (equivalent to the elevation difference between the RWST and RCS cold legs). Compared to Criterion 1, this criterion results in limiting system delivered flow.

Under the worst case single passive failure, high head recirculation could be performed by a single HHSI pump. Using the system flow data that was used as a basis for table 3-2, the delivered RCS flow from one header via the intact injection line is small at the subject operating conditions since the majority of flow is directed to the spilling branch line. Operation of both headers would be unacceptable since HHSI pump flow would exceed the pump runout limit as RCS pressure is reduced. In this scenario, RCS pressure would have to drop to approximately 200 psig before adequate cooling flow could be delivered to the RCS from the intact branch line on a single HHSI header.

TABLE 3-1
REVISED IP2 HHSI PUMP HEAD CRITERIA

FLOW (GPM)	HHSI PUMP VENDOR HEAD (FT)			COMPOSITE PUMP HEAD (FT)		ANALYSIS HEAD RANGE (FT)		
	#43461	#43462	#43463	MAXIMUM	MINIMUM	(-7 %)	(-5 %)	(+3 %)
0	3500	3625	3500	3625	3500	3255	3325	3734
50	3375	3500	3400	3500	3375	3139	3206	3605
100	3325	3400	3375	3400	3325	3092	3159	3502
150	3250	3350	3300	3350	3250	3023	3088	3451
200	3200	3300	3200	3300	3200	2976	3040	3399
250	3150	3200	3100	3200	3100	2883	2945	3296
300	3050	3100	3000	3100	3000	2790	2850	3193
350	2900	2950	2875	2950	2875	2674	2731	3039
400	2700	2800	2700	2800	2700	2511	2565	2884
450	2500	2600	2500	2600	2500	2325	2375	2678
500	2300	2350	2250	2350	2250	2093	2138	2421
550	2075	2125	2050	2125	2050	1907	1948	2189
600	1825	1825	1775	1825	1775	1651	1686	1880
650	1600	1600	1500	1600	1500	1395	1425	1648

TABLE 3-2 A

REVISED IP2 HHSI INJECTION PHASE DELIVERED FLOWS

CASE A - HHSI NON-LOCA MINIMUM FLOW DATA

EXISTING ASSUMPTIONS MAINTAINED:

1. Miniflow path opened and sized to pass 25 gpm at shutoff head
2. All lines injecting to RCS
3. Two HHSI pumps running
4. Volumetric to mass flow conversion using 62.4 #/ft3

EXISTING ASSUMPTIONS INVALIDATED:

1. Each header balanced to approx. 630 gpm/pump at vendor head curve
2. Zero branch line flow measurement error
3. Allowable pump degradation of 5% of design head over vendor curve
4. Calculated mass flows arbitrarily reduced by 3%

REVISED HHSI SYSTEM BALANCING INPUTS/ASSUMPTIONS:

1. Each Header is balanced to lower range (570 gpm/pump - indicated)
2. +/- 7 gpm per branch line flow measurement error considered
3. Allowable pump TDH range: +3% to -7% of vendor curve
4. Calculated flows reduced by 20 gpm to address 35 gpm miniflow/pump

REVISED FLOW BASIS

PRESSURE DATA (psig) RCS	SPILL	TOTAL VOL. VOL (gpm)	TOTAL MASS FLOW (lbm/sec)
0.0	N/A	1045	145.3
100.0	N/A	1002	139.3
200.0	N/A	958	133.1
300.0	N/A	914	127.0
400.0	N/A	871	121.0
500.0	N/A	825	114.6
600.0	N/A	774	107.6
700.0	N/A	721	100.2
800.0	N/A	663	92.2
900.0	N/A	598	83.1
1000.0	N/A	522	72.5
1100.0	N/A	433	60.1
1200.0	N/A	331	45.9
1300.0	N/A	172	23.9
1400.0	N/A	0	0.0

TABLE 3-2 B

REVISED IP2 HHSI INJECTION PHASE DELIVERED FLOWS

CASE B - HHSI LARGE BREAK/SMALL BREAK LOCA MINIMUM FLOW DATA
(HEADERS SEPARATED)

EXISTING ASSUMPTIONS MAINTAINED:

1. Miniflow path opened and sized to pass 25 gpm at shutoff head
2. Three lines injecting to RCS - fourth line spills to 0 psig
3. Two HHSI pumps running
4. Volumetric to mass flow conversion using 62.4 #/ft3

EXISTING ASSUMPTIONS INVALIDATED:

1. Each header balanced to approx. 630 gpm/pump at vendor head curve
2. Zero branch line imbalance
3. Zero branch line flow measurement error
4. Allowable pump degradation of 5% of design head over vendor curve
5. Valves 851A/B assumed inoperable (stays open)
6. Calculated mass flows arbitrarily reduced by 3%

REVISED HHSI SYSTEM BALANCING INPUTS/ASSUMPTIONS:

1A. Nonspilling header balanced to lower range (570 gpm/pump - ind.)
1B. Spilling header balanced within range (585 - 570 gpm/pump - ind.)
2. 10 gpm branch line imbalance on spilling header (indicated)
3. +/- 7 gpm per branch line flow measurement error considered
4. Allowable pump TDH range: +3% to -7% of vendor curve
5. Valves 851A/B assumed operable (one valve to close to isolate header)
6. Calculated flows reduced by 20 gpm to address 35 gpm miniflow/pump

REVISED FLOW BASIS

PRESSURE DATA (psig) RCS	SPILL	TOTAL VOL. VOL (gpm)	TOTAL MASS FLOW (lbm/sec)
0.0	N/A	775	107.7
100.0	N/A	733	101.9
200.0	N/A	690	95.8
300.0	N/A	644	89.6
400.0	N/A	595	82.7
500.0	N/A	538	74.8
600.0	N/A	467	64.9
700.0	N/A	385	53.6
800.0	N/A	336	46.8
900.0	N/A	289	40.1
1000.0	N/A	251	34.8
1100.0	N/A	206	28.6
1200.0	N/A	155	21.5
1300.0	N/A	75	10.5
1400.0	N/A	0	0.0

TABLE 3-2 C

REVISED IP2 HHSI INJECTION PHASE DELIVERED FLOWS

CASE C - HHSI LARGE BREAK/SMALL BREAK LOCA MINIMUM FLOW DATA (HEADERS NOT SEPARATED)

EXISTING ASSUMPTIONS MAINTAINED:

1. Miniflow path opened and sized to pass 25 gpm at shutoff head
2. Three lines injecting to RCS - fourth line spills to 0 psig
3. Two HHSI pumps running
4. Valves 851A/B assumed inoperable (stay open)
5. Volumetric to mass flow conversion using 62.4 #/ft3

EXISTING ASSUMPTIONS INVALIDATED:

1. Each header balanced to approx. 630 gpm/pump at vendor head curve
2. Zero branch line imbalance
3. Zero branch line flow measurement error
4. Allowable pump degradation of 5% of design head over vendor curve
5. Calculated mass flows arbitrarily reduced by 3%

REVISED HHSI SYSTEM BALANCING INPUTS/ASSUMPTIONS:

1A. Nonspilling header balanced to lower range (570 gpm/pump - ind.)
1B. Spilling header balanced within range (585 - 570 gpm/pump - ind.)
2. 10 gpm branch line imbalance on spilling header (indicated)
3. +/- 7 gpm per branch line flow measurement error considered
4. Allowable pump TDH range: +3% to -7% of vendor curve
5. Calculated flows reduced by 20 gpm to address 35 gpm miniflow/pump

REVISED FLOW BASIS

PRESSURE DATA (psig) RCS	SPILL	TOTAL VOL. VOL (gpm)	TOTAL MASS FLOW (lbm/sec)
0.0	N/A	768	106.8
100.0	N/A	724	100.6
200.0	N/A	675	93.8
300.0	N/A	623	86.6
400.0	N/A	570	79.2
500.0	N/A	510	70.8
600.0	N/A	446	62.0
700.0	N/A	379	52.7
800.0	N/A	304	42.3
900.0	N/A	222	30.9
1000.0	N/A	126	17.5
1100.0	N/A	14	2.0
1200.0	N/A	0	0.0

TABLE 3-2 D

REVISED IP2 HHSI INJECTION PHASE DELIVERED FLOWS

CASE D - HHSI LARGE BREAK LOCA MINIMUM FLOW DATA (3 PUMPS)

EXISTING ASSUMPTIONS MAINTAINED:

1. Miniflow path opened and sized to pass 25 gpm at shutoff head
2. Three lines injecting to RCS - fourth line spills to 0 psig
3. Volumetric to mass flow conversion using 62.4 #/ft3

EXISTING ASSUMPTIONS INVALIDATED:

1. Each header balanced to approx. 630 gpm/pump at vendor head curve
2. Zero branch line imbalance
3. Zero branch line flow measurement error
4. Allowable pump degradation of 5% of design head over vendor curve
5. Valves 851A/B assumed inoperable (stays open)
6. Two HHSI pumps running
7. Calculated mass flows arbitrarily reduced by 3%

REVISED HHSI SYSTEM BALANCING INPUTS/ASSUMPTIONS:

1A. Nonspilling header balanced to lower range (570 gpm/pump - ind.)
1B. Spilling header balanced within range (585 - 570 gpm/pump - ind.)
2. 10 gpm branch line imbalance on spilling header (indicated)
3. +/- 7 gpm per branch line flow measurement error considered
4. Allowable pump TDH range: +3% to -7% of vendor curve
5. Valves 851A/B assumed operable (stays open)
6. Three HHSI pumps running (single failure is RHR pump)
7. Calculated flows reduced by 30 gpm to address 35 gpm miniflow/pump

REVISED FLOW BASIS

PRESSURE DATA (psig) RCS	SPILL	TOTAL VOL. VOL (gpm)	TOTAL MASS FLOW (lbm/sec)
0.0	N/A	945	131.4
100.0	N/A	901	125.3
200.0	N/A	855	118.9
300.0	N/A	807	112.1
400.0	N/A	756	105.1
500.0	N/A	703	97.7
600.0	N/A	644	89.5
700.0	N/A	581	80.7
800.0	N/A	513	71.3
900.0	N/A	437	60.7
1000.0	N/A	346	48.1
1100.0	N/A	211	29.3
1200.0	N/A	145	20.1
1300.0	N/A	65	9.0
1400.0	N/A	0	0.0

TABLE 3-2 E

REVISED IP2 HHSI INJECTION PHASE DELIVERED FLOWS

CASE E - HHSI LARGE BREAK LOCA/SGTR MAXIMUM FLOW DATA

EXISTING ASSUMPTIONS MAINTAINED:

1. Miniflow path opened and sized to pass 25 gpm at shutoff head
2. All lines injecting to RCS
3. Three HHSI pumps running
4. Volumetric to mass flow conversion using 62.4 #/ft3
5. Valves 851A/B assumed operable (stays open)

EXISTING ASSUMPTIONS INVALIDATED:

1. Each header balanced to approx. 630 gpm/pump at vendor head curve
2. Zero branch line flow measurement error
3. Vendor pump curve enhanced by 10% of design head

REVISED HHSI SYSTEM BALANCING INPUTS/ASSUMPTIONS:

1. Each header is balanced to upper range (585 gpm/pump - indicated)
2. +/- 7 gpm per branch line flow measurement error considered
3. Allowable pump TDH range: +3% to -7% of vendor curve

REVISED FLOW BASIS

PRESSURE DATA (psig) RCS	SPILL	TOTAL VOL. VOL (gpm)	TOTAL MASS FLOW (lbm/sec)
0.0	N/A	1659	230.7
100.0	N/A	1608	223.5
200.0	N/A	1551	215.6
400.0	N/A	1429	198.6
600.0	N/A	1305	181.4
800.0	N/A	1164	161.8
1000.0	N/A	995	138.2
1200.0	N/A	796	110.6
1400.0	N/A	519	72.2
1600.0	N/A	9	1.2
1800.0	N/A	0	0.0

Table 3-2 F

REVISED IP2 HHSI INJECTION PHASE DELIVERED FLOWS

CASE F - HHSI MINIMUM FLOW DATA WITH ALL PUMPS RUNNING

HHSI SYSTEM BALANCING INPUTS/ASSUMPTIONS:

1. Miniflow path opened and sized to pass 25 gpm at shutoff head
2. All lines injecting to RCS
3. Three HHSI pumps running
4. Volumetric to mass flow conversion using 62.4 #/ft3
5. Each header is balanced to lower range (570 gpm/pump - indicated)
6. +/- 7 gpm per branch line flow measurement error considered
7. Allowable pump TDH range: +3% to -7% of vendor curve
8. Valves 851A/B assumed operable (stays open)
9. Calculated flows reduced by 30 gpm to address 35 gpm miniflow/pump

AVAILABLE FLOWS

PRESSURE DATA (psig) RCS	SPILL	TOTAL VOL. VOL (gpm)	TOTAL MASS FLOW (lbm/sec)
0.0	N/A	1279	177.7
100.0	N/A	1231	171.0
200.0	N/A	1179	163.9
300.0	N/A	1127	156.6
400.0	N/A	1071	148.9
500.0	N/A	1013	140.7
600.0	N/A	951	132.2
700.0	N/A	881	122.5
800.0	N/A	807	112.2
900.0	N/A	723	100.5
1000.0	N/A	631	87.7
1100.0	N/A	528	73.4
1200.0	N/A	392	54.4
1300.0	N/A	216	30.0
1400.0	N/A	0	0.0

4.0 SAFETY EVALUATION

This section presents the individual safety evaluations made in the LOCA, Non-LOCA, SGTR and Radiological Consequences, Containment Integrity, and Mechanical and Fluid Systems areas. Each of these individual evaluations were made against pertinent licensing-basis acceptance criteria for IP2 as identified in section 2.

4.1 LOCA Evaluation

4.1.1 Large Break LOCA

The IP2 FSAR Large Break LOCA (LBLOCA) analysis of record was performed with the 1981 LBLOCA Evaluation Model with BASH. The analysis resulted in a PCT of 2039°F for a double-ended cold leg guillotine break with a discharge coefficient of 0.4 and has since been supplemented by a number of safety evaluations. The penalties associated with these evaluations and those associated with several potential issues have increased the LBLOCA PCT to 2168.5°F. This information is summarized in Table 4-7.

For the LBLOCA, the limiting single failure assumption results in the failure of a RHR system pump which provides the low head safety injection. This is a standard assumption for LBLOCA analyses and is based on several factors, the most important of which is the role of containment pressure in the LBLOCA transient. For LBLOCA analyses, low containment pressure results in a more severe transient than high containment pressure. Based on this fact, the NRC requires that containment pressure reducing systems and processes be modeled (10 CFR 50 Appendix K, item I.D.2).

Sensitivity studies were previously performed by Westinghouse to determine the limiting single failure for LBLOCA. These studies demonstrated that the loss of containment pressure reducing equipment associated with the loss of an Emergency Diesel Generator (EDG) is less conservative than maintaining the equipment and losing an RHR pump. Thus, the limiting single failure used in the IP2 LBLOCA analysis was loss of an RHR pump. A detailed explanation of the limiting single failure used in the Westinghouse LBLOCA analyses was transmitted to Con Edison in letter IPP-89-712 (reference 5).

Though the limiting single failure applicable to the IP2 LBLOCA analysis was loss of an RHR pump, the analysis more conservatively assumed the loss of an HHSI pump in addition to the loss of an RHR pump. Safety Evaluations performed prior to this for reduced HHSI have taken credit for this third HHSI pump to determine the effect on the LBLOCA analysis. For this evaluation, however, both the two pump and three pump cases were evaluated. Additionally, the effect of the revised HHSI balancing criteria on the maximum safeguards analysis results was evaluated.

For the two HHSI pump case, the effect on PCT of a reduction in flow resulting from the revised balancing criteria was evaluated. The HHSI flows used in the analysis and those based on the revised balancing criteria are given below.

Table 4-1: Two HHSI Pump Case

RCS Pressure (psig)	Analysis HHSI Flowrate (lbm/sec)	Revised HHSI Flowrate (lbm/sec)
0.0	126.4	106.8
100.0	119.9	100.6
200.0	113.3	93.8
300.0	106.1	86.6
400.0	98.3	72.3
500.0	90.2	70.8
600.0	81.8	62.0
700.0	73.1	52.7
800.0	62.9	42.3
900.0	52.0	30.9
1000.0	40.3	17.5
1100.0	24.9	2.0
1200.0	6.3	0.0
1300.0	0.0	0.0

The revised HHSI flows shown above were based on the assumptions identified in Table 3-2 C.

As Table 4-1 demonstrates, the flows based on the revised HHSI balancing criteria are substantially lower than those used in the analysis. The effect of this reduced HHSI pump flow is that 345 lbm less water will be pumped into the RCS from the time HHSI begins in the analysis until the time the PCT is predicted to occur. To make up for this shortfall, approximately 0.8 seconds of additional safety injection flow must be delivered to provide the reactor vessel with sufficient water inventory to turn the clad temperature transient around. Based upon a maximum fuel rod heatup rate observed between the time that safety injection begins and the time at which the PCT is predicted to occur, the LBLOCA PCT will increase by 15.8°F due to the additional second of fuel rod heatup.

For the three pump case, the flows used in the analysis and those based on the revised balancing criteria are given in table 4-2.

Table 4-2: Three HHSI Pump Case

RCS Pressure (psig)	Analysis HHSI Flowrate (lbm/sec)	Revised HHSI Flowrate (lbm/sec)
0.0	126.4	131.4
100.0	119.9	125.3
200.0	113.3	118.9
300.0	106.1	112.1
400.0	98.3	105.1
500.0	90.2	97.7
600.0	81.8	89.5
700.0	73.1	80.7
800.0	62.9	71.3
900.0	52.0	60.7
1000.0	40.3	48.1
1100.0	24.9	29.3
1200.0	6.3	20.1
1300.0	0.0	9.0

The revised flows given in table 4-2 are based on the assumptions in table 3-2 D.

Table 4-2 demonstrates that the flows based on three pumps running are greater than those used in the analysis. As such, no penalty was assessed to the LBLOCA analysis PCT for the revised balancing criteria when three pumps are assumed operating.

The effect of the revised HHSI balancing criteria on the maximum safeguards analysis was also evaluated. The flows used in the analysis and those based on maximum safeguards assumptions are given in table 4-3.

Table 4-3: Maximum Safeguards Case

RCS Pressure (psig)	Analysis HHSI Flowrate (lbm/sec)	Revised HHSI Flowrate (lbm/sec)
0.0	232.5	230.7
100.0	225.2	223.5
200.0	217.1	215.6
400.0	200.9	198.6
600.0	182.2	181.4
800.0	162.1	161.8
1000.0	138.0	138.2
1200.0	110.2	110.6
1400.0	77.0	72.2
1600.0	16.4	1.2
1800.0	0.0	0.0

The revised HHSI maximum flows given in table 4-3 are based on the assumptions in table 3-2 E.

As table 4-3 indicates, all revised HHSI flows at and below 600 psig are lower than those used in the analysis. Therefore, the maximum flow rates used in the analysis bound those based on the revised balancing criteria. The HHSI flows at 800 psig and above are not used in the analysis because the pressure would never get that high in a LBLOCA. Thus, the fact that some of the revised flows above 600 psig are greater than those used in the analysis is not relevant.

Based on this evaluation, the LBLOCA PCT is predicted to increase by 15.8°F assuming two pumps running. If three pumps are assumed running, the revised flows will actually be greater than those used in the analysis, resulting in a reduction in PCT. This benefit was not quantified as part of this analysis. Additionally, the LBLOCA analysis based on minimum safeguards remains limiting for IP2. The LBLOCA PCT based on two pumps operating is then 2184.3°F. Therefore, the reduction in HHSI flow resulting from the revised HHSI balancing criteria will still maintain the LBLOCA PCT within the 2200°F limit defined in 10 CFR 50.46.

Also, as part of the LBLOCA analyses, it was confirmed that the calculated total oxidation of cladding will be substantially less than 17% of the total cladding thickness prior to oxidation. Furthermore, it was confirmed that the total hydrogen generation will be less than 1% of the hypothetical amount that would be generated if all the cladding were to react with water and steam.

4.1.2 Small Break LOCA

The licensing basis Small Break LOCA (SBLOCA) analysis for IP2 was performed using the NRC approved NOTRUMP Evaluation Model. That analysis resulted in an analysis PCT of 1218.5°F for a 6 inch diameter cold leg break. The term "analysis PCT" identifies a PCT that has not been supplemented by penalties based on the results of other previous safety evaluations and outstanding potential issues. There have been several other safety evaluations that have resulted in LBLOCA PCT penalties. The penalties resulting from those evaluations, and penalties associated with applicable potential issues had previously increased the IP2 PCT to 1496°F. This information is summarized in table 4-7.

The limiting single failure assumed in the IP2 SBLOCA analysis was the loss of an EDG resulting in the loss of an HHSI pump. The effect of the revised HHSI balancing criteria on the SBLOCA analysis was evaluated by Westinghouse. The flows used in the analysis and those based on the revised balancing criteria are shown in table 4-4.

TABLE 4-4: SBLOCA Flow Comparison

RCS Pressure (psig)	Analysis HHSI Flowrate (lbm/sec)	Revised HHSI Flowrate (lbm/sec)
0.0	125.0	106.8
100.0	120.0	100.6
200.0	115.0	93.8
300.0	110.0	86.6
400.0	105.0	72.3
500.0	99.0	70.8
600.0	94.0	62.0
700.0	88.0	52.7
800.0	82.0	42.3
900.0	74.0	30.9
1000.0	66.0	17.5
1100.0	57.0	2.0
1200.0	45.0	0.0
1300.0	29.0	0.0
1400.0	7.0	0.0
1500.0	0.0	0.0

The revised flow data given in table 4-4 are based on the assumptions provided in table 3-2 C.

As this table indicates, the HHSI flows based on the revised balancing criteria are substantially lower than those used in the analysis. It was determined that it was necessary to perform a SBLOCA analysis using the NOTRUMP Evaluation Model to support this reduction in HHSI flow.

Several different break sizes were analyzed to determine if the current limiting break size of 6 inches would change and, if changed, to identify and confirm a new limiting break size. These cases and the corresponding PCT's are identified in table 4-6. Note that, to reduce the analysis PCT for the 4 inch case, another run was made using the flows in table 4-5. The revised flow data in table 4-5 is based on the assumptions in table 3-2 B which include assuming that valves 851A/B are operable. The table 4-4 flows were used in the analysis from the beginning of the transient to the time at which the valves closed (at about 130 seconds). The flows in table 4-5 were used from the time the valves closed to the end of the transient.

TABLE 4-5: SBLOCA FLOWS (Valves 851A/B Closed)

RCS Pressure (psig)	Analysis HHSI Flowrate (lbm/sec)	Revised HHSI Flowrate (lbm/sec)
0.0	125.0	107.7
100.0	120.0	101.9
200.0	115.0	95.8
300.0	110.0	89.6
400.0	105.0	82.7
500.0	99.0	74.8
600.0	94.0	64.9
700.0	88.0	53.6
800.0	82.0	46.8
900.0	74.0	40.1
1000.0	66.0	34.8
1100.0	57.0	28.6
1200.0	45.0	21.5
1300.0	29.0	10.5
1400.0	7.0	0.0
1500.0	0.0	0.0

TABLE 4-6: SBLOCA CASES ANALYZED

Break Size (inches)	HHSI Flow Bases	Analysis PCT (°F)
6	Table 4	1542.5
4	Table 4	2071.2
4	Tables 4 & 5	1597.7
3	Tables 4 & 5	2079.2
2	Tables 4 & 5	1432.8

Based on the analysis PCT of 2079.2°F, and on a reassessment of previous evaluations and effects of potential issues, it was determined that the IP2 SBLOCA PCT will increase to 2152.2°F, maintaining margin to the 10 CFR 50.46 limit of 2200°F.

Also, as was done with the LBLOCA analyses, it was confirmed that the calculated total cladding oxidation criteria of 17% and the total hydrogen generation criteria of 1% will be met.

4.1.3 LOCA Hydraulic Forces

The blowdown hydraulic forcing functions resulting from a postulated LBLOCA are considered in Chapter 14.3.4 of the IP2 FSAR. That section addresses the effects of a pipe rupture on the RCS and serves as a basis for the core and reactor internals integrity analysis.

The peak loads generated on the reactor vessel as a result of a LBLOCA typically occur between 10 and 500 milliseconds and subside well before 1 second. Since the forces have peaked and subsided well before the earliest possible injection of water from the HHSI or LHSI pumps, there is no effect of the revised HHSI balancing criteria on the LOCA Hydraulic Forces analysis. This ensures that the core geometry will remain amenable to cooling.

4.1.4 Post-LOCA Long Term Core Cooling

The Westinghouse licensing position for satisfying the requirements of 10 CFR 50.46 Section (b) Item (5), "Long-Term Cooling", is defined in WCAP-8339 (reference 6). The Westinghouse commitment is that the reactor will be maintained in a shutdown state by ECCS borated water. Since credit is not taken for control rods in LBLOCA analyses, the ECCS water provided by the RWST and accumulators must contain enough boron, when combined with other borated and non-borated sources of water, to maintain the core subcritical following a LOCA.

For each cycle of operation, the ability of the ECCS sytem to maintain the core subcritical following a LOCA is reevaluated. The calculation of expected post-LOCA sump boron concentration is checked to determine if any of the pertinent parameters, such as water volumes and boron concentrations, have changed since the last cycle. The objective of the calculation is to conservatively determine the anticipated sump boron concentration by minimizing or maximizing RCS component boron concentrations and water volumes appropriately. The calculated sump boron conditions are then compared to the subcriticality requirements of the new core design.

As stated, the calculation to determine the anticipated post-LOCA sump boron concentration is dependent on total RCS component volumes and boron concentrations. The amount of water delivered from the RWST, however, is independent of the HHSI or LHSI flowrates. Therefore, the reduction in HHSI pump flow rate has no effect on the calculation and does not prevent the Long-Term Core Cooling requirement from being met.

4.1.5 Hot Leg Switchover to Prevent Boron Precipitation

Hot leg recirculation time is determined for inclusion in the plant Emergency Operating Procedures (EOPs) and is calculated to ensure that boron precipitation will not occur in the core as a result of post-LOCA boiling. The time at which hot leg switchover occurs is dependent on core power history and RCS component water volumes and boron concentrations.

The input for this calculation is similar to that of the Post-LOCA Long Term Core Cooling calculation except that the boron concentrations are maximized. As stated above, HHSI pump flow rates will have no effect on the total RWST volume delivered to the RCS. Therefore, the revised HHSI balancing criteria will have no effect on the calculated hot leg switchover time.

Another requirement of this calculation is that the boiloff rate in the core must be matched by safety injection flow at the time of hot leg switchover, for both the LBLOCA and SBLOCA. For the LBLOCA, the total flow into the core based on the reduced HHSI pump flows has been compared to the boiloff rate in the core at the hot leg switchover time for both cold leg and hot leg injection. Since the flow rates were found to be greater than the boiloff rate, the requirement for LBLOCA is met.

For SBLOCA, the requirement is that the total recirculation flow in the hot leg mode with one hot leg line spilling must be greater than the boiloff rate. For this calculation, the RCS is assumed to be at the steam generator secondary side safety valve setpoint. Assuming a single active failure, there is sufficient flow to match boiloff at 1100 psig RCS pressure with a hot leg injection line spilling to 0.0 psig. Assuming a limiting single passive failure, only one HHSI pump would be available and would provide sufficient flow to match boiloff only if the plant would be depressurized to 200 psig or less within 24 hours following a SBLOCA. Per a 6/13/91 telephone confirmation from Con Edison, the IP2 EOPs do require post-LOCA plant cooldown and depressurization consistent with the Westinghouse Owner's Group (WOG) Emergency Response Guidelines (ERGs). However, plant depressurization must reach 200 psig or less within 24 hours following a SBLOCA.

TABLE 4-7: Summary of Current Large and Small Break LOCA PCT

Large Break LOCA		
Analysis of Record		2039.0°F
Prior ECCS EM 10CFR50.46 Assessments	+	10.0°F
Prior 10CFR50.59 Assessments		
1. RHR Shorfall	+	2.0°F
2. Pressurizer, Power, RCS Uncertainties	+	28.5°F
3. Fuel Temperature Discrepancy	+	5.0°F
4. Transition Core Penalty	+	10.0°F
Temporary Margin Assessments to Address Current Issues +		
1. Fuel Rod Initial Condition Inconsistency	+	10.0°F
2. S/G Tube Seismic/LOCA Assumption	+	20.0°F
3. Power Distribution Assumption	+	100.0°F
4. Cold Leg Streaming Temp. Gradient	+	4.0°F
Assessment of the Effect of Revised HHSI Balancing Criteria	+	15.8°F
Margin Allocated (15% S/G Tube Plugging)	-	60.0°F
Overall LBLOCA PCT		2184.3°F
Small Break LOCA		
Analysis of Record		2079.2°F
Prior ECCS EM 10CFR50.46 Assessments	+	0.0°F
Prior 10CFR50.59 Assessments		
1. Pressurizer, Power, RCS Uncertainties	+	34.0°F
2. AFW Delay	+	30.0°F
3. Fuel Temperature Discrepancy	+	5.0°F
4. Implementation of IFBA	+	2.0°F
5. "S" Signal Delay Time Error	+	2.0°F
Assessment of the Effect of Revised HHSI Balancing Criteria		NOTE 1
Overall SBLOCA PCT		2152.2°F

NOTE 1: The reduced HHSI flows were incorporated into the analysis and is reflected in the 2079.2°F analysis of record PCT.

4.2 Non-LOCA Transient Evaluation

4.2.1 Steamline Break - Core Response Analysis

Several cases with high (including the highest) heat fluxes and low RCS pressures have been evaluated because these conditions cause the most limiting DNBR. For this event, the double-ended rupture (upstream of the steam generator flow restrictor) with available offsite power case is the most limiting with respect to peak core heat flux. Therefore, this case was used to evaluate the reduction in the HHSI flow rate.

In the current licensing-basis analysis (FSAR) for the limiting case described above, the main steamline break (SLB) is assumed to occur at time zero (t = 0 seconds). The affected steam generator depressurizes at a fast rate while the steam flow from the three intact steam generators is limited by the flow restrictor in the broken line. This results in a high differential steamline pressure signal at 1.4 seconds which subsequently initiates SI and feedwater isolation. At 14.3 seconds a signal to initiate steamline isolation is actuated, and at 21.3 seconds, isolation of the three intact SGs is completed. Due to the rapid depressurization of the faulted SG, the cooling effect on the RCS is such that the core reaches criticality at approximately 14 seconds. Borated water from the SI system reaches the core at approximately 47.6 seconds once the SIS piping purge volume is cleared. Nuclear power continues to increase, however, as a result of the low boration rate and fast cooldown. The maximum nuclear power level (i.e. peak heat flux) is reached at about 149 seconds (22.3% of nominal).

Based on the reduced HHSI flow rates as described in table 3-2 F, the following key change in the results previously described occur. Specifically, boron injection into the core occurs at approximately 53.0 seconds (previously 47.6 seconds). Note, however, that the maximum power level remains at 22.3% of nominal and still occurs at the same time (approximately 149 seconds). As a result of the DNB evaluation, which was subsequently performed on statepoints based on the reduced HHSI flow rate reanalysis supporting this event, it has been determined that the DNBR limit continues to be met.

4.2.2 Steamline Break - Mass & Energy Release Inside Containment

For the steamline break mass and energy release inside containment analysis, the limiting hot full power case was reanalyzed using the reduced HHSI flow rates. The conclusion of the evaluation show that the total integrated energy release, the energy release rate, and the mass flow out of the break into containment are insensitive to the reduced HHSI flows. Therefore, the applicable safety criteria has been met.

4.3 SGTR and Radiological Consequences Evaluation

The SGTR analysis in the IP2 FSAR was performed to evaluate the radiological consequences due to the accident. The major factors affecting the radiological doses for an SGTR event are the amount of radioactivity assumed to be available in the reactor coolant, the amount of reactor coolant transferred to the secondary side of the ruptured steam generator through the ruptured tube, and the amount of steam released from the ruptured steam generator to the atmosphere. An evaluation has been performed with respect to these factors to determine the effect of the revised HHSI system performance.

The FSAR SGTR analysis is based on an assumption of 1% defective fuel which will not be affected by the revised high head safety injection flow rates. However, changes in the HHSI flow rates may affect both the primary to secondary break flow through the ruptured tube, and the steam release from the ruptured steam generator.

For the FSAR analysis, it was assumed that the primary to secondary break flow and the steam release from the ruptured steam generator would be terminated within 30 minutes after the accident. An SGTR results in a loss of coolant inventory and SI is actuated on a low pressurizer pressure signal. After SI actuation, it is assumed that the RCS pressure stabilizes at the equilibrium value where the incoming SI flow rate matches the tube rupture break flow rate. The equilibrium break flow is assumed to persist until 30 minutes following the accident. The maximum SI flow is conservatively assumed for the design basis SGTR analysis in order to maximize the break flow. The amount of steam released from the ruptured steam generator is then calculated based on a mass and energy balance for the RCS and the steam generators for the 30 minute period.

A review of the revised maximum HHSI flow rates (table 3-2 E) indicates that, in the pressure range of interest, the SI flow rate is higher than the values used for the SGTR analysis of record (see reference 9). The SGTR analysis of record was performed to support operation at the Stretch Core Power rating of 3071.4 MWt, RCS operating temperatures in the range between a minimum cold leg temperature of 515.8^{o}F and a maximum hot leg temperature of 611.7^{o}F, and steam generator tube plugging up to 25%. An evaluation indicates that the increased HHSI flow rates would result in an increase in the calculated break flow of 7.5% and an increase in the steam release from the ruptured steam generator of 1.2%. The increased break flow and steam release would result in an increase in the offsite doses at the site boundary to 2.7 rem thyroid and 0.75 rem whole-body. The offsite doses calculated for the increased HHSI flow rates do not constitute an increase in the consequences of the accident. This judgement is based on the fact that the dose increases are small (less than 0.5 rem) and that the total dose is very low, being below the NRC definition of a "small fraction" of the 10 CFR 100 exposure guideline. This "small fraction" is defined as 10% of the guideline value, that is, 30 rem thyroid and 2.5 rem whole body, and is the smallest of the exposure limits defined by the NRC in Standard Review Plan, NUREG-0800, Section 15.6.3.

4.4 Containment Integrity Evaluation

To demonstrate that an unreviewed safety question does not exist, the decrease in HHSI performance was evaluated for the Containment Analysis licensing-basis safety analyses for IP2. The criterion that the peak calculated pressure should be less than the containment design value of 47 psig, which is stated in reference 3 (the current licensing-basis containment analysis), was used in demonstrated that the conclusions for the FSAR Chapter 14 Containment Integrity safety analyses remain valid and that no safety issue exists.

Included also in the evaluation were effects previously documented in SECL-90-524-I (Recirculation Switchover Sequence Change), SECL-89-743-I (Securing Motor-Driven AFW Pumps During Post-LOCA Switchover), SECL-89-744 (Change to the Recirculation Switch Sequence), and SECL-89-829-I (Reduced Safety Injection Flow). It should be noted that these items were included for completeness even though any or all of the items may not be implemented at IP2.

The containment integrity analyses described in FSAR Chapter 14 consider: Short Term and Long Term Mass and Energy Release Analyses for Postulated Loss-of-Coolant Accidents (LOCA's); Containment Response Analyses following a LOCA or Steam line Break Inside Containment; and Subcompartment Pressure Transient Analyses.

4.4.1 Short Term LOCA Mass and Energy Releases / Subcompartment Pressure Analyses

For the Short Term mass and energy release and subcompartment pressure analysis a reduction in the safety injection flow rate would have no affect on the calculated results. This is because the safety injection flow does not factor into the analysis due to the short duration of the transient ($\leq$ 3 seconds).

4.4.2 Long Term Mass and Energy Release

The long term mass and energy release and containment pressure response calculations following a LOCA consider the effects of long term depressurization and secondary side heat transfer. The analyses consider the total energy available to the containment from both the primary and secondary side sources at all particular time segments of the transient.

Similar to the Short Term Analysis evaluation basis, the mass and energy release analyses were performed to conservatively maximize the mass and energy release available to the containment.

In addition to the impact of the subject HHSI performance degradation, the evaluation discussed herein included the effects documented in SECL-90-524-I, SECL-89-743-I, SECL-89-744, and SECL-89-829-I.

Based upon the results of the evaluation there is a 1.0 psi impact of the HHSI degradation on the peak calculated containment pressure for a postulated LOCA. The cumulative effect on peak pressure is 1.20 psi, when the potential effects of the issues identified in SECL's 89-743, 89-744, 89-829, and 90-524 are included. The resulting peak pressure at the Stretch Core Power of 3071.4 MWt becomes 41.51 psig. At an increased power of 3216 MWt, the peak pressure becomes 42.32 psig., Both of these are less than the containment design pressure of 47 psig. Therefore, the IP2 design basis analysis of reference 3 and its conclusions remain valid, and margin is maintained between the peak calculated containment pressure and the design pressure.

4.4.3 MSLB Inside Containment

Containment response calculations for postulated steam line break mass and energy releases inside containment are performed to ensure that the containment pressure and temperature do not exceed acceptable levels. Based upon the conclusions of the evaluation for the MSLB mass and energy release calculations, there would be no change in the mass and energy release to the containment due to the HHSI degradation. Therefore, the containment response calculations for the current licensing-basis analysis remain valid.

4.4.4 Peak Sump Temperature

The peak sump temperature calculation is not an explicit FSAR Chapter 14 safety analysis. However, the results are part of the input to the Ultimate Heat Sink Analysis (WCAP-12312 - reference 8). It has been determined that the degradation in HHSI flows considered herein does not affect the current peak sump temperature of 250°F.

4.5 HHSI System and Pump Operability and Integrity

The scope of this evaluation is limited to the safety significance of the revised HHSI balancing criteria, with respect to HHSI system and pump operability.

The IP2 Technical Specification Surveillance Requirement 4.5.A.1.c requires that a flow test of the HHSI system be conducted after any modification is made to either its piping and/or valve arrangement. This test typically evaluates total pump flow and branch line flow balance.

At IP2, the HHSI flowrates are measured by using orifice plates in the branch lines. As indicated in Westinghouse notification letter IPP-91-618 (reference 4), the potential exists for the ECCS flow measurement orifice plates flow coefficient values to be greater than originally determined using ASME standards. The potential discrepancy in orifice plate flow coefficients may result in ECCS flowrates being higher than what is indicated by flow measurement instruments. The higher flow rate may result in a lower injected flow to the reactor core, and a higher pump runout. Con Edison has procured and installed new HHSI branch line orifices and has indicated that the flow measurement uncertainty for the new orifices is bounded by the range of +/- 7 gpm. In addition to the flow measurement orifice replacement, Con Edison has installed variable orifices (throttle valves) in the discharge piping of each HHSI pump to facilitate balancing the three pumps during system flow balance testing. The system balancing requirements to accommodate these system changes were developed based on the effects of the three potential issues identified in section 1.

At IP2, the emergency core cooling function is performed by the Safety Injection System (SIS). Therefore, the terms SIS and ECCS are synonyms in this evaluation. The primary purpose of the SIS is the automatic delivery of cooling water to the reactor core following a LOCA or non-LOCA event. The SIS is operated in three modes: passive accumulator injection, active safety injection, and long term recirculation.

During the passive injection phase, core cooling is supplied by the accumulators when the RCS pressure has decreased to approximately 600 psig. During the active injection phase, the three HHSI and the two RHR pumps are used, as needed depending on break size, to inject cooling water from the RWST. For the recirculation phase, the SIS is arranged so that the ECCS recirculation pumps take suction from the recirculation sump and deliver it back to the core and/or the containment spray headers through the RHR heat exchangers. The system is also arranged to allow either of the RHR pumps to take over the recirculation function as a backup. For smaller breaks in the RCS, where recirculated water must be injection against higher RCS pressures, the system is arranged to deliver the water from the RHR heat exchangers to the HHSI pump suction.

It had been considered that the subject HHSI recirculation alignment could represent a potential challenge to HHSI pump operability. As previously stated, the ECCS recirculation or RHRS pumps provide flow to the HHSI pumps during recirculation. This LHSI boost increases the suction pressure and may cause the HHSI pumps to runout further. Therefore, revised HHSI balancing criteria were developed that preclude the HHSI pumps from operating under conditions in which their runout limit is exceeded. In general, exceeding the runout limit of the pump could result in pump damage and/or loss of function.

4.5.1 HHSI Pump Operability

The IP2 HHSI pumps are Dresser pumps, model 2-1/2" JTCH, with a design runout limit of 650 gpm. All JTCH pumps and all replacement rotors for these pumps were manufactured with sandcasted impellers, and there is only one (low capacity) impeller design. These pumps were evaluated to determine the amount of runout margin available.

In order to evaluate the pump runout limits, two major concerns were addressed: cavitation and motor horsepower capability. Cavitation will occur if the pump NPSH requirements at the higher runout flow rates is not satisfied by the available system NPSH. Minor cavitation can lead to long-term pump degradation, while severe cavitation and two-phase flow can lead to short-term pump damage. Therefore, operation with cavitation should be avoided. Operation at increased runout flows also can increase the brake horsepower required by the pump. The motor must be capable of operating satisfactorily at the new horsepower level.

4.5.1.1 Pump Cavitation Characteristics

The characteristics of centrifugal pump impellers often result in a specific flow capacity at which the NPSH required to suppress cavitation increases in an asymptotic manner. This condition can occur in the suction impeller of the pump or in the subsequent radial impellers, dependent on the particular characteristics of the specific impeller design. If an attempt is made to operate at or beyond this critical flow capacity, cavitation will occur regardless of the NPSH available at the suction of the pump. The developed head of the pump will degrade until it matches the system, and the pump will operate in a state of partial cavitation.

Cavitation in a pump can be associated with both long-term and short-term degradation mechanisms. Long-term degradation mechanisms would include impeller, diffuser, and wear ring erosion due to the continual presence of low level cavitation energy. Short-term degradation mechanisms would include wear ring rubbing, mechanical seal face wear, and bearing wear due to high levels of rotor vibration and deflection resulting from very high levels of cavitation. Very high levels of cavitation can be similar in effect to running a pump dry.

The point at which the asymptotic increase in required NPSH occurs in a particular pump is critical in evaluating the increase in pump runout flow rates. Dresser Pumps test data indicates that the asymptote is located beyond 675 gpm for the IP2 HHSI pumps with the low-capacity, sandcasted impellers. This flow rate should be treated as the maximum allowable flow for acceptable pump operation. This flow rate is acceptable only if the available NPSH satisfies the identified pump requirements.

4.5.1.2 Horsepower Considerations

The HHSI pumps are designed such that the pump developed head falls sharply as the flow rate approaches and surpasses the design runout flow. The falling head curve causes the brake horsepower curve to become very flat at flow rates beyond the design runout point. Because of this horsepower curve characteristic, the horsepower at the increased runout flow rates will be essentially the same as the horsepower at the design runout flow rate. It is expected that the required horsepower at increased runout flow rates will remain within the horsepower capability of the motor. Therefore, the increased runout flow rates should not affect the qualified life of the motor insulation system. Additionally, the increased runout flow rates are not expected to change the electrical load requirements for the EDGs. However, each of these factors should be checked on a pump specific basis before increased runout flow rates are approved.

4.5.1.3 HHSI Pump Limitations

Dresser Pumps has identified that the controlling NPSH limit for the model JTCH HHSI pumps at IP2 is in the suction impeller. Thus, these pumps are limited by first stage cavitation rather than second stage cavitation. The Dresser Pumps test data indicates that these pumps should not start to cavitate until the flow rate has exceeded 675 gpm. Thus, the HHSI pumps should not be operated beyond 675 gpm in order to preclude cavitation. To support operation at 675 gpm, the 2-1/2" JTCH pumps should have an available NPSH of at least 30 feet.

4.5.2 ECCS PERFORMANCE ANALYSIS

In general, the revised balancing criteria that was developed as discussed in section 3 assumed a miniflow range of 25 to 35 gpm, a 10 gpm indicated branch line imbalance, a branch line flow measurement error of +/- 7 gpm, and an allowable pump Total Developed Head (TDH) range of either +3 to -7% or +0 to -5% of the composite vendor curves. In addition, both minimum and maximum RWST volume assumptions were used to modeling different events. These assumptions were adjusted for the different events to yield conservative results, and are detailed in section 3.

The revised HHSI balancing criteria require that the cold leg branch lines should be balanced to an indicated flow range of 570 to 585 gpm per pump with +3 to -7% of the composite vendor curve, or 565 to 590 gpm with a TDH range of +0 to -5%. In addition to the cold leg injection requirements, the revised HHSI balancing criteria provide a requirement for hot leg recirculation of a minimum of 250 gpm indicated flow with only one cold leg injection line open. These flow ranges will assure that the actual pump flow does not exceed the pump runout limit of 675 gpm during high-head recirculation. As previously stated, exceeding the pump's runout limit may result in pump damage and/or loss of function. The revised HHSI balance flow ranges address the concerns of RHRS pumps boost of the HHSI pumps during the recirculation mode, the flow imbalance between HHSI cold leg injection lines, and flow measurement bias/uncertainty due to use of orifice plates in the HHSI injection lines.

4.6 Emergency Diesel Generator Loading Study Affects

The flow rate of the SI pump can either directly or indirectly affect the loads on the EDGs. These loads are compiled in WCAP-12655 (reference 7), the EDG loading study applicable to the Stretch Power uprating (completed prior to implementation of the EDG enhancement program). Following completion of WCAP-12655, Con Edison has assumed responsibility for updating and maintaining the EDG loading study.

4.6.1 Direct Impacts for LOCA Events

The SI flows can have a direct impact on the EDG loads since the brake horsepower (BHP) for the pump, and the power requirement for the pump motor, are directly affected by the flow. The maximum BHP for the pump were used to determine the limiting SI pump motor loads for LBLOCA and SBLOCA in WCAP-12655. Including the power required for the SI circulating water pumps (2 kw), the maximum SI pump load used for LBLOCA and SBLOCA in WCAP-12655 is 326 kw. A maximum BHP value bounding the three SI pumps near, but not exactly at, pump runout was selected for this load. Based on this conservative approach, degradation of the SI pump flow does not have an adverse direct impact on the EDG loading analysis for either LBLOCA and SBLOCA.

4.6.2 Direct Impacts for Non-LOCA Events

For non-LOCA events, the SI pump load used in WCAP-12655 was assumed to be 298 kw. This is conservatively based on a flow of 435 gpm per pump with two pumps operating against an RCS pressure of 1000 psig. For design basis non-LOCA events, it is expected that the SI pumps would be terminated before the RCS pressure becomes significantly less than 1000 psig. Although the SI pump motor power requirements for the non-LOCA events could be affected by the flow degradation, the flow rates and power requirements for the non-LOCA events would generally be reduced and the affect would be small. Regardless of the direction of the change, it is expected that the EDG loads for the non-LOCA events would generally remain bounded by those determined for the LOCA events.

4.6.3 Indirect Impacts Due to Containment Pressure Increases

The degraded SI pump performance also has an indirect affect on the EDG loads because of increased loads from the containment fan cooler units. As noted in the containment integrity evaluation, the pressure following a LOCA event can increase approximately 1.0 psi due to the SI flow degradation. Including other impacts, the peak pressure increase is about 1.2 psi. Based on Table 3.2-1 of WCAP-12655, this increase is equivalent to a fan motor power requirement increase of at most 5 BHP or 4 kw. At the Stretch Core Power level of 3071.4 MWt, the revised peak pressure of 41.5 psig results in a fan cooler power requirement of 247 kw, i.e., 4 kw higher than the previous peak load of 243 kw evaluated at 40 psig.

The above evaluation considers only the affect on the peak fan cooler motor power requirement and not necessarily the peak EDG loading. To simplify the assessment in a conservative manner and to allow for time shifts in the fan motor loads, it is recommended that the EDG loads be evaluated assuming a 5 kw increase if the EDG has one fan cooler unit (i.e., EDG #23) and a 10 kw increase if the EDG provides power to two fan cooler units (EDG #'s 21 and 22). The peak load on EDG #23 per WCAP-12655 would then increase from 1934 kw to 1939 kw. It is recommended that Con Edison evaluate the affect on the current loading analysis to ensure the EDG loads remain acceptable for the enhanced load ratings.

5.0 ASSESSMENT OF NO UNREVIEWED SAFETY QUESTION

The safety significance of the change in the HHSI flows used in IP2 safety analyses that is associated with the revision to the HHSI flow balancing criteria has been evaluated as required per the criteria of 10 CFR 50.59, and does not represent an unreviewed safety question on the basis of the following responses to specific related questions.

1. Will the probability of an accident previously evaluated in the FSAR be increased?

   No. The subject change in HHSI safety analyses flows is unassociated with events involved in the initiation of any accident previously evaluated in the FSAR. In any case, it has been demonstrated that all pertinent licensing-basis acceptance criteria (PCT, fuel cladding oxidation, hydrogen generation, DNBR, containment pressure, dose) have been met. Furthermore, it has been determined that the revised HHSI flow balancing criteria does not adversely affect HHSI pump operability and system integrity, and does not result in a condition where applicable design, material, and construction standards are altered. In general, the integrity of the equipment relied upon in pertinent plant safety analyses is not challenged. Therefore, the subject change in the HHSI safety analyses flows associated with the revised flow balancing criteria does not increase the probability of an accident previously evaluated in the FSAR.

2. Will the consequences of an accident previously evaluated in the FSAR be increased?

   No. It has been demonstrated that all pertinent licensing-basis acceptance criteria (PCT, fuel cladding oxidation, hydrogen generation, DNBR, containment pressure, dose) have been met. In particular, since the LBLOCA and SBLOCA PCT's remain below the 2200°F limit, the source term used for the associated radiological consequences evaluation remains valid and dose releases do not change. Also, based on the SGTR evaluation, it was determined that dose increases are small (less than 0.5 rem), and that the total dose is very low, being below the NRC definition of a "small fraction" of the 10 CFR 100 exposure guideline. Therefore, the subject change in the HHSI safety analyses flows associated with the revised flow balancing criteria does not increase the consequences of an accident previously evaluated in the FSAR.

3 May the possibility of an accident which is different than any already evaluated in the FSAR be created?

No. The subject change in the HHSI safety analyses flows and the associated revised HHSI flow balancing criteria neither results in the initiation of any accident, nor do they create any new credible limiting single failure. Furthermore, they do not result in any previously incredible event becoming credible. The plant design basis considered in the FSAR is unaffected and remains bounding. The subject changes only involves the consideration of degraded HHSI system performance, and equipment that is relied upon in pertinent plant safety analyses are not adversely affected. Also, it has been demonstrated that all pertinent licensing-basis acceptance criteria (PCT, fuel cladding oxidation, hydrogen generation, DNBR, containment pressure, dose) have been met. Therefore, the possibility of an accident which is different than any already evaluated in the FSAR is not created.

4. Will the probability of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?

No. The subject change in the HHSI safety analyses flows and the associated revised HHSI flow balancing criteria do not create any new failure mode for the ECCS or any other safety-related equipment. They do not result in any original design specification to be altered, and do not result in equipment used in accident mitigation to be exposed to an adverse enviroment. The subject flow changes do not adversely affect the operation of the Reactor Protection System (RPS) or any other device used for accident mititgation, and do not affect any protection setpoints. Furthermore, it has been demonstrated that all pertinent licensing-basis acceptance criteria (PCT, fuel cladding oxidation, hydrogen generation, DNBR, containment pressure, dose) have been met. Therefore, the probability of a malfunction of equipment important to safety previously evaluated in the FSAR will not be increased.

5. Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?

No. The subject change in the HHSI safety analyses flows and the associated revised HHSI flow balancing criteria will not increase the consequences of a malfunction of the safeguards train already considered to be inoperable in the licensing-basis safety analyses. Also, no new equipment malfunctions have been identified that will affect fission product barrier integrity. The subject flow changes will not challenge the integrity of the safety injection system or other equipment assumed to be operable for the plant safety analyses. Furthermore, it has been demonstrated that all pertinent licensing-basis acceptance criteria (PCT, fuel cladding oxidation, hydrogen generation, DNBR, containment pressure, dose) have been met. Therefore, the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR will not be increased.

6. May the possibility of a malfunction of equipment important to safety different than already evaluated in the FSAR be created?

   No. The subject change in the HHSI safety analyses flows and the associated revised HHSI flow balancing criteria do not adversely affect the integrity of the ECCS and its ability to perform its intended safety functions. Furthermore, it has been demonstrated that all pertinent licensing-basis acceptance criteria (PCT, fuel cladding oxidation, hydrogen generation, DNBR, containment pressure, dose) have been met. Therefore, the possibility of a malfunction of equipment important to safety that is different than already evaluated in the FSAR has not been created.

7. Will the margin of safety as defined in the bases to any technical specifications be reduced?

   No. It has been demonstrated that all pertinent licensing-basis acceptance criteria (PCT, fuel cladding oxidation, hydrogen generation, DNBR, containment pressure, dose) have been met. Meeting these criteria, as identified in section 2, ensures that there will be no degradation in the margins to safety to pertinent design failure points. For example, demonstrating that the 2200°F PCT limit is met ensures that the margin to safety to fuel melt has not been reduced. Therefore, the margin of safety as defined in the bases to any technical specification will not be reduced.

6.0 CONCLUSIONS

The scope of this safety evaluation were changes to the IP2 HHSI flows employed in related plant safety analyses that are associated with the identified revisions to the HHSI flow balancing criteria. Based on individual evaluations that were performed against pertinent IP2 licensing-basis acceptance criteria as were identified in section 2, it has been demonstrated that:

(a1) Both the LBLOCA and SBLOCA PCT's are less than the 2200°F limit of 10 CFR 50.46. These PCT values are 2184.3°F and 2152.2°F respectively. Note that the SBLOCA had to be formally reanalyzed, and it was determined that the limiting break size dropped from a 6" to a 3" break.

(a2) Regarding other 10 CFR 50.46 criteria:

- the calculated total oxidation of cladding was less than 17% of the total cladding thickness prior to oxidation, and the total hydrogen generated will not exceed 1% of the total amount that would be generated if all the cladding were to react with the water or steam (as generically demonstrated for Westinghouse LBLOCA and SBLOCA analyses).

- the LOCA Hydraulic Forces analysis remains unaffected, thus the core geometry will remain amenable to cooling.

- the Post-LOCA Long-Term Cooling Calculation is unaffected and the Hot-Leg Switchover requirement is met for LBLOCA. The Hot Leg Switchover requirement is met for SBLOCA only as long as the plant depressurizes to 200 psig or less within 24 hours following a SBLOCA.

(b) The minimum DNBR from evaluated Non-LOCA transients will not violate the limit value.

(c) The SGTR offsite dose increase are small (less than 0.5 rem), and the total dose is very low, being below the NRC definition of a "small fraction" of the 10 CFR 100 exposure guideline. This "small fraction" is defined as 10% of the guideline value (30 rem thyroid and 2.5 rem whole body), and is the smallest of the exposure limits defined by the NRC in Standard Review Plan, NUREG-0800, Section 15.6.3.

(d) The peak calculated containment pressure is expected to be less than the containment design value of 47 psig.

(e) The HHSI system and pump operability will not be adversely affected based on an IP2 HHSI pump runout limit of 650 gpm when suction is taken from the RWST, and an extended runout limit of 675 gpm during high head recirculation.

Based on the results of this evaluation, and specifically on the responses to the 10 CFR 50.59 regulatory screening questions of section 5, it has been determined that the IP2 HHSI flows employed in related plant safety analyses that are associated with the subject revisions to the HHSI flow balancing criteria will not represent an unreviewed safety question, and will not involve a change to any plant technical specification. As such, the subject flow changes are consistent with the current IP2 licensing basis and will not adversely affect safe plant operation.

7.0 REFERENCES

(1) "Indian Point Unit No. 2 Updated Final Safety Analysis Report", Revision 8.

(2) NRC Safety Evaluation on the Stretch Power Uprating, 3/7/90, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 148 to Facility Operating License No. DPR-26, Consolidated Edison Company of New York, Inc., Indian Point Unit No.2, Docket No. 50-247".

(3) WCAP-12237, "Containment Integrity Analysis for Indian Point Unit 2, 12/89.

(4) IPP-91-618, "Safety Injection Pump Runout Flow Assessment", 5/31/91.

(5) IPP-89-712, "Information on LBLOCA Limiting Single Failure", 6/30/89.

(6) WCAP-8339, Westinghouse Emergency Core Cooling System Evaluation Model - Summary", 6/74.

(7) WCAP-12655, "Emergency Diesel Generator Loading Study for Indian Point Unit 2", 7/90.

(8) WCAP-12312, Safety Injection for an Ultimate Heat Sink Temperature Increase to 95°F at Indian Point Unit 2, 7/89.

(9) WCAP-12187, "NSSS Stretch Rating - 3083.4 MWT Engineering Report", Con Edison Company of New York, Indian Point Unit 2, 3/89.

SECL-92-339, Rev. 2

Customer Reference No(s).
N/A

Westinghouse Reference No(s).
N/A

WESTINGHOUSE
SAFETY EVALUATION CHECK LIST

1) NUCLEAR PLANT(S) Indian Point Unit 2

2) CHECK LIST APPLICABLE TO Increase in the Containment Pressure High ESF Safety Analysis Limit (SAL) Setpoint to 10 psig

3) The written safety evaluation of the revised procedure, design change or modification required by 10CFR50.59 has been prepared to the extent required and is attached. If a safety evaluation is not required or is incomplete for any reason, explain on Page 2. Parts A and B of this Safety Evaluation Check List are to be completed only on the basis of the safety evaluation performed.

CHECK LIST - PART A

3.1) Yes X No__ A change to the plant as described in the FSAR?
3.2) Yes__ No X A change to procedures as described in the FSAR?
3.3) Yes__ No X A test or experiment not described in the FSAR?
3.4) Yes__ No__* A change to the plant technical specifications (Appendix A to the Operating License)?

4) CHECK LIST - PART B (Justification for Part B answers must be included on page 2.)

4.1) Yes__ No X Will the probability of an accident previously evaluated in the FSAR be increased?
4.2) Yes__ No X Will the consequences of an accident previously evaluated in the FSAR be increased?
4.3) Yes__ No X May the possibility of an accident which is different than any already evaluated in the FSAR be created?
4.4) Yes__ No X Will the probability of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
4.5) Yes__ No X Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
4.6) Yes__ No X May the possibility of a malfunction of equipment important to safety different than any already evaluated in the FSAR be created?
4.7) Yes__ No X Will the margin of safety as defined in the bases to any technical specification be reduced?

* See "REMARKS" on page 2.

If the answers to any of the above questions are unknown, indicate under 5) REMARKS and explain below.

If the answer to any of the above questions in Part (3.4) or Part B cannot be answered in the negative, the change review requires an application for license amendment in accordance with 10 CFR 50.59 (c) and submitted to the NRC pursuant to 10 CFR 50.90.

5) REMARKS:

This safety evaluation only addresses an increase in the Containment Pressure High ESF SAL to 10 psig which is needed to accommodate an increase in the corresponding ESF Technical Specification setpoint from 2.0 to 5.0 psig. The enclosed safety evaluation does not include the No Significant Hazards determination required by 10 CFR 50.92 for changes to the Technical Specifications.

The answers given in Section 3, Part A, and Section 4, Part B, of the Safety Evaluation Checklist, are based on the attached Safety Evaluation.

Reference document(s):

FOR FSAR UPDATE

Section:_____ Pages:_____ Tables:_____ Figures:_____

Reason for/Description of Change:

FSAR updates are not included in this package.

SIGNATURES

Prepared by: Maria A. Ramirez Date: 7/2/93
M. A. Ramirez
Operating Plant Licensing II

Prepared by: Robert R. Laubham Date: 7-2-93
R. R. Laubham
Operating Plant Licensing II

Verified by: J. C. Bass Date: 7/2/93
J. C. Bass
Operating Plant Licensing II

INDIAN POINT UNIT 2
CONTAINMENT HIGH PRESSURE SETPOINT INCREASE
SAFETY EVALUATION CHECKLIST

The purpose of this safety evaluation is to assess a change to the Indian Point Unit 2 Nuclear Power Station Containment Pressure High Engineered Safeguards Feature (ESF) Safety Analysis Limit (SAL) setpoint to determine that the change will not adversely affect the safety analyses and safe plant operation. The SAL is being changed to accommodate an increase in the Containment Pressure High ESF Technical Specification (T/S) setpoint. The safety evaluation does not include the No Significant Hazards determination required by 10 CFR 50.92 for changes to the Technical Specifications.

1.0 BACKGROUND

Westinghouse is currently supporting Consolidated Edison's program to extend the Technical Specification refueling surveillance interval for Indian Point Unit 2 from 18 months to 24 months. One of Westinghouse's functions is to calculate instrument uncertainties for a 30-month extended surveillance cycle. During this effort, Westinghouse has calculated that the instrument uncertainties for the containment pressure channel have increased. The containment pressure channel provides input to the Containment Pressure High ESF trip and the Containment Pressure High-High ESF trip. Westinghouse has performed a safety evaluation (Reference 1) to support a relaxation in the Containment Pressure High ESF trip setpoint assumed in the safety analyses/evaluations of record from 2.0 psig to 7.3 psig. The SAL of 7.3 psig accommodates the increased instrument uncertainties due to the extended fuel cycle length needed to keep the Technical Specification (T/S) setpoint at 2.0 psig. Per Consolidated Edison, no relaxation in the Containment Pressure High-High ESF trip SAL is required since the corresponding T/S setpoint will be changed to accommodate the increase in the associated instrument uncertainties.

To provide additional operating flexibility, Consolidated Edison has requested that Westinghouse perform an evaluation to support a relaxation in the Containment Pressure High ESF T/S setpoint from 2.0 psig to 5.0 psig. A 5.0 psig T/S setpoint will decrease the frequency of high containment pressure alarms as well as increase the margin to ESF trip. As part of this evaluation, Westinghouse has determined that an SAL setpoint of 10.0 psig is required to accommodate the instrument uncertainties associated with the extended fuel cycle length with a Containment Pressure High ESF T/S trip setpoint of 5.0 psig.

Westinghouse has subsequently evaluated the effects of relaxing the SAL to 10.0 psig for the Containment Pressure High ESF trip on the current licensing basis Indian Point Unit 2 safety analyses/evaluations. As a result, the Containment Pressure High ESF trip affects only the containment integrity and LOCA-related analyses/evaluations, including Large Break LOCA, Small Break LOCA, post-LOCA Long-Term Core Cooling, Hot Leg Switchover, and LOCA Hydraulic Forces. The potential effects on other safety-related components and licensing basis analyses has also been reviewed and found not to be affected by the containment pressure SAL relaxation. These areas include:

- Primary Component and Systems Licensing Considerations
- Instrumentation and Controls/Equipment Qualification Considerations
- Radiological Consequences
- Non-LOCA Analyses
- Steam Generator Tube Rupture

- Probabilistic Risk Assessment
- Emergency Operating Procedures

In addition, Westinghouse has reviewed the discussion on diversity as presented in a safety evaluation (Reference 2) to reaffirm that the diversity of the Reactor Protection System/ESF design is not significantly affected for changes in the Containment Pressure High ESF trip setpoint. The principal conclusion of the safety evaluation is that the relaxation in the Containment Pressure High SAL setpoint from 7.3 to 10.0 psig assumed in the safety analyses/evaluation of record to support a new Containment Pressure High ESF T/S trip setpoint of 5.0 psig will not represent an unreviewed safety question and will not adversely affect safe plant operation.

2.0 LICENSING BASES

This evaluation was performed according to the regulations set forth in Title 10 of the Code of Federal Regulations, Part 50, (10 CFR 50.59). This regulation allows the holder of a license authorizing operation of a nuclear power facility the capacity to evaluate changes to the plant and/or procedures and tests or experiments not described in the plant Final Safety Analysis Report (FSAR). Prior Nuclear Regulatory Commission (NRC) approval is not required to implement a change provided that it does not involve an unreviewed safety question or result in a change to plant Technical Specifications. The holder of a license authorizing operation of a nuclear power facility who desires a change in the T/S or a change in the facility or the procedures described in the plant Safety Analysis Report (SAR) or to conduct tests or experiments not described in the SAR which involve an Unreviewed Safety Question (USQ) or a change in T/S must submit an application for amendment of the license pursuant to 10 CFR 50.90 and subsequently provide the Commission its analysis about the issue of no significant hazards consideration using the standards in 10 CFR 50.92.

This safety evaluation only addresses an increase in the Containment Pressure High ESF SAL to 10 psig which is needed to accommodate an increase in the T/S setpoint to 5.0 psig. The safety evaluation does not include the No Significant Hazards determination required by 10 CFR 50.92 for changes to the Technical Specifications.

The determination that the Containment Pressure SAL relaxation does not involve an unreviewed safety question was made based on the individual evaluations in Section 3.0, performed according to pertinent licensing basis acceptance criteria for the Indian Point Unit 2 Nuclear Power Station. The acceptance criteria are as follows:

The containment and radiological analyses safety evaluation (Section 3.1) demonstrates that the peak calculated containment pressure will be less than the containment design and Integrated Leak Rate Test (ILRT) value of 47 psig as identified in WCAP-12237, entitled, "Containment Integrity Analysis for Indian Point Unit 2" (Reference 3) and as specified in the Indian Point Unit 2 Technical Specifications (Section 4.4 A.1.a). WCAP-12237 and evaluations performed in support of the High Head Safety Injection (HHSI) flow balancing criteria effort (Reference 4) document the current licensing basis containment analyses of record. This evaluation accounted for the effects of other plant changes for which Westinghouse is cognizant. These include effects stemming from the Ultimate Heat Sink (UHS) Program, the Containment Integrity Analysis to support the Stretch Power Program, degraded Residual Heat Removal (RHR) pump flows, and effect of degraded Emergency Core Cooling System (ECCS) flows due to a change in the flow balance criteria (Reference 4).

As described in FSAR Section 7.2.5.1.14, the Containment Pressure High ESF Trip Function also provides a diverse signal to initiate reactor trip in the event that the pressurizer signal fails and does not initiate a reactor trip for relatively small breaks in the primary system. Reactor trip is generated through the ESF signal (i.e., reactor trip on Safety Injection Signal). The Containment Pressure High ESF trip setpoint of 2.0 psig is described in the FSAR as an adequate T/S setpoint which will initiate a timely ESF/reactor trip signal to ensure that the core will be protected for a range of small break sizes.

3.0 SAFETY EVALUATIONS

This section presents the individual evaluations performed for the Containment Integrity and the LOCA-Related Analyses.

3.1 Containment Integrity Analysis

The containment integrity analyses are described in Chapter 14 of the Indian Point Unit 2 FSAR. This chapter considers: Short Term and Long Term Mass and Energy Release Analyses for Postulated Loss-of-Coolant Accidents (LOCAs); Containment Response Analyses following a LOCA or Steamline Break Inside Containment; and Subcompartment Pressure Transient Analyses.

Short Term Mass and Energy Releases/Subcompartment Pressure Analyses

For the short term mass and energy release and subcompartment pressure analyses, the relaxation in the containment pressure SAL would have no effect on the calculated results since the SAL change does not factor into the analysis because of the short duration of the transient ($\leq$ 3 seconds). Thus, the current analysis remains valid.

LOCA Mass and Energy Release

The long term mass and energy release and containment pressure response calculations following a LOCA consider the effects of long term depressurization and secondary side heat transfer. The analyses consider the total energy available to the containment from both the primary and secondary side sources at all particular time segments of the transient.

Similar to the short term analysis evaluation basis, the mass and energy release analyses were performed to conservatively maximize the mass and energy release available to the containment.

In addition to the effect of the subject Containment Pressure SAL Relaxation change, this safety evaluation accounted for the effects of other plant changes as identified in the Indian Point Unit 2 HHSI Performance Evaluation. Based upon the results of the evaluation, there is a reduction of 0.6 psi on the peak pressure at the current licensing basis power level of 3083.4 MWt, when the cumulative effect of the Containment Pressure SAL relaxation and the issues identified are included. At the increased power level of 3216 MWt, a reduction of 0.8 psi is calculated. The resulting peak pressure at 3083.4 MWt becomes 40.89 psig (at the increased power of 3216 MWt, the peak pressure becomes 41.49 psig), both less than the containment design and Integrated Leak Rate Test (ILRT) T/S value of 47 psig. Therefore, the Indian Point Unit 2 design basis analysis of record and its conclusions remain valid, and margin is maintained between the peak calculated containment pressure and the design pressure. Figures 1 and 2 illustrate the calculated peak pressures profiles for the respective 3083.4 and 3216 MWt power levels.

Figures 3 and 4 illustrate the corresponding temperature profiles. As can be seen from Figures 3 and 4, the temperature response of the Containment is similar to and generally bounded by the temperature profile reported in WCAP-12237.

MSLB Inside Containment

Containment response calculations for postulated steam line break mass and energy releases inside containment are performed to ensure that the containment pressure does not exceed acceptable levels. The Hot Full Power, Feedwater Control Valve Failure case is the current limiting case for containment response following a MSLB. The existing MSLB mass and energy releases inside containment for Indian Point Unit 2 are not affected by changing the High Pressure setpoint. Specifically, no credit for these signals have been taken in the steamline break analyses used to generate the existing licensing basis mass and energy release for Indian Point Unit 2. For the containment response calculation, credit for the containment pressure signal is assumed. The limiting case was reanalyzed with the relaxed SAL limit of 10.0 psig. The peak containment pressure for the limiting MSLB event was calculated to be 40.1 psig, or an increase of 0.04 psi resulting from the relaxation of the SAL containment pressure limit assumed in the previous containment analysis. This pressure is less than the containment design and ILRT pressure of 47 psig. Thus, margin is maintained between the peak calculated containment pressure and the design pressure. Figure 5 is provided to illustrate the revised calculated pressure profile. The Indian Point Unit 2 licensing basis for Environmental Qualification states that equipment qualified for LOCA is also qualified for MSLB. Accordingly, no temperature plots are included for this case.

Peak Sump Temperature

The peak sump temperature calculation is not an explicit Chapter 14 safety analysis. However, the results are input for the Ultimate Heat Sink Analysis (Reference 5). There is an insignificant effect with respect to the Containment Pressure SAL Relaxation considered herein on the current peak sump temperature. The value remains at 250°F.

Diesel Generator Loading Study

Indirect Impacts Due to Containment Pressure Increases

As noted in the containment integrity evaluation, the pressure following a LOCA event decreases approximately 0.6 psi for the stretch power due to the combined effects plant specific reanalysis. As a result of decreased peak containment pressure, the loads on the Emergency Diesel Generator (EDG) will decrease. This has an indirect impact on the EDG loads because the fan cooler units will require less power to operate at the lower containment pressure. The current EDG loading analysis is based upon the higher Indian Point Unit 2 HHSI Flow Change Performance Evaluation analysis (Reference 4); therefore, these calculations remain bounding.

3.2 LOCA-Related Analyses

LOCA-related accident analyses are described in Chapter 14 of the Indian Point Unit 2 FSAR. The following LOCA-related analyses were evaluated:

- Large Break LOCA
- Small Break LOCA
- Post-LOCA Long-Term Core Cooling

- Hot Leg Switchover
- LOCA Hydraulic Forces

Large Break LOCA

The large break LOCA (LBLOCA) analysis is affected because the Containment High Pressure ESF SAL setpoint is modeled in a portion of the 1981 Evaluation Model with BASH. The Containment High Pressure setpoint assumed in the currently analysis is 2 psig. This was also the previous value given in the Technical Specifications. It was determined that the increase in the Containment High Pressure SAL setpoint to 10 psig would cause an approximate delay of 3 seconds in delivering the ECCS injection. The delay time for the safety injection assumed in the analysis is equal to 25.5 seconds. Thus, the time at which the safety injection would be delivered is increased from the previous time of 25.5 seconds to the revised time of 28.5 seconds. However, from Table 14.3-4 in the Indian Point Unit 2 FSAR, the End of Bypass (EOB) time is 37.2 seconds. This is the time at which the water in the vessel has exited through the break. At this time, the refill period begins, whereby the vessel begins to refill by pumped safety injection. Since the increase in the safety injection time does not increase the delivery time of the pumped safety injection past the EOB time, the LBLOCA analysis will be unaffected (all safety injection flow before that time exits out the break). Consequently, the LBLOCA analysis is unaffected by the proposed increase in the containment high pressure SAL setpoint.

Small Break LOCA

The Containment High Pressure ESF setpoint is not modeled in the Indian Point Unit 2 Small Break LOCA analysis. In Westinghouse small break LOCA analyses, the Low Pressurizer pressure ESF setpoint is assumed to be active and is typically the only ESF setpoint modeled. Since the Containment High Pressure ESF setpoint is not modeled, the results of the Indian Point Unit 2 Small Break LOCA analysis will not be affected by a change in its value. Thus, none of the 10 CFR 50.46 acceptance criteria will be challenged (with respect to the small break LOCA analysis) as a result of the change int he Containment High Pressure ESF setpoint for Indian Point Unit 2.

LOCA Hydraulic Forcing Functions

The blowdown hydraulic forcing functions resulting from a LOCA are also considered in the FSAR. The LOCA Hydraulic Forcing Functions are primarily affected by temperature, pressure, density, enthalpy, and losses in the reactor vessel, reactor coolant loop, and steam generators. The LOCA Hydraulic Forcing Functions (LHFF) transient occurs over the duration of a 500 millisecond interval. In this time period, the containment pressure does not reach the containment high pressure setpoint. Furthermore, the LHFF analysis methodology does not model setpoints. As such, the proposed increase in the containment high pressure setpoint does not affect the LHFFs.

Post-LOCA Long-Term Core Cooling

Following a postulated LBLOCA, the reactor becomes subcritical initially due to massive voiding in the core region. Since credit for control rod insertion is not taken for LBLOCA, the boron concentration of injected water must be sufficiently high as to maintain the core in a shutdown condition. This calculation is based on the primary system water volumes and boron concentrations. The Long Term Core Cooling (LTCC) sump criticality evaluation is affected by changes in volumes and boron concentrations of the Emergency Core Cooling System components. Since setpoints are not modeled, the LTCC evaluation methodology is not affected by the proposed increase to the containment high pressure SAL setpoint.

Hot Leg Switchover to Prevent Potential Boron Precipitation

Post-LOCA hot leg switchover time is determined for inclusion in Emergency Operating Procedures (EOPs) to ensure no boron precipitation in the reactor vessel following boiling in the core. This time is strongly dependent on initial core power and the boron concentration of the fluid residing in the sump/RCS post-LOCA. The proposed increase to the containment high pressure SAL setpoint will increase the calculated time at which safety injection is initiated. The hot leg switchover analysis is not affected by the increase in the containment pressure high SAL setpoint because the net change to the integrated safety injection is negligible compared to the total integrated safety injection over 24 hours.

3.3 Diversity Discussion

As described in FSAR Section 7.2.5.1.14, the Containment Pressure High ESF Trip Function can also provide a diverse signal to initiate reactor trip in the event that the pressurizer signal fails and does not initiate a reactor trip for relatively small breaks in the primary system. A Containment Pressure High ESF trip setpoint of 2.0 psig is described in the FSAR as an adequate setpoint which will initiate a timely ESF/reactor trip signal to ensure that the core will be protected for a range of small break sizes.

The Containment Pressure Diversity discussion presented in the FSAR was in response to Atomic Energy Commission (AEC) questions in 1970 on the diversity available in the Reactor Protection System/ESF System designs to provide core protection. In 1970, the available pressurizer automatic protection functions were a reactor trip on low pressurizer pressure and an ESF trip on low pressurizer pressure coincident with low pressurizer water level. These two trips provided functional diversity in the event of depressurizations of the primary system. To provide additional diversity in the event of small breaks in the primary system, a Containment Pressure High ESF trip setpoint of 2.0 psig was chosen.

In 1979 following the Three Mile Island Unit 2 (TMI-2) event, IE Bulletin 79-06A (Revision 0 and Revision 1) identified actions to be taken by the licensees of reactors designed by Westinghouse. One of the actions identified in IE Bulletin 79-06A was to eliminate the coincident requirement of low pressurizer water level with low pressurizer pressure for an ESF trip. As a result, an ESF trip occurs on low pressurizer pressure only. In the review of the TMI-2 event, it was determined that the low pressurizer water level coincidence limited the reliability of the pressurizer ESF trip. Also, analyses of small breaks located at the top of the pressurizer showed that the pressurizer water level would increase (although the pressure and mass of the primary system would be decreasing) which would preclude an ESF trip.

As such, the diversity of the pressurizer trip functions was strengthened by removing the pressurizer water level coincidence logic from the pressurizer ESF trip function. The low pressurizer pressure reactor trip signal and the low pressurizer ESF trip signal are actuated by separate and diverse logic trains. Also, the overtemperature delta-temperature (OTDT) reactor trip is available depending on initial conditions for

providing a diverse reactor trip in the event of a depressurization of the primary system. Although the Containment Pressure High ESF trip setpoint is relaxed, it is still available to provide diverse protection for a range of breaks in the primary system. Thus, changes in the Containment Pressure High ESF trip setpoint do not significantly affect the protection system diversity available for small breaks in the primary system.

4.0 DETERMINATION OF NO UNREVIEWED SAFETY QUESTION

The safety significance of operating Indian Point Unit 2 with Containment Pressure SAL relaxation to 10 psig has been evaluated using the screening criteria of 10 CFR 50.59 and the guidance of NSAC-125 and does not represent an unreviewed safety question based on the following justification.

1. Will the probability of an accident previously evaluated in the FSAR be increased?

   NO. The change only involves the consideration of Containment Pressure SAL Relaxation to 10 psig in the safety analyses, the integrity of the equipment relied upon in the safety analyses is not expected to be challenged. Therefore, the probability of an accident previously evaluated in the FSAR will not be increased.

2. Will the consequences of an accident previously evaluated in the FSAR be increased?

   NO. The containment pressure design limit continues to be met and containment integrity is not challenged. Therefore, the consequences of the licensing basis Containment Integrity analyses remain unchanged, and no more severe radiological consequences will result. In addition, the consequences of the LOCA accidents previously evaluated in the FSAR will not be increased with respect to LOCA considerations since the assumptions and results of all analyses examined are not adversely affected by the increase in the containment high pressure setpoint to 10 psig.

3. May the possibility of an accident which is different than any already evaluated in the FSAR be created?

   NO. The design basis considered in the FSAR is not changed and remains bounding. The subject change involves the consideration of Containment Pressure SAL Relaxation to 10 psig; therefore, the integrity of the equipment relied upon is not expected to be challenged. Also, the subject SAL relaxation does not introduce any new mechanism (i.e., additional failure of equipment or ESF, etc.) by which a credible LOCA accident beyond design basis LOCA is created.

   Therefore, the possibility of an accident which is different from any accidents previously evaluated in the Indian Point Unit 2 FSAR is not increased as a result of the containment high pressure setpoint relaxation to 10.0 psig.

4. Will the probability of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?

   NO. The Containment Analyses affected by the change consider the active single failure of a safeguards train. The assumption of Containment Pressure SAL Relaxation to 10 psig is not expected to challenge the integrity of the equipment assumed to be operable. Therefore, the probability of a malfunction of equipment important to safety will not be increased.

5. Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?

   NO. Containment Pressure SAL Relaxation will not increase the consequences of a malfunction of the safeguards train already considered to be inoperable in the licensing basis safety analysis. Also, the consequences of equipment malfunction important to safety have previously been considered in the FSAR analyses and evaluations for the LOCA related events through inclusion of an assumed limiting single failure of ECCS equipment. The increase in the containment high pressure setpoint to 10.0 psig will not result in a more severe single failure than that assumed in the LOCA related FSAR analyses. By demonstrating conformance to the regulatory criteria for the proposed modification with continued consideration of the limiting single failure, the consequences of these analyses will not be increased.

6. May the possibility of a malfunction of equipment important to safety different than already evaluated in the FSAR be created?

   NO. As discussed in the answers to questions 4 and 5, Containment Pressure SAL Relaxation will not affect or challenge the integrity of the safety injection system components modeled in the licensing basis event. In addition, these changes are not expected to indirectly affect any other safety equipment relied upon for safety. Therefore, the possibility of a malfunction of equipment important to safety different than any already evaluated in the SAR would not be created.

7. Will the margin of safety as defined in the bases to any technical specifications be reduced?

   NO. The bases of the Technical Specifications are based in part on the ability of the regulatory criteria being satisfied assuming the limiting conditions for operation for various systems. Inasmuch as conformance to the regulatory criteria for operation with the containment high pressure SAL setpoint is demonstrated, and the pertinent licensing basis acceptance criteria are not exceeded, the margin of safety as defined in the Technical Specifications is not reduced.

5.0 SUMMARY AND CONCLUSIONS

In summary, the effects of a Containment Pressure SAL Relaxation have been evaluated. The cumulative effect of the outstanding evaluations on the peak calculated pressure result in the containment response following a postulated LOCA to be the limiting event with respect to peak calculated pressure. The peak calculated pressure at the current licensed power level of 3083.4 MWt is 40.9 psig (at the increased power of 3216 MWt, the peak pressure becomes 41.5 psig), thus the design containment pressure of 47 psig will not be exceeded. In addition, based on the results of this evaluation, the increase in Containment Pressure High SAL setpoint to 10 psig will not affect the assumptions or results of the LOCA-related FSAR accident analyses. Also, changes in the Containment Pressure High ESF trip setpoint do not significantly affect the protection system diversity available for small breaks in the primary system. It should be noted that the effect of the containment temperature on Equipment Qualification is considered out of scope of this evaluation but should be addressed by others.

Hence, operation of Indian Point Unit 2 with Containment Pressure SAL Relaxation neither represents an unreviewed safety question nor compromises the conclusions or pressure margin demonstrated in the current Indian Point Unit 2 Containment Analysis or LOCA-Related safety analyses.

However, it must be noted that the implementation of a new T/S setpoint of 5.0 psig will require approval by the NRC. The safety evaluation does not include the No Significant Hazards determination required by 10 CFR 50.92 for changes to the Technical Specifications.

6.0 REFERENCES

1. Westinghouse Letter IPP-92-639, Kern, J. G. (Westinghouse) to Ellwanger, J. (Consolidated Edison), dated December 18, 1992, "Extended Surveillance Interval Program".

2. Westinghouse Letter IPP-93-645, Hameedy, M. D. (Westinghouse) to Jackson, B. (Consolidated Edison), dated April 5, 1993, "Extended Surveillance Internal Program Increase in the Containment High Pressure Setpoint to 7.3 psig Safety Evaluation Checklist, Rev. 1", SECL-92-339, Rev. 1.

3. WCAP-12237, "Containment Integrity Analyses for Indian Point Unit 2", dated December 1989 (Non-Proprietary Class III).

4. SECL-91-231, "Indian Point Unit 2 High Head Safety Injection Flow Changes Safety Evaluation", dated June 26, 1991.

5. WCAP-12312, "Safety Evaluation for an Ultimate Heat Sink Temperature Increase to 95°F at Indian Point Unit 2", dated July 1989 (Non-Proprietary Class II).

Figure 1

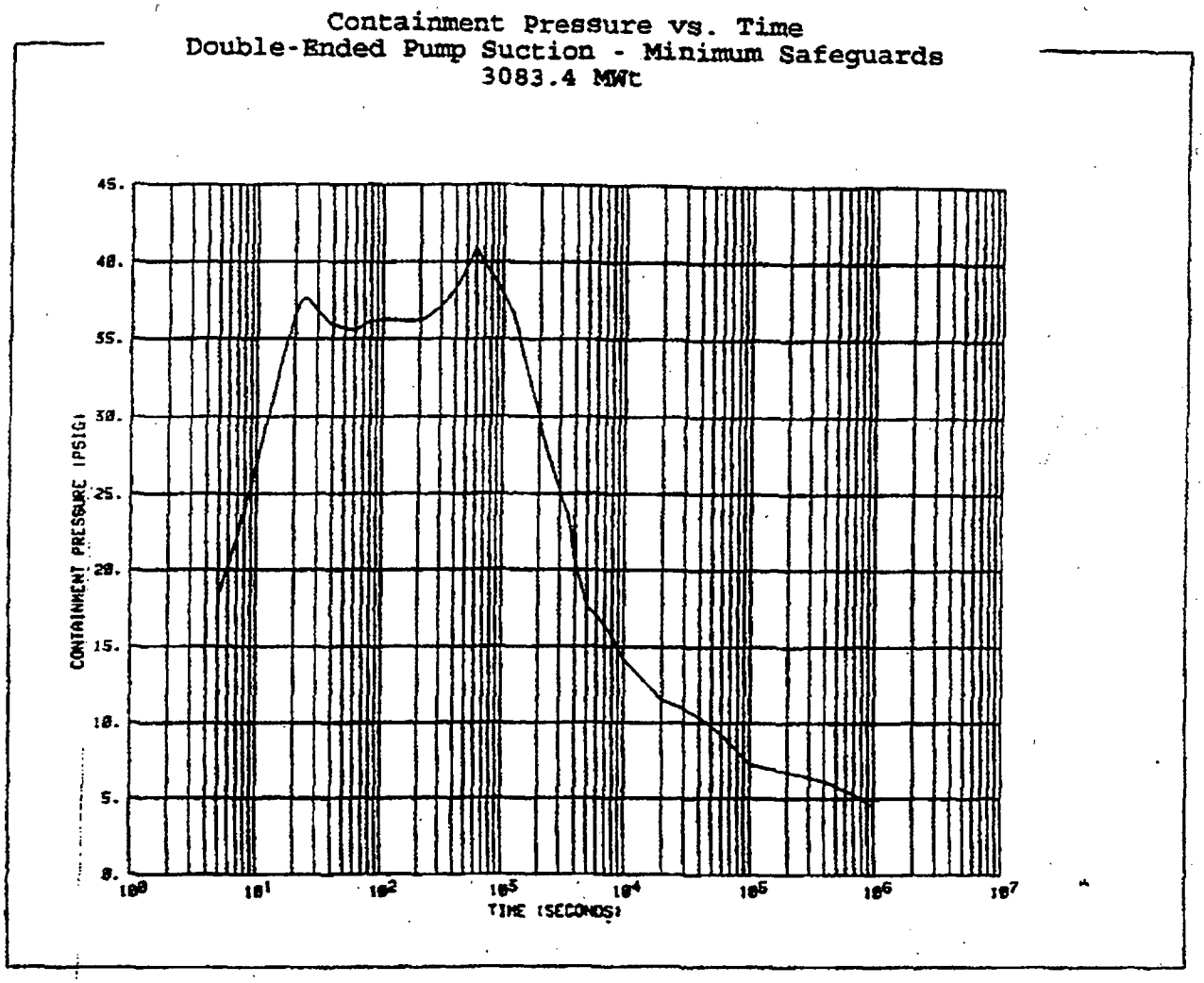

Containment Pressure vs. Time
Double-Ended Pump Suction - Minimum Safeguards
3083.4 MWt
CONTAINMENT PRESSURE (PSIG)
45.
40.
35.
30.
25.
20.
15.
10.
5.
0.
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
TIME (SECONDS)

Figure 2

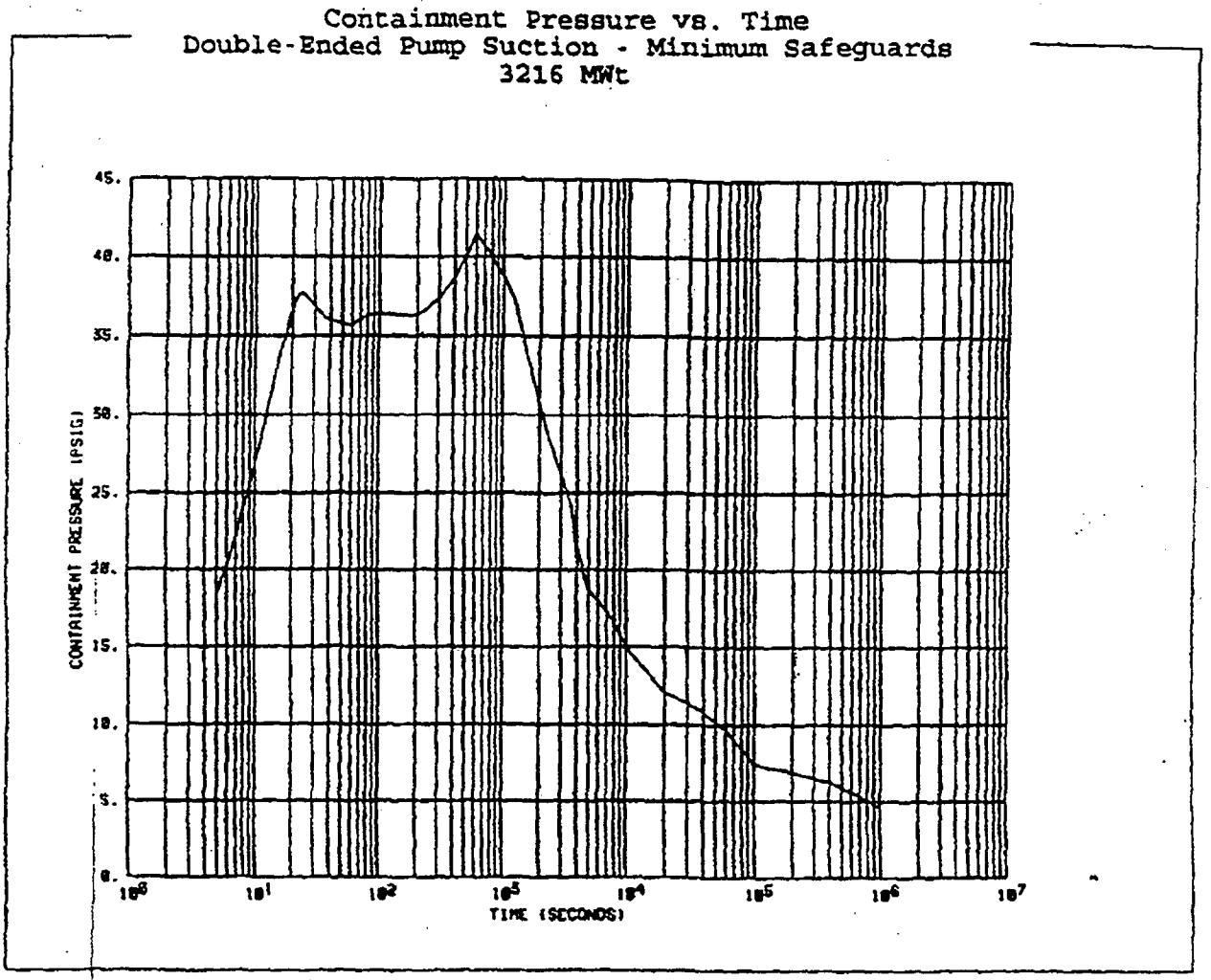

Containment Pressure vs. Time
Double-Ended Pump Suction - Minimum Safeguards
3216 MWt
CONTAINMENT PRESSURE (PSIG)
45.
40.
35.
30.
25.
20.
15.
10.
5.
0.
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
TIME (SECONDS)

Figure 3

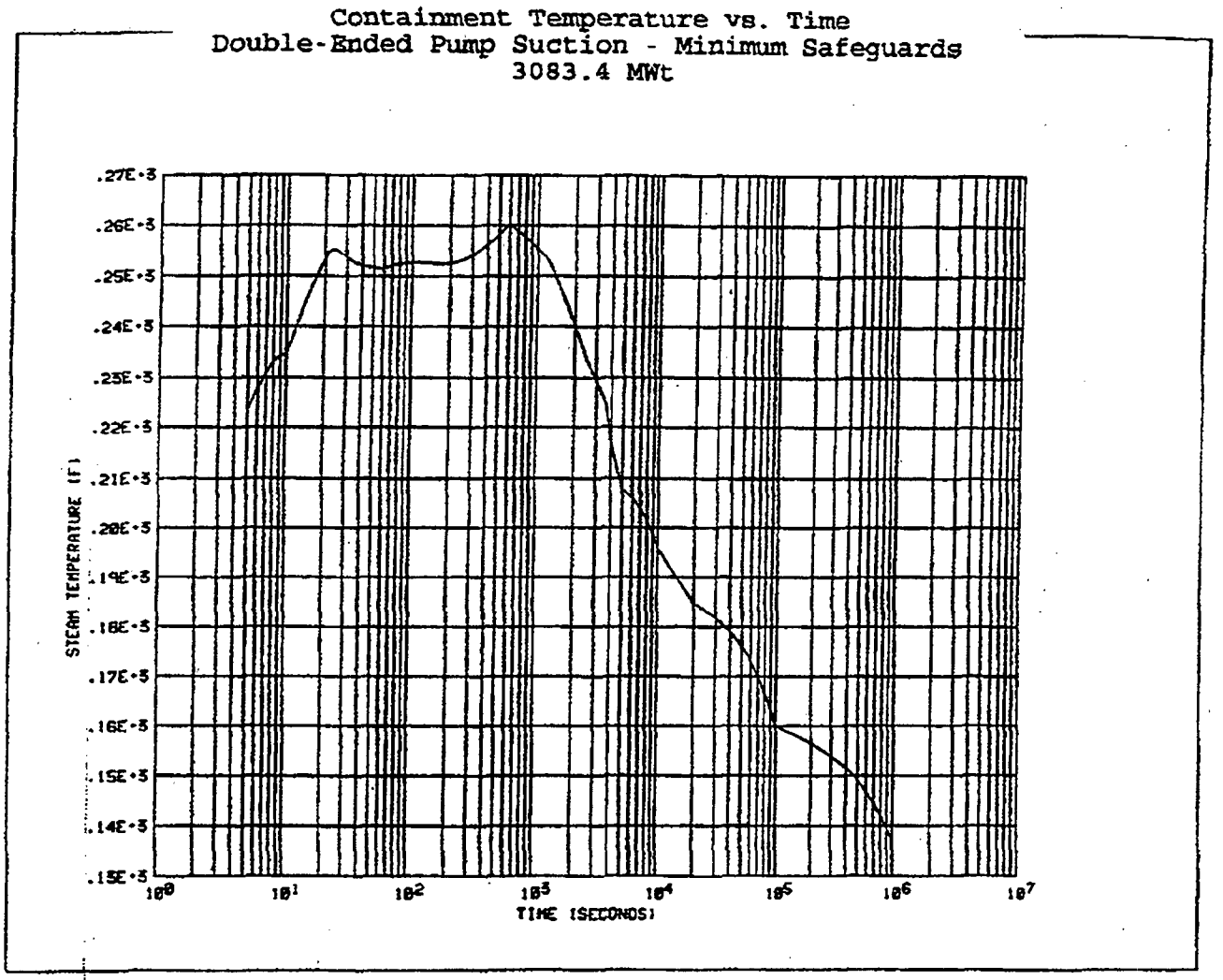

Containment Temperature vs. Time
Double-Ended Pump Suction - Minimum Safeguards
3083.4 MWt
STEAM TEMPERATURE (F)
.27E+3
.26E+3
.25E+3
.24E+3
.23E+3
.22E+3
.21E+3
.20E+3
.19E+3
.18E+3
.17E+3
.16E+3
.15E+3
.14E+3
.13E+3
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
TIME (SECONDS)

Figure 4

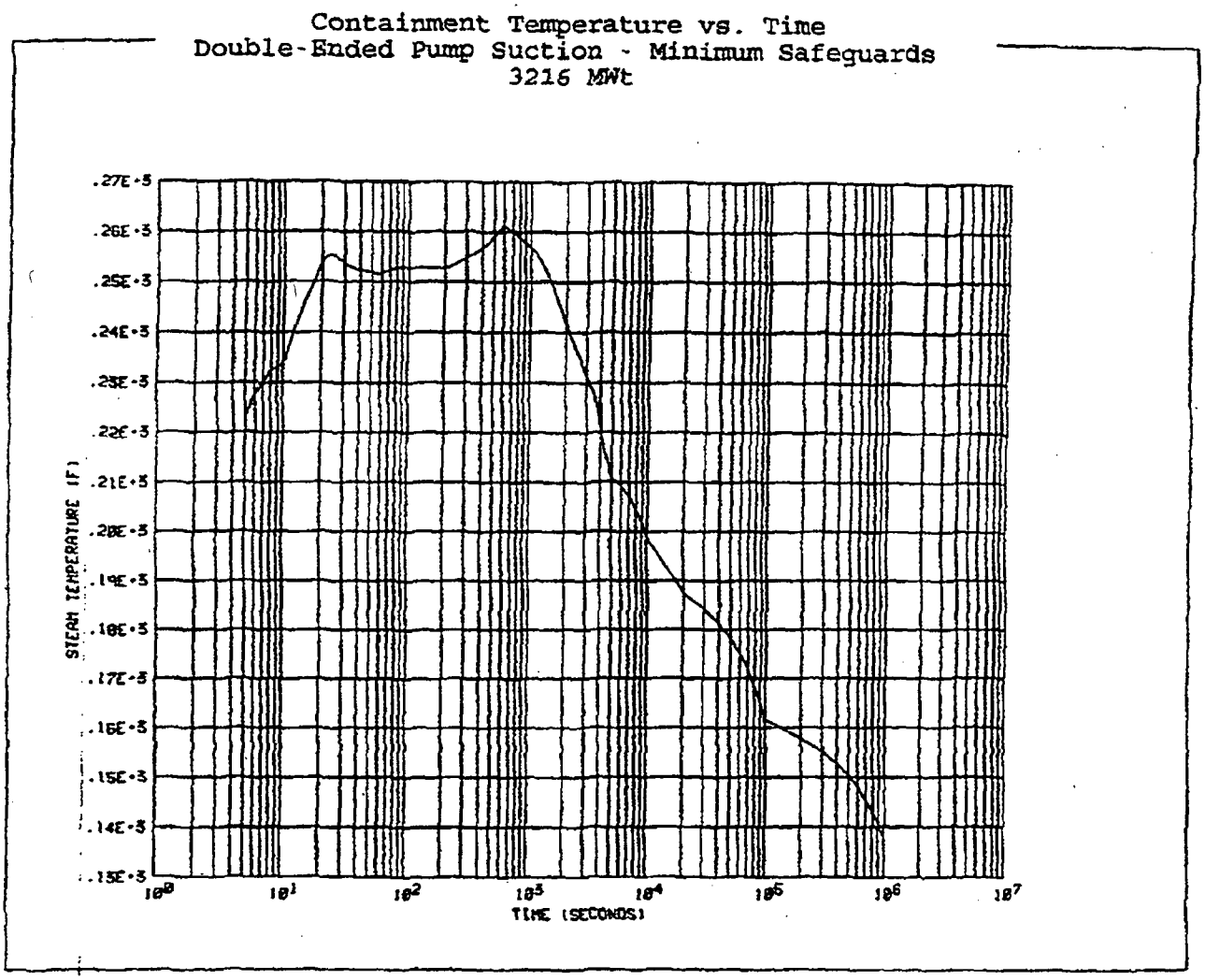
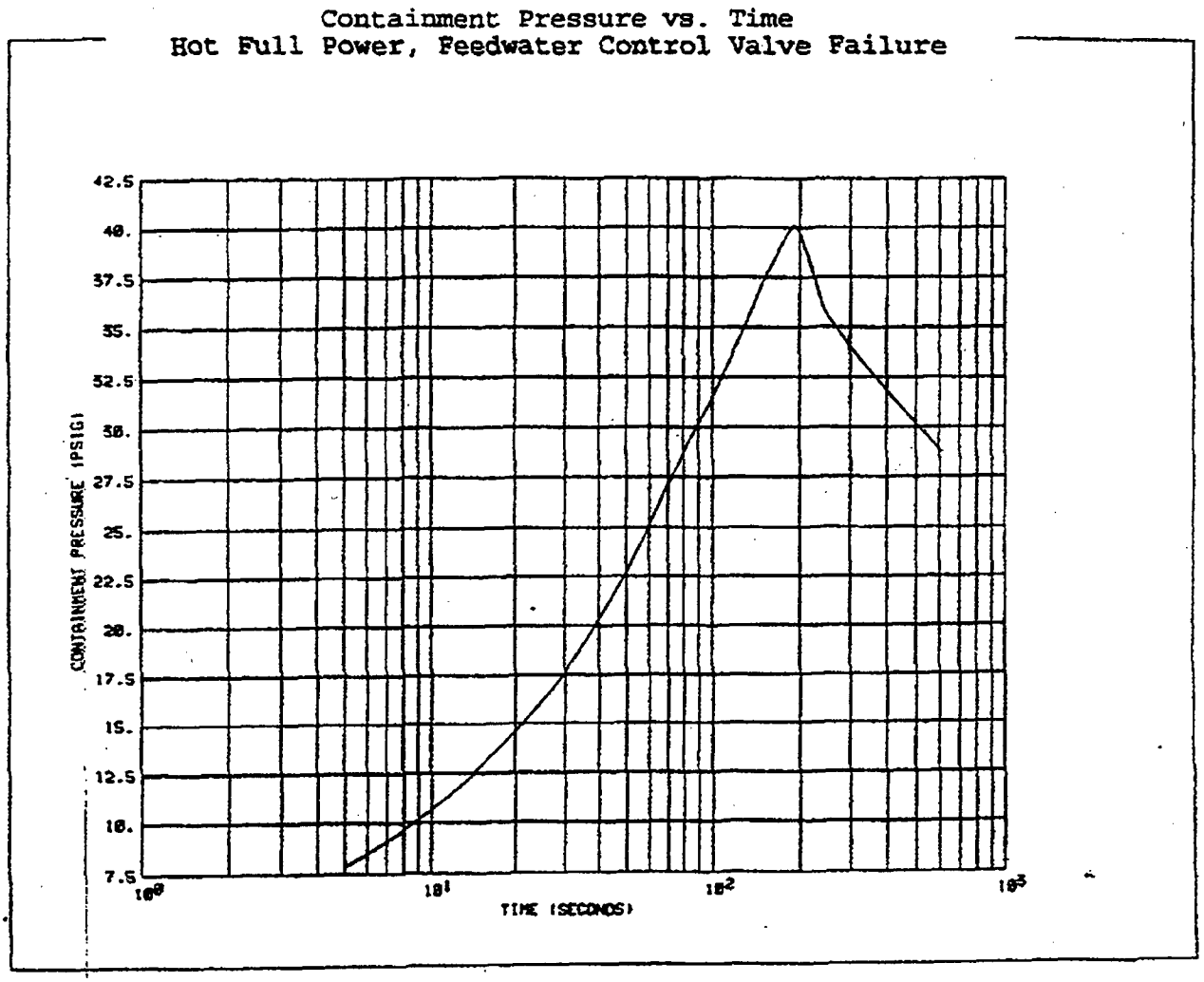

Containment Temperature vs. Time
Double-Ended Pump Suction - Minimum Safeguards
3216 MWt
STEAM TEMPERATURE (F)
.27E+3
.26E+3
.25E+3
.24E+3
.23E+3
.22E+3
.21E+3
.20E+3
.19E+3
.18E+3
.17E+3
.16E+3
.15E+3
.14E+3
.13E+3
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
TIME (SECONDS)

Figure 5


Containment Pressure vs. Time
Hot Full Power, Feedwater Control Valve Failure
CONTAINMENT PRESSURE (PSIG)
42.5
40.
37.5
35.
32.5
30.
27.5
25.
22.5
20.
17.5
15.
12.5
10.
7.5
10^0
10^1
10^2
10^3
TIME (SECONDS)

APPENDIX B

CONTAINMENT RESPONSE ANALYSIS

B.1 Introduction

The information provided is essentially identical with Westinghouse letter LTR-CRA-01-290 dated November 15, 2001. Information described here is used to determine the fan cooler power requirements for large LOCA, steamline break and small LOCA. Information used in the load study is provided in Section 3.2 of the report.

B.2 *Containment Response Calculations*

The COCO containment response computer code (Reference 3) typically used in design basis containment pressure calculations was used for the analysis cases described herein. Major assumptions for these cases are as follows:

NSSS Power (MWt)	3083.4
Reactor Core Power (MWt)	3071.4
Initial Containment Pressure (psig)	2 (16.7 psia)
Initial Containment Temperature (°F)	130
Initial Containment Relative Humidity (%)	20
Fan Cooler Data	
Service Water Temperature (°F)	95
Pressure Setpoint (psig)	10
Delay Time after Setpoint (Sec)	60
Fan Cooler Heat Removal Rate (Per unit, MBtu/hr at 240 °F)	53
Containment Spray System Data	
Pressure Setpoint (psig)	30
Delay Time after Setpoint (Sec)	60
Containment Spray Flow Rate (per pump) gpm	2200

Fan BHP converted directly to a power requirement (in kW) using:

BHP = 1758 * density (References 6 and 7)

Fan Power (kW)= Fan BHP * (.746) / Motor Efficiency (%)
(Assuming a conservative motor efficiency of 0.93; Reference 9, Sec 3.2)

B.3 Large Break Long-Term LOCA For Containment Integrity

The long-term LOCA mass and energy release and containment integrity analyses are performed to demonstrate the acceptability of the containment safeguards systems to mitigate the consequences of a design basis pipe break. The containment safeguards systems must be capable of removing the maximum possible discharge of mass and energy release to containment from the reactor coolant system to prevent containment pressure from exceeding the acceptance criteria peak design pressure of 47 psig (Technical Specification 3.6 Containment Bases).

The limiting single failure for the containment integrity design basis LOCA analysis is the loss of an emergency diesel generator (EDG# 23). This results in the loss of one train of safety injection (i.e., leaving two high head SI pumps and 1 RHR pump during the injection phase), the failure of one containment safeguards train (i.e., one containment spray pump), and the failure of one containment fan cooler. The Indian Point Unit 2 licensing basis (minimum safeguard case) also assumes one additional fan out of service. Loss of off-site power is assumed at event initiation.

The results of the containment integrity design basis LOCA analysis show that accounting for the plant modifications and subject changes to the accident analysis input assumptions, the calculated peak containment pressure following a postulated LOCA long-term mass and energy release is 43.0 psig. This analysis is described in the Reference 1 safety evaluation for the restart effort and is currently the analysis of record to support the licensing basis for Indian Point Unit 2.

Large break LOCA containment response transients (5 cases):

B.3.1 Case 1

(DBA / Licensing Basis Case: Double-Ended Pump Suction-Minimum Safeguards)

<u>Mass and Energy Release - Minimum Safeguards</u>

The limiting single failure that is assumed in the design basis LOCA analysis for containment integrity is the loss of an emergency diesel generator (EDG# 23). This results in the loss of one train of safety injection (i.e., leaving two high head SI pumps and 1 RHR pump) during the injection phase). A minimum flow alignment is assumed for the sump recirculation phase. The minimum delivered flow from either the recirculation pump or the RHR pump is modeled; consequently, the RHR pump flowrate is modeled through one RHR heat exchanger in the containment integrity analysis.

<u>Containment Equipment Alignment -Minimum Safeguards</u>

For minimum safeguards, 3 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 61.75 seconds into transient
Containment Sprays
Initiation time: 71.0 seconds into transient
Spray flow stopped at the RWST low-low level: 2354 seconds. (RWST is depleted;

recirculation spray is not considered in containment pressure analysis)

Containment Response Results
Containment Peak Pressure: 43.0 psig occurring at 1399 seconds
Containment Steam Temperature: 262.82° F occurring at 1399 seconds
Containment Pressure @ 24 hours: 8.681 psig
Containment Steam Temperature @ 24 hours: 166.88° F

Containment Pressure: Figure 1 for Case 1
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 1
Containment Density and Fan Motor Power: Figure 3 for Case 1

B.3.2 Case 2

(DBA / Licensing Basis Case: Double-Ended Pump Suction-Minimum Safeguards; with a modified containment model to effectively address an EDG 22 Failure except crediting only 1 RHR HX)

Mass and Energy Release - Minimum Safeguards (DBA Basis; Conservative for this case)

The limiting single failure that is assumed in the design basis LOCA analysis for containment integrity is the loss of an emergency diesel generator (EDG# 23). This results in the loss of one train of safety injection (i.e., leaving two high head SI pumps and 1 RHR pump) during the injection phase). A minimum flow alignment is assumed for the sump recirculation phase. The minimum delivered flow from either the recirculation pump or the RHR pump is modeled; consequently, the RHR pump flowrate is modeled through one RHR heat exchanger in the containment integrity analysis.

Containment Equipment Alignment

Available safeguard equipment consisting of 3 fan coolers and 2 containment spray pumps was assumed operational.

Fan Coolers
Initiation time: 61.75 seconds into transient
Containment Sprays
Initiation time: 71.0 seconds into transient
Spray flow stopped at the RWST low-low level: 1200 seconds. (Expected start of recirculation switchover; one spray pump would be left running until the RWST is empty (RWST low-low level); recirculation spray is not considered in containment integrity pressure analysis

Containment Response Results
Containment Peak Pressure: 39.4 psig occurring at 23.04 seconds
Containment Steam Temperature: 258.02° F occurring at 23.04 seconds
Containment Pressure @ 24 hours: 8.686 psig
Containment Steam Temperature @ 24 hours: 166.88° F

Containment Pressure: Figure 1 for Case 2
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 2
Containment Density and Fan Motor Power: Figure 3 for Case 2

B.3.3 Case 3

(DBA / Licensing Basis Case: Double-Ended Pump Suction-Minimum Safeguards; with a modified containment model to effectively address a scenario assuming all EDGs available with a limiting failure of one RHR pump; and continuous spray pump operation)

Mass and Energy Release - Minimum Safeguards (DBA Basis; Conservative for this case)

The limiting single failure that is assumed in the design basis LOCA analysis for containment integrity is the loss of an emergency diesel generator (EDG# 23). This results in the loss of one train of safety injection (i.e., leaving two high head SI pumps and 1 RHR pump) during the injection phase). A minimum flow alignment is assumed for the sump recirculation phase. The minimum delivered flow from either the recirculation pump or the RHR pump is modeled; consequently, the RHR pump flowrate is modeled through one RHR heat exchanger in the containment integrity analysis.

Containment Equipment Alignment

Available safeguard equipment consisting of 4 fan coolers and 2 containment spray pumps was assumed operational.

Fan Coolers
Initiation time: 61.75 seconds into transient
Containment Sprays
Initiation time: 71.0 seconds into transient
Spray flow stopped at the RWST low-low level: 2354 seconds (calculated time for minimum safeguards Case 1). RWST is depleted; recirculation spray is not considered in containment pressure analysis.

Containment Response Results
Containment Peak Pressure: 39.4 psig occurring at 23.04 seconds
Containment Steam Temperature: 258.02° F occurring at 23.04 seconds
Containment Pressure @ 24 hours: 6.655 psig
Containment Steam Temperature @ 24 hours: 152.8° F
Containment Pressure: Figure 1 for Case 3
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 3
Containment Density and Fan Motor Power: Figure 3 for Case 3

B.3.4 Case 4

(DBA / Licensing Basis Case: Double-Ended Pump Suction-Minimum Safeguards; with a modified containment model to effectively address a scenario assuming all EDGs available with a limiting failure of one RHR pump)
(Staggered containment spray pump operation)

Mass and Energy Release - Minimum Safeguards (DBA Basis; Conservative for this case)

The limiting single failure that is assumed in the design basis LOCA analysis for containment integrity is the loss of an emergency diesel generator (EDG# 23). This results in the loss of one train of safety injection (i.e., leaving two high head SI pumps and 1 RHR pump) during the injection phase). A minimum flow alignment is assumed for the sump recirculation phase. The minimum delivered flow from either the recirculation pump or the RHR pump is modeled; consequently, the RHR pump flowrate is modeled through one RHR heat exchanger in the containment integrity analysis.

Containment Equipment Alignment

Available safeguard equipment consisting of 4 fan coolers and 2 containment spray pumps was assumed operational.

Containment Spray Pump Operation during injection phase:

a) @ CS pressure setpoint and delay: start 2 CS pumps
b) @ 20 minutes into the containment response transient stop 1 CS pump
c) @ RWST Low-Low level (2354 seconds) stop remaining CS pump

Fan Coolers
Initiation time: 61.75 seconds into transient
Containment Sprays
Initiation time: 71.0 seconds into transient
(Spray pumps stopped during switchover as described above; recirculation spray is not considered in containment pressure analysis.

Containment Response Results
Containment Peak Pressure: 39.4 psig occurring at 23.04 seconds
Containment Peak Steam Temperature: 258.02° F occurring at 23.04 seconds
Containment Pressure @ 24 hours: 6.712 psig
Containment Steam Temperature @ 24 hours: 153.03° F

Containment Pressure: Figure 1 for Case 4
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 4
Containment Density and Fan Motor Power: Figure 3 for Case 4

B.3.5 Case 5

(DBA / Licensing Basis Case: Double-Ended Pump Suction-Minimum Safeguards; with a modified containment model to effectively address a scenario assuming all EDGs available with an alternate limiting failure of one CTS pump)

Mass and Energy Release - Minimum Safeguards (DBA Basis; Conservative for this case)

The limiting single failure that is assumed in the design basis LOCA analysis for containment integrity is the loss of an emergency diesel generator (EDG# 23). This results in the loss of one train of safety injection (i.e., leaving two high head SI pumps and 1 RHR pump) during the injection phase). A minimum flow alignment is assumed for the sump recirculation phase. The minimum delivered flow from either the recirculation pump or the RHR pump is modeled; consequently, the RHR pump flowrate is modeled through one RHR heat exchanger in the containment integrity analysis.

Containment Equipment Alignment

Available safeguard equipment consisting of 4 fan coolers and 1 containment spray pump was assumed operational.

Fan Coolers
Initiation time: 61.75 seconds into transient
Containment Sprays
Initiation time: 71.0 seconds into transient
Spray flow stopped at the RWST low-low level: 2354 seconds (calculated time for minimum safeguards Case 1). RWST is depleted; recirculation spray is not considered in containment pressure analysis.

Containment Response Results
Containment Peak Pressure: 40.27 psig occurring at 496.83 seconds
Containment Steam Temperature: 258.7° F occurring at 496.83 seconds
Containment Pressure @ 24 hours: 6.644 psig
Containment Steam Temperature @ 24 hours: 152.86° F

Containment Pressure: Figure 1 for Case 5
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 5
Containment Density and Fan Motor Power: Figure 3 for Case 5

B.4 Main Steam Line Break For Containment Integrity

The long-term steam line break (SLB) mass and energy release and containment integrity analyses are performed to demonstrate the acceptability of the containment safeguards systems to mitigate the consequences of a design basis pipe break. The containment safeguards systems must be capable of removing the maximum possible discharge of mass and energy release to containment from the reactor coolant system to prevent containment pressure from exceeding the acceptance criteria peak design pressure of 47 psig (Technical Specification 3.6 Containment Bases).

The limiting single failure for the containment integrity design basis SLB analysis (References 4 and 5) is the hot full power case, with the limiting single failure assumed to be the failure of a feedwater control valve (FCV) in the faulted loop to close. The containment model credits 2 containment spray pumps and 5 fan coolers. One train of safety injection is assumed unavailable (i.e., leaving two high head SI pumps during the injection phase).

The results of the containment integrity design basis MSLB analysis show that accounting for the plant modifications and subject changes to the accident analysis input assumptions, the calculated peak containment pressure following a postulated MSLB long-term mass and energy release is 37.52 psig occurring at 349.55 seconds. This analysis is documented in Reference 4 and presented in the RSG SECL Reference 5. The evaluation for the Restart Effort Reference 1 revalidated the results for restart and continued operation and is currently the analysis of record and the support the licensing basis for Indian Point Unit 2.

B.4.1 Case 6

(DBA Licensing Basis; ~605 seconds transient)

<u>Mass and Energy Release - Minimum Safeguards</u>

The break mass and energy release break flow rates were from Reference 4. The limiting single failure for the containment integrity design basis SLB analysis is the hot full power case, with the single limiting single failure assumed to be the failure of a feedwater control valve (FCV) in the faulted loop to close. One train of safety injection is assumed unavailable (i.e., leaving two high head SI pumps during the injection phase).

<u>Containment Equipment Alignment -Maximum Safeguards</u>

For maximum safeguards 5 fan coolers and 2 containment spray pumps were assumed operational.
Fan Coolers
Initiation time: 76.65 seconds into transient
Containment Sprays
Initiation time: 264.0 seconds into transient

Containment Response Results

Containment Peak Pressure: 37.52 psig occurring at 349.55 seconds
Containment Steam Temperature: 259.4° F occurring at 39.0 seconds
Containment Pressure @ 24 hours: n/a
Containment Steam Temperature @ 24 hours: n/a

Containment Pressure: Figure 1 for Case 6
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 6
Containment Density and Fan Motor Power: Figure 3 for Case 6

B.4.2 Case 7

(Double Failure Scenario: FCV -Secondary and EDG - Containment)

Mass and Energy Release - Minimum Safeguards

The break mass and energy release break flow rates were from Reference 4. The limiting single failure for the containment integrity design basis SLB analysis is the hot full power case, with the single limiting single failure assumed to be the failure of a feedwater control valve (FCV) in the faulted loop to close. One train of safety injection is assumed unavailable (i.e., leaving two high head SI pumps during the injection phase).

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards 3 fan coolers and 1 containment spray pump was assumed operational.
Fan Coolers
Initiation time: 76.65 seconds into transient
Containment Sprays
Initiation time: 255.0 seconds into transient
Spray Pumped stopped at 1500 seconds
(Note: 17.0 psig pressure setpoint occurs at: ~ 1963 seconds)

Containment Response Results
Containment Peak Pressure: 39.48 psig occurring at 353.35 seconds
Containment Steam Temperature: 259.4° F occurring at 39.0 seconds
Containment Pressure @ 24 hours: n/a
Containment Steam Temperature @ 24 hours: n/a

Containment Pressure: Figure 1 for Case 7
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 7
Containment Density and Fan Motor Power: Figure 3 for Case 7

B.5 Small Break LOCA

The break flow mass and energy release rates were taken from Reference 2 [SEC-SAI-4389-C0, "Indian Point Unit 2 (IPP) Small Break LOCA Analysis for Vantage+ Fuel Upgrade", January 21, 1994]. This small break study (for EDG Loading) consisted of both 3-inch and 4- inch cases. Sensitivity cases were run using the mass and energy release as presented from Reference 2 and also assuming safety injection spill to containment. Tow of three HHSI pumps inject into the RCS.

B.5.1 Case 8

(4" Small Break LOCA - 1 containment spray pump and 3 fan coolers; without Safety Injection (SI) water spill to containment)

Mass and Energy Release

4" LOCA (Injection phase mass and energy release)

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards, 3 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 123.0 seconds into transient
Containment Sprays
Initiation time: 3811.0 seconds into transient

Containment Response Results
Containment Peak Pressure: 30.15 psig occurring at 3846.99 seconds
Containment Steam Temperature: 240.22° F occurring at 3846.99 seconds
Containment Pressure @ end of transient (2 hours): 20.51 psig (declining)
Containment Steam Temperature @ end of transient (2 hours): 216.1° F (declining)

Containment Pressure: Figure 1 for Case 8
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 8
Containment Density and Fan Motor Power: Figure 3 for Case 8

B.5.2 Case 9

(4" Small Break LOCA - 1 containment spray pump and 3 fan coolers; with Safety Injection (SI) water spill flow to containment)

Mass and Energy Release

4" LOCA (Injection phase mass and energy release)

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards, 3 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 123.0 seconds into transient
Containment Sprays
Initiation time: 3822.0 seconds into transient

Containment Response Results
Containment Peak Pressure: 30.18 psig occurring at 3836.13 seconds
Containment Steam Temperature: 240.21° F occurring at 3836.13 seconds
Containment Pressure @ end of transient (2 hours): 20.56 psig (declining)
Containment Steam Temperature @ end of transient (2 hours): 216.07° F (declining)

Containment Pressure: Figure 1 for Case 9
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 9
Containment Density and Fan Motor Power: Figure 3 for Case 9

B.5.3 Case 10

(4" Small Break LOCA - 1 containment spray pump and 4 fan coolers; without Safety Injection (SI) water spill flow to containment)

Mass and Energy Release

4" LOCA (Injection phase mass and energy release)

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards, 4 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 123.0 seconds into transient
Containment Sprays
Initiation time: Pressure setpoint not met; spray not on

Containment Response Results
Containment Peak Pressure: 26.4 psig occurring at 7200 seconds (Pressure still increasing due to M&E constant flow rate from ~3000 seconds on.)
Containment Steam Temperature: 231.86° F occurring at 7200 seconds
Containment Pressure @ end of transient (2 hours): 26.4 psig (increasing)
Containment Steam Temperature @ end of transient (2 hours): 231.86° F (increasing)

Containment Pressure: Figure 1 for Case 10
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 10
Containment Density and Fan Motor Power: Figure 3 for Case 10

B.5.4 Case 11

(4" Small Break LOCA - 1 containment spray pump and 4 fan coolers; **with Safety Injection (SI) water spill flow to containment)**

Mass and Energy Release

4" LOCA (Injection phase mass and energy release)

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards, 4 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 123.0 seconds into transient
Containment Sprays
Initiation time: Pressure setpoint not met; spray not on

Containment Response Results
Containment Peak Pressure: 26.48 psig occurring at 7200 seconds (Pressure still increasing due to M&E constant flow rate from ~3000 seconds on.)
Containment Steam Temperature: 231.92° F occurring at 7200 seconds
Containment Pressure @ end of transient (2 hours): 26.48 psig (increasing)
Containment Steam Temperature @ end of transient (2 hours): 231.92° F (increasing)

Containment Pressure: Figure 1 for Case 11
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 11
Containment Density and Fan Motor Power: Figure 3 for Case 11

B.5.5 Case 12

(4" Small Break LOCA - 1 containment spray pump and 5 fan coolers; without Safety Injection (SI) water spill flow to containment)

Mass and Energy Release

4" LOCA (Injection phase mass and energy release)

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards, 5 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 123.0 seconds into transient
Containment Sprays
Initiation time: Pressure setpoint not met; spray not on

Containment Response Results
Containment Peak Pressure: 22.96 psig occurring at 793 seconds

Containment Steam Temperature: 223.49° F occurring at 792.7 seconds
Containment Pressure @ end of transient (2 hours): 20.68 psig (Although pressure is increasing due to M&E constant flow rate from ~3000 seconds on.) (increasing)
Containment Steam Temperature @ end of transient (2 hours): 216.98° F (increasing)

Containment Pressure: Figure 1 for Case 12
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 12
Containment Density and Fan Motor Power: Figure 3 for Case 12

B.5.6 Case 13

(4" Small Break LOCA - 1 containment spray pump and 5 fan coolers; **with Safety Injection (SI) water spill flow to containment)**

Mass and Energy Release

4" LOCA (Injection phase mass and energy release)

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards, 5 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 123.0 seconds into transient
Containment Sprays
Initiation time: Pressure setpoint not met; spray not on

Containment Response Results
Containment Peak Pressure: 22.98 psig occurring at 793.17 seconds
Containment Steam Temperature: 223.52° F occurring at 792.77 seconds
Containment Pressure @ end of transient (2 hours): 20.76 psig (Although pressure is increasing due to M&E constant flow rate from ~3000 seconds on.) (increasing)
Containment Steam Temperature @ end of transient (2 hours): 217.06° F (increasing)

Containment Pressure: Figure 1 for Case 13
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 13
Containment Density and Fan Motor Power: Figure 3 for Case 13

B.5.7 Case 14

(3" Small Break LOCA - 1 containment spray pump and 3 fan coolers; without Safety Injection (SI) water spill flow to containment)

Mass and Energy Release

3" LOCA (Injection phase mass and energy release)

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards, 3 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 199.5 seconds into transient
Containment Sprays
Initiation time: Pressure setpoint not met; spray not on

Containment Response Results
Containment Peak Pressure: 28.78 psig occurring at 7200 seconds (Pressure still increasing due to M&E constant flow rate from ~3000 seconds on.)
Containment Steam Temperature: 237.3° F occurring at 7200 seconds
Containment Pressure @ end of transient (2 hours): 28.78 psig (increasing)
Containment Steam Temperature @ end of transient (2 hours): 237.3° F (increasing)

Containment Pressure: Figure 1 for Case 14
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 14
Containment Density and Fan Motor Power: Figure 3 for Case 14

B.5.8 Case 15

(3" Small Break LOCA - 1 containment spray pump and 3 fan coolers; **with accumulator spill flow to containment)**

Mass and Energy Release

3" LOCA (Injection phase mass and energy release)

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards, 3 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 199.5 seconds into transient
Containment Sprays
Initiation time: Pressure setpoint not met; spray not on

Containment Response Results
Containment Peak Pressure: 28.88 psig occurring at 7200 seconds (Pressure still increasing due to M&E constant flow rate from ~3000 seconds on.)
Containment Steam Temperature: 237.38° F occurring at 7200 seconds
Containment Pressure @ end of transient (2 hours): 28.88 psig (increasing)
Containment Steam Temperature @ end of transient (2 hours): 237.38° F (increasing)

Containment Pressure: Figure 1 for Case 15
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 15
Containment Density and Fan Motor Power: Figure 3 for Case 15

B.5.9 Case 16

(3" Small Break LOCA - **modified for reduced Decay Heat effects)**- 1 containment spray pump and 3 fan coolers; without Safety Injection (SI) water spill flow to containment)

Mass and Energy Release

3" LOCA (Injection phase mass and energy release; **modified for reduced Decay Heat effects**)

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards, 3 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 199.5 seconds into transient
Containment Sprays
Initiation time: Pressure setpoint not met; spray not on

Containment Response Results
Containment Peak Pressure: 26.28 psig occurring at 5660.38 seconds
Containment Steam Temperature: 231.68° F occurring at 5650.38 seconds
Containment Pressure @ end of transient (2 hours): 26.07 psig (decreasing)
Containment Steam Temperature @ end of transient (2 hours): 231.16° F (decreasing)

Containment Pressure: Figure 1 for Case 16
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 16
Containment Density and Fan Motor Power: Figure 3 for Case 16

B.5.10 Case 17

(3" Small Break LOCA - **modified for reduced Decay Heat effects)**- 1 containment spray pump and 3 fan coolers; **with Safety Injection (SI) water spill flow to containment)**

Mass and Energy Release

3" LOCA (Injection phase mass and energy release; **modified for reduced Decay Heat effects**)

Containment Equipment Alignment -Minimum Safeguards

For minimum safeguards, 3 fan coolers and 1 containment spray pump were assumed operational.
Fan Coolers
Initiation time: 199.5 seconds into transient
Containment Sprays

Initiation time: Pressure setpoint not met; spray not on

Containment Response Results
Containment Peak Pressure: 26.35 psig occurring at 5679.81 seconds
Containment Steam Temperature: 231.74° F occurring at 5654.81 seconds
Containment Pressure @ end of transient (2 hours): 26.16 psig (decreasing)
Containment Steam Temperature @ end of transient (2 hours): 231.25° F (decreasing)

Containment Pressure: Figure 1 for Case 17
Containment Atmosphere and Sump Temperatures: Figure 2 for Case 17
Containment Density and Fan Motor Power: Figure 3 for Case 17

B.6 References

1. IPP-00-413, "Consolidated Edison Company of New York Indian Point Unit 2 **Transmittal of SECL-00-164 -- Indian Point Unit 2 Restart Support**", December 20, 2000.

2. SEC-SAI-4389-C0, "Indian Point Unit 2 (IPP) Small Break LOCA Analysis for Vantage+ Fuel Upgrade", January 21, 1994.

3. Bordelon, F. M. and E. T. Murphy, "Containment Pressure Analysis Code (COCO), WCAP-8327", July 1974.

4. CN-CRA-00-62-R0, "Indian Point Unit 2 (IPP) Main Steam Line Break (MSLB) Inside Containment for the Replacement Steam Generator Model 44F, Mass and Energy Releases and Containment Response", August 21, 2000.

5. SECL-00-191, Rev. 1, "Replacement Steam Generator Evaluation".

6. CN-EMT-00-222-R0, "IP2 RCFC HEPA & Charcoal Filter Elimination Fan Performance", November 29, 2000.

7. LTR-EMT-00-1791, "Indian Point No. 2 RCFC Fan/Motor Performance Evaluation with HEPA and Charcoal Filters Removed", November 29, 2000.

8. CN-POE-01-20-R0, Miscellaneous Calculations for the Indian Point Unit 2 Emergency Diesel Generator Loading Study, October 15, 2001.

9. WCAP-12655 Revision 1, "Indian Point Unit 2 Emergency Diesel Generator Loading Study", May 1996. (Not attached)

Figure 1 for Case 1

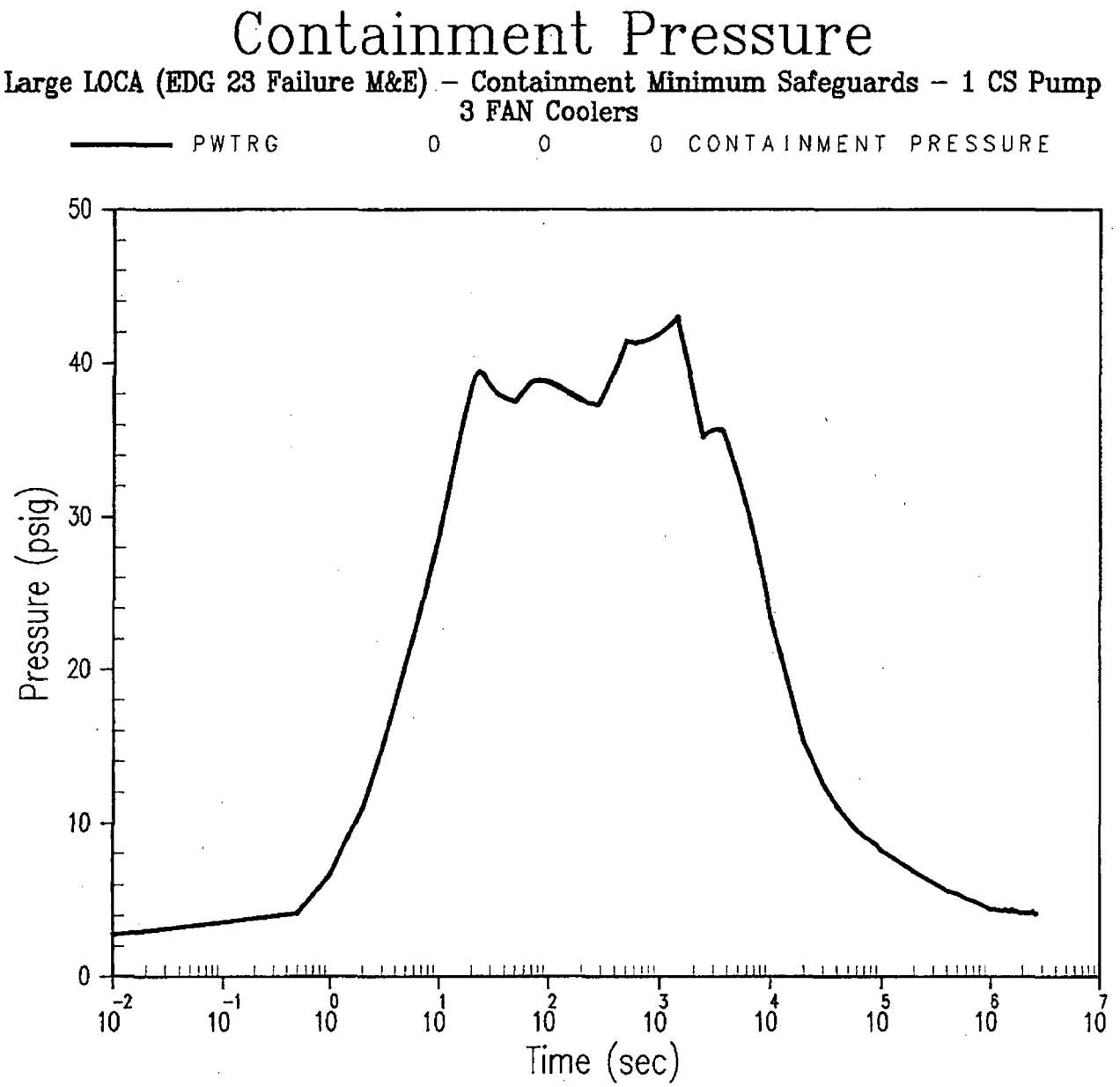


Figure 2 for Case 1

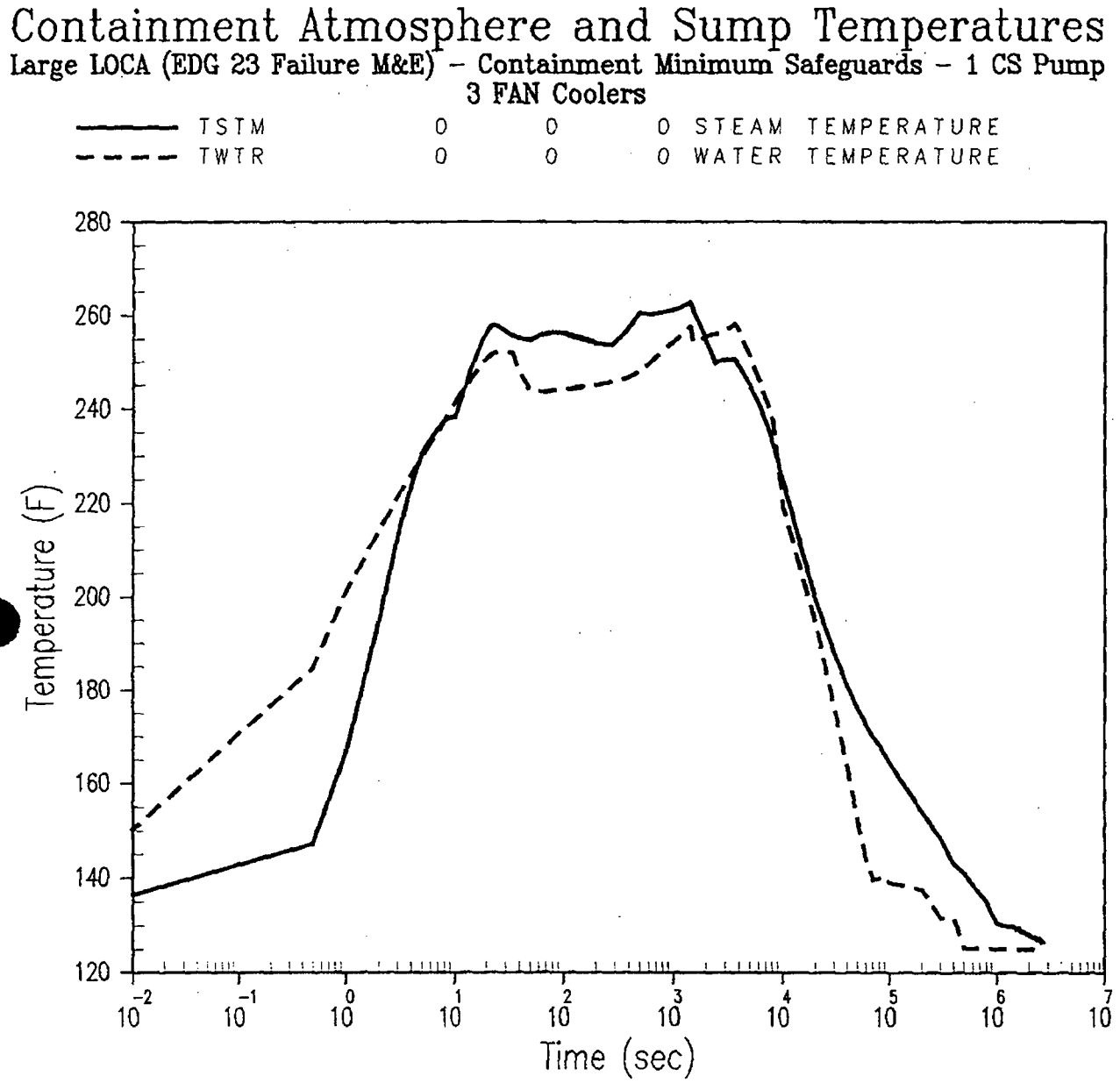


Figure 3 for Case 1

Containment Density and Fan Motor Power

Large LOCA (EDG 23 Failure M&E) – Containment Minimum Safeguards – 1 CS Pump 3 FAN Coolers

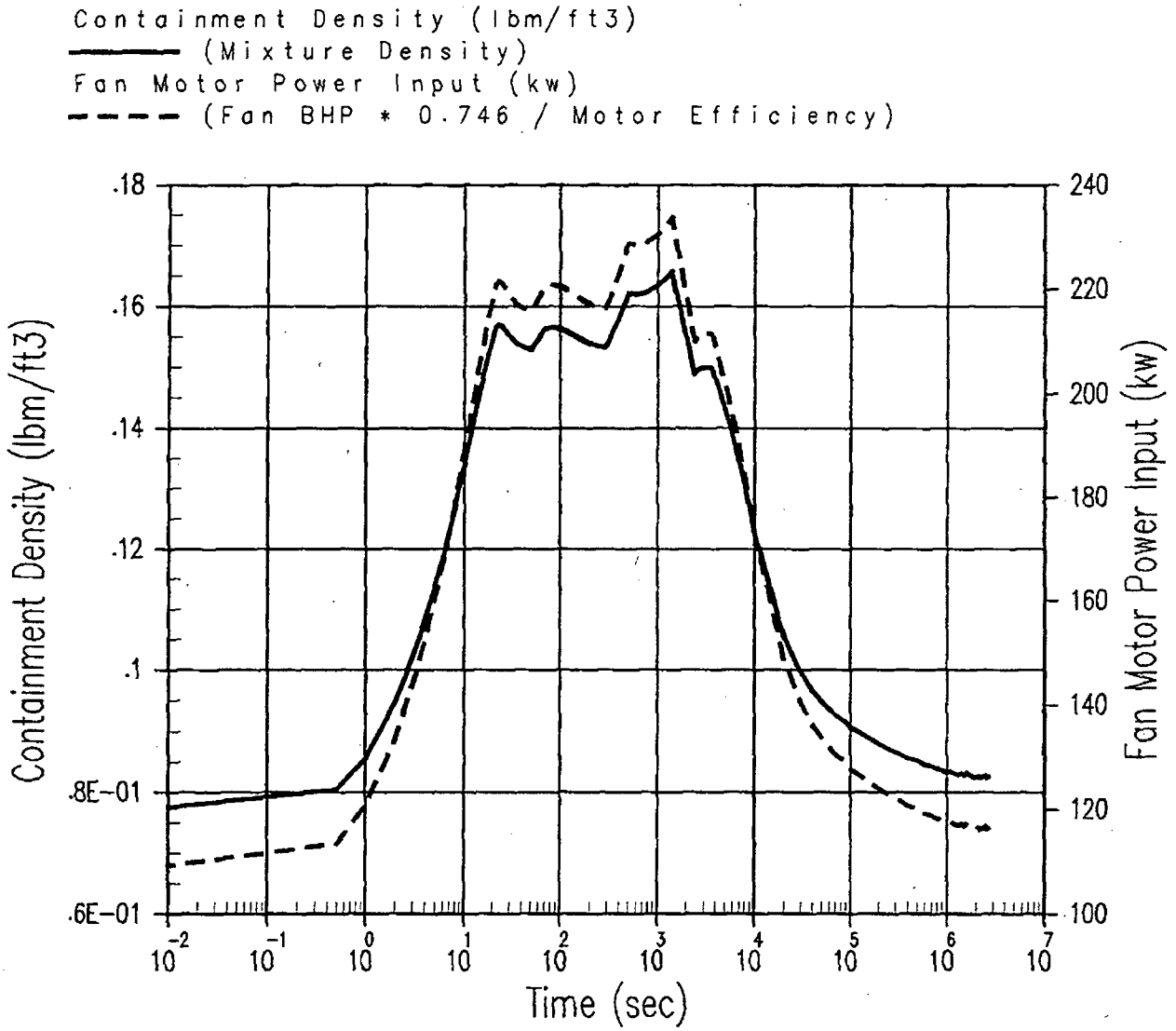


Figure 1 for Case 2

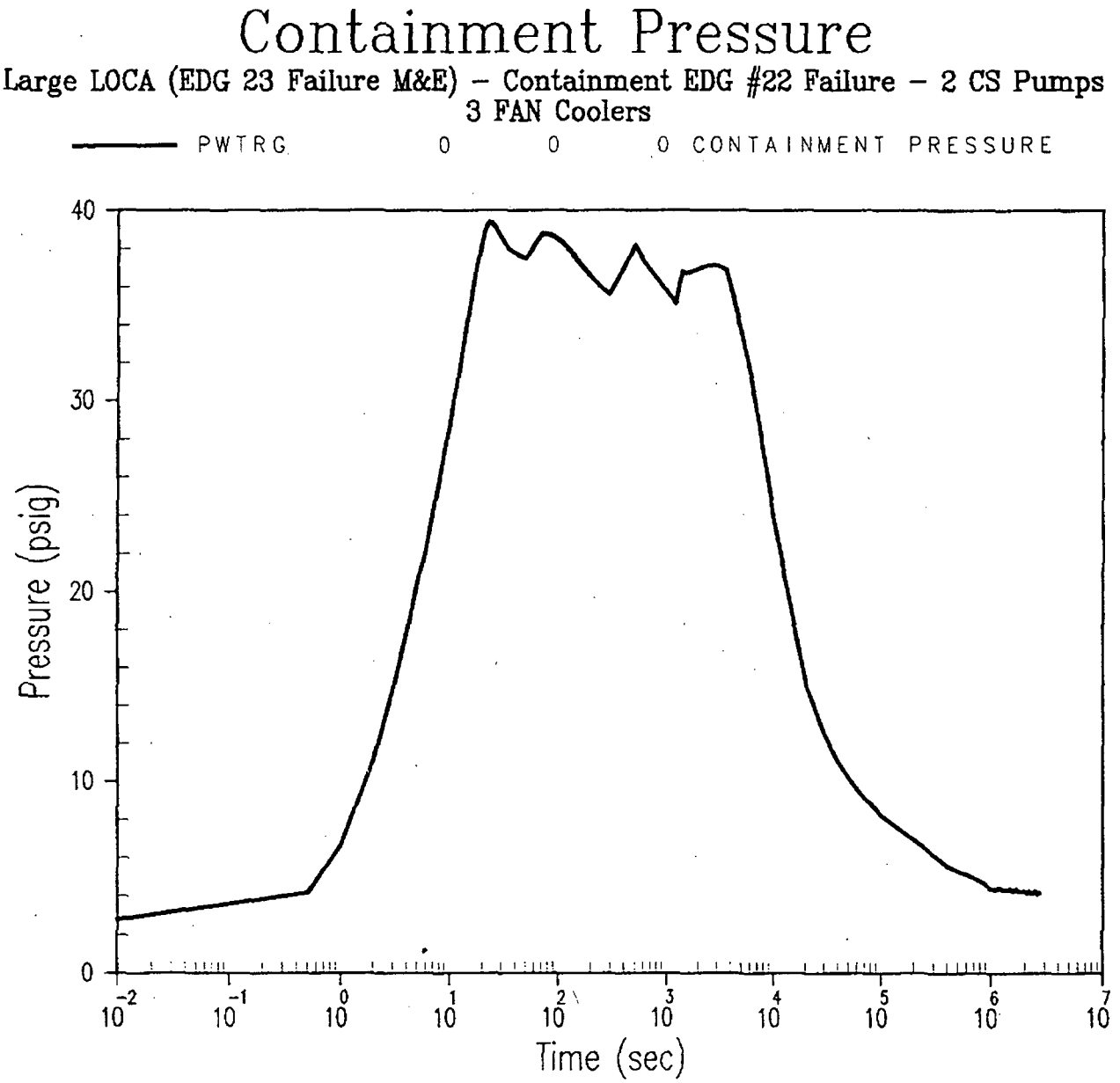


Figure 2 for Case 2

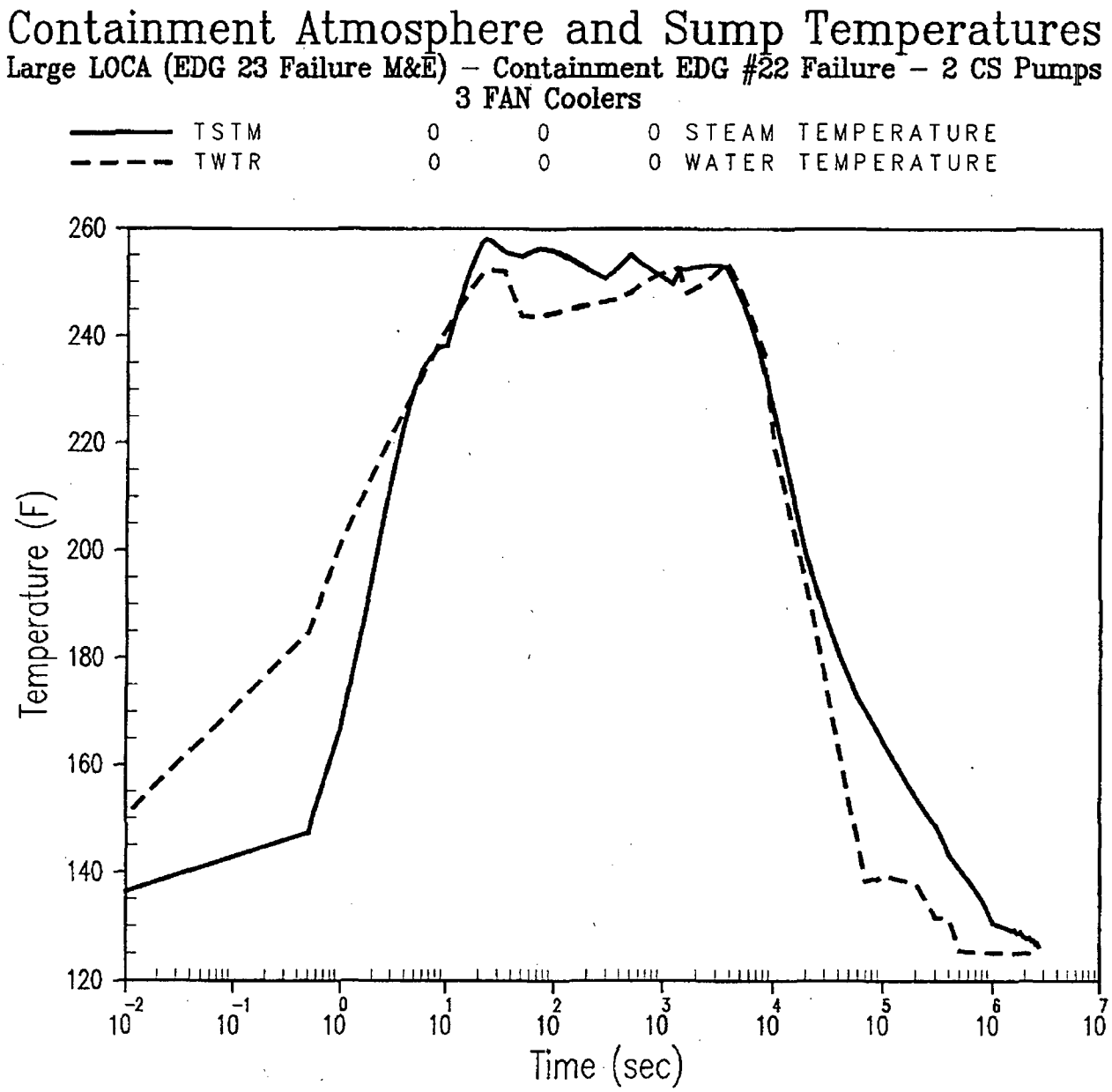


Figure 3 for Case 2

Containment Density and Fan Motor Power

Large LOCA (EDG 23 Failure M&E) – Containment EDG #22 Failure – 2 CS Pumps 3 FAN Coolers

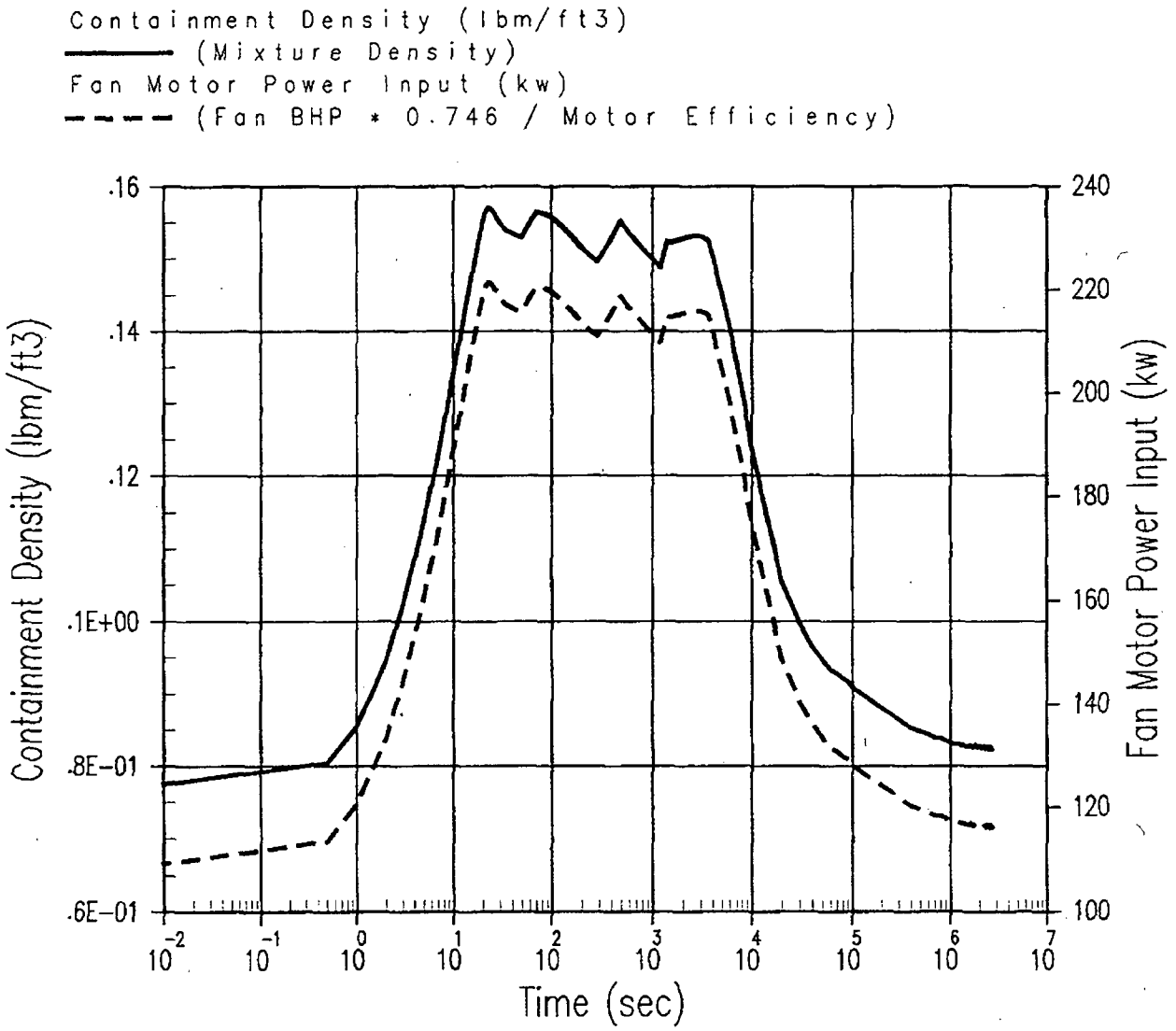


Figure 1 for Case 3

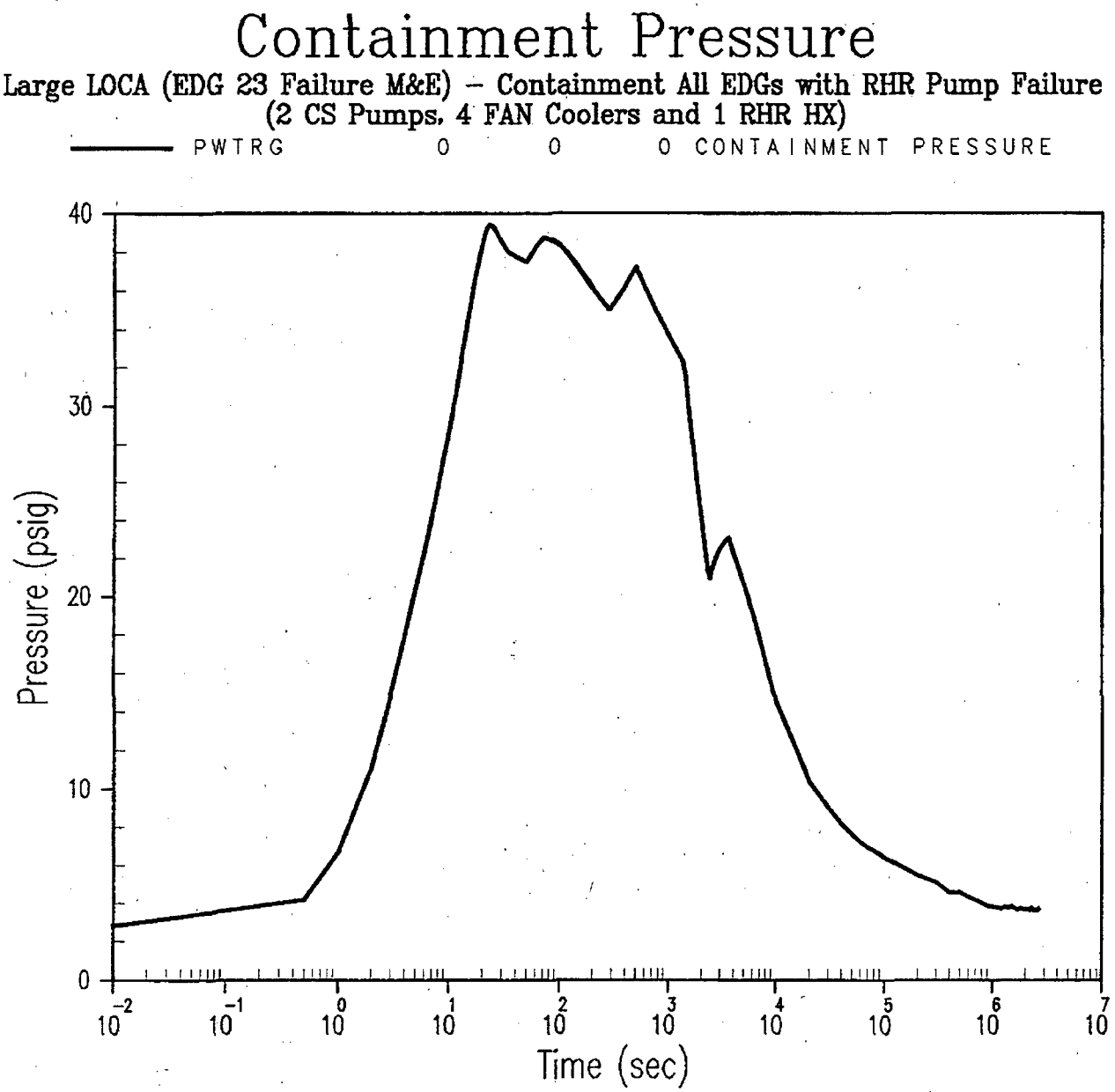


Figure 2 for Case 3

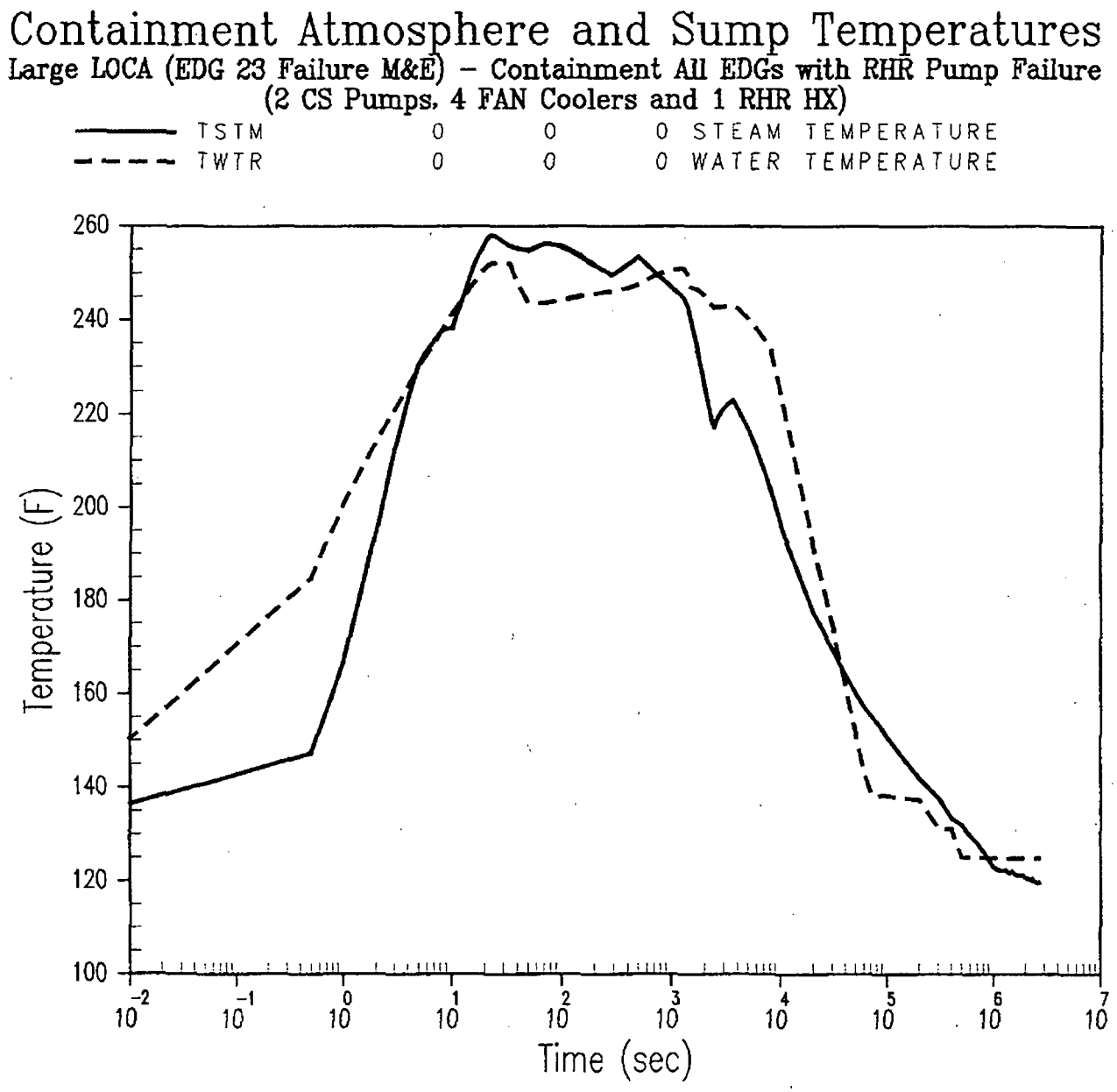


Figure 3 for Case 3

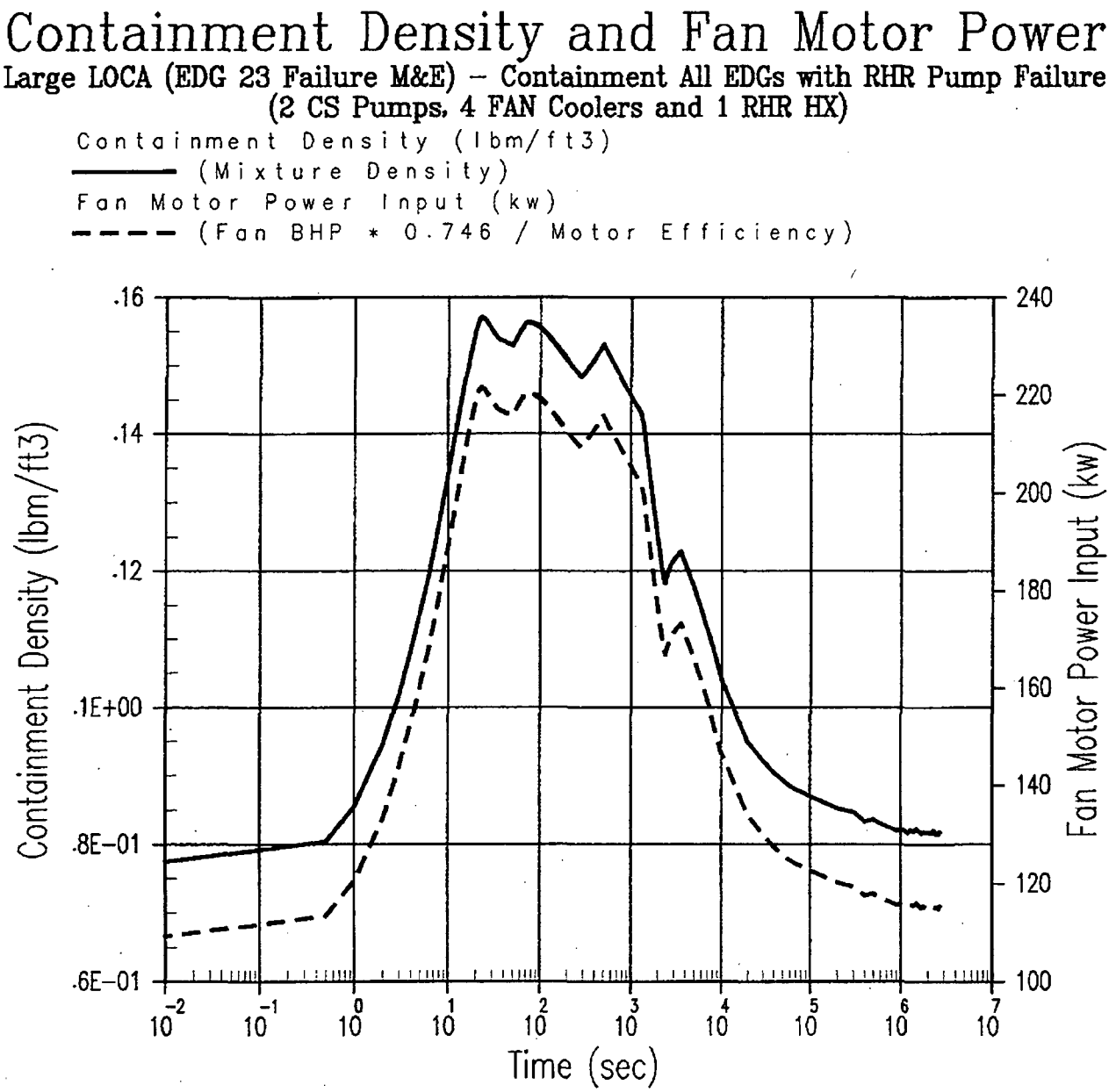


Figure 1 for Case 4

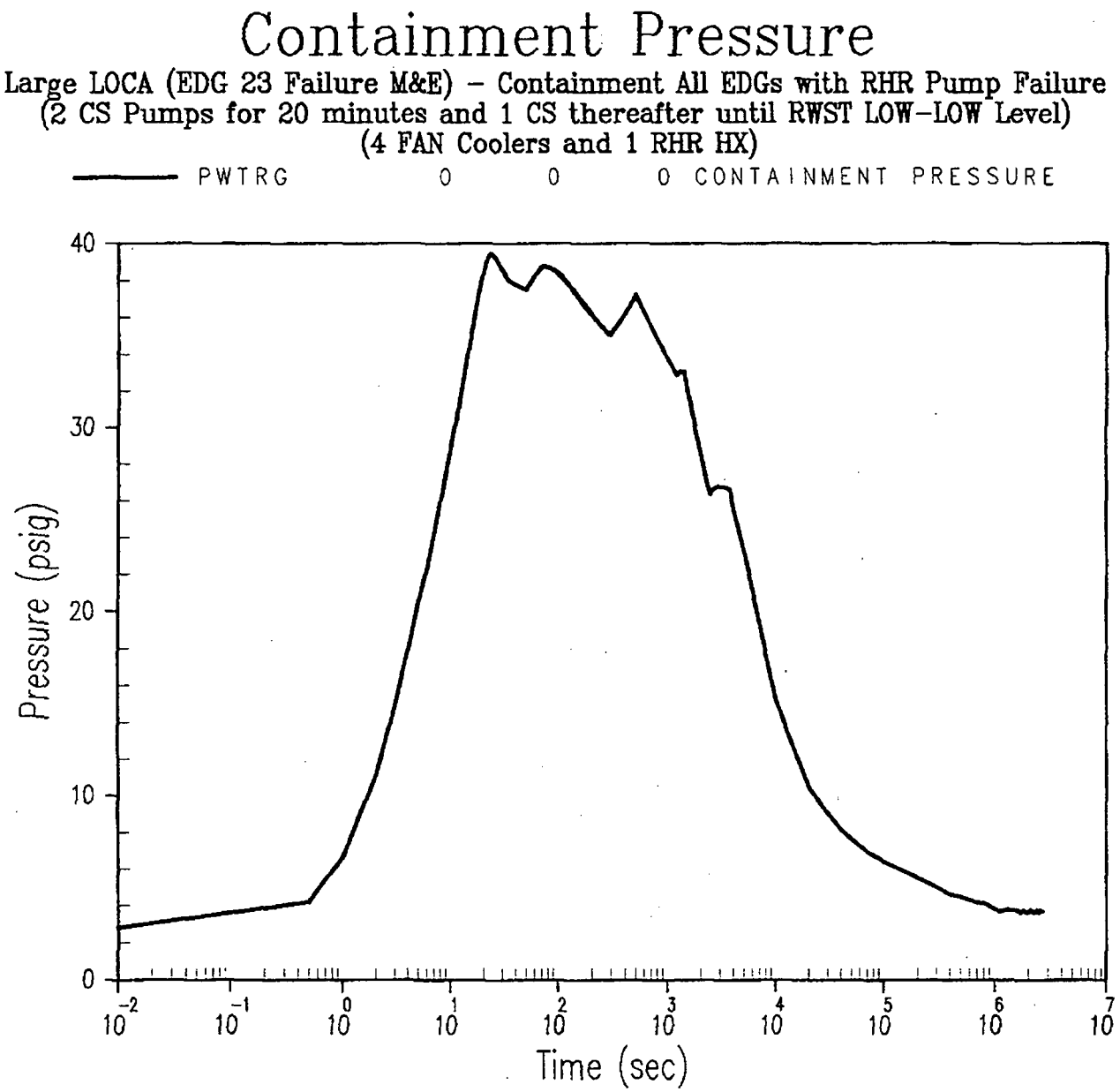


Figure 2 for Case 4

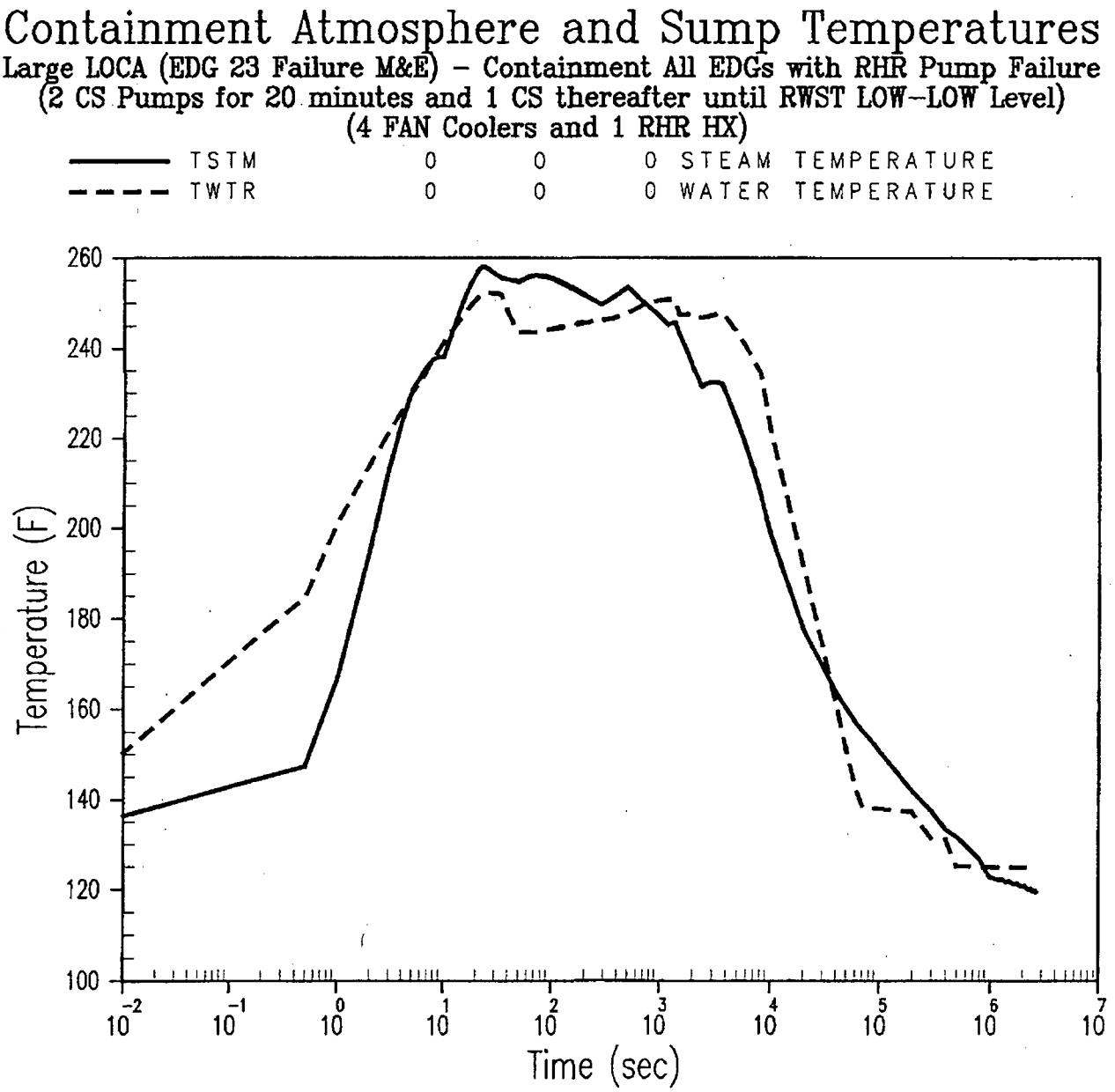


Figure 3 for Case 4

Containment Density and Fan Motor Power

Large LOCA (EDG 23 Failure M&E) - Containment All EDGs with RHR Pump Failure
(2 CS Pumps for 20 minutes and 1 CS thereafter until RWST LOW-LOW Level)
(4 FAN Coolers and 1 RHR HX)

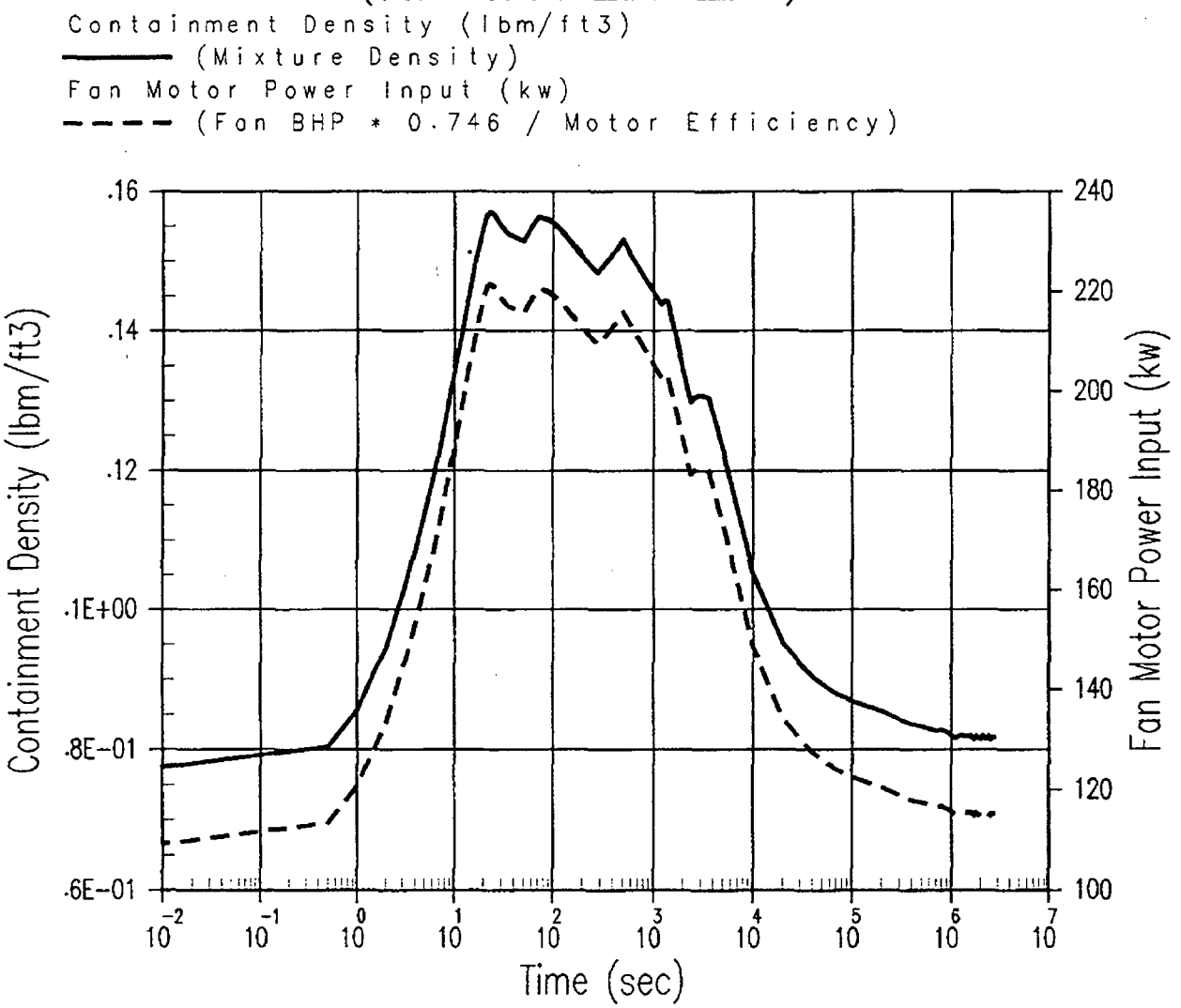


Figure 1 for Case 5

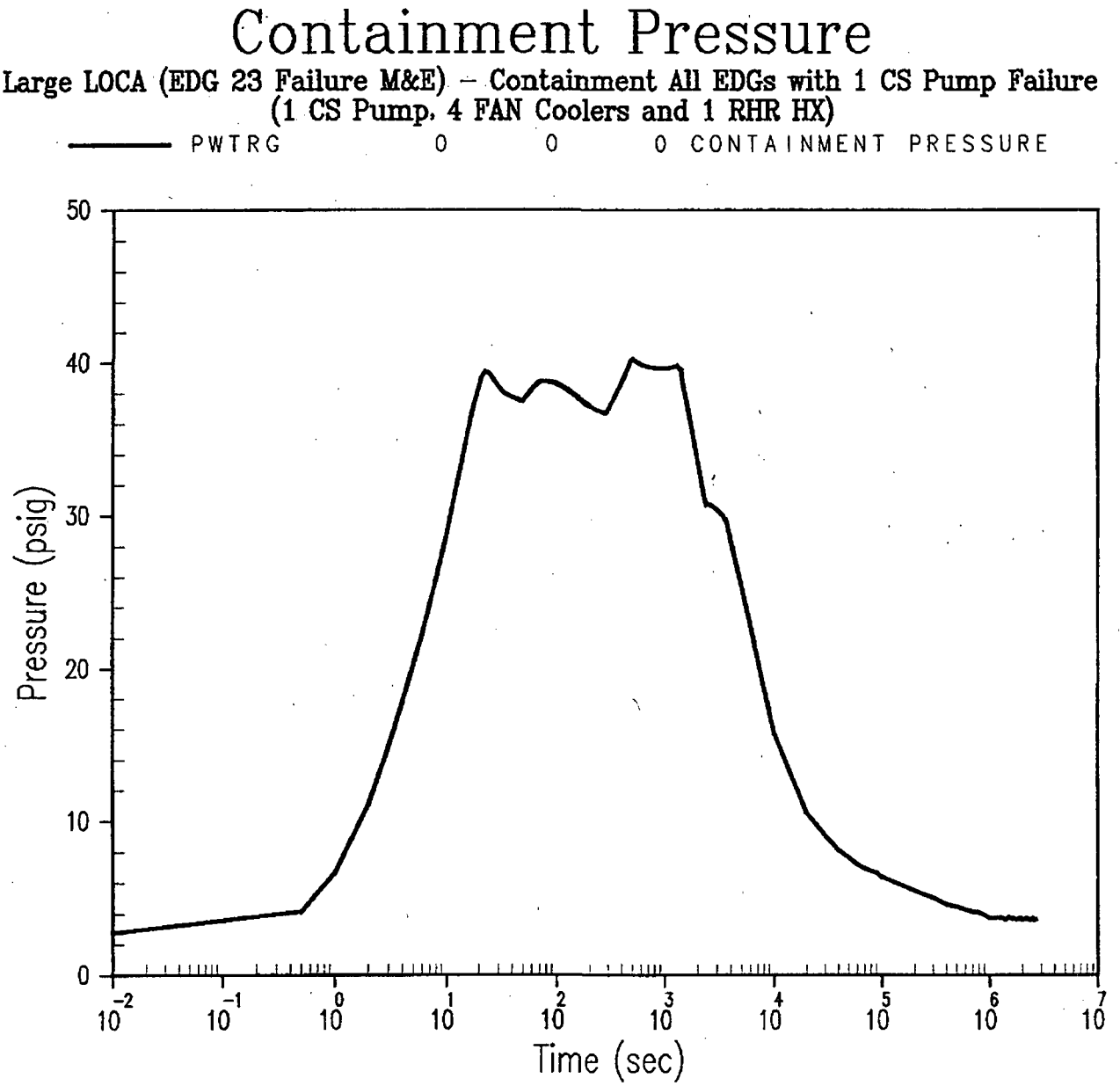


Figure 2 for Case 5

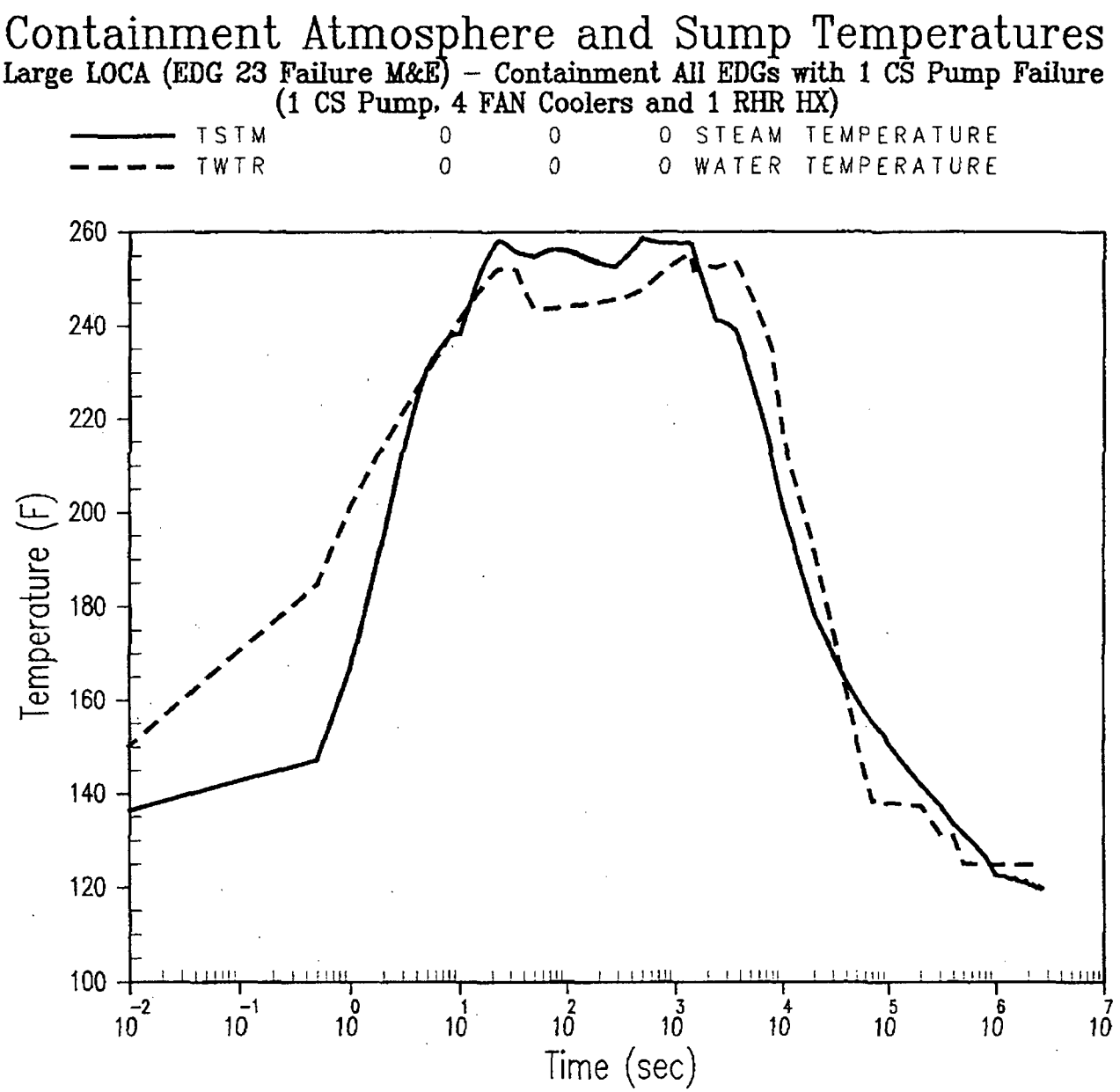


Figure 3 for Case 5

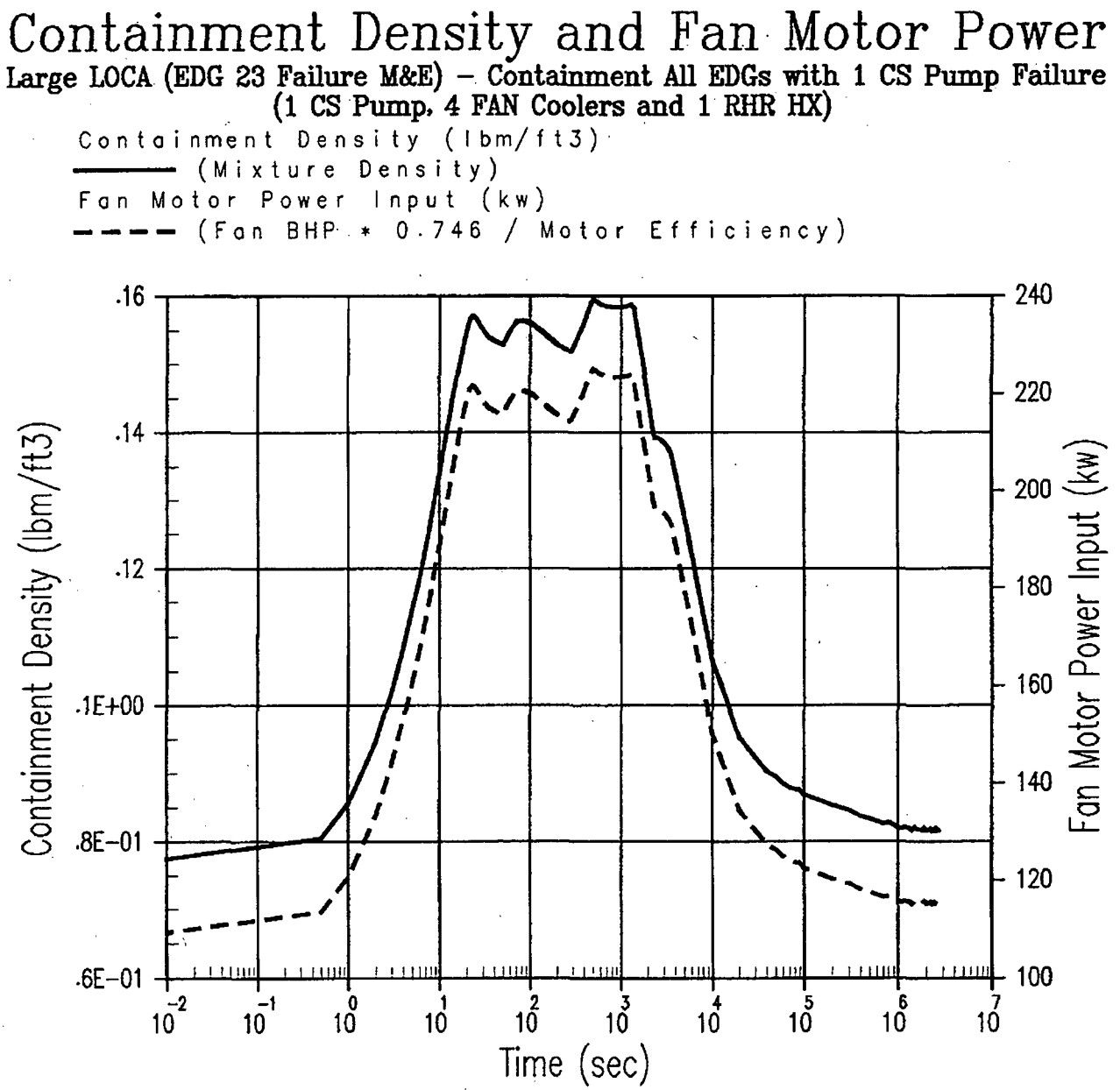


Figure 1 for Case 6

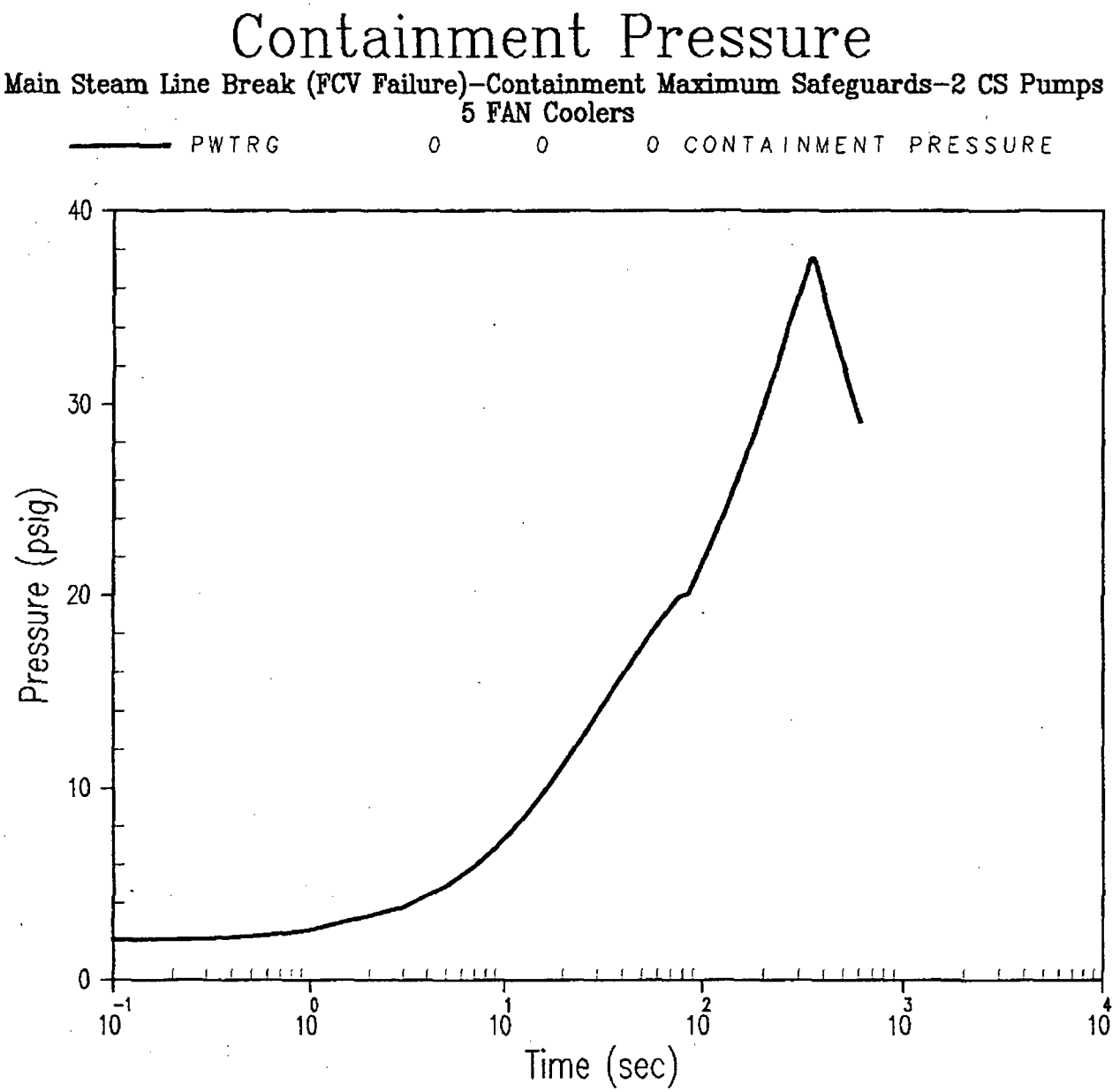


Figure 2 for Case 6

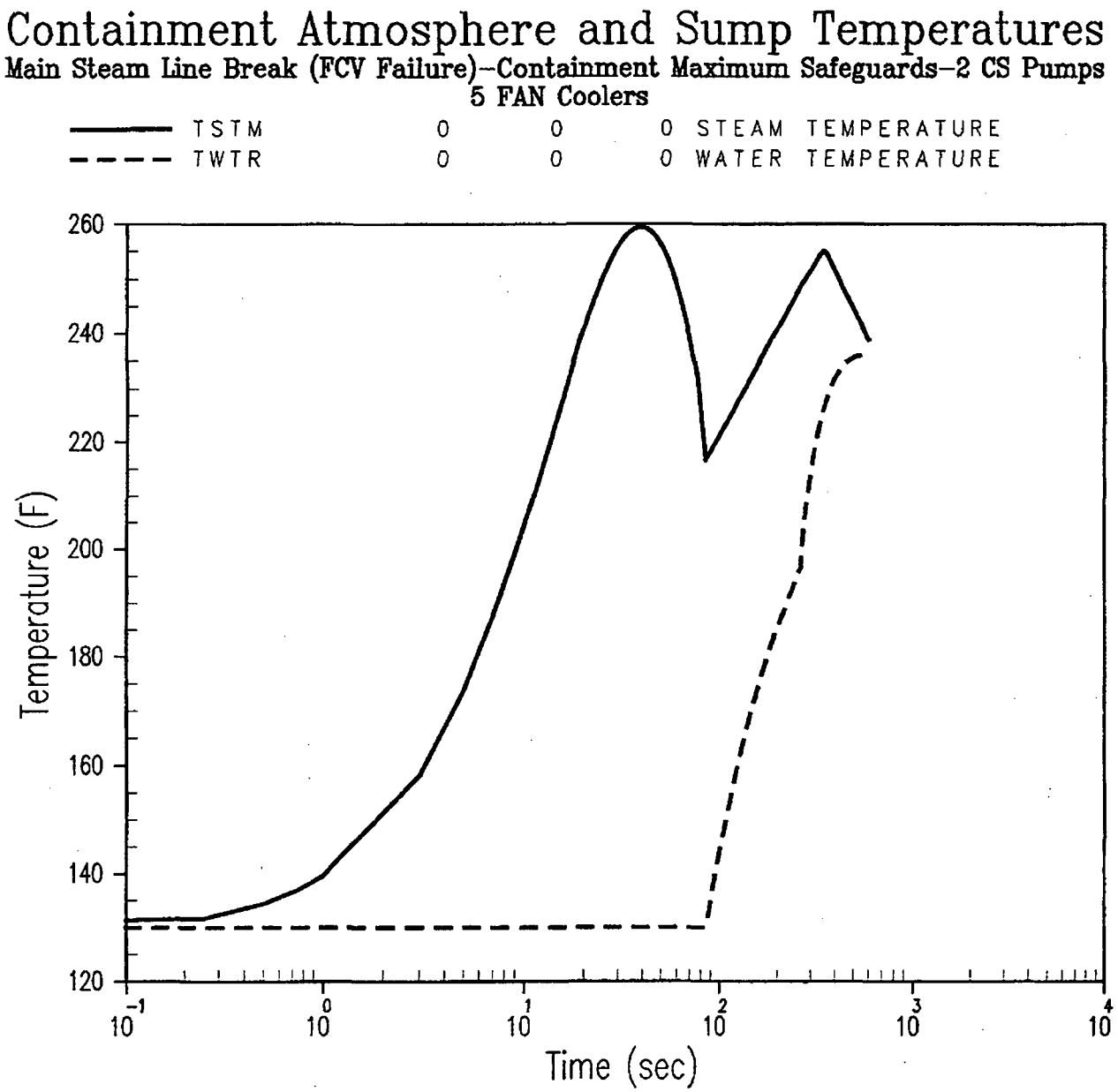


Figure 3 for Case 6

Containment Density and Fan Motor Power

Main Steam Line Break (FCV Failure)–Containment Maximum Safeguards–2 CS Pumps 5 FAN Coolers

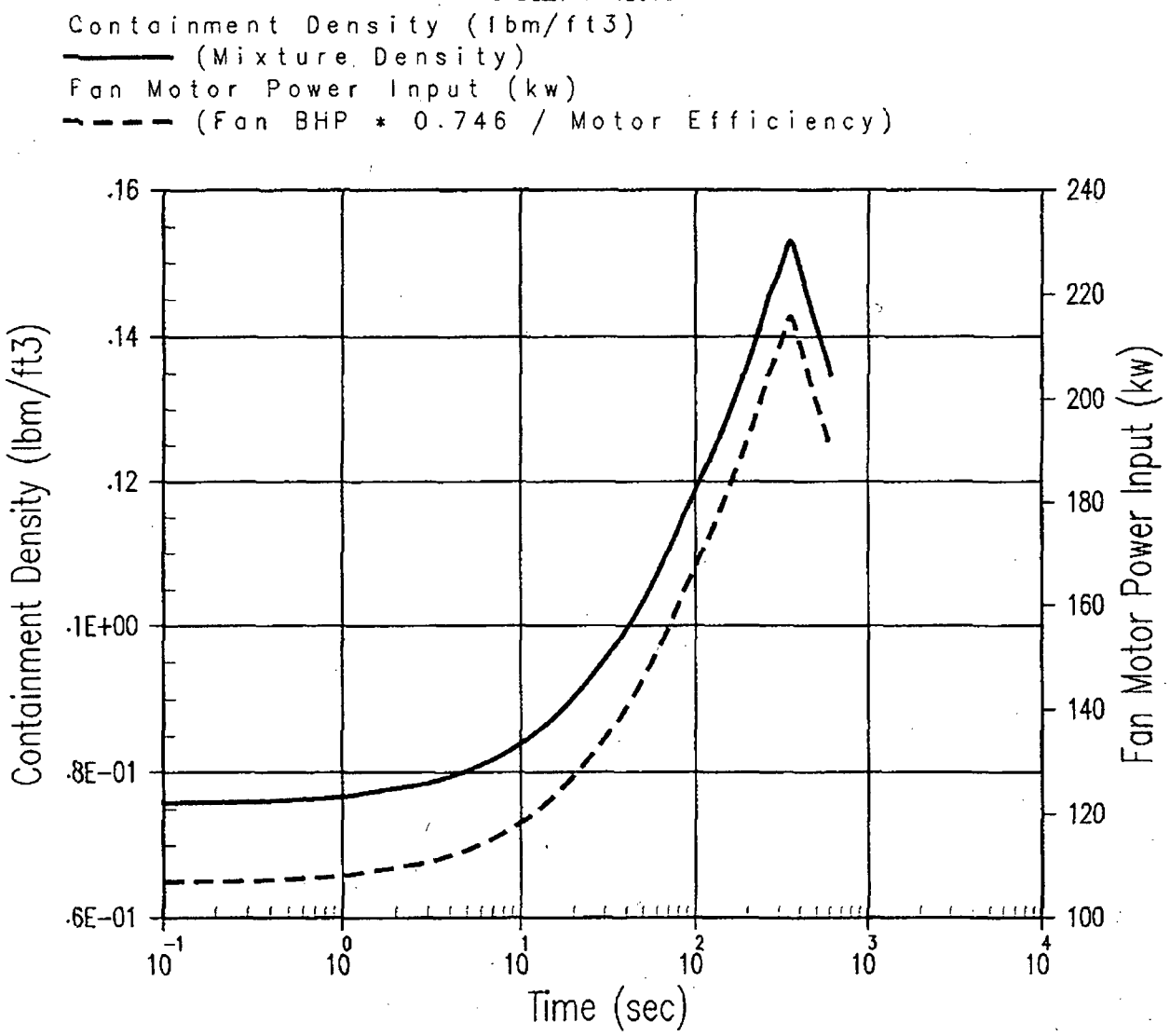


Figure 1 for Case 7

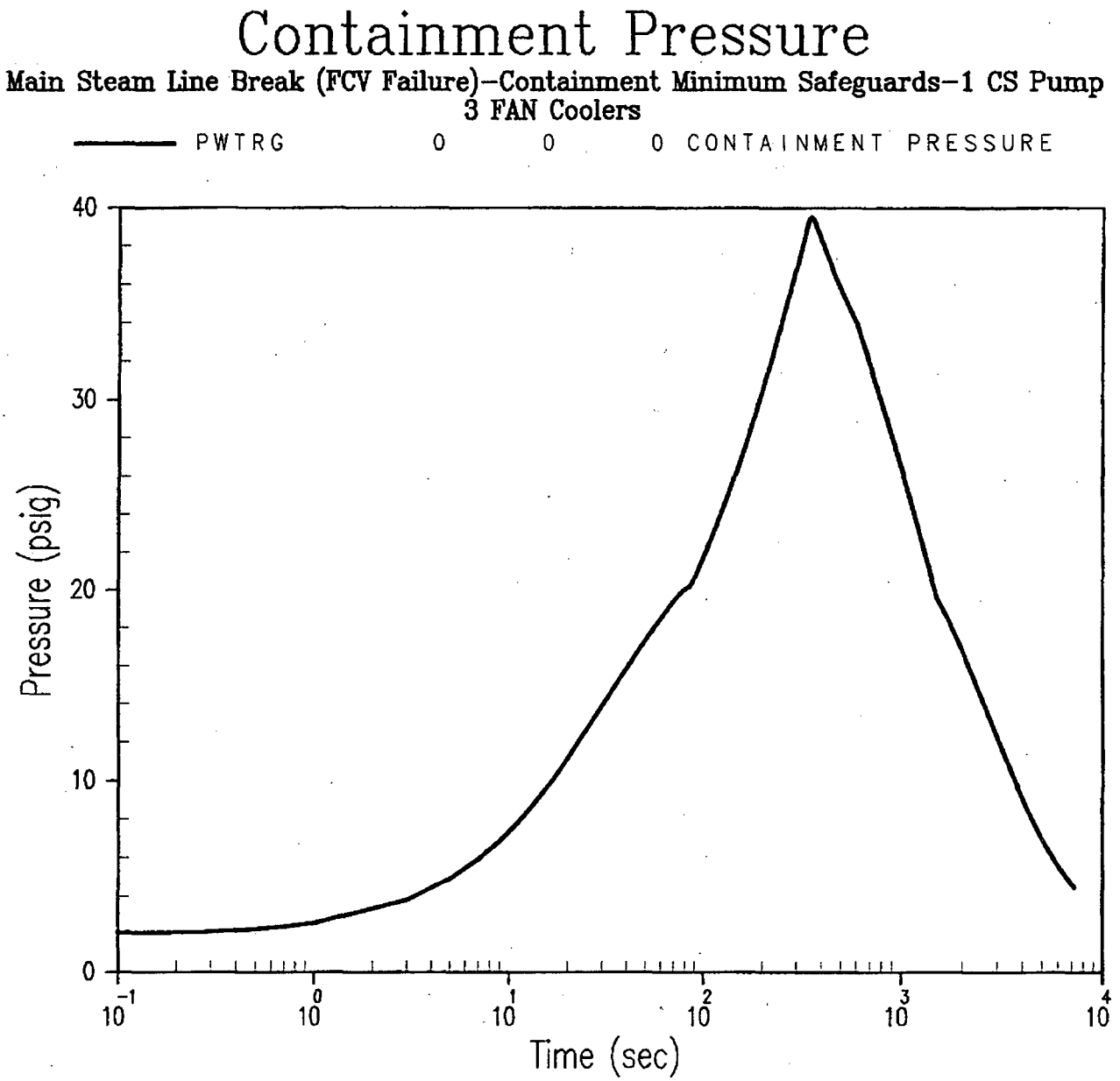


Figure 2 for Case 7

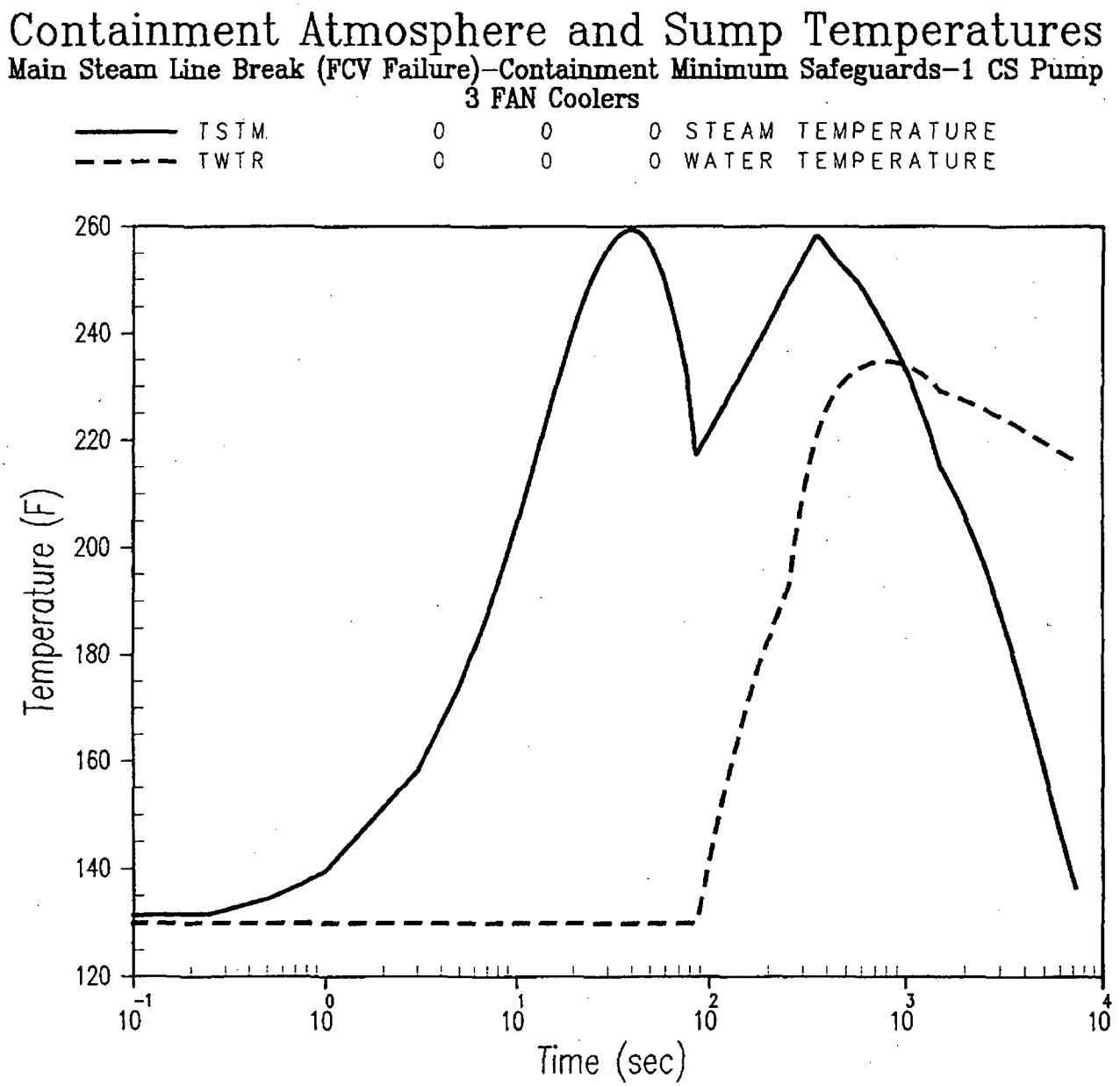


Figure 3 for Case 7

Containment Density and Fan Motor Power

Main Steam Line Break (FCV Failure)–Containment Minimum Safeguards–1 CS Pump 3 FAN Coolers

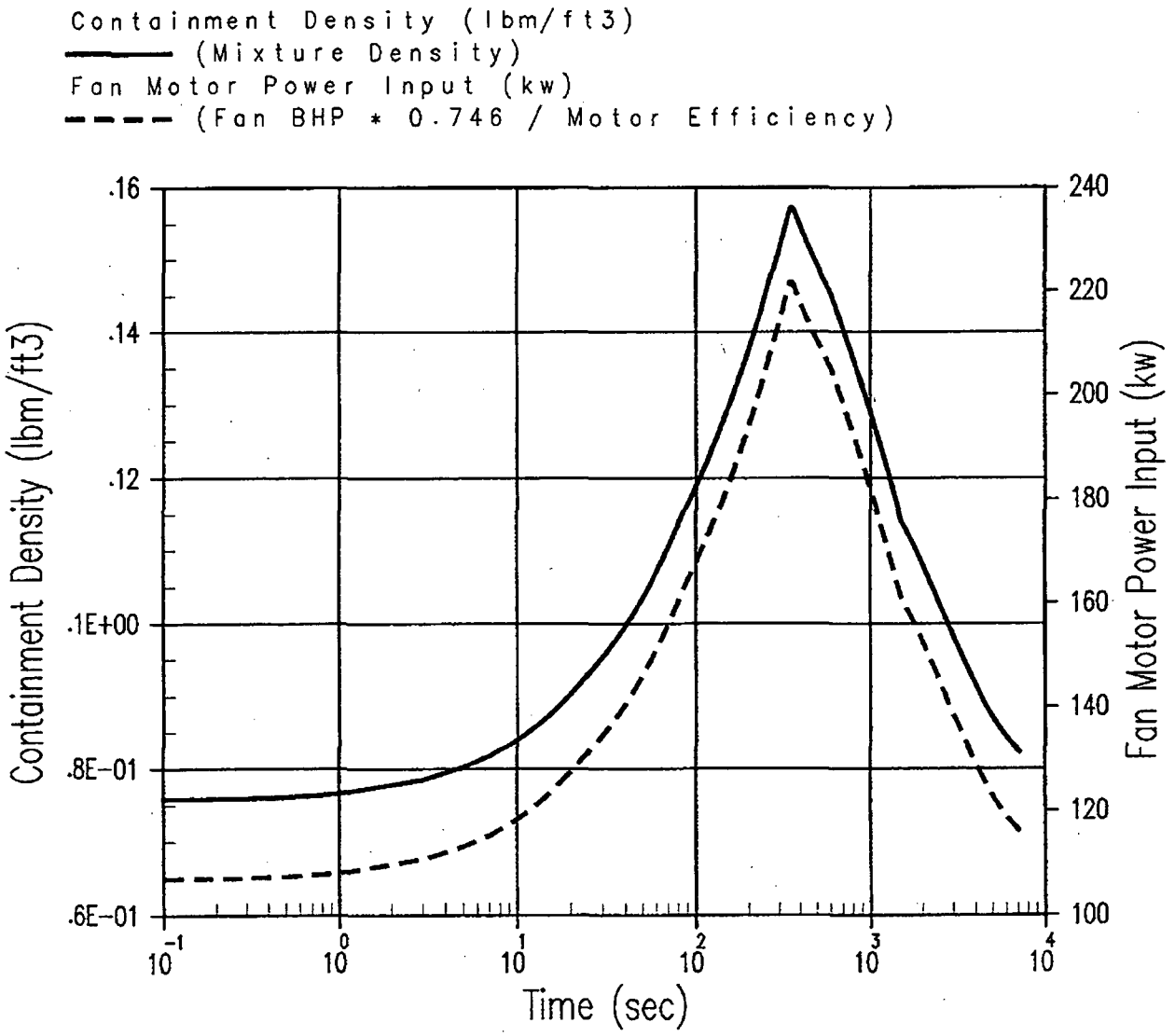


Figure 1 for Case 8

Containment Pressure

4 Inch LOCA – Containment Minimum Safeguards – 1 CS Pump, 3 Fan Coolers (No SI Spill Flow)

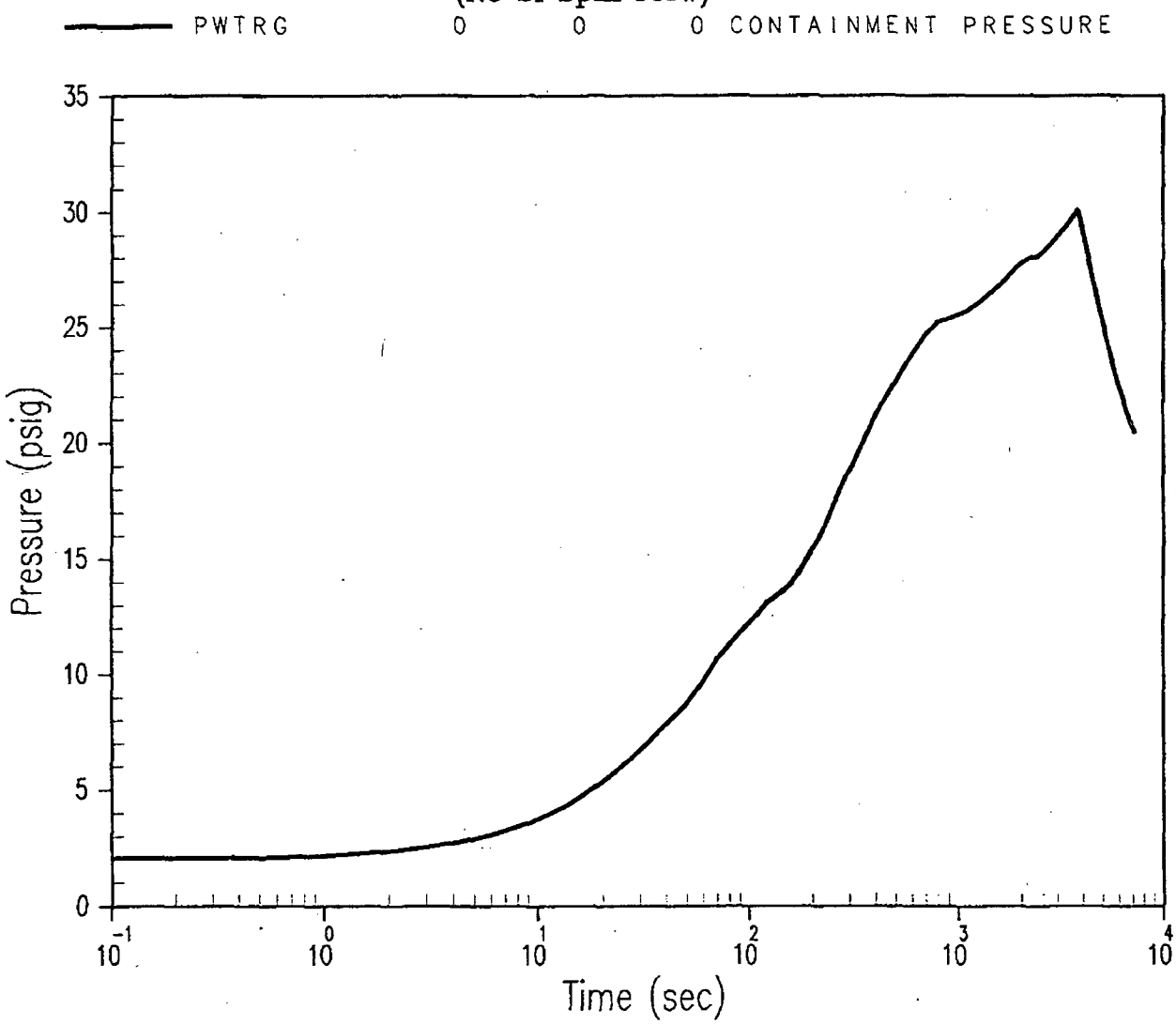


Figure 2 for Case 8

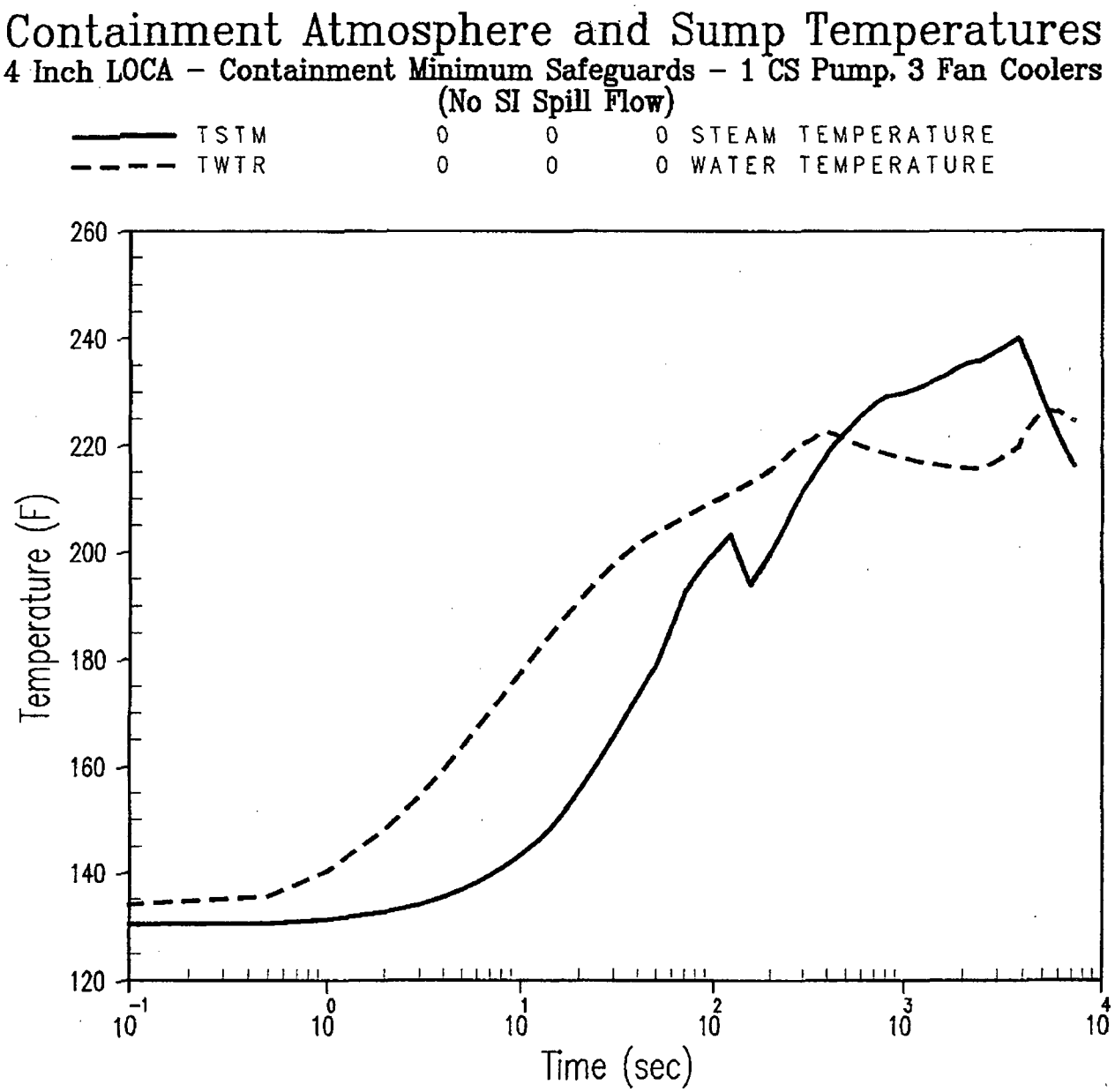


Figure 3 for Case 8

Containment Density and Fan Motor Power

4 Inch LOCA – Containment Minimum Safeguards – 1 CS Pump, 3 Fan Coolers (No SI Spill Flow)

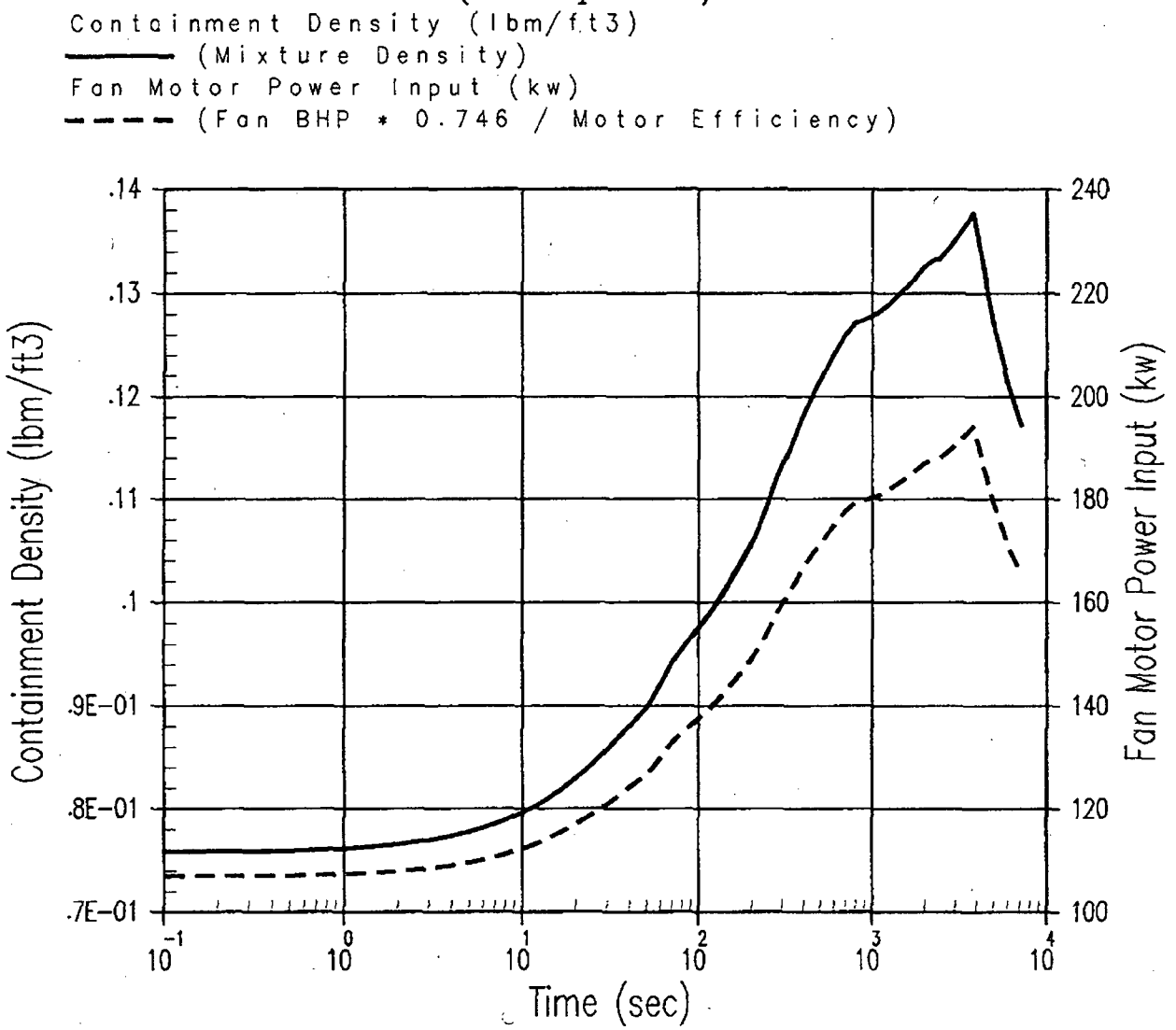


Figure 1 for Case 9

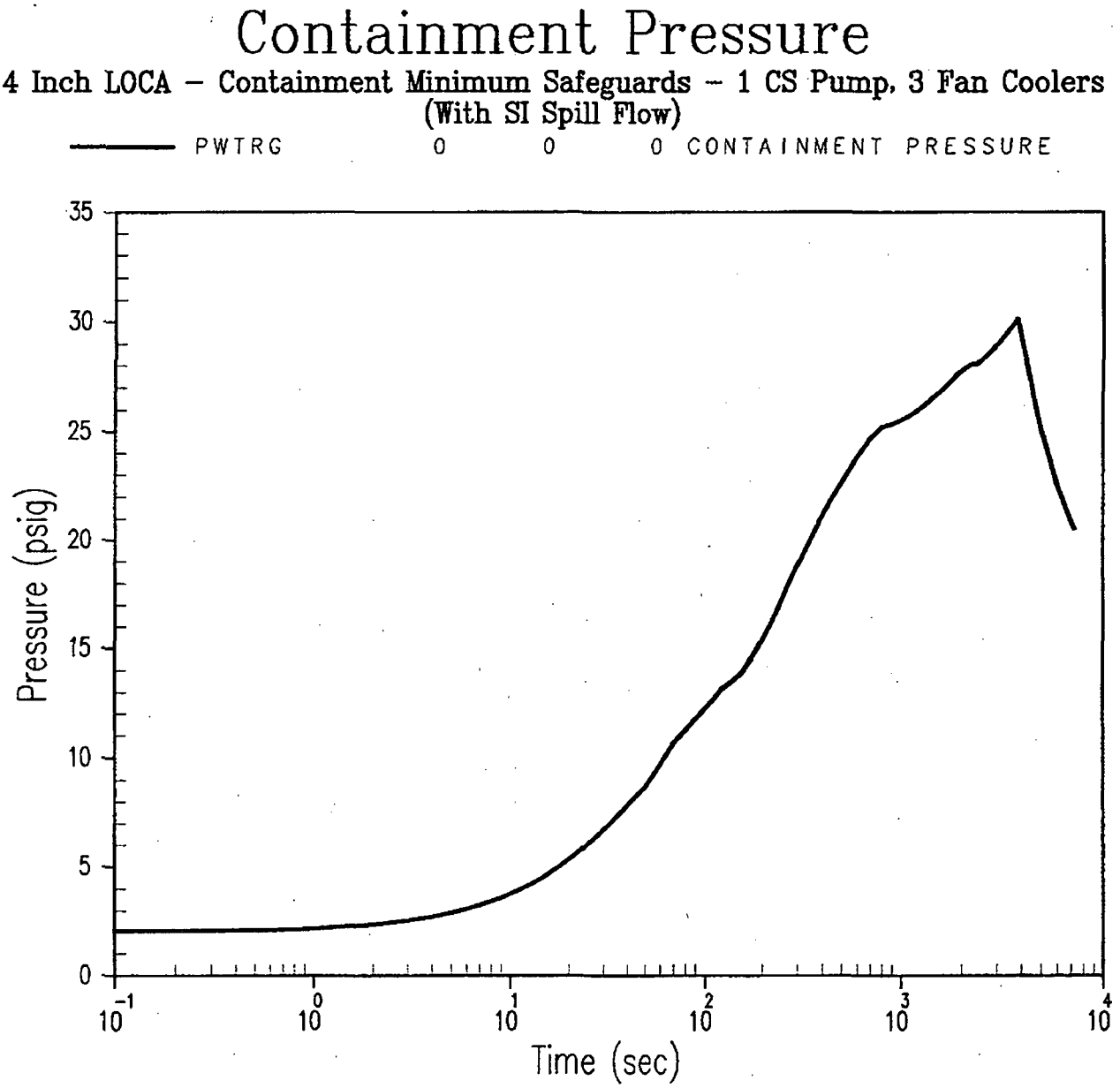


Figure 2 for Case 9

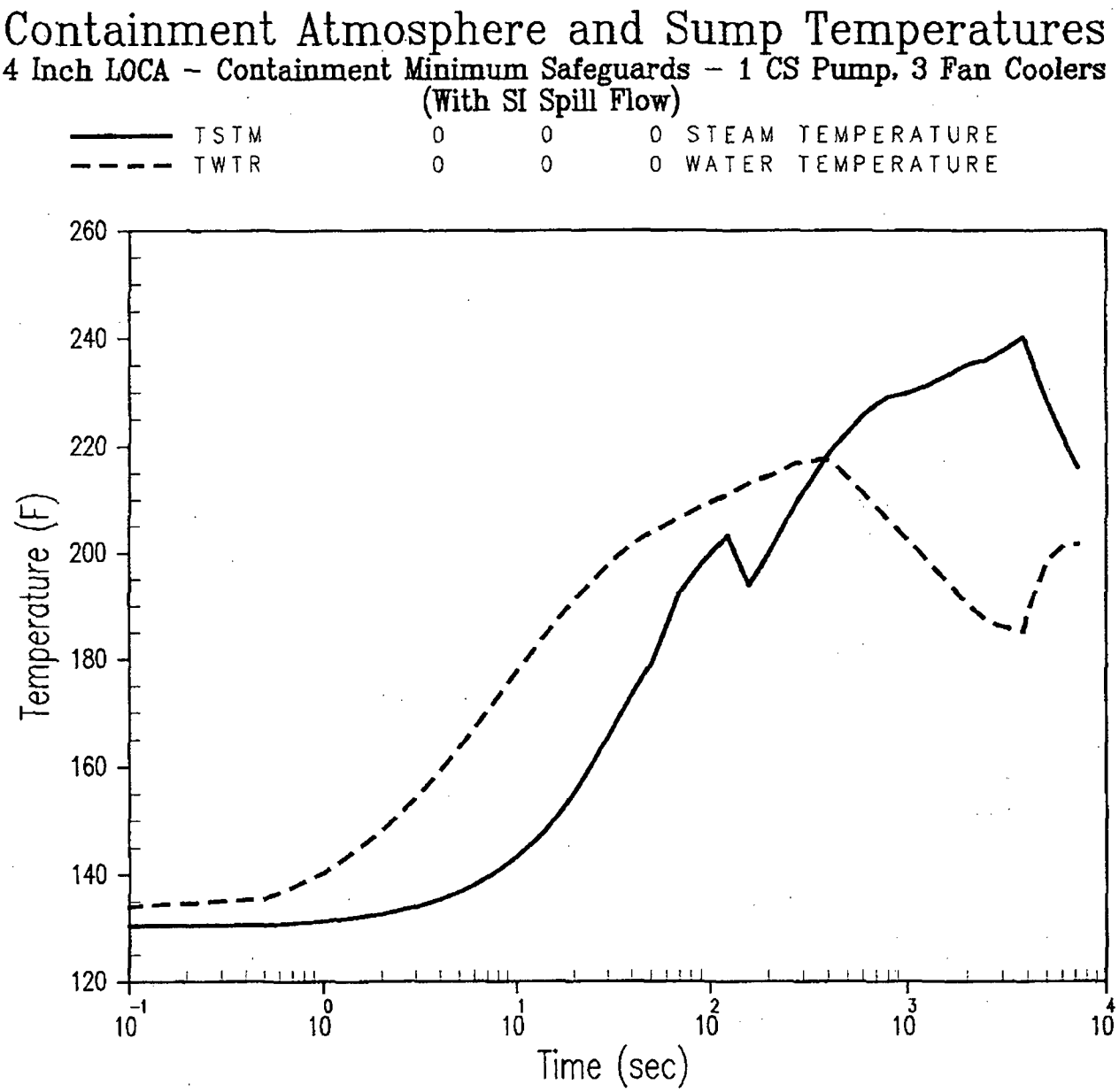


Figure 3 for Case 9

Containment Density and Fan Motor Power

4 Inch LOCA – Containment Minimum Safeguards – 1 CS Pump, 3 Fan Coolers (With SI Spill Flow)

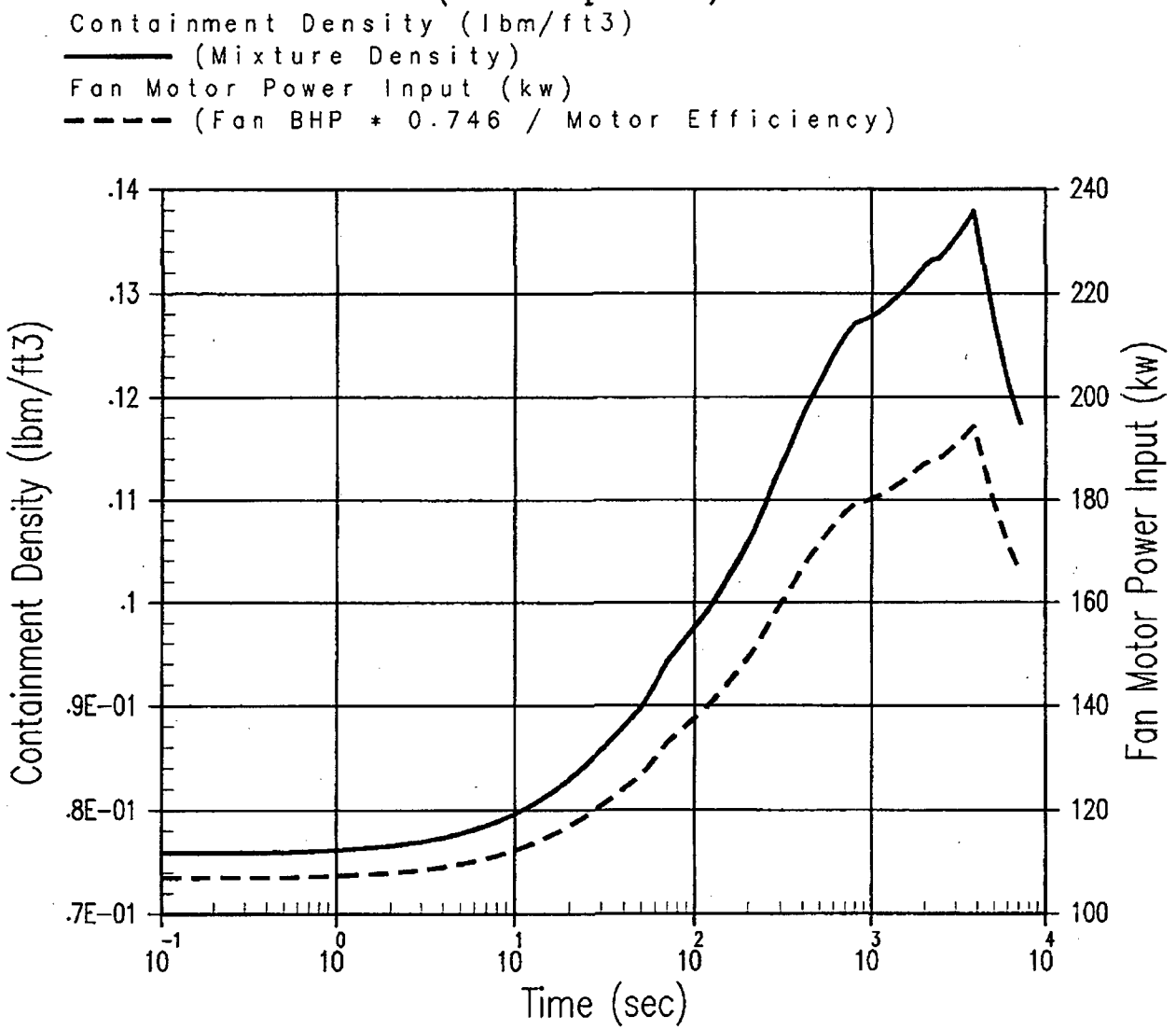


Figure 1 for Case 10

Containment Pressure

4 Inch LOCA – Containment Safeguards – 1 CS Pump, 4 Fan Coolers (No SI Spill Flow)

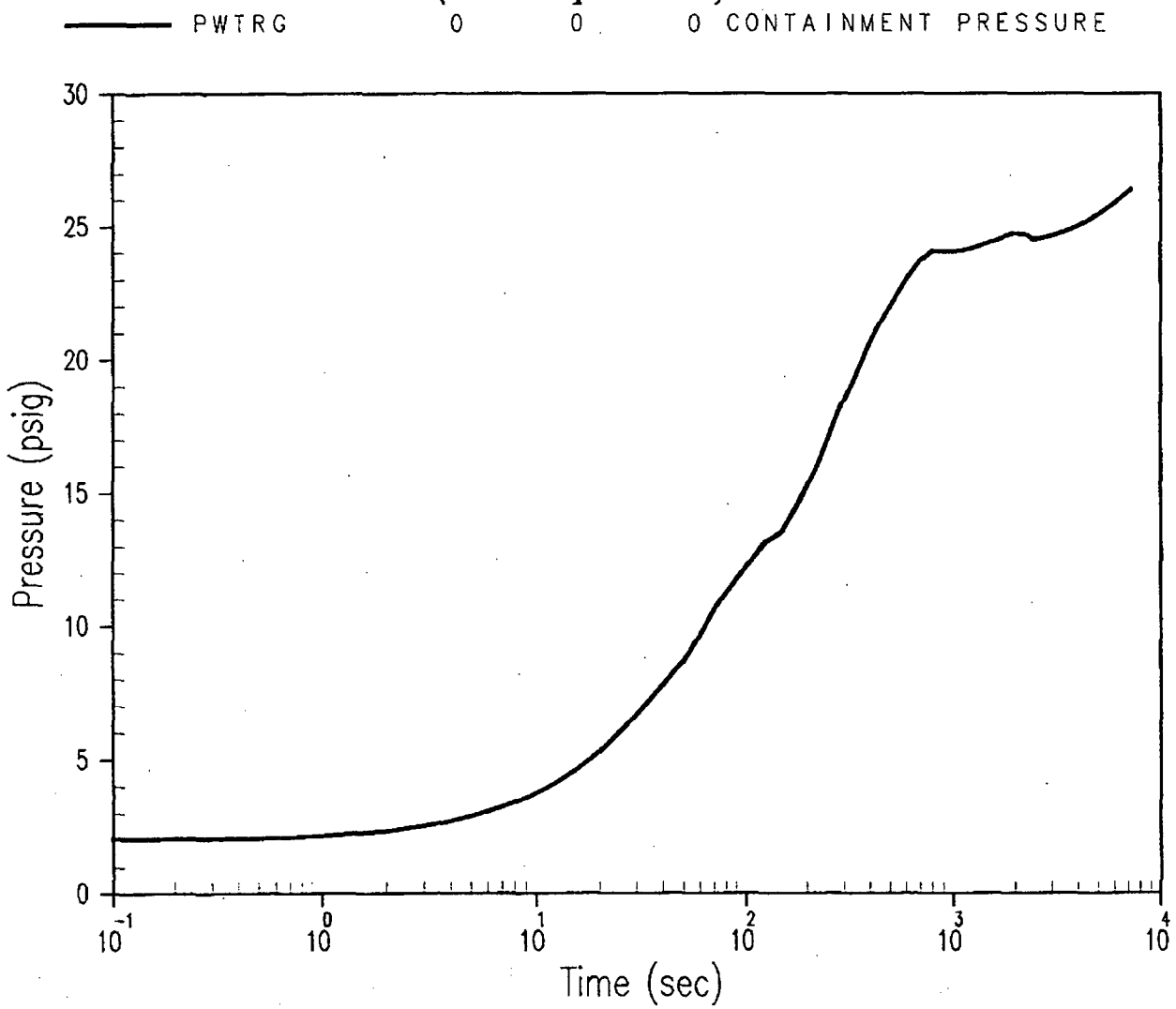


Figure 2 for Case 10

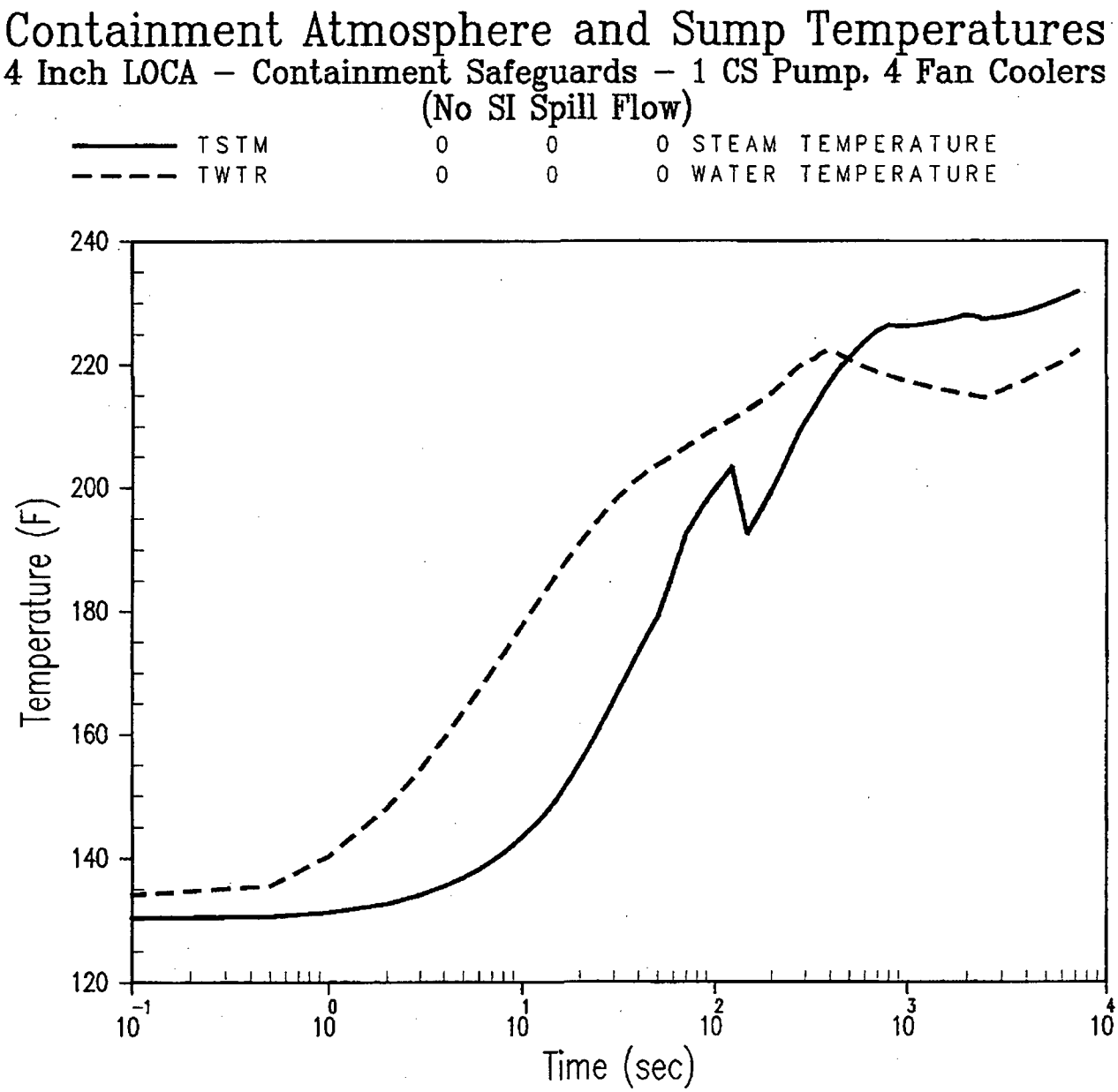


Figure 3 for Case 10

Containment Density and Fan Motor Power

4 Inch LOCA – Containment Safeguards – 1 CS Pump, 4 Fan Coolers (No SI Spill Flow)

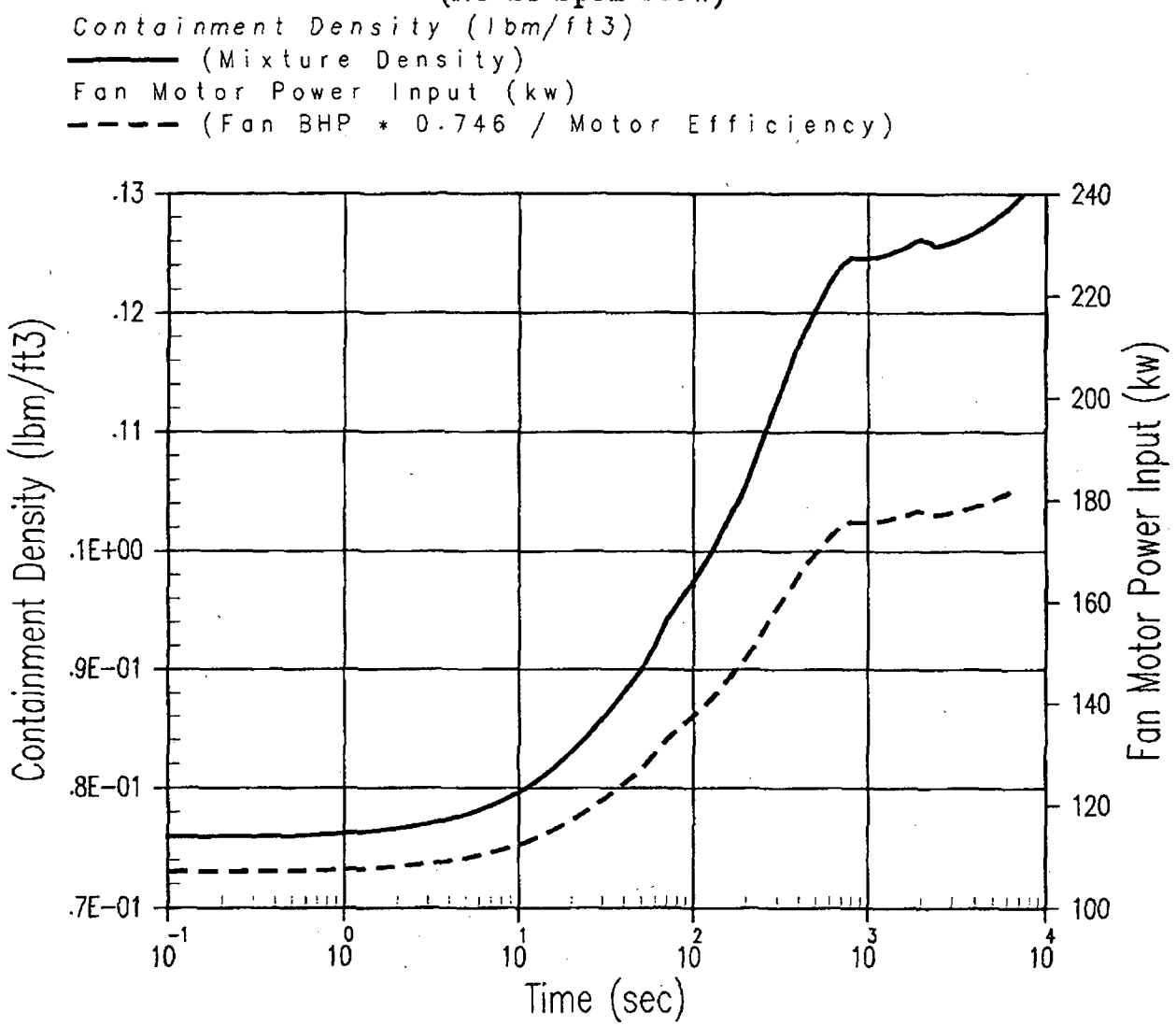


Figure 1 for Case 11

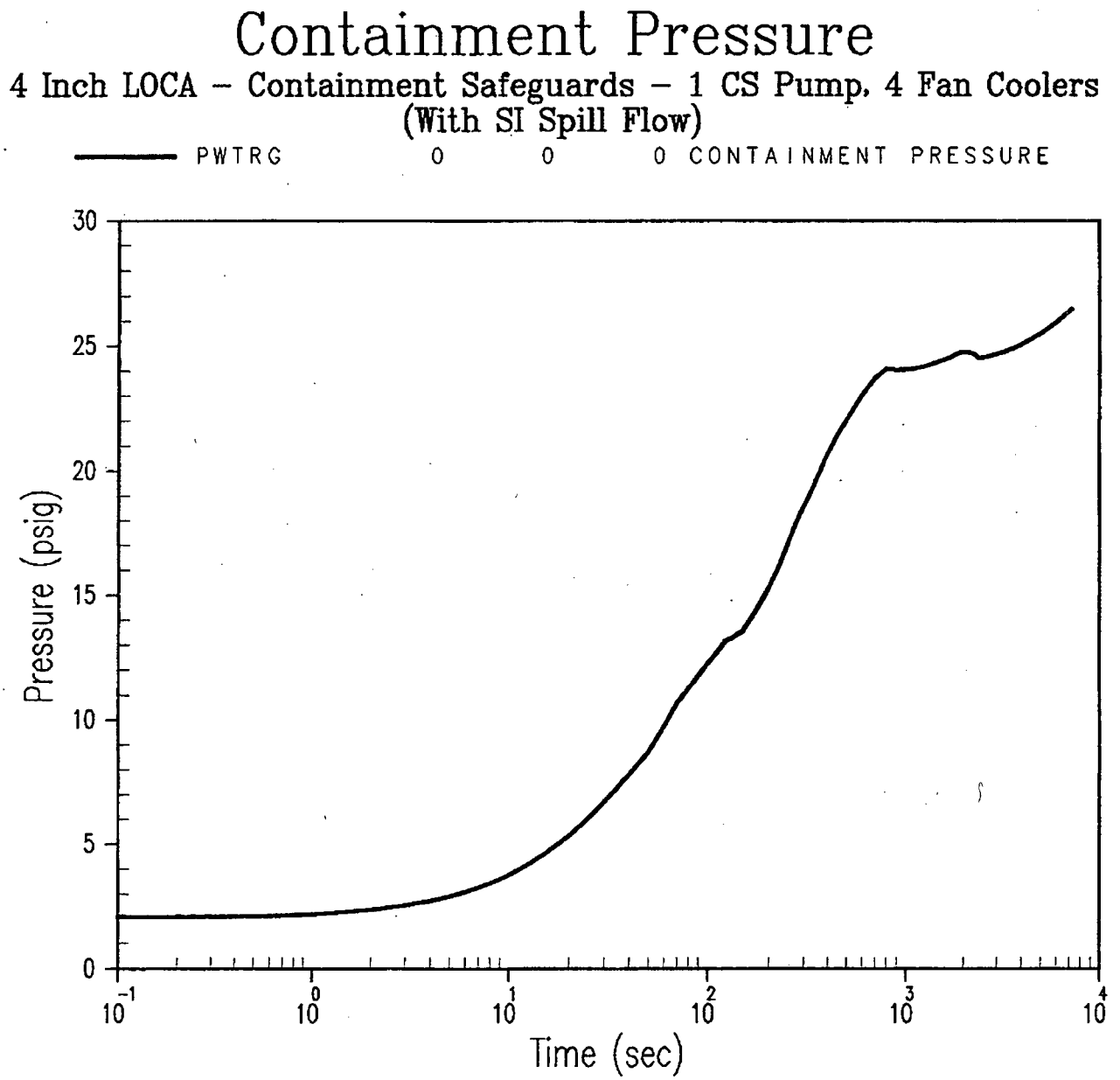


Figure 2 for Case 11

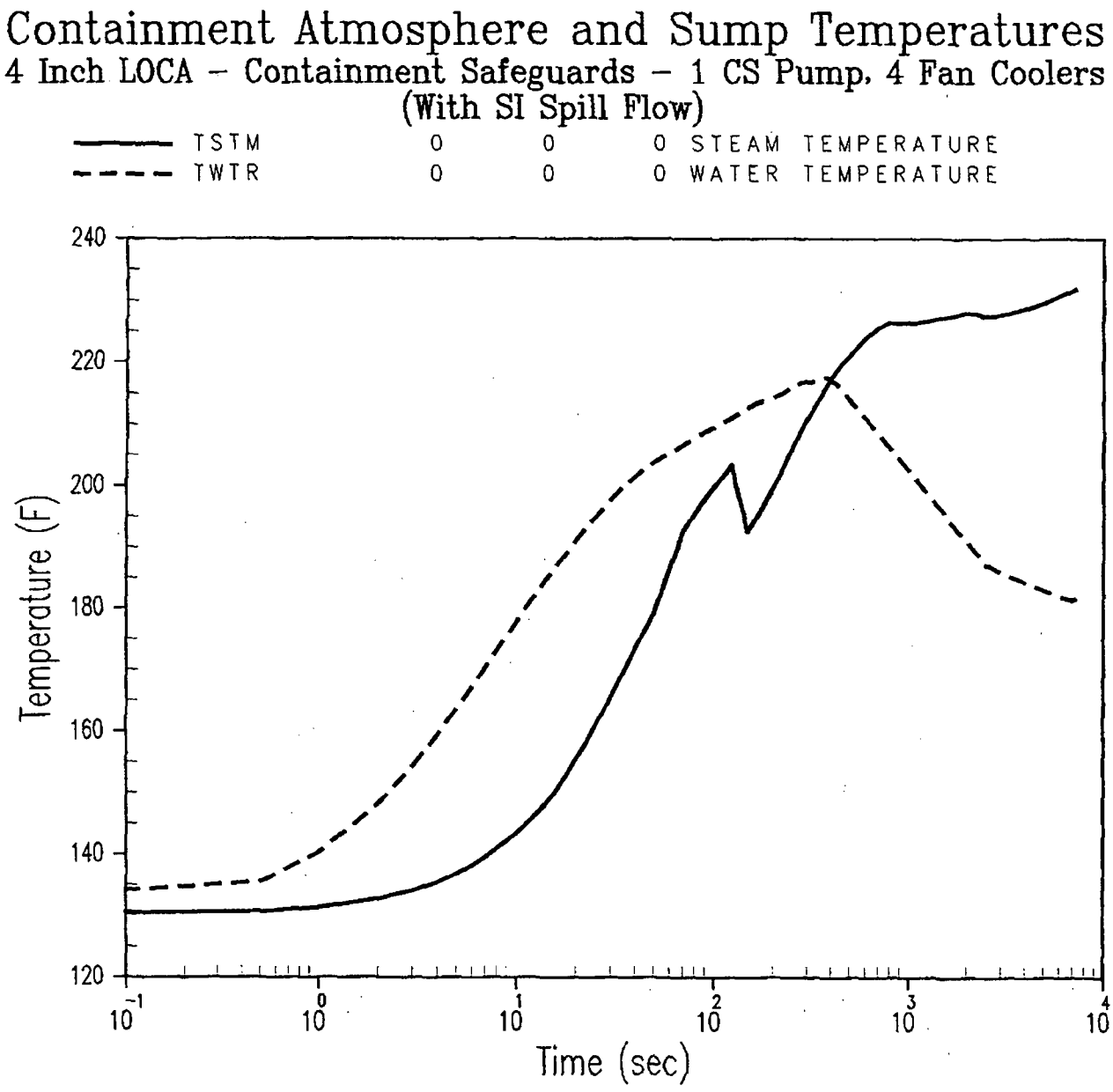


Figure 3 for Case 11

Containment Density and Fan Motor Power

4 Inch LOCA – Containment Safeguards – 1 CS Pump, 4 Fan Coolers (With SI Spill Flow)

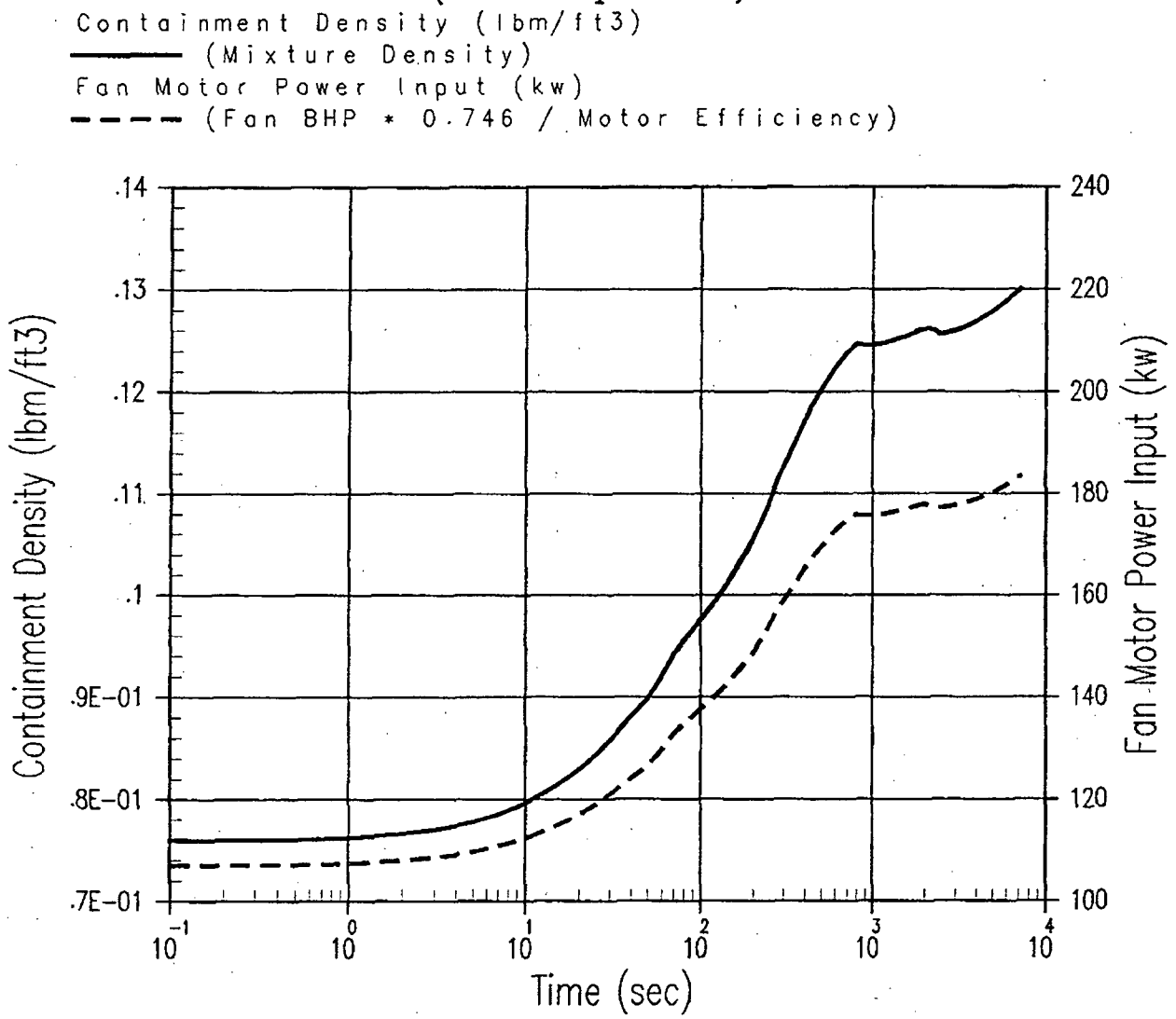


Figure 1 for Case 12

Containment Pressure

4 Inch LOCA – Containment Safeguards – 1 CS Pump, 5 Fan Coolers
(No SI Spill Flow)

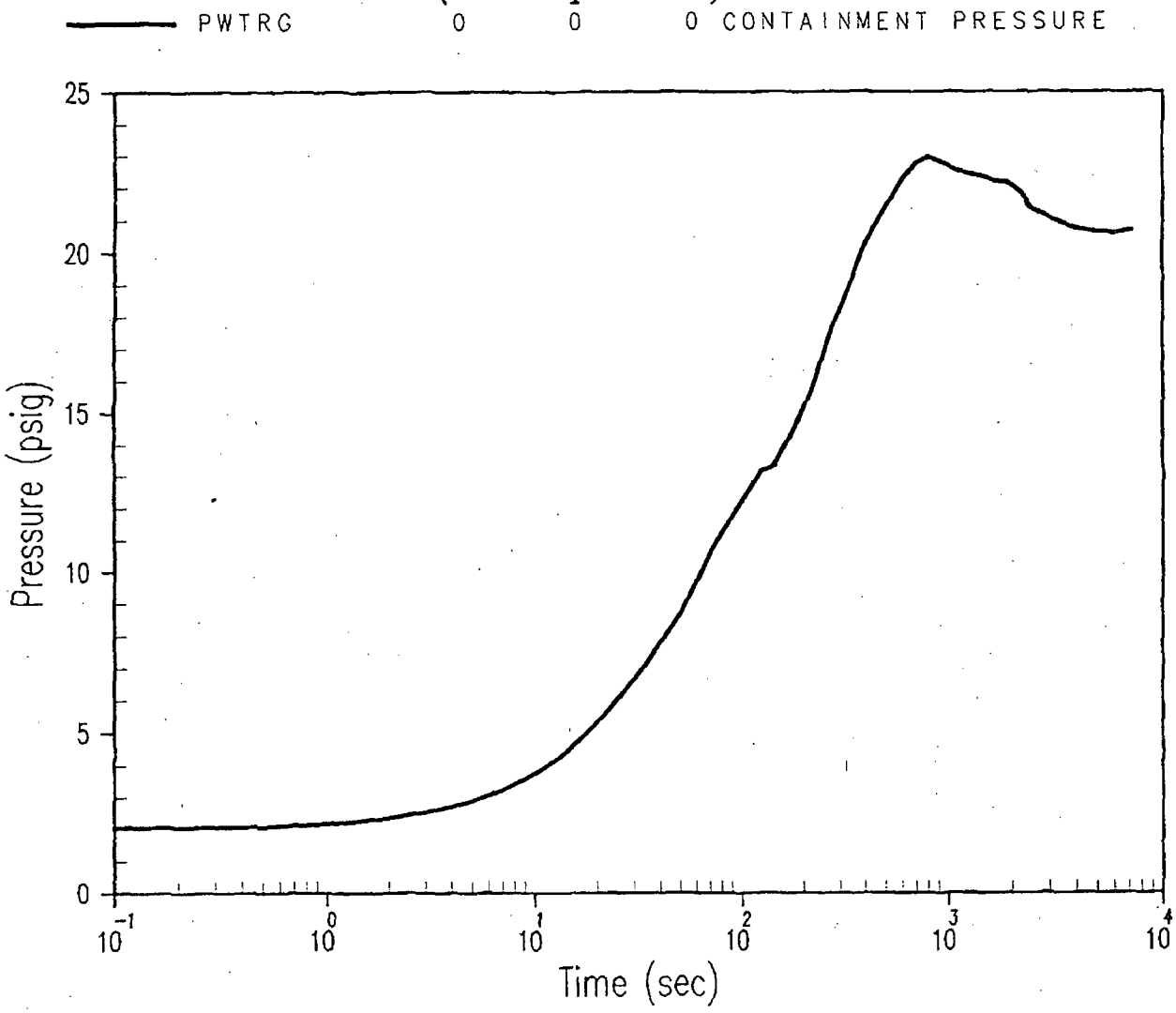


Figure 2 for Case 12

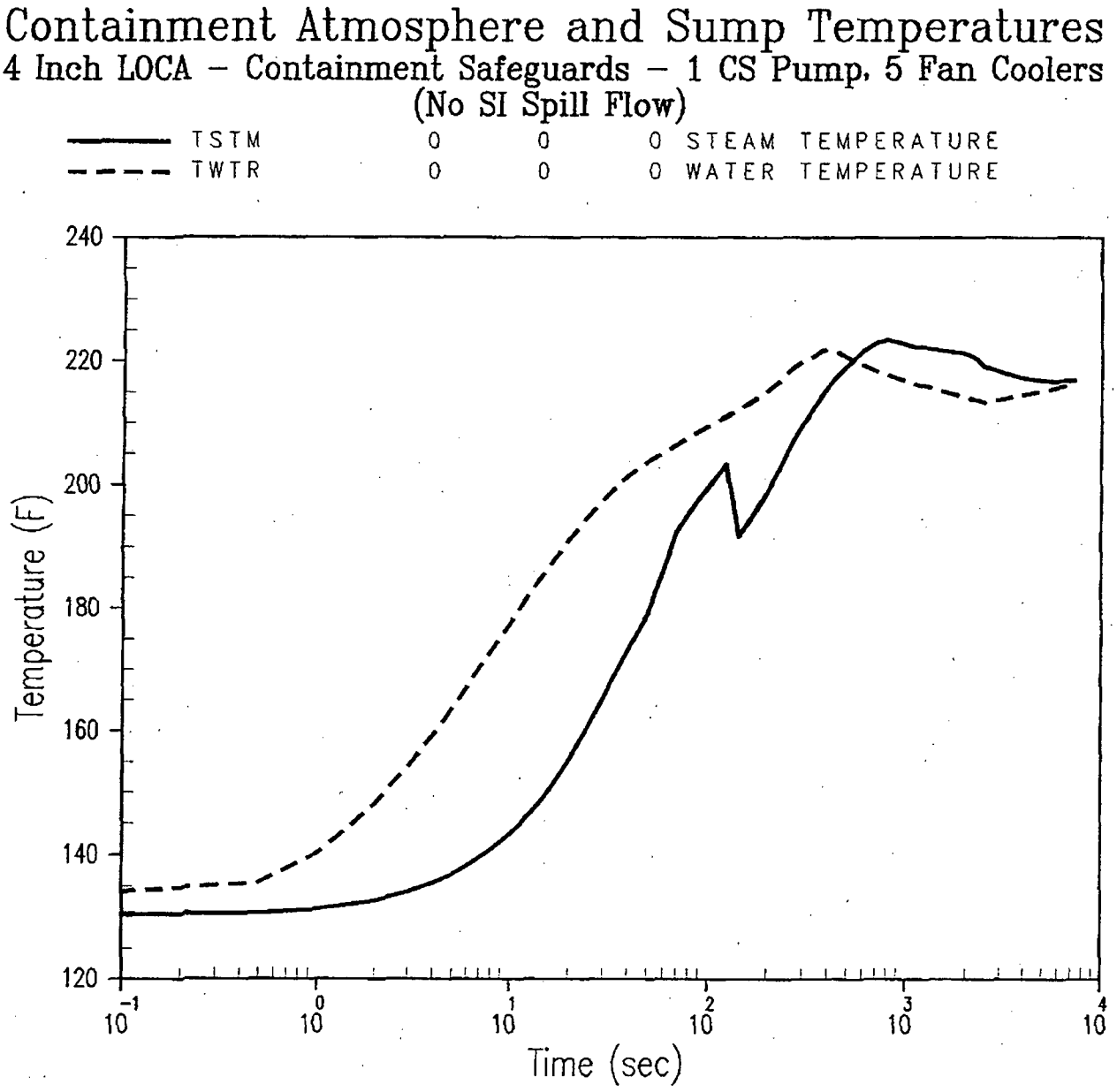


Figure 3 for Case 12

Containment Density and Fan Motor Power

4 Inch LOCA – Containment Safeguards – 1 CS Pump, 5 Fan Coolers (No SI Spill Flow)

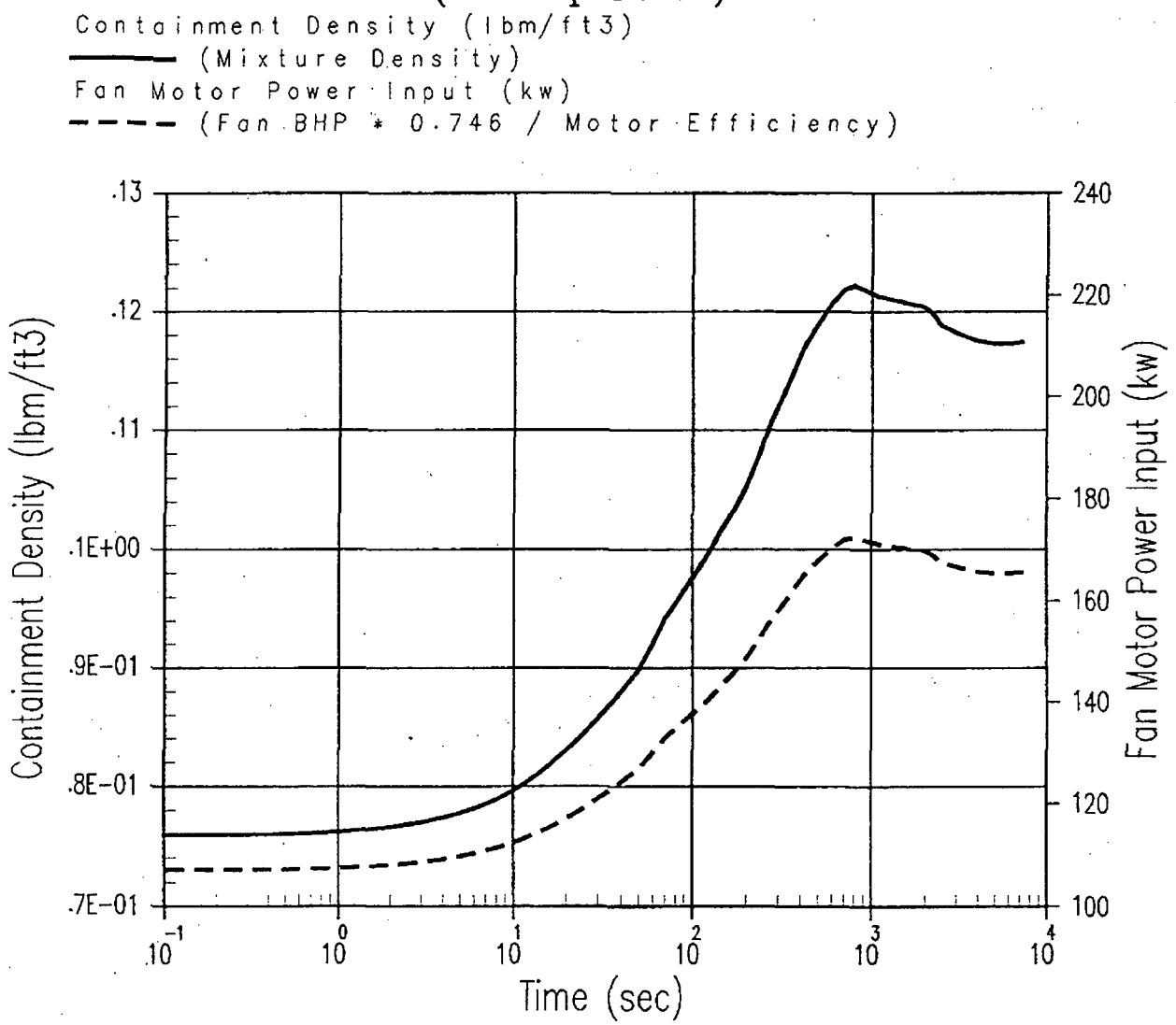


Figure 1 for Case 13

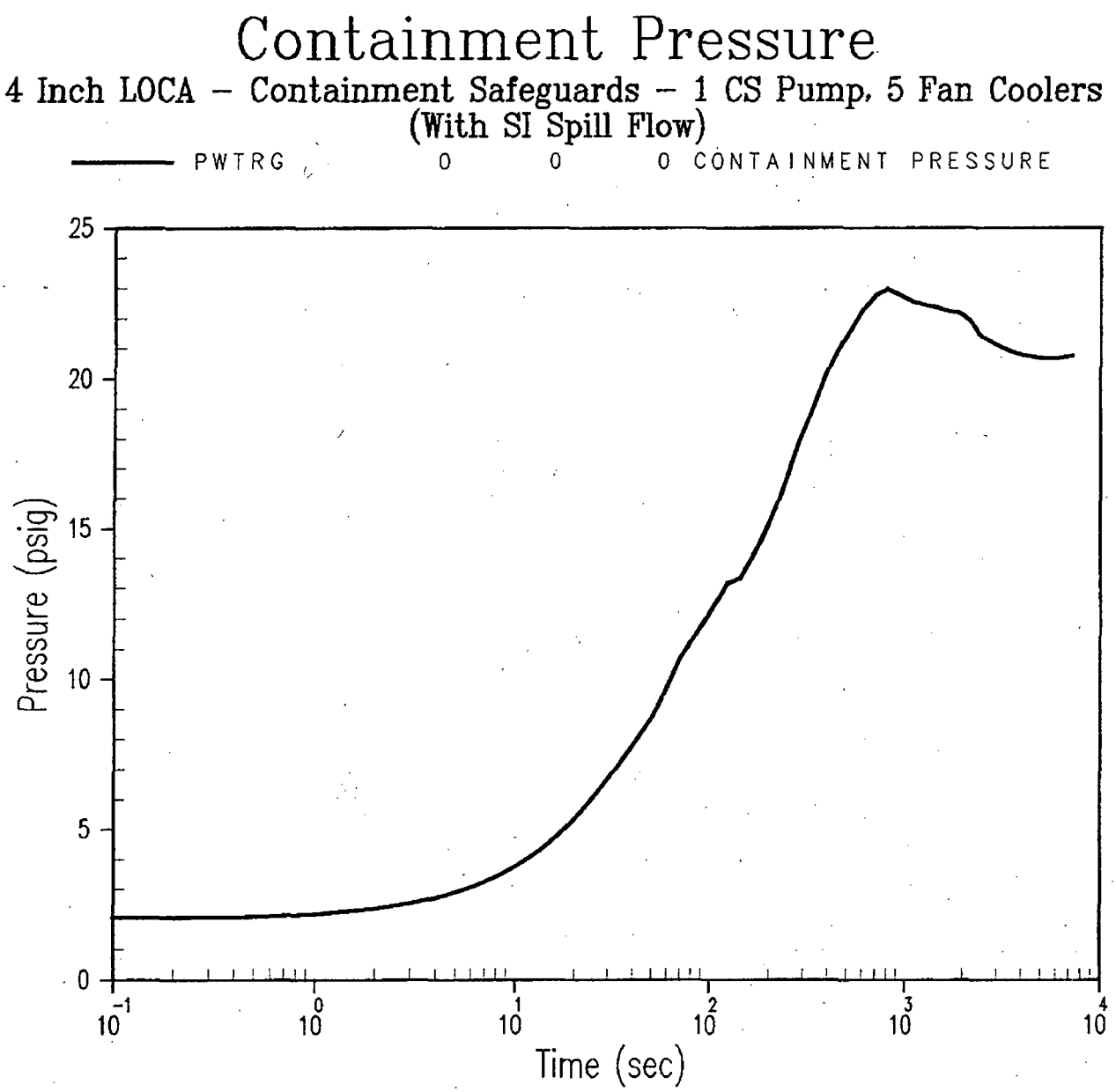


Figure 2 for Case 13

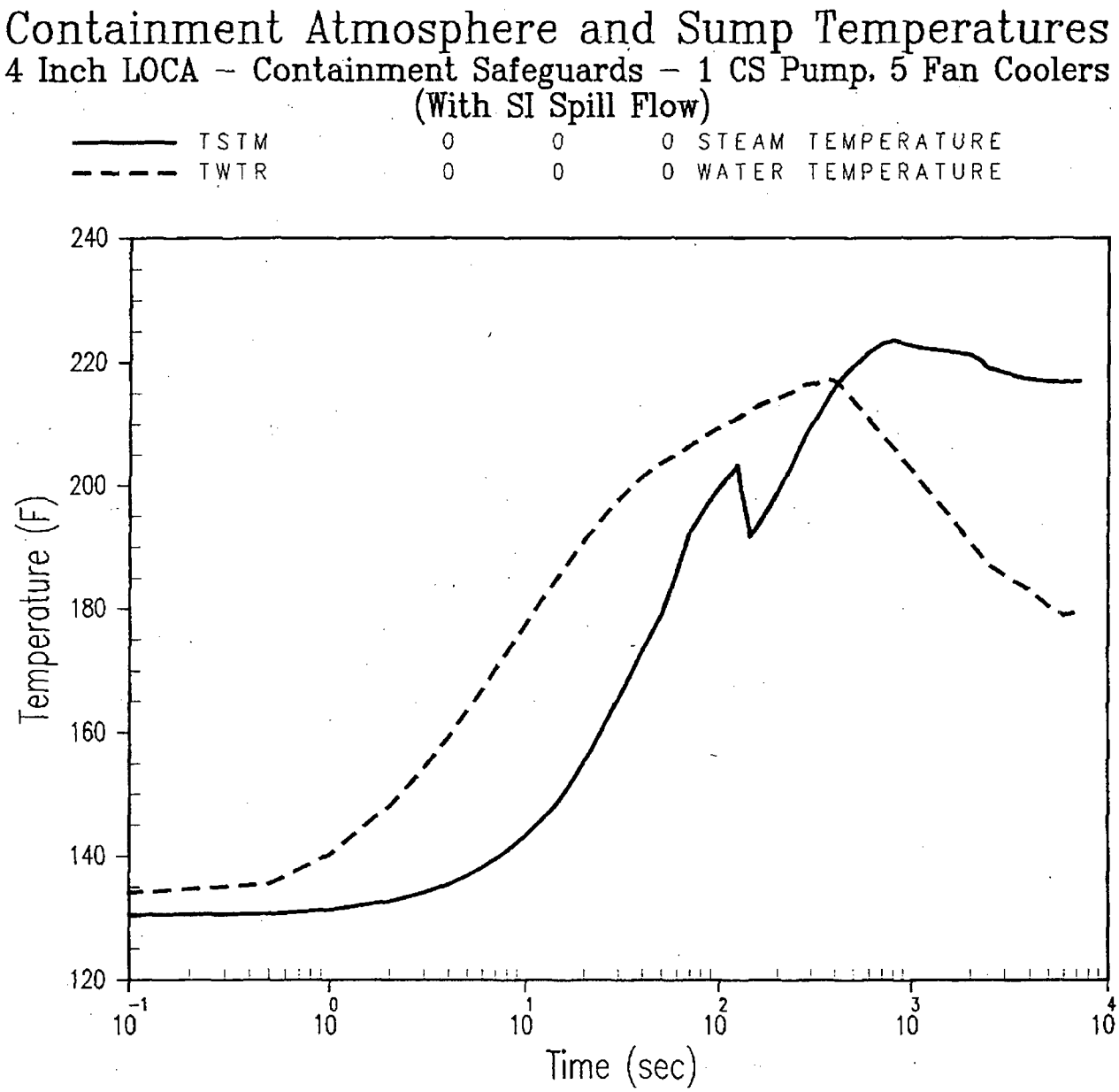


Figure 3 for Case 13

Containment Density and Fan Motor Power

4 Inch LOCA – Containment Safeguards – 1 CS Pump, 5 Fan Coolers (With SI Spill Flow)

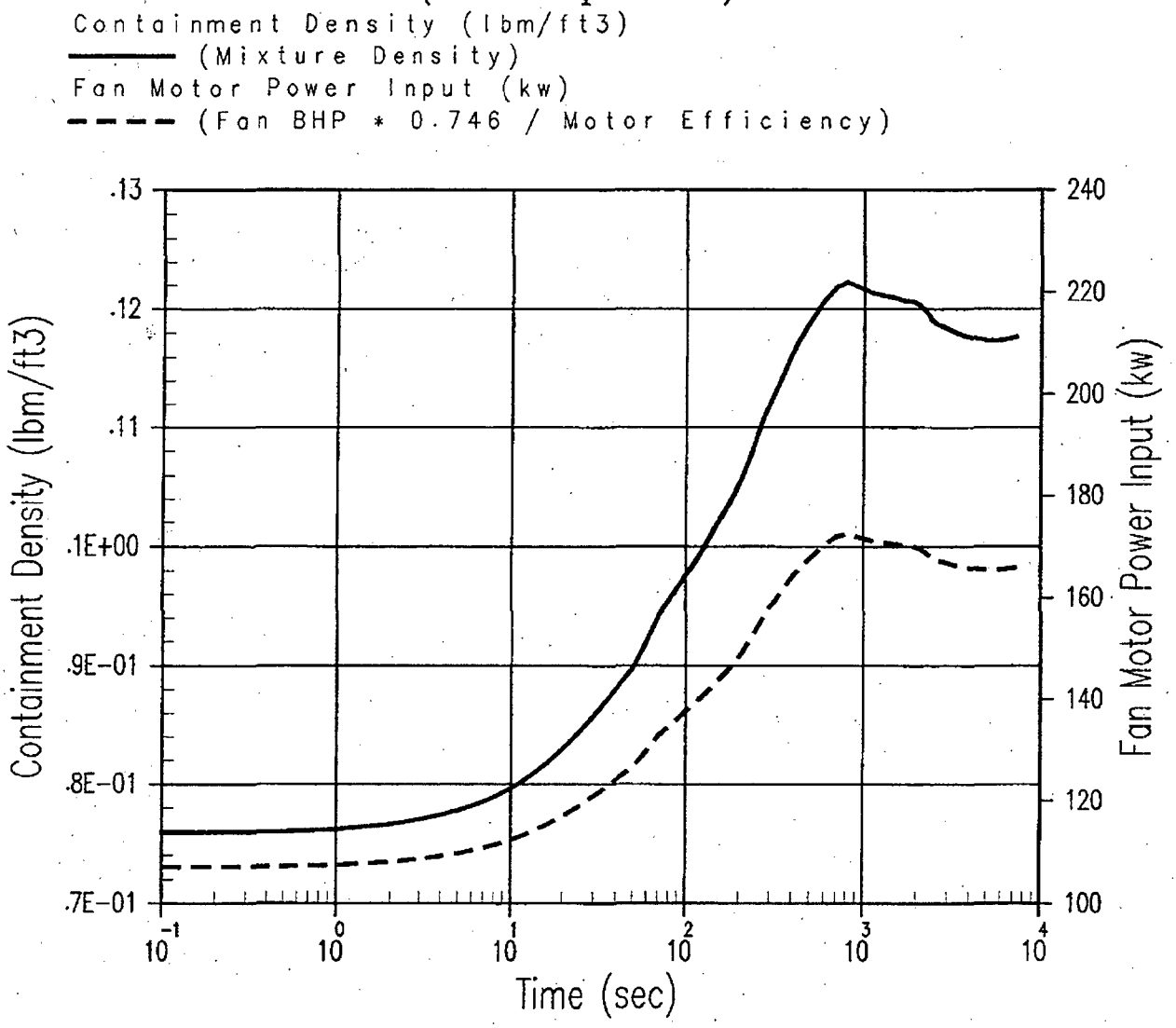


Figure 1 for Case 14

Containment Pressure

3 Inch LOCA – Containment Minimum Safeguards – 1 CS Pump, 3 Fan Coolers (No SI Spill Flow)

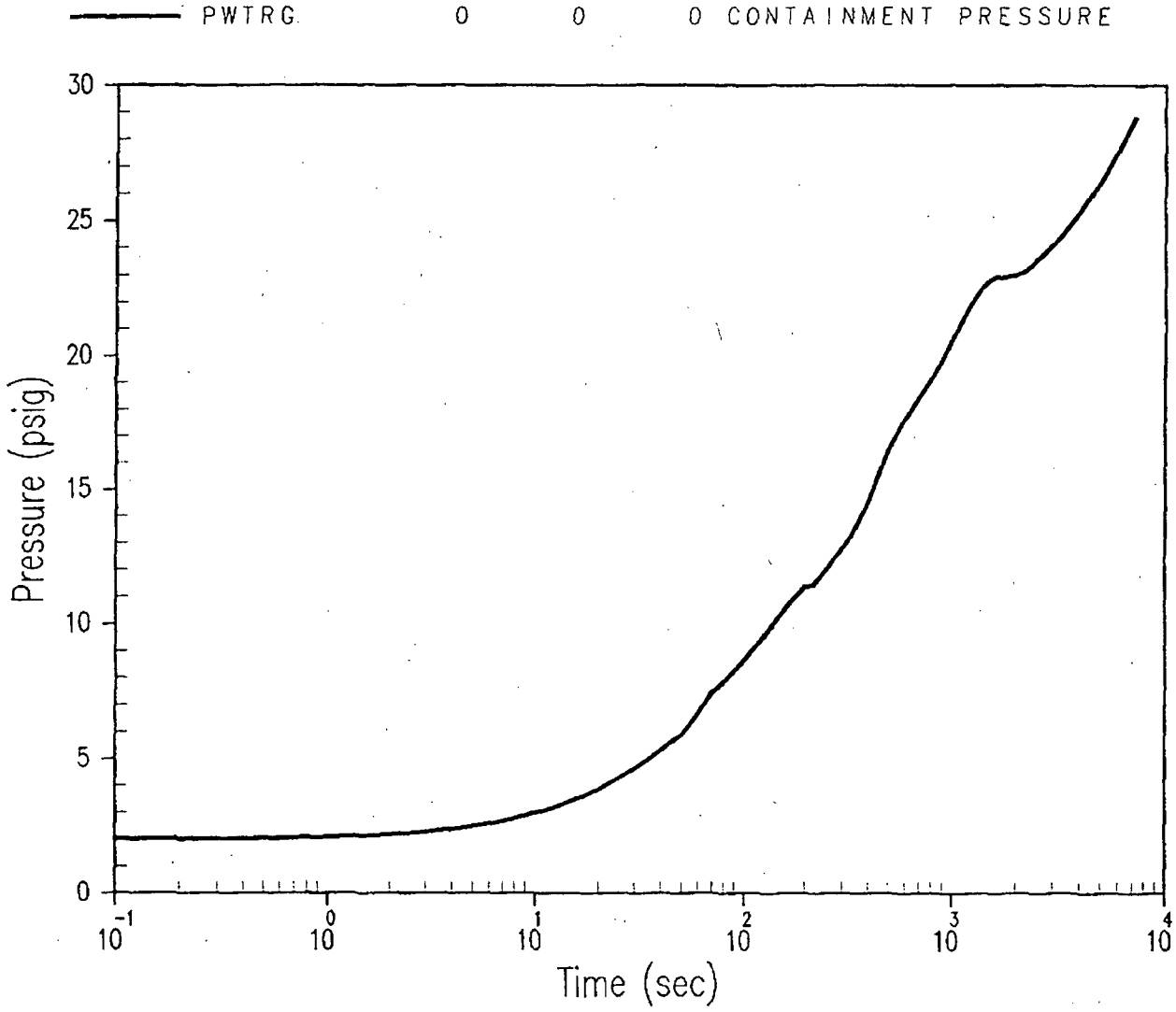


Figure 2 for Case 14

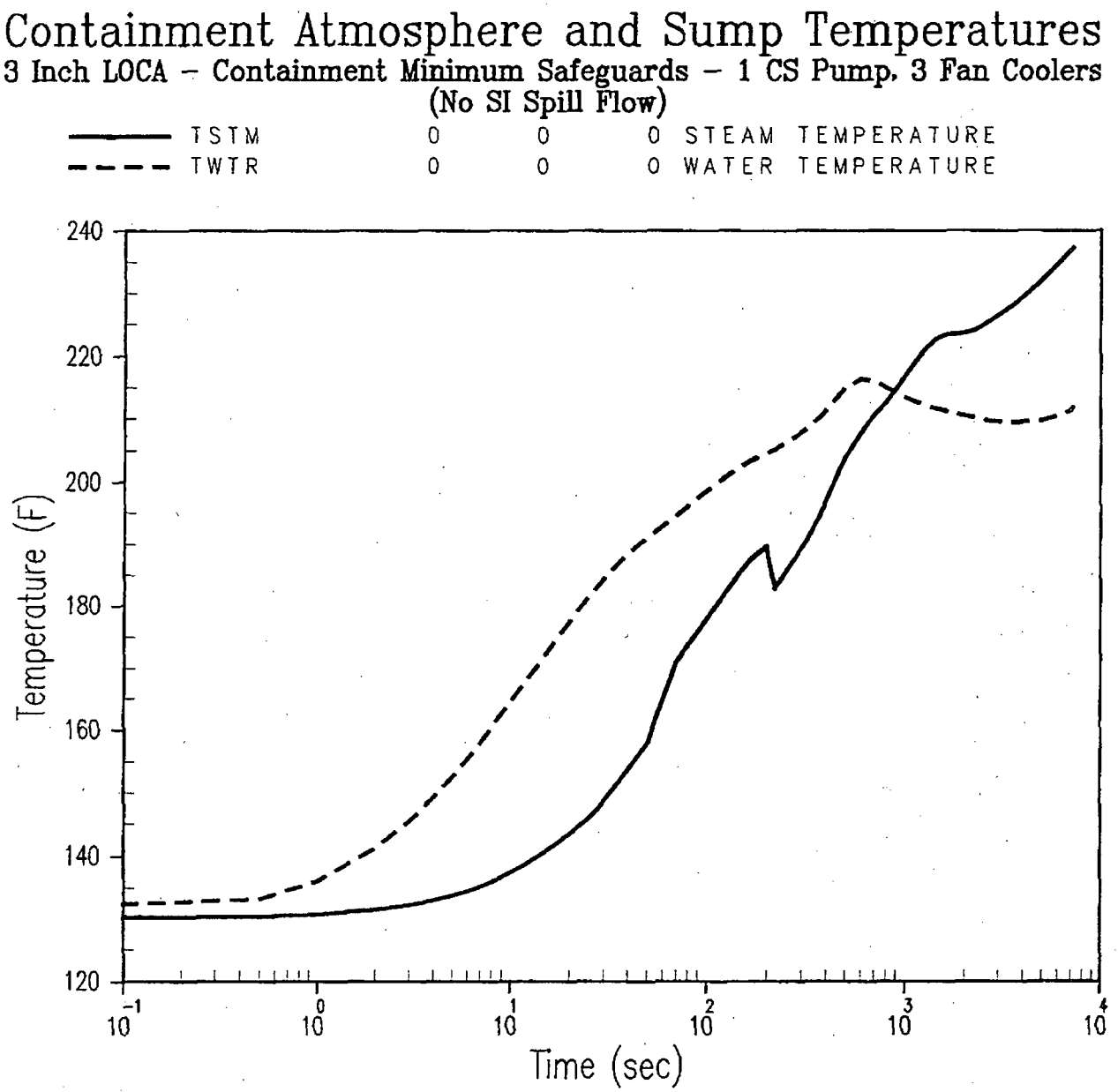


Figure 3 for Case 14

Containment Density and Fan Motor Power

3 Inch LOCA – Containment Minimum Safeguards – 1 CS Pump, 3 Fan Coolers (No SI Spill Flow)

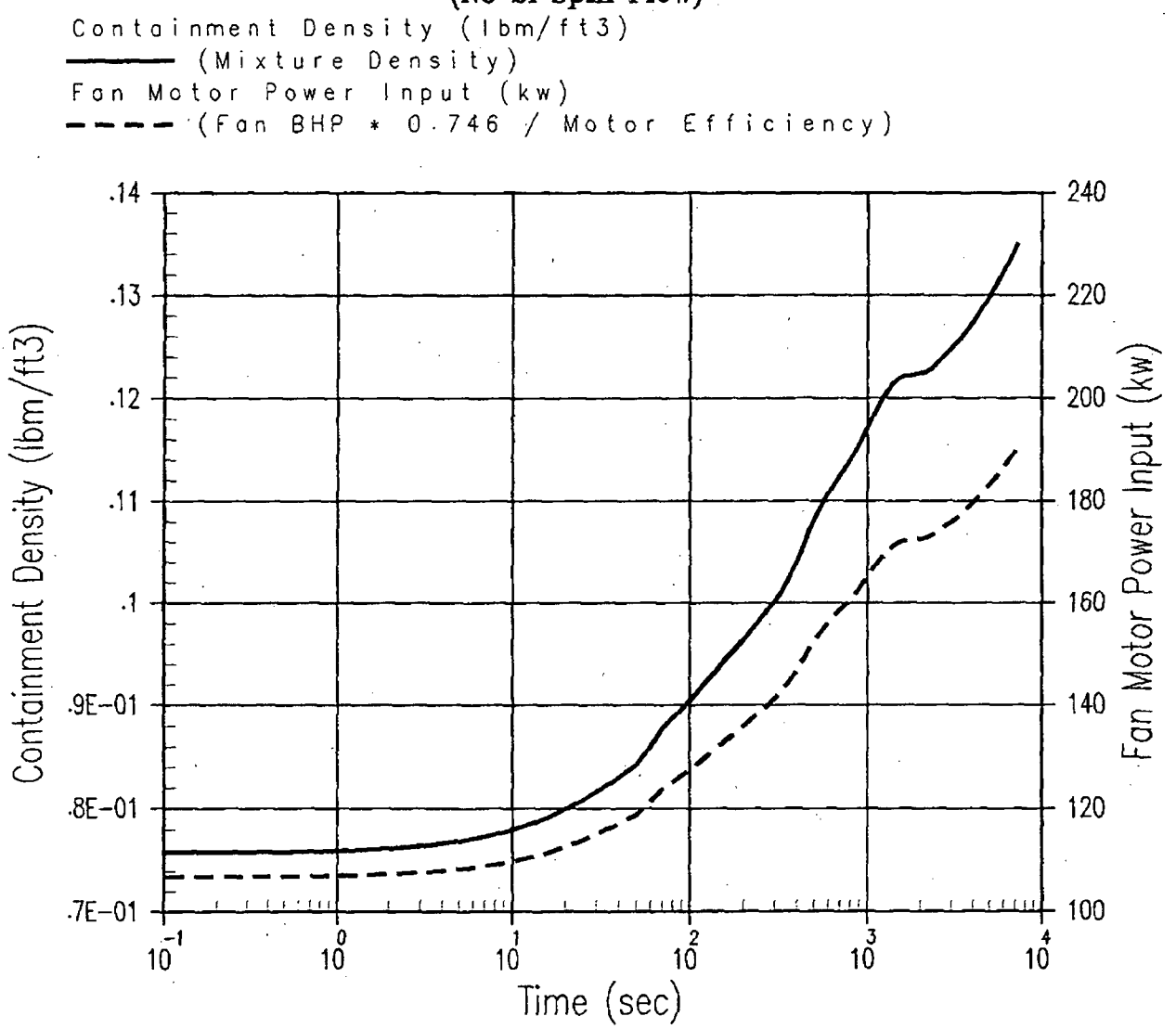


Figure 1 for Case 15

Containment Pressure

3 Inch LOCA – Containment Minimum Safeguards – 1 CS Pump, 3 Fan Coolers (With SI Spill Flow)

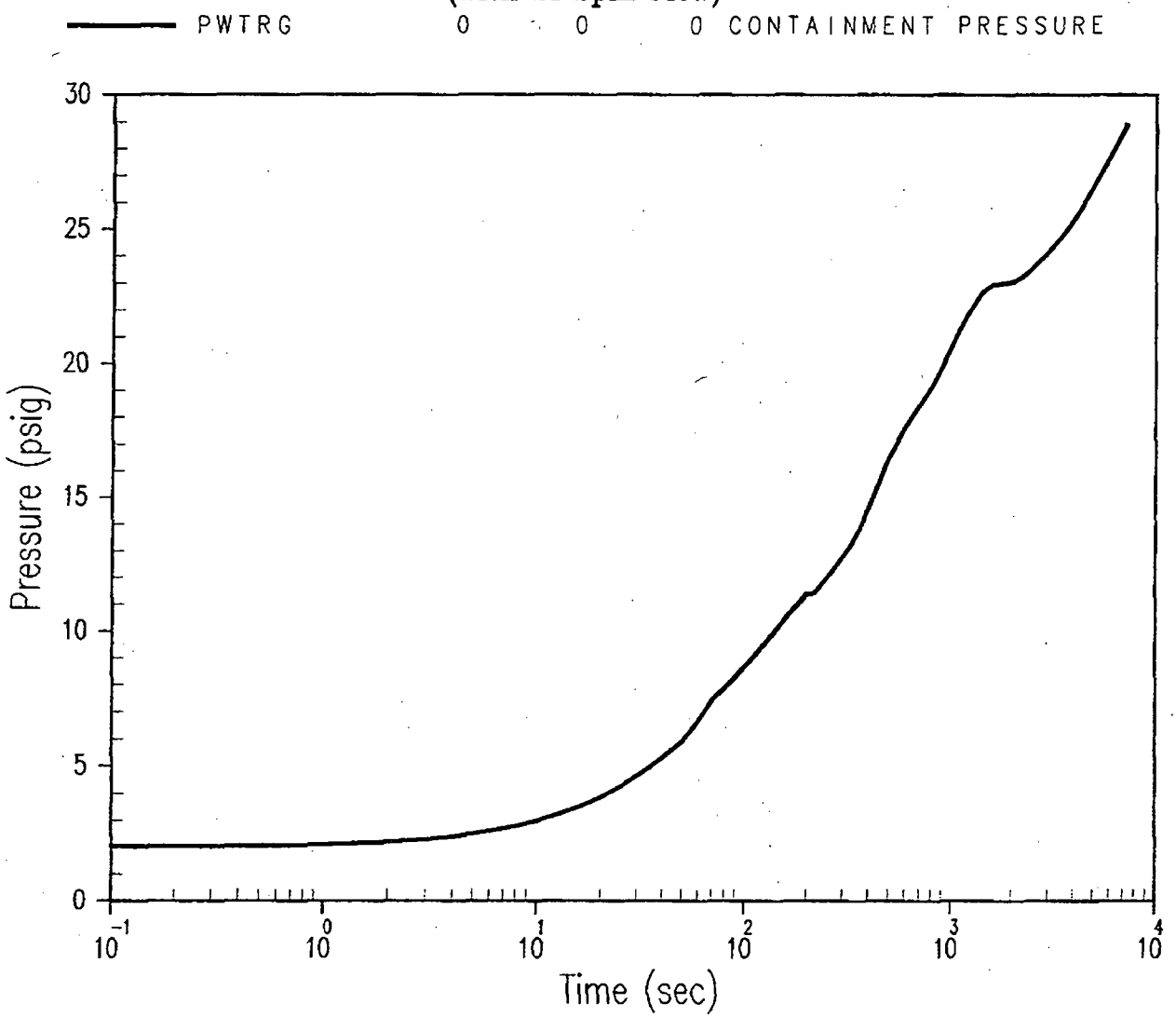


Figure 2 for Case 15

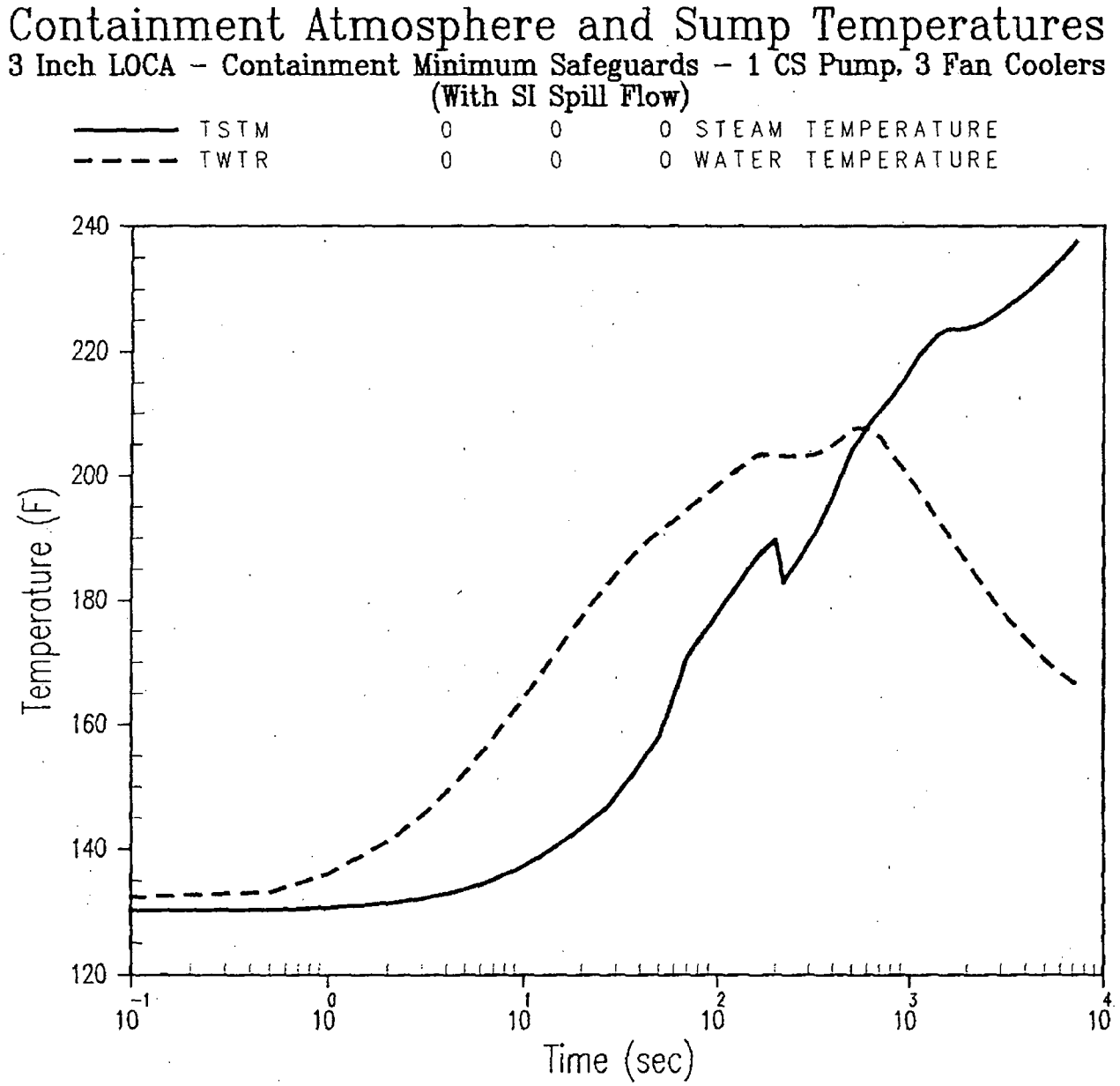


Figure 3 for Case 15

Containment Density and Fan Motor Power

3 Inch LOCA – Containment Minimum Safeguards – 1 CS Pump, 3 Fan Coolers (With SI Spill Flow)

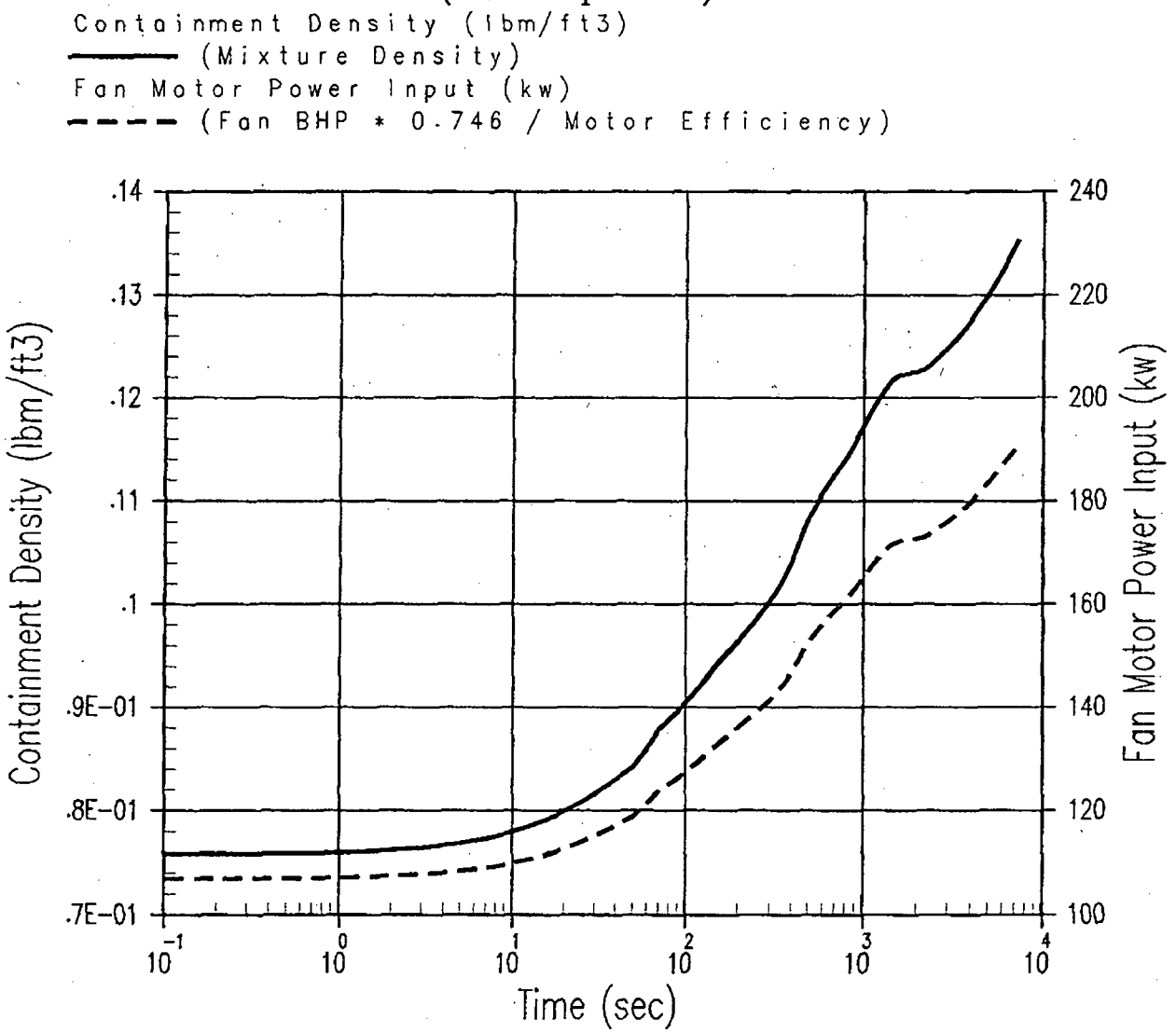


Figure 1 for Case 16

Containment Pressure

3 Inch LOCA (Rev. M&E for Reduced Decay Heat)– Containment Minimum Safeguards
1CS Pump, 3 Fan Coolers
(No SI Spill Flow)

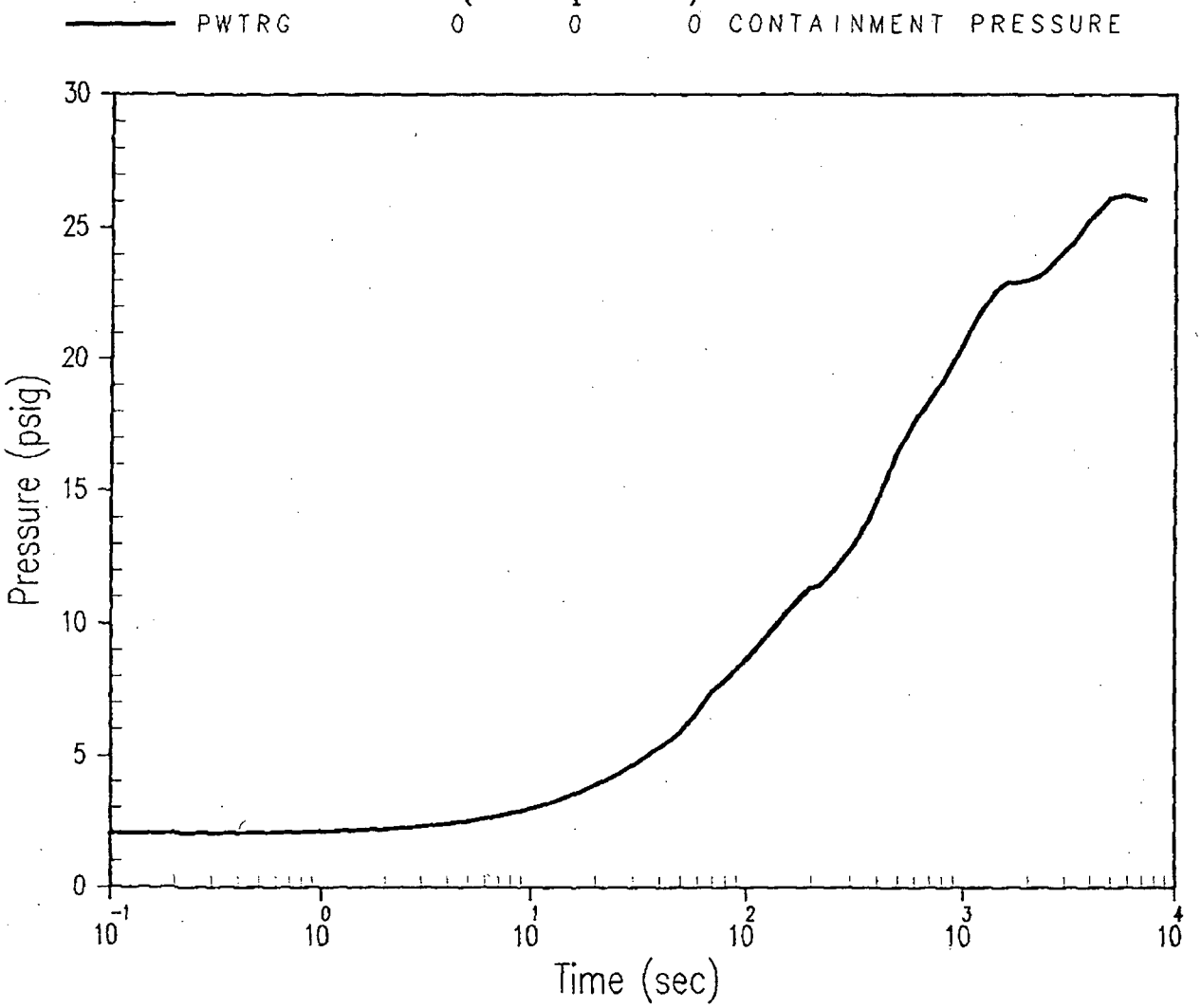


Figure 2 for Case 16

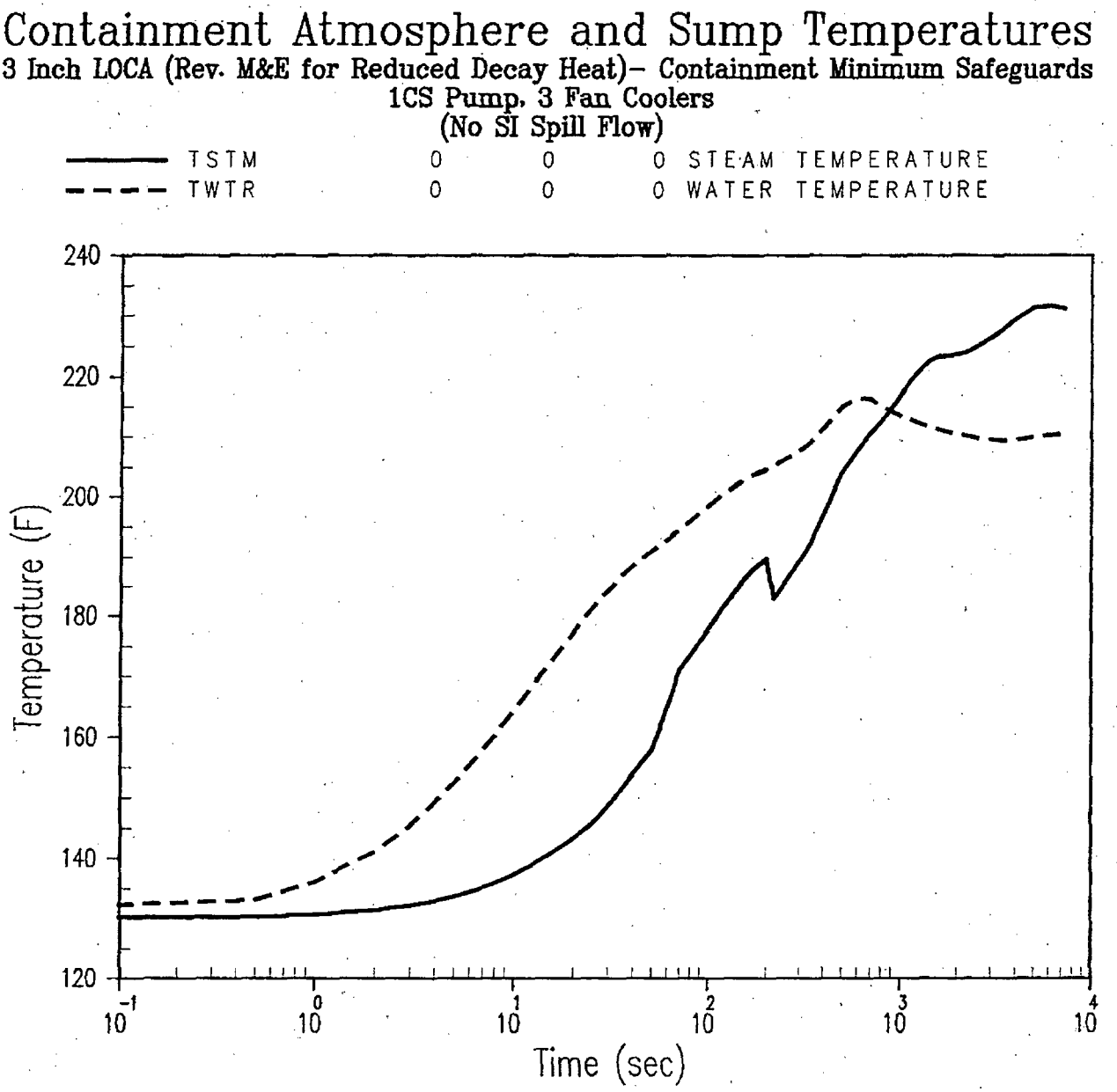


Figure 3 for Case 16

Containment Density and Fan Motor Power

3 Inch LOCA (Rev. M&E for Reduced Decay Heat)– Containment Minimum Safeguards
1CS Pump, 3 Fan Coolers
(No SI Spill Flow)

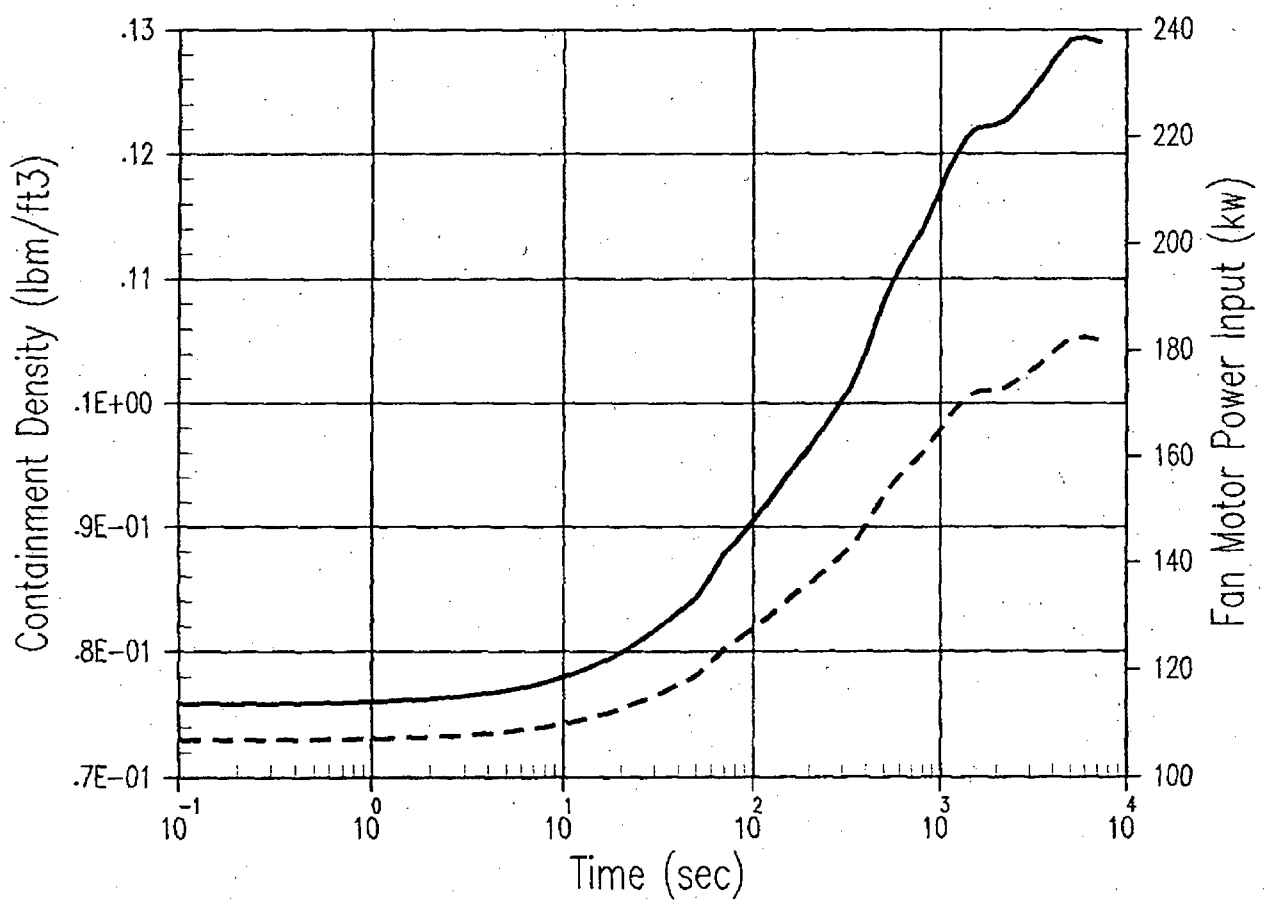


Figure 1 for Case 17

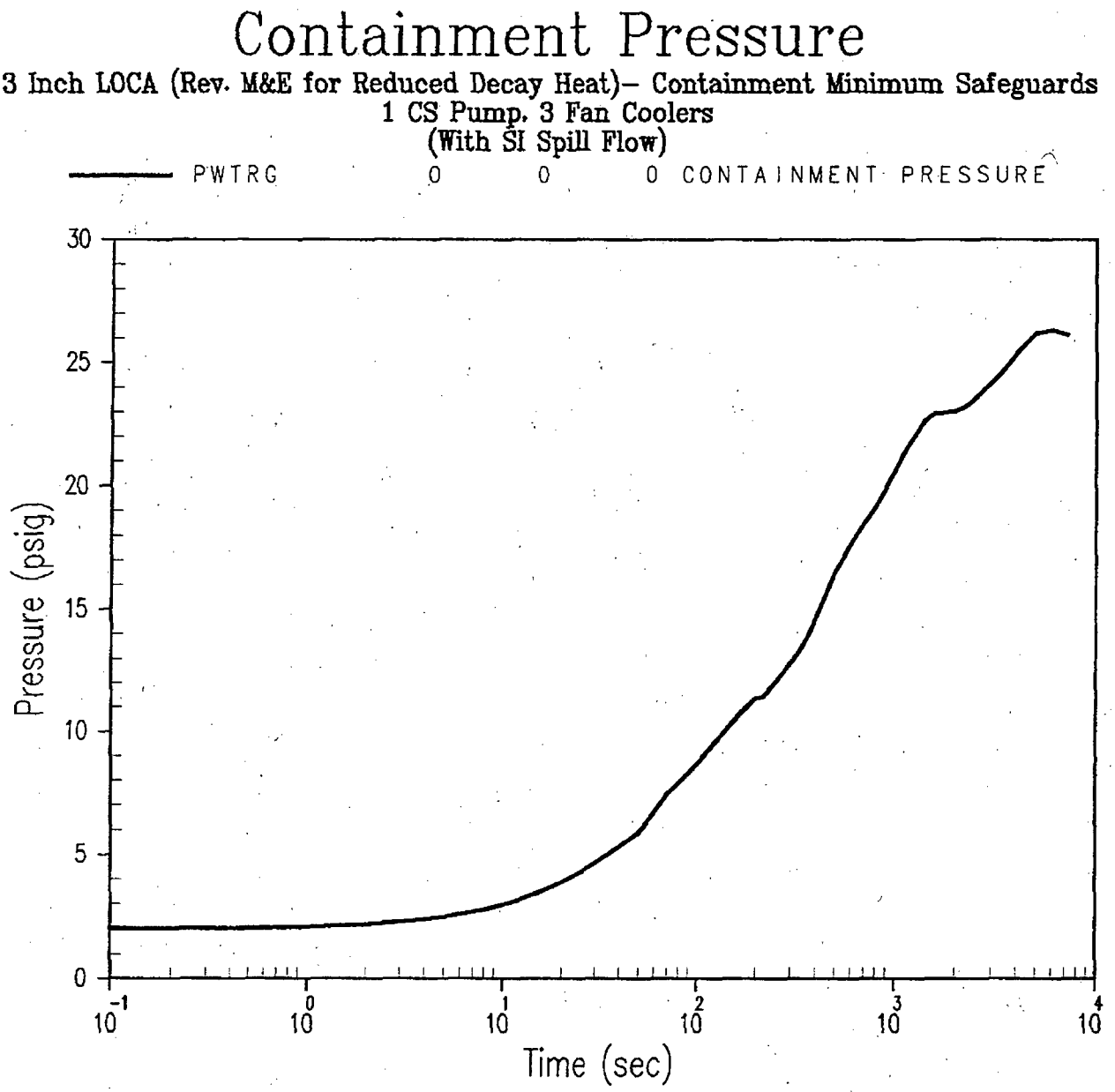


Figure 2 for Case 17

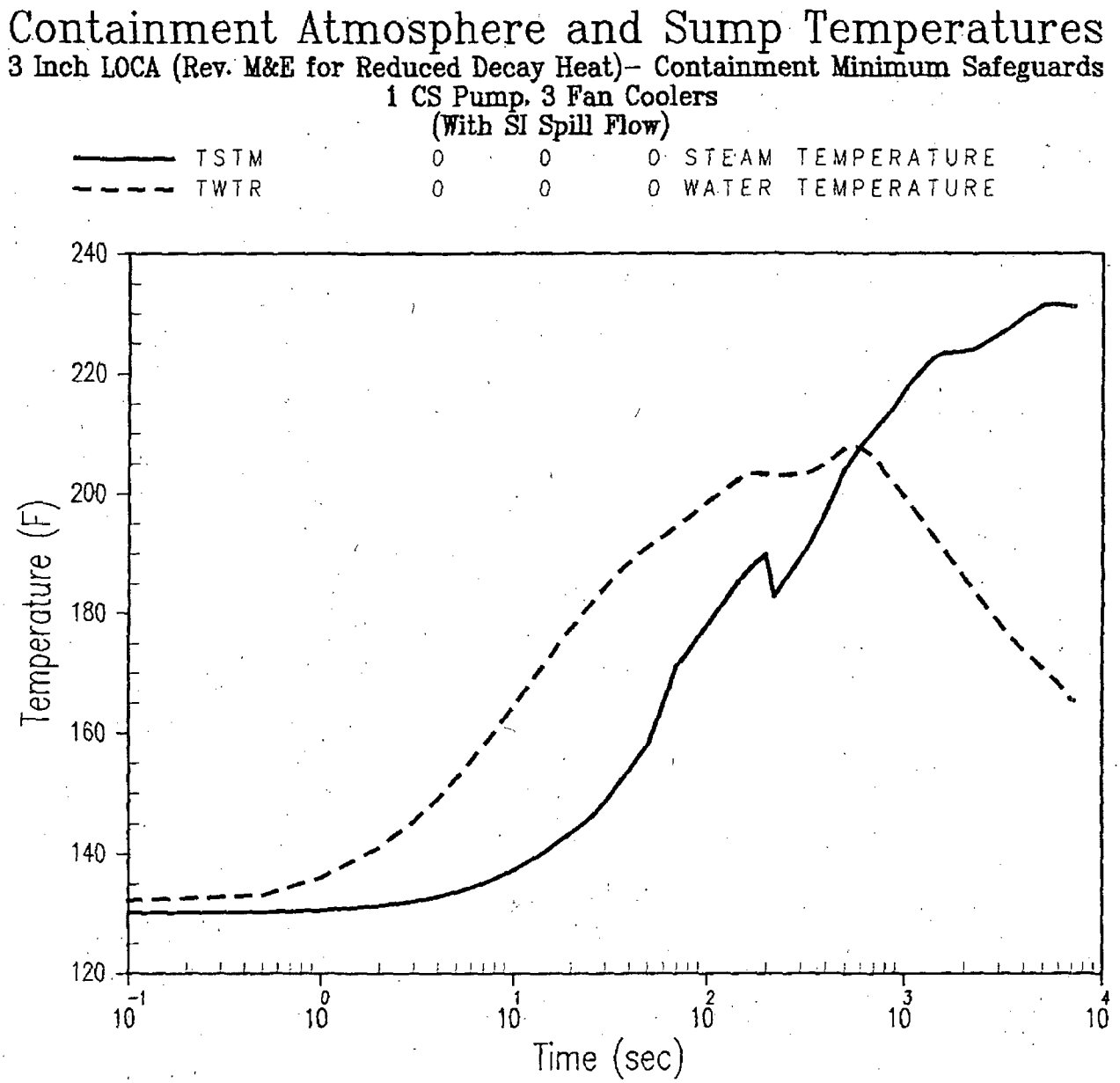
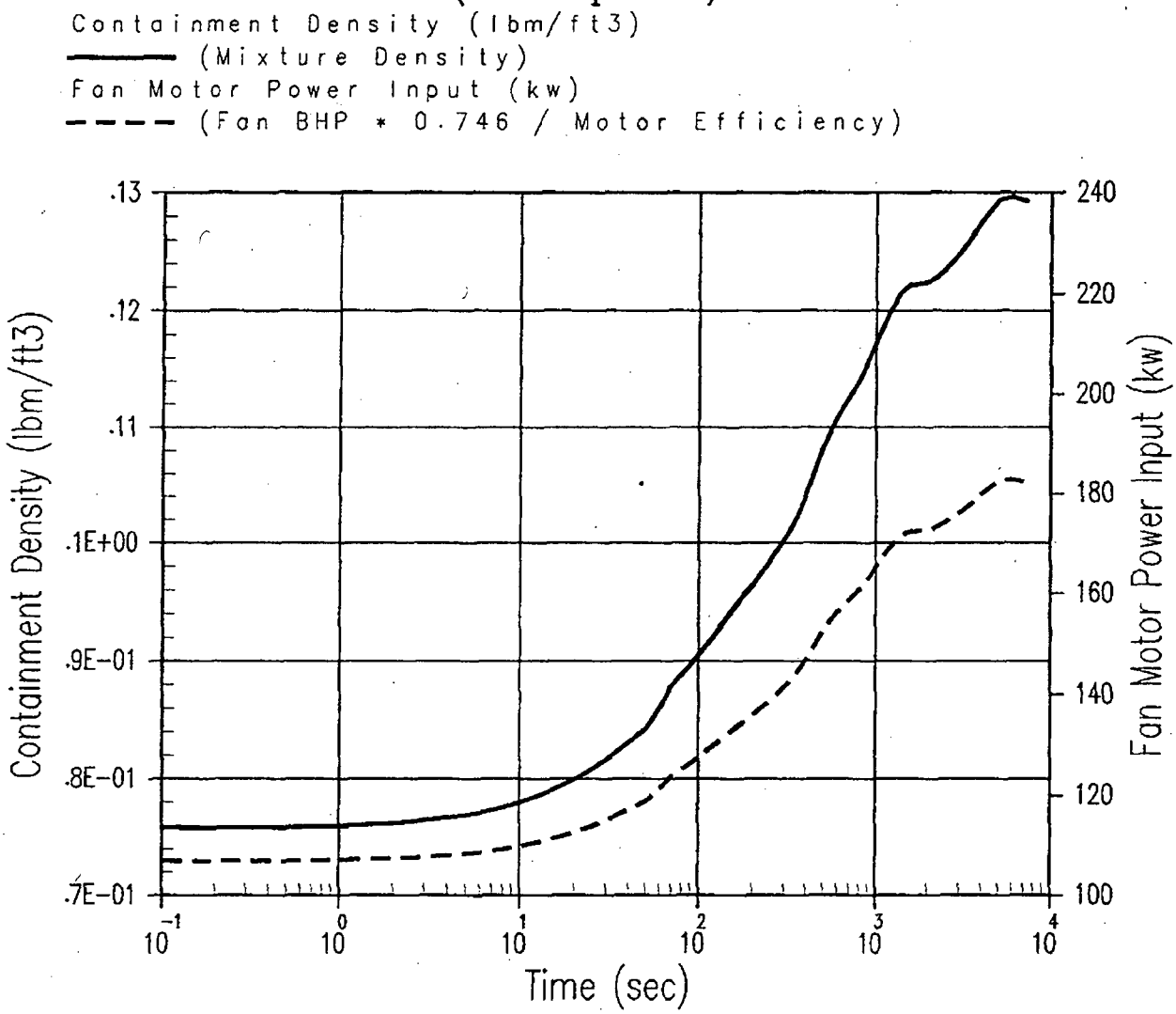


Figure 3 for Case 17

Containment Density and Fan Motor Power

3 Inch LOCA (Rev. M&E for Reduced Decay Heat)– Containment Minimum Safeguards
1 CS Pump, 3 Fan Coolers
(With SI Spill Flow)



ATTACHMENT 3 TO NL-07-128

(Regarding response to Question 4 in Attachment 1)

POWER FACTOR EVALUATION FOR IP2 DIESEL GENERATORS
(excerpt from Operability Evaluation for CR-IP2-2006-3530 and -3685)

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT NO. 2
DOCKET 50-247

EXCERPT FROM OPERABILITY EVALUATION FOR CR-IP2-2006-03530 & 03685

GENERATOR / EXCITER OPERABILITY EVALUATION:

Reference 4, the EDG Loading Study, determines the worst case accident loading on IP2's EDG's for various accident scenarios. However, this study only analyzes the required kW output of the EDG's and does not address the required generator output, which is measured in kVA. The generator output, in kVA, is the vector summation of the kW output and kVAR output. In order to assess the kVA output of the generators relative to the required accident values, it is necessary to determine the expected worse case accident kVAR output. To calculate the kVAR output, the overall power factor of the accident load must be determined first. The power factor calculation is shown in Attachments 1 through 3 of this Operability Evaluation. The power factor used for this calculation is associated with the worst case peak load as shown in Table 2 above using data from Reference 5, the IP2 Load Flow Analysis, and calculating the equivalent power factor during the worst case peak output. The specific loads that are considered in the power factor calculation are those loads "running" during the time the peak is reached. The power factor data is taken from motor test data sheets for the specific motors used in the calculation. For the purpose of determining power factor, the calculations only considered running loads 50kW and above and included all major safety related motors including Auxiliary Feedwater Pumps, Service Water Pumps, SI Pumps, RHR Pumps, Recirculation Pumps and Recirculation Fans. The remaining loads on the EDG's represent a mix of lighting, heating, battery charger and small motors, including MOV's and when considered together, would not significantly change the resulting power factor value. This power factor value is then used to calculate a worst case DBA peak kVAR. The worst case peak kVA is then calculated from the vector summation of the worst case peak kW and peak kVAR. It must be emphasized that the worst case peak DBA kVA load is based on the loss of one EDG, which is the assumed single failure for the accident loading analysis. The peak DBA loads used in this OE for all three EDG's occurs during the Recirculation Switch Sequence for duration of approximately one minute at the time points shown above in Table 2 with the loss of one EDG assumed. The peak DBA loads in Reference 4 for cases where all EDG's are available are significantly less than those with the loss of one EDG, including the loss of a single safety related pump on one EDG. The following table summarizes the results of Attachments 1 through 3:

TABLE 3 – Summary of Results

EDG	Worst Case DBA Peak kVAR	Worst Case DBA Peak kVA
21	1224 kVAR	2577 kVA
22	1177 kVAR	2386 kVA
23	1184 kVAR	2493 kVA

The capability of the generator to produce maximum required DBA kVA output, calculated above, can be found in the review of past surveillance tests. References 9, 10 and 11 are 8 hour EDG load tests that were performed during Outage 2R15 to demonstrate compliance with the TS Surveillance Requirements that were part of the original Custom Technical Specifications (CTS) prior to implementing the Improved Technical Specification (ITS). Attachment 4 is a comparison of the worst case DBA peak loading, calculated in Attachments 1 through 3, with this load test data. Referring to the attachment, for the DBA loading, the peak kW is the values listed in Table 2, the power factor is from Attachments 1 through 3 for the respective EDG, the peak kVAR is calculated from the power factor and the peak kW, the kVA is calculated from the peak kW and peak kVAR and the load current is calculated from the kVA for the nominal safeguards bus voltage (480V) and the tested EDG output voltages (494V and 504V). For the test loading, the test kW and test kVAR is from Step 7.4 of the test procedure for each EDG, the power factor and kVA are calculated from the test kW and kVAR, and the load current is calculated from the kVA for the nominal safeguards bus voltage (480V) and the tested EDG output voltages (494V and 504V). By comparing the DBA load data for kW, kVAR, kVA, pf, and Amps to the associated test data it is concluded that the EDG testing performed prior to the implementation of ITS bounded the worst case DBA peak loading. Of particular interest is the kVA output data which shows DBA required and tested kVA output significantly higher than the generator rated kVA output of 2188kVA. IP2 generators are capable of a continuous output of 2300kW, 480 volts at 0.8pf. This corresponds to a rated kVA output of 2875kVA. This rating is documented via a memorandum from Westinghouse included in this OE as Attachment 8. This provides additional supporting documentation that the EDG's are operable and capable of performing their DBA safety function.

When reviewing the exciter performance in the most recent 2R17 EDG testing (References 1, 2 and 3), it was noted that when checking the relationship of the EDG test data for AC current and AC volts with the test data for field current, that the field current was significantly higher than the expected value extrapolated from the Synchronous Generator V Curves, included in this OE as Attachment 5. Does the test result indicate potential generator degradation?

The generator field current limits specified in the TS SR test procedures are derived from the Synchronous Generator V Curves (Attachment 5) and are based on the specified TS SR test kW output (See Table 1), power factor and the associated maximum output current. For the 2R17 tests, these values are shown below in Table 4.

Table 4 – Generator TS SR Field Current Limits

TS SR Test kW	pf	Output Current	Field Current
1750kW	0.8	2631A	112A
1925kW	0.8	2894A	114A

The output current and associated field current in the above table is based on a generator voltage of 480V.

Attachment 6 is data taken from the Operator Log for the test associated with EDG 22 (Reference 2). The particular data used in the test review was at Time = 1400 hours. Using this data from Attachment 6 for AC current of 2575 amps and power factor (pf) of 0.86, enter the V Curve at a Per Unit (PU) Stator Current of 2575A/2630A = 0.98 PU. (Note: 1.0 PU Stator Current is equal to the generator rated output current or 2630A.) Move across the curve at 0.98 PU Stator Current, to an overexcited power factor equal to approximately 0.86 and then down to the PU Field Amps and the expected value is 1.9 PU or approximately 105 amps. (Note: 1.0 PU Field Amps is equal to 55 amps for the IP2 Generators.) Comparing this value from the V Curve with the recorded test value of 114A, shows that the generator field current was higher than indicated from the V Curve. The V Curve for the IP2 generators is based on a generator voltage equal to rated nameplate volts, which is 480 volts, and the field current is based on a power factor of 0.8 as shown in Table 4. The generator voltage (AC Volts) during the test was 494 volts as documented on Attachment 6. When the generator is operated in parallel mode with the grid, the field current may need to be varied through a wide range if the generator is required to maintain a near constant kW output while maintaining rated voltage. When it is necessary for the generator to assume a higher reactive load, for example during the higher output part of the test, it is necessary to raise the field current so that the generator takes on more reactive load from the system it is paralleled with. This is accomplished by raising the generator terminal voltage and monitoring the field current until the desired kVAR output is reached. (Note: Output voltage and field current adjustments have no impact on the kW output; this can only be varied by a change to the engine governor settings.)

A check of the higher output voltage versus the generator field current can be performed by review of the generator "Saturation Curves" for the IP2 generators. These curves are included in Attachment 7. Saturation Curves are provided for "No Load Saturation" and "Full Load Saturation at 0 pf". An additional check point is provided for Full Load Saturation at 0.8 pf. The Saturation Curves show the relationship between generator output voltage (Line Volts) and Field Current (Field Amps). As generator output voltage increases for a constant load, the generator field current also increases. Using the test values for AC Volts, AC Current, and power factor shown in Attachment 7 at Time = 1400 hours and by interpolation of the Saturation Curve for these values, it can be shown that the expected generator field current is approximately 114A, which is consistent with the recorded data.

The exciter operation was evaluated as part of the EDG upgrade modification performed in the early 1990's. Reference 18 is the Basler exciter test report and this report concludes that the generator field current could be operated as high as 141 amps without exceeding the worst case exciter component temperature limits. Reference 19 provides a validation of the IP2 generator V Curves and this analysis shows that the expected field current values at 480V output and 0.8pf are 112 amps for 1750kW output, 124 amps for 2100kW output and 131 amps for 2300kW output. This demonstrates that the maximum expected field current value of 131 amps at the peak EDG kW loading of 2300kW is bounded by the Basler report test results and would not be exceeded by operation at the calculated DBA peak kW loading shown in Table 2.

As a final check of generator performance consistency, the rated continuous load test data from the Outage 2R15 tests were compared to the same continuous load test data from the Outage 2R17 tests for each generator. This data is summarized in Attachment 9.There were no significant differences noted in the generator parameter data for any of the generators when comparing between the two sets of test data. This provides a reasonable assurance that the performance of the generators, including the exciters, remains consistent and acceptable up to the present time.

CR-IP2-2006-03530 and 3685 Operability Evaluation
Attachment 1
Calculated DBA Load Power Factor and kVA Load for EDG 21

Load ID	kW	PF	Calculated kVA	Calculated kVAR
SI Pump 21	345	0.910	379.12	157.18
CS Pump 21	350	0.906	386.31	163.51
CR Fan 21	223	0.850	262.35	138.20
CR Fan 22	223	0.850	262.35	138.20
RC Pump 21	294	0.874	336.38	163.45
ESW Pp 24	282	0.885	318.64	148.35
NSW Pp 21	282	0.885	318.64	148.35
IAC 21	56	0.830	67.47	37.63

Total = 2055 kW 1094.87 kVAR
Calculated PF = 0.88

EDG Worst Case DBA Peak kW = 2268 kW
EDG Worst Case DBA Peak kVAR = 1224 kVAR
EDG Worst Case DBA Peak kVA = 2577 kVA

Remarks:
EDG Worst Case Peak kW = This is based on Westinghouse EDG Loading Study, FEX-00039-02, Table 5.5-2a @ T=42 minutes
EDG Worst Case DBA Peak kVAR = (EDG DBA Peak kW) X (Tan (Acos(Calculated PF)))
EDG Worst Case DBA Peak kVA = Vector Sum of Peak kW and Peak kVAR
PF = Power factor based on motor data sheets (Reference 5)

CR-IP2-2006-03530 and 3685 OE
EDG 21 Operator Log Data
2R17 8 Hour Test 2-PT-R084A Performed 4/27/06

Time	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00
Field Current (A)	94	94	95	108	108	108	108	114	114
AC Current (A)	2010	2010	2010	2300	2400	2350	2300	2530	2500
AC Volts (V)	494	494	494	494	494	494	494	501	500
kW	1650	1650	1650	1690	1740	1730	1650	1900	1900
kVAR	625	625	690	1125	1190	1140	1150	1250	1300
kVA	1764.4	1764.4	1788.5	2030.2	2108.0	2071.8	2011.2	2274.3	2302.2
pf	0.935	0.935	0.923	0.832	0.825	0.835	0.820	0.835	0.825

CR-IP2-2006-03530 and 3685 Operability Evaluation
Attachment 2
Calculated DBA Load Power Factor and kVA Load for EDG 22

Load ID	kW	PF	Calculated kVA	Calculated kVAR
SI Pump 22	345	0.868	397.47	197.38
AFW Pump 21	223	0.840	265.48	144.05
CR Fan 23	223	0.850	262.35	138.20
CR Fan 24	223	0.850	262.35	138.20
ESW Pump 25	282	0.885	318.64	148.35
NSW Pump 22	282	0.885	318.64	148.35
CCW Pump 22	230	0.891	258.14	117.20
IAC 22	56	0.830	67.47	37.63

Total = 1864 kW 1069.36 kVAR
Calculated PF = 0.87

EDG Worst Case DBA Peak kW = 2076 kW
EDG Worst Case DBA Peak kVAR = 1177 kVAR
EDG Worst Case DBA Peak kVA = 2386 kVA

Remarks:
EDG Worst Case Peak kW = This is based on Westinghouse EDG Loading Study, FEX-00039-02, Table 5.5-2b @ T=40 minutes
EDG Worst Case DBA Peak kVAR = (EDG DBA Peak kW) X (Tan (Acos(Calculated PF)))
EDG Worst Case DBA Peak kVA = Vector Sum of Peak kW and Peak kVAR
PF = Power factor based on motor data sheets (Reference 5)

CR-IP2-2006-03530 and 3685 OE
EDG 22 Operator Log Data
2R17 8 Hour Test 2-PT-R084B Performed 5/4/06

Time	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00
Field Current (A)	112	103	107	108	108	110	109	114	114
AC Current (A)	2450	2250	2300	2300	2350	2400	2400	2550	2575
AC Volts (V)	494	494	494	494	494	494	494	496	494
kW	1750	1750	1725	1700	1740	1725	1750	1850	1870
kVAR	1150	850	1000	1025	1000	1100	1020	1100	1100
kVA	2094.0	1945.5	1993.9	1985.1	2006.9	2045.9	2025.6	2152.3	2169.5
pf	0.836	0.900	0.865	0.856	0.867	0.843	0.864	0.860	0.862

CR-IP2-2006-03530 and 3685 Operability Evaluation
Attachment 3
Calculated DBA Load Power Factor and kVA Load for EDG 23

Load ID	kW	PF	Calculated kVA	Calculated kVAR
SI Pump 23	345	0.910	379.12	157.18
CS Pump 22	350	0.906	386.31	163.51
AFW Pump 23	223	0.840	265.48	144.05
CR Fan 25	223	0.850	262.35	138.20
RC Pump 22	294	0.874	336.38	163.45
ESW Pump 26	282	0.885	318.64	148.35
NSW Punp 23	282	0.885	318.64	148.35

Total = 1999 kW 1063.09 kVAR
Calculated PF = 0.88

EDG Worst Case DBA Peak kW = 2194 kW
EDG Worst Case DBA Peak kVAR = 1184 kVAR
EDG Worst Case DBA Peak kVA = 2493 kVA

Remarks:
EDG Worst Case Peak kW = This is based on Westinghouse EDG Loading Study, FEX-00039-02, Table 5.3-2b @ T=37 minutes
EDG Worst Case DBA Peak kVAR = (EDG DBA Peak kW) X (Tan (Acos(Calculated PF)))
EDG Worst Case DBA Peak kVA = Vector Sum of Peak kW and Peak kVAR
PF = Power factor based on motor data sheets (Reference 5)

CR-IP2-2006-03530 and 3685 OE
EDG 23 Operator Log Data
2R17 8 Hour Test 2-PT-R084C Performed 4/20/06

Time	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00
Field Current (A)	108	105	105	105	110	107	114	114	114
AC Current (A)	2225	2200	2220	2350	2330	2300	2530	2550	2510
AC Volts (V)	494	494	494	494	494	494	500	499	499
kW	1650	1675	1720	1750	1725	1740	1900	1900	1898
kVAR	1025	925	925	990	1100	1060	1200	1200	1195
kVA	1942.5	1913.4	1953.0	2010.6	2045.9	2037.4	2247.2	2247.2	2242.9
pf	0.849	0.875	0.881	0.870	0.843	0.854	0.845	0.845	0.846

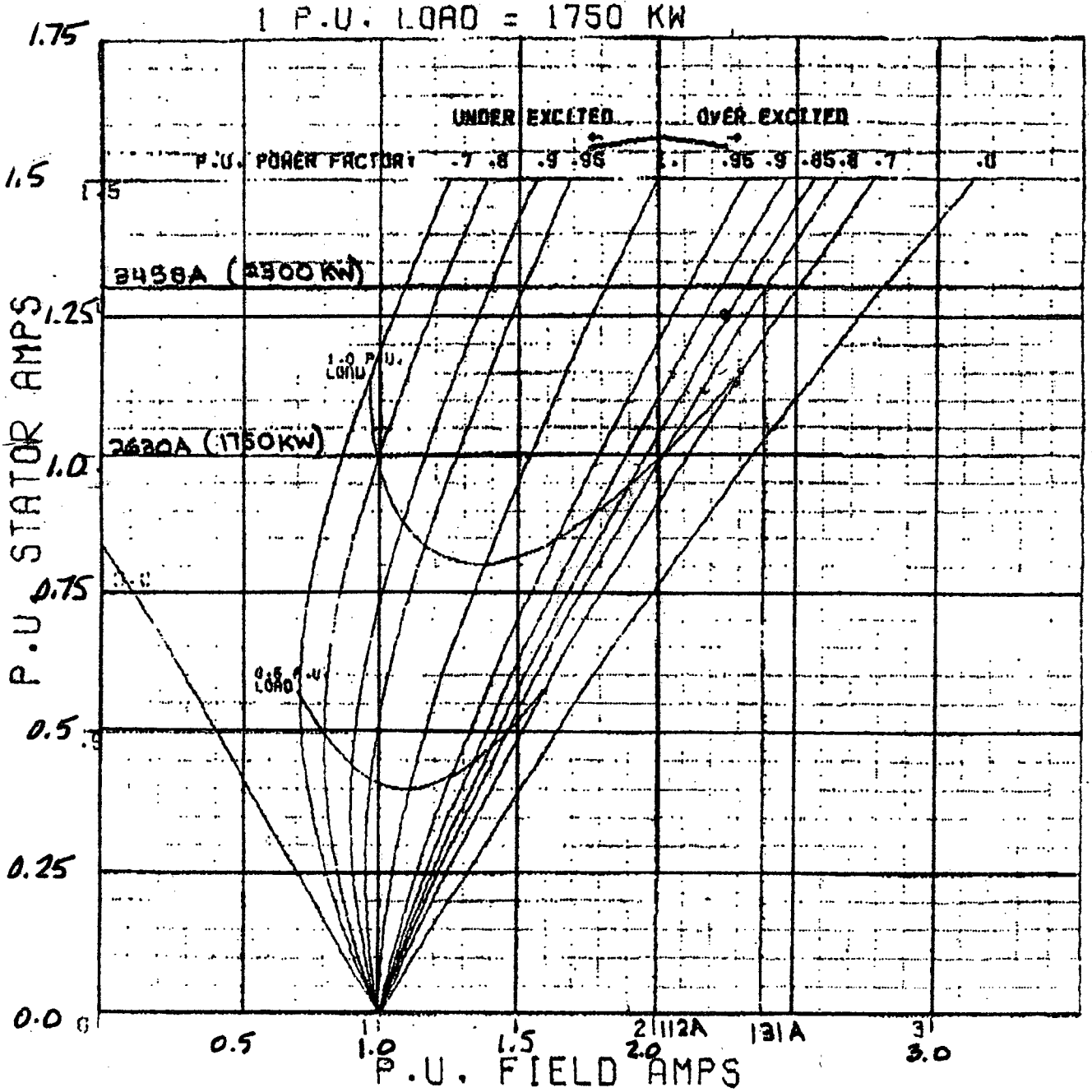
CR-IP2-2006-03530 and 3685 Operability Evaluation
Attachment 4
Comparison of DBA Peak Load and CTS EDG Load Testing

EDG	Peak kW	Peak kVAR	pf	kVA	Amps (480V)	Amps (494V)	Amps (504V)
21	2268	1224	0.88	2577	3100	3012	2952
22	2076	1177	0.87	2386	2870	2789	2734
23	2194	1184	0.88	2493	2999	2914	2856
EDG	**Test kW**	**Test kVAR**	**pf**	**kVA**	**Amps (480V)**	**Amps (494V)**	**Amps (504V)**
21	2300	1280	0.87	2632	3166	3076	3015
22	2300	1400	0.85	2693	3239	3147	3085
23	2300	1300	0.87	2642	3178	3088	3027

CR-IP2-2006-03530/3685 DE
ATTACHMENT 5

SYNCHRONOUS GENERATOR V-CURVES

(1750 KW)
2188 KVA 480 VOLTS 3 PHASE 60 HZ
0.80 PF 2630 AMPS 8 POLES 900 RPM
S.O. GENERATOR G.O. OR
CUST. ORDER ENGINEER PERTTULA
CUSTOMER CONSOLIDATED EDISON
1 P.U. STATOR CURRENT = 2630 AMPS
1 P.U. FIELD CURRENT = 55 AMPS
1 P.U. LOAD = 1750 KW



WESTINGHOUSE ELECTRIC CORPORATION - HIMO ROUND ROCK, TEXA

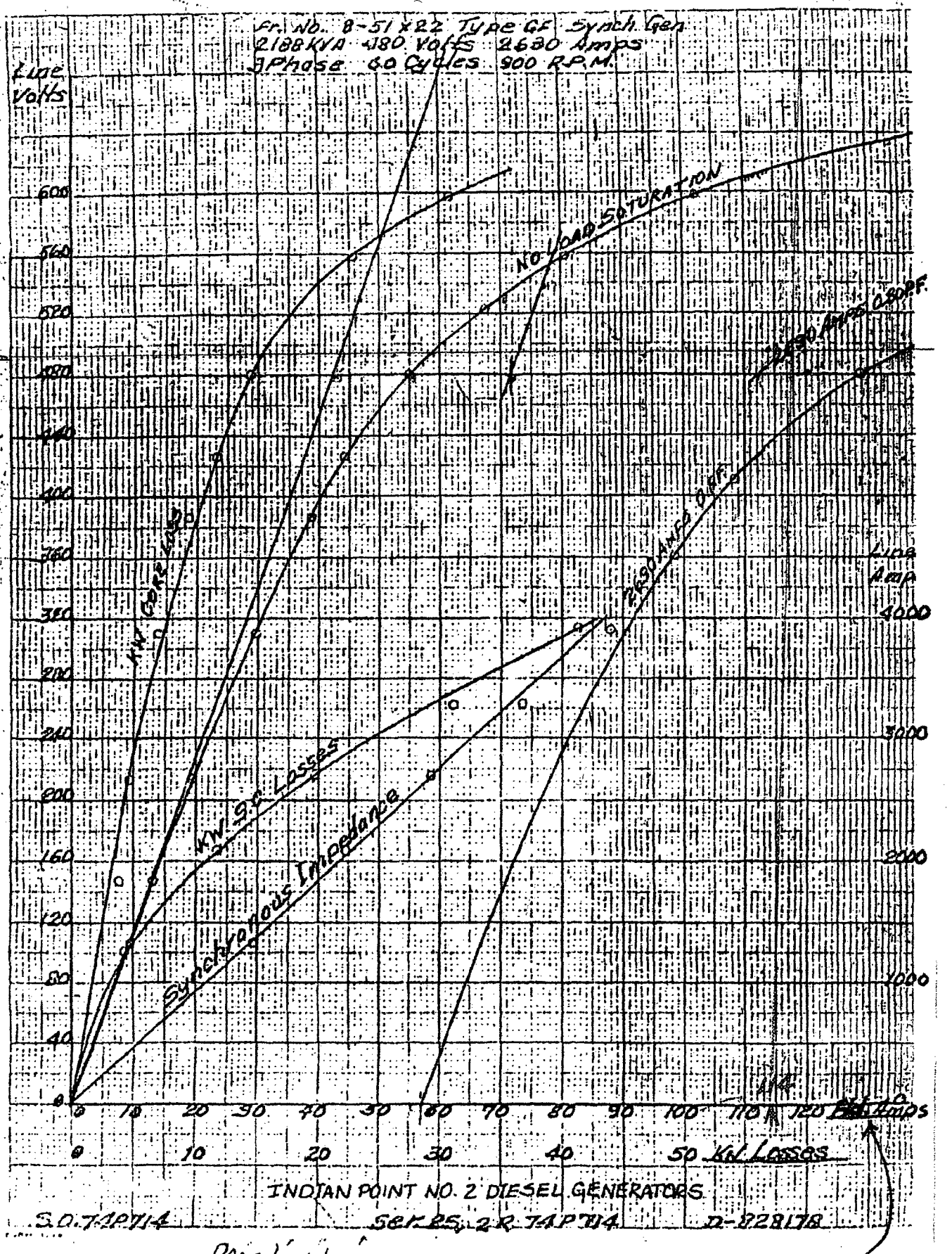
CR-IP2-2006-03530 and 3685 OE
EDG 22 Operator Log Data
2R17 8 Hour Test 2-PT-R084B Performed 5/4/06

Time	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00
Field Current (A)	112	103	107	108	108	110	109	114	114
AC Current (A)	2450	2250	2300	2300	2350	2400	2400	2550	2575
AC Volts (V)	494	494	494	494	494	494	494	496	494
kW	1750	1750	1725	1700	1740	1725	1750	1850	1870
kVAR	1150	850	1000	1025	1000	1100	1020	1100	1100
kVA	2094.0	1945.5	1993.9	1985.1	2006.9	2045.9	2025.6	2152.3	2169.5
pf	0.836	0.900	0.865	0.856	0.867	0.843	0.864	0.860	0.862

CR-IP2-2006-03530/3685 OE

ATTACHMENT 7

CURVE NO. G27697



INDIAN POINT NO. 2 DIESEL GENERATORS

S.O. 74P714 SEP 25, 2R 74P714 D-828178

PAGE 1 OF 1

FIELD AMPS

ATTACHMENT 4 TO NL-07-128

(Regarding response to Question 6 in Attachment 1)

PROPOSED CHANGES TO INDIAN POINT 2

TECHNICAL SPECIFICATION BASES SECTION 3.8.1

REGARDING DIESEL GENERATOR ENDURANCE TEST SURVEILLANCE

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT NO. 2
DOCKET 50-247

BASES

BACKGROUND (continued)

In the event of a loss of the 138 kV offsite circuit, the ESF electrical loads are automatically connected to the DGs in sufficient time to provide for safe reactor shutdown and to mitigate the consequences of a Design Basis Accident (DBA) such as a loss of coolant accident (LOCA).

Certain required unit loads are returned to service in a predetermined sequence in order to prevent overloading the DG in the process. Within 1 minute after the initiating signal is received, all loads needed to recover the unit or maintain it in a safe condition are returned to service.

Replace with INSERT A

Ratings for DGs 21, 22 and 23 are consistent with the requirements of Regulatory Guide 1.9 (Ref. 3). Each diesel generator consists of an Alco Model 16-251-E engine coupled to a Westinghouse 900 rpm, 3-phase, 60-cycle, 480 V generator. Each diesel generator has a capability of 1750 kW (continuous), 2300 kW for 1/2 hour in any 24 hour period, and 2100 kW for 2 hours in any 24 hour period. There is a sequential limitation whereby it is unacceptable to operate DGs for two hours at 2100 kW followed by operating at 2300 kW for a half hour. Any other combination of the above ratings is acceptable. The ESF loads that are powered from the 480 V ESF buses are listed in Reference 2.

APPLICABLE SAFETY ANALYSES

The initial conditions of DBA and transient analyses in the UFSAR, Chapter 6 (Ref. 4) and Chapter 14 (Ref. 5), assume ESF systems are OPERABLE. The AC electrical power sources are designed to provide sufficient capacity, capability, redundancy, and reliability to ensure the availability of necessary power to ESF systems so that the fuel, Reactor Coolant System (RCS), and containment design limits are not exceeded. These limits are discussed in more detail in the Bases for Section 3.2, Power Distribution Limits; Section 3.4, Reactor Coolant System (RCS); and Section 3.6, Containment Systems.

The OPERABILITY of the AC electrical power sources is consistent with the initial assumptions of the accident analyses and is based upon meeting the design basis of the unit. This results in maintaining at least 2 of the 3 safeguards power trains energized from either onsite or offsite AC sources during accident conditions in the event of:

a. An assumed loss of all offsite power or all onsite AC power and

b. A worst case single failure.

The AC sources satisfy Criterion 3 of 10 CFR 50.36.

INSERT A for page B 3.8.1-4:

Each diesel generator consists of an Alco Model 16-251-E engine coupled to a Westinghouse 900 rpm, 3-phase, 60-cycle, 480 V generator. The ESF loads that are powered from the 480 V ESF buses are listed in Reference 2. The DG ratings (Reference 12) are as follows:

Continuous	Normal steady-state electrical power output capability that can be maintained 24 hours/day, with no time constraint.
2-hour	An overload electrical power output capability that can be maintained for up to 2 hours in any 24-hour period.
½-hour	An overload electrical power output capability that can be maintained for up to 30 minutes in any 24 hour period.

The electrical output capabilities applicable to these three ratings are as follows:

RATING	DG LOAD	TIME CONSTRAINT
Continuous	≤ 1750 kW	None
2-hour	≤ 2100 kW	≤ 2 hours in any 24-hour period [Note A]
½-hour	≤ 2300 kW	< 30 minutes in any 24-hour period [Note A]

Note A: Operation at the overload ratings is allowed only for ≤ 2300 kW (1/2-hour) followed by ≤ 2100 (2-hour), not vice versa.

The loading cycle (½ -hour, 2-hour, continuous) may be repeated in successive 24-hour periods. Operation in excess of 2300 kW, regardless of duration is not analyzed. In such cases, the DG is assumed to be inoperable and the vendor should be consulted.

BASES

REFERENCES (continued)

10. Generic Letter 84-15, July 2, 1984.

11. Calculation SGX-00073-01, dated February 6, 2004.

12. Indian Point Unit 2 License Amendment 153, dated May 9, 1991.