Millstone Unit 2

Individual Plant Examinations for External Events

(MP2 IPEEE)

Prepared by

Northeast Utilities Service Company
(NUSCO)

for

Millstone Unit 2 (MP2)

Response to

Generic Letter 88-20, Supplement 4

December 1995

MP2 IPEEE

Disclaimer

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1.0 Executive Summary

1.1 Background and Objectives

As a part of the implementation of the Nuclear Regulatory Commission statement policy on severe accidents in nuclear power plants (Ref. 1-1), the staff issued Generic Letter 88-20, Supplement No. 4 (Ref. 1-2) on June 28, 1991, requesting that each licensee conduct an individual plant examination of external events (IPEEE) for severe accident vulnerabilities. Consistent with the Commission's Severe Accident Policy Statement and pursuant to 10 CFR 50.54(f), licensees are requested to perform this IPEEE for plant-specific severe accident vulnerabilities initiated by external events and to submit the results, together with any licensee-determined improvements and corrective actions, to the NRC. The staff document, NUREG-1407 (Ref. 1-3), provides additional guidance for the performance and submittal of the IPEEE.

The general objectives of the licensee's IPEEE are:

- To develop an appreciation of severe accident behavior.
- To understand the most likely severe accident sequences that could occur at its plant under full power operating conditions.
- To gain a qualitative understanding of the overall likelihood of core damage and radioactive material release.
- If necessary, to reduce the overall likelihood of core damage and radioactive material releases by modifying hardware and procedures that would help prevent or mitigate severe accidents.

This report documents the methods employed and results obtained from the IPEEE effort. It also illustrates how Millstone Unit No. 2 (MP-2) meets the overall IPEEE objectives as delineated by GL #88-20.

1.2 Plant Familiarization

While performing the MP-2 IPEEE, plant familiarization was achieved by several means. The project team consisted of NUSCO engineers who have a large number of years of experience with the plant operation. PRA engineers who supported the IPEEE were extremely familiar with the plant systems and operations. They had gained this experience during the internal event PRA that was performed for the IPE (Ref. 1-4). Contractor support was used in areas of expertise such as seismic, where in-house expertise was limited or unavailable. In-house engineering contributed to approximately 50 percent of the total engineering effort that was expended on the project. Section 2.4 describes additional information resources that were utilized.

1.3 Overall Methodology

The overall methodologies used for the MP-2 IPEEE are in conformance with guidance provided by Generic Letter 88-20, Supplement 4 (Ref. 1-2) and the detailed guidance provided by NUREG-1407 (Ref. 1-3). Special methods had to be devised to perform bounding PRA analysis for "External Flooding" and "Tornado/High Winds" initiators. All of these methods are explained in detail under the individual sections on each of the external initiators.

1.4 Summary of Major Findings

The IPEEE process utilized approximately ten person-years of inhouse and external resources. Through the evaluations performed, several plant vulnerabilties (outliers) to severe external events were identified. These issues are summarized in Table 7.1-1. Findings will be prioritized based on their risk significance and the method of resolution, for each finding, will strongly depend upon the potential risk reduction that can be achieved.

1.5 References

1-1 U. S. Nuclear Regulatory Commission (USNRC), "Policy Statement on Severe Accidents", Federal Register, Vol. 50, 32138, August 8, 1985.

1-2 James G. Partlow letter to Licensees Holding Operating Licenses and Construction Permits for Nuclear Power Reactor Facilities, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - 10CFR50.54(f) (Generic Letter 88-20, Supplement 4)," dated June 28, 1991.

1-3 USNRC NUREG-1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events for Severe accident Vulnerabilities", May 1991.

1-4 Millstone Unit 2 Individual Plant Examination (IPE) for External Events, December 1993.

2.0 Examination Description

2.1 Introduction

As a result of the Generic Letter 88-20, Supplement 4, a project was initiated to evaluate plant specific vulnerabilities to severe accidents caused by external events. After a thorough review of GL 88-20 (Ref. 2-1) and NUREG-1407 (Ref. 2-2) a workscope was developed and all affected engineering disciplines were notified and coordinated to provide a response.

2.2 Conformance with Generic Letter and Supporting Material

The NRC Generic Letter 88-20, Supplements 4 and 5 (References 2-1 and 2-5) as well as the guidance document NUREG-1407 (Ref. 2-2) provide guidance on how to perform the licensee's Individual Plant Examination for External Events (IPEEE).

As recommended by the NRC, in order to gain the maximum benefit from the IPEEE, the licensee's staff was involved in all aspects of the examination. This included participation in the analysis and technical reviews as well as by validating both the process and its results by including an independent peer review process.

2.3 General Methodology

The Individual Plant Examination of External Events (IPEEE) for MP-2 was performed using the methods that were recommended in NUREG-1407. Analysis of the external initiators were performed in three distinct phases. They are:

- Hazard Analysis
- Plant Response (Fragility) Analysis
- Risk Determination

Depending on the external event being evaluated, the specific method of identifying risk outliers varied yet were in conformance with the options allowed by References 2-1, 2-4 and 2-5. The general methodology for each evaluation was as follows:

<u>Seismic:</u>

The MP2 Seismic IPEEE has been performed using the Seismic Margins assessment option per the methodology of EPRI NP-6041. (Stevenson and Associates, a company that specializes in seismic evaluation of structures, was contracted to perform this assessment). With this method, a seismic margins earthquake (SME) is postulated (beyond design basis) and the items needed for safe shutdown are then evaluated for the SME demand. If it is determined that the component or structure can survive the SME, without loss of function, then this item is screened out. Items that are not screened out are subject to a more detailed evaluation that usually involves calculation of the high-confidence-low-probability of failure (HCLPF) peak ground acceleration PGA level of the item. A 0.30 PGA earthquake level was used. The response spectra shape used is the NUREG/CR-0098 median shape applicable to a rock site.

In order to evaluate the demand on components mounted within the structures, the in-structure demand for the SME was determined. This was done by generating new demand curves using building mathematical models. Once this was established, credited equipment was evaluated against the SME demand using simplified methods such as walkdowns, similarity principles and simple calculations. For this phase, work performed for the USI A-46 effort was utilized as much as possible.

Civil Structure Capacity Screening was performed by Jack Benjamin Associates as a subcontractor to Stevenson and Associates. Walkdowns for this evaluation were performed in 1993.

Piping screening was performed by selecting some of the weaker piping runs, as determined by engineering judgement, and performing walkdowns. With the information gathered from walkdowns, small scale piping evaluations were performed. These confirmed the generally high capacity of the piping systems that exist at MP2.

Findings regarding the seismic capacity of components and plant structures is discussed in Section 3.2.4.

Fire:

A PRA/Fire Induced Vulnerability Evaluation (FIVE) methodology was used to determine the risk outliers due to fire for MP2, provided an area could not be screened from consideration using qualitative means. This PRA is based on the MP2 level 1 IPE model with its' initiators modified to reflect determined fire initiating event frequencies. A more complete description of the methodology utilized for this evaluation is presented in Section 4.2.

External Flooding, High Winds/Tornadoes, Transportation and Nearby Facilities and Others:

Figure 5.1 of NUREG 1407 represents the general method that was used to evaluate these external hazards. In general, the most detail evaluations performed were hazard frequency evaluations. No detailed PRA evaluations were utilized to assess any identified risk outliers. Further discussion of methodology is presented in Section 5.1.1 5.2.1, 5.3.1 and 5.4.1.

2.4 Information Assembly

The IPEEE process included a considerable effort to assemble information relevant to all of the external events analyzed. A variety of existing information sources were utilized to support the IPEEE:

- MP2 IPE Model - The MP2 level 1 IPE model served as the basis for the fire PRA and determining important equipment to be evaluated for the seismic margins analysis.

- MP2 FSAR

- Appendix R and Appendix A Programs - The Appendix R and Appendix A programs provided an enormous amount of plant specific information to support the fire IPEEE.

- USI A-46 Program - A significant effort had been undertaken by NUSCO to address the USI A-46 issue. As explained in detail in Section 3.3.3, the evaluations performed in response to USI A-46 were used as input to the seismic IPEEE.

- Walkdowns - Many walkdowns were performed to collect or verify information supporting all external events. Details of seismic and fire walkdowns are provided in Section 3.2.2.3 and 4.4, respectively. Walkdowns were also performed to support analysis of other external initiators such as "external flooding," and "snow."

2.5 References

2-1 James G. Partlow letter to Holders of Operating Licenses and Construction Permits for Nuclear Power Reactor Facilities, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - 10CFR50.54(f) (Generic Letter 88-20, Supplement 4)," dated June 28, 1991.

2-2 "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities (NUREG-1407) Final Report," published in June 1991.

2-3 James G. Partlow letter to Licensees Holding Operating Licenses and Construction Permits for Nuclear Power Reactor Facilities, "Initiation of the Individual Plant Examination for Severe Accident Vulnerabilities - 10CFR50.54(f) - Generic Letter 88-20, Supplement 1," dated August 29, 1989.

2-4 "Millstone Unit 2, Individual Plant Examination for Severe Accident Vulnerabilities," December, 1993.

2-5 D. M. Crutchfield letter to Holders of Operating Licenses and Construction Permits for Nuclear Power Reactor Facilities, "Individual Plant Examination of External Events for Severe Accident Vulnerabilities," (Generic Letter 88-20, Supplement 5), dated September 8, 1995

3.0 Seismic Analysis

3.1 Methodology Selection

The Generic Letter (GL 88-20, Supplement 4) and NUREG-1407 presents three methods which a licensee may select to perform the seismic IPEEE. They are:

- Seismic PRA
- NRC Seismic Margins Method with appropriate enhancements
- EPRI Seismic Margins Method with appropriate enhancements

Of these, Northeast Utilities Service Company (NUSCO) selected the EPRI Seismic Margins Method. This assessment has been performed using the methodology presented in EPRI NP - 6041 (Reference 3-1). Millstone Unit No. 2 (MP2) is different than other Northeast Utilities plants with respect to this evaluation method. After careful consideration, it was concluded that an SMA would be an effective means of determining seismic vulnerabilties beyond design basis and have the benefit of conserving PRA manpower resources needed to perform a seismic PRA. Because MP2 is well designed from a seismic standpoint, a seismic PRA, as a risk evaluation tool, has minimal future benefit.

3.2 Seismic Margins Method

3.2.1 Seismic Margins Earthquake and In-Structure Response Spectra

3.2.1.1 Seismic Margins Earthquake

Figure 3.2-1 shows a plot of the earthquake response spectrum (RS) shape used for the seismic margin assessment of MP2. The Review Level Earthquake (RLE) is the NUREG/CR-0098 median shape, applicable to a rock site, scaled to a 0.30g peak ground acceleration. This is consistent with the guidelines of EPRI NP -6041 and NUREG -1407 and is typical of east coast sites. Together, the PGA and RS shape define the Review Level Earthquake (RLE).

3.2.1.2 In-Structure Response Spectra

New median centered in-structure response spectra (IRS) were generated for major civil structures at MP2. The new IRS provided the review level seismic demand on components located within structures. Section 4 of NP-6041 was used as a guide in developing the new IRS.

Mathematical models of buildings were developed to generate the new IRS. For the Turbine Building, a model was developed by the project team as part of the seismic capacity evaluation of that building (see Section 3.2.3.5). The model was also used to generate IRS.

A new mathematical model and new median centered IRS were generated for the Auxiliary Building as part of the USI A-46 resolution effort (References 3-2 and 3-3). These IRS were

based on the MP2 safe shutdown earthquake (SSE). After scaling to account for differences between the SSE and RLE, these IRS were used in the seismic margin assessment (SMA).
For other buildings, the project team obtained mass and stiffness data from existing design basis reports (References 3-4, 3-5 and 3-6). Dynamic models were re-created from this data. The models were then used to generate IRS for the RLE. These models, for the Containment Interior, Intake Structure and Warehouse Building, were 2 dimensional stick models with no directional coupling. For the Containment Interior, there is substantial symmetry so neglecting torsion from the 2-D model is acceptable. Both the Intake Structure and Warehouse Building are rectangular in plan and are generally symmetric with regard to mass and E/W stiffness, but both have N/S stiffness asymmetry not included in the modeling. This effect will tend to result in increased system flexibility and non-uniform loading on lateral load elements. These effects would need to be included in a building capacity evaluation. For IRS generation, the models were judged acceptable since the calculated major N/S modes were in the peak spectral range (i.e., increased flexibility not a concern).

Table 3.2-1 summarizes the IRS generation process. A 7% damping value was used for all buildings, based on expected stress levels and guidance in NP-6041. Multiple time history analysis was used to calculate the Auxiliary Building response. Direct generation methods were used to calculate response for other buildings.

3.2.2 Review of Plant Information and Walkdown

3.2.2.1 Plant Information

MP2 was designed in the late 1960s - early 1970"s and began operation in 1975. It was designed to withstand the effects of unusual natural phenomena including earthquakes. The plant was designed to withstand a design basis event (DBE) earthquake, also known as a safe shutdown earthquake (SSE), with a peak horizontal ground acceleration of 0.17g (17% of gravity) and a vertical ground acceleration of 0.11 g.

In order to respond to GL 88-20, Supplement 4, seismic-related information of structures, systems, components, and site soil characteristics were needed.

3.2.2.2 Structures Information

Safety-related systems and equipment are contained in the following structures:

- Containment
- Enclosure Building
- Auxiliary Building
- Warehouse
- Turbine Building
- Intake Structure

Information regarding their seismic capacity was retrieved from drawings, past analysis, and other investigations that included walkdowns, as needed.

3.2.2.3 Soil Characteristics

The MP2 site is primarily a rock site. The structures that are supported on bedrock include the:

- Containment
- Enclosure Building
- Auxiliary Building
- Intake Structure
- Turbine Building

The following structures are supported on compacted structural backfill:

- Warehouse portion of the Auxiliary Building
- Auxiliary Feedwater Pump foundations located in the auxiliary bay of the Turbine Building

3.2.2.4 Systems and Equipment Information

As part of the A-46 program, a list of components and systems required to safely shut the plant down, in the event of an earthquake, was developed (the Safe Shutdown Equipment List (SSEL)). This list considered predetermined shutdown methods and the equipment required to satisfy those methods. Additionally, this list was augmented by the components and systems modeled in the internal MP2 PRA model that were not already included in the list. Since the A-46 program addresses mechanical and electrical equipment, only, piping systems and the structures were added to the list of items to be reviewed. Also, passive components such as strainers, heat exchangers and tanks, that are not specifically modeled in the internal events PRA model, were added since they may have credible seismically induced failure modes that could affect PRA modeled systems. In a few cases, PRA modeled equipment was removed from the SSEL if it had a low seismic capacity and negligible contribution to risk as determined by various PRA importance measures assessed using the MP2 internal events PRA model.

3.2.2.5 Information Sources

As stated in the Millstone Nuclear Power Station FSAR, (Reference 3-7) plant buildings and systems have been seismically designed. The FSAR was used to obtain seismic design criteria for the DBE earthquake.

Current seismic evaluations of safety-related piping, mechanical and electrical equipment were primarily found in MP2 project engineering files. Piping stress summaries and equipment stress analyses, as they were available, were obtained from these files. As-built and original installation drawings were used to obtain routing, equipment weights, and anchorage details.

The Generic Implementation Procedure (GIP) (Reference 3-8) for resolution of the NRC's Unresolved Safety Issue A-46 (USI A-46) was performed in coordination with the SMA. The results of that procedure, contained in USI A-46, formed the basis for a substantial part of the conclusions about equipment vulnerability.

Much of the methodology of the seismic fragility program was based on the procedures prescribed in EPRI Report NP-6041 which establishes bases for seismic "binning" and screening of nuclear power plant equipment, mechanical and electrical distribution systems, and structures. A great deal of the basis for the procedures in NP-6041 rests on the GIP. Ancillary supporting documentation for the GIP and NP-6041, that is used in this study for MP2, include EPRI Reports NP-5228 (Reference. 3-9) for anchorage issues, NP-7146 (Reference 3-10) for electrical cabinet amplification characteristics, and NP-7147 (Reference 3-11) for relay generic seismic ruggedness levels.

3.2.2.6 Plant Walkdowns

The MP2 seismic PRA took advantage of the overlapping requirements between the IPEEE and A-46 examination programs. All insights gained from A-46 walkdowns were transmitted to the IPEEE team. Additional walkdowns were performed by the MP2 seismic PRA team to cover systems, structures, and components not covered by A-46. Seismic Review Teams (SRT) conducted the MP2 seismic PRA walkdowns following the walkdown procedures detailed in EPRI NP-6041. Each team consisted of at least two Seismic Review Engineers trained by EPRI both in the A-46 walkdown requirements, and also in the IPEEE add-on requirements.

Northeast Utilities (NU), Stevenson & Associates (S&A), and Jack R. Benjamin & Associates (JRBA) provided trained seismic engineers. Typically, at least one NU engineer participated as an SRT member during plant walkdowns.

Specific walkdowns were conducted to evaluate equipment. For the sake of documentation, all equipment were treated as if they were A-46 items, even if they were designated as PRA equipment items only. Each item was assigned a fragility level. Safety-related piping, electrical raceways, and ductwork were walked down separately to assess fragility capabilities. Essential relays were evaluated based on circuit analyses and then, seismic screening rules. In accordance with GIP rules, spot checks were made throughout during walkdowns to confirm, type (model number and manufacturer), location, and installation adequacy. Structural screening walkdowns were conducted by Dr. John Reed of JRBA to assess the primary site structures and determine building fragilities.

An independent peer review was conducted by Dr. Robert P. Kennedy of RPK Structural Mechanics and Dr. John D. Stevenson of S&A. They personally conducted two days of walkdowns with the SRTs and independently made determinations regarding completeness and correctness of the SMA and A-46 walkdown. Their conclusions were that the walkdowns were being conducted competently and the findings made were appropriate, even conservative, when compared to their own judgments (Reference 3-12).

3.2.3 Structures and Their Design Basis, Evaluation and Screening

3.2.3.1 General Plant Structures Description

The Millstone Unit No. 2 nuclear power plant structures, included in the seismic margin assessment (SMA), are the Containment and interior structures, Enclosure building, Auxiliary building, Warehouse, Intake Structure and Turbine Building. The plant is located on a rock site. However, several of the structures are founded on compacted structural backfill.

The Containment consists of a prestressed, reinforced concrete cylinder and dome connected to and supported by a massive reinforced concrete foundation slab that is integral with the tendon access gallery. The interior structures consist of the primary shield walls, concrete floor slabs, structural steel and other internal structures. The Enclosure Building is a limited leakage braced steel framed structure with un-insulated metal siding and an insulated roof deck. It is partially supported off of and braced to the Containment, Auxiliary and Turbine buildings. The Auxiliary Building is a multistory reinforced concrete structure with flat slabs and shear walls. Some of the areas of this building are enclosed by structural steel frames. The Warehouse is adjacent to the Auxiliary Building, but is seismically separated from it. It also is a concrete shear wall building with a steel frame structure housing the fuel handling area. The Intake Structure is a reinforced concrete box structure with shear walls that resist seismic forces. The Turbine Building is a rigid frame steel structure that contains both rigid and braced frames. The Turbine Building surrounds a reinforced concrete pedestal that supports the turbine.

These buildings are Class I structures, except for the turbine pedestal which is a Class II structure.

3.2.3.2 Structures Evaluation and Screening

From a review of the plant documentation all structures mentioned above, except for the Turbine Building, were pre-screened based on the guidelines provided in Table 2-3 of EPRI Report NP-6041. As discussed below, a high confidence low probability of failure (HCLPF) capacity was calculated for the Turbine Building. The basis for the pre-screening is provided in the Section 3.2.3.3 A walkdown to familiarize the Seismic Review Team (SRT) with the layout and visual details of the structures was performed. Based on the walkdown and review of the drawings, reports and calculation files the pre-screening decisions were verified. All concerns identified during the walkdown were resolved based on review of the pertinent documents or calculations by the SRT.

3.2.3.3 Summary of Structural Design Basis

The plant was designed in the late 1960's - early 1970's with Class I structures designed for a horizontal seismic input based on a modified Housner response spectrum and a shape similar to the NUREG/CR-0098 median shape (Reference 3-13). The modified Housner spectral shape was used for structures founded on rock and the shape similar to the NUREG/CR-0098 median curve was used for the Warehouse which is founded on compacted structural backfill. These spectral shapes were anchored to 0.09g peak ground acceleration (pga) for the operating basis earthquake (OBE) and 0.17g pga for the safe shutdown earthquake (SSE). A vertical seismic acceleration equal to 2/3 of the horizontal ground motion was considered simultaneously with the larger horizontal acceleration (from the two horizontal directions).

Class 2 structures were not designed for seismic forces. Thus, the turbine pedestal was included in the HCLPF analysis of the Turbine Building as discussed below.

The original seismic analysis, at the time the plant was designed, was performed by the Bechtel Corp. Lumped-mass stick models were analyzed for each of the buildings, and the resulting forces and moments were used to perform the building designs. These forces and moments were bench marked in this review against results obtained from reanalyses of the original models, but using the SMA ground input (i.e., NUREG/CR-0098 median shape anchored to 0.3g peak pga). The comparison showed that the original design input was reasonable.

The following codes and specifications established the methods, material properties and allowable stresses used in the design of structures:

- American Concrete Institute, "Building Code Requirements for Reinforced Concrete," ACI 318-63.
- "Specifications for Structural Concrete for Buildings," ACI 301-66.
- American Institute of Steel Construction, "Manual of Steel Construction" 6th Edition, 1963.
- Uniform Building Code, 1967 Edition.
- State of Connecticut Building Code.
- American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, 1968 Edition.

A summary of the original analysis parameters for each structure is provided in Table 3.2-2.

The procedure, used in the design of structures with concrete shear walls that resist seismic forces (i.e., Auxiliary Building, Warehouse and Intake structure), was based on the recommendations given in 3-14 for the design of shear wall reinforcement. This procedure required that the minimum amount of reinforcement in walls (designed to resist shearing forces caused by earthquake motions) be 0.25 percent of the wall cross-sectional area in both horizontal and vertical directions. In addition, this publication recommends that the shear and moment cracking capacities be checked against the design moment and shears increased by a factor of 1.5. When the cracking resistance is not sufficient to counteract 1.5 times the design moment and/or shear, then, reinforcement should be provided according to the following expressions:

Vertical Reinforcement

$$M = \frac{1}{3} As_V f_y L$$

where:

M	=	design moment
As_V	=	total cross-sectional area of the vertical reinforcement distributed over the length of the wall
f_y	=	yield strength of reinforcement
L	=	length of wall in the horizontal direction (net of length of openings)

Horizontal Reinforcement

$$V = 1.9 bL \sqrt{f_c'} + As_H f_y$$

where:

V	=	design shear force
b	=	wall width
f_c'	=	compressive strength of concrete
As_H	=	total cross-sectional area of the horizontal reinforcement distributed uniformly over a height of wall equal to half its length

It was found in reviewing the design calculations for sample shear walls that, in many cases, the design moments and shears were increased by the factor of 1.5. This is beyond the recommendations in Reference 3-14, which implies that the factor of 1.5 should be used only in performing the cracking capacity check. However, there were other places found in the design calculations where the additional factor of 1.5 was not used. Also, the minimum percent of reinforcement in some cases was equal to 0.15 (not 0.25) for the vertical direction, which is consistent with the requirements of the ACI 318-63 code when the empirical design requirements are used. In summary, it was found that the design of shear walls met the requirements of ACI 318-63, or was substantially better. It is expected that actual HCLPF capacities will be much greater than the screening level.

The note in Table 2-3 of NP-6401 (for reinforced concrete containment shell) is "no" which means that no caveats have to be checked. For the remaining structures, the entry in Table 2-3 is note (e) which states:

> *"Evaluation not required for Class I Structures if design was for a SSE of 0.1g or greater."*

Based on the original design, all Class I structures met the intent of the first screening column in Table 2-3 (i.e., designed for a SSE of 0.17g). **On this basis, all structures that house equipment included in the internal events PRA model (i.e., as listed above) are pre-screened. This pre-screening decision was verified as discussed in Section 3.2.3.4.**

3.2.3.4 Screening Verification

Construction drawings, analysis reports and design calculations were reviewed. A plant walkdown was conducted to familiarize the SRT with the layout and general structural details. Separations between structures were observed at several locations and found to be as indicated on the drawings.

Example reinforcement details were reviewed. Embedment and splice lengths in the walls were found to be more than sufficient to develop the strength of the reinforcing steel (i.e., yield strength equal to 60 ksi). Shear wall steel percentages generally exceeded the minimum required values of 0.0015 and 0.0025 in the vertical and horizontal directions, respectively for the 1963 ACI code which was the plant design basis. Reinforcement details found at corners and around openings will ensure ductile behavior.

Containment penetrations were reviewed and found to be compact and seismically resistant. The lengths of piping and conduits on each side of the penetrations are adequate to resist differential motions between structures due to earthquakes.

Steel frame details were also reviewed. In the Auxiliary Building, Warehouse, and Enclosure Building, steel framed structures are laterally braced from the concrete portions of the buildings.

3.2.3.5 Conservative Deterministic Failure Margin Assessment of Turbine Building

The Turbine Building is rectangular in plan with the long axis in the north/south direction. It is mainly a steel frame structure. East/west lateral loads are carried by a series of 11 moment resisting frames (portal frames). The portal frame at the north end also has diagonal bracing to carry east/west loads. At the south end, there are a series of block walls that will tend to carry east/west loads. North/south lateral loads are mainly carried by braced frames along the long sides of the building.

The initial review of structures indicated that a detailed capacity evaluation of the Turbine

Building was warranted. In particular the review indicated that the east/west seismic capacity should be examined in detail.

Finite element techniques were used to create a three dimensional model of the Turbine Building. It was determined that the capacity of the load carrying east/west block walls was likely to be below the 0.30g PGA review level demand. Therefore, the walls were not credited in the baseline model (conservative). A second model, including the walls, was developed to assess the sensitivity to the baseline assumption.

The response spectrum technique was used to determine Turbine Building member forces for the postulated seismic event. The capacity was evaluated using guidelines in EPRI NP-6041. More specifically, AISC Part 2 criteria was used to evaluate steel members. Because of the moment frame configuration, moment at the base of the steel columns (bents) was the controlling demand parameter. Anchorage of the bents was evaluated using AISC Part 2 and J-bolt embedment criteria consistent with British Standards Institute Standard CP 110. Lateral loads were highest on southern-most portal frames (where the block walls were discounted). Capacity was controlled by anchorage of the bents to concrete piers. A HCLPF PGA capacity of 0.25g was calculated for that failure mode.

The interaction of the Turbine Building and the adjacent Auxiliary Building was also evaluated. The Turbine Building is separated from the Auxiliary Building by an isolation joint. The joint allows for relative horizontal motion between the two structures. During IPEEE walkdowns the isolation joint was found to be bridged at discrete locations where Turbine Building bents are against the slab between column lines E and E.5 of Elevation 54.5'. The condition may result in impact loading under seismic motion, although local cracking of the slab is likely to reduce the effect. The impact loading was conservatively evaluated where local cracking was not credited. The interaction was evaluated for its potential to increase seismic demand on equipment at that elevation and for the potential to increase story shears and moments in the Auxiliary Building.

To evaluate the effect on equipment at the 54.5' elevation, in-structure response spectra (IRS) were generated for the Auxiliary Building for both the uncoupled and impact-coupled cases. The Auxiliary Building model used is described in Section 3.2.1.2, In-Structure Response Spectra. For the coupled case, that model was combined with the Turbine Building model described above. A time history analysis was performed for both cases. The results showed that the peak of the IRS does not increase when impact is considered (peak is near Auxiliary Building 6.7 Hertz natural frequency). The impact does tend to excite higher modes of the building above 15 Hertz, but the high frequency peak is well below the overall peak. The effect was considered in evaluating anchorage of equipment.

The effect on Auxiliary Building story shears and moments was also evaluated with the impact-coupled model. The time history results showed only a minor increase in Auxiliary Building shears and moments (less than 5%). This result is consistent with the fact that the mass of the Auxiliary Building greatly exceeds the mass of the Turbine Building. The minor increase in load was judged to be not significant with regard to Auxiliary Building capacity.

3.2.3.6 Conclusions Regarding Structures

Based on the review of the structures in the SMA, the following structures are screened out based on the first column in Table 2-3 of EPRI NP-6041 which was verified by the SRT:

- Containment Vessel and Interior Structure
- Enclosure Building
- Auxiliary Building
- Warehouse
- Intake Building

A HCLPF value for the Turbine Building/Turbine Pedestal of 0.25g was calculated.

3.2.4 Component Screening

The component screening process followed the guidelines of EPRI NP-6041. The screening guidelines are summarized in Section 2 of that document. The basis for the screening guidelines are discussed in Appendix A of NP-6041.

The Seismic Review Team (SRT) was provided with the list of equipment within the IPEEE scope (provided by systems engineers). This equipment was then subjected to a screening evaluation that determined which items can be considered seismically rugged and which items require more detailed evaluation. This process is referred to as component screening. Component screening generally involved consideration of three broadly defined areas of seismic vulnerability:

- Functional and structural capacity
- Anchorage
- Seismic interaction

This framework for seismic capacity evaluation is based on recommended procedures in NP-6041 and is similar to the method in the USI A-46 Generic Implementation Procedure (GIP).

Items that are screened are judged to have a seismic capacity in excess of the SME demand. Items that are not screened are included in the next phase of component capacity evaluation (calculation of HCLPF capacity). These components are identified in Section 3.2.5.

The cornerstone of the component screening process is the seismic walkdown. During the walkdown the equipment is evaluated against the equipment class caveats (described below). In addition, anchorage is inspected and recorded (when possible) for later use in capacity calculations, and the area around the item is scanned for potential interaction hazards.

SMA walkdowns were performed during 1994 and 1995. The SRT was composed of W. Djordjevic and J.J. O'Sullivan of Stevenson and Associates (S&A) with typically atleast one Northeast Utilities Engineer participating as an SRT member during plant walkdowns. Follow-up walkdowns were conducted as needed by J.J. O'Sullivan and NU personnel. The USI A-46 walkdowns were conducted during the same time period and the efforts were coordinated with the IPEEE project (Reference 3-3). When appropriate, the A-46 walkdown results were used for both A-46 and SMA component screening.

Table 2-4 of NP-6041 supplied the formal screening guidance with respect to functional and structural capacity. Those tables have three columns from which to make screening decisions and assign a screening level. The screening level, which infers a minimum seismic capacity, is based on meeting inclusion rules (caveats) specific to equipment type. Inclusion rules become more stringent as inferred seismic capacity increases. MP2 components were evaluated against the 0.8g spectral acceleration column of NP-6041. This is consistent with the review level demand.

Equipment anchorage and seismic interaction are important considerations in assessing the vulnerability of each component. These vulnerabilities are not considered when assigning a screening level from the tables in NP-6041 and must be addressed separately.
With the exception of piping and other in-line equipment, all equipment was subject to an anchorage screening evaluation. Anchorage was evaluated using the Instructure Response Spectra (IRS) developed for the SMA (see Section 3.2.1.2) and the conservative, deterministic analysis techniques of NP-6041. In many cases anchorage screening relied on the availability of evaluations performed for USI A-46.

Potential seismic interaction hazards were identified by the SRT and added to the list of components designated for further review. In each case, components vulnerable to the interaction hazard were identified. The interaction hazard, such as a masonry block wall, was treated as an independent component and tracked.

A peer review was performed by Dr. R. P. Kennedy of R. P. Kennedy Consulting and Dr. J. D. Stevenson of Stevenson & Associates. They personally conducted two days of walkdowns with the SRT and independently made determinations regarding completeness and correctness of the SMA walkdown. Their conclusions were that the walkdowns were being conducted competently and that the findings were appropriate (Reference 3-12). All identified concerns were tracked by initially screening in relevant components.

The walkdown component screening results are summarized in the subsections below.

3.2.4.1 NSSS

Based on Table 2-4 of NP-6041, the piping and vessels of the Nuclear Steam Supply System (NSSS) were screened. NSSS supports were also screened based on a review of existing seismic design basis. Per NP-6041 Table 2-4, NSSS supports may be screened at 0.30g level if supports are designed for combined SSE and pipe break loading. Per MNPS-2 FSAR, Section 4.5.2, two faulted conditions are considered for design including:

"Loading resulting from the combined effects of the DBE, normal operation at full power and pipe rupture conditions".

In addition, a dynamic seismic analysis of the reactor coolant system (RCS), which includes the reactor vessel, steam generators, reactor coolant pumps, pressurizer and interconnected piping, was conducted as documented in Appendix 4A of the MNPS-2 FSAR. The analysis, conducted to confirm the adequacy of the design, used modern computer methods of structural analysis. Using conservative techniques for demand prediction and ASME design allowables, the analysis concluded that the RCS was seismically adequate. The NSSS and NSSS supports were screened based on the above.

3.2.4.2 Reactor Internals

Per NP-6041 Table 2-4, reactor internals should be handled on a plant by plant basis (no generic screening). However, per NRC Generic Letter 88-20 Supplement 5, dated September 8, 1995, reactor internals need not be evaluated for focused scope plants. In addition, a dynamic seismic analysis of the reactor internals was conducted as documented in Appendix 3A of the MNPS-2 FSAR. The analysis, conducted to confirm the adequacy of the design, used modern computer methods of structural analysis. Using conservative techniques for demand prediction and ASME design allowables, the analysis concluded that the reactor internals were seismically adequate. The reactor internals were screened based on the above.

3.2.4.3 Control Rod Drive Housings and Mechanisms

Per NP-6041 Table 2-4, the CRD housings and mechanism may be screened if the housings have lateral seismic support. The MNPS-2 reactor, including CRD components, was supplied by Combustion Engineering (CE). The CE outline drawings and Appendix 3A of the MNPS-2 FSAR were reviewed to determine the support conditions of the CRD components. The CRD components are well supported at two points within the reactor vessel by the Upper Guide Structure and Fuel Alignment Plate. CRD components outside the vessel cantilever vertically from the vessel head (i.e., no external lateral support). Based on lack of external support above the vessel, the SRT judged that additional evaluation was required for screening.

Additional information was available from the published results of the Maine Yankee seismic margin review, summarized in NUREG/CR-4826. The Maine Yankee reactor is a similar 800 megawatt class Combustion Engineering (CE) pressurized water reactor. A review of the CE reference drawings showed that the design and the support conditions of the Maine Yankee CRDs are similar to those of MNPS-2. The Maine Yankee CRD housings and mechanisms were screened for a 0.30g PGA review level earthquake (NUREG/CR-0098 median rock spectral shape). That screening decision was based on a review of CE drawings and seismic qualification data. The MNPS-2 CRD housings and mechanisms were screened based the similarity to the Maine Yankee CRD components.

3.2.4.4 System Piping

A walkdown of plant piping was conducted to verify the seismic capacity of piping within the IPEEE scope. The walkdown was conducted using the guidance of Section 5 of NP-6041. Per NP-6041, welded steel piping has performed well in past earthquakes and is generally not vulnerable to seismic inertial effects. The goal of the walkdown was to check for piping configurations that have been identified with lower seismic capacity. These conditions include:

- Low capacity supports or dead load only supports
- Large nozzles loads on equipment due to laterally unrestrained piping
- Brittle connections such as threaded fittings or brittle material (e.g., cast iron)
- Small branch lines with limited flexibility
- Failure of threaded rods on non-seismic rod hung piping
- Inadequate flexibility across building gaps

The walkdown revealed that seismic issues were conservatively addressed in piping design at MP2. The safety related piping within the SMA scope was found to be very well supported and seismically rugged. In addition to rugged dead load support, piping was consistently found to have substantial lateral restraint near heat exchangers, pumps and other connected equipment. The seismic review team (SRT) concluded that the piping could be conservatively screened at the 0.30g level. Similar conclusions regarding generic ruggedness of MP2 piping were reached by seismic experts R.P. Kennedy and J.D. Stevenson as part of the IPEEE peer review (Reference 3-12).

3.2.4.5 Valves

All included valves were subject to a walkdown and all valves were screened. Based on NP-6041, Table 2-4, these valves were screened for the SMA because they did not possess vulnerabilities associated with low capacity valves (e.g., not on small line, not large extended operator, not cast iron).

One valve was found to have independent support of its yoke. This condition can lead to high loads on the yoke if the support acts to resist piping loads. The yoke of air operated valve 2-CHW-11 is connected to a building brace by a steel angle. This condition was judged to be acceptable because the nearby piping is well supported to the same structure within about 4' of valve. This item is being tracked under USI A-46 resolution (as a GIP outlier). It is assumed that this issue will be successfully resolved by A-46 effort.

3.2.4.6 Atmospheric Storage Tanks

All large atmospheric storage tanks are typically screened in (generic anchorage concerns). The large atmospheric storage tanks included in the SMA scope were the Condensate Storage Tank (CST), the Refueling Water Storage Tank (RWST), the Diesel Engine Fuel Oil Supply Day Tanks, the Boric Acid Tanks and the RBCCW Surge Tank.

The CST, equipment ID T40, is a steel tank containing water. It is about 32.5' high to the top of the cylindrical portion and 37.5' in diameter. The shell is 3/8" thick near the base. A 25' high by 2' thick reinforced concrete tornado wall surrounds the tank (cast against the shell). The anchorage of the tank and tornado wall was upgraded circa 1992 (see NU calculation 90-032-422-EC). The upgrade provided eighteen 1.25" Drillco Maxi-Bolts at the base of the wall and eighteen 1.25" Maxi-bolts at the top of the wall. These are in addition to 64 existing 1.25" J-bolts at the base of the tank. The system was conservatively evaluated for a SSE acceleration of 0.60g and found to be acceptable. The CST was screened for RLE loads based on substantial anchorage, support from a tornado wall (prevents buckling) and the review of the existing Northeast Utilities calculation.

The RBCCW Surge Tank, equipment ID T3, is a large vertical tank on four legs. The tank was evaluated as part of USI A-46 resolution and did not pass the evaluation (Reference 3-3). When the A-46 outlier condition was determined, a temporary design modification was installed to resolve the issue prior to start up. PDCR 2-95-040 has been prepared and approved to replace the temporary design with a permanent design modification. With this modification the tank capacity will exceed the RLE demand.

Seismic capacity was evaluated for the other tanks within the scope of the review. The methodology and results are described in Section 3.2.5.

3.2.4.7 Buried Tanks

There are no buried tanks within the SMA scope.

3.2.4.8 Heat Exchangers and Pressure Vessels

The walkdowns showed that piping attached to heat exchangers and vessels was consistently well and independently supported (i.e., piping did not rely on exchanger or vessel for support). Horizontal heat exchangers tended to be anchored with large diameter cast-in-place J-bolts. Some heat exchangers in the Containment Structure were bolted to steel beams.

Heat exchangers and horizontal tanks were subject to a support and anchorage screening evaluation via review of USI A-46 GIP evaluations. Generally, if an item had an allowable load factor of about 1.5 for GIP seismic loads, the item was screened. The 1.5 factor relates the median centered in-structure demand at 0.30g PGA (used for the SMA) to the conservative in-structure demand, at 0.17g PGA, required for the GIP. Some heat exchangers did not pass this check and were screened in for evaluation of supports and anchorage. The evaluations are summarized in Section 3.2.5.

3.2.4.9 Batteries on Racks

The racks supporting the station batteries were found to have relatively large gaps between the rack base and the floor. The racks were not screened based on expected low anchorage capacity. The evaluation is summarized in Section 3.2.5.

3.2.4.10 Emergency Diesel Generators

Per NP-6041, diesel generators are judged to be seismically rugged as long as they are properly anchored and associated components are well supported. The MP2 Emergency Diesel Generators are very well anchored and were judged to be seismically rugged. However, 1.25" diameter expansion anchors were used and an anchorage HCLPF was calculated to confirm high seismic capacity. On one generator (H7A), one isolation mount housing for a local control panel was found to be cracked. The panel is small and the support still remained substantially effective. The panel was pull tested to verify substantial load capacity. The cracked support was judged not to reduce seismic ruggedness below the SME. However, as good practice, the SRT recommended replacement or repair. The work has been completed and this issue has been resolved (Reference 3-15).

3.2.4.11 Pumps

All horizontal pumps were screened after walkdown and anchorage screening. Good support of attached piping eliminated cases where pumps had to act as an anchor for piping. As a result, horizontal pumps tended to have high margin for anchorage since they have a low center of gravity and are well anchored. Horizontal pumps are typically anchored with six or more cast-in-place J-bolts; bolt diameter is typically 3/4" or greater.

The Service Water Pumps (P5A, B, C) were not screened. These deep-well vertical pumps are in the Intake Structure. The pumps had substantial anchorage, (12 total 1.75" diameter cast-in-place bolts) but, edge distance was limited. In addition, the pump shaft was relatively long and could tend to induced high base moment at on the anchorage as well as high stresses in the pump shaft. A HCLPF was calculated for the pumps. The methodology and results are described in Section 3.2.5.

3.2.4.12 Fans, Air Handlers, Chillers

All fans, air handler and chiller units were screened. No coil spring isolated units were found and all units had sufficient anchorage. Fans F38A and F38B units did have resilient neoprene (or similar) isolation mounts. These units had 1/2" bolts that provide vertical and additional lateral restraint and were judged acceptable. Other units had a similar detail. A number of in-line and hung units were evaluated and judged to be rugged.

3.2.4.13 Electrical Equipment-General

Switchgear and motor control centers (MCCs) were typically welded to embedded steel. Switchgear embedments were typically 4" steel channel anchored with 1/2" diameter by 5" long cast-in-place headed studs 18" on center. Some 125V DC switchgear and MCC embedments were 4" steel channel in a grout pocket. The grouted in place channel is welded to a plate and the plate is anchored with expansion anchors. This configuration does not rely on grout bond for tension resistance.

Most switchgear were plug welded to the embedded steel. The plug welds were made at the 7/8" diameter holes in the base frame (probably bolt hole locations), typically six per cubicle. To verify proper fusion to parent materials, the plug welds were visually inspected by a welding specialist. The specialist concluded that welds were properly fused to parent material (Reference 3-15). MCCs were typically stitch welded to embedded steel or anchored steel.

One switchgear cabinet within the SMA scope was located in the Switch Yard, within an environmental enclosure (Equipment ID # 22S3-2-2,). The enclosure was anchored by eight total 3/8" diameter expansion anchors. The item was screened in for evaluation of enclosure anchorage.

The main control board is welded to embeded 6" and 4" steel channels. The channels are anchored with 5/8" diameter cast-in-place headed studs at 18" on center. Most other cabinets, in the Control Room, are welded to 6" or 4" channel that is anchored down with 3/4" diameter through-bolts 18" on center.

The anchorage of cabinets C25A and C25B could not be determined. These cabinets are bolted together and have exterior angles along each the base, front and rear, but the anchors are partially covered. These cabinets are being tracked as USI A-46 GIP outliers. The exterior angles are likely to be anchored with expansion anchors similar to adjacent cabinet C80. It is assumed that the anchorage of these cabinets will be successfully resolved for USI A-46 GIP and anchorage capacity is as good as C80.

Most other electrical equipment was anchored with expansion anchors. Expansion anchors used for original equipment were typically WEJIT brand; for newer equipment HILTI Kwik-bolts were typically used.

All electrical equipment was subject to an anchorage screening evaluation. In many cases this consisted of a review of USI A-46 GIP evaluations. Anchorage HCLPF calculations were performed for unscreened cabinets. The methodology and results are described in Section 3.2.5.

A number of cabinets were found to be susceptible to impact loading that could cause relay chatter (e.g., adjacent cabinets not bolted together). These cabinets were noted and the issue was evaluated as part of the relay review. In one instance, the potential impact also represented an anchorage concern; the switchgear in the upper switchgear room are susceptible to the impact loading from Turbine Building/Auxiliary Building interaction. This loading was evaluated for its potential to increase anchorage loads (see Section 3.2.3.5, Conservative Deterministic Failure Margin Assessment of the Turbine Building).

3.2.4.14 Cable Trays, Conduit and Ductwork

Per NP-6041 cable trays and conduit were screened. Ductwork was evaluated for support during equipment walkdowns and was screened. Ductwork was found to be sufficiently supported, often from light metal framing, and no significant concerns were found.

3.2.4.15 Masonry Block Walls

As noted above, masonry block walls were noted by the SRT when they represented a significant seismic interaction hazard. In addition, potential block wall hazards were identified by a review of plant drawings. The availability of calculations developed in response to NRC IE Bulletin #80-11 aided in making screening decisions.

Any wall that was not evaluated as "safety related" under IE Bulletin #80-11 was considered a potential interaction hazard if it could fall on the equipment under review. In addition, a sampling of block walls covered by IE Bulletin #80-11 was reviewed for capacity. The sampled IE Bulletin #80-11 walls were found to have high capacity relative to the review level demand, and the walls covered by IE Bulletin #80-11 were screened. One non-safety wall was determined to be a potential hazard (block wall adjacent to Inverter INV 5). A HCLPF capacity was calculated for this wall.

3.2.4.16 Other Interaction Hazards

File cabinets in the Control Room presented an interaction hazard. The hazard is mainly a relay chatter issue since soft targets on front are generally not vulnerable. However, subsequent to the walkdown a corrective action was issued to correct seismic housekeeping problems (Reference 3-15).

A number of cabinets were susceptible to impact loading from adjacent equipment. These cases were judged to be relay chatter concerns and not functional capacity concerns (see Section

3.2.4.13).

The Millstone Unit 1 vent stack was investigated as an interaction hazard to yard equipment and structures. The 400' tall, reinforced concrete stack was evaluated under the Systematic Evaluation Program (SEP) as reported in NUREG/CR-2024 (Reference 3-16). That evaluation used a 0.20g U.S. NRC spectrum for seismic demand and found the stack to be adequate, with the provision that the pile loadings should be evaluated. The pile loadings were subsequently evaluated by Northeast Utilities and found to be acceptable (Reference 3-17). The R. G. 1.60 spectrum has substantially more low frequency content then the RLE and the loadings for SEP evaluation are equivalent to the RLE loadings. The vent stack was, therefore, screened as an interaction hazard. It should be noted that it is unlikely the stack would reach MP2 SMA scope equipment, even if stack failure is postulated, since the stack would tend to break apart as it fell.

3.2.5 Component HCLPF Capacities

Components not screened out were subject to a conservative deterministic failure margin (CDFM) analysis as outlined in NP-6041. Seismic demand was obtained from the median centered IRS developed for the seismic margin assessment (previously described). The results produce a high-confidence of low probability of failure (HCLPF) seismic capacity for the component. Refer to NP-6041 for a definition of CDFM and HCLPF.

Table 3.2-3 lists HCLPF capacities for all screened in components. The capacity is defined in terms of peak ground acceleration (PGA). The type of failure mode is also cited. Summaries of the evaluations are provided below.

3.2.5.1 Evaluation of Atmospheric Storage Tanks

Vertical storage tanks were evaluated using the procedure in Appendix H of NP-6041. The Appendix H procedure considers the fluid/structure dynamics of these tanks (impulsive and sloshing modes) in determining seismic demand. Capacity checks are performed on shell buckling, anchorage tension capacity, base shear and slosh height. For shell buckling both the elephant foot and diamond shape buckling modes are considered. The MP2 tanks had HCLPF capacities above the screening level.

The RWST is 38.5' tall, 47' in diameter and made of steel. With 96 total 1.5" diameter cast-in-place J-bolts, it is very well anchored. The controlling capacity of the anchor was determined to be J-bolt pull out. Because of a potentially brittle tension failure mode no inelastic uplift of the tank was allowed. The tank still had substantial moment capacity due to a favorable aspect ratio, large number of anchors and relatively thick shell (7/16" near the base). A HCLPF of 0.34g was determined, based on sliding of the tank.

Both the Boric Acid Tanks and Diesel Oil Storage Day Tanks are relatively small vertical tanks housed inside civil structures. The Boric Acid Tanks are about 14' high and 9.5' in diameter and made of steel. Each tank is anchored with 12 total 1" expansion anchors. Since tension failure of the expansion anchor may be brittle, no uplift of the tank was allowed. The tank is not a typical vertical storage tank because it has a domed base and sits on a cylindrical skirt. As a result the weight of the fluid is effective for hold-down. A HCLPF capacity of 0.31g was determined, based on peak shear on an expansion anchor.

The Diesel Oil Storage Day Tanks are 11' high, 14' diameter, steel tanks. Each is anchored with 8 total 1.5" diameter cast in place bolts. Based on potential brittle failure of embedment, no uplift of the tank was allowed. The tank wall near the base is 1/4" thick. The relatively thick tank wall and a favorable aspect ratio help increase base moment capacity. A HCLPF of 0.31g was determined, based on sliding of the tank. The analysis considered the forces and moments caused by the sloshing of the oil in the tanks and satisfies the seismic loading concerns identified as unresolved item # 93-81-09 in Reference 3-18.

3.2.5.2 Station Batteries

Battery racks DB1 and DB2 are steel frame racks anchored with 1/2" diameter expansion anchors. Rack DB1 supports thirty total 13" by 14" by 20" batteries. Gaps between the base on the rack and the floor vary between no gap and about 2". The gap can result in reduced shear capacity because of the moments introduced on the bolts. A procedure in EPRI TR-103960 was used to evaluate the capacity of the anchors with gaps. A HCLPF of 0.13g was determined for rack DB1. DB2 will have about the same or slightly higher capacity, and was assigned a 0.13g capacity. Even though the HCLPF is lower than the design basis GPA, the mounting configuration of the battery rack does not violate licensing basis because the original plant construction practices allow the use of spacer plates under similar supports. Furthermore, even if some bolt failures occured, redistribution of loads would take place and other supports would take up the redistributed loads and enable the racks/batteries to remain operable.

3.2.5.3 Service Water Pumps

The anchorage of the Service Water Pumps was evaluated considering the limited edge distance and the potential for embedment failure. The evaluation determined that the anchorage was controlled by embedment, but the pump still had relatively high anchorage capacity due the size and number of bolts (12 total 1.75" diameter cast-in-place bolts). The anchorage HCLPF capacity exceeded 0.50g. The pumps were assigned a 0.50g capacity based on Table 2-4 of NP-6041.

3.2.5.4 Heat Exchangers

Evaluation of the heat exchangers generally followed the procedure in Section 7 of the GIP, except allowable stresses were based on the guidance of NP-6041.

3.2.5.5 Anchorage Evaluation of Mechanical and Electrical Equipment

Unscreened electrical cabinets typically required an anchorage HCLPF calculation. Capacities of expansion anchors were based on Appendix O of NP-6041. Capacities of welds were based on AISC Part 2 allowables. Embedments were evaluated per ACI-349 Appendix B.

3.2.5.6 Block Walls

Evaluation of reinforced block followed the procedure in Appendix L on NP-6041. The block wall adjacent to INV-5 is not considered "safety related" as evaluated for IE Bulletin # 80-11" and was assumed to be unreinforced. A rocking/collapse calculation was performed for this wall.

3.2.5.7 Plant Capacity

Based on the SMA, the overall plant capacity is assumed to be limited by the Turbine Building HCLPF PGA of 0.25g. As noted within Tabie 3.2-3, six components have HCLPF capacities below that of the Turbine Building. With the exception of the racks supporting Battery 201A and B, these components do not pose a measurable risk to the plant either collectively or individually when their importance to core damage is considered. The battery racks for Battery 201A and B were evaluated as part of USI A-46 resolution and, also, did not pass the evaluation of gaps betwen the base of the racks and the floor. Modifications are expected to be made on the racks to resolve the A-46 outlier condition. These modiofications will further improve their HCLPF capacity.

3.2.6 Analysis of Containment Performance

3.2.6.1 Seismic Induced Failure Modes

The Millstone Unit 2's seismic containment performance was analyzed for several containment failure modes. They include: gross containment failure, containment systems failure, containment bypass, containment isolation failures and interactions with containment (Reference 3-19).

3.2.6.2 Containment Systems

The Containment systems analyzed include: the Containment Air Recirculation Fan (CARF) system and Containment Spray (CS) system. These systems where review to ensure their functionality, i.e. their ability to maintain Containment integrity during an RLE. The Containment isolation function was also evaluated by reviewing Containment isolation valves and penetrations

(See Section 3.2.6.4).

CARF System

The CARF system consists of four air recirculation units (air recirculation fans and coolers) located in the Containment annulus. The CARF system is used for normal operation control of Containment air temperature and post accident containment temperature/pressure reduction.

Seismic walkdowns were performed on the major components of the CAR fan system. The walkdowns confirmed the CARF system to be seismically rugged.

CS System

The CS system serves as an additional means of depressurizing Containment during post accident conditions. The system consists of the Containment Spray pumps, Shutdown Cooling Heat Exchangers and Containment Spray valves.

Seismic walkdowns were performed on the major components of the CS system. The walkdowns confirmed the CS system to be seismically rugged.

3.2.6.3 Containment Structure Failure

The method used to evaluate the seismic adequacy of the containment structure for gross containment failure includes: expert walk downs of containment identifying containment strength, interactions effects, anchorage of major structures that might interact with the containment boundary, review of drawings, reports and calculation files.

The seismic evaluation of the containment structure was performed by John Reed who has determined that the containment structure has adequate strength and can be screened out (Reference 3-20).

3.2.6.4 Containment Isolation Failure

Relay chatter evaluations of penetrations for containment bypass failure (ISLOCA type failure) and isolation function failure was performed. First the containment penetrations were screened using the following criteria. Containment penetrations that meet any of the following criteria could be screened out:

- Valves and penetrations that belong to closed system (A closed system, for the purpose of this investigation, was a system such as the Charging system that does not directly communicate with the Containment environment),

- Penetrations with piping of ≤ 2",
- Penetration piping with locked closed valves and
- Penetrations with manual valves and components with no associated relays.

(Penetrations that could not be screened out required a detailed relay chatter evaluation of their isolation valves).

The basis for the screening criteria is as follows. Penetrations of closed piping systems were not considered significant vulnerabilities because a radiological release would require the simultaneous failure of the isolation valves and a failure, such as a pipe break or other means system integrity failure. The probability of this occurring was assumed to be negligibly small. Unless a question had been raised on the seismic ruggedness of the piping, these penetrations did not require additional investigations in order to identify any outliers not identified by the IPE.

Penetrations with pipes with diameters 2 inches or less are not considered important to containment bypass failures since aerosol plugging is likely to reduce the amount of leakage which could occur through these pipes . Further, breach through a 2 inch line, if it were to occur, would have relatively small consequences.

Penetration piping with locked closed valves, manual valves and components without relays are not important to relay chatter since, these components are not actuated by relays.

Penetrations that belong to normally operating or normally open plant systems are not important to relay chatter failure and can be screened out since, closure or chatter of these valves might impact the performance of the system but does not impact bypass failure or isolation function of Containment.

All Containment penetrations for Millstone Unit 2 were evaluated following the screening criteria above. Table 3.2-4 lists each penetration and its status. It was found that 7 Containment penetrations, namely P-12, P-13, P-14, P-35, P-51, P-82 and P-83, could not be screened out using the above screening criteria. Consequentially, the relays associated with these penetrations were evaluated for seismic relay chatter concerns (Reference 3-21). The relay evaluation determined that there were no relay chatter vulnerabilities with the relays associated with these penetrations.

All Containment penetrations for Millstone Unit 2 were screened as shown in Table 3-4. Therefore, seismically induced relay chatter Containment bypass and isolation function failure is not a concern.

Penetration failures include penetration seal failure, penetration isolation valve failure and failure of penetration piping legs between containment and the isolation valves. These failures allow a direct venting of Containment causing a failure of the Containment's isolation function.

The seismic evaluation of the Containment penetrations was performed by John Reed who has determined that the Containment penetrations are structurally compact and seismically resistant. The lengths of piping and conduits on each side of the penetrations are adequate to resist differential motions between structures due to earthquakes (Reference 3-22). An additional walkdown was performed that also concluded that the Containment penetrations and piping segments are seismically rugged and can be screened at the 0.8g level (Reference 3-23).

3.3 USI A-45 and Other Seismic Issues

3.3.1 USI A-45 Resolution

At MP2 three different methods can be utilized to perform decay heat removal during hot shutdown, hot standby and cold shutdown. They are:

- Main Feedwater (MFW)
- Auxiliary Feedwater (AFW)
- Feed and Bleed heat removal

Main Feedwater:

The seismic ruggedness of the MFW system is limited by the offsite power that provides motive power to the MFW. Plant walkdowns did not reveal any outliers that may degrade the seismic ruggedness of MFW significantly below that of Offsite power.

Auxiliary Feedwater:

Plant walkdowns did not reveal any outliers that may degrade the seismic ruggedness of AFW. Therefore, this system can be relied upon for decay heat removal subsequent to an earthquake AFW is also being investigated under USI A-46..

Feed and Bleed Function:

The success of the Feed and Bleed function (once-through cooling, addressed in EOP 2540) will depend upon the success of multiple systems that comprise of a large number of components and also the successful operator actions. The systems needed for success are:

- PORVs
- High Pressure Safety Injection (HPSI)
- Atmospheric Dump Valves (ADVs)

There are no major vulnerabilities associated with these systems. When the Feed and Bleed function is successfully implemented, Containment heat removal must be accomplished. This can be accomplished by either the CAR Fan System (CARF) or the Containment Spray System (CS). The details on the seismic ruggedness is included under "Analysis of Containment Performance" in Section 3.2.6.

Conclusion:

There are no major vulnerabilties that would degrade the three diverse means used for decay heat removal. Therefore, the seismic portion of USI-45 is considered closed under this IPEEE evaluation.

3.3.2 Eastern U.S. Seismicity Issue

In performing the Seismic Margins Evaluation as part of the MP2 IPEEE, the "Eastern U.S. Seismicity Issue has been resolved.

3.3.3 Coordination with USI A-46

Both the Generic Letter and NUREG-1407 identified many advantages that may be realized by appropriate integration of the USI A-46 program.

Therefore, a major effort was expended to coordinate these two programs to maximize the mutual benefits. Some of the key aspects of the program integration and coordination are discussed below:

Contractor Selection:

In order to ensure that expertise obtained from external consultants is maximized, the IPEEE project team contracted the same seismic experts used by the USI A-46 project team.

USI A-46/IPEEE Component Selection:

The PRA systems engineers reviewed the safe shutdown equipment list (SSEL) created by the USI A-46. This review accomplished multiple objectives. They are:

- Providing systems expertise to USI A-46 team.
- Identifying components that are IPEEE only, i.e., components that do not belong to SSEL, however, are important to the plant seismic risk assessment. These were needed so that the USI A-46 and IPEEE walkdown could be integrated.
- Providing the list of "IPEEE only" relays for relay chatter evaluation.

Walkdown:

Since the same group of external seismic consultants were hired by both USI A-46 and IPEEE, all knowledge gained from USI A-46 walkdowns was utilized by IPEEE project team. Since the "IPEEE only" components were identified prior to the walkdowns, the USI A-46 walkdown team could walkdown the "IPEEE only" components also.

Seismic Calculation:

All fragility calculations performed for USI A-46 and insights gained from those (e.g., Anchorage Calculations) were a significant source of information for the IPEEE team.

Relay Chatter Evaluation:

This major task was carried out by the USI A-46 team. The IPEEE project team identified the additional set of "IPEEE only" components that have relays associated with them. For example, relay associated with the safety injection pumps were not included in the A-46 relay chatter evaluation. However, per the request of the IPEEE project team, the USI A-46 project team expanded the scope to include these relays also.

3.3.4 References

3-1 "A Methodology for Assessment of Nuclear Power Plant Seismic Margin", Palo Alto, California: Electric Power Research Institute, prepared by Jack R. Benjamin and Associates, Inc., et al., June 1991, NP-6041, Revision 1.

3-2 VECTRA calculation, "Auxiliary Building Model Development", 0024-00099-MOD-1, prepared for Northeast Utilities Service Company, June 1994.

3-3 Millstone Nuclear Power Station Unit 2 USI A-46 Resolution Generic Implementation Procedure Seismic Evaluation Report (preliminary), Northeast Utilities Service Company, expected completion date January 1996.

3-4 Bechtel Corporation, "Seismic Analysis Turbine Building and Intake Structure", prepared for The Millstone Point Company, July 31, 1972, Job 7604.

3-5 Bechtel Corporation, "Seismic Analysis Containment Structure and Containment Internal Structures", prepared for The Millstone Point Company, February 10, 1971, Job 7604.

3-6 Bechtel Corporation, "Seismic Analysis Warehouse Building ", prepared for The Millstone Point Company, July 31, 1972, Job 7604.

3-7 Millstone Nuclear Power Station Unit 2 Final Safety Analysis Report, Northeast Utilities Service Company.

3-8 Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment. Prepared by Winston & Strawn et al., prepared for Seismic Qualification Utility Group, February 1992.

3-9 'Seismic Verification of Nuclear Plant Equipment Anchorage,' Electric Power Research Institute , prepared by URS / J. A. Blume & Associates, Inc., et al., June 1991, NP-5228, Revision 1.

3-10 'Guidelines for Development of In-Cabinet Amplified Response Spectra for Electrical Benchboards and Panels,' Electric Power Research Institute, prepared by Stevenson & Associates, Dec. 1990, NP-7146.

3-11 'Seismic Ruggedness of Relays,' Electric Power Research Institute, prepared by ANCO Engineers, Aug. 1991, NP-7147.

3-12 J. D. Stevenson and Robert P. Kennedy letter to S. W. Wainio, "Millstone, Unit 2 Peer Review, dated November 3, 1994

3-13 N.M. Newmark and W.J. Hall, "Development of Criteria for Seismic Review of Selected Nuclear Power Plants", NUREG/CR-0098, May 1978.

3-14 Blume, J.A., et al., "Design of Multistory Reinforced Concrete Buildings for Earthquake Motions", Portland Cement Association, 1961.

3-15 S. Pornpraset Northeast Utilities letter to W. Djordjevic, "Millstone Unit 2 - Closeout of the A-46 Related Peer Review Walkdown Comments", May 3, 1995. ES-SD-95-056.

3-16 T. A. Nelson et al, "Seismic Review of the Millstone Nuclear Power Station as Part of the Systematic Evaluation Program", prepared for the U. S. Nuclear Regulatory Commission, July 1981. NUREG/CR-2024.

3-17 Northeast Utilities Service Company Calculation # 79-232-58-GC, "MP1 Vent Stack Pile Loadings", December 1991.

3-18 J. F. Opeka letter to U. S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit No. 2 Inspection Report No. 50-336/93-81, Revised Schedule for Resolution of Unresolved Items," dated May 12, 1995.

3-19 PRA Calc. File PRA95NQA-01257S2 Rev. 0, "Millstone Unit 2 Seismic Containment Performance," M.L. Szoke, June 1994.

3-20 J.J. O'Sullivian letter to J. M. Powers, "Millstone Point Unit 2 IPEEE Report", dated December 4, 1995

3-21 IPEEE Relay Evaluation for Millstone Unit 2, dated November 8, 1995, VECTRA Technologies

3-22 J.J. O'Sullivian letter to J. M. Powers, "Millstone Point Unit 2 IPEEE Report", dated December 4, 1995

3-23 S&A Letter 93C2799-LSC-023, "Millstone Point Unit 2 Containment Penetration Walkdown Results," June 8, 1995.

3-24 Procedural and Submittal Guidance for the Individual Plant Examination for External Events (IPEEE) for Severe Accident Vulnerabilities , prepared by NRC External Events Committee, prepared for U.S. Nuclear Regulatory Commission, June 1991. NUREG-1407.

3-25 NRC Generic Letter 88-20 Supplement 5, dated September 8, 1995.

3-26 A Methodology for Assessment of Nuclear Power Plant Seismic Margin. Palo Alto, California: Electric Power Research Institute, prepared by Jack R. Benjamin and Associates, Inc., et al., August 1991. NP-6041-SL, Revision 1.

3-27 "Manual of Steel Construction", 9th Edition, American Institute of Steel Construction.

3-28 "Building Code Requirements for Reinforced Concrete", ACI 318-89, American Concrete Institute.

3-29 The Structural Use of Concrete, British Standards Institute, November 1972, Amended 1977. CP 110.

3-30 Stevenson & Associates, correspondence and calculations for job 92C2799, November 1994.

3-31 Seismic Margin Review of the Maine Yankee Atomic Power Station, prepared for the US Nuclear Regulatory Commission, prepared by EQE, Inc., NUREG/CR-4826, March 1987.

3-32 "Code Requirements for Nuclear Safety Related Reinforced Concrete Structures", ACI 349-90, American Concrete Institute.

3-33 Recommended Approach to Resolving Anchorage Outliers, Electric Power Research Institute, prepared by URS/John Blume & Associates, June 1994. TR-103960.

3-34 Regulatory Guide 1.60, Revision 1, "Design Response Spectra for Seismic Design of Nuclear Power Plants", U. S. Nuclear Regulatory Commission, December 1973.

TABLE 3.2-1 :-Summary of IRS generation

Building	Model Description	Fundamental Freq. (Hz)	Damping	IRS Calculation & Comments
Auxiliary Building	New 3-D model generated as part of USI A-46	6.71	7%	Median centered SSE IRS from multiple time history analysis, scaling used to convert to SME IRS
Containment Interior	Design basis 2-D stick model	10.2	7%	Direct generation method used to calculate SME IRS
Intake Structure	Design basis 2-D stick model	6.84	7%	Direct generation method used to calculate SME IRS
Warehouse Building	Design basis 2-D stick model	3.12	7%	Mode at 3.12 Hz is mainly steel superstructure, first mode of interest is at 10.1 Hz. Direct generation method used to calculate SME IRS
Turbine Building	New 3-D model generated as part of SMA	1.10	7%	Direct generation method used to calculate SME IRS

Table 3.2 - 2

Original Analysis Parameters

Structure	Foundation	Structural System	Design Response Spectrum	Structure Damping	Modal Combination	Direction Combination	Design Codes	Material Strength
Containment and Interior Structures	Mat on rock	Prestressed reinforced concrete cylinder (and dome) and reinforced concrete internal structure	Modified Housner shape anchored to 0.09g for OBE and 0.17g for DBE. Vertical comp. = 2/3 horizontal	Concrete: 3% for OBE and 5% for DBE	Absolute sum of all modes less than 35 Hz (minimum of 5 modes)	Absolute summation of horizontal and vertical components	ACI-318-63 AISC Code, 1963 Edition ASME BP&V Code - 1968 Edition	Concrete 28 day strength: 3000 to 5000 psi. Rebar: A615 Grade 60. Steel: A-36. Tendon: A-421. Liner A-285
Enclosure Building	Grade beams and caissons, and partially supported on auxiliary, turbine building and containment dome	Steel frame structure with metal siding and insulated roof deck	Modified Housner shape anchored to 0.09g for OBE and 0.17g for DBE. Vertical comp. = 2/3 horizontal	Concrete: 3% for OBE and 5% for DBE. Bolted Steel: 2.5% for OBE and DBE	Absolute sum of all modes less than 35 Hz (minimum of 5 modes)	Absolute summation of horizontal and vertical components	ACI-318-63 AISC Code, 1963 Edition	Concrete 28 day strength: 3000 psi, except foundation is 4000 psi. Rebar: A615 Grade 60. Steel: A-36
Auxiliary Building	Mat on rock	Reinforced concrete shear walls. Steel frame structure above EL 38'-6"	Modified Housner shape anchored to 0.09g for OBE and 0.17g for DBE. Vertical comp. = 2/3 horizontal	Concrete: 3% for OBE and 5% for DBE. Bolted Steel: 2.5% for OBE and DBE	Absolute sum of all modes less than 35 Hz (minimum of 5 modes)	Absolute summation of horizontal and vertical components	ACI-318-63 AISC Code, 1963 Edition	Concrete 28 day strength: 3000 psi, except foundation mat is 4000 psi. Rebar: A615 Grade 60. Steel: A-36

Original Analysis Parameters

Structure	Foundation	Structural System	Design Response Spectrum	Structure Damping	Modal Combination	Direction Combination	Design Codes	Material Strength
Warehouse	Mat on compacted structural backfill	Reinforced concrete shear walls. Steel frame structure housing fuel handling area	Similar to NUREG/CR-0098 median shape anchored to 0.09g for OBE and 0.17g for DBE. Vertical comp. = 2/3 horizontal	Concrete: 3% for OBE and 5% for DBE. Bolted Steel: 2.5% for OBE and DBE. Soil: 2% for OBE and 5% for DBE	Absolute sum of all modes less than 35 Hz (minimum of 5 modes)	Absolute summation of horizontal and vertical components	ACI-318-63 AISC Code, 1963 Edition	Concrete 28 day strength: 3000 psi, except foundation is 4000 psi. Rebar: A615 Grade 60. Steel: A-36
Intake Building	Mat on rock	Reinforced concrete structure	Modified Housner shape anchored to 0.09g for OBE and 0.17g for DBE. Vertical comp. = 2/3 horizontal	Concrete: 3%* for OBE and 5% for DBE. *Calculation file indicated 2% was actually used	Absolute sum of all modes less than 35 Hz (minimum of 5 modes)	Absolute summation of horizontal and vertical components	ACI-318-63	Concrete 28 day strength: 4000 psi. Rebar: A615 Grade 60
Turbine Building	Footings on lean concrete to rock, except for auxiliary feedwater pump which is on compacted structural fill	Rigid framed steel structure with metal siding and precast concrete panels on exterior	Modified Housner shape anchored to 0.09g for OBE and 0.17g for DBE. Vertical comp. = 2/3 horizontal	Concrete: 3% for OBE and 5% for DBE. Bolted Steel: 2.5% for OBE and DBE	Absolute sum of all modes less than 35 Hz (minimum of 5 modes)	Absolute summation of horizontal and vertical components	ACI-318-63 AISC Code, 1963 Edition	Concrete 28 day strength: 3000 psi, except slabs and footings are 4000 psi. Rebar: A615 Grade 60. Steel: A-36

TABLE 3.2-3 : Component HCLPF Capacities

ID(s)	Description	HCLPF PGA (g)	Controlling Capacity
N/A	ALL SCREENED COMPONENTS	>0.30g	Lower bound functional capacity of screened components
22 C/DD	480V BUS 22 C/D	0.28	Plug weld shear/tension
22S3-2-2	RSST FEEDER BREAKER	0.19	Enclosure expansion anchor shear
BW-7.8	BLOCK WALL 7.8	0.051	Displacement induced collapse, hazard to INV 5
C38, C39	DIESEL GENERATOR H7A CONTROL CABINETS	0.48	Expansion anchor shear with bolt bending due to gaps
C80	VITAL SWITCHGEAR VENT CONTROL CABINET	0.37	Expansion anchor shear/tension interaction
D02	125VDC EMERGENCY BUS D02	0.26	Expansion anchor shear/tension interaction
D12	125VDC DISTRIBUTION PANEL D12	0.42	Expansion anchor shear/tension interaction
DB1, DB2	BATTERY 201A, 201B	0.13	Expansion anchor shear with bolt bending due to gaps
H7A, H7B	EMERGENCY DIESEL GENERATOR	0.50	Expansion anchor shear
INV 5	INVERTER NO 5	0.051	Seismic interaction with BW-7.8, INV 5 assumed to fail at same level as wall BW-7.8
P5A, P5B, P5C	A SERVICE WATER PUMPS	0.50	Functional capacity per NP-6041 Table 2-4, anchorage HCLPF is higher
T41	REFUELING WATER STORAGE TANK	0.34	Base shear (sliding)
T48A, T48B	DIESEL ENGINE FUEL OIL SUPPLY DAY TANK"	0.31	Base shear (sliding)
T8A, T8B	BORIC ACID TANKS	0.31	Expansion anchor shear
T98	CHILLED WATER SURGE TANK	0.22	Expansion anchor shear/tension interaction
TB	TURBINE BUILDING	0.25	See previous section
UAC1	REGULATING TRANSFORMER UAC1	0.50	Functional capacity per NP-6041 Table 2-4, anchorage HCLPF is higher
VR11, VR21	120VAC INST PANEL VR21	0.17	Expansion anchor shear/tension interaction, narrow base results in high anchor tension
X18A, X18B, X18C	RBCCW HEAT EXCHANGERS	0.29	Cast-in-place bolt shear
X20A, X20B	SPENT FUEL POOL COOLING HEAT EXCHANGERS	0.26	Cast-in-place J- bolt shear/tension interaction
X23A, X23B	SHUTDOWN COOLING HEAT EXCHANGERS	0.32	Uplift of roller support

Table 3.2-4 Containment Performance Relay Chatter Evaluation

Pen. #	System	Isolation Valves	P&IDs	Comments
1	Primary Make-up water	2-PMW-319, 2-PMW-43, 2-PMW-3	26014 Sh. 2	Locked open manual valve A-PMW-319 in series with Fail closed, normally closed SOV 2-PMW-43 and check valve 2-PMW-3 2 inch piping. Screened out, because normally closed SOV 2-PMW-43 is in series with check valve 2-PMW-3.
2	Letdown	2-CH-006, C-CH-089, 2-CH-341, 2-CH-343, 2-CH-342, 2-CH-344	26017 Sh. 2	Normally open manual valve 2-CH-006 in series with Normally open fail closed SOV 2-CH-089 and parallel valves normally open manual valve 2-CH-341, 2-CH-342 and Normally close manual valve 2-CH-343, 2-CH-344 2 inch piping Potential ISLOCA **Check ISLOCA Calc. file PAGE 47**
3	Charging	2-CH-429	26017 Sh. 1	Normally open MOV 2-CH-429 2 inch piping Screened out based on 2" piping
4	CTMT Spray	2-CS-5A, 2-CS-4.1A, 2-CS-4A	26015 Sh. 1,3	Inside CTMT: Check valve 2-CS-5A, normally open manual valve. Outside CTMT: MOV, normally closed 2-CS-4.1A and Locked open manual valve 2-CS-4A. Screened out because normally closed MOV 2-CS-4.1A is in series with check valve 2-CS-5A
5	CTMT Spray	2-CS-5B, 2-CS-065, 2-CS-4.1B, 2-CS-4B	26015 Sh. 1,3	Inside CTMT: check valve 2-CS-5B and Locked open manual valve 2-CS-065 Outside CTMT: Normally closed MOV 2-CS-4.1B and Locked open manual valve 2-CS-4B Screened out because normally closed MOV 2-CS-4.1B is in series with check valve 2-CS-5B
6	SI	2-SI-706D, 2-SI-644, 2-SI-247	26015 Sh. 3,2	Check valve 2-SI-706D, line splits: Normally open MOV 2-SI-644, Check valve 2-SI-245, and Check valve 2-SI-247 Screened out, because check valves are not affected by fire, and check valve 2-SI-706D is in series with MOV 2-SI-644
7	SI	2-SI-706A, 2-SI-614, 2-SI-217	26015 Sh. 3,2	Check valve 2-SI-706A line splits: Normally open MOV 2-SI-614 and Check valve 2-SI-217 Screened out, because check valves are not affected by fire, and check valve 2-SI-706A is in series with MOV 2-SI-614

Table 3.2-4 Cont'd

Pen. #	System	Isolation Valves	P&IDs	Comments
8	SI	2-SI-706C, 2-SI-634, 2-SI-237	26015 Sh. 3,2	Check valve 2-SI-706C line splits: Normally open MOV 2-SI-634 and Check valve 2-SI-237 Screened out, because check valves are not affected by fire, and check valve 2-SI-706C is in series with MOV 2-SI-634
9	SI	2-SI-706B, 2-SI-632, 2-SI-227	26015 Sh. 3,2	Check valve 2-SI-706B Normally open MOV 2-SI-632, and Check valve 2-SI-227 Screened out, because check valves are not affected by fire, and check valve 2-SI-706B is in series with MOV 2-SI-632
10	Shutdown Cooling	2-SI-651, 2-SI-652, 2-SI-704	26015 Sh. 3,1	Normally closed MOVs 2-SI-651 and 2-SI-652 Locked closed manual valve 2-SI-704 all in series Screened out because manual valves are not affected by fire and locked closed manual valve 2-SI-704 is in series with the MOVs
11	SI Tank Test line	2-SI-810, 2-SI-463, 2-SI-459	26015 Sh. 3	Manual valve 2-SI-810 normally open Locked closed manual valves 2-SI-463 and 2-SI-459 in series Screened out because manual valves are not affected by fire
12	CTMT Sump Recirc. line	2-CS-16.1A, 2-CS-15A	26015 Sh. 2	Normally closed MOV 2-CS-16.1A (West Pipe Penetration Room -25'6") Check valve 2-CS-15A valves in series
13	CTMT Sump Recirc. line	2-CS-16.1B, 2-CS-153	26015 Sh. 2	Normally closed MOV 2-CS-16.1B (West Pipe Penetration Room -25'6") Check valve 2-CS-153 valves in series
14	CTMT Sump Aerated Drain Tank	2-SSP-16.1, 2-SSP-16.2	26014 Sh. 1	Normally closed fail closed SOV's 2-SSP-16.1 (Southwest Corner of Reactor Building 3'6") and 2-SSP-16.2 (West Pipe Penetration Room -5'6") in series
15	Feedwater	2-FW-5A, 2-FW-12A	26005 Sh. 2, 26028 Sh. 3	Normally open fail closed SOV's 2-FW-5A (East Pipe Penetration Room 38'6") and 2-FW-12A (West Pipe Penetration Room -5'6") (parallel)
16	Feedwater	2-FW-5B, 2-FW-12B	26005 Sh. 2 26028 Sh. 3	Normally open fail closed SOV's 2-FW-5B (West Pipe Penetration Room 38'6") and 2-FW-12B (West Pipe Penetration Room 38'6") (parallel)
19	Main Steam	2-MS-64A	26002 Sh. 1 26028 Sh. 3	AOV 2-MS-64A will fail closed (East Pipe Penentratiom Room 38'6")
20	Main Steam	2-MS-64B	26002 Sh. 1 26028 Sh. 2	AOV 2-MS-64B will fail closed (West Pipe Penetration Room 38'6")

Table 3.2-4 Cont'd

Pen. #	System	Isolation Valves	P&IDs	Comments
21	Reactor Coolant & Prz sampling	2-LRR-265, 2-LRR-61.1, 2-RC-002, 2-RC-001, 2-RC-003, 2-RC-45	26028 Sh. 3 26020 Sh. 5 26014 Sh. 1,2 26025 Sh. 1	3/4" lines (less than 2") Four lines coming in: 1. Check valve 2-LRR-265 and SOV 2-LRR-61.1 (normally closed, fail closed) in series 2. SOV 2-RC-002; normally closed, fail closed 3. SOV 2-RC-001 normally closed, fail closed 4. SOV 2-RC-003; normally closed, fail closed These lines join and have isolation SOV 2-RC-45 (Normally closed, fail closed) Screened out based on the less than 2" piping
22	SG Bottom Blowdown	2-MS-12A, 2-MS-406, 2-MS-220A, 2-MS-147B, 2-MS-149A	26002 Sh. 2	Manual valves (normally open) 2-MS-12A, 2-MS-406, and SOV- 2-MS-220A normally open (fail closed) line splits off, manual valves 2-MS-147B (East Pipe Penetration Room 38'6") and 2-MS-149A (East Pipe Penetration Room 38'6")(normally open) Can manual valves be closed if necessary?
23	SG Bottom Blowdown	2-MS-411, 2-MS-220B, 2-MS-12B	26002 Sh. 2	Manual valves (Normally open) 2-MS-12B (inside) and 2-MS-411 (East Pipe Penetration Room -5'6") (outside) SOV 2-MS-220B normally open, fail closed Can manual valves be closed if necessary?
24	RBCCW inlet to RCP	2-RB-30.1A	26022 Sh.6	Normally open MOV 2-RB-30.1A (West Pipe Penetration Room 5'6")
25	RBCCW to CARFANs	2-RB-26.1D	26022 Sh. 5	Normally open SOV (fail open) 2-RB-26.1D
26	RBCCW to CARFANs	2-RB-26.1B	26022 Sh. 5	Normally open SOV (fail open) 2-RB-26.1B
27	RBCCW to CARFANs	2-RB-26.1A	26022 Sh. 5	Normally open SOV (fail open) 2-RB-26.1A
28	RBCCW to CARFANs	2-RB-26.1C	26022 Sh. 5	Normally open SOV (fail open) 2-RB-26.1C
29	RBCCW outlet from RCPs	2-RB-37.2A	26022 Sh. 4, 1, 5	Normally open MOV 2-RB-37.2A (West Pipe Penetration Room -5'6")
30	RBCCW from CARFANs	2-RB-28.3D, 2-RB-28.2D, 2-RB-29D	26022 Sh. 5	Parallel SOVs 2-RB-28.3D and 2-RB-28.2D, both normally open, fail closed and in series with normally open manual valve 2-RB-29D (West Pipe Penetration Room -5'6") Can the manual valves be closed if necessary?
31	RBCCW from CARFANs	2-RB-28.3B, 2-RB-28.2B, 2-RB-29B	26022 Sh. 5	Parallel SOVs 2-RB-28.3B and 2-RB-28.2D, both normally open, fail closed and in series with normally open manual valve 2-RB-29B (West Pipe Penetration Room -5'6") Can the manual valves be closed if necessary?

Table 3.2-4 Cont'd

Pen. #	System	Isolation Valves	P&IDs	Comments
32	RBCCW from CARFANs	2-RB-28.3A, 2-RB-28.2A, 2-RB-29A	26022 Sh. 5	Parallel SOVs 2-RB-28.3A and 2-RB-28.2A, both normally open, fail closed and in series with normally open manual valve 2-RB-29A (East Pipe Penetration Room -5'6") Can the manual valves be closed if necessary?
33	RBCCW from CARFANs	2-RB-28.3C, 2-RB-28.2C, 2-RB-29C	26022 Sh. 5	Parallel SOVs 2-RB-28.3C and 2-RB-28.2C both normally open, fail closed and in series with normally open manual valve 2-RB-29C (East Pipe Penetration Room -5'6") Can the manual valves be closed if necessary?
34	Nitrogen Supply	2-SI-801, 2-SI-800, 2-SI-312, 2-SI-744	26015 Sh. 3	Inside CTMT: Two locked open manual valves in series, 2-SI-801 and 2-SI-800 Outside CTMT: Normally open, fail closed SOV 2-SI-312 and manual valve (normally open) 2-SI-744 (East Pipe Penetration Room -5'6") in series. Can manual valve 2-SI-744 be closed if necessary?
35	Drain from Primary Tank	2-LRR-43.2, 2-LRR-43.1	26020 Sh. 5	Two normally closed, fail closed SOVs 2-LRR-43.2 (West Pipe Penetration Room -5'6") and 2-LRR-43.1 (Southwest Corner Reactor Building -3'6") in series.
36	Instrument Air	2-IA-569, 2-IA-566, 2-IA-595	26009 Sh. 6	Inside CTMT: Check valve 2-IA-569 Outside CTMT: Two normally closed manual valves 2-IA-566 and 2-IA-595 in series Screened out base on the fact that manual valves and check valves are not affected by fire
37	Instrument Air	2-IA-43, 2-IA-27.1	26009 Sh. 6,8	Inside CTMT: Check valve 2-IA-43 Outside CTMT: Normally open, fail closed SOV 2-IA-27.1 Screened out because check valve 2-IA-43 is in series with SOV 2-IA-27.1
38	Station Air	2-SA-19, 2-SA-22	26009 Sh. 8	Locked closed manual valves 2-SA-19 in series with check valve 2-SA-22 Screened out because manual valves are not affected by fire
39	Purge Air Inlet	2-AC-5, 2-AC-4, 2-AC-3, 2-AC-1	26028 Sh. 1	Normally closed, fail closed SOV 2-AC-5 (Southwest Corner Reactor Building 38'6") in series with normally closed, fail closed SOV 2-AC-4 The line splits into two lines with normally close, fail close SOVs 2-AC-3 and 2-AC-1
40	Purge Air Discharge	2-AC-6, 2-AC-7, 2-AC-57	26028 Sh. 1	Normally closed, fail close SOV 2-AC-6 (Southwest Corner Reactor Building 38'6") in series with normally closed?, fail closed SOV 2-AC-7 and normally closed, fail closed SOV 2-AC-57
42	Fuel Transfer Tube	2-RW-280	26023 Sh.1	Fuel transfer tube manual isolation valve 2-RW-280 Screened out because manual valves are not affected by fire

Table 3.2-4 Cont'd

Pen. #	System	Isolation Valves	P&IDs	Comments
43	RCP Seals Controlled Bleadoff	2-CH-506, 2-CH-767, 2-CH-766	26017 Sh. 2	3/4" line (less than 2") Normally open, fail closed SOV 2-CH-506 The line splits into two lines with locked open manual valve 2-CH-767 and locked open manual valve 2-CH-766 Screened out because it has less than 2" piping
47	ESF Actuation System	2-AC-97	26028 Sh. 1 28150	Valve 2-AC-97 normally open. How big is the line?
49	Fire Protection	2-FIRE-108	26011 Sh. 1	Locked closed manual valve 2-FIRE-108 Screened out because manual valves are not affected by fire
51	Waste Gas Header	2-GR-11.2, 2-GR-11.1	26021 Sh. 2	Two SOVs in series, normally open, fail closed 2-GR-11.2 (Southwest Corner Reactor Building - 3'6") and 2-GR-11.1 (East Pipe Penetration Room -5'6")
53	RBCCW Inlet to RCPs	2-RB-30.1B	26022 Sh. 6	Normally open MOV 2-RB-30.1B (West Pipe Penetration Room -5'6")
54	RBCCW Outlet from RCPs	2-RB-37.2B	26022 Sh. 4	Normally open MOV 2-RB-37.2B (West Pipe Penetration Room -5'6")
61	CTMT Air Sample	2-AC-12, 2-EB-88	26028 Sh. 2	Two normally open, fail closed SOVs 2-AC-12 and 2-EB-88 in series 1" line (less than 2") Screened out because of less than 2" piping
62	CTMT Air Sample	2-AC-15, 2-AC-50, 2-AC-54, 2-AC-49	26028 Sh. 2	Normally open, fail closed SOV 2-AC-15, manual valve 2-AC-50, check valve 2-AC-54 and locked open manual valve 2-AC-49 1" line (less than 2") Screened out because of less than 2" piping
63	CTMT Pressure Test Conn.	2-AC-115, 2-AC-114, 2-AC-117	26028 Sh. 1	Three locked closed manual valves in series 2-AC-115, 2-AC-114, and 2-AC-117 Screened out because manual valves are not affected by fire
64	CTMT Pressure Test Conn.	2-AC-113, 2-AC-112, 2-AC-116	26028 Sh. 1	Three locked closed manual valves in series 2-AC-113, 2-AC-112, and 2-AC-116 Screened out because manual valves are not affected by fire
65	SG Blowdown Sample	2-MS-16A, 2-MS-191A	26002 Sh. 2 26028 Sh. 3	Inside CTMT: Normally open manual valve 2-MS-16A Outside CTMT: SOV normally open,, fail closed 2-MS-191A 1/2" line (less than 2") Screened out because of less than 2' piping

Table 3.2-4 Cont'd

Pen. #	System	Isolation Valves	P&IDs	Comments
67	Refueling Water Purification	2-RW-232, 2-RW-21, 2-RW-20	26023 Sh. 1, 2	Two locked closed manual valves 2-RW-232 and 2-RW-21 and Check valve 2-RW-20 in series Screened out because manual and check valves are not affected by fire
68	Refueling Water Purification	2-RW-154, 2-RW-63, 2-RW-64	26023 Sh. 1, 2	Two locked closed manual valves 2-RW-154 and 2-RW-63 and Check valve 2-RW-64 in series Screened out because manual and check valves are not affected by fire
69	ESF Actuation System	2-AC-99	26028 Sh. 1	Manual valve 2-AC-99 (West Pipe Penetration Room -5'6") Screened out because manual valves are not affected by fire
70	ESF Actuation System	2-AC-98	26028 Sh. 1	? Manual valve 2-AC-98 (West Pipe Penetration Room -5'6") Screened out because manual valves are not affected by fire
71	ESF Actuation Systema	2-AC-96	26028 Sh. 1	? Manual valve 2-AC-96 (West Pipe Penetration Room -5'6") Screened out because manual valves are not affected by fire
72	SG Blowdown Sample	2-MS-168, 2-MS-220B	26002 Sh. 2	Normally open manual valve 2-MS-168 and normally open, fail closed SOV 2-MS-220B in series 1/2" line (less than 2") Screened out because of less than 2" piping
82	Hydrogen Purge	2-EB-91, 2-EB-92	26028 Sh. 3	Two normally closed, fail closed SOVs 2-EB-91 (Southwest Corner Reactor Building 38'6") and 2-EB-92 (East Pipe Penetration Room 38'6") in series
83	Hydrogen Purge	2-EB-100, 2-EB-99	26028 Sh. 3	Two normally closed, fail closed SOVs 2-EB-100 (Southwest Corner Reactor Building 38'6") and 2-EB-99 (East Pipe Penetration Room 38'6") in series
86	CTMT Air Sample	2-AC-47, 2-EB-89	26028 Sh. 2	Two normally open, fail closed SOVs 2-AC-47 and 2-EB-89 in series 1" line (less than 2") Screened out becasue of less than 2" piping
87	CTMT Air Sample	2-AC-20, 2-AC-55, 2-AC-52	26028 Sh. 2	Normally open, fail closed SOVs 2-AC-20, check valve 2-AC-55 and locked open manual valve 2-AC-52 in series 1" line (less than 2") Screened out because of less than 2" piping
88	Post-Incident CTMT Hydrogen Sample	2-AC-51	26025 Sh. 4 26028 Sh. 3	Locked closed manual valve 2-AC-51 1" line (less than 2") Screened out because of less than 2" piping
89	Post-Incident CTMT Hydrogen Sample	2-AC-48	26025 Sh. 4 26028 Sh. 3	Locked closed manual valve 2-AC-48 1" line (less than 2") Screened out because of less than 2" piping

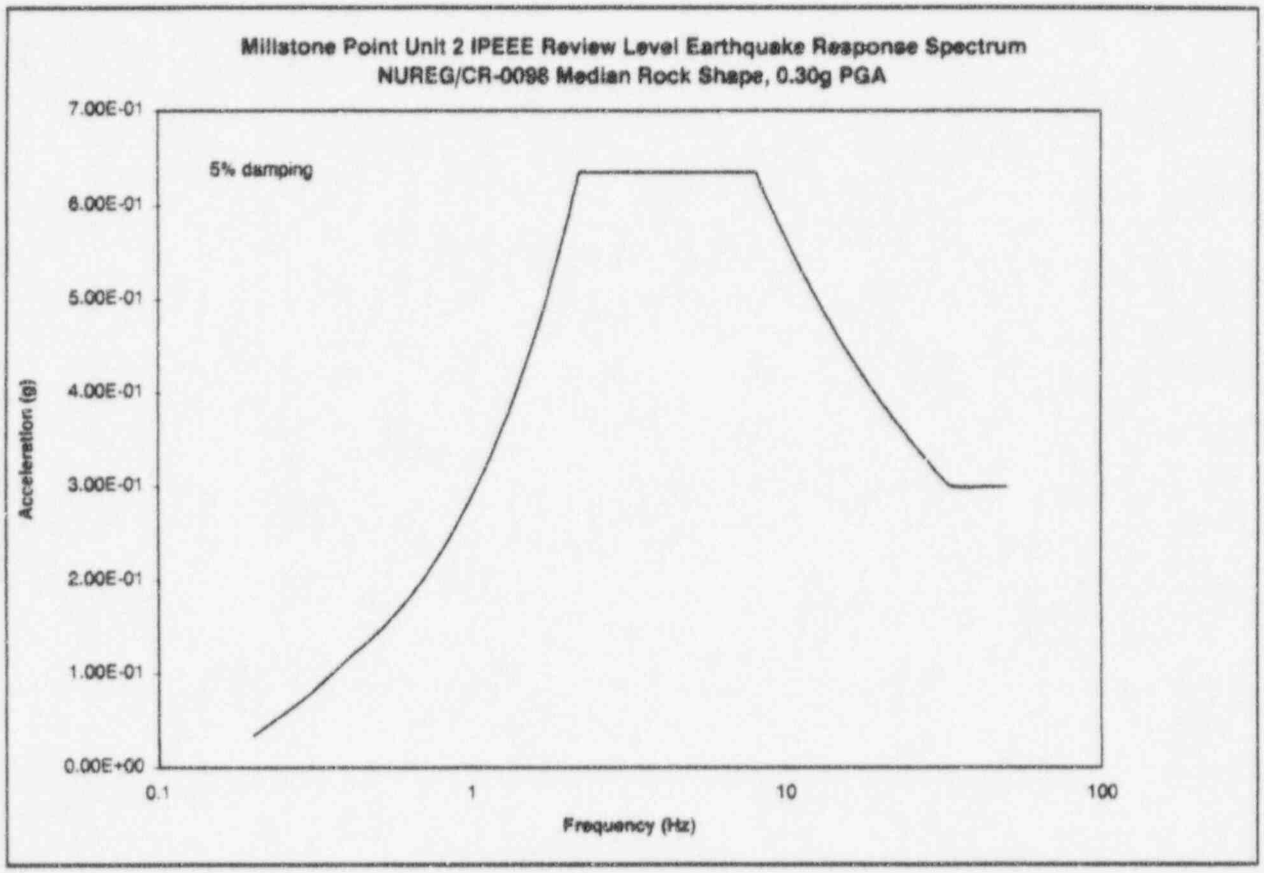


FIGURE 3.2-1: - Review Level Earthquake RS shape

4.0 Internal Fire Analysis

4.1 Introduction

A fire hazard risk analysis was performed to support the MP2 IPEEE response to Generic Letter 88-20, Supplement 4. The results of this analysis represent the best estimates of fire risks at MP2 and are described in the following sections.

The current analysis uses a combination of the Fire Induced Vulnerability Evaluation Methodology (FIVE, Ref. 4-1) and Fire PRA. FIVE data and methods are used to calculate area fire ignition frequencies, qualitatively and quantitatively screen areas, and provide hazards analysis for the resulting identified critical areas. Fire PRA is used for the quantification of the core damage frequencies. The fire induced initiating events are propagated through MP2 plant model event trees similar to those used in the MP2 IPE report.

The results of this fire analysis for MP2 are presented in Sections 4.6.2, 4.8.3, 4.9.1, 4.10, 4.11, and 4.12.

4.2 Description of the Methodology

The fire PRA was performed by a team with expertise in fire modeling, fire protection engineering, and PRA. The analysis used completed work from the MP2 Appendix R (Ref 4-2), the MP2 Fire Hazards Analysis (MP2-FHA, Ref. 4-3), and the MP2 IPE. It also incorporated data from a state-of-the-art fire database and enhanced fire hazard analysis methods from the Fire-Induced Vulnerability Evaluation methodology.

The analysis combines methods of previous fire PRAs and recently developed FIVE methodology. The methodology differs from a previous fire PRA in the application of the FIVE methodology to perform Fire Growth and Propagation Analysis and fire damage evaluation. The methodology uses advantages of 1) PRA/IPE logical models and computational aids, and 2) simplified FIVE methodology worksheets and equations. Plant walkdowns, addressing Sandia Fire Risk Scoping Study issues, and feedback from new data are part of the analysis. The overall process is illustrated by the logic diagram presented in Figure 4.2-1.

Logical flow of the methodology provides for a maximum selection and an ability to focus early in the analysis on significant fire areas and issues. IPE models are applied in a very limited number of areas, which prove to be significant through the screening process. Flow and phases of the methodology are illustrated in Figure 4.2-2 and discussed below.

Phase 1, Qualitative Screening: In this phase, areas with no safety components and where fire will not induce a plant trip, were screened out. Steps in this phase are as follows:

1.1 **Definition of the Fire Areas to be Analyzed** - The MP2 Appendix R and the MP2-FHA fire areas and zones were used as a basis for this study. Fire Compartment Interaction Analysis, discussed below, was performed in order to determine exact boundaries of the fire areas/compartments to be analyzed.

1.2 **Identification of the Safety Systems/Components in Each Area** - This step was performed by developing a spatial database (Ref. 4-4) of equipment and cable routings for the defined fire areas. A record was created for each safety component identified in the IPE process. This record included the component location, motive and control power supplies to the component and their location, and power and control cable locations. The Appendix R Analysis was the principal source for equipment locations and cable routings. Information for equipment not addressed in Appendix R was obtained from plant arrangement drawings, walkdowns, and Millstone Unit 2 cable routing drawings.

1.3 **Identification of the Possible Initiating Events Induced by a Fire in Each Area** - For each area, possible fire-induced plant trips were analyzed involving manual trips, inadvertent actuation of the signals or inadvertent opening of the valves, and induced consequential LOCAs.

1.4 **Fire Compartment Interaction Analysis (FCIA)** - For each fire compartment (fire zone), possible fire propagation was analyzed applying the FIVE methodology criteria for FCIA. Based on the results of the FICA analysis (Ref. 4-5), decisions were made on how to combine compartments for further evaluation (i.e., which groups of compartments can be treated as a single compartment - MP2 IPEEE specific fire area). Steps 1.2 and 1.3 were then repeated for each independent group of compartments.

1.5 **Phase 1 Screening** - Each MP2-FHA area not containing equipment or cables that cause an initiating event, and not containing safety equipment or cables needed to mitigate the effects of an initiating event, was screened out from further analysis.

Results of this phase are presented in Section 4.6.

Phase 2, Quantitative Screening: In this phase, areas were screened out based on the fire ignition frequencies for the area and availability of the Mitigating Safety Systems outside of the area. Steps in this phase are as follows: [Note: These steps are performed for the areas which were not screened out in Phase 1.]

2.1 **Quantification of Fire Ignition Frequencies for Each Area** - The fire ignition frequencies (Ref. 4-6) were developed based on the latest industry fire frequency data from the EPRI Fire Database for the MP2-FHAs and MP2 IPEEE specific fire areas (Ref. 4-4 spatial data base). This EPRI fire data was applied to the areas based on the actual components (results from spatial database, Ref. 4-4) and combustible loads in the area. Results of this step are presented in Section 4.5.

2.2 **Identification of Mitigating Safety Systems Outside of the Area** - For each initiating event identified in the areas in Step 1.3, Mitigating Safety Systems were identified from IPE models. The system was considered to be outside the area if no component or cable which can jeopardize system operation can be found in that area.

2.3 **Phase 2 Screening** - In this Phase 2 screening, it was conservatively assumed that fire in the area disables all equipment in the MP2-FHA or the MP2 IPEEE specific fire area. Plant response to a fire in each area was evaluated based on the IPE models and identified Safety Systems outside the area. If calculated fire-induced Core Damage Frequency (CDF) was less than 1.0E-6/year, the area was screened out from further analysis. It should be noted that in many cases simplifying and overly conservative assumptions are made to expedite screening of an area. These assumptions have been made for the purpose of "screening only" and are not necessarily intended to parallel Appendix R or FHA evaluation assumptions.

Results of this phase are also presented in Section 4.6.

Phase 3, Fire Damage Evaluation Screening: In this phase, areas were screened out, or evaluated in detail, based on Fire Growth and Propagation Analysis and/or fire damage evaluation. Steps in this phase are as follows: [Note: These steps are performed only for the areas which were not screened out in Phase 1 and Phase 2.]

3.1 **Evaluation of Fire Hazard Parameters** - A fire hazard database (Fire Hazard Matrix, Table 4.3-3) was developed to provide the information necessary to support the fire damage evaluation. For each area, this database contains information on fire detection, fire suppression, fire barriers, ventilation, and types and amounts of combustibles.

3.2 **Evaluation of Fire Growth and Propagation** - For each area, target sets of interest were identified. Fire growth and propagation analysis (Ref. 4-7) was performed based on the FIVE worksheets and heat transfer equations. For each target set, it was determined whether or not there was enough combustible present in the area to cause damage and, if so, the time it would take to cause damage and the time it would take to actuate detection or suppression. Each specific fire target set where there was not enough combustibles present to cause damage to the target was screened out from further analysis.

3.3 **Evaluation of Fire Suppression** - Evaluation of automatic and manual suppression (Ref. 4-8) was performed for systems and manual brigades response times.

3.4 **Identification of Fire Scenarios Within Each Area** - Analyzed fires, or target sets, in each area were combined in the fire scenarios based on the induced initiating events and the plant response.

3.5 **Quantification of Fire Damage Probability** - For each identified fire target set, fire damage probability was determined based on the simplified FIVE equations. Each fire target set with a low probability of fire damage (less than 1.0E-6) was screened out from further analysis.

3.6 **Quantification of Fire Scenario Frequencies** - The frequencies of the fire scenarios were quantified as the sum of corresponding fire target set frequencies, which were based on the fire ignition frequency of the fire sources and the fire damage probability for the targets.

Results of this phase are presented in Section 4.8.

Phase 4, Fire Scenario Evaluation and Quantification: IPE models were applied to quantify fire-induced core damage frequencies for each fire scenario in the unscreened areas. This evaluation included evaluation of human actions needed to respond to the analyzed fire scenarios, such as Control Room evacuation and operation of equipment from remote locations. The results of this phase determined the contribution from fire events to the Millstone Unit 2 core damage frequency. They are presented in Section 4.9.

4.3 Review of Plant Information

This section describes sources of information used to perform the Millstone Unit 2 fire analysis. This information was used to support analysis activities and the development of the equipment spatial and fire hazard databases. In addition to the written documentation, plant walkdowns and interviews with plant personnel were performed. Plant walkdowns are described in Section 4.4.

4.3.1 Information Sources

A number of sources of plant information were reviewed in support of this effort, primarily the current Millstone Unit 2 Appendix R documentation, Fire Hazard Analysis, and fire-related procedures. In addition, generic fire analysis documentation was used, including the FIVE methodology report and EPRI fire events database.

The following is a description of the most important sources of information:

- Millstone Unit 2 Fire Protection Evaluation Shutdown Availability Summary, Appendix R, Revision 2, 1994

  The Appendix R documentation was used to determine fire areas and some of the safe shutdown equipment and cables within them. Also, plant initiating events and responses detailed in the Appendix R Analysis were compared with the results derived using the spatial database developed for this study, and any differences were resolved.

- Millstone Unit 2 Fire Hazard Analysis, Appendix A, Revision 3, 1992

  The Appendix A documentation was used to determine, for each fire area, the combustible loading, fire barriers, and suppression and detection systems.

- Final Safety Analysis Report (FSAR)

  The FSAR was used as a source of information regarding the Fire Protection System, plant layout, and plant response.

- PMMS (Plant Maintenance Management Systems) Reports

  The PMMS records were used to determine the location of potential fire sources in the plant: pumps, compressors, heaters, air conditioning units, fans, batteries, chargers, etc.

- Millstone Unit 2 Individual Plant Examination for Severe Accident Vulnerabilities, Northeast Utilities Service Company, 1993

  The plant IPE model was used to determine safety significant equipment, initiating events and plant responses, backup system unavailabilities, etc. Especially useful was a document developed for IPE examination: "System Dependencies and Support State Development for Millstone Unit 2," Calculation No. W2-517-808-RE, Revision 0, 1991, which identifies all IPE active components and their dependencies.

- Cable Routing Drawings (Component and Cable Routing Information, Component and Cable Circuit Failure Analysis), Appendix R Drawings, W. J. Lepper, 1993

  These drawings provided useful information on the cable routings for a large number of safety components.

  Administrative Control Procedures

ACP-QA-2.03B	"Control of Welding"
ACP-QA-2.05	"Fire Protection Program"
ACP-QA-2.05B	"Control of Combustible Materials, Flammable Liquids Compressed Gases, & Ignition Sources"
ACP-2.22	"Station Fire Watch"
ACP-QA-3.15	"Performance of Fire Protection Reviews"
ACP-QA-4.01	"Plant Housekeeping"
ACP-8.02	"Fire Fighting training Program"
MAP-2.40	"Use of Tobacco Products at Millstone Station"
WC-7	"Fire Protection Program"

- These procedures provide information on the control of ignition sources and combustibles, fire protection equipment, fire patrols, and fire brigade training and qualifications.

- Fire-Induced Vulnerability Evaluation, prepared for the Electric Power Research Institute by Professional Loss Control, Inc., EPRI-TR-100370, April 1992

  The FIVE methodology criteria were used to perform Fire Compartment Interaction Analysis. The FIVE methodology worksheets, tables, and equations were used in performing Fire Growth and Propagation Analysis. The FIVE methodology assumptions, data, and equations were also used to perform Fire Damage Evaluation.

- Fire Events Database for U. S. Nuclear Power Plants, EPRI Database, Revision 1, 1993

  Fire frequency data was obtained from the EPRI database which includes over 1,250 reactor years of data through 1988. This data was used to develop component fire ignition frequencies, transient ignition frequencies, and area fire frequencies for the initial screening and for the detailed hazard analysis.

Numerous other plant procedures (i.e., Fire AOPs, EOPs, etc.) drawings and documents (i.e., Operator Logs, Fire Brigade Drill records, etc.) were also reviewed during this analysis.

They are referenced in the text where applicable.

4.3.2 Equipment Spatial Database

An equipment spatial database (Ref. 4-6) was created for safety equipment and cables to support the Internal Fire Analysis. A record for each component was created, which includes the component location, motive and control power supplies and locations, power and control cable locations, and normal states and required states for mitigating an initiating event. Records were created for pumps and valves, power supplies, and instrumentation. Table 4.3-1 lists the available input fields for the equipment spatial database.

Appendix R was the principle source of information for equipment location and cable routing. Information for equipment not addressed by Appendix R was obtained from the plant arrangement drawings, walkdowns, and the cable routing drawings.

Based on the information in the equipment database, a simple program was created to produce the Location Database. The Location Database contains, for each MP2 IPEEE specific fire area, all relevant equipment information: equipment ID and description, system to which the equipment belongs, power source the equipment is supplied from, and "location type." Location type defines what "part" of the equipment is in the location: power supply, control supply, power cable, control cable, or equipment, itself. One example of the location report is given in Table 4.3-2. The Location Database also provides the connection to IPE models because it contains IPE identifiers (modules and basic events) connected with the equipment.

A good equipment spatial database is a very important part of the fire evaluation. Both quantitative and qualitative screening are based on the information contained in this database. Important fire areas in the analysis are determined by those screenings. This is why a large effort needs to be put into ensuring quality and completeness of information in this database.

4.3.3 Fire Hazard Matrix

A Fire Hazards Matrix was developed to provide and organize the information necessary to support the Fire Damage Evaluation effort.

This matrix partitions the plant on the basis of Appendix R fire areas. For each area, the presented information consists of the type of detection and alarm location; the type of suppression and suppression actuation, fire barriers' orientation, and ratings; the types and amounts of combustibles, and information on the ventilation systems, if relevant. This information was obtained from the MP2 Fire Hazard Analysis and supplemented by the other document searches, as well as several plant walkdowns.

Table 4.3-3 presents a sample page from this Fire Hazard Matrix.

4.4 Plant Walkdowns

At various stages of the Millstone Unit 2 Fire IPEEE plant walkdowns were performed in support of the analysis. The purpose of the plant walkdowns were to verify plant configurations, equipment locations, house keeping, and to address pertinent Fire Risk Scoping Studies Issues.

The plant walkdowns were usually conducted by a team comprised of a plant fire protection engineer, PRA engineers from NUSCO, and at times a consultant with expertise in a particular field. The walkdowns consisted of three basic types, as follow.

The first series of walkdowns, conducted in the early stages of the study (Jan.-Mar., 1995) reviewed the fire hazard characteristics of the areas and verified plant equipment located in them. These walkdowns examined all the plant areas except those initially identified as not important to risk during the qualitative screening effort. Fire protection data reviewed included fire barriers, detection, suppression, and combustible loading (fixed and transient). Room equipment layouts were verified to identify vital plant components and also verify potential ignition sources. Specific equipment of interest included pumps and motors, valves, electrical busses and switchgear, and control panels. The results of these walkdowns were documented in the Fire Hazard database, described in Section 4.3.3.

The second series of walkdowns were required for various areas which were not eliminated either by the qualitative or the quantitative screening process. The purpose of these walkdowns was to re-review selected areas in finer detail. This was done to support the evaluation of detailed fire propagation, equipment response, and in some cases operator response.

The third series of walkdowns were performed to specifically address the Sandia fire risk safety study issues. In addition, the walkdown conducted in support of the IPEEE-seismic update addressed the issues of the seismic ruggedness of fire protection components and the failure of non-safety related components impacting important equipment. The results and observations of these walkdowns were used to address the Sandia issues as discussed in Section 4.11.

4.4.1 Summary of Walkdown Insights

Insights from the walkdowns were used in support of the analysis and also indicated areas within the plant where potential improvements could be made (see Section 1.4 for a description of conclusions and recommendations). The following summarizes the insights gained from the plant walkdowns which were used in the fire analysis.

- Auxiliary Building (AB) - This is a multi-level structure which is comprised of numerous fire areas. The majority of the Auxiliary Building does not have an automatic suppression system and in the event of a fire manual fire suppression is relied upon in most areas. Generally, the fixed combustible loading is considered low to moderate and is primarily comprised of cabling. A few areas were noted to have large quantities of transient combustibles (protective clothing) in open storage racks. These were usually located near concentrations of cable trays and were thus considered for further analysis. However, irrespective of the analysis results, as a good house keeping practice the amount of these transient combustibles should be reduced and adequately stored in enclosed fire rated lockers or removed from these areas.

- The cable spreading area is basicly sandwiched between the Control Room (above) and the DC Switchgear Rooms 'A' & 'B' (below). This area is the primary collection point for the majority of non-safety and safety related power and control cables at MP2. These cables are run primarily in horizontal cable trays. The cable tray loading is generally one layer of cables (approx. 50% of the trays) and only in a few cases is there what could be considered a second layer of cables (approx. 5%). Of the remaining cable trays (approx. 45%), a tray may contain 1 to 10 cables. In certain areas the cable trays are stacked above each other at one foot intervals for a maximum stack height of eight trays. Fire suppression (auto) is located on in cable concentration areas at a maximum ten foot interval for straight runs and at every junction point. Fire detection is also present in the ceiling area and provides adequate detection coverage. There were a few observed fixed ignition sources (2 - 480-208/120V transformers and 3 low voltage cabinets (SE corner)) in the cable spreading area. Some safety related cabling in the area is protected by Thermo-lag due to separation concerns.

- Main Control Board - the main control board panels extend from the floor to the false ceiling of the Control Room. Ventilation air enters through the end doors and at the floor level and exits into the area above the false ceiling. The main control board has a center walkway which travels down the center of the control board and divided into sections/panels which are separated by steel barriers which extend from the floor level to the false ceiling level. The individual panels of the main control board do not have train separation for components controlled from their respective panel. Component wiring generally comes together at a common wiring bundle for the panel. Detectors are located within the main control board at regular intervals at the false ceiling level.

- Intake Structure - does not contain a automatic suppression system, the Circulating Water pumps use approximately 55 gallons of lube oil each, and the Service Water pumps are in close proximity.

- MP1/MP2 Fire Pump House - is divided into two rooms which contain MP2s electric fire pump in one room and MP1s electric and diesel fire pumps in the other. These three pumps tie into a common fire suppression header for the Millstone site.

Northeast Utilities requires all of its employees that are badged at any of its nuclear facilities to take annual General Employee Training (GET) (Ref. 4-9). As part of the GET employees are taught to recognize the following; 1) the various types of fires, 2) Control Room reporting requirements, 3) how to suppress different classes of fires and 4) the employee is given the freedom to combat certain fires if they feel confident after reporting. MP2 Fire Brigade response to unannounced drills is approximately 15 minutes until they can actually be credited with fire fighting. This supports the overall industry observation that the majority of fires are suppressed by individuals and only in rare cases is the fire brigade required to combat the fire.

The electrical panels throughout MP2 were inspected for their design and combustible loading during various walkdowns in comparison to Reference 4-10. The following insights were gained; 1) the combustible loading within electrical panels (buses and MCCs) is low to moderate (estimated at < 20% of volume), 2) panel/cubicle construction is of heavy gauge steal, 3) panels/cubicles have very limited penetrations to allow fire spread, and 4) the combustibles control program at MP2 discourages use of acetone within the switchgear rooms or the Control Room. Based upon these factors and a review of Reference 4-10, it is difficult to imagine a single panel/cubicle fire on a bus or MC which could affect the entire bus or MC let alone propagate to other buses or MCCs at MP2.

The main control board panels combustible loading is also considered to be moderate to low. However, they extend from floor to ceiling with all the wiring generally coming together in a common wiring bundle for each panel. Therefore, a relatively small well placed fire within a particular main control board panel could disable that entire panel. During some of the walkdowns Control Room operators and trainers were given a scenario of a fire in the main control board. The operators and trainers were requested to role play and the response times were observed. The maximum observed response time was approximately two minutes from the time of detection (first fire panel alarm) until the fire was considered suppressed.

The overall house keeping of the plant was found to have improved significantly between Jan. 1995 and Sept. 1995 and found to be generally adequate at present. No large quantities of unprotected transient combustibles were observed in the majority of plant areas during the numerous walkdowns of the plant. Those areas which did contain large quantities of unprotected combustibles were identified for further analysis. Plastic trash or clothing containers contained minimal amounts of combustibles and metal containers were fitted with flame arrectors. The plant personnel are sensitive to transient controls during work and maintenance activities for the entire plant, with a very high level of sensitivity for the switchgear rooms and the Control Room.

4.5 Fire Ignition Database

The development of MP2 fire ignition frequencies (Ref. 4-6) was based on the industry data collected in the EPRI Fire Database and the area loads with fire sources and combustibles (method recommended in the EPRI Fire Database).

The EPRI Fire Event Database for U. S. Nuclear Power Plants (Ref. 4-11) was used in estimating fire ignition frequencies for equipment at different plant locations. This database contains 753 fire events that occurred in PWRs and BWRs between February 1965 and December 1988. The database represents 1,264 reactor years: 786 PWR reactor years and 478 BWR reactor years.

The data from this database provide generic frequencies for different fire ignition sources (equipment) at specific plant locations. In order to reduce the uncertainty in using equipment data from different locations at different plants in the EPRI database, all components of a similar type in the same general location were treated the same. For example, the electrical cabinets in all Switchgear Rooms or the pumps in all Auxiliary Buildings were analyzed together. Locations applicable to PWR plants are grouped in the following categories: Auxiliary Building, Switchgear Rooms, Control Room, Cable Spreading Room, Battery Rooms, Diesel Generator Rooms, Turbine Building, Intake Structures, and Transformer Yard. Some of the components, such as air compressors, ventilation subsystems, or hydrogen tanks, are treated as plant-wide components (not connected to any specific location). Transient fires and fires caused by welding are also treated as plant-wide fires. Fire ignition sources and frequencies by applicable plant location from the EPRI database are summarized in Table 3.1 of the EPRI Report.

In order to determine fire frequencies for equipment in MP2-specific fire locations, a detailed analysis was performed for each fire area. This analysis involved identification of all potential ignition sources in the area, including major components such as pumps or cabinets, and more difficult to locate components such as junction boxes or ventilation subsystems. This information was collected from Appendix A (Fire Hazard Analysis), Plant Arrangement Drawings, and PMMS records, and was confirmed in the plant walkdowns.

The applicability of transient sources involving welding and grinding was also analyzed for each area. If some of the generic transient sources (i.e., heaters, extension cords, or hot piping) were not applicable to a specific MP2 location, the transient fire frequency was modified.

The process of determining fire frequencies for equipment in MP2-specific locations consists of the following steps:

1. Identify all potential fire sources/components in a selected location (i.e., the total number of each component type in the location).

2. Select generic fire frequencies from the EPRI Fire Database applicable to the fire sources/components in the selected location.

3. Determine source weighting factors (i.e., the number of components in the selected location versus the total number of components in the similar type of location).

4. Calculate the fire ignition frequency for each source and location (i.e., the generic frequency times the weighting factor).

The weighting factors are determined based on the methods proposed in Table 3-1 of the EPRI Report, except in the following case:

The weighting factor method applied in the analysis of Millstone Unit 2 switchgears is different than that proposed in Reference 4-11, and it is discussed in Reference 4-12. The major difference is that Weighting Factor Method "B" (obtain the ignition source weighting factor by dividing the number of ignition sources in the fire compartment by the number in the selected location) was applied for Switchgear Room electrical cabinets instead of proposed Weighting Factor Method "A" ("no factor if necessary") from Reference 4-11. This change allowed to account for the difference in the load with electrical cabinets between the various switchgear rooms (AC & DC) at MP2. If during a walkdown it was found that a breaker cubicle was empty and unused, it was deleted from the analysis.

A summary of the results for Millstone Unit 2 fire areas is given in Table 4.5-1. The summary table gives the total area ignition frequency and ignition frequency per single component in the area (for major fire sources such as pumps or cabinets) and also gives the transient ignition frequency for the area. With few exceptions, the transient frequency is the same for all the fire areas since the same transient sources were applicable (welding, heaters, etc.).

Examples of the ignition frequency evaluations for three Millstone Unit 2 areas are given in Table 4.5-2 for an Auxiliary Building area, Table 4.5-3 for the Turbine Building general area, and Table 4.5-4 for the DC Switchgear Room "A".

Occasionally, in order to model more realistic ignition frequencies, it was necessary to analyze specific records from the EPRI database and to break the generic frequencies down to more detailed categories. An example of this maybe the breaking of the general category "pump fires" into subcategories such as "pump motor fires" or "pump fires involving lube oil."

4.6 Identification of Important Fire Areas

This section provides information on the identification of important fire areas, the location of important equipment within these areas, and the postulate consequences of a fire in each area. Information is also provide on the fire area structure (i.e. walls, floor area, doors).

All the fire areas/zones from Appendix R (Ref. 4-2) and Appendix A (FHA) were reviewed in this section in order to identify critical fire areas. A list of the analyzed areas is given in Table 4.6-1.

Table 4.6-1 identifies the Fire Area, Building, Area Group (corresponds to the PWR plant locations from the EPRI Fire Event Database used to determine fire ignition frequencies in the area, see Section 4.5), fire zone, fire compartment number (see discussion below), zone description, and elevation.

For each of the areas/zones, fire hazard characteristics were analyzed. Area structure and location, types of detection and suppression used in the area, combustible loading, and fire barriers are considered in this analysis. Results from the Fire Compartment Interaction Analysis (FCIA) (Ref. 4-5) were also included in the analysis. If, during the FCIA, it was determined that fire propagation from a specific fire zone (area) was not possible (screening of specific boundaries between zones was based on the FIVE methodology criteria), then that zone (area) was analyzed as a separate fire compartment.

In Table 4.6-1, the column "Analyzed FCIA Compartment Number" identifies all fire zones/areas which are analyzed as separate compartments (it does not apply to the zones/areas which do not contain any safety relevant equipment). Zones/areas are treated as separate compartments only if propagation of fire cannot occur into or out of the zone/area.

The purpose of the analysis summarized in this section is to identify critical fire compartments where fire can produce important risk effects leading to substantial degradation or loss of a safety function. This is accomplished by one of the two screening processes (described more fully in Section 4.2). They are:

> Qualitative Screening - Fire compartment (area/zone) is qualitatively screened out it if does not contain equipment or cables which would cause an initiating event and does not contain safety equipment or cables needed to mitigate the effects of an initiating event.
>
> Quantitative Screening - (1) Fire compartment (area/zone) is quantitatively screened out if, by assuming that fire in the area disables all equipment, CDF due to fire is less than 1.0E-6/year (high availability of backup systems outside of the area); (2) fire compartment (area/zone) is quantitatively screened out if it contains a single train of safety equipment, and fire-induced equipment unavailability will be small compared to the unavailability due to internal failures; (3) fire compartment (area/zone) is quantitatively screened out if the effects of the fire in that compartment are expected to be similar but less severe and significantly less probable than the fire effects in another fire compartment which is analyzed (the analysis of this compartment is enveloped by the detailed analysis of the other compartment). It should be noted that in many cases simplifying and overly conservative assumptions are made to expedite screening of an area. These assumptions have been made for the purpose of "screening only" and are not necessarily intended to parallel Appendix R or FHA evaluation assumptions.

Fire compartments (areas/zones) which are not screened out during this review, are analyzed in detail in Sections 4.8 and 4.9.

4.6.1 Evaluation of MP2 Fire Compartments

Evaluation of all Millstone Unit 2 fire areas within Table 4.6-1 are described in this section. An evaluation was performed for each fire area/zone which, during the FCIA Analysis, was determined to represent an independent or separate fire compartment (meaning that propagation of fire through the compartment boundaries is not likely). For the large areas, where numerous safety equipment are present, possible fire effects and consequences are analyzed by evaluating the survivability of important safety functions like RCS Integrity, RCS Inventory Control, Secondary Side Cooling, etc.

The following areas were screened out, by inspection, based on either the absence of equipment that is safety related and is used in mitigating accidents occuring at power or the absence of equipment that provides an "important to safety" function as modeled in the internal events PRA. Therefore, a fire originating within or propagating into the area, would not result in a plant transient or failure of a mitigating system.

	Area Description	PRA FHA - ID	Append. A - ID
o	Waste Tank Room	AUXB-1	A-1D

o	Waste Gas Decay Tank Room	AUXB-1	A-1E
o	Waste Gas Comp. Surge Tank Room	AUXB-1	A-1F
o	Boric Acid Evaporator and Tanks Room	AUXB-1	A-1I
o	Evaporator and Tank Room	AUXB-1	A-1J
o	Ion Exchange Room	AUXB-1	A-11
o	Sample Area	AUXB-1	A-12B
o	Boronmeter Room	AUXB-1	A-12C
o	Spent Fuel Pool & Cask Laydown Area	AUXB-1	A-14A
o	Spent Fuel Pool & Fuel Handling Area	AUXB-1	A-14C
o	Cask Washdown Area	AUXB-1	A-14E
o	Solid Radwaste Drumming Storage Area	RWRD	A-17
o	Storage Area	STRG1	A-18
o	HP Access/Control Area	AUXB-1	A-19A
o	Spent Resin Tank Area	STRA	A-7
o	Old Computer Room	OPBR	A-26
o	New Computer Room	CMPT	A-27
o	RCP Rebuild Shop Prep. Room	RCPSH	A-29
o	Hydrogen Seal Oil Unit	TB	T-1B
o	DC Switchgear Area	TB	T-1D
o	Turbine Auxiliary Battery Area	TB	T-1E
o	Iron Chromatogarph Room	TB	T-1G
o	Turbine Lube Oil System	TB-LO	T-2
o	I&C Equipment Storage Room	TB	T-5
o	Intake Structure Hypochlorite Room	IS-SHR	I-1B

o	Intake Structure, MC Room	IS-MC	I-1C
o	Flammable/Hazardous Waste Storage	FHWS	Y-3

However, many of these areas were included in the determination of the ignition frequency of the areas selected for this analysis.

The following sections provide a brief description of the areas evaluated and a summary of the screening results.

4.6.1.1 A-25, Control Room (CR)

The Control Room (CR), located in the Auxiliary Building at elevation 38' 6", has minimum one and a half hour rated floor, and walls. The CR is also located directly above one portion of the Cable Vault (A-24). The drop ceiling is mineral acoustic tile (noncombustible) and the flooring is carpet tile.

The Control Room contains the control room panels and equipment and cables that are associated with the safe shutdown of the plant. In addition it contains the instruments and control switches on the panels for safety related systems.

The combustible loading of this zone was 13,426 Btu/sq.ft., due to recent renovations the combustible loading is expected to increase; however, it is still expected to be less than 20,000 Btu/sq.ft.. Hose stations and portable fire extinguishers are available. An ionization smoke detection system is installed above the control rack, the main control board and a detector is located in the return air duct. The Control Room system controls are organized on the Main Control Board (MCB) and on several other panels which are not vital to plant safety.

The control room has a total fire ignition frequency of 9.3E-3/year. Given this ignition frequency and the conservative assumption for all Control Room fires operator failure to shutdown from out side the control room (1.0E-03/year - screening value) dominates, the CDF for the Control Room is 9.3E-06/year. This CDF is above the screening criteria and therefore the Control Room is selected for a detailed analysis.

Main Control Board (MCB)

The MCB is partitioned into eight panels (C01 through C08). These panels have a front and back section. Analysis of the MCB is performed per panel, separating the front and back section when possible (propagation between sections, as well as propagation between two adjacent panels, is analyzed in Section 4.8). The following are brief descriptions of the major component controls located on each set (front and back) of panels;

<u>MCB, Panel C01</u>:

Front & back panel section: (Engineered Safeguards Panel)

- LPSI pumps (P-42A & B)
- HPSI pumps (P-41A, B, & C)
- Containment Spray pumps (P-43A & B)
- CAR fans (F-14A to D)

An unsuppressed fire in this panel can cause either spurious actuation of HPSI, LPSI, Containment Spray and/or CAR fans or result in total failure of the Safety Injection and Containment protection systems to perform their design function.

<u>MCB, Panel C02</u>:

Front & back panel section: (Chemical Volume and Control System Panel)

- Charging pumps (P-18A, B, & C)
- Boric acid pumps (P-19A & B)
- RCP bleed off control
- VCT indication and control
- Letdown indication and control

An unsuppressed fire in this panel can in the spurious actuation of additional Charging pumps and/or the Boric Acid pumps. Also, total failure of these systems to perform their design function could result. The MP2 PRA model credits these systems for emergency boration.

<u>MCB, Panel C03</u>:

Front & back panel section: (Reactor Coolant System Panel)

- Reactor coolant pumps
- PORVs
- Pressurizer indication and control

An unsuppressed fire in this panel can cause the Reactor Coolant pumps to trip and/or a PORV LOCA. Which would result in a plant trip.

<u>MCB, Panel C04</u>:

Front panel section: Reactivity Control

Back panel section: Reactor Coolant Pump Controls

An unsuppressed fire in this panel can cause the Reactor Coolant pumps to trip. Which would result in a plant trip. Also, the potential exists for an inadvertent plant trip to occur.

MCB Panel C05:

Front & back panel section:

- SG Control
- Condensate Pumps
- Main FW Pumps
- Aux. FW Pumps

An unsuppressed fire in this panel can cause a plant transient/trip due to loss of Condensate, Main FW and/or SG controls and loss of remote AFW control.

MCB, Panel C06:

Front & back panel section: (Plant Auxiliaries Controls)

- Circulating Water Pumps
- Service Water Pumps
- RBCCW Pumps
- TBCCW Pumps
- Ventilation/Heat Exchanger indication and controls

A fire in this panel can cause a plant transient/trip due to loss Service Water to support other plant auxiliaries (RBCCW, Ventilation, EDGs, etc.).

MCB, Panel C07:

Front & back side: Turbine Generator Control

Loss of this panel will result in a loss of Turbine Generator control which will eventually result in a turbine trip and ultimately a reactor trip.

MCB, Panel C08:

Front & back panel sections:

- Normal Station Service Transformer indication
- Reserve Station Service Transformer indication
- 6.9 KV AC Buses 25A and 25B indication and breaker controls
- 4.16 KV AC Buses 24A, 24B, 24C, and 24D indication and breaker controls
- 480 V AC Buses 22A, 22B, 22C, 22D, 22E, and 22F indication and breaker controls
- EDG 15G-12U and 15G-13U indication and breaker controls
- MP1 cross connection controls and indication
- DC Buses 201A and 201B indication

An unsuppressed fire in this panel can cause station blackout (loss of off-site power with the inability to either start the Emergency Diesel Generators or use the MP1 cross connection from the control room). This will occur as a result of spurious trips on the various breakers and protective relays. Operators would have to take local control of supply breakers to re-establish either offsite or emergency power.

4.6.1.2 AUXB-1 (Appendix A Areas; A-1A, A-1B, A-1C, A-1G, A-1H, A-9, & A-12A)

For this portion of the analysis AUXB-1 is comprised of seven MP2 Appendix A, Fire Hazard Analysis (Ref. 4-3) areas.

These Auxiliary Building areas range in elevation form -45'6" to 14'6" and primarily consist of corridors (Appendix A areas; A-1A, A-1B, A-1G, & A-12A) within the building.

The majority of the combustible loading within the corridors is attributed to the cables and some transient combustibles such as clothing. There is an automatic wet pipe sprinkler system above and below numerous cable trays in many locations within these corridors. This area is also equipped with hose stations and portable fire extinguishers. Additional hose stations are available in adjacent areas. Ionization smoke detectors are installed throughout the area.

Among others, RBCCW, Safety Injection, and Residual Heat Removal (RHR) Systems all have components that could be affected by a fire in this area.

The combined areas have a fire ignition frequency of 3.3E-2/year. For the purpose of screening, the results from the MP2 IPE model for the loss of both DC Buses were used to bound the consequences of failing the equipment in this area since most systems of concern are dependent on DC power except for the Charging System. Accordingly, unavailability of the backup systems outside of this area is 5.9E-2. The worst case expected core melt frequency due to fire is 2.0E-3/year, well above the screening criteria. Therefore, this compartment was selected for a detailed analysis.

For the safety functions of RCS Integrity, potential effects of a fire in this area are discussed below.

RCS Integrity

Fire has multiple potentials that may result in the loss or degradation of RCP thermal barrier cooling:

- RBCCW Pumps P-11A, P-11B, and P-11C are located in this area and have cabling routed through this area, so fire has the potential to result in a loss of RBCCW and RCP thermal barrier cooling.

- Service Water supply valves to RBCCW heat exchangers are also located in this zone. Their spurious closure, due to fire, would result in loss of RCP thermal barrier cooling.

4.6.1.3 AUX-2 (Appendix A Areas; A-14B, A-14D, and A-32)

AUX-2 is comprised of three MP2 Appendix A, Fire Hazard Analysis (Ref. 4-3) areas.

These Auxiliary Building areas range in elevation form 14' 6" to 38' 6"(Appendix A areas; A-14B, A-14D, & A-32).

The combustible loading of the three areas which comprise AUX-2 are 8,429, 53,097, and 1,405 BTU/sq.ft., respectively. The majority of the combustible loading within these areas is attributed to cables, charcoal filters, and some transient combustibles such as wood. There is an automatic wet pipe sprinkler system above area A-14B. This area is also equipped with hose stations and portable fire extinguishers. Additional hose stations are available in adjacent areas. Ionization smoke detectors are installed throughout the area.

AUX-2 contains control and power cabling for the following components/systems; Control Room, DC Battery Room, & DG Room ventilation, CAR fans A & C, instrument air compressor F-3A, chilled water pump P-122A, chiller X-A, MC 22E, 120V AC panel VR11, and valves 2-MS-65A, 2-MS-201, 2-CS-13.1B.

Screening of AUX-2: As a quantitative screening of AUX-2, a transient is analyzed assuming the loss of the entire compartment due to fire. The resultant plant transient is conservatively assumed to be similar to a General Plant Transient coincident with a loss of Facility 1 DC Switchgear Room Cooling. DC Switchgear Room A has temperature indication within the Control Room and requires operators to take compensatory measures to reestablish room cooling. For purposes of this screening analysis these actions were not credited.

The results from the MP2 IPE model for the loss of DC Bus A the unavailability of the backup systems outside of this compartment is 6.9E-5. The total fire ignition frequency in the compartment is 4.7E-3/year. The worst case expected core melt frequency due to fire is approximately 3.2E-7/year, below the screening criteria. This area is quantitatively screened out from further analysis.

4.6.1.4 A-19B, Hallway Storage Area (STGR2)

This area is located in the Auxiliary Building at elevation 38' 6" and represents a hallway storage area. The combustible loading for the area is 7,998 BTU/sq.ft. with the combustibles being primarily comprised of transient combustibles. The area has smoke detectors and an automatic wet-pipe sprinkler system in the north half of the area.

The diesel exhaust ducts and combustion and room ventilation air ducts are passive components and are routed through this area. It is conservatively assumed that a fire in the area would render both diesels inoperable due to smoke ingress which chokes the diesel. However, since no other safety related equipment is routed through the area no plant transient/trip is expected to occur (Ref. 4-2 & 4-3).

Screening of A-19B: The diesels are only required during loss of normal power events. Thus, the unavailability of the diesel generators due to fire in this zone can be compared with the unavailability of diesels due to internal failures. From the MP2 IPE model, the unavailability of both diesels due to internal common cause failures to start is 3.7E-04. Fire ignition frequency for this area is 9.7E-4/year. Probability to have a fire-related loss of both diesels during the required mission time of 24 hours is 2.7E-6. Therefore, the unavailability of both diesels due to fire in this area (A-19B) is small compared with the unavailability due to internal common cause failures. This area is quantitatively screened out from further analysis.

4.6.1.5 A-33, Ventilation Equipment Room, (HVAC)

This area is located in the Auxiliary Building at elevation 38' 6". The combustible loading for the area is 11,391 BTU/sq.ft.. The combustibles are primarily comprised of charcoal filters and cable insulation. The area has ionization smoke detectors and high temperature alarms for the charcoal filters. A hose station is available in the area along with portable fire extinguishers

The area contains ventilation equipment associated with the following areas; Control Room, East 480V Load Center, Cable Vault, and "B" DC Switchgear & Battery Room. Also, located within the area are MC 22-2F and control & power cables for chilled water pump P-122B, chiller X-169B, valves 2-FW-44, 2-MS-202, 2-MS-65B, and 120V panel VR21. For screening purposes it was conservatively assumed that a fire in the area would render all of the equipment associated with this area inoperable. Control Room ventilation failure is also expected to occur; however, operators would to take measures to re-establish adequate ventilation for the Control Room.

Screening of A-33: For the quantitative screening of A-33, a transient is analyzed assuming the loss of the entire compartment due to fire. The resultant plant transient is conservatively assumed to be similar to a General Plant Transient coincident with a Loss of Facility II DC Switchgear Room Cooling. DC Switchgear Room B has temperature indication within the Control Room and requires operators to take compensatory measures to reestablish room cooling. For purposes of this screening analysis, these actions were not credited.

The results from the MP2 IPE model for the loss of DC Bus B the unavailability of the backup systems outside of this compartment is 7.3E-5. The total fire ignition frequency in the compartment is 4.8E-3/year. The worst case expected core melt frequency due to fire is approximately 3.5E-7/year, below the screening criteria. This area is quantitatively screened out from further analysis.

4.6.1.6 A-24, Cable Vault (CV-AB)

The Cable Vault, located in the Auxiliary Building at elevation 25' 6", has a minimum one and a half hour rated walls and ceiling.

The combustible loading in this area is 91,310 Btu/sq.ft.. The area contains a combination of temperature, heat rate-of-rise, and cross-zoned ionization/photoelectric fire detection system. An automatic wet pipe water fire suppression system specifically designed for cable tray fires is installed in the area. In addition, portable fire extinguishers (in the area) and a hose cabinet (in an adjacent area) are available for suppression.

The majority of equipment power and control cables are routed through this fire compartment. Because of the importance of this area to plant safety and the combustible loading in combination with ignition frequency, this compartment has been selected for a detailed analysis.

4.6.1.7 A-4, HPSI Swing Pump Room

The HPSI Swing Pump Room is a located in the Auxiliary Building at elevation (-) 45' 6". The fire area is has a minimum fire barrier rating of one and a half hours. The combustible loading of this area is negligible. An ionization smoke detector is located in the area which alarms in the Control Room. Manual suppression from the hose station or portable fire extinguishers located in adjacent fire area A-1A and are relied upon in the event of a fire in this area.

The main effect of the fire in this area will be loss of the swing HPSI pump, P-41B. The loss of this due to fire will not result in an automatic plant trip. Facilities Z1 and Z2 related ESF components will still be available and unaffected. .

Screening of A-4: Due to the limited effect of a fire in this area, this area is qualitatively screened out from further analysis.

4.6.1.8 A-13, 480V MC B61 & B41A (MCCB61)

The 480V Motor Control Centers (MC) B61 & B41A area located in the Auxiliary Building at elevation 14' 6". The fire area is has a minimum fire barrier rating of one and a half hours. The combustible loading of this area is 37,099 Btu/sq.ft. An ionization smoke detector is located in the area which alarms in the Control Room. Manual suppression from the hose station or portable fire extinguishers located in adjacent fire area A-12A and are relied upon in the event of a fire in this area.

The main effect of the fire in this area will be loss of MCCs B61 and B41A which in turn result in the loss of control for the following components; 4160V Switchgear B Room fan F-133, ESF Room B air recirc. fan F-15B, DG B vent. fan F-38B, East 480V Room fan F-52, DC Switchgear Room B fan F-54B, Charging Pumps P-18B & P-18C, Boric Acid Pumps P-19A & P-19B, 120V panel IAC-2, and valves 2-CH-514, 2-CS-16.1B, 2-CS-4.1B, 2-HV-255B, 2-HV-256B, 2-RB-30.1B, 2-RB-37.2B, 2-RC-001, 2-RC-002, 2-RC-003, 2-RC-405, 2-SI-412, 2-SI-616, 2-SI-626, 2-SI-634, 2-SI-635, 2-SI-636, 2-SI-644, 2-SI-645, 2-SI-646, 2-SI-652, 2-SI-653, 2-SI-662, 2-SW-90B, & 2-SW-90C. Facility Z1 relate HPSI and LPSI will still be available and unaffected.

Screening of A-13: For the quantitative screening of A-13, a transient is analyzed assuming the loss of the entire compartment due to fire. The resultant plant transient is conservatively assumed to be similar to a General Plant Transient coincident with a loss of Facility Z2 DC Switchgear Room Cooling and Facility Z2 ESF Room Cooling. DC Switchgear Room B has temperature indication within the Control Room and requires operators to take compensatory measures to reestablish room cooling. For purposes of this screening analysis these actions were not credited.

The results from the MP2 IPE model for the loss of DC Bus B the unavailability of the backup systems outside of this compartment is 7.3E-5. The total fire ignition frequency in the compartment is 5.1E-3/year. The worst case expected core melt frequency due to fire is approximately 3.7E-7/year, below the screening criteria. This area is quantitatively screened out from further analysis for this transient.

4.6.1.9 PN-W, West Pen. Area (Appendix A Areas; A-8B, A-8C, A-8D, & A-8E)

The West penetration area (PN-W) is locate in the Auxiliary Building and is comprised of four Appendix A fire areas; A-8B, A-8C, A-8D, and A-8E, which range in elevation from (-)25' 6" to 38' 6". These areas were combined since they are connected via floor gratings from one level to another. The combustible loading in these areas are 22,487 BTU/sq.ft., 8,985 BTU/sq.ft., 20,743 BTU/sq.ft., and 2,278 BTU/sq.ft., respectively. Ionization smoke detectors are provided in areas A-8C and A-8D. Manual suppression from the hose stations or portable fire extinguishers located in adjacent fire areas of the Auxiliary Building are relied upon in the event of a fire in this area.

The PN-W area contains certain Facility Z2 MOVs, AOVs, along with control, power, and instrumentation cabling routed through the area for other facility Z2 components. The following components are located or could be affected by a fire in this area:

Valves (MOVs & AOVs);

2-AC-5, 2-AC-6, 2-AC-57, 2-CH-089, 2-CH-110P, 2-CH-198, 2-CH-201P, 2-CH-429, 2-CH-505, 2-CH-506, 2-CH-516, 2-CH-517, 2-CH-519, 2-CS-4.1A, 2-EB-91, 2-EB-92, 2-FW-5B, 2-FW-43B, 2-IA-27.1, 2-MS-64B & 65B, 2-MS-190B & 191B, 2-MS-202, 2-MS-239 to 246, 2-MS-294, 2-RB-28.1B & 28.1D, 2-RB-28.2B & 28.2D, 2-RB-28.3B & 28.3D, 2-RB-30.1A & 30.1B, 2-RB-37.2A & 37.2B, 2-RC-001 to 003, 2-RC-45, 2-RC-100F, 2-RC-404 to 406, 2-RC-416 & 417, 2-RC-424 & 425, 2-SI-615 to 617, 2-SI-625 to 627, 2-SI-634 to 637, 2-SI-644 to 647, and 2-SI-652

CAR Fans;

F-14B & 14D

Charging Pumps;

P-18B & 18C

Level, Pressure, & Temperature Transmitters;

LT-103, LT-110 & 110Y, LT-1113B & 1113D, LT-1123B & 1123D, LT-206 & 208, LT-5273 & 5274, LT-5282, PT-100Y, PT-1013B &1013D, PT-1023B & 1023D, PT-102B & 102B-1, PT-

102D, PT-103, PT-4224, PT-8115 & 8116, TE-112CB & 112CD, TE-112HB & 112HD, TE-121X, TE-122CB & 122CD, TE-122HB & 122HD, and TE-125

Upon review of these components (many of which are considered non-risk significant) it was determined that the most limiting transient resulting from a fire in the area would be a General Plant Transient (GPT) with Facility Z2 unavailable. A fire in this area could potentially result in a GPT from the inadvertent opening of atmospheric steam dump valve (2-MS-190B). This valve is normally closed and fails closed on loss of either motive or control power. Therefore, a fire in the area would need to result in a sustained hot short on the valve for this transient scenario. In conservatively assuming that a sustained hot short results in failing the valve open, the transient is assumed similar to a GPT from the MP2 IPE with only Facility Z1 available.

Screening of PN-W: From the MP2 IPE model, the GPT initiator frequeny is 3.1/year. The fire ignition frequency for this area is 3.1E-3/year. It was assumed this transient will result in a (GPT), given a fire in this area. From the MP2 IPE model the GPT event tree was requantified with the following changes: the GPT initiator frequency was redefine as 3.1E-3/year and the components mentioned above; which were modeled in the IPE, were redefined as failed. The calculated MP2 backup system unavailability for Facility Z1 is 4.0E-5; Thus, the core damage frequency due to fire in the area is 1.2E-7/year (does not factor in the probability of a coincidental hot short) due to a fire in the area. This is below the screening criteria. Therefore, this area is quantitatively screened out from further analysis.

4.6.1.10 T-8, West Cable Vault (CV-W)

The Turbine Building West Cable Vault is located in the Turbine Building at elevation 45' 0". The fire area has a minimum fire barrier rating of one and a half hours. The combustible loading of this area is from cabling and is 48,095 Btu/sq.ft. Ionization smoke detectors are located in the area and alarm in the Control Room. Suppression is provided via an automatic sprinkler spray system over the cable trays. Additional suppression from a hose station or portable fire extinguishers located in adjacent fire area (operating floor/turbine deck, T-1C) are available in the event of a fire in this area.

The area contains control and power cabling for the following components; circuit breakers - DG 15G-13U, CB 2S3-24B-2, CB 22S2-25B-2, CB 22S3-24D-2, CB 24D-1T, CB 24D-2T, CB 24D7-2, and CB 2S2-25B-2; pumps - RBCCW P-11C, Condensate P-2C, HPSI P-41C, LPSI P-42B, Containment Spray P-43B, Service Water P-5C, Circ. Water P-6B & P-6D, and motor driven AFW Pump P-9B.

The main effect of a fire in this area will be loss of power to the Facility Z2 4160V bus 24D, due to either power cable or circuit breaker failures form the NSST and the RSST. For this analysis it was conservatively assumed that a fire in this area could potentially result in a partial loss of normal power transient .

Screening of T-8: The unavailability of the bus due to fire in this area can be compared with the unavailability of the bus due to internal failures. From the MP2 IPE model, the unavailability for the bus due to internal failures is 9.19E-5/demand. The fire ignition frequency for this area is 7.3E-4/year. The probability to have a fire-related loss of these Facility Z2 bus during the required mission time of 24 hours is 2.0E-6. Therefore, the unavailability of the bus due to fire in this area is small compared with the unavailability due to internal failures.

Additionally, it was conservatively assumed that a ten percent probability exists that this transient will result in a total LNP (MP2 IPE does not model partial LNPs), given a fire in this area. From the MP2 IPE model, the LNP initiator frequency was redefine as 7.3E-5/year and bus 24D failed. The calculated MP2 core damage frequency due to fire in the area is 4.4E-8/year, below the screening criteria. This area is quantitatively screened out from further analysis.

4.6.1.11 T-10, 6.9KV & 4.16KV Swgr. Rm. (SWGR-W)

The 6.9KV & 4.16KV Switchgear Room is a located in the Turbine Building at elevation 54' 6". The fire area has a minimum fire barrier rating of one and a half hours. The combustible loading of this area is 4,727 Btu/sq.ft. Ionization smoke detectors are located in the area. Manual suppression from the hose station or portable fire extinguishers located in adjacent fire area (operating floor/turbine deck, T-1F) and are relied upon in the event of a fire in this area.

The main effect of a fire in this area will be loss of the Facility Z2 6.9KV and 4160V buses and switchgear. For this analysis it was conservatively assumed that a fire in this area could potentially result in a partial loss of normal power transient .

Screening of T-10: The unavailability of the bus due to fire in this area can be compared with the unavailability of the bus due to internal failures. From the MP2 IPE model, the unavailability for the bus due to internal failures is 9.19E-5/demand. The fire ignition frequency for this area is 2.3E-3/year. The probability to have a fire-related loss of these Facility Z2 bus during the required mission time of 24 hours is 6.3E-6. Therefore, the unavailability of the bus due to fire in this area is small compared with the unavailability due to internal failures.

Additionally, it was conservatively assumed that a ten percent probability exists that this transient will result in a total LNP (MP2 IPE does not model partial LNPs), given a fire in this area. From the MP2 IPE model, the LNP initiator frequency was redefine as 2.3E-4/year and bus 24D failed. The calculated MP2 core damage frequency due to fire in the area is 1.4E-7/year, well below the screening criteria. This area is quantitatively screened out from further analysis.

4.6.1.12 TB, (Appendix A Areas; T-1A, T-1C, & T-1F)

Fire area TB is comprised of Appendix A zones T-1A, T-1C, and T-1F. The exterior walls, ceiling, floor, interior walls, penetrations, and doors of this fire area have various ratings or exemptions.

These zones are located in the Turbine Building will be analyzed as a single area. The interior walls, penetrations, and doors of this fire area have various ratings or exemptions. They have been combined because of the potential for fire propagation between the zones.

The Turbine Building general area (T-1A, elevation 14' 6") has a combustible loading of 37,726 Btu/sq.ft.. The Turbine Building general area (T-1C, elevation 31' 6") has a combustible loading of 43,161 Btu/sq.ft.. The Turbine Building turbine deck area (T-1F, elevation 54' 6") has a combustible loading of 25,917 Btu/sq.ft.. The floors separating these areas have open floor grates which allows propagation between these areas of the Turbine Building. The Turbine Building has a large combustible loading, however, this is concentrated in a limited number of areas within the Turbine Building. Note that most of the Turbine Building is protected by a sprinkler system.

Automatic detection systems are provided in these zones/areas. All the areas have some type of localized automatic suppression systems over certain components that have specific fire suppression needs as well as numerous manual hose stations and fire extinguishers.

This large area contains feedwater associated equipment which includes MFW and Condensate Pumps, feedwater flow control and bypass valves, and feedwater isolation valves. It also contains and high pressure steam dump isolation valves. The instrument and station air compressors and valves are also located in this area, among other things.

Fire in this area has the potential to affect Secondary Side Cooling by resulting in a loss of MFW and the AFW pumps. Service water power cables are also routed through the area which would render SW unavailable thus affecting the Emergency DGs. Additionally, electrical bus cross-tie control and power cables are routed through the area which results in potentially nonrecoverable loss of offsite power. Thus, an unsuppressed fire in the Turbine Building could potentially result in a station blackout with no feed and bleed capabilities, ie. core damage.

These Turbine Building areas have numerous fire sources. Therefore, the Turbine Building has a high fire ignition frequency of 5.8E-2/year. Assuming a worst case unsuppressed fire, based upon this ignition frequency, would result in core damage approximately every 17 years. Based upon nuclear plant operating history and the history of fires in nuclear plants, an unsuppressed Turbine Building fire that leads to a total loss of the Turbine Building and its equipment is highly improbable. Therefore, this area will be analyzed in detail for credible fire scenarios and their potential contribution to core damage. Typical scenarios for the Turbine Building would be fires which result in loss of MFW and/or Control Air (Instrument & Service). This is dependent upon factors such as spatial interactions which governs time to damage, availability of automatic/manual suppression, and availability of backup systems. The unavailability of backup systems, given the initiating event of a loss of MFW, from the MP2 IPE Analysis, is 1.6E-5. The unavailability of backup systems, given the initiating event of a loss of control air, from the MP2 IPE Analysis, is 2.5E-4. Therefore, CDF due to fires (assuming total Turbine Building fire ignition frequency) resulting in a loss of MFW is 9.2E-7/year, and CDF due to fires resulting in a loss of Control Air is 1.4E-5/year. Therefore, a detailed analysis is necessary to evaluate the probability of a fire large enough to disable the Control Air System.

4.6.1.13 T-3, Motor Driven Auxiliary Feed Pump (MDAFW) Pit

The Motor Driven Auxiliary Feedwater (MDAFW) Pump Room is a located in the Turbine Building at elevation 1' 6".

The combustible loading of this area is negligible. Photoelectric detectors are located in the area. Manual suppression from the hose station or portable fire extinguishers, located in fire zone T-1A, are available and relied upon in the event of a fire in this area.

The main effect of a fire in this area would be loss of the MDAFW pumps. Loss these pumps, due to a fire, would not result in an automatic plant trip. The MFW and Turbine Driven AFW Pumps would still be available and unaffected.

Screening of T-3: The unavailability of the MDAFW pumps due to fire in this zone can be compared with the unavailability of the MDAFW pumps due to internal failures. The failure of the MDAFW pumps due to a fire in the area is not expected to result in a plant trip. From the MP2 IPE model, the unavailability of both motor-driven AFW pumps, due to internal failures to start, is 1.28E-03/demand. Fire ignition frequency for this area is 8.8E-4/year. The probability to have a fire-related loss of the MDAFW pumps during the required mission time of 24 hours is 2.4E-6. Therefore, the unavailability of the pumps due to fire in this area is small compared with the unavailability due to internal failures. This area is quantitatively screened out from further analysis.

4.6.1.14 CHGPMP, Charging Pump Room and Degasifier Area (Appendix A Areas; A-6A & A-6B)

The area CHGPMP, located in the Auxiliary Building at elevation (-)25' 6", has three hour rated walls on three sides and the east wall has an opening for access. Access to this area is via a locked gate from Appendix A fire zone A-1B (AUX-1). The area is comprised of Appendix A fire zones A-6A (Charging Pumps Area) and A-6B (Degasifer Area).

The combustible loading in these zones is 39,427 and 15,253 Btu/sq.ft.; respectively, mainly from cable insulation and lube oil. Fire suppression can be accomplished with either the hose station or portable fire extinguishers located in fire zone A-1B. A sprinkler water curtain system immediately outside CHGPMP is installed to ensure that a fire can not propagate into or out of area AUX-1. Ionization smoke detectors are installed at the entrance to this area and in adjacent fire zone A-1B.

The Charging Pumps are credited in the MP2 level 1 PRA for delivering borated water for the purpose of emergency boration. (They are not credited for injection purposes). The loss of the Charging Pumps is not expected to result in a plant trip if lost due to a fire in this area. The loss of Charging Pumps is not considered as a transient initiator. The MP2 IPE credits Charging Pumps for mitigating ATWS events.

Screening of CHGPMP: The analysis for Charging Pump unavailability due to fire in this area is compared with the internal common mode failure probability of the pumps. The demand failure rate of a pump from the MP2 IPE data is 3.62E-5. Fire frequency in this area is 2.7E-3/year. Probability to have a fire-related loss of the CHGPMP during the required mission time of 24 hours is 7.4E-6, small compared to the unavailability due to internal unavailabilities. Therefore, this zone can be quantitatively screened out since expected Charging Pump unavailability due to fire is small compared to unavailability due to internal pump failures.

Additionally, the MP2 IPE models for consequential ATWS events for GPT, LNP, and loss of MFW event tree quantifications were reviewed. Form this review it was determined that the MP2 core damage frequency due to fire in the area would be less than 1.0E-9/year due to a fire in the area. This is below the screening criteria; therefore, this area is quantitatively screened out from further analysis.

4.6.1.15 A-8A, Facility Z1 ESF Room

The Facility Z1 ESF Room is a located in the Auxiliary Building at elevation (-)45' 6". The fire area has a minimum fire barrier rating of one hour. The combustible loading of this area is 9,318 Btu/sq.ft. Ionization smoke detectors are located in the area. Manual suppression from the hose station or portable fire extinguishers located in adjacent fire area A-1A and are relied upon in the event of a fire in this area.

The main effect of a fire in this area will be loss of the following Facility Z1 components: Containment Spray Pump P-43A, Shutdown Heat Exchanger X-23A, HPSI pump P-41A, and LPSI pump P-42A. The loss of this equipment will not result in an automatic plant trip.

Screening of A-8A: The unavailability of these components, due to fire in this area, can be compared with the unavailability of these components due to internal failures. From the MP2 IPE model, the sum of the unavailabilities for these components due to internal failures to start is 3.9E-03/demand. The fire ignition frequency for this area is 2.0E-3/year. The probability to have a fire-related loss of these Facility Z1 pumps during the required mission time of 24 hours is 5.5E-6. Therefore, the unavailability of the pumps, due to fire in this area, is small compared with the unavailability due to internal failures.

Additionally, given a fire in this area, it is assumed operators would manually trip the plant. From the MP2 IPE model, for a manual trip with loss of one train of high and low pressure injection, the unavailability of the backup systems is 1.4E-6. Given an area ignition frequency of 2.0E-3/year, the expected core damage frequency, due to fire in the area, is 2.8E-9. (Well below the screening criteria). This area is quantitatively screened out from further analysis.

4.6.1.16 A-3, Facility Z2 ESF Room

The Facility Z2 ESF Room is a located in the Auxiliary Building at elevation (-)45' 6". The fire area has a minimum fire barrier rating of one hour. The combustible loading of this area is 12,196 Btu/sq.ft. Ionization smoke detectors are located in the area. Manual suppression from the hose station or portable fire extinguishers located in adjacent fire area A-1A and are relied upon in the event of a fire in this area.

The main effect of a fire in this area will be loss of the following Facility Z2 components: Containment Spray pump P-43B, Shutdown Heat Exchanger X-23B, HPSI Pump P-41C, and LPSI Pump P-42B. The loss of this equipment will not result in an automatic plant trip.

Screening of A-3: The unavailability of these components, due to fire in this area, can be compared with the unavailability of these components due to internal failures. From the MP2

IPE model, the sum of the unavailabilities for these components due to internal failures to start is 3.9E-03/demand. The fire ignition frequency for this area is 2.0E-3/year. The probability to have a fire-related loss of these Facility Z2 pumps during the required mission time of 24 hours is 5.5E-6. Therefore, the unavailability of the pumps due to fire in this area is small compared with the unavailability due to internal failures.

Additionally, given a fire in this area, it is assumed operators would manually trip the plant. From the MP2 IPE model, for a manual trip with loss of one train of high and low pressure injection, the unavailability of the backup systems is 1.4E-6. Given that the ignition frequency for the area is 2.0E-3/year, the expected core damage frequency due to fire in the area is 2.8E-9. (well below the screening criteria). This area is quantitatively screened out from further analysis.

4.6.1.17 A-15, Emergency Diesel Generator Room A (DGR-A)

The Emergency Diesel Generator Room A, located in the Auxiliary Building at elevation 14' - 6", has a three hour rating for the structural steel in the ceiling and three hour rated walls. A floor drain is installed to receive spilled flammable liquids in the general area of the diesel and to keep oil spills from the diesel's control panel.

This zone contains large amounts of combustible material such as lube oil, diesel fuel, and cable. This gives the zone a combustible loading of 333,000 Btu/sq.ft.. An automatic pre-action water sprinkler system is provided over the diesel generator which protects the diesel and the structural steel in the ceiling. A hydrant is located outside this area and a hose station is available in the Auxiliary Building. Inaddition, portable fire extinguishers are available within the general area. The ionization smoke detection system, when alarmed, will activate the automatic pre-action sprinkler system.

Numerous components connected with the operation of Diesel Generator A are located in this fire area. They include Diesel Generator H-7A, Service Water Bypass AOV 2-SW-231A, Service Water Inlet AOV 2-SW-89A, 480 VAC panel, 125 VDC panel, Diesel Exhaust Fan, and motor-operated dampers. Almost any fire in this zone will have the potential to disable DG H-7A.

Screening of A-15: As a quantitative screening of A-15, the unavailability of DG H-7A due to fire, was compared to the random failure due to internal events of the IPE. The loss of a diesel due to a fire is not expected to result in a plant trip. The diesels are only required for loss of offsite power events. From the MP2 IPE, the unavailabilities of a diesel due to internal failures to start or OOS for maintenance are 9.83E-3 and 1.02E-2, respectively. The ignition frequency for the area is 1.6E-2/year. The probability to have a fire-related loss of the diesel during the required mission time of 24 hours is 4.8E-5. Therefore, the unavailability of the diesel due to fire in this area is small compared with the unavailability due to internal failures. This is justification for quantitative screening of this area.

4.6.1.18 A-31, Diesel Oil Day Tank Room A (DGDT-A)

The Diesel Oil Day Tank Room A, located in the Auxiliary Building at elevation 38' - 6", has three-hour rated ceiling and walls. A floor drain is installed to receive spilled flammable liquids in the general area to keep oil spills from accumulating.

This zone contains a large amount of combustible material in the form of diesel fuel oil which gives the zone a combustible loading of 5,363,397 Btu/sq.ft.. An automatic wet-pipe sprinkler system is provided over the Diesel Day Tanks. No fire or smoke detection system is provided for this area.

The effect of loosing the Diesel Day Tank A to a fire would result in the respective loss of its associated diesel generator. No plant trip is expected to occur as a result of a fire in this area and the diesels are only required for loss of offsite power events.

Screening of A-31: As a quantitative screening of A-31, the unavailability of DG H-7A due to a fire in the diesel day tank A room was compared to the random failure of the diesel due to internal events of the IPE. From the MP2 IPE the unavailabilities of a diesel due to internal failures to start or OOS for maintenance are 9.83E-3/demand and 1.02E-2/demand, respectively. The ignition frequency for the area is 7.3E-4/year. The probability to have a fire-related loss of the diesel during the required mission time of 24 hours is 2.0E-6. Therefore, the unavailability of the diesel due to fire in its respective diesel oil day tank area is small compared with the unavailability due to internal failures. This is justification for quantitative screening of this area.

4.6.1.19 A-16, Diesel Gen. Room B (DGR-B)

The Diesel Room B, located in the Axuiliary Building at elevation 14' - 6", has a three hour rating for the structural steel in the ceiling and three hour rated walls. Floor drains are installed to receive spilled flammable liquids in the general area of the diesel and to keep oil spills from the respective diesel's control panel.

This zone contains large amounts of combustible material such as lube oil, diesel fuel, and cable which gives the zone a combustible loading of 135,177 Btu/sq.ft.. An automatic pre-action water sprinkler system is provided over the diesel generator wich protects the diesel and the structural steel in the ceiling. There is no automatic suppression system over the electrical equipment or at the south end of the room. A hydrant is located outside this area and a hose station is available in the Auxiliary Building. In addition portable fire extinguishers are available within the general area. The ionization smoke detection system, when alarmed, will activate the automatic pre-action sprinkler system.

Numerous components connected with the operation of Diesel Generator B are located in this fire area. They include Diesel Generator H-7B, Service Water Bypass AOV 2-SW-231B, Service Water Inlet AOV 2-SW-89B, 480 VAC panel, 125 VDC panel, Diesel Exhaust Fan, and motor-operated dampers. Almost any fire in this zone will have the potential to disable DG H-7B.

Screening of A-16: As a quantitative screening of A-16, the unavailability of DG H-7B due to fire was compared to the random failure due to internal events of the IPE. The loss of a diesel due to a fire is not expected to result in a plant trip. The diesels are only required for loss of offsite power events. From the MP2 IPE the unavailabilities of a diesel due to internal failures to start or OOS for maintenance are 9.83E-3 and 1.02E-2, respectively. The ignition frequency for the area is 1.6E-2/year. The probability to have a fire-related loss of the diesel during the required mission time of 24 hours is 4.8E-5. Therefore, the unavailability of the diesel due to fire in this area is small compared with the unavailability due to internal failures. This is justification for quantitative screening of this area.

4.6.1.20 A-30, Diesel Oil Day Tank Room B (DGDT-B)

The Diesel Oil Day Tank Room B, located in the Auxiliary Building at elevation 38' - 6", has three-hour rated ceiling and walls. A floor drain is installed to receive spilled flammable liquids in the area to keep oil spills from accumulating.

This zone contains a large amount of combustible material in the form of diesel fuel oil which gives the zone a combustible loading of 5,360,397 Btu/sq.ft.. An automatic wet-pipe sprinkler system is provided over the Diesel Day Tanks. No fire or smoke detection system is provided for this area.

The effect of loosing the Diesel Day Tank B to a fire would result in the respective loss of its associated diesel generator. No plant trip is expected to occur as a result of a fire in this area and the diesels are only required for loss of offsite power events.

Screening of A-30: As a quantitative screening of A-30, the unavailability of DG H-7B due to a fire in the Diesel Day Tank B room was compared to the random failure of the diesel due to internal events of the IPE. From the MP2 IPE the unavailabilities of a diesel due to internal failures to start or OOS for maintenance are 9.83E-3/demand and 1.02E-2/demand, respectively. The ignition frequency for the area is 7.3E-4/year. The probability to have a fire-related loss of the diesel during the required mission time of 24 hours is 2.0E-6. Therefore, the unavailability of the diesel due to fire in its respective diesel oil day tank area is small compared with the unavailability due to internal failures. This is justification for quantitative screening of this area.

4.6.1.21 A-20, East DC Switchgear Room (DCEQ-E)

This area is located in the Auxiliary Building at elevation 14' - 6". The combustible loading for the area is 20,111 BTU/sq.ft. with the combustibles being primarily comprised of cable insulation. The area has cross-zoned ionization smoke detectors and high temperature alarms. The area suppression system is a total area Halon 1301 flooding system. Additional hose stations and portable fire extinguishers are available in adjacent areas.

The area contains the following equipment; DC bus 201A, 125V DC panels DV10 & DV30, 120V AC panels VA10, VA30, & VR11, battery chargers 201A & 201C, inverters INV-1 & INV-3, motor-generator set A, static switches VS1 & VS3, reactor trip switchgear, CEDS logic panels, transfer switch RS1, transformers UAC1, UAC3, and control rod drive panels RC07A &

RC07B. For screening purposes it was conservatively assumed that a fire in the area would render all of the equipment associated with this area inoperable.

Screening of A-20: For the quantitative screening of A-20, a transient is analyzed assuming the loss of the entire compartment due to fire. The resultant plant transient is assumed to be similar/identical to the effects of a loss of DC Bus 201A initiator from the MP2 IPE.

The results from the MP2 IPE model for the loss of DC Bus 201A, the unavailability of the backup systems outside of this compartment is 6.9E-5. The total fire ignition frequency in the compartment is 7.7E-3/year. The worst case expected core melt frequency due to fire is approximately 5.3E-7/year, well below the screening criteria. This area is quantitatively screened out from further analysis

4.6.1.22 A-22, East Battery Room (BATT-E)

This area is located in the Auxiliary Building at elevation 14' - 6". The area boundaries have a minimum one and a half hour fire rating. The combustible loading for the area is 97,300 BTU/sq.ft. with the combustibles being primarily comprised of batteries and cable insulation. The area has ionization smoke detectors and portable fire extinguishers are available outside the area.

The area contains the following equipment; DC battery 201A, disconnect switch, computer battery, and spare battery cells with charger. For screening purposes it was conservatively assumed that a fire in the area would render all of the equipment associated with this area inoperable.

Screening of A-22: From the MP2 Plant IPE data, an internal failure rate of battery output is 2.7E-6/hour, which corresponds to an annual frequency of 3.2E-2/year. The frequency of a fire in this zone is 1.8E-3/year. Because the frequency of losing the battery due to fire is small compared to the frequency of losing the battery due to internal failures, and since the loss of the battery will not directly affect any safety functions, this area is quantitatively screened out.

Additionally, for the quantitative screening of A-22, a transient is analyzed assuming the loss of the entire compartment due to fire. The resultant plant transient is conservatively assumed to be similar/identical to the effects of a loss of DC Bus 201A initiator from the MP2 IPE. This plant transient could potentially occur if the bus/battery protection breaker failed allowing the battery fault to propagate to the bus. For purposes of this analysis the protection breaker was not credited.

The results from the MP2 IPE model for the loss of DC Bus 201A, the unavailability of the backup systems outside of this compartment is 6.9E-5. The total fire ignition frequency in the compartment is 1.8E-3/year. The worst case expected core melt frequency due to fire is approximately 1.2E-7/year, well below the screening criteria. This area is quantitatively screened out from further analysis

4.6.1.23 A-21, West DC Equip. Room (DCEQ-W)

This area is located in the Auxiliary Building at elevation 14' - 6". The combustible loading for the area is 16,491 BTU/sq.ft. with the combustibles being primarily comprised of cable insulation. The area has cross-zoned ionization smoke detectors and high temperature alarms. The area suppression system is a total area Halon 1301 flooding system. Additional hose stations and portable fire extinguishers are available in adjacent areas.

The area contains DC bus 201B, 125V DC panels DV20 & DV40, 120V AC panels VA20 & VA40, battery charger 201B, inverters INV-2 & INV-4, motor-generator B, VR21, VS-2 and VS-4, Transformers UAC2 and UAC4, and RS2. For screening purposes it was conservatively assumed that a fire in the area would render all of the equipment associated with this area inoperable.

Screening of A-21: For the quantitative screening of A-21, a transient is analyzed assuming the loss of the entire compartment due to fire. The resultant plant transient is assumed to be similar/identical to the effects of a loss of DC Bus B initiator from the MP2 IPE.

The results from the MP2 IPE model for the loss of DC Bus B, the unavailability of the backup systems outside of this compartment is 7.3E-5. The total fire ignition frequency in the compartment is 7.1E-3/year. The worst case expected core melt frequency due to fire is approximately 5.1E-7/year, well below the screening criteria. This area is quantitatively screened out from further analysis.

4.6.1.24 A-23, West Battery Room (BATT-W)

This area is located in the Auxiliary Building at elevation 14' - 6". The area boundaries have a minimum one and a half hour fire rating. The combustible loading for the area is 55,663 BTU/sq.ft. with the combustibles being primarily comprised of batteries and cable insulation. The area has ionization smoke detectors and portable fire extinguishers are available outside the area.

The area contains the only contains DC battery 201B and its associated disconnect switch. For screening purposes it was conservatively assumed that a fire in the area would render all of the equipment associated with this area inoperable.

Screening of A-23: From the MP2 Plant IPE data, an internal failure rate of battery output is 2.7E-6/hour, which corresponds to an annual frequency of 3.2E-2/year. The frequency of a fire in this zone is 1.6E-3/year. Because the frequency of losing the battery due to fire is small compared to the frequency of losing the battery due to internal failures, and since the loss of the battery will not directly affect any safety functions, this area is quantitatively screened out.

Additionally, for the quantitative screening of A-23, a transient is analyzed assuming the loss of the entire compartment due to fire. The resultant plant transient is conservatively assumed to be similar/identical to the effects of a loss of DC Bus 201B initiator from the MP2 IPE. This plant transient could potentially occur if the bus/battery protection breaker failed allowing the battery fault to propagate to the bus. For purposes of this analysis the protection breaker was not credited.

The results from the MP2 IPE model for the loss of DC Bus 201B, the unavailability of the backup systems outside of this compartment is 7.3E-5. The total fire ignition frequency in the compartment is 1.6E-3/year. The worst case expected core melt frequency due to fire is approximately 1.2E-7/year, well below the screening criteria. This area is quantitatively screened out from further analysis

4.6.1.25 A-28, East 480V Load Center (LC480V-E)

The East 480V Load Center Room (LC480V-E) is a located in the Auxiliary Building at elevation 38' - 6". The fire area is has a minimum fire barrier rating of one and a half hours. The combustible loading of this area is 26,384 Btu/sq.ft. Ionization smoke detectors are located in the area. Manual suppression from fire extinguishers in the area or from the hose stations and portable fire extinguishers located in adjacent fire areas are relied upon in the event of a fire in this area. This area is directly adjacent and connected to Control Room via a set of double fire rated doors. These doors have windows for viewing this area from the Control Room.

The main effect of a fire in this area will be loss of the facility Z2 480V bus 22F and buses 22C and 22D (non vital Facility Z1and Facility Z2 respectively). The loss of 480V bus 22F would result in a plant trip (general plant transient) with the possible loss of the following components; DG H-7A, HPSI pumps P-41A & P-41B, LPSI pumps P-42A & P-42B, RBCCW pumps P-11A & P-11C, CAR fans F-14B & F-14D, IA comp. F-3C, cont. spray pumps P-43A & P-43B, and TBCCW pumps P-7A & P-7C.

Screening of A-28: The unavailability of the bus due to fire in this area can be compared with the unavailability of the bus due to internal failures. From the MP2 IPE model, the unavailability for the bus due to internal failures is 9.19E-5/demand. The fire ignition frequency for this area is 3.0E-3/year. The probability to have a fire-related loss of these Facility Z1 bus during the required mission time of 24 hours is 8.2E-6. Therefore, the unavailability of the bus due to fire in this area is small compared with the unavailability due to internal failures.

Additionally, it was assumed this transient will result in a General Plant Transient (GPT), given a fire in this area. From the MP2 IPE model the GPT event tree was requantified with the following changes: the GPT initiator frequency was redefine as 3.0E-3/year and the components mentioned above; which were modeled in the IPE, were redefined as failed. The calculated MP2 core damage frequency due to fire in the area is 1.2E-7/year due to a fire in the area. This is below the screening criteria; therefore, this area is quantitatively screened out from further analysis.

4.6.1.26 T-4, Steam Aux. Feed Pump Pit (SDAFW)

The Steam Auxiliary Feedwater (SDAFW) Pump Room is a located in the Turbine Building at elevation 1' 6".

The combustible loading of this area is 1,765 Btu/sq.ft. from lube oil. No detection or suppression is provided in this area.

The main effect of the fire in this area will be loss of SDAFW. Loss of SDAFW due to fire will not result in an automatic plant trip. MFW will still be available and unaffected. The Technical Specifications require the operator to restore inoperable SDAFW pump to operable status within 72 hours.

Screening of T-4: The unavailability of the SDAFW pump due to fire in this zone can be compared with the unavailability of the SDAFW pump due to internal failures. From the MP2 IPE model, the unavailability of both turbine-driven AFW pump due to internal failures to start is 4.8E-03/demand. The fire ignition frequency for this area is 9.2E-4/year. Probability to have a fire-related loss of the SDAFW pump during the required mission time of 24 hours is 2.5E-6. Therefore, the unavailability of the pump due to fire in this area is small compared with the unavailability due to internal failures. This area is quantitatively screened out from further analysis.

4.6.1.27 T-6, West 480V Load Center (LC480V-W)

The West 480V Load Center Room is a located in the Auxiliary Building at elevation 38' - 6". The fire area is has a minimum fire barrier rating of one and a half hours. The combustible loading of this area is 4,874 Btu/sq.ft. Ionization smoke detectors are located in the area. Manual suppression from fire extinguishers in the area or from the hose stations and portable fire extinguishers located in adjacent fire areas are relied upon in the event of a fire in this area.

The main effect of a fire in this area will be loss of the auxiliary shut down panel C-21 and 480V buses 22E and 22B/A. The loss of 480V bus 22E (facility Z1) would result in a plant trip (GPT) with the possible loss of the following components; CAR fans F-14A & F-14C, SA comp. F-2, IA comp. F-3A, Main FW pump P-1A, and TBCCW pumps P-7A & P-7B.

Screening of T-6: The most vital component in this area is the Facility Z1 bus 22E. The unavailability of the bus due to fire in this area can be compared with the unavailability of the bus due to internal failures. From the MP2 IPE model, the unavailability for the bus due to internal failures is 9.19E-5/demand. The fire ignition frequency for this area is 2.8E-3/year. The probability of having a fire-related loss of the facility Z1 bus during the required mission time of 24 hours is 7.7E-6. Therefore, the unavailability of the bus due to fire in this area is small compared with the unavailability due to internal failures.

Additionally, it was assumed this transient will result in a general plant transient (GPT), given a fire in this area. From the MP2 IPE model the GPT event tree was requantified with the following changes: the GPT initiator frequency was redefine as 2.8E-3/year and the components mentioned above (which were modeled in the IPE) were redefined as failed. The calculated MP2 core damage frequency due to fire in the area is 1.2E-7/year due to a fire in the area. This is below the screening criteria; therefore, this area is quantitatively screened out from further analysis.

4.6.1.28 T-7, Facility Z1 6.9KV & 4.16KV Swgr. Rm. (SWGR-E)

The Facility Z1 6.9KV & 4.16KV Switchgear Room (SWGR-E) is a located in the Turbine Building at elevation 36' 6". The fire area is has a minimum fire barrier rating of one and a half hours. The combustible loading of this area is 4,874 Btu/sq.ft. Ionization smoke detectors are located in the area. Manual suppression from the hose station or portable fire extinguishers are located in adjacent fire areas and are relied upon in the event of a fire in this area.

The main effect of a fire in this area will be loss of the Facility Z1 4160V bus 24C which would be considered equivalent to a partial loss of normal power transient.

Screening of T-7: The unavailability of the bus due to fire in this area can be compared with the unavailability of the bus due to internal failures. From the MP2 IPE model, the unavailability for the bus due to internal failures is 9.19E-5/demand. The fire ignition frequency for this area is 2.7E-3/year. The probability to have a fire-related loss of these Facility Z1 bus during the required mission time of 24 hours is 7.4E-6. Therefore, the unavailability of the bus due to fire in this area is small compared with the unavailability due to internal failures.

Additionally, it was conservatively assumed that a ten percent probability exists that this transient will result in a total LNP, given a fire in this area. From the MP2 IPE model, the LNP initiator frequency was redefined as 2.7E-4/year and bus 24C failed. The calculated MP2 core damage frequency due to fire in the area is 1.6E-7/year, below the screening criteria. This area is quantitatively screened out from further analysis.

4.6.1.29 T-9, East Cable Vault (CV-E)

The Turbine Building East Cable Vault is located in the Turbine Building at elevation 45' - 0". The fire area is has a minimum fire barrier rating of one and a half hours. The combustible loading of this area is from cabling and is 48,913 Btu/sq.ft. Ionization smoke detectors are located in the area and alarm in the Control Room. Suppression is provided via an automatic sprinkler spray system over the cable trays. Additional suppression from a hose station or portable fire extinguishers located in adjacent fire area (operating floor/turbine deck, T-1C) are available in the event of a fire in this area.

The area contains control and power cable for the following components; circuit breakers - DG 15G-12U, CB 2S3-24A-2, CB 2S2-25A-2, CB 2S2-25B-2, CB 22S3-24D-2, CB 24D-1T, CB 24D-2T, CB 24D7-2, and CB 2S2-25B-2; pumps - RBCCW P-11A & P-11B, condensate P-2A & P-2B, HPSI P-41A, LPSI P-42A, Containment Spray P-43B, Service Water P-5A & P-5B, circ. water P-6A & P-6C, and MDAFW P-9A.

The main effect of a fire in this area will be loss of power to the Facility Z1 4160V bus 24C and 24E, due to either power cable or circuit breaker failures form the NSST. For this analysis it was conservatively assumed that a fire in this area could potentially result in a partial loss of normal power transient .

Screening of T-9: The unavailability of the bus due to fire in this area can be compared with the unavailability of the bus due to internal failures. From the MP2 IPE model, the unavailability for the bus due to internal failures is 9.19E-5/demand. The fire ignition frequency for this area is 7.3E-4/year. The probability to have a fire-related loss of these Facility Z2 bus during the required mission time of 24 hours is 2.0E-6. Therefore, the unavailability of the bus due to fire in this area is small compared with the unavailability due to internal failures.

Additionally, it was conservatively assumed that a ten percent probability exists that this transient will result in a total LNP (MP2 IPE does not model partial LNPs), given a fire in this area. From the MP2 IPE model, the LNP initiator frequency was redefine as 7.3E-5/year and bus 24D failed. The calculated MP2 core damage frequency due to fire in the area is 4.4E-8/year, well below the screening criteria. This area is quantitatively screened out from further analysis.

4.6.1.30 C-1, Containment (CMNT)

The Containment Building is a high integrity concrete and steel structure which is considered by its structural design to be separated from all other areas of the plant. From the safety related perspective the CB contains the following equipment; safety related cables, CAR fans, Steam Generators, Pressurizer, Reactor and the Reactor Coolant Pumps (RCPs). The combustible loading within the CB is comprised mainly of cable insulation and RCP oil. This combustible loading is considered low when accounting for the overall area of the CB. There are no large concentrations of combustibles within containment which could affect more than one component located in the immediate vicinity.

4.6.1.31 IS-PMP, Intake Structure Pump Room (Appendix A Area; I-1A & I-1C)

The Intake Structure Pump Room fire area is a single level structural steel and concrete. A none fire rated wall and door exists between the fire zones I-1A and I-1C.

FCIA analysis did not indicate that there is potential for fire propagation from I-1A to fire zone I-1C or visa versa. The combustible loadings of fire zones I-1C and I-1A are 1,364 Btu/sq.ft. and 18,506 Btu/sq.ft., respectively (Ref. 4-3). However, during a walkdown, maintenance activities on the Circ. Water Pumps indicated that 55 gal. drum of lube oil as a transient combustible through both of these areas. Therefore, these two areas will be combined for the determination of fire hazard risk for this area.

Ionization smoke detectors are provided in each area of the pumphouse. Portable carbon dioxide fire extinguishers are available in each area and outdoor hydrants are available adjacent to the building.

Service Water pumps P-5A, B, and C, and Circulating Water pumps P-6A, B, C, and D are located in area I-1A. Located in the area I-1C are MC B-13 & B-42.

From the MP2 model, unavailability of backup systems, given a loss of Service Water System, is quantified to be 2.0E-4. Given that the fire ignition frequency for the combined zones is 7.4E-3/year (4.1E-3 + 3.3E-3), the worst case expected core melt frequency is 1.5E-6/year, which is above the screening criteria. This area needs to be analyzed in detail, in order to determine all fires which can result in a partial or total loss of Service Water.

4.6.1.32 A-10A, East Piping Penetration Area (PNPI-E)

The east penetration area is located in the Auxiliary Building at elevations (-)5'-6" and (-)25'-6". The combustible loading in this area is 57 BTU/sq.ft.. Ionization smoke detectors are provide in area A-10B, located above A-10A Manual suppression from the hose stations or portable fire extinguishers located in adjacent fire areas of the Auxiliary Building are relied upon in the event of a fire in this area.

The A-10A area contains certain Facility Z1 MOVs, AOVs, along with control, power, and instrumentation cabling routed through the area for other facility Z1 components. The following components are located or could be affected by a fire in this area:

- valves (MOVs & AOVs);
  2-CS-4.1B, 2-DG-95A, 2-DG-96A, 2-MS-64A, 2-MS-65A, 2-MS-190A, 2-MS-201, 2-MS-220A & 220B, 2-RB-28.1A & 28.1C, 2-RB-28.2A & 28.2C, 2-RB-28.3A & 28.3C, 2-RC-100E, 2-SW-231A, and 2-SW-89A
- CAR Fans F-14A & 14C
- Control Room Fan (F-21A)
- 4160V Bus 24C
- DC Battery Room A Exhaust Fan (F-112A)
- DG H-7A Ventilation Fan (F-38A)
- DG A control cabinet (C38) and panel
- pressure transmitter PT-4223

Upon review of these components (many of which were considered non-risk significant by the MP2 IPE) it was determined that the most limiting resulting transient for a fire in the area would be a GPT with Facility Z1 unavailable. A fire in this area could potentially result in a GPT from the inadvertant opening of atmospheric steam dump valve (2-MS-190A). This valve is normally closed and fails closed on loss of either motive or control power. Therefore, a fire in the area would need to result in a sustained hot short on the valve for this transient scenario. In conservatively assuming that a sustained hot short results in failing the valve open, the transient would be similar to a GPT from the MP2 IPE with only Facility Z1 available.

Screening of A-10A: From the MP2 IPE model, the GPT initiator frequeny is 3.1/year. The fire ignition frequency for this area is 1.9E-3/year. It was assumed this transient will result in a GPT, given a fire in this area. From the MP2 IPE model the GPT event tree was requantified with the following changes: the GPT initiator frequency was redefine as 1.9E-3/year and the components mentioned above; which were modeled in the IPE, were redefined as failed. The calculated MP2 backup system unavailability for Facility Z1 is 4.0E-5; Thus, the core damage frequency due to fire in the area is 8.6E-8/year (does not factor in the probability of a coincidental hot short) due to a fire in the area. This is below the screening criteria. Therefore, this area is quantitatively screened out from further analysis.

4.6.1.33 A-10B, East Elect. Penetration Area (PNEL-E)

The East Electrical Penetration Area is located in the Auxiliary Building at elevation 14' - 6". The combustible loading in this area is 17,435 BTU/sq.ft.. Ionization smoke detectors are provide in the area. Manual suppression from the hose stations or portable fire extinguishers located in adjacent fire areas of the Auxiliary Building are relied upon in the event of a fire in this area.

The area contains certain Facility Z1 MOVs, AOVs, along with control, power, and instrumentation cabling routed through the area for other facility Z1 components. The following components are located or could potentially be affected by a fire in this area:

- valves (MOVs & AOVs);
  2-AC-4, 2-AC-7, 2-CH-515, 2-CH-518, 2-CS-4.1B, 2-EB-99, 2-EB-100, 2-FW-5A, 2-MS-64A & 65A, 2-MS-190A, 2-MS-201, 2-MS-220A & 220B, 2-MS-289, 2-RB-28.1A & 28.1C, 2-RB-28.2A & 28.2C, 2-RB-28.3A & 28.3C, 2-RC-100E, 2-RC-402 & 403, 2-RC-412 & 413, 2-SA-23.1, 2-SI-614, 2-SI-624, 2-SI-651, 2-SW-231A, and 2-SW-89A
- Chilled Water Pump (P-21A)
- IA Compressor (F-3A)
- CAR Fans (F-14A & 14C)
- Control Room Fan (F-21A)
- 480V MC 22-1E & 2E
- DC Battery Room A Exhaust Fan (F-112A)
- DG H-7A Ventilation Fan (F-38A)
- DG H-7A control cabinet (C38) and panel
- Chiller X-A
- level, pressure, & temperature transmitters;
  LT-110X, LT-1113A & 1113C, LT-1123A & 1123C, LT-5271 & 5272, PT-100X, PT-1013A & 1013C, PT-1023A & 1023C, PT-102A, PT-103-1, PT-4223, PT-8113 & 8114, TE-112CA & 112CC, TE-112HA & 112HC, TE-122CA & 122CC, and TE-122HA & 122HC

Upon review of these components (many of which were considered non-risk significant by the MP2 IPE) it was determined that the most limiting resulting transient for a fire in the area would be a GPT with Facility Z2 unavailable. A fire in this area could potentially result in a GPT from the inadvertent opening of atmospheric steam dump valve (2-MS-190B). This valve is normally closed and fails closed on loss of either motive or control power. Therefore, a fire in the area would need to result in a sustained hot short on the valve for this transient scenario. In conservatively assuming that a sustained hot short results in failing the valve open, the transient would be similar to a GPT from the MP2 IPE with only Facility Z1 available.

<u>Screening of A-10B:</u> From the MP2 IPE model, the GPT initiator frequeny is 3.1/year. The fire ignition frequency for this area is 3.1E-3/year. It was assumed this transient will result in a general plant transient (GPT), given a fire in this area. From the MP2 IPE model the GPT event tree was requantified with the following changes: the GPT initiator frequency was redefine as 3.1E-3/year and the components mentioned above; which were modeled in the IPE, were redefined as failed. The calculated MP2 backup system unavailability for Facility Z1 is 4.0E-5; Thus, the core damage frequency due to fire in the area is 1.2E-7/year (does not factor in the

probability of a coincidental hot short) due to a fire in the area. This is below the screening criteria. Therefore, this area is quantitatively screened out from further analysis.

4.6.1.34 A-10C, East MSSV/Blowdown Tank Room (MSSV-E)

The east MSSV/Blowdown Tank Room area is located in the Auxiliary Building at elevation 38' 6". The combustible loading in this area is 787 BTU/sq.ft.. No detection system is provided in the area. Manual suppression from the hose stations or portable fire extinguishers located in adjacent fire areas of the Auxiliary Building are relied upon in the event of a fire in this area.

The area contains certain Facility Z1 MOVs, AOVs, along with control, power, and instrumentation cabling routed through the area for other Facility Z1 components. The following components are located or could potentially be affected by a fire in this area:

- valves (MOVs & AOVs);
  2-AC-4, 2-AC-7, 2_AC-57, 2-CS-4.1B, 2-DG-95A, 2-DG-96A, 2-EB-92, 2-FW-5A, 2-MS-64A & 65A, 2-MS-190A, 2-MS-201, 2-MS-220A & 220B, 2-MS-247 to 254, 2-MS-289, 2-RB-28.1A & 28.1C, 2-RB-28.2A & 28.2C, 2-RB-28.3A & 28.3C, 2-RC-100E, 2-SW-89A, and 2-SW-231A
- CAR Fans (F-14A & 14C)
- Control Room fans (F-21A & F-31A)
- 4.16KV Emergency Bus 24C (alternate feed)
- DC Battery Room A Exhaust Fan (F-112A)
- DG A Ventilation Fan (F-38A)
- DG A control cabinet (C38) and panel
- pressure transmitter (PT-4223)

Upon review of these components (many of which were considered non-risk significant by the MP2 IPE) it was determined that the most limiting resulting transient for a fire in the area would be a GPT with Facility Z1 unavailable. A fire in this area could potentially result in a GPT from the inadvertent opening of atmospheric steam dump valve (2-MS-190A). This valve is normally closed and fails closed on loss of either motive or control power. Therefore, a fire in the area would need to result in a sustained hot short on the valve for this transient scenario. In conservatively assuming that a sustained hot short results in failing the valve open, the transient would be similar to a GPT from the MP2 IPE with only Facility Z1 available.

Screening of A-10C: From the MP2 IPE model, the GPT initiator frequeny is 3.1/year. The fire ignition frequency for this area is 9.9E-4/year. It was assumed this transient will result in a GPT, given a fire in this area. From the MP2 IPE model the GPT event tree was requantified with the following changes: the GPT initiator frequency was redefine as 9.9E-4/year and the components mentioned above; which were modeled in the IPE, were redefined as failed. The calculated MP2 backup system unavailability for Facility Z1 is 4.0E-5; Thus, the core damage frequency due to fire in the area is 4.9E-8/year (does not factor in the probability of a coincidental hot short) due to a fire in the area. This is below the screening criteria; therefore, this area is quantitatively screened out from further analysis.

4.6.1.35 FP-2, Unit 2 Fire Pump House (FP-2)

The Unit 2 Fire Pump House is locate in the site yard away from the main MP2 buildings at an elevation of 14' - 6".

FPH contains the MP2 electric fire pump P-82 and its controls. The combustible loading of this area is negligible Btu/sq.ft. from lube oil. No detection or suppression is provided in this area.

Screening of FP-2: The main effect of the fire in this area will be loss of the electric fire pump P-82 for the Millstone site. The MP1 fire pump house is located adjacent to FP-2 and is credited for maintaining site fire suppression system inventory and pressure. Fire propagation from FPH to the MP1 fire pump house is not considered credible due to the lack of combustibles in FHP. Loss of the fire water pump due to fire in FHP will not result in an automatic plant trip nor is the fire water pump credited within any accident mitigation scenario of the MP2 IPE. This area is screened out from further analysis.

4.6.1.36 XR-1, XR-2, & XR-3, Main, Normal, & Reserve Transformers

The main (XR-1), normal (XR-2), and reserve transformers are located in the site yard away for the main MP2 buildings at an elevation of 14' 6". Fires in transformer yards are considered because 1) they can potentially result in a Loss of Off-Site Power (LISP), and 2) they can propagate to other buildings.

The Transformer Yard does not contain Safe Shutdown or Safety-related equipment. The switchyard is constructed of crushed stone enclosed with chain link fencing. The switchyard equipment is separated by approximately 30 feet from each other.

Each of these transformers has an automatic deluge sprinkler system actuated by a rate-of-rise detection system. The detection system is annunciated within the Control Room. Additionally, yard hydrants in adjacent areas are available for manual fire suppression.

The generic frequency of yard transformer fires resulting in LISP is 1.6E-3/year, much smaller than the internal frequency of LISP (9.0E-2/year). The generic frequency of yard fires propagating to the Turbine Building is 4.0E-3/year, significantly smaller than the frequency of fires originating in the Turbine Building (5.6E-2/year).

Therefore, transformer yard areas can be quantitatively screened out from further analysis.

4.6.2 Summary of Results

Summary of the evaluation of MP2 fire compartments is presented in three tables.

In Table 4.6-2, safety systems from the MP2 IPE models are identified versus analyzed fire compartment. As indicated on the table a fire in any of the compartments could result in a total loss of the system (T), a partial loss of the system (P), or a minor effect on the system (M).

In Table 4.6-3, the possibility of a fire-induced initiating event is analyzed for each fire compartment. Initiating events correspond to those identified in the MP2 IPE models. For each compartment, the specific initiating event was identified as likely (X), possible (P), or not possible (blank).

Table 4.6-4 gives a summary of the overall evaluation. There were 93 fire compartments analyzed; 39 are qualitatively screened out (they do not contain any safety related equipment, can not cause an initiating event, and a fire in these compartments cannot spread to an adjoining compartment), and 41 are quantitatively screened out. The basis for the quantitative screen is given in Table 4.6-4. Most of these 41 compartments are screened out based on the high availability of backup systems outside the compartment (if a total loss of equipment in the compartment is assumed, CDF is still below the screening criteria of 1.0E-6/year). Other bases for quantitative screening are given in the table and discussed in the beginning of this section.

Five fire areas were selected for the detailed analysis because it was determined that fire inside those areas can have an important risk effect. Those areas are;

AUXB-1	(Auxiliary Building, A-1A, A-1B, A-1C, A-1G, A-1H, A-9, & A-12A)
I-1A	(Screenwash House)
A-24	(Cable Spreading Room)
A-25	(Control Room)
TB	(Turbine Building, T-1A, T-1C, & T-1F)

These fire areas are analyzed in detail to determine fire growth and propagation and the probability of fire damage to specific identified safety targets.

4.7 Fire Detection and Suppression

This section describes the detection, auto suppression, and manual suppression systems available (Ref. 4-8) at the MP2. The detection and suppression systems available in each fire area are given in the Fire Hazard Matrix (see Table 4.3-3) and as appropriate, considered in the fire damage evaluation (see Section 4.8). The effectiveness of manual fire fighting and suppression-induced damage to equipment is discussed in Section 4.11.

4.7.1 Detection

Several methods of fire detection are used at the Millstone Unit 2 Plant. These methods consist of smoke ionization, fixed temperature, and thermal rate-of-rise sensors.

There are several plant areas that, due to low combustible loading or safety impact (plant or personnel), have no automatic detection capabilities. Other plant areas have one or a combination of the above types of automatic detectors. A few safety important areas have cross-zoned detectors which actuate an automatic suppression system (Halon 1301 or CO_2). The type of detection available for each fire area is presented in the Fire Hazard Matrix, a sample of which is provided in Section 4.3.3.

In general, upon actuation, the fire detector will send a signal to a local fire protection control panel. This panel then sends an area alarm to the Main Control Room. Upon receiving an alarm at the Control Room, fire brigade personnel are sent to the applicable local control panel to specifically identify its location.

The temperature and time response of detectors are addressed in the fire damage evaluation of individual target sets presented in Section 4.8. The basis for detector response parameters are provided in the FIVE methodology (Ref. 4-1).

Although the EPRI Fire Events Database identified that the majority of plant fires were detected by station personnel, no credit was taken in this study for human detection of fires.

4.7.2 Automatic Suppression

The automatic suppression systems at MP2 consist primarily of water and halon-based systems along with one CO_2 system on the main generator exciter.

The water-based system for MP2 is an integral part of the Millstone Site fire protection water system which serves Unites 1, 2 and 3. The site fire protection water system consists of a water supply subsystem and delivery subsystems. The water supply subsystem consists of two electric pumps, one diesel engine-driven pump, and two locations for connection into the local city water hydrants. Each of the pumps has an operating capacity of 2000 gpm. Fire water is pumped normal pumped from two 245,000 gallon ground level suction tanks. Each tank is automatically filled through a 6 inch valved water line fed by a 12 inch city water line. The city supply is capable of refilling the suction tanks in approximately 8 hours.

The water delivery subsystems consist of automatic preaction, deluge, and/or wet pipe sprinklers.

The fire water supply subsystem at the Millstone Site was not analyzed using fault tree methods due to the level of redundancy (two electric pumps, one diesel pump, and city supply) associated with the subsystem. Additionally, the supports for each of these pumps comes from a diverse source. Therefore, it was determined not to analyze the subsystem further since, the weak link to the fire protection water system at MP2 would be the delivery subsystem(s) for an affected area.

Data for delivery subsystems is taken from a generic fire suppression system unavailability database. This database is compiled from suppression system unavailability values for general industry in the U. S. These unavailability values are expected to be conservative with respect to nuclear industry experience because general industry does not have the level of control over fire suppression systems that is found at nuclear power plants. For water-based systems, total system unavailability is the sum of the specific water delivery subsystem unavailability and water supply subsystem unavailability.

The halon suppression systems are typically actuated upon receipt of a signal from a second smoke detector (cross zone detection system). Usually, there is a time delay after the second detector actuation, before the system starts to release halon. That delay, designed to allow for evacuation, in the MP2 plant is between 55 to 60 seconds. There is another 10-second delay until full halon concentration is reached in the room. The automatic trip can be delayed by an operator. The operator can also bypass the time delay at a manual pull station.

The CO_2 system for the main generator exciter enclosure is automaticly discharged when both heat detectors in the enclosure are activated. No time delay and no manual stop override exists for this system.

The unavailabilities for automatic suppression systems are given in Table 4.7-1. Double results in the table correspond to availability or unavailability of support systems which impact operation of the water-supply subsystems. As can be seen from Table 4.7-1, if support systems are available, the unavailabilities of automatic suppression systems are strongly dominated by the generic unavailabilities for delivery subsystems.

4.7.3 Manual Suppression

The EPRI Fire Events Database shows that most fires are either self extinguished or put out using manual suppression prior to fire brigade activation. No credit was taken for nonfire brigade manual suppression except in certain cases (ie., Control Room fires, Cable Spreading area fires). These fires are discussed in detail in Section 4.8.

Northeast Utilities requires all employees that are badged at their nuclear facilities to take annual General Employee Training (GET) (Ref. 4-13). As part of the GET employees are taught: 1) the various types of fires, 2) Control Room reporting requirements 3) acceptable suppression methods for different classes of fires and 4) that they are allowed to fight certain types of fires if they feel comfortable in doing so. MP2 Fire Brigade response to unannounced drills is approximately 15 minutes until they can actually be credited with fire fighting. This supports the overall industry observation that the majority of fires are suppressed by individuals and only in rare cases is the fire brigade required to combat the fire.

As suggested by the FIVE methodology, to take credit for fire brigade or manually actuated suppression system response, it must be demonstrated that the fire brigade can assemble, fight, and control a fire in the compartment before damage occurs to safety systems. The response time t_r is specific to the compartment under consideration and has to be evaluated by the project team based on the drills.

There is currently no simple or approved method to determine t_r or fire fighting effectiveness in general. The method utilized in this evaluation consisted of establishing t_r on the basis of unannounced drills. The method for quantifying manual suppression unavailability is based on an expression given in the FIVE methodology. Manual suppression unavailability cannot be better than 0.1.

Due to the limited amount of fire brigade drill times available from MP2 records, manual suppression was only credited if the recorded times were well below the calculated time to target damage. Credit for manual suppression was taken only on a case-by-case basis and is presented in the fire damage evaluation in Section 4.8. When credit was given to manual suppression, it was assumed that P_{ms} is equal to 0.1, since the MP2 Program adequately addresses issues relative to manual fire fighting effectiveness.

The manual fire fighting effectiveness in the MP2 is also evaluated in addressing Fire Risk Scoping Study issues, in Section 4.11.

4.8 Fire Hazard Evaluation

4.8.1 Description of Methodology

The fire hazard evaluation (Ref. 4-7) for the MP2 was performed in four steps:

Step 1: Identification of Important Fire Target Sets and Fire Scenarios

Important fire target sets and fire scenarios were identified in the fire areas and compartments which were selected for a detailed analysis during the screening process. This step is described in Subsection 4.8.1.1.

Step 2: Fire Growth and Propagation Analysis

This step was performed in order to estimate whether the analyzed fire has potential to cause damage to the selected target. If fire has the potential to cause damage, then time to damage was estimated. This step is described in Subsection 4.8.1.2.

Step 3: Ignition Frequency for the Analyzed Fire Source

Each fire source in the analyzed target sets was evaluated in order to assign a realistic fire ignition frequency for that source. The data for this step is provided in the fire ignition database, presented in Section 4.5. This step is described in Subsection 4.8.1.3.

Step 4: Fire Damage Evaluation

This step was performed in order to estimate the probability that damage to the target will occur. In this process, credibility and availability of the automatic or manual suppression was analyzed, as well as the probability of the presence of transient combustibles in the critical amounts in the critical range. This step is described in Subsection 4.8.1.4.

4.8.1.1 Fire Target Sets and Fire Scenarios

The first step in the fire hazard evaluation was to identify which target sets need to be evaluated within an unscreened fire area or fire compartment. A target set is defined as a combination of a specific target (component or cable) and a corresponding fire source/combustible (pump, cabinet, etc). In this analysis, target sets were identified based on the results of the screening and on the selection of major initiating events in the unscreened fire compartments (Section 4.6). Identification of the target sets was also dependent on the spatial relation between major fire sources and important safety components and cables. For this reason, a detailed, comprehensive walkdown was very important in the process of identifying target sets to be analyzed.

A fire scenario is defined as a combination of events which starts with a fire ignition in a specific fire compartment and results in (1) demand for a safe shutdown function and/or (2) damage to safe shutdown components. The selection of fire scenarios to be analyzed was closely related to the selection of the fire target sets, and both were based on the identification of important fire-induced initiating events in the analyzed fire compartment. In this analysis, target sets which lead to the same initiating event in the same fire location were grouped in the same fire scenario. Specific fire scenarios selected for evaluation in this report and their corresponding target sets are listed in Table 4.8-1.

4.8.1.2 Fire Growth and Propagation

The FIVE methodology was used as a basic screening methodology in evaluating fire growth and propagation. This methodology provided the means to make conservative estimates about conditions that could develop at a target as a result of a specified fire. These conditions were then compared with target damage threshold criteria (temperature or heat flux); and, if the criteria were not exceeded, this specified fire could be screened from further analysis. Otherwise, more analysis was required.

[Note: If the specified fire led to a fire scenario which is an important contributor to plant risk, more detailed Fire Growth and Propagation Analysis than provided in the FIVE methodology may have been needed.]

The Fire Growth and Propagation Analysis began with the identification of important target sets, as discussed in the previous subsection. For every identified target set, it was necessary to determine the location and the geometric relationship between potential targets and fire sources. Three general fire-type cases were applied in the analysis:

- Targets located in the plume, directly above a fire source
- Targets located in the hot gas layer (outside the plume, but possibly in the ceiling jet)
- Targets exposed to heating by thermal radiation, located next to a fire source

As part of the Fire Growth and Propagation Analysis, calculation spreadsheets were developed for above fire types, based on the FIVE worksheets, equations and lookup tables (tables identified in the spreadsheets correspond to the FIVE tables). Calculation spreadsheets consist of one input and two output spreadsheets. Output spreadsheets are different for each fire-type case.

One example of an input spreadsheet (for a Target Set M2A1B-1 in Auxiliary Building area A-1B) is provided in Figure 4.8-1. As illustrated in the figure, the following input data needs to be defined in the analysis:

- The location of targets relative to a potential fire source

- The exposure fire peak intensity and total energy content
- The fire enclosure volume and heat loss fraction
- Damage threshold criteria for the targets

This analysis used the basic FIVE methodology damage threshold criteria. The key criteria are repeated below:

- A temperature of 700°F was used as the failure temperature criterion for IEEE-383 qualified cables. A temperature of 425°F was used for non-qualified cables. This is a conservative estimate which was based on the cable ignition temperatures. (The ignition temperature of the cable is always reached before a cable function is lost.)

- The FIVE methodology imposes a critical heat flux of 1 Btu/sec/ft^2 for IEEE-383 qualified equipment subjected to radiant heat, and a critical heat flux of 0.5 Btu/sec/ft^2 for non-qualified equipment. Those values were used in the analysis.

The spreadsheet outputs were based on the FIVE equations or the data from the lookup tables (if equations were not available). Two outputs were provided. The first output was designed to estimate whether damage to the target will occur, or whether the specific fire will pass the screening procedure. An example of the output for the target-out-of-plume case is given in Figure 4.8-2. This example corresponds to the input parameters defined in Figure 4.8-1. If the fire did not pass the screening, the next step was to calculate the time necessary to damage the target. This is provided in the second output from the spreadsheets, an example of which is given in Figure 4.8-3. This example also corresponds to the input parameters defined in Figure 4.8-1 and the evaluation in Figure 4.8-2. Analysis to determine the time to actuate a detector or an automatic sprinkler was very similar (detectors and sprinklers were analyzed as targets in the analysis).

Several conservative assumptions were made to simplify the analysis. They were considered appropriate for the first pass through the screening process. These assumptions are listed below:

- The FIVE Methodology does not provide the means to model the time to damage the target when the fire-type scenario includes prior ignition of an intervening combustible (e.g., intervening cable trays). In this type of scenario, damage and times to damage were estimated for the intervening combustible, not for the actual target.

- Thermal damage to cable inside steel conduit was estimated ignoring the protection provided by the conduit. Intervening noncombustibles also were not considered.

- Sandia Tests were used as a source of data for the cabinet fires. Actual electrical cabinets, analyzed as fire source and combustible at MP2, were visually examined and found to contain less combustible loading (cable jacketing and insulation) than the Sandia cabinets.

- When it was determined that a fire has the potential to cause damage to cables, it was assumed that the cable function was lost. The probability of an inadvertent operation of the equipment, or the probability of a hot short, was estimated to be 7.0E-2 (NUREG/CR

2258), based on the value used in the industry.

- When time to actuate a sprinkler and time to damage the target were close, suppression was not analyzed. Also, when fire duration was shorter than the time necessary to damage the target, it was conservatively decided to consider damage to the target (except in the extreme cases, when time necessary to damage was very long).

These assumptions, together with other conservatisms in the FIVE model for fire growth and propagation, often led to the unrealistically short times to damage and very conservative results for fire scenarios.

4.8.1.3 Fire Source Ignition Frequencies

Each fire source in the analyzed target sets was evaluated in detail in order to assign a realistic fire ignition frequency for that target set. Data for ignition frequency was taken from the ignition database, presented in Section 4.5. The fire ignition frequency model (involving the weighting factor method) is similar to one proposed in Reference 4-11, with few modifications developed by Yankee Atomic Energy Company (YAEC) and discussed in Section 4.5 and Reference 4-12.

Occasionally, a more detailed analysis than provided in Reference 4-11 was performed in order to estimate realistic ignition frequencies in a few specific cases. One of those cases is described below:

- The goal was to determine a separate ignition frequency for pump fires which involve lube oil exposure and leaks. Pump fire frequencies given in Reference 4-11 involve all types of pump fires (motor, electric, etc.). Analysis of data from the EPRI Fire Database showed that, out of 65 pump fires, 32 involved small oil leaks. In this analysis, because of the lack of data for more significant oil leaks, it was conservatively assumed that 50% of pump fires would involve a lube oil leak and exposure.

Ignition frequencies for each target set identified in Table 4.8-1 and the basis for their determination, are given in Table 4.8-4.

4.8.1.4 Fire Damage Evaluation

This section describes the methodology used to estimate the likelihood of damage due to fire to the targets identified in the analysis. The methodology used is similar to that recommended in the FIVE methodology. In order to perform this evaluation, the project team interviewed plant personnel and fire protection personnel (who perform transient combustible and housekeeping inspections) to identify the types and quantities of transient combustibles that could be found in different areas. Completed inspection records were also examined.

Since damage can occur from either a fixed or transient combustible, probability of damage (P_D) is represented by combinations of the probability of damage due to exposure to a fixed combustible (P_F) and the probability of damage due to exposure to a transient combustible (P_T).

P_F is represented by:

P_F = 0 if Fire Growth and Propagation Analysis has shown that there is not enough fixed combustibles in the area to cause damage to the target

P_F = 1 if Fire Growth and Propagation Analysis has shown that damage to the target is going to occur and suppression cannot be credited.

P_F = $P_{as} * P_{ms}$ if Fire Growth and Propagation Analysis has shown that damage to the target is going to occur in time sufficiently long to credit suppression. P_{as} represents unavailability of automatic suppression and P_{ms} represents unavailability of manual suppression. These unavailabilities are discussed in Section 4.7.

P_T is represented by:

P_T = 0 if Fire Growth and Propagation Analysis has shown there is no possibility to have enough transient combustibles in the area to cause damage to the target.

P_T = $u * p * w$ if Fire Growth and Propagation Analysis has shown that there is a possibility to have enough transient combustibles in the area to cause damage to the target, and suppression cannot be credited. Parameters are defined below.

P_T = $u * p * w * P_{as} * P_{ms}$ if Fire Analysis has shown that there is a possibility to have enough transient combustibles in the area to cause damage to the target and that damage is going to occur in time sufficiently long to credit suppression. Parameters are defined below:

u - Probability of Transient Combustibles Being Located in the Damage Range of Targets:

Because transient combustibles can be located anywhere in the fire area or compartment, u defines the probability of storing transient combustibles directly below the target or inside a damage range for the target. In this analysis, in order to simplify the evaluation, it was conservatively assumed that a transient combustible is always located in the range of a target (i.e., u = 1).

p - Probability of Combustibles Being Exposed:

Transient combustibles are considered exposed if they are not stored in proper containers while in the fire area or compartment. In accordance with FIVE, in order to take credit for combustibles not being exposed, the plant must have and be able to demonstrate:

- Effective transient combustible controls.
- A combustible administrative control program that requires combustibles to be stored in noncombustible enclosures, such as metal cabinets, approved flammable liquid containers, and noncombustible RWP clothing containers with fusible link actuated covers.

- An inspections program that monitors these administrative controls and takes corrective action when violations are discovered. Transient combustibles used by plant personnel while working in an area, but immediately removed when vacating the area, need not be considered exposed if plant controls restrict storing transient materials in the area.

The program at the MP2 Plant only satisfies the above requirements in a limited number of cases, no credit was taken for combustibles not being exposed, and the FIVE recommended probability, $p = 1.0$, was assumed.

Fixed combustibles (e.g., pump lube oil or diesel generator fuel oil) were usually considered to be exposed, except in the case when a large oil exposure was considered (e.g., a complete leak of lube/fuel oil on the floor area). Such large exposure is only possible if an additional failure was involved (e.g., a pipe break, or a maintenance error). In those cases, it was conservatively assumed that the probability of exposure is also equal to 0.1. (If one of those cases showed to be a significant contributor to the fire risk, then a realistic probability of an additional failure may need to be evaluated.)

w - Probability of a Critical Amount of Transient Combustible Being Present Between Inspections:

The probability of finding critical amounts of transient combustibles stored in violation of plant policies depends on the frequency of periodic inspection. This probability is a function of the ratio $x = F_{ccl}/F_w$, and represented by:

$w = x/2 \ln 1/x$.

Terms F_{ccl} and F_w are defined as follows:

F_{ccl}- Critical Combustible Loading Frequency:

This term is defined as the number of times per year that a critical quantity of transient combustibles could be found in the fire area or compartment. If the critical combustible quantity is not allowed without review by the Combustible Control Program, then the frequency F_{ccl} is chosen as the number of times the critical quantity of combustible was found present in violation of the combustible control procedure.

F_w - Combustible Material Inspection Frequency:

This term represents, for each fire area or compartment, the highest frequency of inspection by personnel specifically for transient combustibles.

4.8.2 Analysis of Fire Scenarios and Fire Target Sets for the MP2

After the qualitative and the quantitative screening, ten fire compartments at MP2 were identified as important and in need for a more detailed analysis. The screening process of identifying important fire compartments and the results of the process are presented in Section 4.6 and Table

4.6-4.

After the screening process was completed, ten important compartments were studied in detail. Critical safety equipment was identified, and its proximity to potential fire sources/combustibles was established during walkdowns. The process of fire hazard evaluation is described above. The results of the evaluation are presented here in a deductive way which is described below:

- For each unscreened area, the analyzed fire scenarios are identified.

- For each fire scenario, the fire consequences are described and corresponding target sets are identified (refer to Table 4.8-1). Target sets are presented in the groups with common fire source and combustible.

- For each target set group, the fire source and corresponding combustible are defined. The duration of the postulated fire is given, along with the times needed for that fire to actuate a detector or sprinkler (refer to Table 4.8-2).

  Also, for each target set group, the ignition frequency for the postulated fire source is given (refer to Table 4.8-4) and the probability of the combustible being present and exposed is also included (refer to Table 4.8-5).

  [Note: The target set groups, based on the common fire source/combustible, are only introduced in order to simplify the description of the analysis by eliminating unnecessary repetitions. The analysis results in the summary tables are still presented for each separated target set.]

- For each single target set, a specific target and target location relative to the fire source are described. The applied fire scenario is identified and the time to damage the target is given from the Fire Growth and Propagation worksheets (refer to Table 4.8-2). Based on those times, and times it will take for the postulated fire to actuate a sprinkler or detector, credibility of auto or manual suppression is decided (refer to Table 4.8-3).

  [Note: Credibility of manual suppression is based on the times to detect and on the fire brigade response times, as described in Section 4.7.]

Occasionally, for a specific fire scenario, target sets with the same fire source and consequence were analyzed (e.g., damage from the same fire source to the bus by a radiant exposure, or to the bus power cables by an exposure in plume). This was done in order to compare damage probabilities for those redundant target sets and to select the most probable damage scenario or target set.

As stated above, the results of the Fire Hazard Evaluation are presented in Tables 4.8-1 through 4.8-6. The contents of those tables are described below:

Table 4.8-1 gives specific fire scenarios selected for evaluation at MP2 and corresponding target sets.

Table 4.8-2 gives results from the Fire Growth and Propagation Analysis, for target sets identified in Table 4.8-1 and for corresponding detection and suppression devices.

Table 4.8-3 summarizes results from Table 4.8-2 and the Fire Growth and Propagation Analysis identifying the possibility to credit auto or manual suppression.

Table 4.8-4 gives ignition frequencies for each target set and the basis for their determination.

Table 4.8-5 gives results from the Fire Damage Evaluation for each target set (probabilities that damage will occur).

Table 4.8-6 gives a final fire scenario frequency by combining results from Tables 4.8-4 and 4.8-5. Those results are discussed in Section 4.8.3.

Fire Hazard Evaluation for the MP2 was primarily based on the analysis of fixed combustibles. The only transient combustibles modeled were in the Auxiliary Building. The reasons for such low involvement of the transient combustibles in the analysis are numerous. As an example, the plant combustible control programs are very effective (no violations recorded), and aerosol cans (nonexposed combustibles) are used for contact cleaning in Switchgear Rooms and the Control Room. In the areas where a large number of fixed fire sources and combustibles are present, the contribution of transient combustibles was not considered to be important.

Fire Hazard Evaluation results for the MP2 are presented below for each unscreened compartment.

4.8.2.1 Auxiliary Building, AUXB-1 (Areas A-1B, A-1G, and A-12)

As described in Section 4.6, this is one of the vital fire compartments in the plant. Fire in this compartment has the potential to disable RCP thermal barrier cooling while simultaneously seriously degrading RCS Inventory Control (Charging, Residual Heat Removal, High and Low Pressure Injection Systems). All potential fires in this compartment are analyzed in detail.

Based on walkdowns several sub-compartments (Appendix A areas) were identified for further analysis. These areas were selected primarily due to the large number of cable trays in these areas and the existence of ignition and combustible sources in the vicinity of these cable trays. Fire Growth and Propagation Analysis for areas A-1B, A-1G, and A-12 of the AUXB-1 compartment were performed.

These areas were observed to have pumps, electrical cabinets, and transient combustibles. Pump and electrical cabinet fires were modeled as both the ignition and combustible source. Fires associated with transient combustibles were modeled as requiring a transient ignition source.

The fire source ignition frequencies for the area scenarios were based on the fire ignition sources for AUXB-1 (Ref. 4-6). Thus, for this analysis a scenario involving a pump fire is the frequency for a pump fire (2.4E-4/year) given that a lube oil leak is involved (50% of the pump fires) is 1.2E-4/year. The electrical cabinet frequency for the analysis is 7.2E-5/year. The transient ignition frequency for transient combustibles is for the transient portion and for this analysis is 1.7E-4/year. The transient welding portion was not considered applicable due to required fire watch program for cutting and welding. For the majority of the scenarios, given that both fire source and combustible are fixed, the probability of the combustible being present and exposed is equal to one.

The electrical cabinet peak fire intensity for this analysis was extrapolated from Reference 4-10 for cabinets with qualified cables and is based on guidance provided from the *draft* EPRI Fire PRA Implementation Guide (Ref. 4-32). The peak fire intensity was determined to be approximately 53 BTU/second (20% of 65 BTU/sec.) since the tops of the cabinets have sealed penetrations. The Q_{total} for these cabinets was assume to be equivalent to 150,000 BTU which yields a fire of approximately 35 minute duration. A fire of this duration is sufficiently long enough to possibly credit manual suppression given detection. Failure of detection and/or manual suppression is assumed to potentially result in loss of the area.

When stacks of cable trays are involved for a scenario, all are assumed to be affected if the tray closest to the fire source is affected. The exception is if the cable trays have an adequate automatic suppression system to prevent spread from one tray to another.

(1) M2A1B-*: Fire in Area A-1B, RBCCW Pump & Heat Exchanger Area, El. -25'6"

This fire scenario describes the fires in the RBCCW Pump & Heat Exchanger Area (A-1B), El. -25'6".

Three target sets were analyzed for this fire scenario: M2A1B-1*, M2A1B-2*, and M2A1B-3*. Results are presented below.

Target Sets M2A1B-1*, M2A1B-2*, and M2A1B*-3: Area A-1B, Transient Combustible Fire, Aerated Waste Panel Fire, and RBCCW Pump Fire with exposure to cables trays, RBCCW pumps, and detectors.

Results from the Fire Growth & Propagation (FG&P) worksheets for the three analyzed target sets are given below:

Target Set M2A1B-1i: The postulated fire source for the target sets is a transient ignition source. The postulated combustible is approximately a cubic yard of transient combustible (protective clothing in open storage racks) stored in the area. The targets are cables in cable trays (Z22AB30, Z24FF60, Z26ED10, Z26EC20, Z25BB30, & Z24FD10) which are considered in plume. For this scenario, transient combustibles were observed in this location (H.2/18.5) during an earlier walkdown (the transient combustibles are currently in a different location). The target-in-plume scenario was analyzed. Damage to the target (the bottom most tray) is expected to occur in less than one second and the fire duration is approximately seventeen and a half minutes. Automatic suppression can not be credited since it does not exist in the area. Manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2A1B-1r: The postulated fire source for the target sets is a transient ignition source (a fixed source is also in the immediate area - a low voltage transformer). The postulated combustible is approximately a cubic yard of transient combustibles (protective clothing in open storage racks). The targets are cables in cable trays (Z24FD20, Z25BB30, & Z26EC30) which are subject to radiant exposure. This scenario corresponds to the current location (H.4/18..1) of the transient combustibles and the radiant exposure scenario was analyzed. Damage to the target was determined not to occur.

Target Set M2A1B-1d: The postulated fire source for the target sets is the transient ignition source. The postulated combustible is approximately a cubic yard of transient combustibles (protective clothing in open storage racks). The target is the detector located in the general area. The target-out-of-plume scenario was analyzed. The detector was determined to actuate in five seconds.

Target Set M2A1B-2i: The postulated fire source and the combustible for the target sets are the Aerated waste panels. The targets are cables in cable trays (Z15EA50, Z26EC20, Z25BB30, & Z24FD10) which are in plume. Damage to the target (the bottom most tray) is expected to occur in approximately 168 seconds. Automatic suppression can not be credited since it does not exist in the area. Manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2A1B-2d: The postulated fire source and the combustible for the target sets is the Aerated waste panels and the cable trays. The target is the detector located in the general area. The target-out-of-plume scenario was analyzed. The detector was determined to actuate 33 seconds after the target in M2A1B-2i ignites.

Target Set M2A1B-3i: The postulated fire source and the combustible for the target sets is the RBCCW pump C. Targets are cables for RBCCW pumps A & B which are in plume 13' above pump C. The target-in-plume scenario was analyzed. Damage to the target is expected to occur in 20 seconds and the fire duration is 21 seconds. Manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2A1B-3d: The postulated fire source and the combustible for the target sets is the RBCCW pump C. The target is the detector located in the general area. The target-out-of-plume scenario was analyzed. The detector was determined to actuate in approximately 2.5 seconds.

(2) M2A1G*-*; Fire in Area A-1G, General Area, El. -5'0"

This fire scenario describes the fires in the Auxiliary Building General Area (A-1G), El. -5'0".

Four target sets were analyzed for this fire scenario: M2A1G-1*, M2A1G-2*, M2A1G-3*, and M2A1G-4*. Results are presented below.

Target Sets M2A1G-1*, M2A1G-2*, M2A1G-3*, and M2A1G*-4; Area A-1G - Transient Combustible Fire, Panel C-65 Fire, Panel C-63 Fire, and MC B-31A Fire with exposure to cables trays, and detectors.

Results from the FG&P worksheets for the four analyzed target sets are given below:

Target Set M2A1G-1i: The postulated fire source for the target sets is a transient ignition source. The postulated combustible is approximately a cubic yard of transient combustibles (protective clothing in open storage racks) located in the area. The targets are cables in cable trays (Z24FH10, Z25BC30, Z26EB30, & Z24FX10) which are considered in plume. The target-in-plume scenario was analyzed. Damage to the target (the bottom most tray) is expected to occur in 0.2 seconds. Automatic suppression can not be credited since it does not exist in the area. Manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2A1G-1r: The postulated fire source for the target sets is the transient ignition source. The postulated combustible is approximately a cubic yard of transient combustible (protective clothing in open storage racks). The targets are a cables in cable tray (Z23HA30) which are subject to radiant exposure. The radiant exposure scenario was analyzed. Damage to the target was determined not to occur.

Target Set M2A1G-1d: The postulated fire source for the target sets is the transient ignition source. The postulated combustible is approximately a cubic yard of transient combustible (protective clothing in open storage racks). The target is the detector located in the general area. The target-out-of-plume scenario was analyzed. The detector was determined to actuate in approximately two seconds.

Target Set M2A1G-2i: The postulated fire source and the combustible for the target sets is the evaporator panels (C-65). Targets are cables in cable trays (Z16EE10, Z15BF10, Z14FK10, Z25BD10, Z24FH30, & Z22HA30) which are in plume. The target-in-plume scenario was analyzed. Damage to the target (the bottom most tray) is expected to occur in 53 seconds. Automatic suppression can not be credited since it does not exist in the area. Manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2A1G-2r: The postulated fire source and the combustible for the target sets is the evaporator panel (C-65). The targets are cables in cable trays (Z24FD10, Z25BB10, Z26EC20, Z26ED10, Z24FF60, Z22AB20, Z66HT46, & Z26HT45) which are subject to radiant exposure. The radiant exposure scenario was analyzed. Damage to the target was determined not to occur.

Target Set M2A1G-2d: The postulated fire source and the combustible for the target sets is panel C-65. The target is the detector located in the general area. The target-out-of-plume scenario was analyzed. The detector was determined to actuate 32 seconds after the target in M2A1G-2i ignites.

Target Set M2A1G-3i: The postulated fire source and the combustible for the target sets is panel C-63. Targets are cables in cable trays (Z24FD10, Z26EE10, Z25BD10, & Z24FH30) which are in plume. The target-in-plume scenario was analyzed. Damage to the target is expected to occur in approximately 53 seconds. Automatic suppression can not be credited since it does not exist in the area. Manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2A1G-3r: The postulated fire source and the combustible for the target sets is panel C-63. Targets are cables in cable trays (Z16EE30, Z15BF10, & Z14FK10) which are subject to radiant exposure. The radiant exposure scenario was analyzed. Damage to the target was determined not to occur.

Target Set M2A1G-3d: The postulated fire source and the combustible for the target sets is the panel C-63. The target is the detector located in the general area. The target-out-of-plume scenario was analyzed. The detector was determined to actuate 36 seconds after the target in M2A1G-3i ignites.

Target Set M2A1G-4i: The postulated fire source and the combustible for the target sets is MC B-31A. Targets are cables in cable trays (Z14FL10, Z26EE10, Z25BD10, & Z24FH30) which are in plume. The target-in-plume scenario was analyzed. Damage to the target is expected to occur in approximately three seconds. Automatic suppression can be credited. Manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2A1G-4r: The postulated fire source and the combustible for the target sets is MC B-31A. Targets are cables in cable trays (Z16ED40, Z14BE40, & Z14FH40) which are subject to radiant exposure. The radiant exposure scenario was analyzed. Damage to the target was determined not to occur.

Target Set M2A1G-4d: The postulated fire source and the combustible for the target sets is the MC B-31A. The target is the detector located in the general area. The target-out-of-plume scenario was analyzed. The detector was determined to actuate 63 seconds after the target in M2A1G-4i ignites.

(3) <u>M2A12A*: Fire in Area A-12A, General Area, El. 14'6"</u>

This fire scenario describes the fires in the Auxiliary Building General Area (A-12A), El. 14'6". One target sets was analyzed for this fire scenario: M2A12A*. Results are presented below.

Target Set M2A12A-*; Area A-12A - Transient Combustible Fire

Results from the FG&P worksheets for the analyzed target set are given below:

Target Set M2A12A-i: The postulated fire source for the target sets is the transient ignition source. The postulated combustible is approximately two cubic yards of transient combustibles (protective clothing in open storage racks). Targets are cables in cable trays (Z24FC10, & Z25BA10) which are considered in plume. The target-in-plume scenario was analyzed. Damage to the target is expected to occur in approximately one second. Automatic suppression can not be credited since it does not exist in the immediate area of the combustible and the target. Manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2A12A-r: The postulated fire source for the target sets is the transient ignition source. The postulated combustible is approximately two cubic yards of transient combustibles (protective clothing in open storage racks). The targets are a cables in cable trays (Z25BC20, Z26EB20, Z22AB20, Z24FF60, Z26ED20, Z26EC20, & Z25BB20) which are subject to radiant exposure. The radiant exposure scenario was analyzed. Damage to the target is not expected to occur.

Target Set M2A12A-d: The postulated fire source for the target sets is the transient ignition source. The postulated combustible is approximately two cubic yards of transient combustibles (protective clothing in open storage racks). The target is the detector located in the general area. The target-out-of-plume scenario was analyzed. The detector was determined to actuate in approximately 17 seconds.

4.8.2.2 Cable Vault (A-24)

The combustibles in this fire area are cable trays, routed in various arrangements, including parallel vertical stacks or multiple intersections. The cables in the trays are IEEE-383 qualified. The fire sources in this area are transient, lighting panels, and low voltage transformers. Based upon walkdowns the potential fire source of concern is a low voltage transformer near several cable trays.

The fire scenario of interest in this fire zone is the scenario which would involve fire spread between different cable trays. It was conservatively assumed that if fire spreads between two neighboring trays, it will spread between multiple trays, and potentially the entire area will be lost. The name for this fire scenario is M2A24-*. The scenario describes all fires with the potential to disable the Cable Vault.

The cable trays are assumed to be two feet wide, without solid bottoms or covers. It was conservatively assumed that all trays are filled with cables. Sprinklers have been provided on every 10 feet of tray length for a straight cable run, and also at every point where tray bends or two trays cross. The majority of sprinklers are 175°F rated fragile bulb types, positioned 6" above the tray and a small local deluge system.

<u>M2A24-*; Fire in Area A-24, Cable Vault, El. 25'6"</u>

This fire scenario describes the fires in the Auxiliary Building Cable Vault Area (A-24), El. 25'6".

When stacks of cable trays are involved for a scenario all are assumed to be affected. The exception is if the cable trays have an adequate automatic suppression system to prevent spread from one set of adjacent trays to another.

Both, auto and manual suppression, can be credited to prevent spread between cable trays. The probability of fire spreading through the cable vault area from Fire Scenario M2A24-1 is 2.0E-3, as given in Table 4.8-5. One target set was analyzed for this fire scenario: M2A24-*. Results are presented below.

Target Set M2A24-*; Area A-24 - Low voltage transformer fire.

Results from the FG&P worksheets for the analyzed target set are given below:

Target Set M2A24-1r: The postulated fire source and combustible for the target sets is a small metal enclosed low voltage transformer located approximately 21 inches from the cable trays. The postulated combustible is initially the transformer and then the cables in the affected cable tray. The targets are cables in a stack of cable trays (Z16HB25, Z14GA70, 16EL20, Z15HC20, Z14FX65, & Z15PB20) which are subject to radiant exposure. The radiant exposure scenario was analyzed. Damage to the target (the nearest tray) is expected to occur in approximately four seconds..

Target Set M2A24-1d: The postulated fire source for the target sets is the metal enclosed transformer. The postulated combustible is initially the transformer and then the cables in the affected cable tray. The target is the detector located in the general area. The target-out-of-plume scenario was analyzed. The detector was determined to actuate 2 seconds after the target in M2A24-1 ignites.

Target Set M2A24-1s: The postulated fire source for the target is the metal enclosed low voltage transformer located approximately 48 inches from the nearest wet pipe sprinkler head. Based upon the radiant exposure analysis the sprinklers do not actuated to prevent damage to the cable trays nearest the fire ignition and combustible source. However, once the cable trays ignite, suppression is expected to occur in a few seconds to prevent spread of the fire.

4.8.2.3 Control Room (A-25)

The main fire sources and combustibles in this vital fire area are electrical cabinets/panels (80% of the total area ignition frequency is contributed to the cabinet fires). Except for trash, the only transient combustibles which can be found in the area are 12 oz. aerosol cans of "Blue Shower," for contact cleaning, and they are not likely to present a significant fire risk. Based on this and the fact this area is staffed continuously, transient fires were considered not to be a significant contributor to the fire risk in the Control Room.

There are 57 various electrical cabinets in the Control Room. Twenty four of those are safety significant: 16 cabinets of the Main Control Board (MCB) and eight cabinets of the Engineered Safety Actuation System.

The MCB is a steel construction, roughly 6 to 8.5 feet deep and 7.6 feet high. The MCB consists of eight front and eight back cabinets (eight panels labeled "C01" through "C08R"). There are single thickness steel panels positioned between cabinets with unsealed penetrations. The front cabinets (benchboard or vertical) and back cabinets (vertical) are positioned across a 24" to 26" aisle way. The cabinets are all open to the aisle (there is no cabinet back wall).

The ceiling of the MCB is open to the space above the suspended ceiling (ten feet above the floor), which forms part of the exhaust plenum. The ventilation ranges from 5,000 to 15,000 cfm (8 to 15 air changes per hour). Cables in the MCB are IEEE-383 qualified.

Since the Sandia Cabinet Test results (Reference 4-10) are the only ones available to be used in estimating fire growth and propagation inside cabinets, cabinets from the Sandia Test were compared to the cabinets in the MP2 MCB. The comparison results are as follows:

1. The Sandia Test cabinets width, length, and height dimensions are similar to the MP2 benchboard type cabinets. MP2 vertical cabinets are not as deep and their width varies. Construction of the cabinets is similar.

2. Cable loading and orientation are similar.

3. The Sandia MCB cabinets were tested with the back panel doors open. Similarly, the MP2 MCB cabinets do not have doors and are open to the aisle.

4. The Sandia Test enclosure was 48,000 cubic feet with one air change per hour. The MP2 Control Room enclosure is approximately 35,000 cubic feet with 8 to 15 air changes per hour.

5. In the Sandia Test, smoke detectors are assumed inside the cabinet. The MP2 MCB has smoke detection above the walkway between the front and back cabinets. Even though the detectors are not actually inside the cabinets, they are in the smoke exhaust path.

Different Sandia test cabinet characteristics are compared with MP2 cabinet characteristics in the table presented next:

	Sandia Test Cabinets			MP2 MCB Cabinets
	Test PCT 6	Test No. 23	Test No. 25	
Cable Type	383 Qualified	383 Qualified	Non-383 Qualified	383 Qualified,
Cabinet Type	Benchboard	Benchboard	Vertical	Benchboard/ Vertical
Ignition Source	Transient	Transient	Electrical	Electrical
Ventilation Rate	15 Air Changes/hr	1 Air Change/hr	8 Air Changes/hr	8-15 Air Changes/hr
Peak Heat Release Rate	170 Btu/sec	1142 Btu/sec	796 Btu/sec	---

Based on the ventilation rate, MP2 results are expected to be the most similar to the Test No. 25. Based on this, a cabinet fire growth timeline, predicted for the MP2 MCB cabinets, is presented in the table below.

The fire growth timeline presented in the following table was conservatively selected to model CR cabinet fires at MP2. The tests selected are all with non-qualified cables and electrical ignition sources since none of the qualified cable cabinet test could not be ignited with an electrical ignition source. The transients ignited were determined not to be applicable due to the transient controls program precludes this quantity of transient combustibles from entering the CR. Independent of size, all cabinets are considered the same for this evaluation.

	Fire Growth Timeline for Cabinets		
	Sandia Test Cabinets		Predicted for MP2 MCB Cabinets (seconds)
	Test No. 24 (seconds)	Test No. 25 (seconds)	
Ignition (visible smoke)	0	0	0
Detector Actuation	---	30-60	90
Cables Flame	330	390	390
Heat Release Rate of 62 Btu/sec	690	510	510
Thick Smoke at Eye Level	930	1,170	1,170
Peak Heat Release Rate	1,020	810	810

The MP2 Control Room has ionization smoke detectors provided above the control rack and the main control board..

Manual Fire Brigade response time to this area, based on drill results from similar locations, is approximately 10 minutes (Ref. 4-8). However, considering that fire brigade members are typically stationed in the Control Room, it could be expected that a manual extinguisher will be used prior to the arrival of the full brigade. Data in the EPRI Fire Event Database (Ref. 4-11) shows that every Control Room cabinet fire was manually suppressed, without using a manual hose station. Fire duration times ranged from 30 seconds to 5 minutes. Based on this industry data from the Control Room, manual suppression by the Control Room operators was credited if the time to damage was longer than two minutes from the time of detection (based upon Section 4.4 walkdown insights).

For all Control Room fire scenarios, four different target sets were analyzed: M2A25-1, M2A25-2, M2A25-3, and M2A25-4. Target Sets M2A25-1 through M2A25-3 were defined in order to analyze MCB cabinet fires and a propagation of fire between cabinets. Each target set corresponds to the different number of cabinets involved. Target Set M2A25-4 was defined in order to analyze Engineered Safety Actuation System (ESAS) cabinet fires. Target Set M2A25-4 models a single cabinet fire.

[Note: Based on the terminology used in this analysis, one MCB Panel (C01 through C08) actually consists of two cabinets: back and front.]

Target Set M2A25-1: Fire in a Single MCB Cabinet

The fire source, combustible, and the target in this atypical target set is a MCB cabinet.

Fire originates in one of the MCB cabinets. A smoke detector inside the MCB will actuate in 90 seconds. Since the exact origin of the fire inside the cabinet cannot be predicted, it was assumed that the cabinet is damaged instantly. (Actually, a panel can be considered lost when cable flames appear in 390 seconds according to the fire growth timeline for the cabinets. The assumption used here is conservative.) Suppression was not credited to prevent damage to the cabinet. Suppression was credited to prevent spread to adjacent cabinets.

The ignition frequency for this fire source was determined based on the panel fire ignition frequency in the Control Room (1.7E-4/year). Given that the fire source and combustible are fixed, the probability of a combustible being present and exposed is equal to one.

Fire limited to one cabinet was assumed not to require Control Room evacuation.

Target Set M2A25-2: Fire in a MCB Cabinet, Exposing the Cabinet Across the Aisle

The fire source and combustible in this target set is a MCB cabinet. The target is the other MCB cabinet across the aisle. The result is a loss of one MCB panel (back and front).

Fire originates in one of the MCB cabinets. A smoke detector inside the MCB will ctuate in 90 seconds. It is assumed that, when fire reaches an output of 62 Btu/sec, it could spread across the aisle from the front cabinet to the back cabinet and vice versa. After this heat output in the Sandia test, damage temperatures (425°F) were noted in the top of the cabinets and fire was assumed not extinguishable by a manual extinguisher. Based on the fire growth timeline for cabinets, fire will reach a heat release rate of 62 Btu/sec in 510 seconds (8.5 minutes) after ignition. Manual suppression by Control Room personnel can be credited. [Note: The longest Control Room fire duration recorded in available industry data is five minutes.]

The ignition frequency for this fire source was determined based on the panel fire ignition frequency in the Control Room (1.7E-4/year) and the number of cabinets involved (two cabinets are involved, since fire can originate in either the back or front cabinet of a panel). Given that the fire source and combustible are fixed, the probability of the combustible being present and exposed is equal to one.

Fire limited to one panel (two cabinets) was assumed not to require Control Room evacuation.

Target Set M2A25-3: Fire in a MCB Cabinet, Exposing Five Neighboring Cabinets

The fire source and combustible in this target set is a MCB cabinet. The targets are the five cabinets in the immediate vicinity; two on the side and three across the aisle. The result is the loss of six cabinets or three MCB panels (with back and front cabinets).

Fire originates in one of the MCB cabinets. A smoke detector inside the MCB will actuate in 90 seconds. The cabinet will be completely damaged in 390 seconds. If not extinguished, fire will spread across the aisle in 510 seconds. If it is conservatively assumed that fire will spread diagonally and on the side, only one minute after the fire reached an output of 62 Btu/sec and spread across the aisle. Based on the fire growth timeline for cabinets, this corresponds to 570 seconds (9.5 minutes). It is assumed that the second-zone detector will trip well before that time. Therefore, manual suppression by control room personnel was credited [Note: Manual suppression by the full Manual Fire Brigade is not credited, since the time to damage is shorter than 10 minutes.]

The ignition frequency (and probability of combustible being present and exposed) is the same as Target Set M2A25-2, since this fire can originate in either the back or the front cabinet of the middle panel.

According to the fire growth timeline for cabinets, the peak heat release rate will be reached in 810 seconds (13.5 minutes), and thick smoke at eye level will be reached in 1,170 seconds (19.5 minutes). At this time, it is assumed that Control Room evacuation is required. Since the fire growth timeline is based on the heat release rates from the one cabinet, and in this target set multiple cabinets are ignited, it was conservatively assumed that every Control Room fire involving three panels requires Control Room evacuation.

Target Set M2A25-4: Fire in a ESAS Cabinet

In this atypical "target set," an ESAS cabinet is both target and fire source.

The fire is postulated to originate in one of the ESAS cabinets. Since the exact place of the fire origin inside the cabinet cannot be predicted, it was assumed that the cabinet is damaged instantly. Suppression was not credited.

Since ESAS cabinets are isolated from each other, propagation between cabinets was not analyzed.

The ignition frequency for this fire source was determined based on the panel ignition frequency in the Control Room (1.7E-4/year). Given that the fire source and combustible are fixed, the probability of the combustible being present and exposed is to equal to one.

If not suppressed, it was assumed that a cabinet fire will require room evacuation in 1,170 seconds or 19.5 minutes (based on the fire growth timeline for cabinets). In order to prevent room evacuation, two types of suppressions can be credited: manual suppression by Control Room personnel (manual extinguisher), and manual suppression by fire brigade (manual hose station). Events involving a panel fire and failure of all means of suppression requiring Control Room evacuation, are very improbable and will not present a significant contributor to the fire risk. Therefore, it was assumed that an ESAS cabinet fire does not require Control Room evacuation.

4.8.2.4 Screenwash House (I-1), (Intake Structure)

Service water pumps and Circulating Water (CW) pumps are located in this area, as described in Section 4.6. Damage to the service water pumps was analyzed in three fire scenarios. Even though smoke detectors exist in this area, times to detect were not analyzed, because times to damage targets were not long enough to credit manual suppression. The area does not have an automatic suppression system.

The four fire scenarios which were analyzed in Area I-1A are described below:

M2I1A-*: Fire in Screenwash House, Disabling 3 Service Water Pumps

This fire scenario models all fires in the Screenwell House which could disable all Service Water Pumps and result in the total loss of Service Water.

Four target sets were analyzed for this fire scenario: M2I1A-*.

Target Sets M2I1A-1*, M2I1A-2*, M2I1A-3*, and M2I1A-4*: Area I-1A, combinations of Circulating Water or Service Water pump fires, with exposure to all the Service Water Pumps

The postulated fire source for these target sets is an ignition by either of the Circulating Water Pumps A, B, C or D and Service Water pump B. The postulated maximum available combustible is 50.25 gallons of pump lube oil for the Circulating Water pumps and 13.25 gallon for the Service Water pump.

Due to irregularities in the floor approximately 2000 sqft. is available for the lube oil spill area. If 50.25 gallons of pump lube oil is freely spilled over an area of approximately 2000 sqft., the expected fire duration is approximately 23 seconds. This area was approximated by examination of the Intake Structure floor area for obstructions and does not credit floor drains.

The ignition frequency for this fire source was determined based on the pump fire ignition frequency in the Intake Structure (3.2E-3/year), given that a lube oil leak was involved (50% of the fires). The number of pumps which can cause damage to all three SW pumps, was determined through target set analysis, as it is presented below. Given that both the fire source and combustible are fixed, the probability of the combustible being present and exposed is equal to one. Thus, the ignition frequency (1.0E-4/yr (1.9E-4/yr*0.5)) for the target sets was based on the per pump fire ignition frequency with lube oil present for the intake structure. The probability of damage is based on the probability of oil being exposed (leaking).

Results from the FG&P worksheets for the analyzed target set are given below.

Target Set M2I1A-1r: The target is the three service water pumps (A, B, and C). The fire source is the B Circulating Water Pump and the farthest Service Water Pump (A). The longest distance between the target and the source (involving the oil spill area) is 21 feet. The radiant exposure scenario was analyzed. The minimum amount of lube oil to result in damage was calculated to be between 8 to 9 gallons. For this case the fire duration and time to damage is approximately 8 seconds. Total loss of SW is expected for this scenario.

Target Set M2I1A-2r: The target is the two Service Water Pumps on either side of SW pump B. The fire source is the B service water pump. The longest distance between the target and the source (involving the oil spill area) is 17 feet. 13.25 gallons of lube oil was used and the radiant exposure scenario was analyzed. Damage to the target is expected to occur since fire duration is 8 seconds and time to damage is approximately one second. Total loss of SW is expected for this scenario.

Target Set M2I1A-3r: The targets are the three service water pumps (A, B, and C). The fire source is the D Circulating Water Pump and the farthest Service Water Pump (A). The longest distance between the target and the source (involving the oil spill area) is 51 feet. The radiant exposure scenario was analyzed. The fire duration is approximately 23 seconds and damage to the target is expected to occur in 65 seconds. This scenario is not expected to result in a total loss of SW since the time to damage is greater than the expected fire duration.

Target Set M2I1A-4r: The targets are the three Service Water Pumps (A, B, and C). The fire source is the either the A or C Circulating Water Pump and the farthest Service Water Pump C or A, respectively. The longest distance between the target and the source (involving the oil spill area) is 40 feet. 50.25 gallons of lube oil was used and the radiant exposure scenario was analyzed. Damage to the target is expected to occur in 25 seconds. Total loss of SW is expected for this scenario.

4.8.2.5 Turbine Building (T-1)

The general area of the Turbine Building contains the majority of the balance of plant systems. The concerns for this area is the potential for a plant transient (loss of air, SW, off-site power, etc.) as a result of a potential fire associated with components located within the area. The analysis of the turbine building is to identify locations for such fires and the potential consequences. A catastrophic fire which could result in the collapsing of the entire building was also analyzed.

The Turbine Building was walked down on numerous occasions to identify potentially credible fire scenarios which could possibly result in a plant transient. This required identifying the equipment which could initiate and be involved in a fire and potential spatial interactions with other equipment (ie., cabling in the vicinity). Six fire scenarios were identified for this evaluation. These involved the TBCCW Pumps (M2TB-1*), the Main Condenser Pumps (M2TB-2*), a large oil filed transformer (M2TB-3*), the Condensate Pumps (M2TB-4*), the Instrument & Station Air Compressors (M2TB-5*), and the Main Feedwater Pumps (M2TB-6*).

<u>M2TB-1*: Fire in Turbine Building involving the TBCCW Pumps</u>

This fire scenario models all fires in the Turbine Building which could disable all TBCCW Pumps and other components in the area of the TBCCW Pumps.

Six target sets were analyzed for this fire scenario: M2TB-1*.

Manual suppression for these fire scenarios was not credited due to the relatively short target damage times and the duration of the fire versus fire brigade response time.

Target Set M2TB-1l: TBCCW Pump Lube Oil Fire, with exposure to conduit 5T540.

The postulated fire source in this target set is a the B TBCCW Pump. The postulated combustible is approximately a half a gallon of lube oil (generally contains less than a half gallon).

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight seconds. The target is conduit 5T540 which is in plume. The cable in the conduit was determined to be damaged in approximately one and a half seconds. The analysis work sheet does not credit the conduit or the Thermo-Lag around the conduit. Thus, given the duration of the fire, and the relative rating of the Thermo-Lag (originally three hours) damage to the cable in the conduit is not expected to occur.

Target Set M2TB-1r1: TBCCW Pump Lube Oil Fire, with exposure to conduit 52BA10.

The postulated fire source in this target set is a the B TBCCW Pump. The postulated combustible is approximately a half a gallon of lube oil (generally contains less than a half gallon).

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight seconds. The target is the conduit 52BA10. This target was analyzed for damage due to radiant exposure. The cable in the conduit was determined to be damaged in approximately fourteen seconds. Thus, given the duration of the fire, damage to the cable in the conduit is not expected to occur.

Target Set M2TB-1r2: TBCCW Pump Lube Oil Fire, with exposure to A TBCCW Pump.

The postulated fire source in this target set is a the B TBCCW Pump. The postulated combustible is approximately a half a gallon of lube oil (generally contains less than a half gallon).

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight seconds. The target is the A TBCCW Pump. This target was analyzed for damage due to radiant exposure. The TBCCW Pump was determined to be damaged in approximately seventy seconds. Thus, given the duration of the fire, damage to the TBCCW Pump is not expected to occur.

Target Set M2TB-1r3: TBCCW Pump Lube Oil Fire, with exposure to C TBCCW Pump.

The postulated fire source in this target set is a the B TBCCW Pump. The postulated combustible is approximately a half a gallon of lube oil (generally contains less than a half gallon).

The ignition frequency for this target set was based on the Pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight seconds. The target is the cabling for the C TBCCW Pump. This target was analyzed for damage due to radiant exposure. The TBCCW Pump C cabling was determined to be damaged in approximately three seconds. Thus, given the duration of the fire, damage to the TBCCW Pump C cabling is expected to occur.

M2TB-2*: Fire in Turbine Building involving the Main Condenser Vacuum Pumps

This fire scenario models all fires in the Turbine Building which could disable all Main Condenser Pumps and other components in the area of these pumps.

Three target sets were analyzed for this fire scenario: M2TB-2*.

Target Set M2TB-2r1: Main Condenser Vacuum Pump lube oil fire, with exposure to conduit Z52EA10.

The postulated fire source in this target set is a the A Main Condenser Vacuum Pump. The postulated combustible is approximately a half a gallon of lube oil (generally contains less than a half gallon).

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight seconds. The target is conduit Z52EA10 and the target was analyzed for damage due to radiant exposure.which is in plume. The cable in the conduit was determined to be damaged in approximately seven seconds. The analysis work sheet does not credit the conduit or the Thermolag around the conduit. However, given the duration of the fire, and the relative rating of the Thermolag (originally three hours) damage to the cable in the conduit is not expected to occur.

Target Set M2TB-2r2: A Main Condenser Vacuum pump Lube Oil Fire, with exposure to the B pump.

The postulated fire source in this target set is a the A Main Condenser Vacuum Pump. The postulated combustible is approximately a half a gallon of lube oil (generally contains less than a half gallon).

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight seconds. The target is the B Main Condenser Vacuum Pump and TBCCW Pump A. This target was analyzed for damage due to radiant exposure. The pumps were determined to be damaged in approximately 106 seconds. Thus, given the duration of the fire, damage to these pumps is not expected to occur.

M2TB-3*: Fire in Turbine Building involving the transformer 15G-2Y

This fire scenario models all fires in the Turbine Building

Two target sets were analyzed for this fire scenario: M2TB-3*.

Automatic suppression was credited to prevent fire spread to other components and areas based upon the duration of the fire and the time to damage of nearby equipment.

Target Set M2TB-3r: Transformer 15G-2Y fire, with exposure to Turbine Hydrogen Seal Oil Unit.

The postulated fire source in this target set is the transformer 15G-2Y. The postulated combustible is the oil from the transformer.

The ignition frequency for this target set was based on the single transformer fire ignition frequency of 1.0E-4/yr for the Turbine Building.

The expected fire duration is approximately nineteen minutes and forty seconds. The targets are component are components of the hydrogen seal oil system (hydrogen lines and the seal oil unit). The targets were analyzed for damage due to radiant exposure. These components were determined to be damaged in approximately eight minutes and twenty seconds. Thus, given the duration of the fire, manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s)..

Target Set M2TB-3s: Transformer 15G-2Y Fire, with exposure to the sprinkler system.

The postulated fire source in this target set is a the transformer 15G-2Y. The postulated combustible is this oil filed transformer.

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 5.0E-5/yr (1.0E-4/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking). The approximately two feet from and surrounding the transformer base is a six inch high dike contain oil spills. The available area for the oil is approximately eighty square feet.

The expected fire duration is approximately nineteen minutes and forty seconds. The target is the sprinkler system which is located 9 feet above the top of the transformer and was modeled for target in plume. The sprinkler was determined to be actuated in approximately twelve seconds.

M2TB-4*: Fire in Turbine Building involving the condensate pumps

This fire scenario models all fires in the Turbine Building which could disable all Condensate Pumps and other components in the general area of these pumps.

Five target sets were analyzed for this fire scenario: M2TB-4*.

Automatic suppression was credited to prevent fire spread to other components and areas based upon the duration of the fire and the time to damage of nearby equipment.

Target Set M2TB-4i: Condensate Pump Lube Oil Fire, with exposure to cable trays.

The postulated fire source in this target set is a the B Condensate Pump. The postulated combustible is approximately a 30.25 gallons of lube oil.

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately twenty six seconds. The targets are cables in cable trays (16FA30, 14GA20, 15DA30, & 13EA10) which are in plume. Damage to the target (the bottom most tray) is expected to occur almost instantly. Automatic suppression can not be credited to prevent damage to these trays since it does not actuate for approximately 9 seconds (target set M2TB-4s). However, suppression can be credited to prevent the fire from potentially spreading to other portions of the Turbine Building. Additionally, manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2TB-4r1: Condensate Pump Lube Oil Fire, with exposure to Condensate Pumps A & C.

The postulated fire source in this target set is a the B Condensate Pump. The postulated combustible is approximately a 30.25 gallons of lube oil.

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately twenty six seconds. The targets are the A & C Condensate Pumps. These targets were analyzed for damage due to radiant exposure. These components were determined to be damaged in approximately two seconds. Thus, given the duration of the fire, damage to all the Condensate Pumps is expected to occur. Automatic suppression can not be credited to prevent damage to these pumps since it does not actuate for approximately 9 seconds (target set M2TB-4s). However, suppression can be credited to prevent the fire from potentially spreading to other portions of the Turbine Building. Additionally, manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2TB-4r2: Condensate Pump Lube Oil Fire, with exposure to the A Condensate Pump.

The postulated fire source in this target set is a the C Condensate Pump. The postulated combustible is approximately a 30.25 gallons of lube oil.

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately twenty six seconds. The targets are the A & B condensate pumps. These targets were analyzed for damage due to radiant exposure. These components were determined to be damaged in approximately ten seconds. Thus, given the duration of the fire, damage to all the Condensate Pumps is expected to occur. Automatic suppression can not be credited to prevent damage to these trays since it does not actuate for approximately 9 seconds (target set M2TB-4s). However, auto and manual suppression can be credited to prevent the fire from potentially spreading to other portions of the Turbine Building.

Target Set M2TB-4r3: Condensate Pump Lube Oil Fire, with exposure to the A Station Air Compressor.

The postulated fire source in this target set is a the C Condensate Pump. The postulated combustible is approximately a 30.25 gallons of lube oil.

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately twenty six seconds. The targets are the A & B Instrument Air Compressors and the Station Air Compressor. These targets were analyzed for damage due to radiant exposure. These components were determined to be damaged in approximately thirty seconds. Thus, given the duration of the fire, damage to the Station Air Compressor is not expected to occur.

Target Set M2TB-4s: Condensate Pump Lube Oil Fire, with exposure to sprinkler system.

The postulated fire source in this target set is a the B Condensate Pump. The postulated combustible is approximately a 30.25 gallons of lube oil.

The ignition frequency for this target set was based on the pump fire ignition frequency with lube oil present 2.1E-5/yr (4.2E-5/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately twenty six seconds. The target is the sprinkler system located 24 feet above the Condensate Pump floor and are considered in plume. Automatic suppression is actuated approximately four and a half seconds after the start of the fire for this scenario. Therefore, it may be possible to credit auto suppression for some of the scenarios.

M2TB-5*: Fire in Turbine Building involving the Air Compressors

This fire scenario models all fires in the Turbine Building which could disable the Station Air Compressor and other components in the general area of this compressor (Instrument Air Compressors A & B.

Four target sets were analyzed for this fire scenario: M2TB-5*.

Automatic suppression was credited to prevent fire spread to other components and areas based upon the duration of the fire and the time to damage of nearby equipment.

Target Set M2TB-5i: Station Air Compressor, with exposure to cable tray.

The postulated fire source in this target set is a the Station Air Compressor. The postulated combustible is approximately a 4.5 gallons of lube oil.

The ignition frequency for this target set was based on the air compressor fire ignition frequency with lube oil present 2.0E-4/yr (3.9E-4/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight seconds. The target is cables in cable tray 14GK10 which is in plume. Damage to the target is expected to occur in almost instantly. Automatic suppression can not be credited to prevent damage to these trays since it does not actuate for approximately four and a half seconds (target set M2TB-5s). However, auto. and manual suppression can be credited to prevent the fire from potentially spreading to other portions of the Turbine Building.

Target Set M2TB-5r1: Station Air Compressor, with exposure to the B Instrument Air Compressor.

The postulated fire source in this target set is the Station Air Compressor. The postulated combustible is approximately a 4.5 gallons of lube oil.

The ignition frequency for this target set was based on the air compressor fire ignition frequency with lube oil present 2.0E-4/yr (3.9E-4/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight seconds. The targets are the A & B Instrument Air Compressors and the Station Air Compressor. These targets were analyzed for damage due to radiant exposure. The B Instrument Air Compressor was determined to be damaged in approximately twelve seconds. Thus, given the duration of the fire, damage to the B Instrument Air Compressor is not expected to occur.

Target Set M2TB-5r2: Station Air Compressor, with exposure to cable trays.

The postulated fire source in this target set is the Station Air Compressor. The postulated combustible is approximately a 4.5 gallons of lube oil.

The ignition frequency for this target set was based on the air compressor fire ignition frequency with lube oil present 2.0E-4/yr (3.9E-4/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight seconds. The targets are the cable trays (12FA10, 14GU10, 14GD60, 16FD60, & 14GG10) in the area of the Station Air Compressors. These targets were analyzed for damage due to radiant exposure. The bottom most tray was determined to be damaged in approximately five seconds. Thus, given the duration of the fire, damage to the cable trays is expected to occur. Automatic suppression can not be credited to prevent damage to these trays since it does not actuate for approximately 9 seconds (target set M2TB-4s). However, suppression can be credited to prevent the fire from potentially spreading to other portions of the turbine building. However, automatic and manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2TB-5s: Station Air Compressor, with exposure to sprinkler system.

The postulated fire source in this target set is the Station Air Compressor. The postulated combustible is approximately a 4.5 gallons of lube oil.

The ignition frequency for this target set was based on the air compressor fire ignition frequency with lube oil present 2.0E-4/yr (3.9E-4/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight seconds. The target is the sprinkler system locate 15 feet above the Station Air Compressor floor and are considered in plume. Automatic suppression is actuated approximately four and a half seconds after the start of the fire for this scenario.

<u>M2TB-6*: Fire in Turbine Building involving the Main Feedwater (MFW) Pumps</u>

This fire scenario models all fires in the Turbine Building which could disable the MFW pumps components in the general area of these pumps.

Two target sets were analyzed for this fire scenario: M2TB-6*.

Automatic suppression was credited to prevent fire spread to other components and areas based upon the duration of the fire and the time to damage of nearby equipment.

Target Set M2TB-6r: MFW pump, with exposure to the other MFW pump.

The postulated fire source in this target set is the MFW pump. The postulated combustible is approximately a 100 gallons of lube oil was used in the analysis for determining the potential for damage to the other MFW pump and for suppression actuation. The total lube oil inventory is 1020 gallons for a MFW pump, to involve this much oil would require additional failures.

The ignition frequency for this target set was based on the MFW pump fire ignition frequency with lube oil present 1.0E-3/yr (2.0E-3/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight minutes. The target is the other MFW pump and was analyzed for damage due to radiant exposure. The other MFW pump was determined to be damaged in approximately ten seconds. Thus, given the duration of the fire, damage to the MFW pump is expected to occur. Automatic suppression can be credited to prevent damage to these pumps since it actuates in approximately 2 seconds (target set M2TB-6s). Additionally, manual suppression was credited to prevent fire spread in the area, it was not credited for preventing damage to the target(s).

Target Set M2TB-6s: MFW pump, with exposure to sprinkler system.

The postulated fire source in this target set is the a MFW pump. The postulated combustible is approximately a 100 gallons of lube oil.

The ignition frequency for this target set was based on the MFW pump fire ignition frequency with lube oil present 1.0E-3/yr (2.0E-3/yr*0.5) for the Turbine Building. The probability of damage is based on the probability of oil being exposed (leaking).

The expected fire duration is approximately eight minutes. The target is the sprinkler system locate 8 feet above the MFW pump floor and are considered in plume. Automatic suppression is actuated approximately two seconds after the start of the fire for this scenario.

FTBLARGE: Large Turbine Building Fire (Special Case Study)

This scenario is not analyzed using target sets and, therefore, is not in the summary tables presented in this section. The concern in this scenario is a large Turbine Building fire which can result in a total loss and/or collapse of the Turbine Building

In order to answer this, Turbine Building fires which occurred in the industry between 1965 and 1993, and which involved large losses, were studied (Ref. 4-14). In this period approximately 15 significant Turbine Building fires occurred. One of those fires, in Unit 2 at the Chernobyl Nuclear Power Station in 1991, resulted in major construction damage (collapse of the roof). Many other factors were involved in this event. For example, the coating on the roof had been removed after a 1986 accident at Chernobyl, unit 4; the local ventilation system was not designed for adequate smoke and heat removal; the sprinkler systems in the turbine building were not designed to cool the structural supports; and the plant fire pumps could not provide adequate flow to the area sprinkler systems and to the local fire fighters at the same time.

Another significant Turbine Building fire, which occurred in the Roseton Plant (Central Hudson Gas and Electric) in 1993, had a very high intensity, but didn't result in collapse of the Turbine Building walls or roof. The other problem discovered in the Roseton fire was that the Control Room operators were trapped in the Control Room. The Control Room, similar to other plants, has several exit doors, but these all led to areas of the Turbine Building. This is not a problem at MP2.

Based on industry experience, total collapse of the Turbine Building is considered unlikely. The operating floor, which usually includes extensive grated flooring, and the protected steel construction of the building are expected to withstand the worst case fire.

4.8.3 Summary of Results

A summary of the fire scenario frequencies for the MP2 is presented in Table 4.8-6.

Fire scenario M2A1B (Auxiliary Building, elevation -25'6", RBCCW Pump & Heat Exchanger Area (A-1B)) describes two potential initiating fire/transient events for the analyzed area; general plant transient and a loss of RBCCW, which have a frequencies of 2.2E-04/year and 1.2E-04/year, respectively. A 35% contributor to the General Plant Transient is associated with transient combustibles. Removal or alternate storage of these transient combustibles would virtually eliminate that portion for the associated fire scenario.

Fire scenario M2A1G (Auxiliary Building, elevation (-)5', general area (A-1G)) describes a potential initiating fire/transient event for the analyzed area; General Plant Transient, which has a frequency of 2.3E-03/year. The major contributor to this scenario is associated with an MC (90.6%). This is a result of counting each breaker cubicle as a single cabinet, which given the configuration and size differences is considered very conservative. These differences may need to be revisited should this scenario prove to be a dominant contributor to core damage. Additionally, a 3% contributor to the general plant transient is associated with transient combustibles. Removal or alternate storage of these transient combustibles would virtually eliminate that portion for the associated fire scenario.

Fire scenario M2A12A (Auxiliary Building, elevation 14'6", Boric Acid Batch & Chemical Addition Tank Area (A-12A)) describes a potential initiating fire/transient event for the analyzed area; General Plant Transient, which has a frequency of 7.5E-05/year. The major contributor (100%) to the general plant transient is associated with transient combustibles. Removal or alternate storage of these transient combustibles would virtually the associated fire scenario.

Fire scenario M2A24 (Auxiliary Building, elevation 25'6", Cable Vault Area (A-24)) describes a potential initiating fire/transient event for the analyzed area; General Plant Transient with shutdown outside the Control Room, which has a frequency of 2.E-07/year. The major contributor (100%) to the scenario is associated with a low voltage transformer near cable trays. This scenario credits automatic suppression and manual suppression to contain the fire to a small area and prevent the fire from spreading throughout the Cable Vault. Failure to suppress results in shutdown from outside the Control Room.

Fire scenario M2A25 (Auxiliary Building, elevation 38'6", Main Control Room Vault Area (A-25)) describes potential initiating fire/transient events for the analyzed area; General Plant Transient with shutdown outside the Control Room, which has a frequency of 2.E-07/year. The major contributors to the scenario are fires associated with main control board and ESAS cabinets. This scenario credits manual suppression to contain the fire to a small area and prevent the fire from spreading throughout the Control Room. Failure to suppress results in shutdown from outside the Control Room.

Fire scenario M2I1A describing a loss of all SW pumps in the Service Water Intake Structure, has a frequency of 3.E-4/year. That frequency is dominated by the frequency for target set M2I1A-1 & 4 (75.0%), which evaluates loss of all Service Water Pumps from a fire due to any of the Circulating Water Pumps. Fire of any of these three pumps, if lube oil is involved, can result in the loss of all SW pumps. The remaining contribution is associated with a Service Water Pump fire that results in a total loss of Service Water.

Fire scenario M2TB (Turbine Building, elevations 14'6" to 54'6", (areas T-1A, T-1C, & T-1F)) describes three potential initiating fire/transient events for the analyzed areas; General Plant Transient, loss of Instrument Air, and a loss of Main Feedwater, which have a frequencies of 8.5E-05/year, 1.12E-05/year, and 1.E-04/year, respectively. Certain of these scenarios automatic suppression if it is provided in the area of the fire. The Turbine Building fires which can disable all air compressors (three Instrument Air Compressors (IA) and one Station Air (SA) compressor) of potential concern. Two IA compressors (A & B) and the SA compressor are located in the southwest corner of the Turbine Building, next to the Condensate Pumps. One IA compressor (C) is located in the northwest corner of the Turbine Building. Two concerns exist with a fire for the scenario; loss of the compressors near the Condensate Pumps with cables for the other compressor routed over the Condensate Pumps, and smoke from the fire getting into the intakes for all the compressors. The cable routing issue will be addressed in the following section (Section 4.9). The issue associated with smoke resulting in the loss of the air compressors, the IA compressors A & B and the SA compressor have intakes inside the Turbine Building, the IA compressor C has an air intake from outside the Turbine Building. Additionally a cross tie to Millstone Unit 1 air system exists; therefore a loss of Instrument Air due to smoke from a fire in the Turbine Building can be screened from further consideration.

These fire scenarios are analyzed in the next section as fire initiating events in order to determine the plant responses and contributions to core damage frequencies.

4.9 Analysis of Fire Sequences and Plant Response

This section describes the important plant fire scenario sequences that were analyzed for the Millstone Plant Unit 2 (MP2) fire hazard risk analysis (Ref. 4-9). The results of this analysis represent the best estimates of fire risks at MP2.

4.9.1 Results

The total CDF for MP2 fire scenarios was quantified using the results from the MP2 Individual Plant Examination for Severe Accident Vulnerabilities (Ref. 4-15) and are documented in the 'MP2 Fire CDF Final Quantification' calculation file (Ref. 4-9). The CDF associated with fires at MP2 was determined to 6.30E-06/year. This is based upon the majority of the various individual analyzed fire scenarios being less than 1.0E-06/year. The reason for the fire scenarios relatively low contributions to CDF are varying combinations of the following;

- fire/combustibles/spatial interactions
- one train of electrical separation for the majority of fire scenarios
- three Auxiliary Feedwater Pumps (2 motor driven, 1 steam driven)
- small potential for RCP seal LOCAs
- unit cross connections (AC power, and instrument air)

Table 4.9-1 presents the results of the various analyzed fire scenarios. Auxiliary Building fires dominate the MP2 CDF at approximately 44%. The Auxiliary Building fire scenarios are associated with transient combustibles; specifically, large open racks of protective clothing located near cable trays at various locations within the Auxiliary Building. A catastrophic Turbine Building fire was determined to be the second most dominate contributor to MP2 fire induced CDF at approximately 26%. This fire scenario is a result of a bounding analysis and a high degree of uncertainty is associated with the inputs. However, given the importance of the turbine building for safe shutdown and the type of fire required, this bounding value is a considered a reasonable approximation of the fire CDF associated with the MP2 Turbine Building.

The Service Water Intake Structure fires contributed approximately 15% (9.6E-07/year) to the total fire CDF. There is no automatic suppression system in the intake structure and manual suppression was not credited in the analysis due to the estimated times to damage.

The fire scenarios associated with the control room and cable vault contributed the remainder of approximately 15%. These scenarios are by dominated operator failure to shutdown from outside the control room at the fire shutdown panel.

4.9.2 Methodology

The total fire CDF was calculated by summing the CDFs for all credible fire scenarios that can potentially occur in critical plant areas/zones at MP2. The fire scenario CDFs for MP2 were quantified using conditional core damage probabilities of representative initiating events from the MP2 Individual Plant Examination (IPE) for Severe Accident Vulnerabilities (Ref. 4-15). The identified IPE initiating events and their quantification allows the IPE conditional core damage probabilities to be used in the quantification for the fire analysis.

4.9.2.1 Modeling and Assumptions

Plant damage states, mutually exclusive cutsets, and circular logic are discussed within the internal events quantification (Ref. 4-15) and the fire CDF uses the basic internal events model. Therefore, no further discussion of plant damage states, mutually exclusive cutsets, or circular logic is required within this analysis.

A fire in any area was always assumed to result in a reactor trip from either automatic or manual initiation. Therefore, a fire in any area, at a minimum results in a General Plant Transient initiator/reactor trip (considered conservative in some cases since a review of affected components for the identified scenario would not result in or warrant the operators to trip the reactor, Ref. 4-9). The exceptions are those instances wherein the fire results in an initiator comparable to other initiators identified in the IPE (loss of RBCCW, loss of Instrument Air, loss of Service Water, etc.).

The quantification was performed as an iterative process crediting post fire human recovery actions for the IPE backup system unavailability dominant sequences when possible. Operator actions were credited whenever it was determined that the action was not affected by the fire scenario. The recovery actions modeled in the event trees or those manually added are discussed in Section 4.9.3 of this analysis.

4.9.2.2 Fire Analysis

The fire analysis quantified the total MP2 CDF via a manual summation of the various CDFs associated with the MP2 fire scenarios,

The CDFs for the various fire scenarios were quantified by multiplying the fire ignition frequency and the conditional core damage probability for a particular corresponding initiator from the IPE. Each analyzed fire initiator scenario for an area can be equated to a particular IPE plant transient initiator.

The fire scenario initiators were in some cases easily determined. For example - fire results in total loss of RBCCW, therefore the IPE total loss of RBCCW event tree is applicable. In other instances where a fire results in equipment and cable tray damage, a review of the affected equipment was warranted to determine the appropriate initiator. Reference 4-9, Appendix A contains the listing of the cable trays and the respective cables within the cable trays along with the components they serve which were determined to be affected by the various fire scenarios. These cable trays/cables were reviewed given certain fire scenarios to determine the appropriate initiator.

Based upon the previous discussion, it was determined that only a limited number of the internal event trees were applicable/relevant to the fire CDF quantification. These are:

Initiating Event	Independent Sys. Unavail.	Figure #
General Plant Transient	1.39E-06	4.9-1

Loss of DC 'A'	7.33E-04	4.9-2
Loss of DC 'B'	7.33E-04	4.9-3
Loss of RBCCW	1.50E-04	4.9-4
with Consequential Small LOCA	1.50E-03	4.9-5
with Consequential Small Small LOCA	1.50E-03	4.9-6
Total Loss of Service Water	2.18E-04	4.9-7
with Consequential Small LOCA	1.50E-03	4.9-5
with Consequential Small Small LOCA	1.50E-03	4.9-6
Loss of Main Feedwater	2.54E-06	4.9-8
Loss of Instrument Air	1.92E-05	4.9-9
Loss of Normal Power	8.31E-04	4.9-10

Generally, a fire scenario would result in one of these transient events depending upon the location of the fire within the plant and the equipment affected.

4.9.3 Human/Recovery Actions

The OA/HIs credited within this analysis were originally derived in the internal events analysis (Ref. 4-15). These OA/HIs were evaluated to determine their applicability to this analysis (can the operator still perform the action or does the fire scenario location preclude him from performing that action). Base upon the review of all applicable internal events and their associated OA/HIs, it was determined that the OA/HIs were applicable to this analysis (see Ref. 4-15 for a listing of the OA/HIs for the initiating events discussed in Sec 4.9.2.2). The only exception to this was a screening value that was assigned to the ability of the operator to successfully shutdown from outside the Control Room following evacuation from the Control Room (due to fire) or Cable Spreading Room fires.

4.9.3.1 HRA Insights

The operator actions associated with shutdown from the fire shutdown panel are important for Control Room fires and Cable Spreading area fires.

A fire in these areas has the potential for disabling vital equipment necessary to safely shutdown the plant. Additionally, fires within the Control Room may create habitability concerns for the operators. Therefore, a fire in these areas may or may not require the Control Room to be evacuated yet control may need to be established from the Fire Shutdown Panel located in the Facility Z2 4160V Switchgear Room.

The design of the MP2 main control board and Cable Spreading area is such that limited separation exists. Due to this limited separation, a relatively small panel fire or spreading area fire can affect a significant amount of equipment located throughout the plant. Thus, for certain fire scenarios of concern, the operators may be required to shutdown using equipment associated with MP2 bottleup panels and the fire shutdown panel.

In general, the following observations can be made concerning fires within these areas at MP2:

The fire has the potential to cause spurious signals in control and instrumentation circuits. As a result, instrumentation readings may not be correct. This should prompt the operators to question any instrumentation readings on the affected main control board panel

Operator response due to insufficient or false instrumentation could further compound the adverse effects to the fire on the plant.

For Control Room fires which result in a small LOCA (shorting within a control panel that results in lifting PORVs) the operator can mitigate the transient via control switches located in the "bottleup" panels beside the Control Room door in the East 480V Load Center Room (area A-28).

The important operator actions for a fire in these areas are: 1) the decision to shutdown from inside or outside the Control Room, 2) isolating the Control Room by the "bottleup" panels when warranted, and 3) establishing control from the Fire Shutdown Panel. These actions are covered within plant procedures (Ref. 4-16). The associated OA/HI failure probability is assumed to be 1.0E-03. This failure probability is a screening value and is based on HRA calculator for actions with training and procedures available.

The additional evaluated human actions associated with recovery from fires which in some cases are covered by procedure are discussed below:

Fires are assumed to disable the auto start function of the diesel generators therefore operators are required to start the diesel generators locally.

AFW pumps can be controlled from various locations within the plant (alternate and fire shutdown panels) as well as locally from within the AFW enclosures if control is lost from the control room.

Those OAs and HIs that were developed specifically for the MP2 fire analysis are based upon MP2 Station Fire Procedures (Ref. 4-17 through 4-20).

4.9.4 Fire Sequence Evaluation/Quantification

In some cases the method employed for the evaluation/quantification of the MP2 fire sequences used MP2 IPE CAFTA model fault trees, and event trees for the dominant fire scenarios identified in Table 4.8-6. For a scenario, the relevant IPE event tree or trees were selected and then modified to represent the fire scenario being analyzed. In other cases IPE results were used directly independent to the IPE initiating event frequency.

For instances where a CAFTA quantification was considered warranted the following actions were performed for the quantification;

The IPE initiating event frequencies associated with the event trees were redefined to the fire event scenario and set equal to one. This yields the independent support system unavailability for the various fire scenario cases analyzed.

The truncation limit for support system unavailability was set at 1.0E-6 or each of the various cases. This truncation limit when multiplied by a fire ignition scenario frequency of generally 1.0E-2 or less yields a CDF of 1.0E-8 or less. A CDF of 1.0E-8 or less is considered non-risk significant for purposed of this analysis.

Components affected by the fire scenario within the respective event tree were all assumed unavailable and the basic event or module redefined equal to one (failed) within the appropriate CAFTA flag file.

In some instances recovery actions modeled within the event tree(s) could not be credited. Therefore, these actions/paths were assumed failed in the event tree and the results revised accordingly.

For fire scenarios that have a CDF (fire scenario ignition frequency times independent support system unavailability) of greater than 1.0E-5, additional post fire recoveries were evaluated and credited for the dominate sequences where alternate recoveries were considered credible. These post fire recoveries are in addition to those recoveries that were by an alternate means than those identified within the IPE.

The total fire hazard CDF for the applicable representative fire scenarios for MP2 is 6.30E-06/yr and is presented within Table 4.9-1. This CDF credits limited post fire operator recovery actions including those previously modeled within the IPE when applicable.

The following are brief summaries of the evaluated fire scenarios along with some of their more dominate cutsets and the associated CDF from Reference 4-9.

Initiator - **Fire Scenario M2A1B1** (2.2E-04)

Description: Transient combustible or panel fire in Auxiliary Building at elevation (-)25' - 6" affecting cable trays in the vicinity of the respective fires. Appendix A of Ref. 4-59, provides a listing of the cables in the cable trays that were considered affected by the respective fires. A review of the affected cables and the associated equipment that they serve determined that the fire would result in a very limited loss Facility Z2 equipment and not result in a significant plant transient.

Resultant Initiating event: Reactor Trip with a limited loss of Facility Z2 components. A loss of DC bus B was assumed to model this event. The loss of DC bus B is considered conservative since it does not credit any Facility Z2 equipment being available.

Event Tree(s): Loss of DC Bus B (no recoveries actions associated with the bus were credited)

Conditional Core Damage Probability (CCDP): 7.33E-4

Major Cutset Sequences: Loss of the steam driven AFW pump and loss of the "A" motor driven AFW pump.

CDF: 1.61E-7/year

Comments: The operator recovery actions in the loss of DC Bus B event tree were not credited. By not crediting recovery of DC bus B, only the motor and steam driven AFW pumps were conservatively credited for shutdown for this scenario.

Initiator - **Fire Scenario M2A1B2** (1.2E-04)

Description: RBCCW pump fire in Auxiliary Building elevation (-)25' - 6" resulting in a total loss of RBCCW. Ref. 4-15 evaluated the total loss of RBCCW.

Resultant Initiating event: Loss of RBCCW with the potential for either consequential small or small small LOCA. No recovery of RBCCW can be credited.

Event Tree(s): Loss of RBCCW, Consequential Small LOCA, Consequential Small Small LOCA

CCDP: 1.0E-05 (Loss of RBCCW), 1.5E-03 (Consequential Small LOCA), 1.5E-03 (Consequential Small Small LOCA)

Major Cutset Sequences: Reactor Trip Failure, Operator fails to trip the RCPs, RCP Seal failure

CDF: 3.60E-07/year

Comments: The operator recovery actions credited in the IPE can not be credited since a nonrecoverable loss of RBCCW is assumed, as a result of the fire.

Initiator - **Fire Scenario M2A1G1** (2.3E-03/year)

Description: Transient combustible or panel fire in Auxiliary Building at elevation (-)5' affecting cable trays in the vicinity of the respective fires. Appendix A of Ref. 4-9, provides a listing of the cables in the cable trays that were considered affected by the respective fires. A review of the affected cables and the associated equipment that they serve determined that the fire would result in a very limited loss facility Z1 equipment and not result in a significant plant transient.

Resultant Initiating event: Reactor Trip with a limited loss of facility Z1 components. A loss of DC bus A was conservatively assumed to model this event. The loss of DC bus A is considered conservative since it does not credit any facility Z1 equipment available.

Event Tree(s): Loss of DC Bus A

CCDP: 7.33E-04

Major Cutset Sequences: Loss of the steam driven AFW pump and loss of the "B" motor driven AFW pump.

CDF: 1.69E-6/year

Comments: The operator recovery actions in the loss of DC Bus A event tree were not credited. By not crediting recovery of DC bus A, only the motor and steam driven AFW pumps were conservatively credited for shutdown for this scenario.

Initiator - **Fire Scenario M2A12A** (7.5E-04/year)

Description: Transient combustible fire in Auxiliary Building at elevation 14' - 6" affecting cable trays in the vicinity of the fire. Appendix A of Ref. 4-9, provides a listing of the cables in the cable trays that were considered affected by the fire. A review of the affected cables and the associated equipment that they serve determined that the fire would result in a very limited loss of Facility Z1 equipment and not result in a significant plant transient.

Resultant Initiating event: Reactor Trip with a limited loss of Facility Z1 components. A loss of DC bus A was conservatively assumed to model this event. The loss of DC bus A is considered conservative since it does not credit any facility Z1 equipment available.

Event Tree(s): Loss of DC Bus A

CCDP: 7.33E-04

Major Cutset Sequences: Loss of the Steam Driven AFW pump and loss of the "B" Motor Driven AFW pump.

CDF: 5.50E-7/year

Comments: The operator recovery actions in the loss of DC Bus A event tree were not credited. By not crediting recovery of DC bus A, only the Motor and Steam Driven AFW pumps were conservatively credited for shutdown for this scenario.

Initiator - **Fire Scenario M2A241** (1.0E-04/year)

Description: Low voltage transformer fire in Auxiliary Building Cable Vault affecting cable trays in vicinity.

Resultant Initiating event: Based upon a review of the potentially affected cables, in the vicinity of the low voltage dry transformer, a partial LNP could result. This scenario was conservatively modeled as an LNP with only facility Z2 assumed available.

Event Tree(s): Loss of Normal Power

CCDP: 8.31E-04

Major Cutset Sequences: Loss of the Steam Driven AFW pump and loss of the "A" Motor Driven AFW pump.

CDF: 8.31E-8/year

Comments: This scenario is considered conservative since it considered a small metal enclosed low voltage dry transformer as the initiator and combustible. Generally these are not considered viable ignition and combustible sources; however, given its relative location to a group of cable trays in the cable vault the scenario was analyzed. The scenario assumes that successful operation of either auto and/or manual suppression are successful fire spread within the cable vault.

Initiator - **Fire Scenario M2A242** (2.0E-07/year)

Description: Unsuppressed fire in Auxiliary Building Cable Vault resulting in a total loss of the cable vault. Both automatic and manual suppression failure probabilities are considered in order for this transient to occur.

Resultant Initiating event: Reactor Trip with a loss of the majority of facility Z1 and Z2 components.

Event Tree(s): N/A

CCDP: 1.0 (The area has cabling protected by THERMOLAG for components required for shutdown for a major fire in this area. Due to the questionable reliability of THERMOLAG for such a large fire, these components were not credited. Therefore, if automatic and manual suppression fail, it is conservatively assume core damage occurs.)

Major Cutset Sequences: N/A

CDF: 2.00E-07/year

Comments: This scenario does not credit the use of the steam drive AFW pump for shutdown.

Due to the amount of equipment affected by a total loss of the cable spreading area the manipulative operator actions associated with shutdown are recognized as being dominate. Therefore, given the relatively low ignition frequency for this event it was conservatively assumed that the CDF is bounded by not crediting shutdown using the steam driven AFW pump.

Initiator - **Fire Scenario M2A25** (3.8E-04/year)

Description: This fire scenario considered the spectrum of fires that can occur in the Control Room main control board. A fire involving multiple cabinets is assumed to require shutdown from outside the Control Room. Fires involving only a single cabinet it was determined base upon cabinet design and is assumed to result in a respective plant transient. as discussed in Sec. 4.9.2.2.

Resultant Initiating event: Reactor Trip with a loss of the majority of Facility Z1 and Z2 components for multiple involved cabinets. Plant transient with Reactor Trip.

Event Tree(s): See Section 4.9.2.2

CCDP: 1.0E-03 (operator failure Fire Shutdown Panel), 7.3E-04 (AFW failure)

Major Cutset Sequences: Operator fails to shutdown from Fire Shutdown Panel, Loss of the Steam Driven AFW pump and loss of the respective Motor Driven AFW pump.

CDF: 6.57E-07/year

Comments: Operator actions were credited for multiple cabinet fire requiring shutdown outside the Control Room. For single cabinet fires the Steam Driven and Motor Driven AFW pumps were credited for safe shutdown

Initiator - **Fire Scenario M2I1A** (3.0E-04/year)

Description: Fire in Intake Structure Pump Area resulting in a total loss of Service Water.

Resultant Initiating event: Total Loss of Service Water with the potential for either consequential small or small small LOCA. No recovery of SW can be credited.

Event Tree(s): Loss of Service Water, Consequential Small LOCA, Consequential Small Small LOCA

CCDP: 2.2E-04 (Loss of Service Water), 1.5E-03 (Consequential Small LOCA), 1.5E-03 (Consequential Small Small LOCA)

Major Cutset Sequences: Reactor Trip Failure, Operator fails to trip the RCPs, RCP Seal failure

CDF: 9.66E-07/year

Comments: The low CDF for the loss of Service Water at MP2 is a result of the following plant design features;

- loss of Service Water has a low probability of resulting in a seal LOCA due to the design of the RCP seals.
- a cross connect for air exists from MP1.
- room temperature/ventilation indication exists for areas where loss of Service Water results in losses of room cooling.

Initiator - **Fire Scenario M2TB1** (8.5E-04/year)

Description: Fire in the Turbine Building in the TBCCW pump and/or condenser vacuum pump area resulting in a General Plant Transient.

Resultant Initiating event: General Plant Transient

Event Tree(s): General Plant Transient

CCDP: 1.39E-06

Major Cutset Sequences: N/A

CDF: 1.18E-09/year

Comments: The potential concern for a fire in this area are potential loss of Service Water pump C, the MP1 4160V backfeed, a train of AFW, and power from 4160V bus Z5 due to these respective cables routed in the vicinity being affected. Given the relative location of these cables to the ignition source, the quantities of combustible, limited protection offered by THERMOLAG, it was determined that a fire in the area would only result in a general plant transient with the previously mentioned equipment still considered available.

Initiator - **Fire Scenario M2TB2** (3.8E-06/year)

Description: Fire in the Turbine Building in the air compressor area resulting in a partial loss of Instrument Air.

Resultant Initiating event: The resulting initiating is a partial loss of instrument air since compressor on opposite side of TB and unit 1 crosstie are not affected by this fire scenario. The initiating event was conservatively modeled as a total loss of Instrument Air

Event Tree(s): Loss of Instrument Air

CCDP: 1.92E-05

Major Cutset Sequences: N/A

CDF: >1.0E-10

Comments: The concern from a from this scenario is the potential loss of the C compressor and the unit 1 crosstie either from fire damage to cabling or smoke. The C compressor has an external intake and no cabling for the C compressor or the crosstie were identified in the vicinity which could be affected by the fire scenario.

Initiator - **Fire Scenario M2TB3** (2.0E-03/year)

Description: Transformer, MFW pump, or Condensate pump fire that results in a plant transient.

Resultant Initiating event: Loss of Main Feedwater (determined to be the most limiting initiator over General Plant Transient or loss of Station Air & partial loss of Instrument Air).

Event Tree(s): Loss of Main Feedwater

CCDP: 2.54E-06

Major Cutset Sequences: Total loss of AFW

CDF: 5.08E-09/year

Comments: The CDF associated with this fire scenario is not considered bounding and is further discussed in fire scenario M2TBL. This fire scenario ignition frequency looks at the broad spectrum of fires. It is concluded based on a review of the data presented in Reference 4-11 and the layout/design of the MP2 Turbine Building the majority these fires if not suppressed would remain fairly localized, cause significant local damage, eventually burn themselves out, yet not result in a total loss of the Turbine Building (TB). The concern is the large catastrophic TB fire for MP2 which discussed further in M2TBL.

Initiator - **Fire Scenario M2TBL (Special Case Study)**

At MP2 the turbine building is recognized as being very important to safe shutdown. The effects of losing certain equipment at MP2 due to fire are already addressed in the previous fire scenarios, where the loss of safety systems in the various areas and zones within the plant are analyzed (Sections 4.6 and 4.9).

The concern in this scenario is a large Turbine Building fire which can result in either extremely large Turbine Building fire with or without a collapse of the Turbine Building. The loss of the Turbine Building will result in a loss of safe shutdown equipment located there (ie. AFW, SW, AC power) and leads to core damage. This scenario is not analyzed using target sets, this scenario was analyzed by a bounding analysis.

The Turbine Building overall has a very relatively high load of combustibles and fire sources. This must be tempered by weighing the following against each other;

- what are potentially credible fires which could involve large quantities of combustibles
- the availability of either automatic and manual suppression at the location of the fire
- the relative location/availability of safe shutdown equipment within the Turbine Building to the fire

When considering these items and upon inspection of Turbine Building the areas where a significant amount of combustible exists along with an ignition source are the, H_2 Seal Oil Unit Zone, the neutral grounding transformer, the Main Feed Water pumps, and the Turbine Generator (T/G). These locations within the turbine have the potential for an extremely large fire which if not contained or suppressed could affect the safe shutdown equipment located in the Turbine Building.

These locations/components have automatic suppression systems associated with them and the fire brigade is trained in combating oil fires. Therefore, both of these suppression capabilities can be credited for the large Turbine Building fire scenario.

The location of safe shutdown equipment relative to these sources varies (approximately 50 - 100 feet) and fire protection is provided (ie., sumps, floor drains, fire rate enclosures, THERMO-LAG, etc.) for these items within the Turbine Building.

The fire ignition frequency associated with the seal oil unit, the MFW pumps, and the T/G (Ref. 4-11) is 2.65E-2/year. This ignition frequency represents a total of 39 fires of all sizes none of which would be consider a large catastrophic fire. The fire of concern for this bounding analysis is the catastrophic fire/combustible which has an estimated ignition frequency of about two orders of magnitude less (2.65E-4/year). If this type of fire is not contained/suppressed it is assumed to result in a total loss of the turbine building and ultimately core damage. Given the automatic (.05) and/or manual (.1) suppression failure probabilities the CDF associated with this scenario is calculated to be 1.33E-06/year.

Another, catastrophic fire/combustible source is the neutral grounding oil filled transformer which has an ignition frequency of 1.0E-04/year, where 60% is associated with explosive failure (6.0E-05/year). Thus, the nature of the failure and some of the additional combustibles in the vicinity, if the fire is not contained/suppressed could result in loss of the turbine building and ultimately core damage. Given the automatic (.05) and/or manual (.1) suppression failure probabilities the CDF associated with this scenario is calculated to be 3.0E-07/year.

It is therefore the engineering judgement of this analyst that the Turbine Building fire CDF be bounded by 1.63E-06/year based upon the previous discussion.

4.10 Analysis of Containment Performance

Containment performance was analyzed to determine whether there are sequences that involve failure modes resulting from fire that are distinctly different from those found in the IPE internal events evaluation or contribute significantly to the likelihood of Containment functional failure. The following Containment failure modes were identified and evaluated:

1. Containment isolation / bypass analysis
2. Containment overpressure failure
3. Thermal attack of penetration seals

4.10.1 Containment Isolation / Bypass Analysis

A summary of the Containment isolation / bypass analysis is given in Table 4.10-1. There were no potential fire related Containment performance vulnerabilities. The screening criteria for each penetration is given in Table 4.10-1.

4.10.2 Containment Overpressure Failure

The CAR Fans and Containment Spray system were identified as the MP2 systems that are designed to prevent overpressurization of Containment. Based on MP2 success criteria, all four CAR Fans and Containment Spray must fail in order to fail the Containment heat removal function. The control and power cable routing of these systems was analyzed to determine if a fire in a single area or compartment could fail all four CAR Fans and Containment Spray. This evaluation concluded that a fire in a single area or adjacent compartment does not have the potential to result in these failures unless it occurs in the Control Room or Cable Vault. With regard to the Control Room, this is unlikely because a fire in the Control Room would be detected early and mitigated. The Cable Vault is not considered a problem because train separation is at least 20 feet (Appendix R). Therefore, a fire is highly unlikely to fail both trains.

4.10.3 Thermal Attack of Penetration Seals

Thermal attack on penetration seals becomes a threat to Containment at temperature above 300 degrees F. Each Containment penetration was located and evaluated to determine if there was sufficient combustibles surrounding them to sustain a fire for a period long enough to damage the penetration seals.

The following penetrations are located in the West Penetration Room at elevation 38'6": 20, 16, 17, 62, 41 and 61. The West Penetration Room (38'6") does not contain sufficient combustibles to damage the penetration seals. (The combustible loading from Appendix A is 2278 Btu/ft^2.). The following penetrations are located in the East Penetration Room at elevation 38'6": 88, 89, 85, 39, 40, 84, 86, 87, 83, 15, 82, and 19. The East Penetration Room (38'6") does not contain sufficient combustible to damage the penetration seals. (The combustible loading from Appendix A is 786 Btu/ft^2.). The following penetrations are located in the West Penetration Room at elevation (-)5': 21, 37, 3, 6, 38, 2, 65, 72, 69, 66, 29, 1, 8, 74, 24, 10, 55, 73 4, 56, 9, 14, 58, 30, 79, 36, 53, 25, 35, 54, 31, 80, 26, 63, 7, 70, 64 and 43. The West Penetration Room (-5') does not contain sufficient combustibles to damage the penetration seals. (The combustible loading from Appendix A is 8985 Btu/ft^2). The following penetrations are located in the East Penetration Room at elevation (-)5': 46, 68, 34, 51, 47, 81, 5, 52, 22, 11, 57, 23, 32, 67, 33, 50, 59, 49, 48, 73, 28, 60, 71 and 27. The East Penetration Room (-5') does not contain sufficient combustibles to damage the penetration seals. (The combustible loading from Appendix A is 57 Btu/ft^2). Penetrations 13 and 12 are located in the West Penetration Room at elevation (-)25'6". This room has a combustible loading of 22486 Btu/ft^2. However, the room does not contain an ignition source.

4.11 Treatment of Fire Risk Scoping Study Issues

NRC Generic Letter 88-20, Supplement 4 lists the following Fire Risk Scoping Study issues to be addressed in the IPEEE fire analysis.

- Effectiveness of manual fire fighting
- Fire barrier assessment
- Seismic/fire interactions
- Effectiveness of fire suppressant on safety equipment
- Control systems interactions

The specific concern regarding each of these issues are discussed in the EPRI-sponsored plant screening guide Fire Induced Evaluation Methodology (FIVE). The FIVE methodology was used as a guidance for evaluating each of the issues. Several walkdowns were performed using Attachment 10.5 of the FIVE methodology as guidance for assessing issues. A matrix was developed to fill in the information relative to each fire zone/area. Designations used in the matrix are the same as that used in the MP2 fire protection program evaluation. The walkdowns were done by fire protection engineers and PRA engineers.

As necessary, relevant fire risk scoping study issues have been incorporated into other phases of this study, such as the area screening and detailed fire scenario evaluations.

The evaluation for each of these issues is discussed below.

4.11.1 Effectiveness of Manual Fire Fighting

To evaluate the manual fire fighting effectiveness at MP2, a questionnaire was developed and transmitted to the Senior Nuclear Fire Training Instructor for input. The questionnaire was based upon the attributes listed in Attachment 10.5 of the FIVE methodology. From the results of the questionnaire, each of the attributes listed in Attachment 10.5 of the FIVE methodology is met by MP2.

Northeast Utilities has recently constructed and completed a state-of-the-art live fire fighting training facility by SYMTRON at Millstone Point. This facility was declared operational and started training fire brigade crews on May 1, 1994. The training structure is a building within a building design. The inner most building is subdivided into six fire fighting areas which simulate the following plant areas;

- turbine generator fires
- hydrogen seal oil fires
- diesel generator fires
- switchgear/cable tray fires
- auxiliary boiler fires
- storage/general area fires

The fires are simulated with natural gas and nontoxic smoke. Millstone Point fire brigade crews have trained and continue to train at this facility.

A review of unannounced fire drills for MP2 was also performed. This review determined that the mean response time for crediting manual fire fighting by the fire brigade is approximately 15 minutes for the majority of MP2 areas.

The exception is the Main Control Room which is continuously manned and observed response times are approximately 2 minutes. During some of the walkdowns Control Room operators and trainers were given a scenario of a fire in the main control board. The operators and trainers were requested to role play and the response times were observed. The maximum observed response time was approximately two minutes from the time of detection (first fire panel alarm) until the fire was considered suppressed.

Based upon these factors for a main control board fire the following was concluded: 1) the short response time of the operators to a fire and the relatively combustible loading of the panels, a fire would remain fairly contained to its respective panel with little or no chance of spread to adjacent panels before it is suppressed, 2) even though an entire panel could be lost from a small fire the overall damage to the adjacent panels from the resultant fire is expected to be minimal.

At MP2 the fire protection program requires that a dedicated fire watch be present any time hot work (welding, grinding, cutting, etc) is being performed. This fire watch is trained in manual fire fighting and must remain in the area for an additional half hour after the hot work has been completed.

Additionally, Northeast Utilities requires all of its employees that are badged at any of its nuclear facilities to take annual General Employee Training (GET). As part of the GET employees are taught ; 1) the various types of fires, 2) Control Room reporting requirements, 3) suppression methods for various classes of fires and 4) that the employee is given the freedom to combat certain fires if they feel confident after reporting it to the Control Room.

This supports the overall industry observation that the majority of fires are suppressed by individuals and only in rare cases is the fire brigade required to combat the fire.

4.11.2 Fire Barrier Assessment

The issue of Fire Barrier Qualification was raised as part of the USNRC sponsored Fire Protection Research program at Sandia. The Fire Risk Scoping Study did not identify any generic vulnerability of qualified fire barrier elements (Reference 4-21). However, the NRC issued several Information Notices which made it necessary that each plant demonstrate that their fire barriers and associated barrier components are being adequately designed, inspected, tested and maintained.

As part of the MP2 IPEEE evaluation, the response to each pertinent Information Notices was reviewed. The various documents mentioned below were reviewed, if additional information was necessary, a fire protection individual was consulted. As a result of this research it was determined that the fire barriers at MP2 are being adequately design, inspected, tested and maintained. The basis for this conclusion is summarized in the subsequent paragraphs.

In October of 1983 the NRC issued I&E Information Notice # 83-69 "Improperly Installed Fire Dampers at Nuclear Power Plants" (Reference 4-22). In response to this, all fire dampers were inspected under the Appendix 'R' Fire Barrier Program at MP2. If fire dampers were found to be improperly installed, their configuration was modified.

Northeast Utilities issued NUSOER # 85-05 (Reference 4-23) in November of 1985 which addresses the issue identified in I&E Information Notice # 89-52 "Potential Fire Damper Operation Problems" (Ref. 4-24). As a result of NUSOER 85-05, MP2 procedure SP-2618G was developed and implemented.

In August of 1988 the NRC issued I&E Information Notices # 88-04, 88-04 Supplement 1 and 88-56, "Inadequate Qualification and Documentation of Fire Barrier Penetration Seals" (Ref. 4-25) and "Potential Problems with Silicon Foam Fire Barrier Penetration Seals" (Ref. 4-26). As a result of these Information Notices, MP2 developed Surveillance Procedure SP2734D and this is performed every 18 months.

4.11.3 Seismic Fire Interactions

Three issues were addressed under the Seismic/Fire interactions. They are: (i) seismically induced fires, (ii) seismic actuation of fire suppression systems, and (iii) seismic degradation of fire suppression systems. Additionally, the insights gained from Information Notice 94-12 (Ref. 4-27) were incorporated into this analysis. The results of associated I&E Information Notice #

94-12 walkdowns are documented in Reference 4-28.

4.11.3.1 Seismically Induced Fires

Breakage of flammable liquid or gas vessels during a seismic event could create fire hazards in the plant. Therefore, potential vulnerabilities were examined during the seismic walkdowns. Reference 4-29 provided a list of major tanks containing flammable/combustible fluids. These tanks were examined during the seismic walkdowns for any potential vulnerabilities. No vulnerabilities were identified with any of the oil storage tanks or hydrogen supply lines at MP2. However, the MP1 diesel fire pump fuel tank was identified for future evaluation (Ref. 4-28). MP2 credits the MP1 fire suppression system (Section 4.7) for fire protection. Several questions were asked and answered with respect to this tank. First, during an earthquake, will the tank fall over?

- Considering the dimensions of the tank, this appears to be a high likelihood event.

And, if the tank falls, are there any available ignition sources?

- Given, the number of electrical components in the area, it appears that ignition is probable.

If a fire does erupt, will the suppression system extinguish the fire or will the structure containing the fire suppression system survive the seismic event to contain the fire?

- The fire pump house suppression system is a wall mounted Halon 1301 system. The system will likely discharge. However, since the fuel tank is likely to fail, the diesel fire pump is considered failed.

4.11.3.2 Seismic Actuation of Fire Suppression Systems

Several types of seismic induced events can cause inadvertent actuation of fire suppression systems and potentially damage the safety related equipment for accident mitigation. The potential adverse effects of actuation of fire protection system on safety-related equipment is discussed in Section 4.11.4 under "Total Environmental Equipment Survival."

Reference 4-27 provides insights the NRC staff gained from resolving Generic Issue # 57, "Effects of Fire Protection System Actuation on Safety Related Equipment." These insights (Attachment #1 to Ref. 4-27) were also reviewed to ensure that MP2 adequately meet the fire/seismic interaction concerns. Reference 4-28 provides the insights/results of walkdowns NUSCO performed to address the findings associated with I&E Information Notice # 94-12.

Halon Systems are used within the Computer Room and the Facility Z1 & Z2 DC Switchgear Rooms. Based on Reference 4-3, the Halon Systems at MP2 are actuated by cross-zoned detection. These cross-zoned detectors are provided to prevent false actuation of the systems. The system will only actuate when two detectors are initiated. Therefore, the probability of inadvertent actuation, via detector failure, becomes low. However, during a seismic event, it is assumed that a spurious signal (dust, relay chatter, etc.) would potentially be generated to activate the cross-zone detection feature. The Computer room and DC Switchgear Rooms are considered habitated areas and are therefore protected with Halon Systems. The Halon Systems have either a one minute or 20 second delay prior to actuation. They also have the additional feature of a manual disable during this time provided that the discharge relays for these systems did not actuate during the seismic event. While an inadvertent discharge of Halon is undesirable in habital areas, the equipment and operators within these areas would still be considered as able to perform there respective functions.

The risk due to water damage, associated with inadvertent operation of sprays, is addressed in Section 4.11.4. The Emergency Diesel Generator Rooms at MP2 have a preaction fire suppression system which requires multiple failures for actuation.

During many walkdowns performed to address USI A-46 and IPEEE, the anchorages of MCCs, switchgear, and other electrical cabinets were examined for adequacy. This examination provided reasonable assurance against damage to fire safety related electrical cabinets.

The only area protected/affected by CO_2 at MP2 is the Main Generator Exciter Enclosure. Inadvertent actuation, at worst, would result in a turbine/plant trip which is considered enveloped by the IPEEE seismic analysis. The anchorage of the CO_2 bottles were examined and found adequate for restraint during a seismic event .

4.11.3.3 Seismic Degradation of Fire Suppression System

In order to ensure that the fire suppression systems are installed in accordance with nationally recognized codes and standards, a request for information was generated by the IPEEE project team. In response to this request, Reference 4-3 states that the MP2 fire protection systems are designed to the National Fire Codes, specifically NFPA-13, 15, 72D, and 72E. Section 7.2 of Reference 4-1 indicates that the fire suppression systems are installed in accordance with nationally recognized codes and standards generally provide an adequate level of support for piping.

In addition to the above, the fire protection system piping was reviewed as part of the seismic walkdowns. These walkdowns examined the potential for seismic interaction effects of fire water pipes and spray nozzles, seismic vulnerabilities and also internal flooding events attributed to seismic induced failures. Reference 4-28 summarizes vulnerabilities identified as a result of these walkdowns. Specifically, the following items appeared to have a very low seismic capacity and be important to the fire suppression capability at MP2:

- a long run of fire water header system piping along the Turbine Building's north wall. (inadequately attached to its supports),
- the MP1 diesel fire pump fuel oil tank,
- and the block wall construction of the MP2 & MP1 fire pump houses.

The Computer Room has a Halon 1301 suppression system mounted on a block wall of indeterminate seismic capacity (Ref. 4-28). The affect of loss of this system or the inadvertent discharge is the potential loss of the Computer Room (The plant computer is not credited for safe shutdown).

The only area protected/affected by CO_2 at MP2 is the Main Generator Exciter Enclosure. Inadvertent actuation, at worst, would result in a turbine/plant trip which is considered enveloped by the IPEEE seismic analysis. The anchorage of the CO_2 bottles were examined and found adequately restraint for a seismic event .

4.11.4 Total Environmental Equipment Survival

Based on the results from the Fire Risk Scoping Study, three major concerns are raised regarding the Total Environmental Equipment Survival issue:

(i) The potential adverse effects of actuation of fire protection systems (inadvertent and advertent) on safety-related equipment.

(ii) The potential adverse effects of combustion products on safety-related equipment.

(iii) The potential adverse effects of a smoke-filled environment on operator effectiveness in performing required actions.

(i) <u>Effects of Fire Protection System Actuation</u>: There has been a significant amount of work done in the area of estimating adverse effects from the Fire Protection System (FPS) actuation. In Reference 4-30, 150 License Event Report (LER) events involving FPS actuation are analyzed. 133 events involve inadvertent actuation (12 of those events occurred before initial criticality) and 17 events involve advertent FPS actuation.

Assessment of available data on effects of water on equipment (Ref. 4-31), showed that equipment failure due to electrical shorts (or due to corrosion in the long term) could occur if water intrusion into equipment occurs. The possibility of water intrusion is dependent on the type of water spray or on the configuration of the equipment enclosure. From the LER data (Ref. 4-30), 32 of 118 water system actuations caused some safety equipment damage. (Note: the equipment damage does not necessarily imply loss of equipment function). Based on the LER data, the probability of damage to safety-related electromechanical equipment was estimated to be 0.27 per exposure (Ref. 4-30). Based on the results from Reference 4-31, it was estimated that water spray patterns under consideration in this analysis will not fail cables in the plant.

Assessment of available data on effects of Halon on equipment (Ref. 4-31), indicated that a certain degree of corrosion on exposed metallic and non-metallic parts is to be expected as a result of a Halon discharge. In the short term, corrosion has not demonstrated a capability to fail electrical equipment. The main concern with Halon would only be long-term corrosion, which is out of the scope of this fire risk analysis. From the LER data (Ref. 4-30), 0 out of

15 Halon reported actuation caused safety equipment damage. Therefore, Halon induced damage on the safety-related equipment was not considered.

Assessment of available data on effects of Carbon Dioxide (CO_2) on equipment (Ref. 4-31) indicated that as a result of CO_2 discharge a certain degree of condensation can be expected to occur. The question is, under what conditions (the surrounding temperatures and the amount of moisture in the air) is there enough condensation formed to cause equipment failure due to electrical shorts. Another area of concern with CO_2 is equipment failure due to snow-ice buildup. From the LER data (Ref. 4-30), 0 out of 17 CO_2 reported actuation caused safety equipment damage. The only area protected/affected by CO_2 at MP2 is the Main Generator Exciter Enclosure. Inadvertent actuation at worst would result in a turbine/plant trip which is considered enveloped by the IPE general plant transient initiator

Inadvertent (not fire-related) actuation of FPSs was evaluated qualitatively but not specifically quantified in this report. Nonseismic FPS actuation frequencies in some of the important fire areas (Ref. 4-11) compared to MP2 fire ignition frequencies in the same areas, are given in the table below:

Fire Zone	FPS in the Zone	Fire Frequency per Reactor Year	FPS Actuation Frequency per Reactor Year
Cable Vault Area	Water Wet Pipe	1.0E-3	9.6E-3
Diesel Generator Room	Water Preaction	1.6E-2	1.6E-3
Switchgear Room	Halon	7.7E-3	9.7E-4

For Cable Vault area, even though the actuation frequency is relatively high, the impact of water spray on cables is insignificant. The concern is water getting to the DC switchgear located below the Cable Vault. This condition is addressed in the MP2 IPE for internal flooding which did not identify any vulnerabilities associated with the Cable Vault fire suppression system. For the DC Switchgear Rooms, the FPS actuation frequency is very low compared to the fire frequency. Further as pointed out earlier, Halon has minimal short term impact on safety system operation. The frequency of actuation (9.7E-4/yr) is low compared to the fire frequency (7.7E-3/yr). Further, only a fraction of those that lead to actuations, lead to system failure. The loss of the Diesel Generator Rooms has also been analyzed by the IPE internal flooding analysis. Therefore, there is no need to separately analyze effects of inadvertent FPS actuation not related to fire.

The effects of FPS inadvertent actuation are also discussed in Section 4.113 Seismic/Fire Interactions and were examined during seismic related walkdowns.

(ii) Effects of Combustion Products: Problems in evaluating or quantifying secondary (non-thermal) fire environmental effects are more difficult than problems in determining effects of fire suppressants. The reason for this is a lack of data on the vulnerability of plant equipment to adverse environments induced by fire. Actual fire reports do not include this level of detail, so that the available fire damage experience data does not provide information on other than thermal aspects of a fire environment (smoke, for example). Without such data, it is not possible to meaningfully quantify the impact of combustion products on plant equipment operability. Until a more thorough understanding of the phenomena involved is available, this remains an unsolved issue in fire risk analysis.

(iii) Operator Effectiveness:

1) MP2 has fire-related Abnormal Operating Procedures (AOPs) which identify the steps for planned shutdown, if necessary, in the event of fire.

2) In this analysis, local operator actions outside of the Control Room are conservatively not credited in any area affected by the fire or smoke.

3) Access paths for operators are also evaluated to ensure that they are not affected by the evaluated fire.

The operator actions in a fire environment are only credited for Control Room fires. Control Room evacuation is conservatively assumed to occur when, based on the Sandia cabinet test, a thick smoke at eye-level is reached in approximately 20 minutes. If the Control Room is not evacuated, the use of protective equipment is assumed, if necessary, and action performance under high stress is evaluated.

The project team reviewed plant fire procedures in order to evaluate operator effectiveness for manual actions during and after a fire and take credit for those actions in the analysis of the plant response (Section 4.9).

4.11. 5 Control System Interactions

In order to respond to the control system interaction issue, the ability to achieve safe shutdown from either the Control Room or fire shutdown panel, was evaluated in detail for numerous Main Control Board (MCB) cabinet fires. Key assumptions and approximations of the MCB fires are re-stated in this section to address this SANDIA issue.

Pessimistic assumptions applied to the rate of fire growth in control cabinets were based on the worst-case results from the Sandia cabinet tests (References 4-1 & 4-10). Sequences of events and failures were identified using PRA techniques, assuming the worst-case failure combinations. These failures included failures to start/actuate and inadvertent trips or actuation of the equipment.

In this analysis, control and actuation functions in each Control Room panel were identified, and panels most critical to safe shutdown were analyzed. As described in Section 4.8.2.3, four different fire scenarios were evaluated in detail (single MCB cabinet fires, three multiple MCB cabinet fires). Loss of control to all equipment located in the affected cabinet(s) was assumed. Spurious actuation of the equipment, leading to a small LOCA or a loss of Off-Site Power, was considered. Spurious trip of equipment, leading for example to a loss of Service Water, was also considered. As mentioned above, the worst-case failure combinations were analyzed.

Operator recovery actions from the fire shutdown panel were credited, as described in Section 4.9. Credit was given only to operation of equipment which could be disconnected from Control Room controls by the bottleup panels and operated independently from the remote location. (Any spurious trip, actuation, or loss of control were evaluated to make sure that affected equipment would be operable from the fire shutdown panel.)

No operator recovery was allowed from the cabinet(s) affected by the fire. Time to transfer control to the fire shutdown panel was included in estimating the time available for operator actions.

As shown in the results, Control Room fires are important contributors to MP2 plant fire risk. The total contribution to CDF by Control Room fires is approximately 6.6E-07/yr which is about 10% of the total CDF due to analyzed fires at MP2. This contribution is attributed to the fact that there is a Fire Shutdown Panel and the capability to successfully shutdown the plant in the event of a Control Room fire. These results support that MP2 has the ability to achieve safe shutdown from either the Control Room or the fire shutdown panel for Control Room fires.

4.12 USI A-45

The decay heat removal (DHR) system at MP2 is discussed in detail in Section 3.4.3 of the IPE Report. The DHR function is accomplished by one of two methods depending upon the initiating event.

Following a transient, it is possible to have continued operation of the power conversion system to provide the normal decay heat removal path. The power conversion system consists of the MFW, AFW, Condensate, Main Steam and Turbine systems. In the event the MFW and AFW systems are not available, Feed and Bleed, together with the sump recirculation, are required to remove decay heat.

Section 4.9 of this analysis presents some of the dominant core damage sequences which are, primarily based upon the IPE sequences. Table 3.4.1-2 of the IPE (Ref. 4-15) presents the majority of the core damage cutsets/sequences which are considered applicable to the fire analysis. The major differences between the IPE analysis results and those of this analysis are; a) applicable initiator frequencies would need to be revised to the appropriate fire induced initiator, and b) a few IPE accident sequence events need to be deleted since a fire does not result in a similar IPE initiating event. The remaining applicable cutsets were reviewed with regard to component failures which result in the loss of the decay heat removal function; no unidentified vulnerabilities were evident.

The total loss of the Turbine Building due to fire will result in a loss of the decay heat removal function. MP2 recognizes the importance of the Turbine Building for this scenario; thus, no unidentified risk outlier exists that has not been previously identified. The associated CDF for this scenario was by a bounding analysis (Section 4.9) and approximated to be 1.63E-06/year.

4.13 References

4-1 EPRI TR-100370, 'Fire-Induced Vulnerability Evaluation (FIVE),' PLC, Inc., April 1992.

4-2 'Millstone Nuclear Power Station Unit 2, Appendix R Compliance Report,' Revision 2, 1994.

4-3 'Millstone Unit 2 Fire Hazard Analysis,' Revision 3, 1992.

4-4 PRA95NQA-01262-S2, Rev. 0, 'MP2 Fire Spatial Data Base'.

4-5 PRA95NQA-01263-S2, Rev. 0, 'MP2 IPEEE: Fire compartment Interaction Analysis'.

4-6 PRA95NQA-01264-S2, Rev. 0, 'MP2 Fire Area Ignition Frequencies.'

4-7 PRA95NQA-01266-S2, Rev. 0, 'MP2 Fire Hazard Evaluation.'

4-8 PRA95NQA-01208-S2, Rev. 0, 'MP2 Fire Detection and Suppression Analysis.'

4-9 PRA95NQA-01267-S2, Rev. 0, 'MP2 Fire CDF Final Quantification.'

4-10 NUREG/CR-4527, J. M. Chavez, 'An Experimental Investigation of Internally Ignited Fires in Nuclear Power Plant Control Cabinets'; Part 1: Cabinet Effects Test, Part 2: Room Effects Test, April 1987.

4-11 'Fire Events Database for U.S. Nuclear Power Plants,' EPRI Database, Revision 1, 1993.

4-12 'Fire Risk Assessment Issues,' EPRI White Paper, YAEC, December 1992.

4-13 '1995 Unescorted Access Training Student Handbook', for NU, Connecticut Yankee and Millstone, published by NU Training Center.

4-14 'A 28 Year Study of Large Losses in the Gas and Electrical Utility Industry,' Dec. 1993, L.R. Hathaway.

4-15 'Millstone Unit 2 Individual Plant Examination for Severe Accident Vulnerabilities,' Northeast Utilities Service Company, 1993.

4-16 AOPs 2579A through 2579PP, 'Fire Procedure for Hot Standby/Cooldown/Cold Shutdown Appendix Fire Area R-1 through R-16.'

4-17 ACP-QA-2.03B, 'Control of Welding'

4-18 ACP-QA-2.05, 'Fire Protection Program'

4-19 ACP-QA-2.05B, 'Control of Combustible Materials, Flammable Liquids, Compressed Gases, & Ignition Sources'

4-20 ACP-2.22, 'Station Fires'

4-21 NUREG/CR-5088, Sand88-0177, 'Fire Risk Scoping Study: Investigation of Nuclear Power Plant Fire Risk, Including Previously Unaddressed Issues.'

4-22 I&E Notice 83-69, 'Improperly installed Fire Dampers at Nuclear Power Plants', dated June 8, 1989.

4-23 NUSOER 85-05 'Ruskin Fire Damper Deficiencies / Inadequate Test Standards For Fire Dampers' dated November 30, 1985.

4-24 I&E Notice 89-52 'Potential Fire Damper Operation Problems' dated June 8, 1989.

4-25 I&E Notice 88-04 and 88-04, Supplement 1, 'Inadequate Qualification and Documentation of Fire Barrier Penetration Seals,' dated August 9, 1988,

4-26 I&E Notice 88-56, 'Potential Problems with Silicon Foam Fire Barrier Penetration Seals,' dated August 4, 1988.

4-27 NRC Information Notice 94-12, "Insights gained from resolving Generic Issue 57: Effects of Fire Protection System Actuation on Safety-Related Equipment." February 9, 1994.

4-28 Memo #NE-95-SAB-247, from J.K. Rothert to M. Kapinski, "PRA Review of IN 94-12 Insights for MP2," June 15,1995.

4-29 Memo #SE-92-558, from S. Ricchexxa to S.D. Weerakkody, "Fire Probibilistic Risk Assessment," June 8, 1992.

4-30 NUREG/CR-5580, 'Evaluation of Genetic Issue 57: Effects of Fire Protection System Actuation on Safety-Related Equipment,' Volumes 1-5, J. Lambright, J. Lynch, M. Bohn, S. Ross, D. Brosseau, December 1992.

4-31 IMPELL Report No. 01-0650-1737, 'Report on the Effects of Fire Suppressants on Electrical Components in Nuclear Power Plants,' Revision B, prepared for EPRI, August 1989.

4-32 EPRI, 'Fire PRA Implementation Guide,' *draft*.

4-33 NSAC 181, 'Fire PRA Requantification Studies,' SAIC, March 1993.

4-34 Sand77-1424, 'A Preliminary Report on Fire Protection Research Program (July 6, 1977 Test),' L. Klamerus.

4-35 Sand78-0518, 'A Preliminary Report on Fire Protection Research Program, Fire Retardant Coatings Tests (Dec. 7, 1997 - Jan. 31, 1978),' L. Klamerus.

4-36 Sand78-1018c, 'Cable Tray Fire Tests,' L. Klamerus.

4-37 NUREG/CR-0381, Sand78-1456 'A Preliminary Report on Fire Protection Research Program Fire Barriers and Fire Retardant Coatings Tests' Sept. 1978, L. Klamerus.

4-38 NUREG-1472, 'Regulatory Analysis for the Resolution of Generic Issue 57: Effects of Fire Protection System Actuation on Safety-Related Equipment,' H. W. Woods, October 1993.

4-39 NUREG/CR-2607, D. A. Dube, 'Fire Protection Research Program for the US Nuclear Regulator Commission 1075-1981', April 1983.

4-40 NUREG/CR-4832, J. Lambrite, 'Analysis of La Salle Unit 2 Nuclear Plant, Risk Method Integration and Evaluation (RMIEP),' Volume 9, March 1993.

4-41 NUREG/CR-5088, Sandia National Laboratories, 'Fire Risk Scoping Study: Investigation of Nuclear Power Plant Risk, Including Previously Unaddressed Issues,' January 1898.

4-42 NUREG/CR-5384, Sand89-1359 'A Summary of Nuclear Power Plant Fire Safety Research at Sandia national Laboratories 1975-1987,' Dec. 1989, S. Nowlen.

4-43 NUREG/CR-5791, 'Risk Evaluation for a General Electric BWR, Effects of Fire Protection System Actuation on Safety-Related Equipment,' J. Lambright, S. Ross, E. Klamezus, S. Daniel, December 1992.

4-44 EPRI NP-6937, 'Operator Reliability Experiments Using Power Plant Simulators,' Volume 2, July 1990. (HRA Calculator - Accident Prevention Group - Research Project 3082-03, DRAFT, November 1991).

4-45 EPRI TR-100443, F. W. Mowrer, 'Methods of Quantitative Fire Hazard Analysis,' May 1992.

4-46 PRA95NQA-01265-S2, Rev. 0, 'Fire Area Screening for MP2 IPEEE.'

4-47 PRA95NQA-1223-S2, Rev. 0, 'MP2 Containment Performance Analysis for Fire IPEEE.'

4-48 AOP 2551, 'Shutdown from Outside the Control Room.'

4-49 SUR 5.5-30, Rev. 5, 'Fire Damper Inspection,' April 9, 1993.

4-50 ONP 505/AOP 2559, 'Fire'

4-51 AOP 2563, 'Loss of Instrument Air.'

4-52 AOP 2564, 'Loss of RBCCW.'

4-53 AOP 2565, 'Loss of Service Water.'

4-54 ACP-QA-3.15, 'Performance of Fire Protection Reviews'

4-55 ACP-QA-4.01, 'Plant Housekeeping'

4-56 ACP-8.02, 'Fire Fighting Training Program'

4-57 MAP-2.40, 'Use of Tobacco Products at Millstone Station'

4-58 WC-7, 'Fire Protection Program'

4-59 MP 2701F, Rev. 9, 'Lubrication (EQ).'

TABLE 4.3-1

Equipment Spatial Database - Input Fields

Field	Field Name	Type	Width	Field Description
1	UNIT	Character	3	Plant/Unit
2	SYSTEM	Character	8	System Component Belongs To
3	EQUIP_ID	Character	18	Component ID
4	EQUIP_DESC	Character	70	Component Description
5	INFO_SOURC	Character	1	Source of Component's Information I - IPE Component R - Appendix R Component B - Both IPE and Appendix R Component
6	PRM_LOC	Character	12	Component Location
7	NORM_POS	Character	2	Component's Normal Position
8	REQUIR_POS	Character	2	Component's Required Position
9	PWR_SUP	Character	14	Motive Power Supply
10	PWR_LOC	Character	12	Motive Power Supply Location
11	PCR_LOC1	Character	12	Motive Power Cable Routing Location 1
12	PCR_LOC2	Character	12	Motive Power Cable Routing Location 2
13	PCR_LOC3	Character	12	Motive Power Cable Routing Location 3
14	PCR_LOC4	Character	12	Motive Power Cable Routing Location 4
15	PCR_LOC5	Character	12	Motive Power Cable Routing Location 5
16	PCR_LOC6	Character	12	Motive Power Cable Routing Location 6
17	PCR_LOC7	Character	12	Motive Power Cable Routing Location 7
18	PCR_LOC8	Character	12	Motive Power Cable Routing Location 8
19	CNT_SUP	Character	14	Control Power Supply
20	CNT_LOC	Character	12	Control Power Supply Location
21	CCR_LOC1	Character	12	Control Cable Routing Location 1
22	CCR_LOC2	Character	12	Control Cable Routing Location 2
23	CCR_LOC3	Character	12	Control Cable Routing Location 3
24	CCR_LOC4	Character	12	Control Cable Routing Location 4
25	CCR_LOC5	Character	12	Control Cable Routing Location 5
26	CCR_LOC6	Character	12	Control Cable Routing Location 6
27	CCR_LOC7	Character	12	Control Cable Routing Location 7
28	CCR_LOC8	Character	12	Control Cable Routing Location 8
29	HA_ID	Memo	10	Human Action ID (Associated with Component)
30	HA_DESC	Memo	10	Human Action Description
31	HAP_LOC1	Character	12	Human Access Path Location 1

Field	Field Name	Type	Width	Field Description
32	HAP_LOC2	Character	12	Human Access Path Location 2
33	HAP_LOC3	Character	12	Human Access Path Location 3
34	HAP_LOC4	Character	12	Human Access Path Location 4
35	HAP_LOC5	Character	12	Human Access Path Location 5
36	HAP_LOC6	Character	12	Human Access Path Location 6
37	HAP_LOC7	Character	12	Human Access Path Location 7
38	HAP_LOC8	Character	12	Human Access Path Location 8
39	MOD_FS	Character	15	IPE Module Associated with Failure to Start
40	MOD_FR	Character	15	IPE Module Associated with Failure to Run
41	MOD_FTO	Character	15	IPE Module Associated with Failure to Open
42	MOD_FTC	Character	15	IPE Module Associated with Failure to Close
43	MOD_FTRO	Character	15	IPE Module Associated with Failure to Remain Open
44	MOD_FTRC	Character	15	IPE Module Associated with Failure to Remain Closed
45	MOD_OPER	Character	15	IPE Module Associated with Failure to Operate
46	BE_FS	Character	9	Basic Event Associated with Failure to Start
47	BE_FR	Character	9	Basic Event Associated with Failure to Run
48	BE_FTO	Character	9	Basic Event Associated with Failure to Open
49	BE_FTC	Character	9	Basic Event Associated with Failure to Closed
50	BE_FTRO	Character	9	Basic Event Associated with Failure to Remain Open
51	BE_FTRC	Character	9	Basic Event Associated with Failure to Remain Closed
52	BE_OPER	Character	9	Basic Event Associated with Failure to Operate
53	COMMENTS	Memo	10	Comments/Notes
54	CHANGE	Logical	1	Note of Change to Record since Running Location Database

MP2 IPEEE

TABLE 4.3-2

Sample Page From Location Database Reports

Location Type
PRM - Primary Location
PWR - Power Supply Location
PCR - Power Cable Location
CNT - Control Power Location
CCR - Control Cable Location

Component Description
For Valves:
CL - Closed (Normal Position)
OP - Open (Normal Position)
FC - Fails Closed (on Loss of Power)
FO - Fails Open (on Loss of Power)

Information Source
I - IPE
R - Appendix R
B - Both IPE and Appendix R

TABLE 4.3-3

Millstone Unit 2
FIRE HAZARD ANALYIS MATRIX

Analyzed Independent Fire Compartment	App A. Area	Detection	Auto Suppression	Manual Suppression	Alarms	Combustibles: Configuration	Combustibles: Amount	Hazardous Material	Ventilation	Comments
CR	Main Control Room (A-25)	- Ionization smoke detection - Duct smoke detection		- Portable extinguishers	C-26, Main Fire Alarm Panel, Zones 2, 3, 42	Cable insulation Paper Clothing Floor Area (ft.^{2}): Total (Btu/ft.^{2}):	20,935,308 Btu 30,546,000 Btu 398,350 Btu 3864 13,426	- None	- 5 dampers	Exemptions: B10430 Engineering Evaluations: 074, 075, 095, 098
OPBR	Operator Break Room (Former Computer Room) (A-26)	- Smoke detection - Heat detection	- Halon 1301	- CO2 portable extinguisher	C-26, Main Fire Alarm Panel, Zones 25 & 26 C-26L, Local Panel	Wood: Cloth/clothing: Cable (Underfloor): Paper (Trans.): Floor Area (ft.^{2}): Total (Btu/ft.^{2}):	1,740,000 Btu 1,590,000 Btu 572,940 Btu 4,242,500 Btu 891 7357	- None	- None	Exemptions: None Engineering Evaluations: None
AUXB-1	Boric Acid & Chem. Add. Tank (A-12A)	- Smoke detection	- Wet-pipe sprinkler - Wet-pipe water curtain	- Hose Stations - Portable extinguishers	C-26, Main Fire Alarm Panel, Zones 41, 64, 66 FLP-4, Local Fire Alarm Panel	Cable insulation: Plastic: Lube Oil: Rubber hoses (Trans.) Clothing (Trans.): Floor Area (ft.^{2}): Total (Btu/ft.^{2}):	131,347,381 Btu 3,000,000 Btu 144,597 Btu 1,604,200 Btu 2,390,100 Btu 4,671 29,648	- None	- 16 dampers	Exemptions: B10430 Engineering E.aluations: 002, 075, 089
	Sample Area (A-12B)	- None		- Hose Station in A-12A		Clothing (Trans.): Floor Area (ft.^{2}): Total (Btu/ft.^{2}):	89,230 Btu 224 398	- None		Exemptions: None Engineering Evaluations: None
AUXB-1 (Cont.)	Boronmeter (A-12C)	- None		- Hose Station in A-12A		Container (Clothing Trans.): Floor Area (ft.^{2}): Total (Btu/ft.^{2}):	267,891 Btu 212 1,263	- None		Exemptions: None Engineering Evaluations: None
	SFP & Cask Laydown Area (A-14A)	- None	- None	- None		--- Floor Area (ft.^{2}):	Negligible 2,574	- None		Exemptions: None Engineering Evaluations: None

TABLE 4.3-3 (continued)

Analyzed Independent Fire Compartment	App A. Area	Detection	Auto Suppression	Manual Suppression	Alarms	Combustibles		Hazardous Material	Ventilation	Comments
						Configuration	Amount			
	SFP & Fuel Handing Area (A-14C)	• None	• None	• Hose Stations • Portable extinguishers		Cable insulation: Paper (Trans.): Plastic (Trans.): Wood (Trans.): Clothing (Trans.): Floor Area (ft.²): Total (Btu/ft.²):	3,728,709 Btu 346,188 Btu 20,736,000 Btu 548,100 Btu 713,843 Btu 6,620 3,938	• None	• 4 dampers • Fan w/damper	Exemptions: None Engineering Evaluations: None
	Cask Washdown Area (A-14E)	• None	• None	• Hose Stations in A-14C • Portable extinguishers in A-14C		Container (clothing, Trans.): Wood (scaffolding): Floor Area (ft.²): Total (Btu/ft.²):	89,230 Btu 17,400,000 Btu 270 63,300	• None	• None	Exemptions: None Engineering Evaluations: None

TABLE 4.4-1

MP2 Walkdown Checklist

Check List Item	Specific Attributes	Reference Data
Equipment Location	Pumps, Valves, Electrical Cabinets, Switchgear, Cable Routings, etc.	General Arrangement Drawings, Equipment Layout Drawings, Spatial Database
Ignition Sources	Pumps, Valves, Electrical Cabinets Loadings, Storage Areas, Cables, etc.	Equipment Layout Drawings, Spatial Database, EPRI Fire Ignition Database
Fire Detection	Type, Quantity, Location, Arrangement	Fire Hazard Database, Fire Risk Scoping Study Issue II
Fire Suppression	Type, Location, Adverse Equipment Impacts	Fire Hazard Database, Fire Risk Scoping Study Issue II
Fire Barriers	Number, Type, Rating, etc.	Fire Hazard Database, Fire Propagation Program
Fixed Combustibles	Pumps, Valves, Electrical Cabinets Loadings, Storage Areas, Cables, etc.	Fire Hazard Database, Spatial Database, EPRI Fire Ignition Database
Transient Combustibles	Maintenance Activities, Storage Areas, Access Pathways, etc.	Fire Hazard Database, EPRI Fire Ignition Database
Fire Growth and Propagation Analysis	Targets, Fuel Sources, Horizontal and Vertical Distances, Combustible Loadings, Fire Brigade Effectiveness	Spatial Database, Target Set Spatial Arrangement, Fire Area Spatial Arrangement

TABLE 4.5-1

Summary of the Fire Ignition Frequencies for MP2

MP2 IPEEE Fire Areas		Description	Total Area Fire Ignition Frequency (per year)	FIRE IGNITION FREQUENCY PER COMPONENT TYPE (per year)			TRANSIENT FIRE IGN. FREQUENCY (per year)
FHA App. A/Specific	Spatial DataBase			PUMP*	ELEC. CABINET	OTHER COMPONENTS	
A-25	CR	Control Room	9.3E-03	-	8.9E-03	2.3E-04	1.5E-04
A-26	OPBR	Operator Break Room (Former Computer Room)	5.2E-04	1.6E-04	-	2.1E-04	1.5E-04
AUXB-1	AUXB-1	Auxiliary Building Area 1	3.3E-02	1.2E-02	9.8E-03	1.0E-02	7.5E-04
AUXB-2	AUXB-2	Auxiliary Building Area 2	4.7E-03	4.8E-04	2.4E-04	1.0E-03	7.5E-04
A-17	RWDR	Solid Radwaste Drumming Storage Area	9.4E-03	-	8.7E-03	-	7.3E-04
A-18	STRG1	Storage Area (Former Snubber Repair Shop)	8.0E-04	-	-	6.5E-05	7.3E-04
A-19B	STRG2	Hallway Storage Area	9.7E-04	-	-	2.4E-04	7.3E-04
A-29	RCPSH	RCP Rebuild Shop Prop. Room	7.3E-04	-	-	-	7.3E-04
A-33	HVAC	Ventilation Equipment Room	4.8E-03	-	2.6E-03	1.4E-03	7.3E-04
A-24	CV-AB	Cable Vault	1.0E-03	-	-	3.2E-04	7.3E-04
A-27	CMPT	New Computer Room	1.7E-03	-	4.7E-04	4.8E-04	7.3E-04
A-4	HPSI	HPSI Pump Room	1.5E-03	7.2E-04	-	-	7.5E-04
A-7	SRTA	Spent Resin Tank Area	7.3E-04	-	-	-	7.3E-04
A-13	MCCB61	480V MCC B61 & B41A	5.2E-03	-	4.5E-03	-	7.3E-04
PN-W	PN-W	West Penetration Areas	3.1E-03	2.4E-04	1.9E-03	2.7E-04	7.8E-04
T-8	CV-W	West Cable Vault	7.3E-04	-	-	-	7.3E-04
T-10	SWGR-W	6.9KV & 4.16KV Switchgear Room (Z2)	2.3E-03	-	1.4E-03	2.0E-04	7.3E-04
TB	TB	Turbine Building	5.8E-02	5.6E-03 (4.0E-03 MFW Pump)	1.2E-02	3.6E-02	7.5E-04
[illegible]3	MDAFW	Motor Driven Aux. Feed Pump Pit	8.8E-04	1.3E-04	-	-	7.5E-04
T-2	TB-LO	Turbine Lube Oil System	1.2E-03	3.3E-04	-	1.3E-04	7.5E-04
A-6A	CHGPMP	Charging Pump Room	2.7E-03	1.9E-03	-	-	7.5E-04
A-8A	LPSI-A	LPSI Pump Room ("A")	2.0E-03	1.2E-03	-	6.7E-05	7.5E-04

See Table 4.6-1 for Cross Reference of Areas

TABLE 4.5-1 (continued)

MP2 IPEEE Fire Areas		Description	Total Area Fire Ignition Frequency (per year)	FIRE IGNITION FREQUENCY PER COMPONENT TYPE (per year)			TRANSIENT FIRE IGN. FREQUENCY (per year)
FHA App. A/Specific	Spatial DataBase			PUMP*	ELEC. CABINET	OTHER COMPONENTS	
A-3	LPSI-B	LPSI Pump Room ("B")	2.0E-03	1.2E-03	-	6.7E-05	7.5E-04
A-15	DGR-A	Diesel Generator Room "A"	1.6E-02	-	1.2E-03	1.3E-02 (Diesel Generator)	7.3E-04
A-31	DGDT-A	Diesel Oil Day Tank Room "A"	7.3E-04	-	-	-	7.3E-04
A-16	DGR-B	Diesel Generator Room "B"	1.6E-02	-	1.2E-03	1.3E-02 (Diesel Generator)	7.3E-04
A-30	DGDT-B	Diesel Oil Day Tank Room "B"	7.3E-04	-	-	-	7.3E-04
A-20	DCEQ-E	East DC Equipment Room ("A")	7.7E-03	-	2.6E-03	4.7E-03 (2.7E-03 MG Set)	7.3E-04
A-22	BATT-E	East Battery Room	1.8E-03	-	-	1.6E-03 (Battery)	1.9E-04
A-21	DCEQ-W	West DC Equipment Room ("B")	7.1E-03	-	1.6E-03	4.8E-03 (2.7E-03 MG Set)	7.3E-04
A-23	BATT-W	West Battery Room	1.6E-03	-	-	8.0E-04 (Battery) 5.7E-04 (Battery Charger)	1.9E-04
A-28	LC480V-E	East 480V Load Center Room	3.0E-03	-	1.7E-03	5.4E-04	7.3E-04
T-4	SDAFW	Steam Driven Aux. Feed Pump Pit	9.2E-04	1.7E-04	-	-	7.5E-04
T-6	LC480V-W	West 480V Load Center Room	2.8E-03	-	1.7E-03	3.1E-04 (Transformer)	7.3E-04
T-7	SWGR-E	6.9KV & 4.16KV Switchgear Room (Z1)	2.7E-03	-	1.7E-03	2.1E-04 (Transformer)	7.3E-04
T-9	CV-E	East Cable Vault	7.3E-04	-	-	-	7.3E-04
C-1	CMNT	Containment	6.7E-04	N/A	N/A	N/A	N/A
I-1A	IS-PMP	Intake Structure, Pump Room	4.1E-03	2.6E-03	-	7.4E-04	7.5E-04
I-1B	IS-SHR	Intake Structure, Sodium Hypochlorite Room	1.6E-03	6.0E-04	1.5E-04	6.7E-05	7.5E-04
I-1C	IS-MCC	Intake Structure, MCC Room	3.3E-03	-	2.2E-03	3.4E-04	7.5E-04
A-10A	PNPI-E	East Piping Penetration Area	1.9E-03	9.6E-04	-	2.0E-04	7.5E-04
A-10B	PNEL-E	East Elec. Penetration Area	3.2E-03	-	2.3E-03	1.3E-04	7.5E-04

See Table 4.6-1 for Cross Reference of Areas

TABLE 4.5-1 (continued)

MP2 IPEEE Fire Areas		Description	Total Area Fire Ignition Frequency (per year)	FIRE IGNITION FREQUENCY PER COMPONENT TYPE (per year)			TRANSIENT FIRE IGN. FREQUENCY (per year)
FHA App. A/Specific	Spatial DataBase			PUMP*	ELEC. CABINET	OTHER COMPONENTS	
A-10C	MSSV-E	East Main Steam Safety Valve Room/Blowdown Tank Room	9.9E-03	2.4E-04	-	-	7.5E-04
FP-2	FP-2	Unit 2 Fire Pumphouse	4.8E-03	-	4.0E-03	-	7.5E-04
Y-1	Y-1	Ecolochem Builing/Make-up Water Facility	N/A	N/A	N/A	N/A	N/A
Y-2	Y-2	Millstone Radwaste Reduction Facility Bldg.	N/A	N/A	N/A	N/A	N/A
Y-3	Y-3	Flammable/Hazardous Waste Storage Bldg.	N/A	N/A	N/A	N/A	N/A
Y-4	Y-4	South Access Point Modular Bldg.	N/A	N/A	N/A	N/A	N/A
Y-5	Y-5	Unit 2 Maint. Building Snubber Shop	N/A	N/A	N/A	N/A	N/A
Y-6	Y-6	Unit 2 Craft Assemble Facility	N/A	N/A	N/A	N/A	N/A
Y-7	Y-7	Unit 2 Maint. Building and Nurse Station	N/A	N/A	N/A	N/A	N/A
Y-8	Y-8	Maint. Air Compressor and Storage Shelter	N/A	N/A	N/A	N/A	N/A
XR-1	XR-1	Main Transformer	2.1E-02	-	-	-	4.0E-03 (Prop. to TB) 1.6E-03(LOSP) 1.5E-02(Other)
XR-2	XR-2	Normal Transformer	2.1E-02	-	-	-	4.0E-03 (Prop. to TB) 1.6E-03(LOSP) 1.5E-02(Other)
XR-3	XR-3	Reserve Transformer	2.1E-02	-	-	-	4.0E-03 (Prop. to TB) 1.6E-03(LOSP) 1.5E-02(Other)
	HPO	Unit 2 Health Physics Offices	N/A	N/A	N/A	N/A	N/A
	FB	Fuel Building	N/A	N/A	N/A	N/A	N/A
	XFMRB	Transformer Building	N/A	N/A	N/A	N/A	N/A
	CLB	Chlorination Building	N/A	N/A	N/A	N/A	N/A
	SWFH	Service Water Filter House	N/A	N/A	N/A	N/A	N/A

See Table 4.6-1 for Cross Reference of Areas

Millstone Unit 2
Plant Location Bin: Auxiliary Building
Fire Area/Zone: AUXB-1 (Multi Levels)

TABLE 4.5-2

Fire Area Ignition Frequency Data Sheet (for PAB)

Component	Generic Fire Frequency (per year)	Number of Components in Area	Total # of Components in Related Area	Total Number of Components in All Plant Locations	Ignition Source Weighting Factor	Fire Frequency per Component Type in Fire Area (per year)	Fire Frequency per Single Component in Fire Area (per year)
Area Specific Components							
Electrical Cabinets	1.9E-02	137	265		5.2E-01	9.8E-03	7.2E-05
Pumps - other than MFW/Fire	1.9E-02	51	79		6.5E-01	1.2E-02	2.4E-04
Pumps - MFW	4.0E-03	0	N/A		0.0E+00	0.0E+00	N/A
Pumps - Fire	4.0E-03	0	N/A		0.0E+00	[illegible]	N/A
Diesel Generator	2.6E-02	0	N/A		0.0E+00	[illegible]	N/A
Batteries	3.2E-03	0	N/A		0.0E+00	[illegible]	N/A
T/G Excitor	4.0E-03	0	N/A		0.0E+00	[illegible]	N/A
T/G Oil	1.3E-02	0	N/A		0.0E+00	[illegible]	N/A
T/G Hydrogen	5.5E-03	0	N/A		0.0E+00	0.0E+00	N/A
Boilers	1.6E-03	0	N/A		0.0E+00	0.0E+00	N/A
Plant-Wide Components							
Fire Protection Panels	2.4E-03	3		21	1.4E-01	3.4E-04	1.1E-04
RPS MG Sets	5.5E-03	0		2	0.0E+00	0.0E+00	N/A
Non-Qualified Cable Run (Btu)	6.3E-03	0		0	0.0E+00	0.0E+00	N/A
Junction Box (Non-Qualified Cable)	1.6E-03	0		0	0.0E+00	0.0E+00	N/A
Transformers	7.9E-03	22		77	4.0E-02	3.2E-04	1.0E-04
Battery Chargers	4.0E-03	0		7	0.0E+00	0.0E+00	N/A
Off-Gas/H2 Recombiner	8.6E-02	0		0	0.0E+00	0.0E+00	N/A
Hydrogen Tanks	3.2E-03	0		0	0.0E+00	0.0E+00	N/A
Misc. Hydrogen Fires	3.2E-03	1		2	5.0E-01	1.6E-03	1.6E-03
Gas Turbines	3.1E-02	0		0	0.0E+00	0.0E+00	N/A
Air Compressors	4.7E-03	0		12	1.7E-01	7.8E-04	3.9E-04
Ventilation Subsystems	9.5E-03	0		142	1.3E-01	1.2E-03	6.7E-05
Elevator Motors	6.3E-03	0		3	6.7E-01	4.2E-03	2.1E-03
Dryers	8.7E-03	0		0	0.0E+00	0.0E+00	N/A
		Applicability of Transient to Area	Total Number of Areas				
Transient Sources							
Transient	1.3E-03	8	62		1.3E-01	1.7E-04	N/A
Cable Fires - Welding	5.1E-03	1	62		1.6E-02	8.2E-05	N/A
Transient Fires - Welding	3.1E-02	1	62		1.6E-02	5.0E-04	N/A

Transient Total:	7.5E-04	
Area Total:	3.3E-02	

See Table 4.6-1 for Cross Reference of Areas

Plant: Millstone Unit 2
Plant Location: Turbine Building
Fire Area/Zone: TB (Turbine Building Fire Zones T-1A, throught T-1G)

TABLE 4.5-3

Fire Area Ignition Frequency Data Sheet (for Turbine Building)

Component	Generic Fire Frequency (per year)	Number of Components In Area	Total # of Componentsin Related Area	Total # of Components in All Plant Locations	Ignition Source Weighting Factor	Fire Frequency per Component Type in Fire Area (per year)	Fire Frequency per Single Component in Fire Area (per year)
Area Specific Components							
Electrical Cabinets	1.3E-02	233	234		1.0E+00	1.3E-02	9.8E-05
Pumps - other than MFW/Fire	6.3E-03	135	151		8.5E-01	5.4E-03	8.5E-05
Pumps - MFW	4.0E-03	2	2		1.0E+00	4.0E-03	2.0E-03
Pumps - Fire	4.0E-03	0	0		0.0E+00	0.0E+00	N/A
Diesel Generator	2.6E-02	0	0		0.0E+00	0.0E+00	N/A
Batteries	3.2E-03	0	4		0.0E+00	0.0E+00	N/A
T/G Excitor	4.0E-03	1	1		1.0E+00	4.0E-03	4.0E-03
T/G Oil	1.3E-02	1	1		5.0E-01	6.5E-03	6.5E-03
T/G Hydrogen	5.5E-03	1	1		1.0E+00	5.5E-03	5.5E-03
Boilers	1.6E-03	0	0		0.0E+00	0.0E+00	N/A
Plant-Wide Components							
Fire Protection Panels	2.4E-03	5		11	2.4E-01	5.7E-04	1.1E-04
RPS MG Sets	5.5E-03	0		3	0.0E+00	0.0E+00	N/A
Non-Qualified Cable Run (Btu)	6.3E-03	0		0	0.0E+00	0.0E+00	N/A
Junction Box (Non-Qualified Cable)	1.6E-03	0		0	0.0E+00	0.0E+00	N/A
Transformers	7.9E-03	17		77	2.2E-01	1.7E-03	3.2E-04
Battery Chargers	4.0E-03	1		7	1.4E-01	5.7E-04	5.7E-04
Off-Gas/H2 Recombiner	8.6E-02	0		0	0.0E+00	0.0E+00	N/A
Hydrogen Tanks	3.2E-03	0		0	0.0E+00	0.0E+00	N/A
Misc. Hydrogen Fires	3.2E-03	1		2	5.0E-01	1.6E-03	1.6E-03
Gas Turbines	3.1E-02	0		0	0.0E+00	0.0E+00	N/A
Air Compressors	4.7E-03	4		12	3.3E-01	1.6E-03	3.9E-04
Ventilation Subsystems	9.5E-03	56		142	3.9E-01	3.7E-03	6.7E-05
Elevator Motors	6.3E-03	1		3	3.3E-01	2.1E-03	2.1E-03
Dryers	8.7E-03	0		0	0.0E+00	0.0E+00	N/A
		Applicability of Transient to Area	Total Number of Areas				
Transient Sources							
Transient	1.3E-03	8	62		1.3E-01	1.7E-04	N/A
Cable Fires - Welding	5.1E-03	1	62		1.6E-02	8.2E-05	N/A
Transient Fires - Welding	3.1E-02	1	62		1.6E-02	5.0E-04	N/A
					Transient Total:	7.5E-04	
					Area Total:	5.8E-02	

Plant: Millstone Unit 2
Plant Location Bin: Switchgear Room East
Fire Area/Zone: T-7 (SWGR-E)

TABLE 4.5-4

Fire Area Ignition Frequency Data Sheet (for SWGR-E)

Component	Generic Fire Frequency (per year)	Number of Components In Area	Total Number of Components in Related Area	Total Number of Components in All Plant Locations	Ignition Source Weighting Factor	Fire Frequency per Component Type in Fire Area (per year)	Fire Frequency per Single Component in Fire Area (per year)
Area Specific Components							
Electrical Cabinets	1.5E-02	35	316		1.1E-01	1.7E-03	4.7E-05
Pumps - other than MFW/Fire	N/A	0	N/A		N/A	0.0E+00	N/A
Pumps - MFW	N/A	0	N/A		N/A	0.0E+00	N/A
Pumps - Fire	N/A	0	N/A		N/A	0.0E+00	N/A
Diesel Generator	N/A	0	N/A		N/A	0.0E+00	N/A
Batteries	N/A	0	N/A		N/A	0.0E+00	N/A
T/G Excitor	N/A	0	N/A		N/A	0.0E+00	N/A
T/G Oil	N/A	0	N/A		N/A	0.0E+00	N/A
T/G Hydrogen	N/A	0	N/A		N/A	0.0E+00	N/A
Boilers	N/A	0	N/A		N/A	0.0E+00	N/A
Plant-Wide Components							
Fire Protection Panels	2.4E-03	0		21	0.0E+00	0.0E+00	N/A
RPS MG Sets	5.5E-03	0		2	0.0E+00	0.0E+00	N/A
Non-Qualified Cable Run (Btu)	6.3E-03	0		0	0.0E+00	0.0E+00	N/A
Junction Box (Non-Qualified Cable)	1.6E-03	0		0	0.0E+00	0.0E+00	N/A
Transformers	7.9E-03	2		77	2.6E-02	2.1E-04	1.0E-04
Battery Chargers	4.0E-03	0		7	0.0E+00	0.0E+00	N/A
Off-Gas/H2 Recombiner	8.6E-02	0		0	0.0E+00	0.0E+00	N/A
Hydrogen Tanks	3.2E-03	0		0	0.0E+00	0.0E+00	N/A
Misc. Hydrogen Fires	3.2E-03	0		2	0.0E+00	0.0E+00	N/A
Gas Turbines	3.1E-02	0		0	0.0E+00	0.0E+00	N/A
Air Compressors	4.7E-03	0		12	0.0E+00	0.0E+00	N/A
Ventilation Subsystems	9.5E-03	1		142	7.0E-03	6.7E-5	6.7E-05
Elevator Motors	6.3E-03	0		3	0.0E+00	0.0E+00	N/A
Dryers	8.7E-03	0		0	0.0E+00	0.0E+00	
		Applicability of Transient to Area	Total Number of Areas				
Transient Sources							
Transient	1.3E-03	7	62		1.1E-01	1.5E-04	N/A
Cable Fires - Welding	5.1E-03	1	62		1.6E-02	8.2E-05	N/A
Transient Fires - Welding	3.1E-02	1	62		1.6E-02	5.0E-04	N/A

Transient Total:	7.3E-04	
Area Total:	2.7E-03	

TABLE 4.6-1

Definition/Cross Reference of IPEEE Fire Areas for MP2

MP2 IPEEE Fire Areas		App. R Area	App. R Cable Routing Zone	Analyzed FCIA Compartment (App. A Zone)	App. A Zone Description	Elevation	Building
FHA App. A/Specific	Spatial DataBase						
A-25	CR	R-1	A-1	A-25	Main Control Room	38'6"	Auxiliary
A-26	OPBR	R-1	A-1	A-26	Operator Break Room (Former Computer Room)	38'6"	Auxiliary
AUX-1	AUXB-1	R-1	A-2	A-12A	Boric Acid & Chem. Add. Tank	14'6"	Auxiliary
			A-2	A-12B	Sample Area	14'6"	Auxiliary
			A-2	A-12C	Boronmeter	14'6"	Auxiliary
			A-2	A-14A	SFP & Cask Laydown Area	-5'0"	Auxiliary
			A-2	A-14C	SFP & Fuel Handling Area	38'6"	Auxiliary
			A-2	A-14E	Cask Washdown Area	38'6"	Auxiliary
			A-2	A-19A	HP Access/Control Area (Former Maintenance Shop)	14'6"	Auxiliary
			A-11	A-5	Coolant Tank Area	-25'6"	Auxiliary
			A-12	A-1G	General Area Elevation -5'	-5"0"	Auxiliary
			A-12	A-1H	Volume Control Tank	-5'0"	Auxiliary
			A-12	A-1I	Boric Acid Evaporator & Tanks	-5'0"	Auxiliary
			A-12	A-1J	Evaporator & Tank (Not Used)	-5'0"	Auxiliary
			A-12	A-9	Maintenance Storage Crib	-5'0"	Auxiliary
			A-12	A-11	Ion Exchanger Room	-5'0"	Auxiliary
			A-13	A-1A	General Area Elevation -45'	-45'6"	Auxiliary
			A-13	A-1B	RBCCW Pump & Hx. Area	-25'6"	Auxiliary
			A-13	A-1C	Waste Tank Pump Room	-45'6"	Auxiliary
			A-13	A-1D	Waste Tank Room	-45'6"	Auxiliary
			A-13	A-1E	Waste Gas Decay Tank Area	-25'6"	Auxiliary
			A-13	A-1F	Waste Gas Compressor & Surge Tank Area	-25'6"	Auxiliary
AUX-2	AUXB-2	R-1	A-2	A-14B	Railroad Bay Area	14'6"	Auxiliary
			A-2	A-14D	EBFAS Equipment Area	14'6"	Auxiliary
			A-2	A-32	Air Handling Units	38'6"	Auxiliary
A-17	RWDR	R-1	A-2	A-17	Solid Radwaste Drumming Storage Area	14'6"	Auxiliary

TABLE 4.6-1 (continued)

MP2 IPEEE Fire Areas: FHA App. A/Specific	MP2 IPEEE Fire Areas: Spatial DataBase	App. R Area	App. R Cable Routing Zone	Analyzed FCIA Compartment (App. A Zone)	App. A Zone Description	Elevation	Building
A-18	STRG1	R-1	A-2	A-18	Storage Area (Former Snubber Repair Shop)	14'6"	Auxiliary
A-19B	STRG2	R-1	A-2	A-19B	Hallway Storage Area	38'6"	Auxiliary
A-29	RCPSH	R-1	A-2	A-29	RCP Rebuild Shop Prep. Room	38'6"	Auxiliary
A-33	HVAC	R-1	A-2	A-33	Ventilation Equipment Room	36'6"	Auxiliary
A-24	CV-AB	R-1	A-4	A-24	Cable Vault	25'6"	Auxiliary
A-27	CMPT	R-1	A-8	A-27	New Computer Room	38'6"	Auxiliary
A-4	HPSI	R-1	A-13	A-4	HPSI Pump Room	-45'6"	Auxiliary
A-7	SRTA	R-1	A-13	A-7	Spent Resin Tank Area	-25'6"	Auxiliary
A-13	MCCB61	R-2	A-7	A-13	480V MCC B61 & B41A	14'6"	Auxiliary
PN-W	PN-W	R-2	A-17	A-8B	Containment Recirc. Valve Room	-25'6"	Auxiliary
			A-17	A-8C	West Piping Penetration Area	-5'0"	Auxiliary
			A-17	A-8D	West Elec. Penetration Area	14'6"	Auxiliary
			A-17	A-8E	West Main Steam Safety Valve Room	38'6"	Auxiliary
T-8	CV-W	R-2	T-3	T-8	West Cable Vault	45'0"	Turbine
T-10	SWGR-W	R-2	T-3	T-10	6.9KV & 4.16KV Switchgear Room (Z2)	56'6"	Turbine
TB	TB	R-3	T-1	T-1A	General Area Elevation 14'6"	14'6"	Turbine
			T-1	T-1B	Hydrogen Seal Oil Unit	14'6"	Turbine
			T-1	T-1C	General Area Elevation 31'6"	31'6"	Turbine
			T-1	T-1D	DC Switchgear Room	31'6"	Turbine
			T-1	T-1E	Turbine Auxiliary Battery Room	31'6"	Turbine
			T-1	T-1F	Operating Floor/Turbine Deck	54'6"	Turbine
			T-1	T-1G	Iron Chromatograph Room	14'6"	Turbine
			T-1	T-5	I&C Equipment Storage Room	25'6"	Turbine
					Condensate Polishing Building		CPB (212)
					Enclosure Building		EB (207)
T-3	MDAFW	R-3	T-5A	T-3	Motor Driven Aux. Feed Pump Pit	1'6"	Turbine

TABLE 4.6-1 (continued)

MP2 IPEEE Fire Areas		App. R Area	App. R Cable Routing Zone	Analyzed FCIA Compartment (App. A Zone)	App. A Zone Description	Elevation	Building
FHA App. A/Specific	Spatial DataBase						
T-2	TB-LO	R-3	T-1	T-2	Turbine Lube Oil System	14'6"	Turbine
CHGPMP	CHGPMP	R-4	A-18	A-6A	Charging Pump Room	-25'6"	Auxiliary
			A-18	A-6B	Degasifier Area	-25'6"	Auxiliary
A-8A	LPSI-A	R-5	A-14	A-8A	LPSI Pump Room ("A")	-45'6"	Auxiliary
A-3	LPSI-B	R-6	A-15	A-3	LPSI Pump Room ("B")	-45'6"	Auxiliary
A-15	DGR-A	R-7	A-9	A-15	Diesel Generator Room "A"	14'6"	Auxiliary
A-31	DGDT-A	R-7	A-9	A-31	Diesel Oil Day Tank Room "A"	38'6"	Auxiliary
A-16	DGR-B	R-8	A-10	A-16	Diesel Generator Room "B"	14'6"	Auxiliary
A-30	DGDT-B	R-8	A-10	A-30	Diesel Oil Day Tank Room "B"	38'6"	Auxiliary
A-20	DCEQ-E	R-9	A-5	A-20	East DC Equipment Room ("A")	14'6"	Auxiliary
A-22	BATT-E	R-9	A-5	A-22	East Battery Room	14'6"	Auxiliary
A-21	DCEQ-W	R-10	A-6	A-21	West DC Equipment Room ("B")	14'6"	Auxiliary
A-23	BATT-W	R-10	A-6	A-23	West Battery Room	14'6"	Auxiliary
A-28	LC480V-E	R-11	A-3	A-28	East 480V Load Center Room	36'6"	Auxiliary
T-4	SDAFW	R-12	T-5B	T-4	Steam Driven Aux. Feed Pump Pit	1'6"	Turbine
T-6	LC480V-W	R-13	T-2	T-6	West 480V Load Center Room	36'6"	Turbine
T-7	SWGR-E	R-14	T-4	T-7	6.9KV & 4.16KV Switchgear Room (Z1)	31'6"	Turbine
T-9	CV-E	R-14	T-4	T-9	East Cable Vault	45'0"	Turbine
C-1	CMNT	R-15	C-1	C-1	Containment	-25'6"+	Containment
I-1A	IS-PMP	R-16	I-1	I-1A	Intake Structure, Pump Room	14'0"	Intake
I-1B	IS-SHR	R-16	I-1	I-1B	Intake Structure, Sodium Hypochlorite Room	14'0"	Intake
I-1C	IS-MCC	R-16	I-1	I-1C	Intake Structure, MCC Room	14'0"	Intake
A-10A	PNPI-E	R-17	A-16	A-10A	East Piping Penetration Area	-25'6" to -5'0"	Auxiliary
A-10B	PNEL-E	R-17	A-16	A-10B	East Elec. Penetration Area	14'6"	Auxiliary
A-10C	MSSV-E	R-17	A-16	A-10C	East Main Steam Safety Valve Room/Blowdown Tank Room	38'6"	Auxiliary

TABLE 4.6-1 (continued)

MP2 IPEEE Fire Areas		App. R Area	App. R Cable Routing Zone	Analyzed FCIA Compartment (App. A Zone)	App. A Zone Description	Elevation	Building
FHA App. A/Specific	Spatial DataBase						
FP-2	FPH			FP-2	Unit 2 Fire Pumphouse	14'6"	FPH (124)
Y-1	MFW			Y-1	Ecolochem Building/Make-up Water Facility	14'6"	MWF (215)
Y-2	MRRF			Y-2	Millstone Radwaste Reduction Facility Building	14'6"	MRRF (216)
Y-3	FHWS			Y-3	Flammable/Hazardous Waste Storage Building	14'6"	FHWS (421)
Y-4	SAPM			Y-4	South Access Point Modular Building	14'6"	SAPM (452)
Y-5	MSS			Y-5	Unit II Maintenance Building Snubber Shop	14'6"	MSS (416)
Y-6	CAF			Y-6	Unit 2 Craft Assembly Facility	14'6"	CAF (465)
Y-7	MBNS			Y-7	Unit 2 Maintenance Building and Nurse Station	14'6"	MBNS (211) & (417)
Y-8	MACSS			Y-8	Maintenance Air Compressor and Storage Shelter	14'6"	MACSS (Open)
XR-1	XR-1			XR-1	Main Transformer	14'6"	Yard-MT (214)
XR-2	XR-2			XR-2	Normal Transformer	14'6"	Yard-NT (213)
XR-3	XR-3			XR-3	Reserve Transformer	14'6"	Yard-RT (218)
	RWST				Refueling Water Storage Tank		Yard-RWST (210)
	CST				Condensate Storage Tank		Yard-CST (219)
	HPO				Unit 2 Health Physics Offices		HPO (206)
	FB				Fuel Building		FB (208)
	XFMRB				Transformer Building		XFMRB (220)
	CLB				Chlorination Building		CLB (221)
	SWFH				Service Water Filter House		SWFH (222)

TABLE 4.6-2

MP2 Fire Compartments Vs. IPE Systems

Fire Area/Zone			IPE System																					
#	ID	Description	EL-AC	EL-DC	EL-SVAC	EL-VAC	EL-GENL	SW	RBCCW	AIR	CARF	AFW	MFW	CHG	EB	HPSI	LPSI	SDC	CS	PRZ	PORV	MS	INST	HVAC
1	A-1A	General Area Elevation -45'					P				P			P	P	P	P							P
2	A-1B	RBCCW Pump & Hx. Area							T					T	P									
3	A-1C	Waste Tank Pump Room							P						P		T							
4	A-1G	General Area Elevation -5'					P				P			P	P	P	P							P
5	A-1H	Volume Control Tank					P				P			P	P	P	P							P
6	A-3	LPSI Pump Room ("B")							P							P	P	P	P					
7	A-4	HPSI Pump Room							M							P		P	P					
8	A-5	Coolant Tank Area							T															
9	A-6A	Charging Pump Room												T										
10	A-6B	Degasifier Area												T										
11	A-8A	LPSI Pump Room ("A")							P							P	P	P	P					
12	A-8B	Contain. Recirc. Valve Room														P	P		P					
13	A-8C	West Piping Penetration Area												P		P	P							
14	A-8D	West Elec. Penetration Area												P		P	P						P	
15	A-8E	West Main Steam Safety Valve Room																			P	P		

T - Total loss of the system is possible

P - Partial loss of the system

M - Minor effect on the system

Systems

EL-AC - Electrical, AC Power
EL-DC - Electrical, DC Power
EL-SVAC - Electrical, Semivital Power
EL-VAC - Electrical, Vital Power
EL-GENL - Electrical, Distribution Panels
SW - Service Water

CCW - Component Cooling Water
AIR - Instrument Air
CARF - CAR Fans
AFW - Auxiliary Feedwater
MFW - Main Feedwater
CHG - Charging

CHG - Charging
EB - Emergency Boration
HPSI - High Pressure Safety Injection
LPSI - Low Pressure Safety Injection
CS - Containment Spray
PRZ - Pressurizer Spray

PROV - PORVs and Block Valves
MS - Main Steam
INST - Instrumentation
SDC - Shutdown Cooling
HVAC - Room Ventilation

TABLE 4.6-2 (continued)

Fire Area/Zone			IPE System																					
#	ID	Description	EL-AC	EL-DC	EL-SVAC	EL-VAC	EL-GENL	SW	RBCCW	AIR	CARF	AFW	MFW	CHG	EB	HPSI	LPSI	SDC	CS	PRZ	PORV	MS	INST	HVAC
16	A-9	Maintenance Storage Crib												P		P	P							
17	A-10A	East Piping Penetration Area												P		P	P						P	
18	A-10B	East Elec. Penetration Area																			P	P		
19	A-10C	East Main Steam Safety Valve Room/Blowdown Tank Room									P				P				P			P		
20	A-12A	Boric Acid & Chem. Add. Tank					P				P			P	P	P	P							P
21	A-13	480V MCC B61 & B41A						P	P					P	P	P	P	P				P	P	P
22	A-14B	Railroad Bay Area	P							P	P					P	P					P	P	P
23	A-14D	EBFAS Equipment Area	P							P	P					P	P					P	P	P
24	A-15	Diesel Generator Room "A"	M																					
25	A-16	Diesel Generator Room "B"	M																					
26	A-19B	Hallway Storage Area																						
27	A-20	East DC Equip. Room ("A")		P	P	P																		
28	A-21	West DC Equip. Room ("B")		P	P	P																		
29	A-22	East Battery Room		P																				
30	A-23	West Battery Room		P																				
31	A-24	Cable Vault	T	T	T	T	T	T	T	T	T	P	T	T	T	T	T	T	T	T	T	T	T	T
32	A-25	Main Control Room	P					M	T		M	M		T	T	T	T	T	P	P		M	P	M
33	A-28	East 480V Load Center Room	P	P				P	P			P	P	P		P	P		P					P
34	A-30	Diesel Oil Day Tank Room "B"	M																					
35	A-31	Diesel Oil Day Tank Room "A"	M																					
36	A-32	Air Handling Units	P							P	P					P	P					P	P	P
37	A-33	Ventilation Equipment Room	P	P						P	P											P		P
38	T-1A	General Area Elevation 14'6"	T					T		T		T												

TABLE 4.6-2 (continued)

Fire Area/Zone			IPE System																					
#	ID	Description	EL-AC	EL-DC	EL-SVAC	EL-VAC	EL-GENL	SW	RBCCW	AIR	CARF	AFW	MFW	CHG	EB	HPSI	LPSI	SDC	CS	PRZ	PORV	MS	INST	HVAC
39	T-1C	General Area Elevation 31'6"	T					T		T		T												
40	T-1F	Operating Floor/Turbine Deck	T					T		T		T												
41	T-3	Motor Driven Aux. Feed Pump Pit										P												
42	T-4	Steam Driven Aux. Feed Pump Pit										P												
43	T-6	West 480V Load Center Room	P	P				P	P			P	P	P		P	P		P					P
44	T-7	6.9KV & 4.16KV Switchgear Room (Z1)	P																					
45	T-8	West Cable Vault	P	P				P	P			P	P	P		P	P		P	P				P
46	T-9	East Cable Vault	P	P				P	P			P	P	P		P	P		P	P				P
47	T-10	6.9KV & 4.16KV Switchgear Room (Z2)	P																					
48	C-1	Containment																						
49	I-1A	Intake Structure, Pump Room							T															
50	FP-2	Unit 2 Fire Pumphouse																	M					
51	XR-1	Main Transformer	P																					
52	XR-2	Normal Transformer	P																					

TABLE 4.6-3

MP2 Fire Compartments Vs. IPE Initiating Events

Fire Area/Zone																
#	ID	Description	SLOCA	SSLOCA	LOSW	LOIA	LDCA	LDCB	LVA 10 & 30	LRBCCW	GPT	RT	LMFW	LOSP	VSEQ
1	A-1A	General Area Elevation -45'									P	P			
2	A-1B	RBCCW Pump & Hx. Area								X					
3	A-1C	Waste Tank Pump Room									P	P			
4	A-1G	General Area Elevation -5'									P	P			
5	A-1H	Volume Control Tank									P	P			
6	A-3	LPSI Pump Room ("B")									P	P			
7	A-4	HPSI Pump Room									P	P			
8	A-5	Coolant Tank Area								P					
9	A-6A	Charging Pump Room									P	P			
10	A-6B	Degasifier Area									P	P			
11	A-8A	LPSI Pump Room ("A")									P	P			
12	A-8B	Contain. Recirc. Valve Room									P	P			
13	A-8C	West Piping Penetration Area									P	P			
14	A-8D	West Elec. Penetration Area									P	P			
15	A-8E	West Main Steam Safety Valve Room											X		
16	A-9	Maintenance Storage Crib									P	P			
17	A-10A	East Piping Penetration Area									P	P			
18	A-10B	East Elec. Penetration Area									P	P			
19	A-10C	East Main Steam Safety Valve Room/Blowdown Tank Room											X		
20	A-12A	Boric Acid & Chem. Add. Tank									P	P			
21	A-13	480V MCC B61 & B41A									P	P			
22	A-14B	Railroad Bay Area									P	P			
23	A-14D	EBFAS Equipment Area									P	P			
24	A-15	Diesel Generator Room "A"									P	P			
25	A-16	Diesel Generator Room "B"									P	P			
26	A-19B	Hallway Storage Area									P	P			

X - Initiating event is likely to occur
P - initiating events is possible

<u>IPE Initiating Events</u>

SLOCA - Small LOCA
SSLOCA - Small Small LOCA
LOSW - Loss of Service Water
LOIA - Loss of Instrument Air
VESQ - V Sequence
LDCA - Loss of DC Bus A
LDCB - Loss of DC Bus B
LVA10&30 - Loss of Vital Panels 10 & 30
LRBCCW - Loss of RBCCW
GPT - General Plant Transient
RT - Reactor Trip
LMFW - Loss of MFW
LOSP - Loss of Off-site Power

TABLE 4.6-3 (continued)

Fire Area/Zone															
#	ID	Description	SLOCA	SSLOCA	LOSW	LOIA	LDCA	LDCB	LVA 10 & 30	LRBCCW	GPT	RT	LMFW	LOSP	VSEQ
27	A-20	East DC Equip. Room ("A")					X								
28	A-21	West DC Equip. Room ("B")						X							
29	A-22	East Battery Room					P								
30	A-23	West Battery Room						P							
31	A-24	Cable Vault	P	P	P	X	X	X	X	X	X	X	X	X	P
32	A-25	Main Control Room	P	P	P	X	X	X	X	X	X	X	X	X	P
33	A-28	East 480V Load Center Room					P								
34	A-30	Diesel Oil Day Tank Room "B"									P	P			
35	A-31	Diesel Oil Day Tank Room "A"									P	P			
36	A-32	Air Handling Units											P		
37	A-33	Ventilation Equipment Room									P	P			
38	T-1A	General Area Elevation 14'6"			X	X					X	X	X	X	
39	T-1C	General Area Elevation 31'6"											X		
40	T-1F	Operating Floor/Turbine Deck											X		
41	T-3	Motor Driven Aux. Feed Pump Pit									P	P			
42	T-4	Steam Driven Aux. Feed Pump Pit									P	P			
43	T-6	West 480V Load Center Room					P								
44	T-7	6.9KV & 4.16KV Switchgear Room (Z1)												P	
45	T-8	West Cable Vault												P	
46	T-9	East Cable Vault												P	
47	T-10	6.9KV & 4.16KV Switchgear Room (Z2)												P	
48	C-1	Containment									P	P			
49	I-1A	Intake Structure, Pump Room				X									
50	FP-2	Unit 2 Fire Pumphouse													
51	XR-1	Main Transformer												X	
52	XR-2	Normal Transformer												X	

TABLE 4.6-4

Summary of the MP2 Fire Compartment Screening Process

Fire Area/Zone			PROCESS OF ANALYSIS					
#	ID	Description	IPE IE	IPE SYS	QUALITATIVE SCREEN	QUANTITATIVE SCREEN	BASIS FOR QUANT SCREEN	DETAILED ANALYSIS
1	A-1A	General Area Elevation -45'	Y	Y				1 (AUX-1)
2	A-1B	RBCCW Pump & Hx. Area	Y	Y				2 (AUX-1)
3	A-1C	Waste Tank Pump Room	Y	Y				3 (AUX-1)
4	A-1D	Waste Tank Room	N	N	1			
5	A-1E	Waste Gas Decay Tank Room	N	N	2			
6	A-1F	Waste Gas Comp. & Surge Tank Room	N	N	3			
7	A-1G	General Area Elevation -5'	Y	Y				4 (AUX-1)
8	A-1H	Volume Control Tank	Y	Y				5 (AUX-1)
9	A-1I	Boric Acid Evap.& Tanks Room	N	N	4			
10	A-1J	Evap. & Tank Room	N	N	5			
11	A-3	LPSI Pump Room ("B")	N	Y		1	CDF	
12	A-4	HPSI Pump Room	N	Y		2	CDF	
13	A-5	Coolant Tank Area	N	Y		3	CDF	
14	A-6A	Charging Pump Room	N	Y		4 (CHGPMP)	CDF	
15	A-6B	Degasifier Area	N	Y		5 (CHGPMP)	CDF	
16	A-7	Spent Resin Tank Room	N	Y		5	CDF	
17	A-8A	LPSI Pump Room ("A")	N	Y		7	CDF	
18	A-8B	Contain. Recirc. Valve Room	N	Y		8 (PN-W0	CDF	
19	A-8C	West Piping Penetration Area	Y	Y		9 (PN-W)	CDF	
20	A-8D	West Elec. Penetration Area	Y	Y		10 (PN-W)	CDF	
21	A-8E	West Main Steam Safety Valve Room	Y	Y		11 (PN-W0	INT/CDF	
22	A-9	Maintenance Storage Crib	N	N				6 (AUX-1)
23	A-10A	East Piping Penetration Area	Y	Y		12	CDF	
24	A-10B	East Elec. Penetration Area	Y	Y		13	CDF	
25	A-10C	East Main Steam Safety Valve Room/Blowdown Tank Room	Y	Y		14	INT/CDF	
26	A-11	Ion Exchange Room	N	N	6			
27	A-12A	Boric Acid & Chem. Add. Tank	Y	Y				7 (AUX-1)
28	A-12B	Sample Area	N	N	7			

Shaded areas indicate the process of analysis for each area.

* - Area/Zone screened by qualitative inspection, area/zone poses no fire threat to safety related areas/zones

Legend:

- CDF: Quantitative screening based on the high availability of backup systems outside of the compartment (CDF < 10^{-6}/year).
- INT: Quantitative screening based on the comparison of a fire-induced system/component unavailability with the unavailability due to internal failures
- ENV: Quantitative screening based on the comparison of fire effects in this compartment with fire effects from the other MP2 fire compartments to be analyzed (enveloped by ongoing analysis).

TABLE 4.6-4 (continued)

Fire Area/Zone			PROCESS OF ANALYSIS					
#	ID	Description	IPE IE	IPE SYS.	QUALITATIVE SCREEN	QUANTITATIVE SCREEN	BASIS FOR QUANT. SCREEN	DETAILED ANALYSIS
29	A-12C	Boronmeter Room	N	N	8			
30	A-13	480V MCC B61 & B41A	Y	Y		15	ENV	
31	A-14A	Spent Fuel Pool & Cask Laydown Area	N	N	9			
32	A-14B	Railroad Bay Area	Y	Y		16 (AUX-2)	CDF	
33	A-14C	Top Of Spent Fuel Pool & Fuel Handling Area	N	N	10			
34	A-14D	EBFAS Equipment Area	N	Y		17 (AUX-2)	CDF	
35	A-15	Diesel Generator Room "A"	N	Y		18	CDF	
36	A-16	Diesel Generator Room "B"	N	Y		19	CDF	
37	A-17	Solid Radwaste Drumming Stroage Area	N	N	11			
38	A-18	Storage Area	N	N	12			
39	A-19A	HP Access/Control Area	N	N	13			
40	A-19B	Hallway Storage Area	Y	Y		20	CDF	
41	A-20	East DC Equip. Room ("A")	Y	Y		21	INT/CDF	
42	A-21	West DC Equip. Room ("B")	Y	Y		22	INT/CDF	
43	A-22	East Battery Room	Y	Y		23	ENV	
44	A-23	West Battery Room	Y	Y		24	ENV	
45	A-24	Cable Vault	Y	Y				8
46	A-25	Main Control Room	Y	Y				9
47	A-26	Operator Break Room	N	N	14			
48	A-27	New Computer Room	N	N	15			
49	A-28	East 480V Load Center Room	N	Y		25	ENV	
50	A-29	RCP Rebuild Shop Prep. Room	N	N	16			
51	A-30	Diesel Oil Day Tank Room "B"	N	Y		26	ENV	
52	A-31	Diesel Oil Day Tank Room "A"	N	Y		27	ENV	
53	A-32	Air Handling Units	N	Y		28 (AUX-2)	CDF	
54	A-33	Ventilation Equipment Room	N	Y		29	CDF	
55	T-1A	General Area Elevation 14'6"	Y	Y				10 (TB)
56	T-1B	Hydrogen Seal Oil Umit	N	N	17			
57	T-1C	General Area Elevation 31'6"	Y	Y				11 (TB)
58	T-1D	DC Switchgear Area	N	N	18			
59	T-1E	Auxiliary Battery Area	N	N	19			
60	T-1F	Operating Floor/Turbine Deck	Y	Y				12 (TB)
61	T-1G	Iron Chromatagraph Room	N	N	20			
62	T-2	Turbine Lube Oil System	N	N	21			

TABLE 4.6-4 (continued)

Fire Area/Zone			PROCESS OF ANALYSIS					
#	ID	Description	IPE IE	IPE SYS	QUALITATIVE SCREEN	QUANTITATIVE SCREEN	BASIS FOR QUANT. SCREEN	DETAILED ANALYSIS
63	T-3	Motor Driven Aux. Feed Pump Pit	N	N		30	CDF	
64	T-4	Steam Driven Aux. Feed Pump Pit	N	Y		31	CDF	
65	T-5	I&C Equipment Storage Area	N	N	22			
66	T-6	West 480V Load Center Room	Y	Y		32	ENV	
67	T-7	6.9KV & 4.16KV Switchgear Room (Z1)	Y	Y		33	CDF	
68	T-8	West Cable Vault	Y	Y		34	ENV	
69	T-9	East Cable Vault	Y	Y		35	ENV	
70	T-10	6.9KV & 4.16KV Switchgear Room (Z2)	Y	Y		36	CDF	
71	C-1	Containment	N	N		37	ENV	
72	I-1A	Intake Structure, Pump Room	Y	Y				13
73	I-1B	Intake Structure Hypochlorite Room	N	N	23			
74	I-1C	Intake Structure, MCC Room	N	N	24			
75	FP-2	Unit 2 Fire Pumphouse	N	Y		38	CDF	
76	XR-1	Main Transformer	Y	N		39	CDF	
77	XR-2	Normal Transformer	Y	N		40	CDF	
78	XR-3	Reserve Transformer	Y	N		41	CDF	
79	Y-1	Ecolochem Buildong	N	N	25*			
80	Y-2	Radwaste Reduction Facility	N	N	26*			
81	Y-3	Flammable/Hazardous Waste Storage	N	N	27			
82	Y-4	South Access Point Building	N	N	28*			
83	Y-5	Maint. Building Snubber shop	N	N	29*			
84	Y-6	Craft Assembly Area	N	N	30*			
85	Y-7	Maint. Building & Nurse Station	N	N	31*			
96	Y-8	Maint. Air Comp. & Storage shelter	N	N	32*			
87		Refueling Water Storage Tank	N	N	33*			
88		Condensate Storage Tank	N	N	34*			
89		Health Physics Office	N	N	35*			
90		Fuel Building	N	N	36*			
91		Transformer Building	N	N	37*			
92		Chlorination Building	N	N	38*			
93		Service Water Filter House	N	N	39*			

TABLE 4.7-1

Unavailability for MP2 Automatic Suppression Systems

System Type	Generic Delivery System Unavailabilty	Water Supply System Unavailability	Total Automatic Suppression System Unavailability
Case 1: Support Systems Available			
Wet Pipe Sprinkler	2.0E-02	1.3E-04	2.0E-02
Preaction Sprinkler	5.0E-02	1.3E-04	5.0E-02
Deluge Sprinkler	5.0E-02	1.3E-04	5.0E-02
CO_2	4.0E-02	N/A	4.0E-02
Halon	5.0E-02	N/A	5.0E-02
Case 2: Support Systems Unavailable			
Wet Pipe Sprinkler	2.0E-02	1.9E-02	3.9E-02
Reaction Sprinkler	5.0E-02	1.9E-02	6.9E-02
Deluge Sprinkler	5.0E-02	1.9E-02	6.9E-02
CO_2	4.0E-02	N/A	4.0E-02
Halon	5.0E-02	N/A	5.0E-02

TABLE 4.8-1

Selected Fire Scenarios for MP2 and Corresponding Target Sets

Fire Scenario	Fire Scenario Description	Target Set	Target Set Description
M2A1B-* (AUXB-1)	Fire in Auxiliary Building area A-1B causing a plant transient and or a loss of RBCCW	M2A1B-1	Cable trays above/near the transient combustibles
		M2A1B-2	Cable trays above/near the areated waste panel
		M2A1B-3	Total loss of RBCCW due to pump fire.
M2A1G-* (AUXB-1)	Fire in Auxiliary Building area A-1G causing a plant transient	M2A1G-1	Cable trays above/near the transient combustibles
		M2A1G-2	Cable trays above/near the evaporator panel
		M2A1G-3	Cable trays above/near the C-63 panel
		M2A1G-4	Cable trays above/near the MCC B-31A
M2A12A-* (AUXB-1)	Fire in Auxiliary Building area A-12A causing a plant transient	M2A12A-1	Cable trays above/near the transient combustibles
M2A24-*	Fire in Cable Vault area A-24 causing a plant transient	M2A24-1	Cable trays near a low voltage transformer
M2A25-*	Fire in the main control board or the ESAS cabinets within the Control Room	M2A25-1	One main control board cabinet (front or back)
		M2A25-2	Two main control board cabinets (front and back)
		M2A25-3	Six main control board cabinets (front, back, and sides)
		M2A25-4	ESAS Cabinets
M2I1A-*	Fire (service water or circulating water pump fire) in Intake Structure (area I-1A) causing a total loss of service water transient	M2I1A-1	Service water pumps and circulating water pumps
		M2I1A-2	Service water pumps and circulating water pumps
		M2I1A-3	Service water pumps and circulating water pumps
		M2I1A-4	Service water pumps and circulating water pumps

TABLE 4.8-1 (continued)

Fire Scenario	Fire Scenario Description	Target Set	Target Set Description
M2TB-*	Fires in turbine building causing a plant transient (ie., loss of inst. air, loss of main feedwater, etc.)	M2TB-1	TBCCW pumps and cable conduits
		M2TB-2	Condenser vacuum pumps, TBCCW pumps, and cable conduits
		M2TB-3	Transformer and trubine hydrogen seal oil unit
		M2TB-4	Condensate pumps, IA & SA compressors, and cable trays
		M2TB-5	SA & IA compressors and cable trays
		M2TB-6	Main feedwater pumps

TABLE 4.8-2

Fire Growth and Propagation Results for MP2 Fire Target Sets

Target Set Number	Location	Target	Consequence	Fire Source	Combustible	Amount of Combustible (gal)	Fixed or Transient Combustible	Fire Scenario Type	Time to Damage/ Actuate (sec)	Fire Duration (min)
M2A1B-1i	A-1B (Aux Bldg.)	Cable Trays	Plant Transient	Transient	Protective Clothing	175	T	1	<1	17.5
M2A1B-1r	A-1B (Aux Bldg.)	Cable Trays	Plant Transient	Transient	Protective Clothing	175	T	3	ND	17.5
M2A1B-1d	A-1B (Aux Bldg.)	Detector	Actuation	Transient	Protective Clothing	175	T	2	5	17.5
M2A1B-2i	A-1B (Aux Bldg.)	Cable Trays	Plant Transient	Control Panel	Cabinet	-	F	1	168	48.1
M2A1B-2d	A-1B (Aux Bldg.)	Detector	Actuation	Control Panel	Cabinet	-	F	2	32	48.1
M2A1B-3i	A-1B (Aux Bldg.)	Cable Trays	Plant Transient	RBCCW pump C	Lube Oil	0.5	F	1	20	.34
M2A1B-3d	A-1B (Aux Bldg.)	Detector	Actuation	RBCCW pump C	Lube Oil	0.5	F	2	2.5	.34
M2A1G-1i	A-1G (Aux Bldg.)	Cable Trays	Plant Transient	Transient	Protective Clothing	175	T	1	<1	17.5
M2A1G-1r	A-1G (Aux Bldg.)	Cable Trays	Plant Transient	Transient	Protective Clothing	175	T	3	ND	17.5
M2A1G-1d	A-1G (Aux Bldg.)	Detector	Actuation	Transient	Protective Clothing	175	T	2	2.1	17.5
M2A1G-2i	A-1G (Aux Bldg.)	Cable Trays	Plant Transient	Control Panel	Cabinet	-	F	1	53	48.1
M2A1G-2r	A-1G (Aux Bldg.)	Cable Trays	Plant Transient	Control Panel	Cabinet	-	F	3	ND	48.1
M2A1G-2d	A-1G (Aux Bldg.)	Detector	Actuation	Control Panel	Cabinet	-	F	2	32	48.1
M2A1G-3i	A-1G (Aux Bldg.)	Cable Trays	Plant Transient	Control Panel	Cabinet	-	F	1	53	48.1

<u>Fixed or Transient Combustibles</u>

F - Fixed Combustible
F* - Fixed Combustible, Requires Additional Failure
T - Transient Combustible

<u>Fire Scenario Type</u>

1 - Target In Plume
2 - Target Outside Plume
3 - Radiant Exposure
General - Total Room Failure

<u>Time to Damage</u>

ND - No Damage
NDSFD - no damage - time to damage is greater than fire duration

TABLE 4.8-2 (continued)

Target Set Number	Location	Target	Consequence	Fire Source	Combustible	Amount of Combustible (gal)	Fixed or Transient Combustible	Fire Scenario Type	Time to Damage/ Actuate (sec)	Fire Duration (min)
M2A1G-3r	A-1G (Aux.Bldg.)	Cable Trays	Plant Transient	Control Panel	Cabinet	-	F	3	ND	48.1
M2A1G-3d	A-1G (Aux.Bldg.)	Detector	Actuation	Control Panel	Cabinet	-	F	2	36	48.1
M2A1G-4i	A-1G (Aux.Bldg.)	Cable Trays	Plant Transient	Control Panel	Cabinet	-	F	1	3	48.1
M2A1G-4r	A-1G (Aux.Bldg.)	Cable Trays	Plant Transient	Control Panel	Cabinet	-	F	3	ND	48.1
M2A1G-4d	A-1G (Aux.Bldg.)	Detector	Actuation	Control Panel	Cabinet	-	F	2	63	48.1
M2A12A-i	A-12A (Aux.Bldg.)	Cable Trays	Plant Transient	Transient	Protective Clothing	350	T	1	1	35
M2A12A-r	A-12A (Aux.Bldg.)	Cable Trays	Plant Transient	Transient	Protective Clothing	350	T	3	ND	35
M2A12A-d	A-12A (Aux.Bldg.)	Detector	Actuation	Transient	Protective Clothing	350	T	1	17	35
M2A24-r	A-24 (Aux.Bldg.)	Cable Trays	Plant Transient	Transformer	Cabinet	-	F	1	4	2
M2A24-d	A-24 (Aux.Bldg.)	Detector	Actuation	Transformer	Cabinet	-	F	2	2	2
M2A24-s	A-24 (Aux.Bldg.)	Sprinkler	Actuation	Transformer	Cabinet	-	F	1	NA	2
M2A25-1	A-25 (CR)	Main Control Board	Plant Transient	Control Panel	Cabinet	-	F	See dicsusion for fires in Control Room Area A-25		
M2A25-2	A-25 (CR)	Main Control Board	Plant Transient	Control Panel	Cabinet	-	F			
M2A25-3	A-25 (CR)	Main Control Board	Plant Transient	Control Panel	Cabinet	-	F			
M2A25-4	A-25 (CR)	ESAS Control Panels	Plant Transient	Control Panel	Cabinet	-	F			
M2I1A-1r	I-1A (SWH)	SW Pump A	Loss of SW	CW Pump B	Lube Oil	8 (50.25)	F	3	8	0.13
M2I1A-2r	I-1A (SWH)	SW Pump A	Loss of SW	SW Pump B	Lube Oil	13.25	F	3	1	0.13

TABLE 4.8-2 (continued)

Target Set Number	Location	Target	Consequence	Fire Source	Combustible	Amount of Combustible (gal)	Fixed or Transient Combustible	Fire Scenario Type	Time to Damage/ Actuate (sec)	Fire Duration (min)
M2I1A-3r	I-1A (SWH)	SW Pump A	Loss of SW	CW Pump D	Lube Oil	50.25	F	3	65 NDSFD	0.4
M2I1A-4r	I-1A (SWH)	SW Pump A	Loss of SW	CW Pump C	Lube Oil	50.25	F	3	25	0.4
M2TB-1i	TB	Cable Conduit	Plant Transient	TBCCW pump	Lube Oil	0.5	F	1	1	0.13
M2TB-1r1	TB	Cable Conduit	Plant Transient	TBCCW pump	Lube Oil	0.5	F	3	14 NDSFD	0.13
M2TB-1r2	TB	TBCCW pump A	Plant Transient	TBCCW pump	Lube Oil	0.5	F	3	70 NDSFD	0.13
M2TB-1r3	TB	TBCCW pump C Cable Conduit	Plant Transient	TBCCW pump	Lube Oil	0.5	F	3	3	0.13
M2TB-2r1	TB	Cable Conduit	Plant Transient	Condenser vacuum pump	Lube Oil	0.5	F	3	7	0.13
M2TB-2r2	TB	TBCCW pump A	Plant Transient	Condenser vacuum pump	Lube Oil	0.5	F	3	105 NDFSD	0.13
M2TB-3r	TB	Hydrogen seal oil unit	Plant Transient	Transformer	Oil	100	F	3	500	19
M2TB-3s	TB	Sprinkler	Actuation	Transformer	Oil	100	F	1	12	19
M2TB-4i	TB	Cable trays	Plant Transient	Condensate pump B	Lube Oil	30.25	F	1	<1	0.23
M2TB-4r1	TB	Condensate pumps	Plant Transient	Condensate pump B	Lube Oil	30.25	F	3	2	0.23
M2TB-4r2	TB	Condensate pump A	Plant Transient	Condensate pump C	Lube Oil	30.25	F	3	10	0.23
M2TB-4r3	TB	IA & SA compressors	Plant Transient	Condensate pump C	Lube Oil	30.25	F	3	30 NDSFD	0.23
M2TB-4s	TB	Sprinkler	Actuation	Condensate pumps	Lube Oil	30.25	F	1	4	0.23
M2TB-5i	TB	Cable trays	Plant Transient	SA compressor	Lube Oil	4.5	F	1	<1	0.13
M2TB-5r1	TB	IA compressor	Plant Transient	SA Compressor	Lube Oil	4.5	F	3	1	0.13
M2TB-5r2	TB	Cable trays	Plant Transient	SA compressor	Lube Oil	4.5	F	3	5	0.13
M2TB-5s	TB	Sprinkler	Actuation	SA compressor	Lube Oil	4.5	F	1	4	0.13

TABLE 4.8-2 (continued)

Target Set Number	Location	Target	Consequence	Fire Source	Combustible	Amount of Combustible (gal)	Fixed or Transient Combustible	Fire Scenario Type	Time to Damage/ Actuate (sec)	Fire Duration (min)
M2TB-6r	TB	Main feedwater pump	Plant Transient	Main feedwater pump	Lube Oil	100 (1020)	F	3	10	8
M2TB-6s	TB	Sprinkler	Actuation	Main feedwater pump	Lube Oil	100 (1020)	F	1	2	8

TABLE 4.8-3

Fire Target Set Results Summary for MP2

Target Set	Location	Target	Fire Source/Combustible	Potential Consequence	Time to Damage (sec)	Time to Actuate Detector (sec)	Time to Actuate Sprinkler or 2nd Detector (Halon,CO_2) (sec)	Manual Suppression Credit	Auto Suppression Credit
M2A1B-1i	A-1B (Aux Bldg)	Calbe Trays	TrS: Transient Ignition TrC: Protective Clothing	Plant Transient	<1	5	NN	NO	NA
M2A1B-1r	A-1B (Aux Bldg)	Calbe Trays	TrS: Transient Ignition TrC: Protective Clothing	Plant Transient	ND	5	NN	NO	NA
M2A1B-2i	A-1B (Aux Bldg)	Calbe Trays	FxS: Control Panel FxC: Cabinets	Plant Transient	168	32	NN	NO	NA
M2A1B-3i	A-1B (Aux Bldg)	Calbe Trays	FxS: RBCCW pump C FxC(ADF): Lube Oil	Plant Transient	20	2.5	NN	NO	NA
M2A1G-1i	A-1G (Aux Bldg)	Calbe Trays	TrS: Transient Ignition TrC: Protective Clothing	Plant Transient	<1	2.1	NN	NO	NA
M2A1G-1r	A-1G (Aux Bldg)	Calbe Trays	TrS: Transient Ignition TrC: Protective Clothing	Plant Transient	ND	2.1	NN	NO	NA
M2A1G-2i	A-1G (Aux Bldg)	Calbe Trays	FxS: Control Panel FxC: Cabinets	Plant Transient	53	32	NN	NO	NA
M2A1G-2r	A-1G (Aux Bldg)	Calbe Trays	FxS: Control Panel FxC: Cabinets	Plant Transient	ND	32	NN	NO	NA
M2A1G-3i	A-1G (Aux Bldg)	Calbe Trays	FxS: Control Panel FxC: Cabinets	Plant Transient	53	36	NN	NO	NA
M2A1G-3r	A-1G (Aux Bldg)	Calbe Trays	FxS: Control Panel FxC: Cabinets	Plant Transient	ND	38	NN	NO	NA
M2A1G-4i	A-1G (Aux Bldg)	Calbe Trays	FxS: Control Panel FxC: Cabinets	Plant Transient	3	63	NN	NO	NA
M2A1G-4r	A-1G (Aux Bldg)	Calbe Trays	FxS: Control Panel FxC: Cabinets	Plant Transient	ND	63	NN	NO	NA
M2A12A-i	A-12A (Aux Bldg)	Calbe Trays	TrS: Transient Ignition TrC: Protective Clothing	Plant Transient	<1	17	NN	NO	NA

Fire Source/Combustible

FxS - Fixed Source
FxC - Fixed Combustible
TrS - Transient Source
TrC - Transient Combustible
(ADF) - Additional Failure Involved (for example: pipe break or an oil leak)

ND - No Damage.
NN - Calculation is Not Necessary (based upon the time to damage).

TABLE 4.8-3 (continued)

Target Set	Location	Target	Fire Source/Combustible	Potential Consequence	Time to Damage (sec)	Time to Actuate Detector (sec)	Time to Actuate Sprinkler or 2nd Detector (Halon,CO_2) (sec)	Manual Suppression Credit	Auto Suppression Credit
M2A12A-o	A-12A (Aux Bldg)	Calbe Trays	TrS: Transient Ignition TrC: Protective Clothing	Plant Transient	59	17	NN	NO	NA
M2A24-r	A-24 (Aux Bldg)	Calbe Trays	FxS: Transformer FxC: Transformer	Plant Transient	4	2	ND	YES	YES (Wet Pipe)
M2A25-1	A-25 (CR)	Main Control Board	FxS: Control Panel FxC: Cabinets	Plant Transient	See dicsusion for fires in Control Room Area A-25			NO	NA
M2A25-2	A-25 (CR)	Main Control Board	FxS: Control Panel FxC: Cabinets	Plant Transient				YES	NA
M2A25-3	A-25 (CR)	Main Control Board	FxS: Control Panel FxC: Cabinets	Plant Transient				YES	NA
M2A25-4	A-25 (CR)	ESAS Contol Panel	FxS: Control Panel FxC: Cabinets	Plant Transient				NO	NA
M2I1-1r	I-1A (SWIntake)	SW Pump A	FxS: CW pump B FxC(ADF): Lube Oil	Loss of SW	8	NN	NN	NO	NA
M2I1-2r	I-1A (SWIntake)	SW Pump A	FxS: SW pump B FxC(ADF): Lube Oil	Loss of SW	1	NN	NN	NO	NA
M2I1-3r	I-1A (SWIntake)	SW Pump A	FxS: CW pump D FxC(ADF): Lube Oil	Loss of SW	65	NN	NN	NO	NA
M2I1-4r	I-1A (SWIntake)	SW Pump A	FxS: CW pump C FxC(ADF): Lube Oil	Loss of SW	25	NN	NN	NO	NA
M2TB-1i	T-1 (TB)	Cable Conduit	FxS: TBCCW pump FxC(ADF): Lube Oil	Plant Transient (Loss of TBCCW)	1	NN	NN	NO	NO
M2TB-1r	T-1 (TB)	Cable Conduit & TBCCW pumps	FxS: TBCCW pump FxC(ADF): Lube Oil	Plant Transient (Loss of TBCCW)	15	NN	NN	NO	NO
M2TB-2r	T-1 (TB)	Cable Conduit & TBCCW pumps	FxS: Vacuum pump FxC(ADF): Lube Oil	Plant Transient (Loss of TBCCW)	19	NN	NN	NO	NO
M2TB-3r	T-1 (TB)	Hydrogen seal oil unit	FxS: Transformer FxC: Transformer Oil	Plant Transient (major fire)	500	NN	12	NO	YES (WP & Deluge)

Fire Source/Combustible

FxS - Fixed Source
FxC - Fixed Combustible
TrS - Transient Source
TrC - Transient Combustible
(ADF) - Additional Failure Involved (for example: pipe break or an oil leak)

ND - No Damage.
NN - Calculation is Not Necessary (based upon the time to damage).

TABLE 4.8-3 (continued)

Target Set	Location	Target	Fire Source/Combustible	Potential Consequence	Time to Damage (sec)	Time to Actuate Detector (sec)	Time to Actuate Sprinkler or 2nd Detector (Halon, CO_2) (sec)	Manual Suppression Credit	Auto Suppression Credit
M2TB-4i	T-1 (TB)	Cable Trays	FxS: Condensate pump FxC(ADF): Lube Oil	Loss of Air	63	NN	4	NO	YES (Wet Pipe)
M2TB-4r	T-1 (TB)	Cond. pumps and IA & SA comp.	TrS: Transient Ignition TrC(ADF): Lube Oil	Loss of Air	55	NN	4	NO	YES (Wet Pipe)
M2TB-5i	T-1 (TB)	Cable Trays & IA Compressor	FxS: SA Compressor FxC(ADF): Lube Oil	Loss of Air	288	NN	2	NO	YES (Wet Pipe)
M2TB-5r	T-1 (TB)	IA Compressors	FxS: SA Compressor FxC(ADF): Lube Oil	Loss of Air	5	NN	12	NO	YES (Wet Pipe)
M2TB-6r	T-1 (TB)	MFW Pump B	FxS: MFW Pump A FxC(ADF): Lube Oil	Plant Transient (Loss of MFW)	5	NN	12	NO	YES (Deluge)

Fire Source/Combustible

FxS - Fixed Source
FxC - Fixed Combustible
TrS - Transient Source
TrC - Transient Combustible
(ADF) - Additional Failure Involved (for example: pipe break or an oil leak)

ND - No Damage.
NN - Calculation is Not Necessary (based upon the time to damage).

TABLE 4.8-4

Ignition Frequencies for MP2 Fire Scenarios

Fire Scenario	Location	Corresponding Target Sets	Fire Source for Target Set	Basis for Ignition Frequency	Ignition Frequency (per year)
M2A1B	Aux. Bldg. area A-1B	M2A1B-1	Transient Combustibles (protective clothing) with Transient Ignition	Transient Fire Ignition Frequency for Auxiliary Building area	7.5E-05
		M2A1B-2	Areated Waste Panel Cabinets (2)	2 * (Electrical Cabinet Fire Ignition Frequency in Auxiliary Building)	1.4E-04
		M2A1B-3	RBCCW Pump B involving lube oil spill	1 * (50% of Pump Fire Ignition Frequency in Auxiliary Building	1.2E-04
M2A1G	Aux. Bldg. area A-1G	M2A1G-1	Transient Combustibles (protective clothing) with Transient Ignition	Transient Fire Ignition Frequency for Auxiliary Building area	7.5E-05
		M2A1G-2	Evaporator Panel Cabinet (1)	1 * (Electrical Cabinet Fire Ignition Frequency in Auxiliary Building)	7.2E-05
		M2A1G-3	C-63 Panel Cabinet (1)	1 * (Electrical Cabinet Fire Ignition Frequency in Auxiliary Building)	7.2E-05
		M2A1G-4	MCC B-31A Breaker Cabinets (23)	29 * (Electrical Cabinet Fire Ignition Frequency in Auxiliary Building)	2.1E-03
M2A12A	Aux. Bldg. area A-12A	M2A12A-1	Transient Combustibles (protective clothing) with Transient Ignition	Transient Fire Ignition Frequency for Auxiliary Building area	7.5E-05
M2A24	Aux. Bldg. area A-24 (Cable Vault)	M2A24	Low Voltage Transformer	Transformer Fire Ignition Frequency for Auxiliary Building area	1.0E-04
M2A25	Aux. Bldg. area A-24 (Control Room)	M2A25-1	Single MCB Cabinet (Front or Back of a MCB Panel)	Cabinet Fire Ignition Frequency in Control Room	1.6E-04
		M2A25-2	MCB Panel (Front and Back Cabinet)	2 * (Cabinet Fire Ignition Frequency in Control Room)	3.2E-04
		M2A25-3	MCB Panel (Front and Back Cabinet)	2 * (Cabinet Fire Ignition Frequency in Control Room)	3.2E-04
		M2A25-1	Single ESAS Cabinet	Cabinet Fire Ignition Frequency in Control Room	1.6E-04
M2I1A	I-1A (SW Intake Structure)	M2I1A-1	CW pump B involving lube oil spill	1 * (50% of Pump Fire Ignition Frequency in Intake Structure)	1.0E-04

TABLE 4.8-4 (continued)

Fire Scenario	Location	Corresponding Target Sets	Fire Source for Target Set	Basis for Ignition Frequency	Ignition Frequency (per year)
		M2IIA-2	SW pump B involving lube oil spill	1 * (50% of Pump Fire Ignition Frequency in Intake Structure)	1.0E-04
		M2IIA-3	CW pump D involving lube oil spill	1 * (50% of Pump Fire Ignition Frequency in Intake Structure)	1.0E-04
		M2IIA-4	CW pump A or C involving lube oil spill	2 * (50% of Pump Fire Ignition Frequency in Intake Structure)	2.0E-04
M2TB	T-1 (TB)	M2TB-1,2	TBCCW Pumps (3) & Main Condenser Vacuum Pumps (2) involving lube oil spill	5* (50% of Pump Fire Ignition Frequency in Turbine Building)	1.1E-04
		M2TB-3	Transformer Fire	Transformer Fire Ignition Frequency in the Plant	1.0E-04
		M2TB-4	Condensate pump fire	3 * (50% of Pump Fire Ignition Frequency)	6.3E-05
		M2TB-5	Station Air Compressor	Air Compressor Fire Ignition Frequency in the Plant	3.9E-04
		M2TB-6	MFW Pumps (2) involving lube oil spill	2 * (50% of MFW Pump Fire Ignition Frequency)	2.0E-03

TABLE 4.8-5

Fire Damage Probabilities for MP2 Fire Scenarios/Target Sets

Fire Scenario	Target Set	Combustible in Target Set	Fixed or Transient Combustible	Combustible Information					P_{as} (1) Auto Suppression Unavail.	P_{ms} Manual Suppression Unavail.	P_D Prob. of Damage
				u Prob. of Being Located in the Range of the Target	p Prob. of Being Exposed	F_{cd} Loading Freq. (1/yr)	F_w Inspection Freq. (1/yr)	w Prob. of Critical Amount Being Present			
M2A1B	M2A1B-1	Protective Clothing	T	-	-	-	-	-	1.0	1.0	1.0
	M2A1B-2	Cabinet	F	-	-	-	-	-	1.0	1.0	1.0
	M2A1B-3	Pump/Lube Oil	F	-	-	-	-	-	1.0	1.0	1.0
M2A1B	M2A1B-1	Protective Clothing	T	-	-	-	-	-	1.0	1.0	1.0
	M2A1B-2	Cabinet	F	-	-	-	-	-	1.0	1.0	1.0
	M2A1B-3	Cabinet	F	-	-	-	-	-	1.0	1.0	1.0
	M2A1B-4	Cabinet	F	-	-	-	-	-	1.0	1.0	1.0
M2A12A	M2A12A-1	Protective Clothing	T	-	-	-	-	-	1.0	1.0	1.0
M2A24	M2A24	Dry Transformer	F	-	-	-	-	-	2.0E-02	0.1	2.0E-03
M2A25	M2A25-1	Cabinet	F	-	-	-	-	-	1.0	1.0	1.0
	M2A25-1	Cabinet	F	-	-	-	-	-	1.0	0.1	0.1
	M2A25-1	Cabinet	F	-	-	-	-	-	1.0	0.1	0.1
	M2A25-1 to 4	Cabinet	F	-	-	-	-	-	1.0	1.0	1.0

TABLE 4.8-5 (continued)

Fire Scenario	Target Set	Combustible in Target Set	Fixed or Transient Combustible	Combustible Information					P_{as} (1) Auto Suppression Unavail.	P_{ms} Manual Suppression Unavail.	P_D Prob. of Damage
				u Prob. of Being Located in the Range of the Target	p Prob. of Being Exposed	F_{ocl} Loading Freq. (1/yr)	F_w Inspection Freq. (1/yr)	w Prob. of Critical Amount Being Present			
M2I1A	M2I1A-1	Pump/Lube Oil	F	-	-	-	-	-	1.0	1.0	1.0
	M2I1A-2	Pump/Lube Oil	F	-	-	-	-	-	1.0	1.0	1.0
	M2I1A-3	Pump/Lube Oil	F	FIRE DOES NOT DAMAGE TARGET (Time to damage is greater than fire duration)							0
	M2I1A-4	Pump/Lube Oil	F	-	-	-	-	-	1.0	1.0	1.0
M2TB	M2TB-1	Pump/Lube Oil	F	-	-	-	-	-	1.0	1.0	1.0
	M2TB-2	Pump/Lube Oil	F	-	-	-	-	-	1.0	1.0	1.0
	M2TB-3	Transformer	F	-	-	-	-	-	5.0E-02	1.0	5.0E-02
	M2TB-4	Pump/Lube Oil	F	-	-	-	-	-	2.0E-02	1.0	2.0E-02
	M2TB-5	Compressor Lube Oil	F	-	-	-	-	-	2.0E-02	1.0	2.0E-02
	M2TB-6	Pump/Lube Oil	F	-	-	-	-	-	5.0E-02	1.0	5.0E-02

TABLE 4.8-6

Summary of Fire Scenario Frequencies for MP2

Fire Scenario	Location	Initiating Event Caused by Scenario	Corresponding Target Sets	Ignition Frequency (per year)	Probability of Damage	Fire Scenario Frequency (per year)	% of Total
M2A1B	A-1B (Aux. Bldg.)	Plant Transient	M2A1B-1	7.5E-05	1.0	7.5E-05	34.9%
			M2A1B-2	1.4E-04	1.0	1.4E-04	65.1%
					Total:	2.2E-04	100%
		Loss of RBCCW	M2A1B-3	1.2E-04	1.0	1.2E-04	
					Total:	1.2E-04	100%
M2A1G	A-1G (Aux. Bldg.)	Plant Transient	M2A1G-1	7.5E-05	1.0	7.5E-05	3.2%
			M2A1G-2	7.2E-05	1.0	7.2E-05	3.1%
			M2A1G-3	7.2E-05	1.0	7.2E-05	3.1%
			M2A1G-4	2.1E-03	1.0	2.1E-03	90.6%
					Total:	2.3E-03	100%
M2A12A	A-12A	Plant Transient	M2A12A	7.5E-05	1.0	7.5E-05	100%
M2A24	A-24 (Cable Vault)	Plant Transient	M2A24	1.0E-04	2.0E-03	2.0E-07	100%
M2A25	A-25 (Control Room)	Plant Transient	M2A25-1	1.7E-04	1.0	1.6E-04	41.7%
			M2A25-2	3.2E-04	0.1	3.2E-05	8.3%
			M2A25-3	3.2E-04	0.1	3.2E-05	8.3%
			M2A25-4	1.6E-04	1.0	1.6E-04	41.7%
					Total:	3.8E-04	100%
M2I1A	I-1A (SW Intake Struct.)	Loss of Service Water	M2I1A-1	1.0E-04	1.0	1.0E-04	25.0%
			M2I1A-2	1.0E-04	1.0	1.0E-04	25.0%
			M2I1A-3	1.0E-04	0.0	1.0E-04	0
			M2I1A-4	2.0E-04	1.0	2.0E-04	50.0%
					Total:	3.0E-04	100%
M2TB		Plant Transient	M2TB-1	6.4E-05	1.0	6.4E-05	75.3%
			M2TB-2	2.1E-05	1.0	2.1E-5	24.7%
					Total:	8.5E-05	100%

Table 4.8-6 (continued)

Fire Scenario	Location	Initiating Event Caused by Scenario	Corresponding Target Sets	Ignition Frequency (per year)	Probability of Damage	Fire Scenario Frequency (per year)	% of Total
		Loss of Inst. Air	M2TB-3	1.0E-04	5.0E-02	5.0E-06	49.5%
			M2TB-4	6.3E-05	2.0E-02	1.3E-06	12.9%
			M2TB-5	1.9E-04	2.0E-02	3.8E-06	37.6%
					Total:	1.1E-05	100%
		Loss of Main Feedwater	M2TB-6	2.0E-03	5.0E-02	1.0E-04	
					Total:	1.0E-04	100%

Table 4.9-1
MP2 Fire Scenario Core Damage Frequencies

Fire Scenario	Fire Location	Resultant Initiating Event	Fire Scenario Freq. (/yr)	Conditional Core Damage Probability	Core Damage Freq. (/yr)	% Contribution to Core Damage Freq.	
M2A1B1	Auxiliary Bldg.	Loss of DC Bus B	2.20E-04	7.33E-04	1.61E-07	2.6%	48.9%
M2A1B2	Auxiliary Bldg.	Loss of RBCCW	1.20E-04	3.01E-03	3.60E-07	5.7%	
M2A1G1	Auxiliary Bldg.	Loss of DC Bus A	2.30E-03	7.33E-04	1.69E-06	26.8%	
M2A12A	Auxilary Bldg.	Loss of DC Bus A	7.50E-04	7.33E-04	5.50E-07	8.7%	
M2A241	Cable Vault	LNP	1.00E-04	8.31E-04	8.31E-08	1.3%	4.5%
M2A242	Cable Vault	Loss of DC Bus B	2.00E-07	1.0	2.00E-07	3.2%	
M2A25	Control Room	Station Blackout	3.80E-04	1.73E-03	6.57E-07	10.4%	
M2I1A	Intake Structure	Loss of SW	3.00E-04	3.22E-03	9.66E-07	15.3%	
M2TB1	Turbine Bldg.	General Plant Transient	8.50E-04	1.39E-06	<1.0E-08	<1.0%	25.9%
M2TB2	Turbine Bldg.	Loss of Inst. Air	3.80E-06	1.92E-05	<1.0E-08	<1.0%	
M2TB3	Turbine Bldg.	Loss of MFW	2.00E-03	2.54E-06	<1.0E-08	<1.0%	
M2TBL	Turbine Bldg.	Total Loss of Turbine Bldg.	1.63E-06	1.0	1.63E-06	25.9%	
				TOTAL	6.30E-6		

TABLE 4.10.1

Containment Penetration Screening

Pen. #	System	Isolation Valves	P&IDs	Comments
1	Primary Make-up water	2-PMW-319, 2-PMW-43, 2-PMW-3	26014 Sh. 2	Locked open manual valve 2-PMW-319 in series with Fail closed, normally closed SOV 2-PMW-43 and check valve 2-PMW-3 2 inch piping. **Screened out**, because normally closed SOV 2-PMW-43 is in series with check valve 2-PMW-3.
2	Letdown	2-CH-006, C-CH-089, 2-CH-341, 2-CH-343, 2-CH-342, 2-CH-344	26017 Sh. 2	Normally open manual valve 2-CH-006 in series with normally open fail closed SOV 2-CH-089 and parallel valves normally open manual valve 2-CH-341, 2-CH-342 and normally close manual valve 2-CH-343, 2-CH-344. Normally open fail closed SOVs 2-CH-515 and 2-CH-516 are in series with 2-CH-006 and 2-CH-089. **Screened out** because normally closed system, a pipe rupture and three SOVs would have to fail to close.
3	Charging	2-CH-429	26017 Sh. 1	Normally open MOV 2-CH-429,2 inch piping. **Screened out** based on 2" piping
4	CTMT Spray	2-CS-5A, 2-CS-4.1A, 2-CS-4A	26015 Sh. 1,3	Inside CTMT: Check valve 2-CS-5A, normally open manual valve. Outside CTMT: MOV, normally closed 2-CS-4.1A and Locked open manual valve 2-CS-4A. **Screened out** because normally closed MOV 2-CS-4.1A is in series with check valve 2-CS-5A
5	CTMT Spray	2-CS-5B, 2-CS-065, 2-CS-4.1B, 2-CS-4B	26015 Sh. 1,3	Inside CTMT: check valve 2-CS-5B and locked open manual valve 2-CS-065. Outside CTMT: Normally closed MOV 2-CS-4.1B and Locked open manual valve 2-CS-4B. **Screened out** because normally closed MOV 2-CS-4.1B is in series with check valve 2-CS-5B
6	SI	2-SI-706D, 2-SI-644, 2-SI-247	26015 Sh. 3,2	Check valve 2-SI-706D, line splits: Normally open MOV 2-SI-644, Check valve 2-SI-245, and Check valve 2-SI-247. **Screened out**, because check valves are not affected by fire, and check valve 2-SI-706D is in series with MOV 2-SI-644
7	SI	2-SI-706A, 2-SI-614, 2-SI-217	26015 Sh. 3,2	Check valve 2-SI-706A line splits: Normally open MOV 2-SI-614 and Check valve 2-SI-217. **Screened out**, because check valves are not affected by fire, and check valve 2-SI-706A is in series with MOV 2-SI-614
8	SI	2-SI-706C, 2-SI-634, 2-SI-237	26015 Sh. 3,2	Check valve 2-SI-706C line splits: Normally open MOV 2-SI-634 and Check valve 2-SI-237. **Screened out**, because check valves are not affected by fire, and check valve 2-SI-706C is in series with MOV 2-SI-634

Pen. #	System	Isolation Valves	P&IDs	Comments
9	SI	2-SI-706B, 2-SI-632, 2-SI-227	26015 Sh. 3,2	Check valve 2-SI-706B, normally open MOV 2-SI-632, and check valve 2-SI-227. **Screened out**, because check valves are not affected by fire, and check valve 2-SI-706B is in series with MOV 2-SI-632
10	Shutdown Cooling	2-SI-651, 2-SI-652, 2-SI-709	26015 Sh. 3,1	Normally closed MOVs 2-SI-651 and 2-SI-652, locked closed manual valve 2-SI-709 all in series. **Screened out** because manual valves are not affected by fire and locked closed manual valve 2-SI-709 is in series with the MOVs.
11	SI Tank Test line	2-SI-810, 2-SI-463, 2-SI-459	26015 Sh. 3	Manual valve 2-SI-810 normally open, locked closed manual valves 2-SI-463 and 2-SI-459 in series. **Screened out** because manual valves are not affected by fire
12	CTMT Sump Recirc. line	2-CS-16.1A, 2-CS-15A	26015 Sh. 2	Normally closed MOV 2-CS-16.1A (West Pipe Penetration Room -25'6"), check valve 2-CS-15A valves in series. **Screened out** because the valves are required to be open following an accident.
13	CTMT Sump Recirc. line	2-CS-16.1B, 2-CS-153	26015 Sh. 2	Normally closed MOV 2-CS-16.1B (West Pipe Penetration Room -25'6"), check valve 2-CS-153 valves in series. **Screened out** because the valves are required to open following an accident.
14	CTMT Sump Aerated Drain Tank	2-SSP-16.1, 2-SSP-16.2	26014 Sh. 1	Normally closed fail closed SOV's 2-SSP-16.1 (Southwest Corner of Reactor Building 3'6") and 2-SSP-16.2 (West Pipe Penetration Room -5'6") in series **Screened out** because there are two normally close fail closed valves in series. The control cables of both valves would have to hot short in order to open them and that is a low probability event.
15	Feedwater (Closed System)	2-FW-5A, 2-FW-12A	26005 Sh. 2, 26028 Sh. 3	Normally open fail closed SOV's 2-FW-5A (East Pipe Penetration Room 38'6") and 2-FW-12A (West Pipe Penetration Room -5'6") (parallel). **Screened out** because it is a closed system and another failure would be required.
16	Feedwater (Closed System)	2-FW-5B. 2-FW-12B	26005 Sh. 2 26028 Sh. 3	Normally open fail closed SOV's 2-FW-5B (West Pipe Penetration Room 38'6") and 2-FW-12B (West Pipe Penetration Room 38'6") (parallel). **Screened out** because it is a closed system and another failure would be required.
19	Main Steam (Closed System)	2-MS-64A	26002 Sh. 1 26028 Sh. 3	AOV 2-MS-64A will fail closed (East Pipe Penetration Room 38'6"). **Screened out** because it is a closed system and another failure would be required.
20	Main Steam (Closed System)	2-MS-64B	26002 Sh. 1 26028 Sh. 2	AOV 2-MS-64B will fail closed (West Pipe Penetration Room 38'6"). **Screened out** because it is a closed system and another failure would be required.
21	Reactor Coolant & Prz sampling	2-LRR-265, 2-LRR-61.1, 2-RC-002, 2-RC-001, 2-RC-003, 2-RC-45	26028 Sh. 3 26020 Sh. 5 26014 Sh. 1,2 26025 Sh. 1	3/4" lines (less than 2"). Four lines coming in: 1. Check valve 2-LRR-265 and SOV 2-LRR-61.1 (normally closed, fail closed) in series 2. SOV 2-RC-002; normally closed, fail closed 3. SOV 2-RC-001 normally closed, fail closed 4. SOV 2-RC-003; normally closed, fail closed These lines join and have isolation SOV 2-RC-45 (Normally closed, fail closed) **Screened out** based on the less than 2" piping

Pen. #	System	Isolation Valves	P&IDs	Comments
22	SG Bottom Blowdown (Closed System)	2-MS-12A, 2-MS-406, 2-MS-220A, 2-MS-147B, 2-MS-149A	26002 Sh. 2	Manual valves (normally open) 2-MS-12A, 2-MS-406, and SOV- 2-MS-220A normally open (fail closed) line splits off, manual valves 2-MS-147B (East Pipe Penetration Room 38'6") and 2-MS-149A (East Pipe Penetration Room 38'6")(normally open). **Screened out** because manual valves are not affected by fire and system is closed.
23	SG Bottom Blowdown (Closed System)	2-MS-411, 2-MS-220B, 2-MS-12B	26002 Sh. 2	Manual valves (Normally open) 2-MS-12B (inside) and 2-MS-411 (East Pipe Penetration Room -5'6") (outside) SOV 2-MS-220B normally open, fail closed. **Screened out** because manual valves are not affected by fire and system is closed.
24	RBCCW inlet to RCP	2-RB-30.1A	26022 Sh.6	Normally open MOV 2-RB-30.1A (West Pipe Penetration Room 5'6"). **Screened out** because it needs to be open to keep seal integrity.
25	RBCCW to CARFANs	2-RB-26.1D	26022 Sh. 5	Normally open SOV (fail open) 2-RB-26.1D. **Screened out** because it is required to be open.
26	RBCCW to CARFANs	2-RB-26.1B	26022 Sh. 5	Normally open SOV (fail open) 2-RB-26.1B. **Screened out** because it is required to be open.
27	RBCCW to CARFANs	2-RB-26.1A	26022 Sh. 5	Normally open SOV (fail open) 2-RB-26.1A. **Screened out** because it is required to be open.
28	RBCCW to CARFANs	2-RB-26.1C	26022 Sh. 5	Normally open SOV (fail open) 2-RB-26.1C. **Screened out** because it is required to be open.
29	RBCCW outlet from RCPs	2-RB-37.2A	26022 Sh. 4, 1, 5	Normally open MOV 2-RB-37.2A (West Pipe Penetration Room -5'6"). **Screened out** because it needs to be open to keep seal integrity.
30	RBCCW from CARFANs	2-RB-28.3D, 2-RB-28.2D, 2-RB-29D	26022 Sh. 5	Parallel SOVs 2-RB-28.3D and 2-RB-28.2D, both normally open, fail closed and in series with normally open manual valve 2-RB-29D (West Pipe Penetration Room -5'6"). **Screened out** because it is required to be open.
31	RBCCW from CARFANs	2-RB-28.3B, 2-RB-28.2B, 2-RB-29B	26022 Sh. 5	Parallel SOVs 2-RB-28.3B and 2-RB-28.2D, both normally open, fail closed and in series with normally open manual valve 2-RB-29B (West Pipe Penetration Room -5'6"). **Screened out** because it is required to be open.
32	RBCCW from CARFANs	2-RB-28.3A, 2-RB-28.2A, 2-RB-29A	26022 Sh. 5	Parallel SOVs 2-RB-28.3A and 2-RB-28.2A, both normally open, fail closed and in series with normally open manual valve 2-RB-29A (East Pipe Penetration Room -5'6"). **Screened out** because it is required to be open.
33	RBCCW from CARFANs	2-RB-28.3C, 2-RB-28.2C, 2-RB-29C	26022 Sh. 5	Parallel SOVs 2-RB-28.3C and 2-RB-28.2C both normally open, fail closed and in series with normally open manual valve 2-RB-29C (East Pipe Penetration Room -5'6"). **Screened out** because it is required to be open.
34	Nitrogen Supply	2-SI-801, 2-SI-800, 2-SI-312, 2-SI-744	26015 Sh. 3	Inside CTMT: Two locked open manual valves in series, 2-SI-801 and 2-SI-800. Outside CTMT: Normally open, fail closed SOV 2-SI-312 and manual valve (normally open) 2-SI-744 (East Pipe Penetration Room -5'6") in series. **Screened out** because line is less than 2".

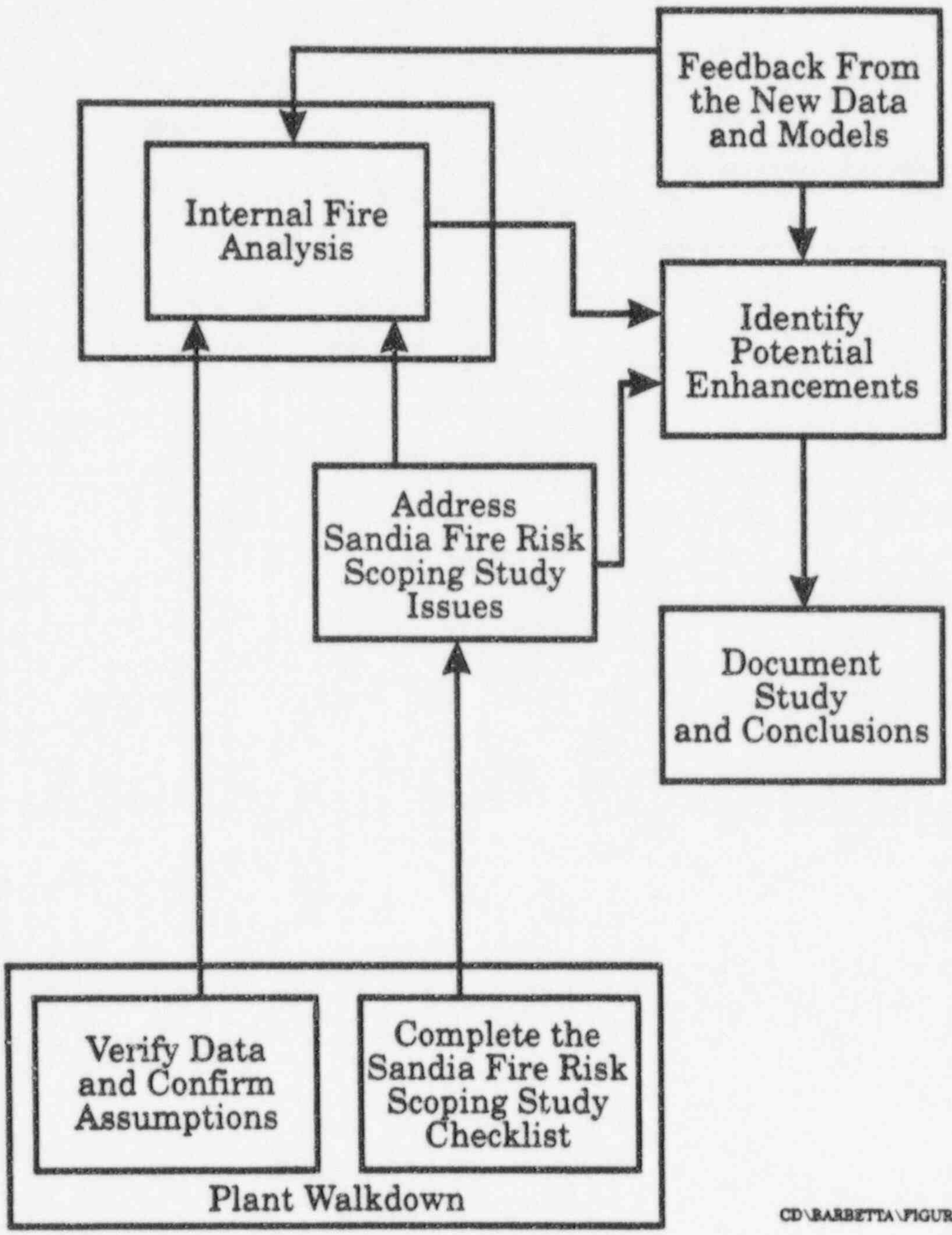
Pen. #	System	Isolation Valves	P&IDs	Comments
35	Drain from Primary Tank	2-LRR-43.2, 2-LRR-43.1	26020 Sh. 5	Two normally closed, fail closed SOVs 2-LRR-43.2 (West Pipe Penetration Room -5'6") and 2-LRR-43.1 (Southwest Corner Reactor Building -3'6") in series. **Screened out** because there are two normally close fail closed valves in series. The control cables of both valves would have to hot short in order to open them and that is a low probability event.
36	Instrument Air	2-IA-569, 2-IA-566, 2-IA-595	26009 Sh. 6	Inside CTMT: Check valve 2-IA-569. Outside CTMT: Two normally closed manual valves 2-IA-566 and 2-IA-595 in series. **Screened out** base on the fact that manual valves and check valves are not affected by fire.
37	Instrument Air	2-IA-43, 2-IA-27.1	26009 Sh. 6,8	Inside CTMT: Check valve 2-IA-43. Outside CTMT: Normally open, fail closed SOV 2-IA-27.1. **Screened out** because check valve 2-IA-43 is in series with SOV 2-IA-27.1
38	Station Air	2-SA-19, 2-SA-22	26009 Sh. 8	Locked closed manual valves 2-SA-19 in series with check valve 2-SA-22. **Screened out** because manual valves are not affected by fire
39	Purge Air Inlet	2-AC-5, 2-AC-4, 2-AC-3, 2-AC-1	26028 Sh. 1	Normally closed, fail closed SOV 2-AC-5 (Southwest Corner Reactor Building 38'6") in series with normally closed, fail closed SOV 2-AC-4. The line splits into two lines with normally close, fail close SOVs 2-AC-3 and 2-AC-1. **Screened out** because more than two valves would have to receive a hot short that opens the valve.
40	Purge Air Discharge	2-AC-6, 2-AC-7, 2-AC-57	26028 Sh. 1	Normally closed, fail close SOV 2-AC-6 (Southwest Corner Reactor Building 38'6") in series with normally closed, fail closed SOV 2-AC-7 and normally closed, fail closed SOV 2-AC-57. **Screened out** because two valves would have to receive a hot short that opens the valve.
42	Fuel Transfer Tube	2-RW-280	26023 Sh.1	Fuel transfer tube manual isolation valve 2-RW-280. **Screened out** because manual valves are not affected by fire.
43	RCP Seals Controlled Bleedoff	2-CH-506, 2-CH-767, 2-CH-766	26017 Sh. 2	3/4" line (less than 2"), normally open, fail closed SOV 2-CH-506. The line splits into two lines with locked open manual valve 2-CH-767 and locked open manual valve 2-CH-766. **Screened out** because it has less than 2" piping
47	ESF Actuation System	2-AC-97	26028 Sh. 1 28150	Valve 2-AC-97 normally open. **Screened out** because piping is less than 2".
49	Fire Protection	2-FIRE-108	26011 Sh. 1	Locked closed manual valve 2-FIRE-108. **Screened out** because manual valves are not affected by fire
51	Waste Gas Header	2-GR-11.2, 2-GR-11.1	26021 Sh. 2	Two SOVs in series, normally open, fail closed 2-GR-11.2 (Southwest Corner Reactor Building -3'6") and 2-GR-11.1 (East Pipe Penetration Room -5'6"). **Screened out** because the only potential failure mechanism is a hot short that would spuriously open both valves and the probability of that occurring is insignificant.
53	RBCCW Inlet to RCPs	2-RB-30.1B	26022 Sh. 6	Normally open MOV 2-RB-30.1B (West Pipe Penetration Room -5'6"). **Screened out** because it needs to be open for seal integrity.

Pen. #	System	Isolation Valves	P&IDs	Comments
54	RBCCW Outlet from RCPs	2-RB-37.2B	26022 Sh. 4	Normally open MOV 2-RB-37.2B (West Pipe Penetration Room -5'6"). **Screened out** because it needs to be open for seal integrity.
61	CTMT Air Sample	2-AC-12, 2-EB-88	26028 Sh. 2	Two normally open, fail closed SOVs 2-AC-12 and 2-EB-88 in series 1" line (less than 2"). **Screened out** because of less than 2" piping
62	CTMT Air Sample	2-AC-15, 2-AC-50, 2-AC-54, 2-AC-49	26028 Sh. 2	Normally open, fail closed SOV 2-AC-15, manual valve 2-AC-50, check valve 2-AC-54 and locked open manual valve 2-AC-49. 1" line (less than 2"). **Screened out** because of less than 2" piping.
63	CTMT Pressure Test Conn.	2-AC-115, 2-AC-114, 2-AC-117	26028 Sh. 1	Three locked closed manual valves in series 2-AC-115, 2-AC-114, and 2-AC-117. **Screened out** because manual valves are not affected by fire
64	CTMT Pressure Test Conn.	2-AC-113, 2-AC-112, 2-AC-116	26028 Sh. 1	Three locked closed manual valves in series 2-AC-113, 2-AC-112, and 2-AC-116. **Screened out** because manual valves are not affected by fire
65	SG Blowdown Sample	2-MS-16A, 2-MS-191A	26002 Sh. 2 26028 Sh. 3	Inside CTMT: Normally open manual valve 2-MS-16A. Outside CTMT: SOV normally open, fail closed 2-MS-191A. 1/2" line (less than 2"). **Screened out** because of less than 2' piping
67	Refueling Water Purification	2-RW-232, 2-RW-21, 2-RW-20	26023 Sh. 1, 2	Two locked closed manual valves 2-RW-232 and 2-RW-21 and Check valve 2-RW-20 in series. **Screened out** because manual and check valves are not affected by fire
68	Refueling Water Purification	2-RW-154, 2-RW-63, 2-RW-64	26023 Sh. 1, 2	Two locked closed manual valves 2-RW-154 and 2-RW-63 and Check valve 2-RW-64 in series. **Screened out** because manual and check valves are not affected by fire
69	ESF Actuation System	2-AC-99	26028 Sh. 1	Manual valve 2-AC-99 (West Pipe Penetration Room -5'6"). **Screened out** because manual valves are not affected by fire
70	ESF Actuation System	2-AC-98	26028 Sh. 1	Manual valve 2-AC-98 (West Pipe Penetration Room -5'6"). **Screened out** because manual valves are not affected by fire.
71	ESF Actuation Systems	2-AC-96	26028 Sh. 1	Manual valve 2-AC-96 (West Pipe Penetration Room -5'6"). **Screened out** because manual valves are not affected by fire.
72	SG Blowdown Sample	2-MS-168, 2-MS-220B	26002 Sh. 2	Normally open manual valve 2-MS-168 and normally open, fail closed SOV 2-MS-220B in series. 1/2" line (less than 2"). **Screened out** because of less than 2" piping.
82	Hydrogen Purge	2-EB-91, 2-EB-92	26028 Sh. 3	Two normally closed, fail closed SOVs 2-EB-91 (Southwest Corner Reactor Building 38'6") and 2-EB-92 (East Pipe Penetration Room 38'6") in series. **Screened out** because the only potential failure mechanism is a hot short that would spuriously open both valves and the probability of that occurring is insignificant.

Pen. #	System	Isolation Valves	P&IDs	Comments
83	Hydrogen Purge	2-EB-100, 2-EB-99	26028 Sh. 3	Two normally closed, fail closed SOVs 2-EB-100 (Southwest Corner Reactor Building 38'6") and 2-EB-99 (East Pipe Penetration Room 38'6") in series. **Screened out** because the only potential failure mechanism is a hot short that would spuriously open both valves and the probability of that occurring is insignificant.
86	CTMT Air Sample	2-AC-47, 2-EB-89	26028 Sh. 2	Two normally open, fail closed SOVs 2-AC-47 and 2-EB-89 in series 1" line (less than 2"). **Screened out** because of less than 2" piping
87	CTMT Air Sample	2-AC-20, 2-AC-55, 2-AC-52	26028 Sh. 2	Normally open, fail closed SOVs 2-AC-20, check valve 2-AC-55 and locked open manual valve 2-AC-52 in series. 1" line (less than 2"). **Screened out** because of less than 2" piping
88	Post-Incident CTMT Hydrogen Sample	2-AC-51	26025 Sh. 4 26028 Sh. 3	Locked closed manual valve 2-AC-51. 1" line (less than 2"). **Screened out** because of less than 2" piping.
89	Post-Incident CTMT Hydrogen Sample	2-AC-48	26025 Sh. 4 26028 Sh. 3	Locked closed manual valve 2-AC-48. 1" line (less than 2"). **Screened out** because of less than 2" piping
17, 41, 46, 48, 50, 52, 55, 56, 57, 58, 59,60,66,73, 74, 79, 80, 81, 84, 85,		Spares		**Screened out** because the penetrations are spares.

FIGURE 4.2-1

Overall Process of Internal Fire Analysis



CD\BARBETTA\FIGURE1

PHASE 1:
QUALITATIVE SCREENING

Definition of the fire ares to be analyzed.
Identification of the safety systems/components in each area.
Identification of the possible initiating events induced by a fire in each area.
Fire Compartment Interaction Analysis.

Screening out of the areas with no safety systems/components and where fire would not induce a plant trip.

↓

PHASE 2:
QUANTITATIVE SCREENING

Quantification of fire ignition frequencies for each unscreened area.
Identification of Mitigating Safety Systems outside of the area.

Screening out of the area based on the fire frequencies and availabilities of Mitigating Safety Systems Outside the area.

↓

PHASE 3:
FIRE DAMAGE EVALUATION SCREENING

Evaluation of fire hazard parameters.
Evaluation of fire growth and propagation.
Evaluation of fire suppression.
Identification of fire scenarios within each area.
Quantification of fire damage probabilities.
Quantification of fire scenario frequencies.

Screening out of the fire target sets based on the fire damage probabilities.
Detailed evaluation of the fire scenarios.

↓

PHASE 4:
FIRE SCENARIOS EVALUATION AND QUANTIFICATION

Evaluation of human actions needed to respond to the analyzed fire scenarios.
Application of IPE models to quantify core damage frequencies for each fire scenario.

Determination of the total fire-induced core damage frequency.

FIGURE 4.2-2

Phases of Internal Fire Analysis

MP2 IPEEE

FIGURE 4.8-1

Example of Input Parameters for Fire Growth and Propagation Analysis

TARGET SET NUMBER:			
TARGET SET DESCRIPTION:			
TARGET SET LOCATION:			
FIRE SCENARIO TYPE:			
FIRE CONSEQUENCES:			
FIRE SOURCE:			
COMBUSTIBLE DESCRIPTION:			
TYPE OF COMBUSTIBLE (ID):			
	1. AMOUNT OF COMBUSTIBLE	660.000	(gal)
	2. SPILL SPECIFIC AREA (TABLE 3E)	185	(ft2/gal)
	3. UNIT HEAT RELEASE RATE (TABLE 2E)	133	(Btu/s-ft2)
	4. NET HEAT OF COMBUSTION (TABLE 2E)	18619	(Btu/lbm)
	5. DENSITY (TABLE 2E)	51	(lbm/ft3)
Enter only if estimated	6. FIRE SURFACE AREA	231.00	(ft2)
Enter only if estimated	7. PEAK FIRE INTENSITY	30723	(Btu/s)
	7A. ACTUAL Qtot FOR CABINETS, BATTERIES, ETC.	N/A	(Btu)
TARGET DESCRIPTION:			
If target is detector/sprinkler, enter "N/A"	8. TARGET THRESHOLD TEMPERATURE (TABLE 1E)	425	(F)
If target is detector/sprinkler, enter "N/A"	9. TARGET THERMAL RESPONSE PARAMETER (TABLE A-2E)	34	
If target is not a detector/sprinkler, enter "N/A"	10. DETECTION DEVICE ACTUATION TEMPERATURE	N/A	(F)
If target is not a detector/sprinkler, enter "N/A"	11. TIME CONSTANT OF DETECTION DEVICE (TABLE A-6E)	N/A	(s)
LOCATION PARAMETERS:	12. HEIGHT OF TARGET ABOVE FIRE SOURCE	14.5	(ft)
	13. HEIGHT OF CEILING ABOVE FIRE SOURCE	19	(ft)
	14. FLOOR AREA OF SPACE	1459	(ft2)
	15. FIRE LOCATION FACTOR	2	
	16. MAXIMUM AMBIENT TEMPERATURE	100	(F)
	17. MINIMUM AMBIENT TEMPERATURE	60	(F)
Enter if target outside plume	18. LONG DISTANCE FROM FIRE SOURCE TO TARGET	30	(ft)
Enter if target outside plume	19. ENCLOSURE WIDTH	17.5	(ft)
Enter if radiant exposure	20. CRITICAL RADIANT FLUX TO TARGET (TABLE 1E)	0.5	(Btu/s/ft2)

FIGURE 4.8.2

Example of Output for Target -Outside-Plume Analysis

TARGET SET NUMBER:

1	TARGET DAMAGE THRESHOLD TEMPERATURE	425	(F)
2	HEIGHT OF TARGET ABOVE FIRE SOURCE	14.5	(ft)
3	HEIGHT FROM FIRE SOURCE TO CEILING, H	19	(ft)
4	RATIO OF TARGET HEIGHT/CEILING HEIGHT	0.76	
TARGET NOT IN CEILING			
5	LONG. DISTANCE FROM FIRE SOURCE TO TARGET, L	30	(ft)
6	LONGITUDINAL DISTANCE TO HEIGHT RATIO, L/H	1.58	
7	ENCLOSURE WIDTH, W	17.50	(ft)
8	HEIGHT TO WIDTH RATIO, H/W	1.09	
8A	DISTANCE TO WIDTH RATIO, L/W	1.71	
9	PEAK FIRE INTENSITY	30723	(Btu/s)
10	FIRE LOCATION FACTOR	2	
11	EFFECTIVE HEAT RATE	61446	(Btu/s)
12	PLUME TEMPERATURE RISE AT CEILING	N/A	(F)
13A	UNCONFINED CEILING JET FACTOR	0.00	
13B	CONFINED CEILING JET FACTOR	0.00	
13	CEILING JET TEMPERATURE RISE FACTOR AT TARGET	0.00	
14	CEILING JET TEMPERATURE RISE AT TARGET	0	(F)
15	CRITICAL TEMPERATURE RISE AT TARGET	325	(F)
16	(CRITICAL-CEILING JET) TEMP RISE AT TARGET	325	(F)
ADDITIONAL CALCULATION NECESSARY			
17	Qnet/V TO ACHIEVE TEMP RISE IN BOX 16	4.37	(Btu/ft3)
18	CALCULATED ENCLOSURE VOLUME V	27721	(ft3)
19	CALCULATED CRITICAL Qnet	121030	(Btu)
20	ESTIMATED HEAT LOSS FRACTION	0.7	
21	ESTIMATE OF CRITICAL Qtot	403432	(Btu)
22	ESTIMATE OF ACTUAL Qtot	83785500	(Btu)
SCENARIO DOES NOT PASS SCREENING PROCEDURE PROCEED WITH CALCULATION OF TIME TO TARGET DAMAGE			
	FIRE DURATION:	45.45	(min)
		2727.1	(sec)

FIGURE 4.8.3

Example of Output for Transient Analysis (Time-To-Damage)

TARGET SET NUMBER: FD1-1

1	Radiative heat flux at target	0.88	(Btu/s/ft2)
2	Convective heat flux at target	5.70	(Btu/s/ft2)
3	Total heat flux at target	6.58	(Btu/s/ft2)
4	Target thermal response parameter	34.00	
5	ESTIMATED TIME TO TARGET DAMAGE (TABLE A-2E)	21.0	(s)
6	Detection device rated temperature rise	N/A	(F)
7	Gas temperature rise at detector	N/A	(F)
8	Detection device temp rise/Gas temp rise	N/A	
9	Dimensionless detection device actuation time	N/A	
10	Time constant of detection device	N/A	(s)
11	ESTIMATED TIME TO DETECTION DEVICE ACTUATION	N/A	(s)

Figure 4.9-1

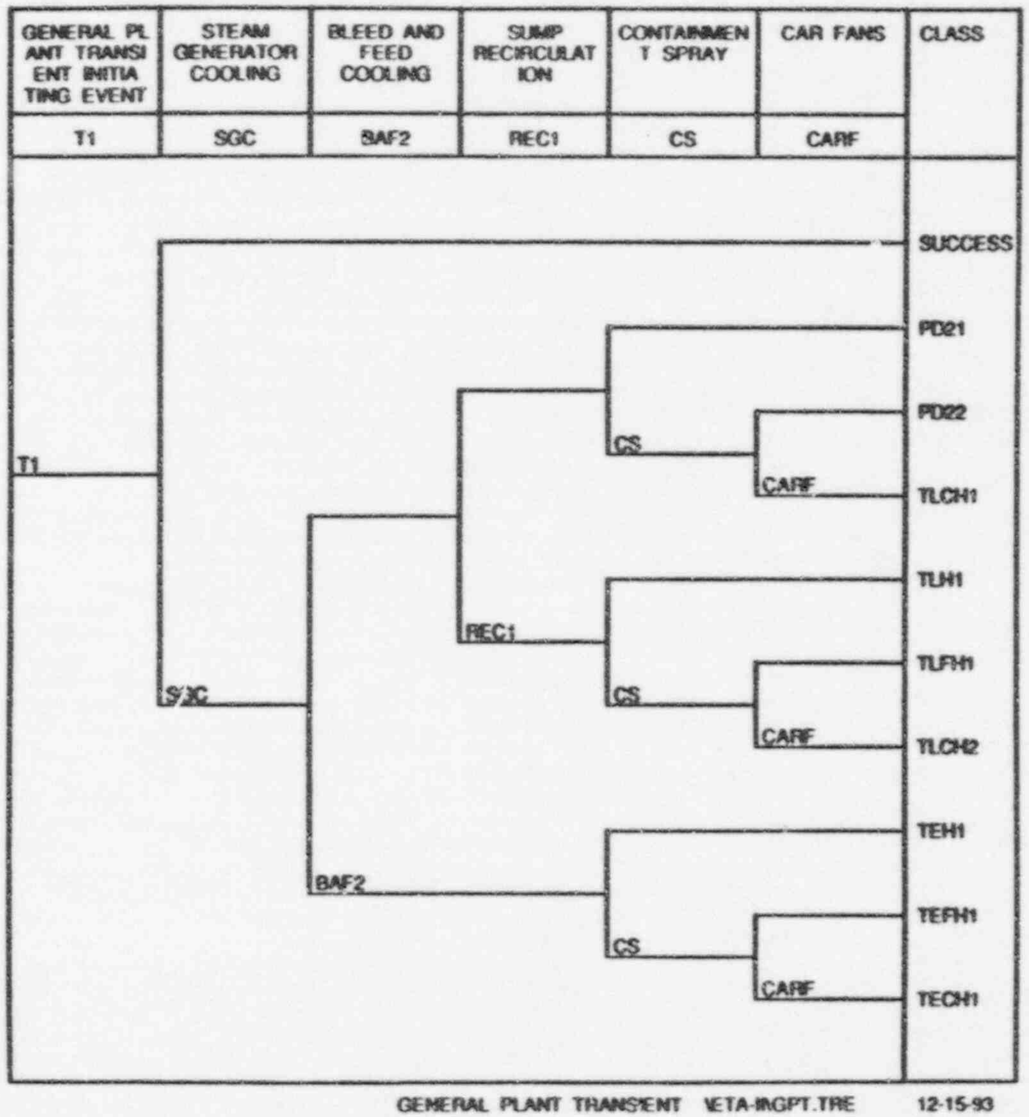

GENERAL PL ANT TRANSI ENT INITIA TING EVENT
STEAM GENERATOR COOLING
BLEED AND FEED COOLING
SUMP RECIRCULAT ION
CONTAINMEN T SPRAY
CAR FANS
CLASS
T1
SGC
BAF2
REC1
CS
CARF
SUCCESS
PD21
PD22
TLCH1
TLH1
TLFH1
TLCH2
TEH1
TEFH1
TECH1
T1
SGC
BAF2
REC1
CS
CARF
CS
CARF
CS
CARF
GENERAL PLANT TRANSIENT \ETA-INGPT.TRE
12-15-93

Figure 4.9-2

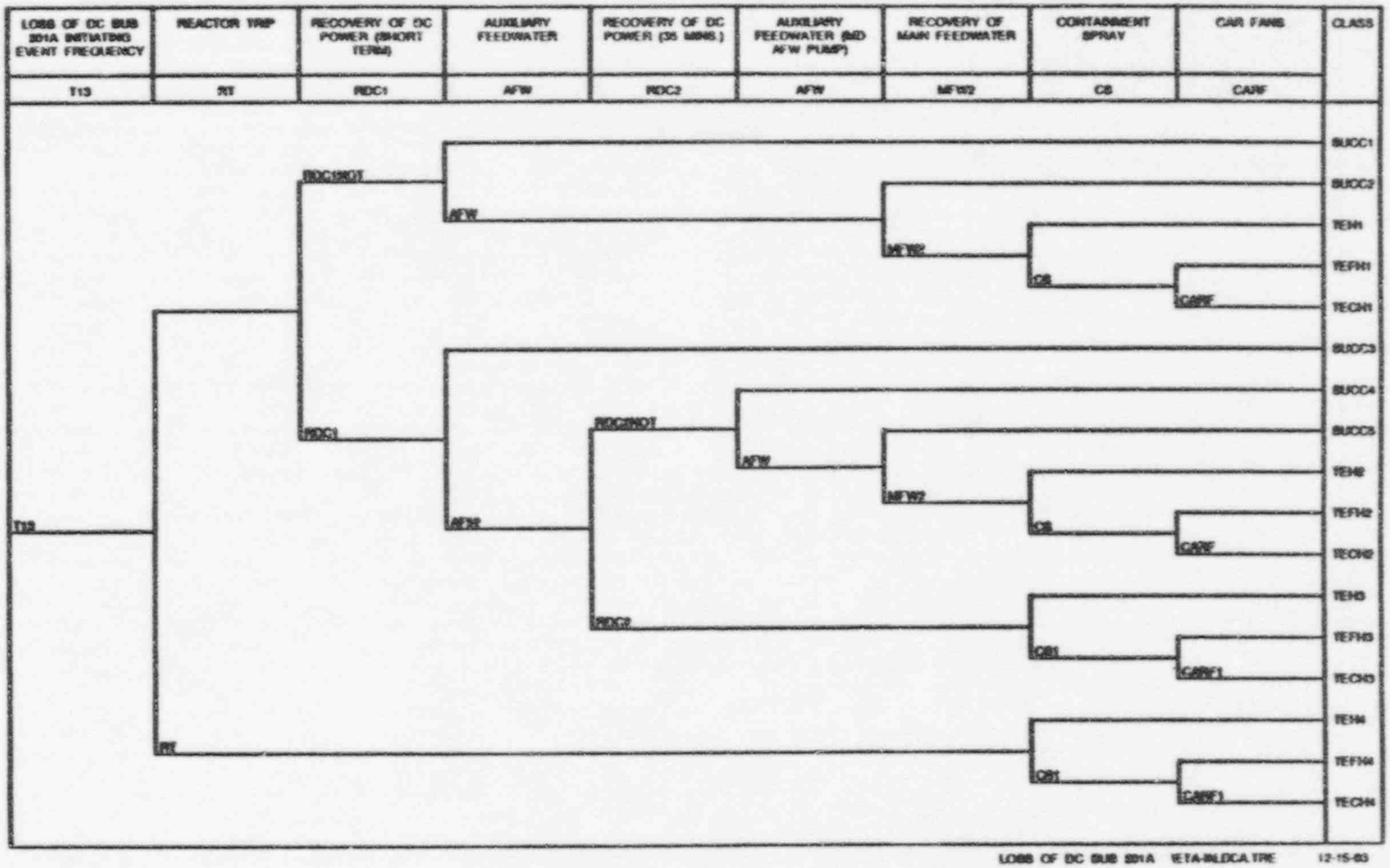

LOSS OF DC BUS 201A INITIATING EVENT FREQUENCY
T13
REACTOR TRIP
RT
RECOVERY OF DC POWER (SHORT TERM)
RDC1
AUXILIARY FEEDWATER
AFW
RECOVERY OF DC POWER (35 MINS.)
RDC2
AUXILIARY FEEDWATER (SD AFW PUMP)
AFW
RECOVERY OF MAIN FEEDWATER
MFW2
CONTAINMENT SPRAY
CS
CAR FANS
CARF
CLASS
BUCC1
BUCC2
TEH1
TEFH1
TECH1
BUCC3
BUCC4
BUCC5
TEH2
TEFH2
TECH2
TEH3
TEFH3
TECH3
TEH4
TEFH4
TECH4
LOSS OF DC BUS 201A
ETA-INLDCA.TRE
12-15-93

Figure 4.9-3

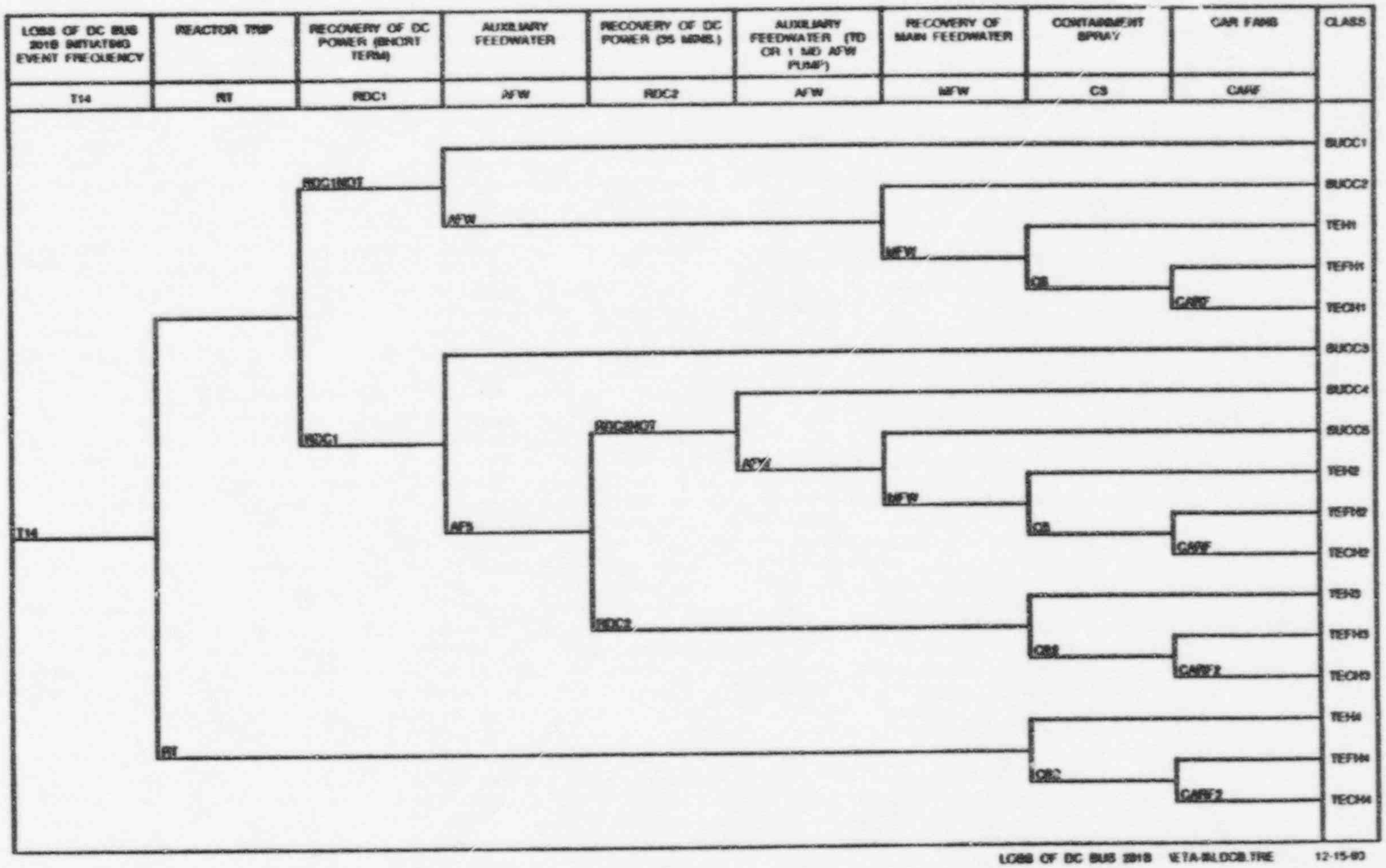

LOSS OF DC BUS 201B INITIATING EVENT FREQUENCY
T14
REACTOR TRIP
RT
RECOVERY OF DC POWER (SHORT TERM)
RDC1
AUXILIARY FEEDWATER
AFW
RECOVERY OF DC POWER (35 MINS.)
RDC2
AUXILIARY FEEDWATER (TD OR 1 MD AFW PUMP)
AFW
RECOVERY OF MAIN FEEDWATER
MFW
CONTAINMENT SPRAY
CS
CAR FANS
CARF
CLASS
SUCC1
SUCC2
TEH1
TEFH1
TECH1
SUCC3
SUCC4
SUCC5
TEH2
TEFH2
TECH2
TEH3
TEFH3
TECH3
TEH4
TEFH4
TECH4
LOSS OF DC BUS 201B
12-15-93

Figure 4.9-4

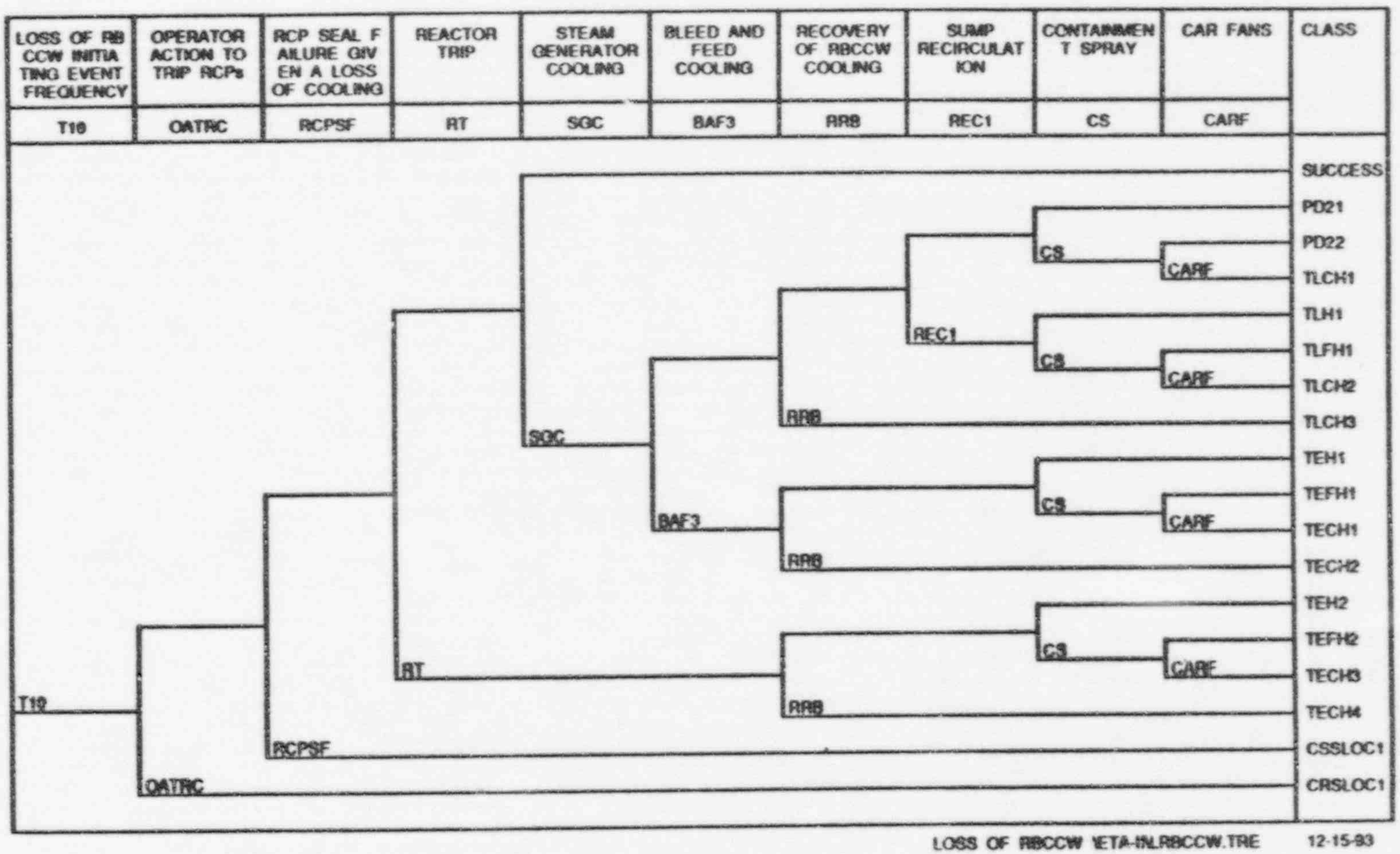
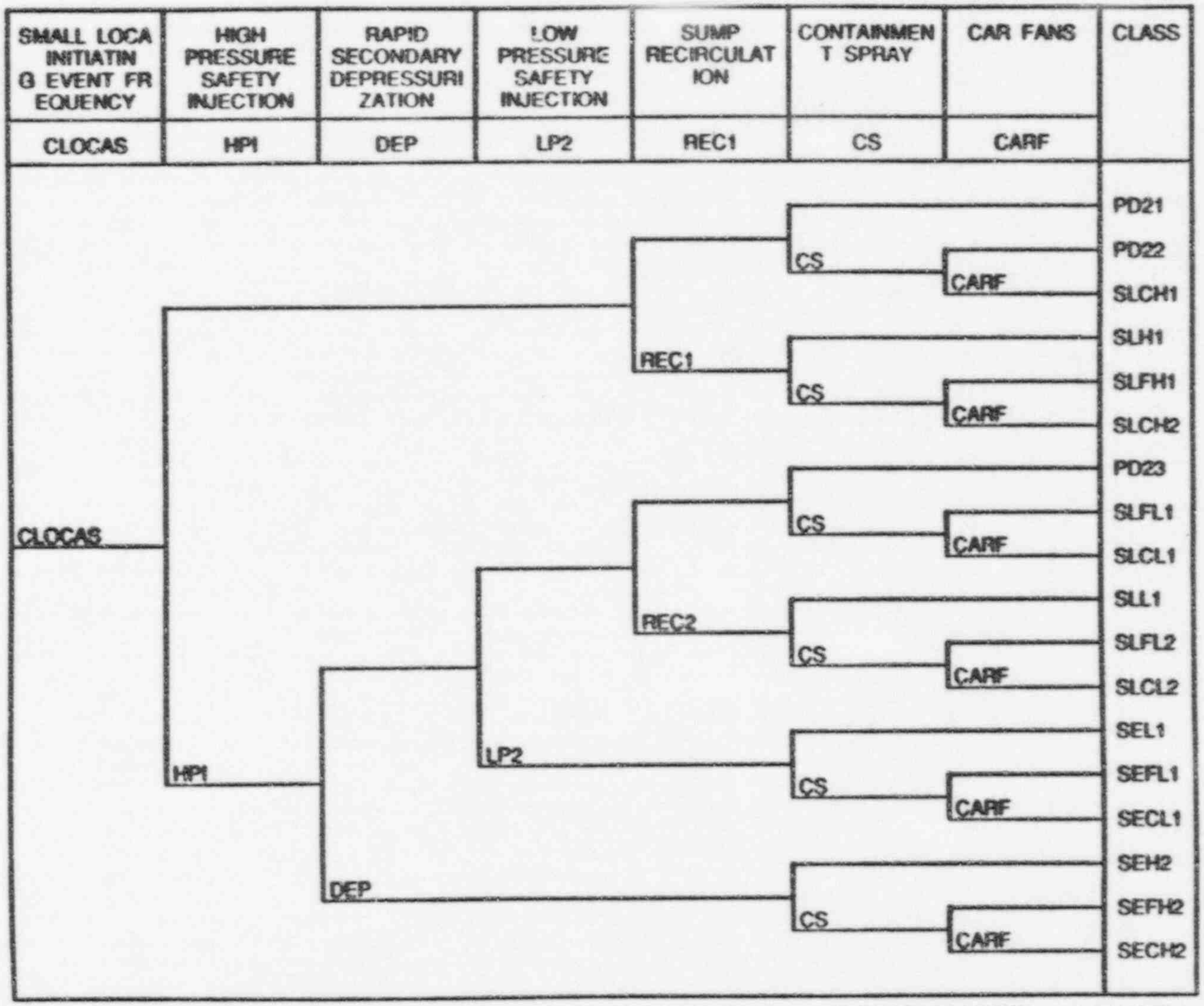

LOSS OF RB CCW INITIA TING EVENT FREQUENCY
T19
OPERATOR ACTION TO TRIP RCPs
OATRC
RCP SEAL F AILURE GIV EN A LOSS OF COOLING
RCPSF
REACTOR TRIP
RT
STEAM GENERATOR COOLING
SGC
BLEED AND FEED COOLING
BAF3
RECOVERY OF RBCCW COOLING
RRB
SUMP RECIRCULAT ION
REC1
CONTAINMEN T SPRAY
CS
CAR FANS
CARF
CLASS
SUCCESS
PD21
PD22
TLCH1
TLH1
TLFH1
TLCH2
TLCH3
TEH1
TEFH1
TECH1
TECH2
TEH2
TEFH2
TECH3
TECH4
CSSLOC1
CRSLOC1
LOSS OF RBCCW \ETA-IN\RBCCW.TRE
12-15-93

Figure 4.9-5



SMALL LOCA EVENT TREE \ETA-INCLOCAS.TRE 12-15-93

Figure 4.9-6

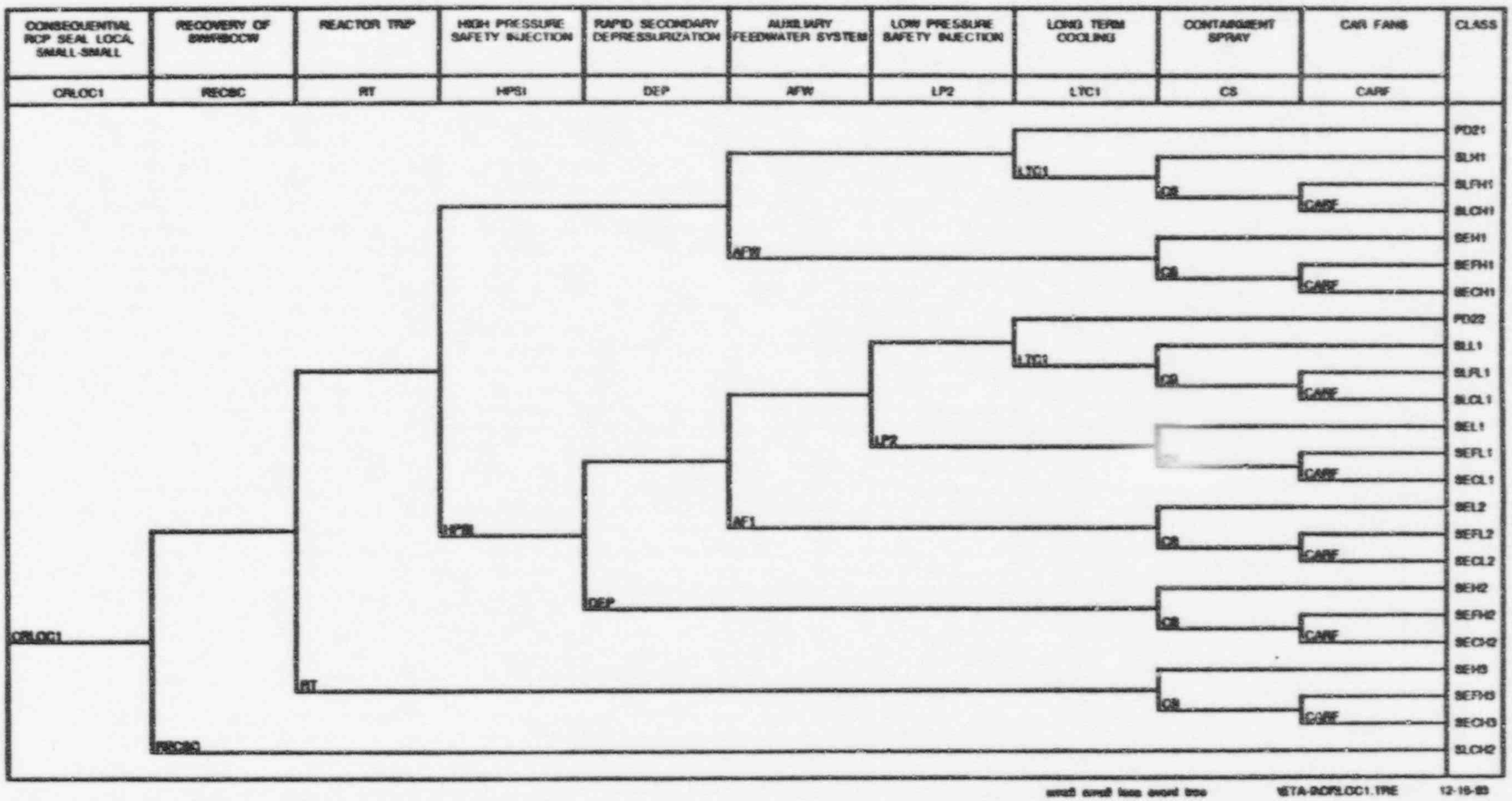

CONSEQUENTIAL RCP SEAL LOCA, SMALL-SMALL
CRLOC1
RECOVERY OF SW/RBCCW
RECBC
REACTOR TRIP
RT
HIGH PRESSURE SAFETY INJECTION
HPSI
RAPID SECONDARY DEPRESSURIZATION
DEP
AUXILIARY FEEDWATER SYSTEM
AFW
LOW PRESSURE SAFETY INJECTION
LP2
LONG TERM COOLING
LTC1
CONTAINMENT SPRAY
CS
CAR FANS
CARF
CLASS
PD21
SLH1
SLFH1
SLCH1
SEH1
SEFH1
SECH1
PD22
SLL1
SLFL1
SLCL1
SEL1
SEFL1
SECL1
SEL2
SEFL2
SECL2
SEH2
SEFH2
SECH2
SEH3
SEFH3
SECH3
SLCH2
CRLOC1
RECBC
RT
HPSI
DEP
AFW
AF1
LP2
LTC1
CS
CARF
small small loca event tree
\ETA-RCPLOC1.TRE
12-16-93

Figure 4.9-7

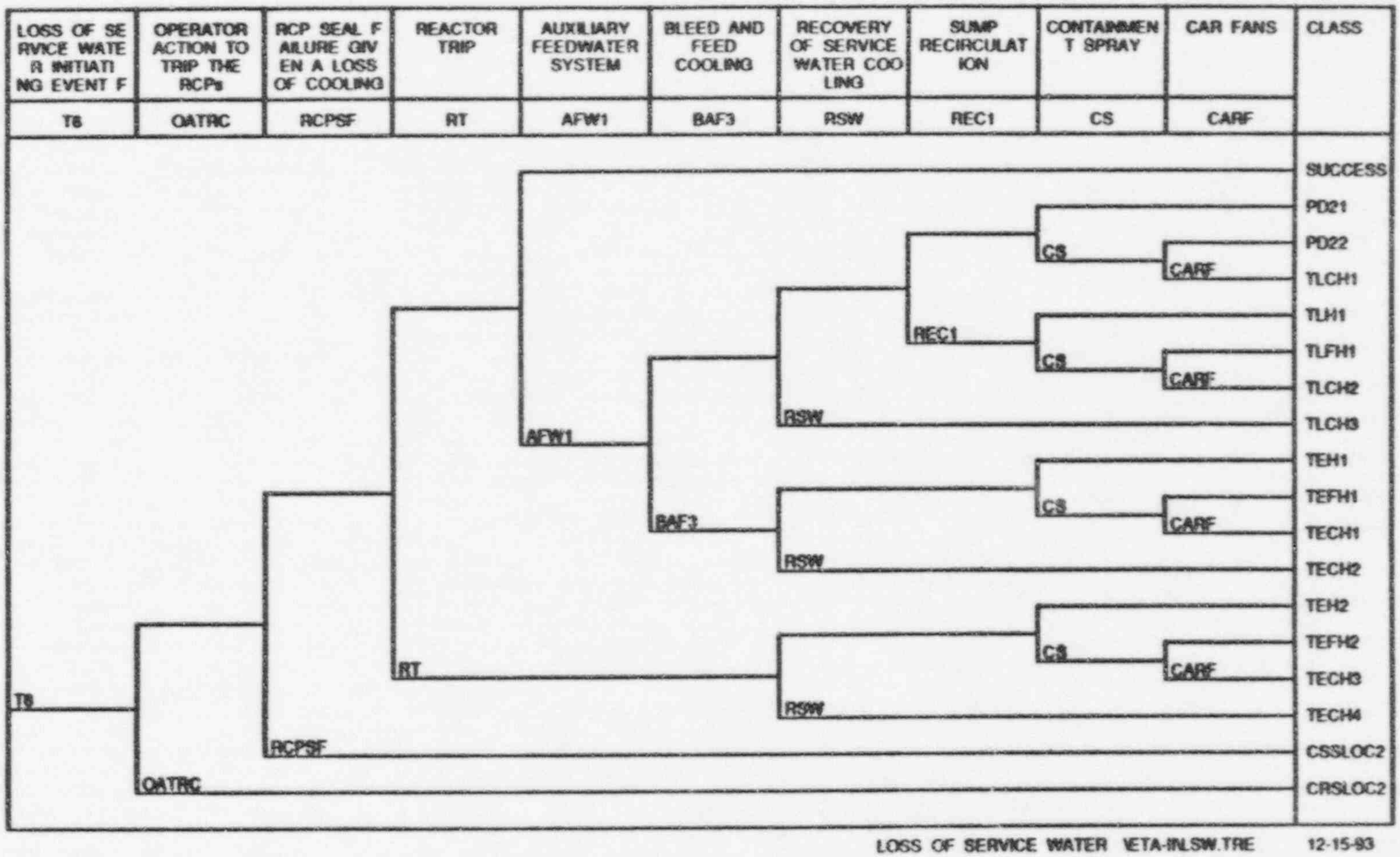
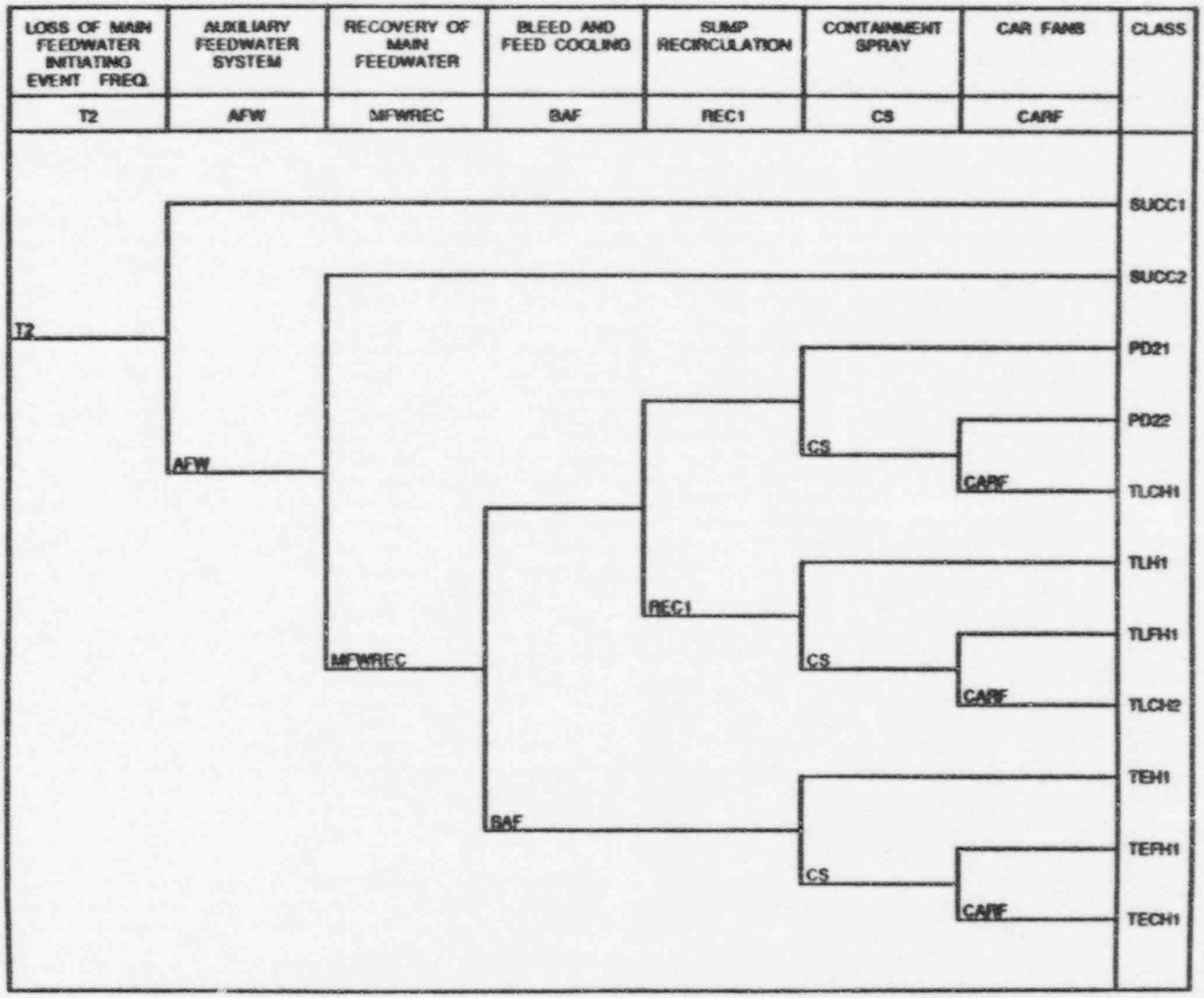

LOSS OF SERVICE WATER INITIATING EVENT F
T6
OPERATOR ACTION TO TRIP THE RCPs
OATRC
RCP SEAL FAILURE GIVEN A LOSS OF COOLING
RCPSF
REACTOR TRIP
RT
AUXILIARY FEEDWATER SYSTEM
AFW1
BLEED AND FEED COOLING
BAF3
RECOVERY OF SERVICE WATER COOLING
RSW
SUMP RECIRCULATION
REC1
CONTAINMENT SPRAY
CS
CAR FANS
CARF
CLASS
SUCCESS
PD21
PD22
TLCH1
TLH1
TLFH1
TLCH2
TLCH3
TEH1
TEFH1
TECH1
TECH2
TEH2
TEFH2
TECH3
TECH4
CSSLOC2
CRSLOC2
LOSS OF SERVICE WATER VETA-INLSW.TRE
12-15-93

Figure 4.9-8



LOSS OF MAIN FEEDWATER \ETA-IN\LMFW.TRE 12-15-93

Figure 4.9-9

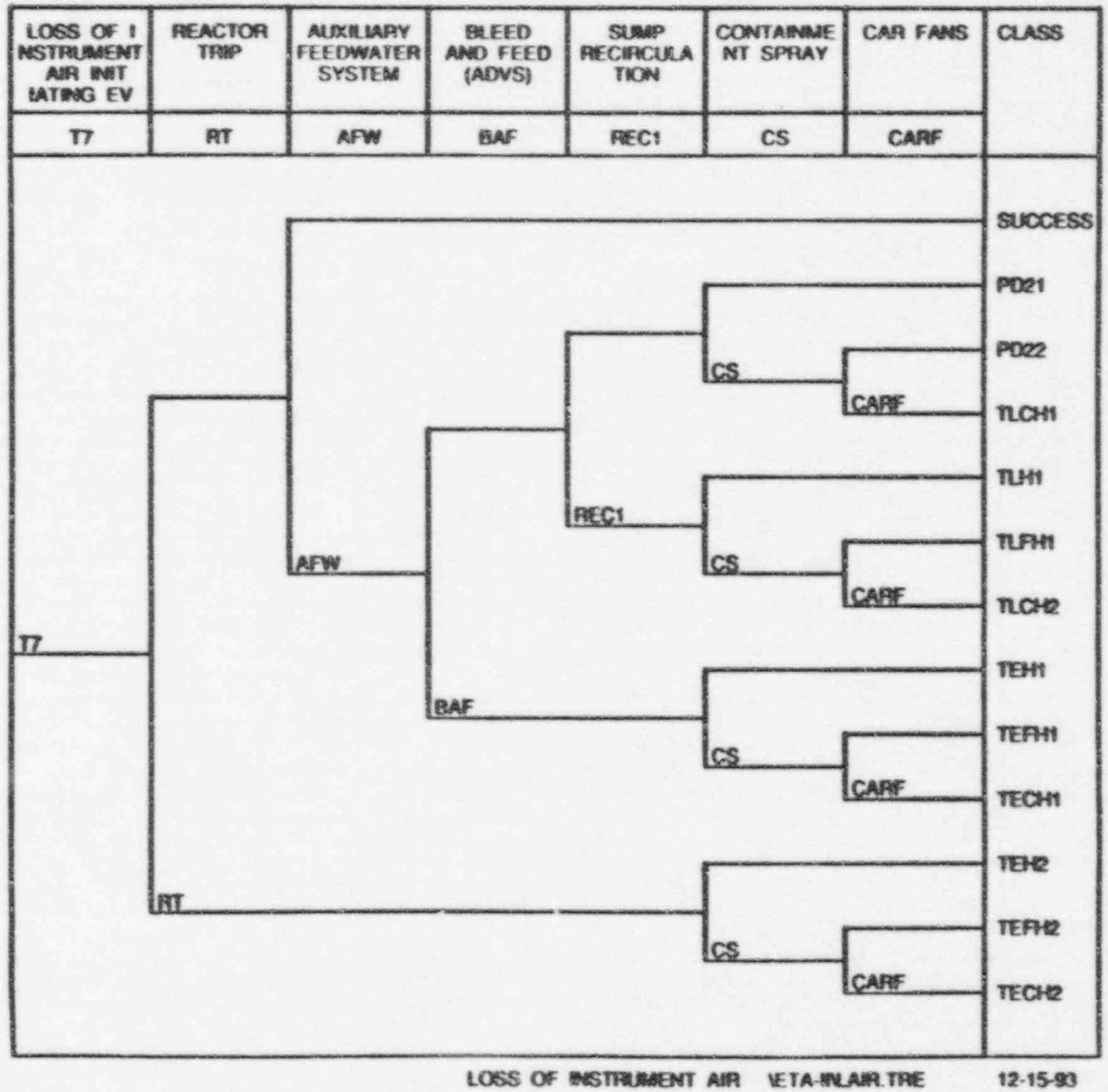
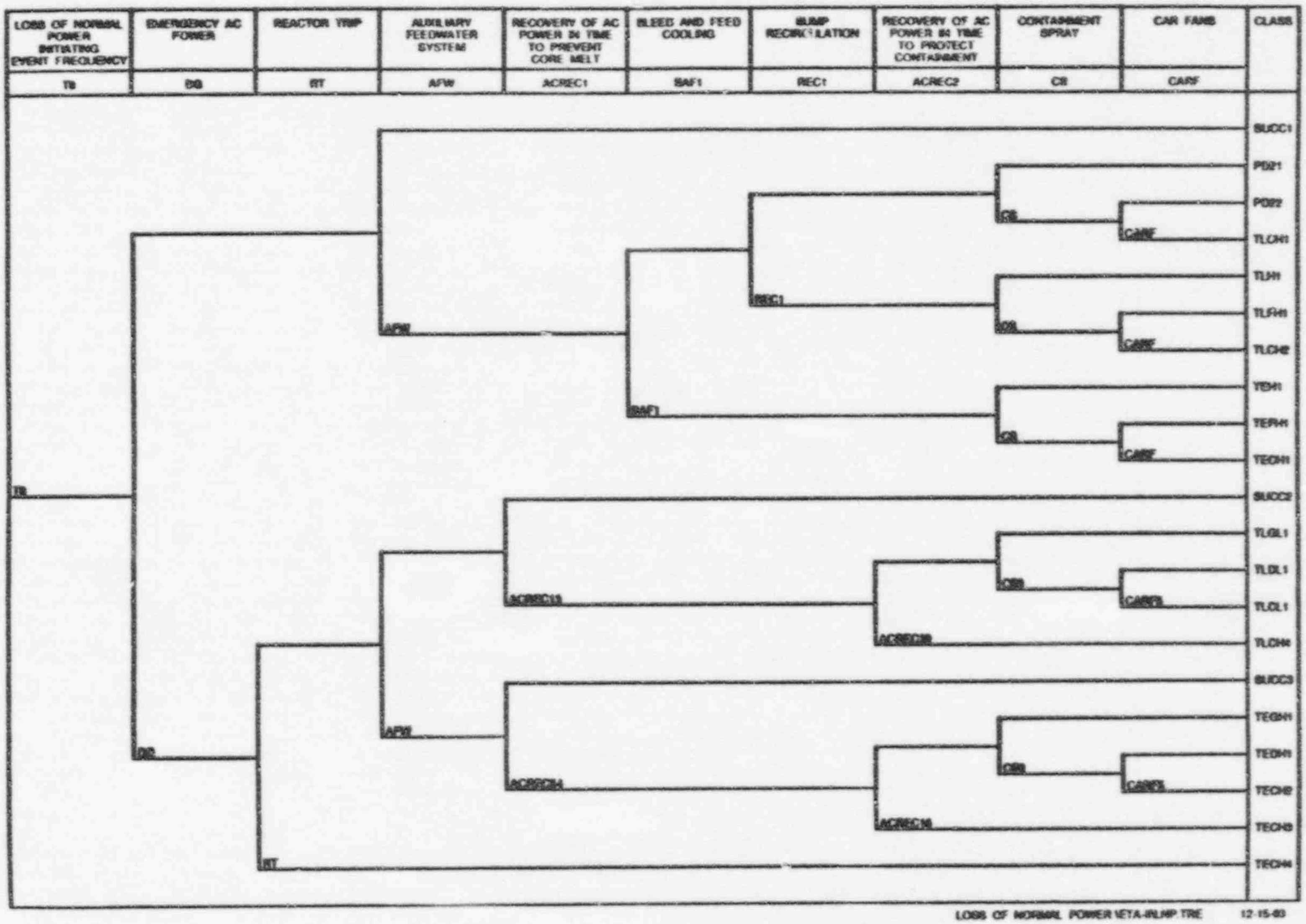

LOSS OF I NSTRUMENT AIR INIT IATING EV
REACTOR TRIP
AUXILIARY FEEDWATER SYSTEM
BLEED AND FEED (ADVS)
SUMP RECIRCULA TION
CONTAINME NT SPRAY
CAR FANS
CLASS
T7
RT
AFW
BAF
REC1
CS
CARF
SUCCESS
PD21
PD22
TLCH1
TLH1
TLFH1
TLCH2
TEH1
TEFH1
TECH1
TEH2
TEFH2
TECH2
LOSS OF INSTRUMENT AIR \ETA-INLAIR.TRE
12-15-93

Figure 4.9-10


LOSS OF NORMAL POWER INITIATING EVENT FREQUENCY
TB
EMERGENCY AC POWER
DG
REACTOR TRIP
RT
AUXILIARY FEEDWATER SYSTEM
AFW
RECOVERY OF AC POWER IN TIME TO PREVENT CORE MELT
ACREC1
BLEED AND FEED COOLING
SAF1
SUMP RECIRCULATION
REC1
RECOVERY OF AC POWER IN TIME TO PROTECT CONTAINMENT
ACREC2
CONTAINMENT SPRAY
CS
CAR FANS
CARF
CLASS
SUCC1
PD21
PD22
TLCH1
TLH1
TLFH1
TLCH2
TEH1
TEFH1
TECH1
SUCC2
TLGL1
TLDL1
TLCL1
TLCH4
SUCC3
TEGH1
TEDH1
TECH2
TECH3
TECH4
LOSS OF NORMAL POWER\ETA-INLHP.TRE
12-15-93

5.0 High Winds, Floods and Others

5.1 High Winds

5.1.1 Determination of the Plant Licensing Basis

The progressive screening approach was used for evaluating tornado/high wind hazards at the Millstone Nuclear Power Station Unit 2 (MP2) as described in NUREG-1407 (Reference 5-1). After a plant design review (to establish the plant licensing basis) and identification of plant changes since issuance of the operating license, the 'as-built' tornado/high wind design basis is checked against criteria in the 1975 Standard Review Plan (SRP) (NUREG-75/087). If the 'as-built' design meets the 1975 criteria, the results are documented, otherwise further analysis is required. This further analysis can be in the form of a hazard frequency analysis, a bounding analysis, or a PRA. For tornado/high winds issues, the following sections of the SRP must to be considered:

SRP No. 2.3.1	Regional Climatology
SRP No. 3.3.1	Wind Loadings
SRP No. 3.3.2	Tornado Loadings
SRP No. 3.5.1.4	Missiles Generated by Natural Phenomena, and
SRP No. 3.5.2	Structures, Systems, and Components to be Protected from Externally Generated Missiles.

The Bechtel Design Manual (Reference 5-2), for Unit 2, and the Final Safety Analysis Report (FSAR) were reviewed to identify and collect original design specifications relevant to this issue. From the Design Manual, the original wind and tornado loads were determined. Subsequent tornado evaluations are described in Section 5 of the FSAR. The list of Class I structures at MP2 is described in Section 5.1.1 of the FSAR.
The wind loadings for all structures are described in the Design Manual and are based on Figure 1 (b) of ASCE Paper 3269 (Reference 5-3) using the fastest mile wind speed for a 100 year recurrence period. The basic wind velocity variation with height is:

Height (ft)	Wind Speed (mph)
0 - 50	90
50 - 150	115
150 - 400	145

The basic design wind velocity for all Class 1 structures at the Millstone site is 115 mph with gusts up to 140 mph.

The tornado wind loads and missile spectrum are described in the Millstone Unit 2 FSAR Section 5. The basic design criteria for tornado effects are as follows:

- The velocity components are applied as a tangential wind velocity of 300 mph and a translational velocity of 60 mph combined for a total speed of 360 mph.
- A negative pressure drop of 3 psi is assumed to occur in 3 seconds (1 psi/sec.).
- Missiles associated with this tornado are:
  - A fir plank, 4 in. x 12 in. x 12 ft., weighing 105 pounds and traveling end-on at a speed of 250 mph,
  - A passenger auto (4000 lb.) impact velocity of 50 mph not more than 25 feet above grade with a contact area of 20 square feet,
  - A 3 in. x 10 foot long (ASA Schedule 40) pipe (72 pounds) traveling end-on at a speed of 100 mph at any elevation on the structure.

In addition, an expanded spectrum of tornado missiles was evaluated in Appendix 5.D to Section 5 of the FSAR. The expanded missile spectrum is:

- Utility pole 13.5 in. diameter x 35 ft. long with density of 43 lbs/ft^3
  - maximum velocity = 182 fps (124 mph)
- 1 in. solid steel rod 3 ft. long with a density of 490 lbs/ft^3
  - maximum velocity = 192 fps (131 mph)
- 6 in. schedule 40 pipe, 15 ft. long with material density of 490 lbs/ft^3
  - maximum velocity = 98 fps (67 mph)
- 12 in. schedule 40 pipe, 15 ft. long with material density of 490 $lbs.ft^3$
  - maximum velocity = not sustained in flight

The Safety Evaluation Report (SER, Reference 5-4) describes the wind and tornado loadings and states that "The criteria used in the design of Category 1 structures to account for the loadings due to specific winds and tornadoes postulated to occur at the site and the method used in determining those loads provide a conservative basis for plant design."

Based upon a review of the Design Manual, the SER, and the FSAR it is concluded that no significant changes in the plant design basis have occurred since issuance of the OL that would either erode or enhance the high winds/tornadoes design basis.

5.1.2 Comparison of the 'As-Built' Design with the 1975 SRP

Comparison of the 'as-built' design wind speeds with 1975 SRP winds show that the 'as-built' wind speeds are consistent with the 1975 SRP wind speeds. A comparison of the wind loads on the Enclosure building, based upon original design calculations as shown in the FSAR against loadings based on ANSI A58.1-1972 (Reference 5-5) show the loadings to be comparable.

Comparison of the 'as-built' tornado loadings with 1975 SRP loadings lead to the following conclusions:

- Structures designed to the 'as-built' tornado wind and pressure differential loadings satisfy the 1975 SRP. The velocity and weight of the missiles used in the 'as built' design are in general slightly less than the velocity and weight of missiles specified in the 1975 SRP.

- Structures designed to the 'as-built' tornado loadings, have significant protection against high winds/tornadoes. Systems and components within these structures are assumed to have significant protection against the effects of tornado winds and missiles. However, because tornado dampers are not installed, some systems (such as ventilation systems) may be vulnerable to tornado induced pressure differentials.

Based upon this evaluation, it was concluded that Millstone Unit 2 does not satisfy all 1975 SRP tornado requirements.

5.1.3 Plant Walkdown

A plant walkdown was performed to identify 'as built' and as operated plant conditions. A primary focus of the walkdown was on the Diesel Generator Building and the Intake Structure. These structures are of particular concern because it is assumed that off-site power will be lost given that a tornado occurs at the site and therefore the diesels will be needed along with cooling water for the diesels. A secondary focus was on the possibility of the collapse of a structure or stack on Class 1 systems and structures. These are concerns that have been identified in NUREG/CR-5042 (Reference 5-6).

Internal and external walkdowns of all Class 1 structures were performed, with the exception of an internal walkdown of Containment. The FSAR states, that for tornado loadings, the hatches over the Circulating Water pumps and the traveling screens serve as blowout panels to relieve the pressure differential. This was verified during the plant walkdown. It was also noted, on the walkdown, that internal systems and components within the Intake Structure may be vulnerable to a tornado missile passing through either the doors or the roof hatches.

During the walkdown of the Diesel Generator Building, it was noted that neither the day tank vent pipe, the exhaust gas silencers, nor the intake combustion air filter are protected from tornado missiles. Impact of a large missile to these targets could cause failure of the diesel to operate or operation at a reduced performance level.

Walkdown of the site found it be relatively free of potential missiles, such as pipes, planks, or other construction material.

5.1.4 Additional Analysis Required

Because the "as built"' design did not fully satisfy the 1975 SRP, further analysis was required. That analysis option is described in Section 5.2.4 - "Determine if the Hazard Frequency is Acceptably Low" (Optional Step of NUREG-1407). The NUREG-1407 IPEEE process allows an acceptable hazard frequency of 10^{-5} with a 10^{-1} conditional probability of core damage or an overall core damage frequency of 10^{-6}. Or, if the 10^{-6} tornado loadings are less severe than the as-built values then the NUREG-1407 hazard screening criteria is satisfied for those structures, systems, and components that have been checked for tornadoes.

NRC tornado design criteria, defined in Regulatory Guide 1.76 (Reference 5-7) and Standard Review Plan (SRP) Sections 3.3.1, 3.3.2 and 3.5.1.4, were established to provide design loads with an annual probability of exceedance of $1x10^{-7}$. The probabilistic basis for Regulatory Guide 1.76 is found in WASH-1300 (Reference 5-8). The WASH-1300 tornado criteria are recognized as being conservative, and as stated in WASH-1300, they were considered at the time of development as interim criteria until more realistic criteria could be developed. It also states that the values should be lowered, as may be justified, when sufficient data become available.

In Reference 5-9 the WASH-1300 methodology was applied. However, a 30 year data base was used as compared to a 13 year data base used in the original WASH-1300 study. In addition, Reference 5-9 showed that the mean path area for tornadoes occurring, within the 5 degree by 5 degree box containing the Millstone site, is considerably less than the 2.82 square miles assumed in WASH-1300. Current estimates (Reference 5-9) of the average path area for the Millstone region is 0.22 square miles. The value of 0.22 square miles is more than a factor of 10 lower than what was used in the WASH-1300 study. Application of the WASH-1300 methodology, with this more complete data base and a mean path area of 0.22 square miles, results in a $1x10^{-7}$ maximum wind speed of 260 mph (Reference 5-9).

Published tornado hazard results appropriate for Millstone Nuclear Power Station are presented in the Systematic Evaluation Program (SEP) results for Millstone Unit 1 (Reference 5-10), ANSI/ANS-2.3 (Reference 5-11), and a site-specific tornado hazard analysis for Millstone Unit 3 (Reference 5-12). The following table presents the wind speed estimates from the SEP, ANSI, and site-specific Millstone study at the 10^{-5}, 10^{-6}, and 10^{-7} annual exceedance level. It also shows an average wind speed based on averaging the results from each of the studies at given probability levels.

Table 5.1-1

Exceedance Probability	SEP (1980) mph	ANSI/ANS (1983) mph	TWISDALE (1985) mph	AVERAGE mph
10^{-5}	120	150	140	137
10^{-6}	184	200	194	193
10^{-7}	245	250	260	252

Based upon the above results, it was concluded that a reasonable estimate of the tornado wind speed hazard for the Millstone site is provided by the average value presented in Table 5.1- 1. Maximum atmospheric pressure drop and rate of pressure drop for the Table 5.1-1 average wind speeds was determined from relationships presented in ANSI/ANS 2.3 and Reference 5-13. The following summarizes the tornado loadings associated with the mean 10^{-6} tornado at the Millstone site:

Wind Speed	193 mph
Maximum Pressure Drop	0.72 psi
Rate of Pressure Drop	0.14 psi/sec.
Missile F Velocity	113 ft/sec.
Missile C Velocity	170 ft/sec.

SRP 3.5.1.4 states that plants not required at the construction permit stage to design to the total missile spectrum should show the capability of the existing structures and components to withstand at least missiles C and F. Millstone Unit 2 falls into this category.

5.1.5 Evaluation of 'As-Built' Plant for 10^{-6} Tornado Loadings and Vulnerabilities Identified During the Plant Walkdown

Based upon the 10^{-6} tornado wind speed for the Millstone site, the 'as-built' missile velocities for missiles C and F exceed the missile velocities based on SRP 3.5.1.4. Therefore, the 'as-built' missile velocities satisfy the IPEEE hazard screening criterion of 10^{-6}.

Comparison of the 'as-built' loadings with 10^{-6} tornado wind speed, and expected missiles shows that the 'as-built' loadings are greater than the 10^{-6} loadings. Therefore, use of the 'as-built' tornado wind speed, pressure drop and missile spectrum for those structures (with enclosed systems and components) is conservative for wind loadings and missiles and satisfies the IPEEE hazard frequency screening level. However, no documentation is available to indicate that the systems and components within these structures have been evaluated for tornado induced pressure differentials.

Based upon the plant walkdown, some potential vulnerabilities were identified. These potential vulnerabilities were evaluated probabilistically. The total annual probability of a diesel failure due to tornado missile impacts of either the day tank vent, the combustion air intake, or the exhaust silencer is bounded by the sum of the failure probabilities for the three sources of failure, or about 3.7×10^{-7}. Because failure of the second diesel due to tornado missiles is not an independent event, a conservative estimate of the failure of both diesels due to tornado missiles is assumed to be on the order of 10^{-7}. Failure of the service water pumps due to tornado missiles is estimated to be on the order of 1×10^{-7}.

5.1.6 Summary

Consistent with the progressive screening approach presented in NUREG-1407, the effects of high winds/tornadoes have been evaluated at MP2. The 'as-built' high winds/tornado design loads for MP2 have been determined. Design loads required by the 1975 SRP have been determined. Based on this information, it is concluded that the 'as-built' plant does not fully satisfy the 1975 SRP. However, the 'as-built' design for tornado wind speed, missile spectrum, pressure drop, and rate of pressure drop satisfies the NUREG-1407 hazard screening criterion with the following exception:

The hazards evaluation revealed that the Control Room and Diesel Generator Room Cooling ducts and dampers may be vulnerable to the 10^{-6} tornado pressure transient loadings. Although this equipment meets design basis requirements this equipment will be further evaluated.

The progressive screening approach has been followed at MP2 and potential vulnerabilities due to high winds/tornadoes have been identified and evaluated. This analysis is documented in Reference 5-14.

5.2 External Floods

The external flood evaluation was performed in two parts. The first part evaluated the Millstone Unit 2 (MP2) plant site design basis flood produced by a Probable Maximum Hurricane (PMH) following the methodology outlined in NUREG-1407 (Reference 5-1). The second part addresses the NRC request in NUREG-1407 to evaluate local site flooding using the latest probable maximum precipitation (PMP) criteria published by the National Weather Service (NWS). The review of the latest NWS criteria was consistent with the information provided in NRC Generic Letter 89-22 (Reference 5-15).

5.2.1 Description of Methodology

The methodology used in the evaluation of the design basis flood was the progressive screening approach suggested in NUREG-1407. The evaluation (Reference 5-16) followed the series of steps and documentation requirements outlined in Figure 5.1 and Appendix C, respectively, of NUREG-1407.

The first step in the evaluation included a review of the applicable sections of the FSAR and the NRC SER (References 5-18, 5-19 and 5-20). The purpose of this review was to determine the basis for the site design flood.

The MP2 site is located on the north shore of Long Island Sound. To the west of the site is Niantic Bay and to the east is Jordan Cove. Site grade elevation around major plant structures is about Elevation 14.0 ft MSL.

Several estimates of site flooding levels associated with a PMH are presented in the FSAR. During the original licensing process, the probable maximum hurricane (PMH) was selected as the meteorological event to predict the design basis probable maximum flood level at the site. The PMH analysis was based upon the parameters of the PMH as defined in the U.S. Weather Bureau Report HUR 7-97 (Reference 5-17). For design purposes a maximum PMH stillwater level of 18.1 ft MSL was selected.

A subsequent PMH analysis predicted a total stillwater surge of 19.17 ft MSL. It is noted in the FSAR that the initial sea level rise used in this PMH analysis was too high, i.e. 2 feet versus the final adopted value of 1 foot. Use of the 1 foot initial rise reduces this PMH estimate from 19.17 ft MSL to about 18.2 ft MSL.

As described in FSAR, Section 2.5.4.2.2, the design flood protection level was selected at 22 ft MSL. The Containment, Turbine and Auxiliary Buildings are protected to at least this elevation by concrete walls in conjunction with flood gates at any openings, i.e. doors, in the walls. All drains from buildings to the storm drainage system are provided with backwater valves to prevent water from flowing back into buildings. These backwater valves are considered outliers until the functionality of these valves has been established.

Concurrent flooding around Millstone Unit 1 (MP1) was considered in the MP1 evaluation. Even for the 19.17 ft MSL surge, flooding of MP2 via MP1 interior connections was shown to be insignificant.

FSAR Section 2.5.4.2.3 describes flood protection for the Intake Structure. The only equipment within the Intake Structure required for safe shutdown are the Service Water pumps. Motors for these pumps and associated electrical and control equipment are protected to Elevation 22 ft MSL. Due to wave action, the maximum water level inside the Intake Structure is Elevation 26.5 ft MSL. By AOP 2560, if water level exceeds plant grade of 14'0" or any 3 items specified in step 4.2.9 of this proceedure are observed, a portable can is installed on a Service Water pump in anticipation of potential flooding beyond the 22' elevation. If water exceeds the 22' elevation, all Service Water pumps are stopped (Emergency Diesel Generators are provided cooling from a Fire Water cross connect) and the protected pump is not started until water level recedes below 22'.

For other safety-related buildings (other than the Intake Structure), the maximum PMH stillwater level of 18.1 ft MSL produces a maximum ponding depth at the buildings of about 4.1 feet. The maximum wave height of 3.2 feet could produce wave runup to Elevation 25.1 ft MSL.

The Containment, Auxiliary and Warehouse Buildings have exterior concrete walls up to a minimum of Elevation 54.5 ft MSL. The Turbine and Enclosure Buildings have metal siding above the concrete wall at Elevation 22 ft MSL. The metal siding to concrete wall connection is caulked and therefore waterproof. Wave runup is, therefore, precluded from entering the buildings through walls. Openings in the walls, where required, are protected to Elevation 22 ft MSL by closeable flood gates.

The NRC review of MP2 site flooding is documented in the NRC SER (References 5-18, 5-19 and 5-20). In the SERs, it is noted that for the PMH surge of 18.2 ft MSL with wave runup to Elevation 25.1 ft MSL, safety-related equipment will not be adversely affected. This statement applies to all safety-related buildings other than the Intake Structure. The NRC estimated a maximum flood inside the Intake Structure of 27.5 ft MSL. The NRC accepted an alternative shutdown procedure along with a means to protect one Service Water pump motor (with motor disconnected) up to Elevation 28 ft MSL. The SER concludes that the design of structures to withstand the effects of flooding (including buoyancy and wave action) satisfies the requirements of AEC General Design Criteria Nos. 2 and 4. Appendix C to the SER corroborates that the extreme flood at the site would be the result of a severe hurricane. All issues associated with shoreline protection were resolved as documented in the SER Supplements.

The second step in the progressive screening process is to identify significant changes to the facility since issuance of the OL. No significant changes to MP2 have occurred since OL issuance with regards to site design basis PMH flooding. Construction of Millstone Unit 3 (MP3) does not impact the PMH site flooding level for MP2.

The third step in the progressive screening process is to determine if the plant design meets the 1975 SRP criteria.

The 1975 SRP criteria of NUREG-75/087 considered applicable to external flooding are listed in the table below and addressed following the table.

Table 5.2-1

External Flooding - 1975 SRP Criteria

SECTION	TITLE
2.4.1	Hydrologic Description
2.4.2	Floods
2.4.3	Probable Maximum Flood (PMF) on Streams and Rivers
2.4.4	Potential Dam Failures (Seismically Induced)
2.4.5	Probable Maximum Surge and Seiche Flooding
2.4.6	Probable Maximum Tsunami Flooding
2.4.7	Ice Effects
2.4.8	Cooling Water Canals and Reservoirs
2.4.9	Channel Diversions
2.4.10	Flooding Protection Requirements
2.4.11	Low Water Considerations
2.4.14	Technical Specifications and Emergency Operation Requirements
3.4.1	Flood Protection

<u>SRP Section 2.4.1</u>

With regards to external flooding, this SRP covers identification of the causal mechanisms of floods at the site.

The hydrology for the Millstone site is described in Section 2.5.4 of the MP2 FSAR, Section 2.4 of the MP1 FSAR and Section 2.4 of the MP3 FSAR. Based upon a review of these FSAR sections, it is concluded that the Millstone site fully satisfies the flood related criteria in SRP Section 2.4.1.

<u>SRP Section 2.4.2</u>

This SRP covers three main areas: flood history, site flood design considerations, and the effects of local intense precipitation.

Based on a review of information presented in the MP1, MP2 and MP3 FSARs, it is concluded that the SRP requirements of identifying historical flooding at the Millstone site are satisfied. It is also concluded that the appropriate controlling flood producing mechanism for the Millstone site has been properly identified, i.e. a PMH in Long Island Sound. This finding is consistent with other plants along the east coast of the United States.

The effects of local intense precipitation and associated site flooding and roof drainage are described in the FSAR. Both yard and roof drainage systems were designed for a rainfall intensity of 3 inches per hour. For site flooding, the FSAR acknowledges that during a rainfall intensity of 9.4 inches per hour, the capacity of the underground storm drainage system will be exceeded. Excess runoff will then accumulate in the yard until it reaches Elevation 14.5 ft MSL at which point it will overtop the site perimeter roadway and flow out into Jordan Cove on the east and Niantic Bay on the west. The actual ponding elevations around MP2 structures are not explicitly described in the FSAR. Drain connections from buildings to the storm drain system are provided with backwater valves to prevent water from backing up into buildings.

As part of this IPEEE review, local intense precipitation was also evaluated in detail. The evaluation of site ponding and roof ponding is described later.

Based on the above, it is concluded that the MP2 plant satisfies the first two areas of SRP Section 2.4.2. The third area, local intense precipitation, is assessed later.

<u>SRP Section 2.4.3</u>

This SRP section addresses the development of the Probable Maximum Flood (PMF) on rivers and the associated flood levels at the plant site. As documented in Section 2.4.3 of the MP3 FSAR, a PMF on streams and rivers is not the controlling flood for the Millstone site.

Therefore, this SRP does not apply to the Millstone site.

<u>SRP Section 2.4.4</u>

This SRP addresses the potential hazard to the facility due to the failure of any upstream or downstream water control structures. As documented in Section 2.4.4 of the MP3 FSAR, flooding of the Millstone site from potential dam failures is not applicable since there are no upstream dams.

Therefore, this SRP does not apply to the Millstone site.

<u>SRP Section 2.4.5</u>

This SRP discusses the development of site design flood levels for the Probable Maximum Hurricane (PMH) surge.

For the Millstone site, the PMH produces the controlling flood. This is corroborated by information in the FSARs for all three Millstone units and is consistent with other plants along the coast of the Atlantic Ocean. The SRP notes that the site design flood is judged against the criteria discussed in Reg. Guide 1.59. Methods recommended to define the PMH parameters are outlined in HUR 7-97 (Reference 5-17).

Regulatory Guide 1.59 (R.G. 1.59) provides PMH stillwater surge estimates at various coastal locations. As noted in R.G. 1.59, these estimates have been reviewed and accepted by the NRC and as such these estimates satisfy the 1975 SRP criteria.

The R.G. 1.59 probable maximum surge estimate for Millstone is 19.4 ft MLW (mean low water). Based on information presented in the MP3 FSAR, mean low water at Millstone Point is (-)1.4 ft MSL. Converting the R.G. 1.59 stillwater surge estimate from MLW to MSL yields 18.0 ft MSL.

During the Systematic Evaluation Program (SEP) for MP1, the predicted PMH flood level used for the SEP assessments was a maximum stillwater level of 18.1 ft MSL and 22.3 ft MSL including wave effects. NRC acceptance of this PMH surge is documented in References 5-21, 5-22 and 5-23. In particular, Reference 5-23 notes that this PMH satisfies current SRP criteria.

The PMH level for MP2 is a maximum stillwater elevation of 18.1 ft MSL with wave runup to 25.1 ft MSL. Since these levels are equal to or greater than those obtained from R.G. 1.59 or used in the MP1 SEP, the MP2 PMH flood levels must also satisfy current SRP criteria.

Based on the above, it is concluded that the PMH flood levels for MP2 satisfy the 1975 SRP Section 2.4.5 criteria.

SRP Section 2.4.6

As documented in Section 2.4.6 of the MP3 FSAR, tsunami are not considered to be a credible natural phenomena which might affect the safety of the Millstone site. Therefore this SRP does not apply to the MP2 site.

SRP Section 2.4.7

Concerning site flooding, one of the items addressed in this SRP is ice-induced flood levels.

Section 2.4.7 of the MP1 and MP3 FSARs and Section 2.5.4.3 of the MP2 FSAR document that there is no history of ice jam formation in Niantic Bay. The MP2 SER concurs with this conclusion. Therefore this SRP does not apply to the MP2 site flood evaluation.

SRP Section 2.4.8

Concerning PMH surge flooding, one of the items addressed in this SRP is the ability of any cooling water canals to transmit sufficient water to meet all safety requirements during postulated extreme hydrologic events.

There are no cooling water canals or reservoirs at the Millstone site. Therefore this SRP does not apply.

SRP Section 2.4.9

There are no channel diversions to the cooling water supply, the cooling water supply is essentially unlimited. Therefore this SRP does not apply to the MP2 site flood evaluation.

SRP Section 2.4.10

This SRP compares the flood protection features and any emergency procedures required to implement flood protection and warning times available for implementation of required actions against the site design flood level. The locations and elevations of safety-related facilities and of structures and components required for protection of safety-related facilities are also compared with the design basis flood levels.

As described previously, the design PMH stillwater level and maximum wave runup levels were accounted for in the design of the MP2 plant. Also as discussed above, these PMH flood levels satisfy 1975 SRP criteria. Maximum wave runup for all MP2 structures is given in the FSAR and SER as Elevation 25.1 ft MSL. The derivation of the runup level is not explained in detail, but some components are discussed in the FSAR and SER as summarized below.

The maximum stillwater level of 18.1 ft MSL, a wave height of 3.2 feet and an allowance for vertical runup on the vertical face of a building all combine for the maximum runup to Elevation 25.1 ft MSL. All safety-related structures have concrete floodwalls and flood gates up to at least Elevation 22 ft MSL. For the metal sided buildings, above Elevation 22 ft MSL, the transition from concrete to metal siding is essentially watertight.

Most of the flood gates provide a complete seal around the door openings. However, several flood gates, e.g. the Auxiliary Building, don't seal at the top since the top of the door is above Elevation 22 ft MSL (which is the design flood protection level). The potential for leakage into buildings for flood doors which are not sealed at the top was evaluated in Reference 5-16 and concluded to be insignificant in volume. This conclusion concurs with the FSAR and SER conclusions.

As part of this step, following the recommended IPEEE approach, a plant walkdown was performed for external flooding on October 28th and 29th, 1993. Notes from the walkdown are provided in Reference 5-16. Photographs were also taken during the walkdown. During the walkdown, all major plant structures were observed. MP2 structures and flood control features observed during the walkdown conform with all documented external flood information pertaining to the site design basis PMH flood.

Also, as part of the IPEEE evaluation, MP2 emergency flood procedures and Technical Specifications for flooding were reviewed. Information from the four flood-related procedures and the one Technical Specification is summarized below.

Station Procedure SP 2615, Rev. 4, Flood Level Determination, addresses the collection and documentation of water level and meteorological conditions associated with a hurricane approaching the Millstone site. The information is required in support of flood protecting one service water pump per Technical Specifications. Based on a review of this procedure it was concluded that the procedure adequately satisfies the stated objectives.

Station Procedure AOP 2560, Rev. 5, Storms, High Winds and High Tides, describes the steps required to place the plant in a safe condition during site flooding. Per Step 4.6.1 of the procedure, the flood gates are to be closed if the flood level exceeds Elevation 14.0 ft MSL. Based on information provided in MP2 FSAR Table 2.5.3, once water levels reach this elevation, the levels may quickly rise on the order of 2 to 4 feet within the next 1 to 2 hours. Therefore the use of 14.0 ft MSL as one of the initiators to closing the flood gates will be evaluated with regards to the time required to close all flood gates in consideration of rising flood waters. Also provided for in Step 4.6.1 of this procedure, at the same flood level, is installation of the flood "can" which protects one Service Water pump motor. In Section 2.5.4.2.3 of the MP2 FSAR, the maximum water level inside the Intake Structure due to a standing wave condition is estimated to reach Elevation 26.5 ft MSL. The NRCs SER estimated a maximum water level inside the Intake Structure of 27.6 ft MSL. Based on these analyses, the water level inside the pumphouse could be, at times, due to wave conditions, much higher than the stillwater level outside the structure. Therefore the use of 14.0 ft MSL as one of the initiators for installing the flood "can" will be evaluated with regards to potential surging inside the pumphouse, the time required to install the "can" and the difficulty of installing the "can" in standing and rapidly rising flood waters.

During review of the flood procedures it was noted that some items in one procedure could enhance the other. For example, both procedures call for stationing personnel at the Intake Structures. However only the MP1 procedure requires running a safety line from the main plant complex to the Intake Structure. Based on this, a side by side comparison of flood procedures is being recommended for all three units in order to identify items that would enhance the other procedures.

Other than the above noted items the procedure was found to be in conformance with MP2 flood protection requirements.

Maintenance Procedure MP 2721C, Rev. 4, Protection and Restoration of Service Water Pump Motors during a PMH, provides instructions to install and remove a flood protection fiberglass cover ("can") on one service water pump motor.

Station Procedure SP 2665, Rev. 2, Building Flood Gates Monthly Surveillance, helps to ensure the availability and operability of the flood gates by periodic inspection requirements.

Technical Specification 3.7.5 is associated with protecting against flooding to a minimum elevation of 28 ft MSL one service water pump motor. Flood proofing one service water pump motor is also addressed in AOP 2560 and MP 2721C.

The effectiveness of the cover in keeping the motor dry is documented in Reference 5-31.

Two other items were identified for further assessment. First, it will be verified that equipment required for Service Water pump operation can not become inoperable if the water level inside the Intake Structure rises to 22 ft MSL. Secondly, it will be verified that inleakage into buildings via underground conduits is minimal and does not cause undo risk to the plant. The conduits include those accessible from yard manholes and the Intake Structure considering site flood levels.

Based on the above, it is concluded that MP2 satisfies 1975 SRP Section 2.4.10 criteria subject to resolution of the items identified above and summarized in Table 7.1-1.

SRP Section 2.4.11

Concerning a PMH event, this SRP addresses minimum low water in the Intake Structure.

Reference 10 and Section 2.5.4.2.3 of the MP2 FSAR present a probable minimum low water level due to a PMH of (-)6.3 ft MSL at the Intake Structures. The source of this low water level estimate was the MP3 PSAR. The MP3 FSAR presents a value of (-)5.85 ft MSL. Since MP3 is licensed to current criteria, the probable minimum low water level of (-)5.85 ft MSL should satisfy 1975 SRP criteria.

MP2 FSAR Section 2.5.4.2.3 notes the Service Water pumps are designed for a low water of Elevation (-)7.0 ft MSL. This is corroborated by information in the NRC SER for MP2. This level is about 1 foot below the MP3 FSAR low water estimate. Therefore, the Service Water pumps should be operable during a low water event that satisfies 1975 SRP criteria.

Based on the above, it is concluded that MP2 satisfies 1975 SRP Section 2.4.11 criteria.

SRP Section 2.4.14

This SRP addresses Technical Specifications and emergency procedures associated with implementation of flood protection for safety-related facilities.

Several items requiring resolution, associated with the flood-related procedures and Technical Specifications, were discussed above in the paragragh discussing SRP Section 2.4.10. Other than these identified items, MP2 satisfies 1975 SRP Section 2.4.14 criteria.

SRP Section 3.4.1

The purpose of this SRP is to provide an overall review of the plant's flood protection.

This report, along with the supporting analyses (References 5-16 and 5-24), document a detailed review of the site PMH flooding and the site flood protection features.

5.2.2 Local Intense Precipitation

The NRC, in Generic Letter 89-22 (Reference 5-15), adopted the latest NWS PMP criteria for future plants. In NUREG-1407, the NRC requested that the IPEEE include an assessment of the revised NWS PMP criteria in terms of on-site flooding and roof ponding due to local intense precipitation. This evaluation for the MP2 plant is documented in Reference 5-24 and summarized below.

This evaluation includes the following major components:

- Determination of the revised NWS PMP applicable to the MP2 local site area.
- Development of a probability-based rainfall consistent with the philosophy of the IPEEE for use as an alternative to the revised NWS PMP.
- Identification of other local intense precipitation events for inclusion in the IPEEE assessment.
- Evaluation of the local plant area flood runoff depth due to the revised NWS PMP and the alternate probability-based rainfall.
- Evaluation of potential roof loads on major plant structures due to the local intense precipitation.
- Evaluation of the local intense precipitation design basis with respect to the appropriate 1975 SRP criteria.

5.2.2.1 Revised NWS PMP

The revised National Weather Service (NWS) Probable Maximum Precipitation (PMP) criteria results in higher precipitation intensities over shorter time intervals and smaller areas than previous NWS criteria. Based on a review of the applicable NWS documents referenced in Generic Letter 89-22 (Reference 5-15), a local intense NWS PMP was determined for the MP2 site. The applicable NWS report for the MP2 site is NOAA NWS Hydrometeorological Report (HMR) No. 52 (Reference 5-26). The one-hour, one-square mile NWS PMP from this report for the MP2 site is 17.3 inches. Using the recommended adjustments, the precipitation was further broken down into 5.8 inches, 9.2 inches, and 13.2 inches for the maximum 5-, 15-, and 30-minute periods, respectively, within the one-hour period. Plant area flood runoff depths and potential roof loads due to ponding were evaluated for these new PMP values.

Use of the revised NWS PMP criteria in this evaluation is not an endorsement of its validity or appropriateness. It is being used simply to address the request in NUREG-1407 to assess its impact on the plant.

5.2.2.2 Probability-Based Rainfall

In order to assess the likelihood of occurrence of the NWS specified PMP and provide a probabilistic-based alternative rainfall, a rainfall probability analysis using data from another NWS document, NWS HYDRO-35 (Reference 5-26), was performed.

NWS HYDRO-35 presents a series of maps that provide the 2-year and 100-year return period precipitations for durations of 5 minutes, 15 minutes and 60 minutes. The report also provides a series of equations to calculate the precipitation for other return periods. These return periods are 5-, 10-, 25-, and 50-year return periods.

The precipitation frequency estimates presented in NWS HYDRO-35 were developed using the Gumbel fitting procedure. The data were plotted on Gumbel paper and the relationship extrapolated to lower probability levels.

The one-hour NWS PMP is 17.3 inches. The annual probability associated with this rainfall magnitude using the Gumbel distribution extrapolation is orders of magnitude below 10^{-8}.

Based on the above, it is concluded that the use of the NWS PMP value with its extremely low probability is not consistent with the philosophy of NUREG-1407 that characterizes a core damage frequency below 10^{-6} as being sufficiently conservative for the IPEEE. As an alternative to the NWS PMP, a probability-based rainfall was also selected for evaluation.

The 10^{-6} annual probability rainfall event was chosen as conservatively satisfying the acceptable core damage frequency criteria for IPEEE. This probability level is conservative since it assumes core damage given the rainfall event.

Using the Gumbel extrapolation, a 10^{-6} annual probability rainfall of 6.0 inches in a one hour period was selected for evaluation.

5.2.2.3 MP2 Design Basis, 1975 SRP and MP1 SEP Local Intense Precipitations

The MP2 local intense PMP design basis is described in FSAR Section 2.5.4.2.2. The 1-hour local PMP is given as 9.4 inches.

SRP Section 2.4.2 contains the 1975 SRP criteria with regards to the effects of local intense precipitation. Per SRP 2.4.2, the local probable maximum precipitation is estimated using HMR No. 33 (Reference 5-27). The time distribution of the rainfall is determined from the Corps of Engineers EM 1110-2-1411 (Reference 5-28). The SRP notes that the effects of the local probable maximum precipitation (PMP) are evaluated with regards to potential ponding on building roofs and site flooding depths.

Using these references, the 10-mi^2, 1-hour PMP for the MP2 site is about 9.2 inches. This local PMP is consistent with 1975 SRP criteria and essentially is identical to the MP2 design basis value.

Local intense PMP was evaluated for MP1 during the SEP. The NRC, in Reference 5-23, provided a 1-hour local PMP estimate of 12.51 inches.

The effects of the MP2 design basis, which satisfies 1975 SRP criteria, and MP1 SEP local PMP values will also be considered in the subsequent MP2 flooding assessments.

5.2.2.4 Local Plant Area Flood Runoff and Depth

The objective of this portion of the IPEEE for external flooding is to evaluate flood depths around safety-related structures, and in particular at openings from the outside to the inside of these structures, produced by local intense rainfall.

Since the three Millstone units are adjacent to each other and are physically connected, it was necessary to consider all three units in the local intense rainfall analysis for MP2.

The first step in this analysis was to determine the drainage area(s) contributing runoff to areas surrounding the Millstone units. This was accomplished using the detailed topographic maps of the Millstone site (Reference 5-29).

The Millstone site is located on Millstone Point which is surrounded by Niantic Bay and Jordan Cove. Surface runoff from this area during extreme rainfall would be towards adjacent waters to the east, south and west.

Three subareas were delineated, the three subareas will be referred to as the northern, central and southern drainage areas. The northern area drains portions of the MP3 complex. Runoff from this northern area eventually flows south along the east side of the area and enters the central area. The northern area has a drainage area of about 420,000 ft^2 (9.6 acres). The central area drains portions of the MP2 complex. This runoff combines with the runoff entering from the northern area. The combined runoff generally flows south into the southern area with a portion discharging offsite from the central area in an easterly direction. The central area has a drainage area of about 328,900 ft^2 (7.6 acres). The southern area drains portions of the MP1 complex around the south and east sides and both MP1 and MP2 along the west side. The combined runoff from the northern and central areas also flow into this area through the northeast corner. Flow out of this area occurs at various low points around the perimeter of the area and towards the adjacent bodies of water. The southern area has a drainage area of about 372,200 ft^2 (8.5 acres).

Peak runoff estimates from the drainage areas were developed using the rational formula. The rational formula is a universally accepted method for estimating peak runoff from small watersheds. Required inputs to the rational formula include a runoff coefficient, rainfall intensity relationships and times of concentration for the drainage areas.

The runoff coefficient in the rational formula was conservatively set equal to 1.0. A rainfall intensity relationship was developed for each local intense rainfall under consideration. Time of concentration for each drainage area and combined drainage areas were developed using standard hydrologic methods.

Peak runoff estimates are summarized in Table 5.2-2 These estimates are conservative since some of the rainfall would go into temporary storage as ponded water on the roofs or enter the interior roof drain or underground storm drainage systems which are not accounted for using the rational method.

Table 5.2-2
Drainage Area Peak Runoff Estimations

Drainage Area	Peak Runoff (cfs)			
	NWS PMP	10^{-6} Probability	MP2 Design Basis	MP1 SEP
Northern (N)	447	126	92	122
Central (C)	335	95	72	95
Southern (S)	508	129	81	108
N & C	607	191	163	217
C & S	714	203	153	203
N, C & S	908	285	244	325

Flood runoff depths around MP2 safety-related structures were estimated using the peak flows shown in Table 2. The evaluations are documented in References 5-24 and 5-30.

Based on visual inspection of the topographic contours, runoff generally flows from the northern drainage area into the central area, then into the southern area. The runoff process was modeled as broad-crested weir flow over the drainage area perimeter high points.

Around the east side of MP2, the controlling runoff is from the combined northern and central drainage areas. From Table 5.2-2, the peak runoff for the NWS PMP is about 610 cfs. For the other three rainfall events the peak runoff estimates range from about 160 to 220 cfs. The estimated water surface elevation associated with the NWS PMP peak flow rate of 610 cfs was determined to be about 16.2 feet. The estimated water surface elevation associated with the range of peak flows for the other three rainfall events was determined to be about 15.5 feet. These water levels apply along eastern portions of MP2. These estimates are conservative since no credit is taken for the storm drainage system.

Around the west side of MP2, the estimated water surface elevations for all of the local intense rainfall events were determined to be equal to or less than about 14.5 feet.

Flood depths around the MP2 Intake Structure would be negligible since runoff would flow directly into the adjoining Niantic Bay.

With local site flood depths defined around the MP2, their impacts on site structures were then be assessed.

As part of the overall flood protection for MP2, exterior doors, which are part of the flood protection perimeter are fitted with flood gates. Nearly all of these flood gates are normally in the open position. By procedure, the open flood gates would be closed during times of severe site flooding. However, since in some cases there could be little warning before a local intense precipitation event, credit is usually not taken for the flood gates to be closed and secured at the onset of the event. This situation differs from the probable maximum hurricane flooding scenario where adequate warning time is assured.

Therefore, some leakage into buildings through door openings or other wall penetrations could occur once the local intense rainfall flood depths exceeded the elevation of the door sills. Even though the flood gate could be open, the door itself is likely to be closed. This would minimize the inleakage.

Based on a review of plant drawings and observations during the IPEEE walkdown, minimum door sill elevation is between 14.5 and 14.6 feet. This is based on the yard grade building slab elevation of 14.5 feet with some allowance for doorways with sills. Due to the location of the Intake Structure, it is not subject to local site flooding. The east door on the Turbine Building has a sill elevation of about 19 feet, therefore it is above the estimated local site flood levels.

All other MP2 flood doors are exposed to local site flooding. The estimated flood levels are about 16.2 ft MSL for the NWS PMP event and about 15.5 ft MSL for the other three rainfall events. These latter rainfall events, which include the estimated 10^{-6} probability, the MP2 design basis and the MP1 SEP rainfalls, are considered more appropriate for the IPEEE.

With flood levels above the door sills for a period of time there would be some inleakage until corrective action could be taken, e.g. closing the flood gates, sandbagging the door openings or other means to control inleakage. A specific walkdown was performed to review inleakage potential and determine the effect on the operability of essential plant equipment. It was determined that given the duration of inleakage, and the potential area available for inleakage, local ponding does not pose a significant plant hazard via external plant doors. (See Table 7.1-1).

To prevent backflow into buildings via the storm drainage system, floor drains are provided with backwater valves (refer to FSAR Section 2.5.4.2.2). As previously discussed, these valves will be evaluated.

Another potential pathway for external flood waters to enter plant buildings is through underground conduits. Since the local flood levels along the east side of the plant described previously are above Elevation 14.5 feet, the conduits could become a pathway for flooding if the manholes were to fill with flood waters and depending on the watertightness of the conduits. Therefore the potential for inleakage into buildings via underground conduits will be further evaluated as previously discussed. These conduits include those accessible from yard manholes subject to local site ponding.

5.2.2.5 Potential Roof Loads

The first step in the roof ponding assessment was to summarize the roof configuration for the major plant structures. The key component is the maximum height of the parapet above the roof deck low points and the associated maximum possible ponding load and how it compares to the roof design live load.

This evaluation was based on plant drawings, the FSAR, the NRC SER and information gathered during the IPEEE walkdown.

MP2 FSAR Section 2.5.4.2.2 notes that the interior roof drainage system was designed for a rainfall intensity of 3 inches per hour. It also notes that to prevent accumulation of water which could exceed the design load of the roof, the parapet walls are provided with scuppers. These items are also noted in Section 2.5 of the NRC SER.

MP2 FSAR Section 5 provides the design roof live loads. The roofs of all safety-related MP2 structures were inspected during the IPEEE walkdown. Parapet heights above the roof decks were measured at various locations. The amount of debris clogging the roof drain inlets was also noted. In general the roof drain inlets were fairly clogged and assumed to be functioning at reduced capacity. Two scupper drains were noted at the east end of the Control Room.

Information from the roof assessment (References 5-24 and 5-31) is summarized in Table 5.2-3. The maximum ponding depths and associated loads are based on the height of the parapet above the roof low points. Actual ponding during an intense local precipitation event would depend on the rate and amount of rainfall and the capacity of the interior roof drains.

Table 5.2-3
Summary of Potential Roof Ponding

Roof	Maximum Ponding		Design Load (psf)
	Depth (inches)	Load (psf)	
Enclosure Bldg.	18	94 (Note 1)	60 (Ref. 5-24)
Turbine Bldg. (Elev.105')	18	94 (Note 2)	40 (Ref. 5-24)
Aux. Bay (Elev.72')	23	120	120 (Ref. 5-31)
Aux. Bldg. (Elev.84')	17	88	60 (Ref. 5-31)
Warehouse	17	88	60 (Ref. 5-31)
Aux. Bldg. (Elev.54.5')	11	57	60 (Ref. 5-31)
Control Room	8	42	60 (Ref. 5-31)
Intake Structure	11	57	60
Fire Pumphouse	0	0	≥ 40

Notes:

1. Does not include weight of blocks on roof.
2. Does not include credit for flow to Unit 1 roof. Minimum load with flow to Unit 1 is still 60 psf or higher.

Some vent openings through the roofs, particularly above the Diesel Generators, are not above the maximum predicted ponding levels on the roof. Depending on the final resolution for roof ponding, it will be verified that all openings into buildings or equipment through the roofs are below the maximum allowable roof ponding levels.

5.2.3 Summary

This report documents the external flood portion of the IPEEE for MP2. The recommended approach outlined in Figure 5.1 of NUREG-1407 was followed in performing this assessment.

Based on the information summarized in this report, it is concluded that the appropriate flood producing mechanism for MP2 site flooding has been identified, i.e. a PMH-induced storm surge in Long Island Sound.

The design basis PMH flood level at MP2 is a stillwater elevation of 18.1 feet MSL. Including wave effects, the maximum flood level is 25.1 feet MSL. During the 1980's, MP1 was evaluated as part of the Systematic Evaluation Program (SEP) to then current SRP criteria. The NRC concluded that the MP1 design basis PMH with a maximum stillwater level of 18.1 feet MSL and wave runup to elevation 22.3 feet MSL satisfies current SRP criteria. Since the design flood levels for MP2 are equal to or greater than those determined for MP1, it is concluded that the MP2 design basis PMH also satisfies the 1975 SRP criteria. The flood gates provide protection to an elevation of 22 feet MSL.

In this evaluation MP2 has been evaluated to all external flood SRP criteria. A site walkdown was also performed. During the walkdown all major plant structures were inspected. Based on the walkdown, it is concluded that the plant structures and flood control features conform with information pertaining to the site design basis flood.

All flood related procedures and technical specifications were also reviewed.

In summary, it is concluded that MP2 satisfies all PMH site design basis flood-related criteria of the 1975 SRP pending resolution of the items requiring additional assessment.

As part of this IPEEE review, new local probable maximum precipitation (PMP) criteria have also been evaluated. A detailed evaluation of roof and site ponding due to local intense precipitation is documented in Reference 5-24.

Most roofs were also inspected during the IPEEE walkdown. Those roofs that were not inspected were observed from nearby roofs.

Local intense precipitation considered included the latest NWS PMP criteria, a 10^{-6} probability estimate, the MP1 SEP value and the MP2 FSAR value. The SEP and FSAR values both satisfy 1975 SRP criteria. The revised NWS PMP criteria were used simply to address the request in NUREG-1407 to assess its impact on the plant. The other rainfalls evaluated are considered more appropriate for the IPEEE.

Local site flooding depths have been estimated around the major plant structures. Openings into buildings at yard grade are at exterior doors. Unlike the hurricane, there may not be adequate warning time to close the flood gates during a local intense precipitation. Maximum flooding depths at some doors range from about 1.0 to 1.6 feet. No credit was taken for the underground storm drainage system.

Various means of potential leakage pathways into buildings were identified but not evaluated and resolved.

Potential roof ponding, assuming no credit for the interior roof drains, was also evaluated. Due to the parapet height and the lack of scuppers, the maximum ponding loads for some MP2 roofs exceed the design loadings (refer to Table 5.3-3 for details).

During the walkdown of the roofs, some vents and other penetrations were noted as potentially not being watertight below the highest potential levels of roof ponding. Some examples are the diesel generator day tank vents, Intake Structure roof vents, Turbine Building roof vents, Enclosure Building roof penetrations and Turbine Building Elevation 72'. These pathways may provide a means for ponded waters on the roofs to enter buildings or equipment. Depending on the final resolution for roof ponding, it will be verified that all openings into buildings or equipment through the roofs are below the maximum allowable roof ponding levels.
In summary, several items were identified that require further evaluation, resolution or confirmation. These items are summarized in Table 7.1-1.

5.3 Transportation and Nearby Facility Accidents

5.3.1 Description of Methodology

This topic had three tasks, with the analysis for each depending on the level of information provided in the FSAR and other licensing and design documents. Each task followed the progressive screening steps described in NUREG-1407, Figure 5.1 (Reference 5-1).

However, only the first three screening steps of six were needed for each task. These included 1) reviewing plant-specific hazard data and licensing bases, 2) identifying significant changes since operating license issuance, and 3) determining if the plant and facilities design meets the 1975 Standard Review Plan (SRP) criteria (Reference 5-32).

Each task review followed 1975 SRP, Sections 2.2.1 and 2.2.2, "Locations and Routes, Descriptions," which identify potential external hazards from industrial, military, and transportation facilities and routes. Hazards identified were then evaluated according to SRP Section 2.2.3, "Evaluation of Potential Accidents," to determine if there are any plant vulnerabilities for the plant. The aircraft hazard analysis followed SRP Section 3.5.1.6, "Aircraft Hazards."

For on-site and off-site chemicals, the above SRP sections followed Regulatory Guide 1.78 (Reference 5-33), whose purpose is to identify those chemicals that could result in Control Room (CR) uninhabitability. Regulatory Guide 1.78 gives screening criteria in terms of proximity (within a five-mile radius) and frequency of shipment (10/year for highway, 30/year for rail, and 50/year for water traffic). A representative list of hazardous chemicals and their toxicity limits is also provided.

For those chemicals not eliminated by the proximity or frequency screening criteria, Regulatory Guide 1.78 provides a methodology to calculate CR concentration versus time after an accidental release. The acceptance criterion is that the time from detection to the time when the toxicity is reached must be at least two minutes to allow operators to take protective action.

The SRP review also followed Regulatory Guide 1.91 (Reference 5-34) to determine if explosions are a concern. Regulatory Guide 1.91 establishes a method to determine a "safe distance" from critical plant structures to a transportation route (or on-site location) beyond which any explosion that might occur is not likely to have an adverse effect on plant operation or to prevent a safe shutdown.

5.3.2 Transportation Accidents

The Millstone Nuclear Power Station, Unit 2 (MNPS-2), FSAR incorporates an evaluation of these types of hazards using Regulatory Guide 1.78 and 1.91 methodology by referencing the Millstone Nuclear Power Station, Unit 3 (MNPS-3), FSAR, which was reviewed in accordance with NUREG-0800 (Reference 5-35). In particular, MNPS-3 FSAR, Section 2.2, "Nearby Industrial, Transportation, and Military Facilities" (Reference 5-36) contains an analysis using Regulatory Guide 1.78 and 1.91 methodology. Because MNPS-2 and MNPS-3 share the same site, the MNPS-3 analysis applies to each for transportation hazards.

The MNPS-3 FSAR analysis, which includes a 1992 update, and recent evaluations (References 5-37 and 5-40), revealed the following results and conclusions for the four modes of transportation near the site: highways, water ways, railroads, and airports.

5.3.2.1 Highways

The nearest major highway, U.S. Route 95, is located four miles from the site. This separation distance exceeds the Regulatory Guide 1.91 minimum distance criterion and, therefore, provides assurance that any transportation accidents resulting in explosions of truck-size shipments of hazardous materials will not adversely effect the safe operation of the plant. This separation distance also eliminates the possibility of a toxic gas release adversely affecting the safe operation of the plant.

This means the MNPS-2 plant design meets the 1975 SRP, Sections 2.2.1 - 2.2.3, evaluation criteria for hazards from highway transportation. Accordingly, there are no plant vulnerabilities from the hazards of transportation on highways.

5.3.2.2 Waterways

Ships that pass the site are generally deep draft (i.e., 20 ft. or more), and must remain at least two miles offshore to avoid running aground on Bartlett Reef. In addition, no oil barges pass to the shore side of Bartlett Reef or pass within two miles of the site. For these reasons as well as the relatively shallow bay surrounding the site, shipping accidents would not adversely affect safety-related facilities.

This means that the 1975 SRP, Sections 2.2.1 - 2.2.3, evaluation criteria are met and that there are no plant vulnerabilities identified from the hazards of transportation on water ways

5.3.2.3 Railroads

Hazardous materials are shipped by the Providence & Worcester Railroad*, located about 0.25 miles from the protected area. Some of these hazardous materials include chlorine, propane, anhydrous ammonia, carbon dioxide, and carbon disulfide.

Accidents involving propane and ammonia vapor cloud explosions and missiles are not design

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* The tracks are a ConRail/AmTrack right-of-way, with approval for P&W Railroad use.

basis events because the probability of these events is less the 1.0 x 10^{-7} per year (Reference 5-36). Also, the rupture of a propane rail tank car resulting in the formation of a toxic gas plume does not produce maximum CR concentrations above the toxic limit, thereby maintaining CR habitability (Reference 5-37).

A recent evaluation (Reference 5-37), however, revealed that only propane remains a potential hazard due to its frequency of transport. Other chemicals are either transported below the Regulatory Guide 1.78 screening frequency criterion of 30/year or are presently not shipped past the Millstone site.

This means that the 1975 SRP, Sections 2.2.1 - 2.2.3, evaluation criteria are met and that there are no plant vulnerabilities from railroad accidents.

5.3.2.4 Airports

Plant specific aircraft hazard data and licensing bases have been reviewed. An analysis of the aircraft hazards is not documented in the MNPS-2 FSAR and, therefore, simple comparisons between past (pre-operational) airport operations (take-offs and landings) with current operations is not possible. However, comparisons between prior analyses for MNPS-1 (Reference 5-38) and for MNPS-3 (Reference 5-39) were made and the results from these studies show that the annual number of operations at Groton are decreasing and that the overall risk from aircraft traffic in the vicinity of the Millstone site is essentially negligible.

An evaluation (Reference 5-40) of the aircraft hazard at MNPS-2 was performed to determine if they meet 1975 SRP criteria. Airports, military installations, and flight corridors around MNPS have been considered. Take-offs and landings at airports near the site have been determined. A conservative estimate of the probability of an aircraft impact at MNPS-2 is 4.3 x 10^{-7}. Aircraft impact does not imply release. The conditional probability of release given impact is likely to be less than 1 in 10. The results of this analysis support the results of previous analyses (References 5-38 and 5-39) that operations to and from Groton Airport do not constitute a significant hazard to the Millstone site.

As per SRP 3.5.1.6, MNPS-2 is considered adequately designed against aircraft hazards if the probability of aircraft accidents resulting in radiological consequences greater than 10 CFR Part 100 exposure guidelines is less than <u>about</u> 10^{-7} per year. Based upon this analysis it has been determined that MNPS-2 satisfies the 1975 SRP Section 3.5.1.6. Therefore, with respect to aircraft hazard, no plant vulnerabilities are identified.

5.3.3 Nearby Facilities

The FSAR contains an evaluation of these types of hazards using Regulatory Guide 1.78 and 1.91 methodology by referencing the Millstone Nuclear Power Station, Unit 3 (MNPS-3), FSAR. The MNPS-3 FSAR was reviewed in accordance with NUREG-0800 (Reference 5-35), and includes a 1992 update. In particular, MNPS-3 FSAR, Section 2.2, "Nearby Industrial, Transportation, and Military Facilities" (Reference 5-36) contains an analysis using Regulatory Guide 1.78 and 1.91 methodology. Because MNPS-2 and MNPS-3 share the same site, the MNPS-3 analysis applies to each for hazards from nearby facilities.

There are no major gas transmission lines, oil transmission or distribution lines, underground gas storage facilities, drilling or mining operations, or firing, or bombing ranges near the site. In addition, due to the innocuous nature of operations at nearby military installations, no potential accidents have been postulated concerning the safe operation or shutdown capability of the plant. Finally, due to distance from the site, the explosion or release of hazardous material from any industrial facility would not affect the safe operation or shutdown capabilities of the plant.

This means that the 1975 SRP, Sections 2.2.1 - 2.2.3, evaluation criteria continue to be met and that there are no plant vulnerabilities identified for hazards from nearby facilities.

5.3.4 On-site Chemical Storage

The FSAR includes a Regulatory Guide 1.78 screening examination of on-site chemicals, and was part of a submittal responding to NRC's post TMI requirements. In particular, NU evaluated Item III.D.3.4, "Control Room Habitability," (Reference 5-41) using Regulatory Guide 1.78 methodology. This study revealed that chlorine, ammonia, and sulfuric acid were the only on-site chemicals to present a potential hazard to CR habitability. But because of their storage indoors and physical properties, an accidental release of ammonia or sulfuric acid would only produce low concentrations in the CR. Hence, neither presents a hazard to CR personnel. Chlorine, although originally an issue, was removed from the site in 1986 (Reference 5-36) and no longer is a hazard.

The NU analysis, however, was performed over ten years ago. Subsequent on-site chemical use and storage practices have changed. Accordingly, a recent review (Reference 5-42) performed a Regulatory Guide 1.78 and 1.91 re-examination by identifying chemicals presently stored on site, re-evaluating CR habitability in the event of a hazardous chemical release, and re-evaluating safety-related buildings in the event of a hazardous chemical explosion.

To update information regarding on-site hazardous chemical use or storage, a walkdown was conducted. All chemicals in quantities of more than 100 pounds stored out-of-doors were considered as well as the physical state of the chemical and its location.

From the information gathered, three hazardous chemicals stored in large (bulk) quantities were identified as potential hazards. They are hydrogen, nitrogen, and carbon dioxide. Hydrogen can affect both safety-related structures and CR habitability because it is flammable and explosive as well as a simple asphyxiants. Carbon dioxides and nitrogen are asphyxiants and, therefore, affect CR habitability. Additionally, nitrogen or carbon dioxide could pose a hazard to the operation of the diesel generators. If, for instance, the diesels are operating when a nitrogen or carbon dioxide release occurs, they could "choke off" due to low oxygen air content as the gas cloud passes the diesel generator air intakes.

Other chemicals identified were judged not to pose a hazard. Most chemicals are stored in limited quantity containers (e.g., gas cylinders of less than 100 lbs.), present no plausible mechanism to enter the CR air intake because of storage location, or are shielded such that an explosion would not adversely affect safety-related equipment.

The review (Reference 5-42) concluded that if hydrogen, nitrogen, or carbon dioxide is released in a postulated, catastrophic or maximum concentration-duration accident, CR habitability can be maintained, according to Regulatory Guide 1.78 screening criteria. Likewise, the diesel generators, during similar release scenarios of nitrogen or carbon dioxide, will not be affected. In addition, the physical properties of hydrogen and its storage location meet the intent of the Regulatory Guide 1.91 "safe distance" in-place explosion criterion.

Therefore, the release or explosion of an on-site chemical meets the 1975 SRP, Sections 2.2.1-2.2.3, evaluation criteria. This means that there are no plant vulnerabilities identified from these hazards.

5.4 Others - Event Screening

In References 5-1 and 5-43, the NRC staff recommended that only the five following events be included in the IPEEE:

- Seismic
- Internal Fire
- High Winds and Tornadoes
- External Floods
- Transportation and nearby Facility Accidents

However, the NRC staff also requested the licensee to confirm that no other plant-unique external events known to the licensee with the potential to initiate severe accidents are excluded from the IPEEE. In order to comply with this request, an initiator screening was performed using 38 external initiators listed in NUREG/CR-2300 (Ref. 5-44) as a starting point.

Table 5.4-1 provides a summary of the conclusions drawn at the end of the screening analysis (Ref. 5-45). Based on this screening, it was determined that in addition to the five initiators identified by the NRC staff in the generic letter, the following events need further analysis prior to eliminating from further consideration.

- Hail
- Lightning
- Turbine-generated missile
- Ice, snow, frost
- Low winter temperature
- High summer temperature
- Soil shrink-swell consolidation

Sections 5.4.1 - 5.4.7 of this section provides results of the additional analysis performed on each of the above initiators.

5.4.1 Hail

Severe weather storms include hailstorms, snowstorms, and ice storms (Refs. 5-46 and 5-47). The hail formation process differs from snow formation although both are considered types of ice formation in the atmosphere. The snow formation process is discussed in Section 5.4.7 and, therefore, will not be discussed here. Hail formation, however, is due to the strong rising convective air currents that cause intense supersaturation and, subsequently, result in raindrops that freeze in the higher cooler air. These frozen drops are what is known as hail.

Hailstones may fall after reaching a certain height and decent through a region of the cloud containing super-cooled water that freezes on the hailstones and results in larger hailstones. This process of hail formation normally occurs during violent summer thunderstorms and, therefore, are different from the so-called soft hail (which consists of pellets of closely packed ice crystals). The latter type of hail breaks apart upon striking a hard surface and, generally, accompanies the less severe winter or spring storms.

Historical data shows that hailstorms have not caused severe nuclear accidents or widespread damage (Ref. 5-46) at nuclear facilities. The data presented in Reference 5-46 on the causes of loss-of-offsite power events over the period from 11/1965 to 12/1985 show no loss-of-offsite power events associated with hail. However, hailstorms could cause delays in restoring failed power lines by delaying the maintenance crews.

The nearest correlation to hail would be ice/snow (Section 5.4.6)induced loss-of-offsite power events. Reference 5-48 reported that only 10 events out of a total of 192 loss-of-offsite power events were caused by ice/snow storms accompanied by strong winds have caused several complete and partial losses of offsite power. The restoration of offsite power after those failures usually did not take long.

Based upon a review of the available data and the methodology outlined in NUREG-1407 it was determined that no credible specific vulnerability exists at Millstone Unit 2 for hail. There are no unique features at MP2 that creates a high likelihood of failing other safety related systems/structures/components concurrent with a loss-of-offsite power induced by a hail storm. Therefore, the risk impact associated with hail at MP2 is enveloped in the loss-of-offsite power events captured by the internal events PRA (MP2 IPE). The CDF associated with the loss-of-offsite power events for the MP2 IPE is 8.44E-06/year with an initiator frequency of 9.1E-02/year for all loss of power events. Based upon the discussion above it was conservatively assumed that 1 of the 192 events resulted in a loss of power due to hail yielding a 0.005 factor per loss of offsite power event associated with hail. Thus, the CDF for hail at MP2 is approximated at 4.22E-08/year and no further evaluation of hail for the IPEEE need be performed.

5.4.2 Lightning

The lightning phenomenon is associated with the existence of electrical storms and thunderstorms. The objectives of this section are two fold: (a) to assess the effectiveness of existing lightning protection measures at MP2 and (b) to investigate the risk consequences of such lightning events. In order to adequately assess the lighting protection features of the plant, the adherence/compliance to the lightning protection requirements in the National Fire Protection Association Lightning Protection Code (NFPA 78-1975) has to be determined. It should be noted that while adherence to the NFPA 78 Code is not a licensing requirement of nuclear plants, it is a widely accepted standard for lightning protection. Based upon the FSAR the building codes and NFPA at the time of construction (1970-1975) were adhered to. Thus, the grounding at a minimum conforms to NFPA 78 1970 (Ref. 5-49). The exception to this is modifications done since 1975. These used the most current code for grounding at the time modifications were performed and also took into account manufactures recommendations for grounding.

A review of NSAC-41 (Ref. 5-50) indicated that a significant number of lightning-initiated turbine trips, plant upsets, and common cause equipment failures are reported each year at nuclear sites. The NSAC-41 study investigated Licensee Event Reports (LERs) as well as Nuclear Power Experience files and provided the following examples of lightning-caused events:

- Numerous turbine-generator trips.
- Loss of off-site power, 120V AC vital buses, and reactor trips.
- False main steam line isolation and safety injection.
- Incapacitated annunciators and transformers.
- Loss of diesel generator power.
- Trip of startup and emergency feedwater pumps.
- Loss of instrument buses and inverters.
- Failure of the main steam pressure transmitters which ultimately tripped the reactor and initiated safety injection.

The NSAC-41 (Ref. 5-50) study lead to the following key insights:

- Nuclear power plants that have higher levels of lightning protection have reported no lightning-caused events. Conversely, plants having less lightning protection experienced significant lightning-caused upsets and damages.

- The best protection against lightning-caused events is a high quality lightning protection system.

- There is an evidence that high structures do not always provide the protection to adjacent structures that is assumed in the design of some lightning protection systems.

- While the likelihood of having a nuclear site struck by lightning varies based on the geographic location of the plant, the probability is sufficiently high even in the low-probability regions and the potential damage is so great that, perhaps, all nuclear sites merit from having highly reliable lightning protection.

- There is a correlation between lightning-caused events and the degree of adherence to the lightning protection practices prescribed in NFPA 78.

- Historically recorded "thunderstorm-days" are not a good guide for determining the level of lightning protection that should be provided. For example, two of the nuclear plants surveyed in NSAC-41 that have had no lightning-induced events are located in regions with a high number of thunderstorm-days while the two plants with reported lightning-related events have fewer thunderstorm-days.

- The NSAC-41 report surveyed four nuclear power plants and compared the lightning protection features of each of them. The results show that Plants with lower levels of installed lightning protection failed worse than plants with better protection.

- The vulnerability of important structures and vital equipment to potentially damaging lightning strikes is associated with a lack of optimum lightning protection, or inadequate maintenance of existing protection features.

- The results indicate that the "thunderstorm-day pei year" as the most commonly used indicator of area lightning activity can be misleading. The level of protection necessary in the lower thunderstorm-day zones appears to be as high as the level necessary in the higher thunderstorm-day zones. Only the thunderstorm strokes that occur from cloud-to-ground, rather than from could-to-cloud, are of interest in determining the lightning protection needs.

- Utilities can help assure that lightning will not damage their nuclear power plants by basing the design and maintenance of their lightning protection systems on a standard such as NFPA 78.

The Electric Power Research Institute (EPRI) conducted a study on the lightning damage (Ref. 5-51) which shows that lightning contributes to about 45% of power outages. Direct lightning strikes could result in high-voltage surges that damage power lines and plant equipment such as transformers.

The following list provides a tabulation of plant component failures due to lightning initiated events. This check list is based on NFPA 78-1975.

Check List
(Based on LERs Related to Lightning at Different Plants)

- Battery Chargers, Circuit Breakers, Electrical Fuses, and Inverters
- Main Stack Gas Monitoring System, Radiation monitors, and Sampling System
- Any Uninterruptible Power Supply that could trip due to lightning
- Power distribution/transmission lines
- Station Switchyard
- Meteorological Instruments Building and Meteorological Tower
- Transmission Tower Shield Lines
- Transformer Fuses of the Diesel Generator
- Electric and Telephone Services, Radio, TV
- Grounding of Fence Wires
- Structures Containing Flammable Liquids
- Electrostatic Shielding
- Grounding Tanks

Reference 5-50 indicates that the major effect of lightning strikes on a nuclear plant is to cause loss-of-offsite power which should be and was analyzed as part of the MP2 internal IPE.

A review of the causes of loss-of-offsite power events over the period from early November 1965 to December 1985 (Ref. 5-46) show that out of 192 events of complete and partial loss-of-offsite power about 40 events (i.e., about 20.8%) are caused by lightning.

Based upon a review of the available data and the methodology outlined in NUREG-1407 it was determined that no credible specific vulnerability exists at MP2 for lightning. Therefore, the risk impact associated with lightning at MP2 is enveloped in the loss-of-offsite power events captured by the internal events PRA (MP2 IPE). The CDF associated with the loss-of-offsite power events for the MP2 IPE is 8.44E-06/year with an initiator frequency of 9.1E-02/year for all loss of power events. Based upon the discussion above it was conservatively assumed that 40 of the 192 events resulted in a loss of power due to lightning yielding a 0.21 factor per loss of offsite power event associated with lightning. Thus, the CDF for lightning at MP2 is approximated at 1.80E-06/year and no further evaluation of lightning for the IPEEE need be performed.

In summary, it is concluded that MP2 does not have risk outliers associated with lightning since the protection system complies with NFPA standards, even though the CDF associated with lightning may be slightly greater than the threshold value of 1.0E-06 per year.

5.4.3 Turbine Generated Missiles

This section is concerned with the evaluation of the potential damage that can caused by turbine generated missiles to safety related structures (such as the containment structure), systems, and components (such as pipes, pumps, and CST).

Overspeed is a dominant mechanism that results in missile generation. Therefore, adequacy of the sub systems which are dedicated for overspeed protection prevention was investigated. Based on the MP2 FSAR, the design details of the turbine overspeed protection system are as follows. The MP2 turbine consists of a completely redundant speed control subsystem (including speed pick up and logic). Logic is processed in electronic and hydraulic channels. Because of the extreme importance of guarding against excessive overspeed, three completely independent lines of defense are provided. These consist of:

- electro-hydraulic over speed trip control system which senses speed via two magnetic hookups in conjunction with a toothed wheel on the main turbine shaft

- mechanical trip system employing an unbalanced ring initiating device

- electrical over speed trip control system using a third magnetic pick up in conjunction with the toothed wheel on the main turbine shaft

During November 1979, the NRC staff became aware of low-pressure turbine disc cracking in Westinghouse turbines at several operating nuclear plants. The turbine generator at MP2 is designed/built/supplied by GE which is not susceptible to the Westinghouse phenomenon. .

The Electric Power Research Institute (Ref. 5-52) has provided an estimate of 1.53E-4 failures/year for the turbine-missile generation rate. The estimated failure rate is based on the collection of historic information over a thirty-year period. The EPRI analysis has utilized two types of data gathering, namely, operating-history data and incident data. The first type of data was collected mainly from manufacturers of turbines since 1950. The second type, namely Incident data, was collected from many sources and included overspeed, operating speed, brittle fracture, ductile fracture, stress corrosion cracking, ... etc.)

In the EPRI study (Ref. 5-52), the estimated turbine-missile generation rate of 1.53E-4 failures/year of which 1.13E-4 failures/year are due to operating speed failures and 0.40E-4 failures/year are due to overspeed failures.

Give the MP2 turbine generated missile frequency of 1.53E-4/year it is conservatively assume that there is a .1 probability (based upon turbine orientation to plant and preferred missile direction being toward the Niantic Bay and away from the balance of plant) that the missile direction is such that it damages sufficient equipment that would warrant shutdown from the alternate shutdown panel or the fire shutdown panel.. The backup system unavailability associated with shutdown from either of these shutdown panels is assumed to be the same as for those for fire scenarios (1.73E-3; Table 4.9-1). This yields an upper bound CDF for turbine generated missiles of 2.6E-8/year for MP2 assuming no coincidental fire. If a coincidental fire is assumed, this event is enveloped by the fire scenario which results in total loss of turbine building. This scenario includes large catastrophic turbine fires which generally result from catastrophic turbine failure that could also result in turbine missile generation.

Based on a) adequate overspeed trip protection, and b) extremely low contribution to the CDF, it is concluded that there are no risk outliers related to turbine generated missile at MP2.

5.4.4 Low Winter Temperatures

The meteorological location of the nuclear power plant (especially, plants in the more northerly latitudes) can have a significant effect on the likelihood of initiating weather-related extreme cold events such as freezing of pipelines that carry cooling service water to vital components such as Diesel Generators, and pumps. For example, failures of diesel generators and loss of offsite power due to severe low temperature conditions have been observed at Brunswick, Crystal River, and Susquehanna (Ref. 5-46). In addition, keeping water pipes from freezing or from getting close to freezing is particularly important for pipes containing borated water such as supply lines from the RWST to the safety injection pumps (Boron tends to be less soluble at lower temperatures). Other effects include freezing of instrument lines which could cause the loss of important sensors needed in the response to a severe accident. Generally, freezing on these types of lines would require an additional coincidental transient before the freezing of these types of lines could potentially lead to core damage.

However, the literature review indicates that effects of such as freezing of water pipes by extreme cold can usually be discounted since plants in the more northern latitudes either protect their pipes with heat tracing or contain their pipes within heated buildings. At MP2, the procedures SP2669A and MP2720L verifies and maintains heat tracing operability prior and during the onset of cold weather.

Severe low-winter temperatures may also result in the reduction (or loss) of the Ultimate Heat Sink (UHS). The term UHS refers to the plant system(s) which are used to remove the waste heat generated during normal plant operation, plant shutdown, decay heat removal, and accident conditions requiring heat rejection to the environment (Ref. 5-46). The plant system(s) includes the access to cooling water sources (river, lake, stream, deep wells) and the necessary retaining structures (reservoir dam, canals, conduits, lake, or river intake structure, etc..). The UHS system may perform the normal plant heat removal functions and the safety-related heat removal with the non-safety-related portions isolated or not isolated during accident conditions. In addition to the fact that UHS systems may be affected by severe low-temperature transients, this system requires AC power and, thus, any event which results in loss-of-offsite power and station blackout may affect the UHS system.

UHS systems are generally regulated by 10 CFR 50 Appendix A, GDC 2 and 44. Regulatory Guide 1.27 (Ref. 5-53) gives the specific rules used by the NRC staff to review UHS systems. In general, the structures that house UHS systems are classified and built to withstand the same licensing design bases conditions as other "Safety-Grade" systems of the plant such as seismic and tornado. Regulatory Guide 1.27 (Ref. 5-53) reports the following types of UHS found acceptable by the NRC:

- A large river
- A large lake
- An ocean
- Two seismic category I design spray ponds.
- One seismic category I design spray pond and a reservoir.
- One seismic category I design spray pond and a river.
- Two seismic category I design mechanical draft towers with basins.
- One seismic category I design mechanical draft tower with basin and a river.
- One seismic category I design mechanical draft tower with basin and a lake.
- A seismic category I design cooling lake with a submerged pond.
- Two seismic category I design wet/dry forced draft towers.
- Two seismic category I design dry forced draft towers.

The UHS must be designed to safely shutdown the plant under the postulated meteorological conditions specified by the NRC staff.

For MP2, the type of UHS is once-through and the makeup source is the Long Island Sound (an ocean). The low winter temperatures do not affect the Long Island Sound temperature to a degree that impairs the UHS function.

In conclusion, there are no vulnerabilities attributed to low winter temperatures due to a) existence of appropriate procedures that ensure operability of heat tracing, and b) relatively small temperature changes of the ocean (Long Island Sound).

5.4.5 High Summer Temperatures

In general, severe high-summer temperature transients may affect nuclear power plants in the United States (Ref. 5-54). Obviously, plants in the more southerly latitudes will tend to be affected more often by extremely high-temperature conditions. However, the effects are usually limited to reducing the capacity of the ultimate heat sink (UHS), natural ventilation in safety relate areas, and loss of offsite power (Ref. 5-46). For MP2, however, the type of ultimate heat sink (UHS) is once-through and the makeup source is the Long Island Sound. A review of the relevant literature shows that the capacity reduction (or loss) of the ultimate heat sink would be a slow process that allows plant operators sufficient time to take proper actions such as reducing power output level or achieving safe shutdown, if necessary, and maintaining the plant in a safe shutdown condition.

MP2 summer ventilation systems are a combination of Freon and water chiller based systems in the majority of plant areas. Natural ventilation forced air is only employed in the turbine and intake structure where high summer temperatures are not a considered a problem. For areas with either Freon or water chiller systems, natural forced air ventilation is the back up in the event of a primary ventilation system failure.

The potential for loss-of-offsite power is as a result of peak demands for power and random failure of a local substation which result in grid instabilities. The loss-of-offsite power, will be or has been considered within the realm of the station blackout rule and the guidance given by Ref. 5-55 as well as the internal event IPE. Therefore, the high-summer temperature transients need not be addressed in the IPEEE.

Based upon a review of the available data and the methodology outlined in NUREG-1407 it was determined that no credible specific vulnerability exists at MP2 for high summer temperatures.

5.4.6 Ice and Snow

The Ice and Snow evaluation for the MP2 site followed the methodology outlined in NUREG-1407. Per NUREG-1407 the effects of severe weather storms need not specifically be evaluated as part of IPEEE since the most credible effect from these events is the loss of off-site power which is addressed in the MP2 IPE program. However, during the IPEEE screening process for MP2 an issue related to Ice and Snow was identified that warranted further review.

As identified in MP2 FSAR the design and the design manual (Ref. 5-56) live loads for the roofs of MP2 structures is 60 pounds per square foot (psf) for the Enclosure/Containment Structure, Intake/Screenwell Building, Auxiliary Building, and Tanks. The Turbine Building live load is 40 psf over non-Class 1 equipment and 60 psf over Class 1 equipment.

As a part of the HNP IPEEE, Yankee Atomic Electric Company (YAEC) was contacted and developed a 'Snow Load Hazard Frequency Relationship for HNP'. The engineering analysis performed by YAEC is documented in Reference 5-57. The roof snow load frequency relationship developed by YAEC for this analysis used a least squares best fit to extrapolate from 25-, 50-, and 100-year ground snow loads to lower probability levels. This development including the adjustment from ground snow load to roof snow load details which are contained in reference 5-57. The results of this hazard frequency development are shown in Figure 5.4-1 of the HNP IPEEE. The HNP hazard curve was reviewed for its applicability to MP2. MP2 is located 22 miles southeast of HNP. MP2 is situated on the Long Island Sound and HNP is located 13 miles inland. Thus, MP2 is influenced by warmer coastal conditions which generally results in lower snow fall accumulations than at HNP.

The HNP hazard curve was reviewed and determined to envelope the expected snow fall conditions at MP2 based upon the comparison with HNP. In light of the information available on roof strengths, it was determined that the frequency at which the roofs would be subjected failures are less than or equal to the threshold frequency of 1.0E-5 per year. Given the relative locations and diversity of safe shutdown capabilities, it was determined that snow and ice do not represent a significant hazard to MP2 roof failures. As part of NRC Inspection Report No. 50-336/93-81 an unresolved item was raised with respect to the vulnerabity of the Diesel Day tank flame suppressors to the accumulation of ice and snow. Based on a walkdown performed by Yankee Atomic, as documented in photos transmitted by Reference 5-58, these flame suppressors, as well as some other vents, could potentially be affected by an accumulation of ice and snow on the roofs. This item requires final resolution and is listed as such in Table 7.1-1

5.4.7 Soil Shrink - Swell Consolidation

The potential of soil-related failures at the MP2 were previously reviewed as part of the MP2 FSAR Sections 2.4 through 2.7. Detailed soil investigations were completed as part of this project and it was determined that the short-term and long-term settlement of foundations and buried equipment is not a safety concern at MP2.

Based on the previous evaluations no further evaluation is required as part of the MP2 IPEEE.

5.5 References

5-1 NUREG-1407, 'Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities,' June, 1991.

5-2 Design Manual, The Millstone Point Company, Millstone Nuclear Power Station Unit No. 2, Waterford Connecticut, Bechtel Corporation, May, 1970.

5-3 ASCE Paper No. 3269, 'Wind Forces on Structures,' Transactions of the American Society of Civil Engineers, Vol. 126, Part II (1961).

5-4 Safety Evaluation , May 10, 1974.

5-5 ANSI A58.1-1972, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures."

5-6 NUREG/CR-5042, 'Evaluation of External Hazards to Nuclear Power Plants in the United States,' Prepared for USNRC, December, 1987.

5-7 U.S. Nuclear Regulatory Commission Regulatory Guide 1.76, 'Design Basis Tornado for Nuclear Power Plants,' Washington D.C. April 1974.

5-8 Markee, E.H., Beckerley, J.G., and Sanders, K.E., 'Technical Basis for Interim Regional Tornado Criteria,' Wash-1300, U.S. Atomic Energy Commission, Office of Regulation, Washington, D.C., 1974.

5-9 Ramsdell, J.V., Andrews, G.L., 'Tornado Climatology of the Contiguous United States,' Pacific Northwest Laboratory Operated by Batelle Memorial Institute, Prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-1461, 1986.

5-10 McDonald, J. R., 'Tornado and Straight Wind Hazard Probability for Millstone Nuclear Power Plant Site, Connecticut,' Prepared for USNRC, May, 1980.

5-11 'Standard for Estimating Tornado and Extreme Wind Characteristics at Nuclear Power Sites,' ANSI/ANS-2.3-1983, American Nuclear Society, La Grange Park, Illinois.

5-12 Twisdale, L. A., Dunn, W. L., Hardy, M. B., Tornado Missile Risk Analysis of Millstone Unit 3 Emergency Generator Enclosure Opening, Final Report C5945.3, 1985.

5-13 Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites, UCRL-53526, Rev. 1, August, 1985.

5-14 Yankee Atomic Electric Company Calculation NUC-150, 'IPEEE High Winds/Tornadoes, December, 1994.

5-15 U.S.N.R.C. Generic Letter 89-22, Potential for Increased Roof Loads and Plant Area Flood Runoff Depth at Licensed Nuclear Power Plants Due to Recent Change in Probable Maximum Precipitation Criteria Developed by the National Weather Service, October 19, 1989.

5-16 Yankee Atomic Calculation No. NUC-152, Millstone IPEEE External Flooding (Site Design Basis), September 1994.

5-17 U.S. Department of Commerce, NOAA, Memorandum HUR 7-97, Meteorological Characteristics of the Probable Maximum Hurricane, Atlantic and Gulf Coasts of the United States, National Weather Service, 1968 (unpublished).

5-18 Safety Evaluation Report (SER), Millstone Nuclear Power Station, Unit 2, U.S.N.R.C., May 10, 1974.

5-19 SER Supplement 1, March 7, 1975.

5-20 SER Supplement 2, August 1, 1975.

5-21 NUREG-0824, Integrated Plant Safety Assessment, Systematic Evaluation Program, Millstone Nuclear Power Station, Unit 1, Final Report, U.S.N.R.C., February 1983.

5-22 NUREG-0824, Supplement 1, November 1985.

5-23 Letter from Shea (NRC) to Counsil (NU), Subject: Millstone Nuclear Power Station, Unit 1 - Safety Evaluation Report on Hydrology SEP Topics II-3.A, II-3.B, II-3B.1 and II-3.C, LS05-82-06-132, June 30, 1982.

5-24 Yankee Atomic Calculation No. NUC-153, Millstone IPEEE External Flooding (Local Intense PMP), November 1994.

5-25 NOAA Hydrometeorological Report No. 52, Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian, National Weather Service, August 1982.

5-26 NOAA Technical Memorandum NWS HYDRO-35, Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States, National Weather Service, July 1977.

5-27 Hydrometeorological Report No. 33, Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1000 Square Miles and Durations of 6, 12, 24 and 48 Hours, U.S. Weather Bureau, April 1956.

5-28 Standard Project Flood Determinations, EM 1110-2-1411, U.S. Army Corps of Engineers, Revised March 1965.

5-29 Connecticut Light & Power, 1991 Photogrammetry, Millstone Point, Drawing No. 21582-

A (Sheet 1 of 1) and Drawing No. 21582 (8 sheets).

5-30 Yankee Atomic Calculation No. NUC-161, Vehicle Bomb Barrier - Flooding Evaluation, Millstone Units 1, 2 and 3, April 1995.

5-31 Letter from J.M. Powers (NU) to T. O'Hara (Yankee Atomic), Subject: Millstone Unit No. 2, IPEEE, External Flooding and High Wind/Tornadoes, NE-95-SAB-210, May 17, 1995.

5-32 USNRC, "Standard Review Plan," NUREG-75/087, November 1975.

5-33 USNRC, Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," June 1974.

5-34 USNRC, Regulatory Guide 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants," February 1978.

5-35 USNRC, "Standard Review Plan for Reviewing Safety Analysis Reports for Nuclear Power Plants," NUREG-0800, June 1987.

5-36. Final Safety Analysis Report, Millstone Nuclear Power Station, Unit 3, Docket 50-423.

5-37 Yankee Atomic Electric Company, Engineering Calculation NUC-103, "IPEEE Off-site Hazardous Materials Analysis," Millstone, Unit 2, December 1993.

5-38 Millstone Unit 1, SEP Topic III-4.D, Site Proximity Missiles, September, 1981.

5-39 Millstone Unit 3 Probabilistic Safety Study, August 1983.

5-40 Yankee Atomic Electric Company, Engineering Calculation NUC-088, "Aircraft Hazard Analysis for Millstone Units 1 & 2," November, 1993.

5-41 CYAPCO Letter from W.G. Council to D.G. Eisenhut, USNRC, Subject: "... Millstone Nuclear Power Station, Unit 2... Post TMI Requirements - Response to NUREG-0737," July 1, 1981.

5-42 Yankee Atomic Electric Company, Engineering Calculation NUC-104, "IPEEE On-site Hazardous Materials Analysis," Millstone, Unit 2, December 1993.

5-43 "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - 10CFR50.54(f) (Generic Letter 88-20, Supplement 4)," dated June 28, 1991.

5-44 NUREG/CR-2300, "PRA Procedures Guide, A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants," Final Report.

5-45 Memo from S.D. Weerakkody, 'GL 88-20, Additional External Events,' NE-93-SAB-239, May 19, 1993.

5-46 NUREG/CR-5042, Supplement 2, "Evaluation of External Hazards to Nuclear Power Plants in the United States", February 1989.

5-47 Berry, F. A., et al., Handbook of Meteorology, First Edition, McGraw-Hill Book Company, New York, 1945.

5-48 NUREG/CR-3992, "Collection and Evaluation of Complete and Partial Losses of Off-Site Power at Nuclear Power Plants", Oak Ridge National Laboratory, TN., February 1985.

5-49 Letter to NRC from D. C. Switzer (NNEC), 'Millstone Nuclear Power Station, Unit No. 2 Evaluation of Standard Review Plan 9.5.1,' Docket No. 50-336-692, Feb. 28, 1977.

5-50 NSAC-41, "lightning Problems and Protection at Nuclear Power Plants", December 1981.

5-51 Mitsche, J., "Reducing Lightning Damage and Outages", EPRI Journal, Vol. 13, Number 8, pp. 40 - 42, December 1988.

5-52 "Probabilistic Analysis of Turbine Missile Risks: Low-Pressure Steam Turbine Missile Generation Events", Volume 1, EPRI Report NP-4334-CCMP, November 1985.

5-53 Regulatory Guide 1.27 "Ultimate Heat Sink for Nuclear Power Plants", U.S. Nuclear Regulatory Commission, Office of Standards Development, Washington, D.C. Revision 2, January 1976.

5-54 NUREG-1032, "Evaluation of Station Blackout Accidents at Nuclear Power Plants", June 1988.

5-55 Regulatory Guide 1.155, "Station Blackout", U.S. Nuclear Regulatory Commission, Office of Research, Washington D. C., June 1988.

5-56 Bechtel Corporation, Design Manual, 'The Millstone Point Company, Millstone Nuclear Power Station Unit No. 2, Waterford, Connecticut,' May 1970.

5-57 Yankee Atomic Electric Company Calculation, "Roof Snow Loads at Haddam Neck," NUC-105, November 1993.

5-58 John P. Jacobson letter to James M. Powers, " Millstone Unit No. 2, IPEEE. External Flooding and High Wind/Tornadoes Walkdown Photograghs", dated June 13, 1995

6.0 Licensee Participation and Internal Review Team

6.1 IPEEE Program Organization

The flowchart in Figure 6.1-1 illustrates how the IPEEE program was organized. In order to ensure that knowledge gained from one IPEEE project was transferred to other IPEEE projects, an IPEEE program coordinator position and discipline lead positions (e.g., fire, seismic) were created.

The fire IPEEE was performed by NUSCO with the assistance Yankee Atomic Electric Company (YAEC). They provided assistance in two major areas. They are:

- Reviewing methods used against state of the art methods.
- Performing technical work inconjunction with NUSCO engineers.

The seismic IPEEE was performed using the assistance of several consultants and in coordination with the USI A-46 project . NNECO Civil engineering provided coordination of this aspect of the MP2 IPEEE as well as technical review and input.

Evaluation of external flooding, high winds/tornados and transportation and nearby facility accident initiators was performed with the assistance of YAEC. This work was coordinated by the NNECO Civil Engineering.

6.2 Composition of Independent Review Teams

Different types of independent reviews were performed during the IPEEE analysis. They include:

a) a general peer review of assumptions and methodology by Northeast Utilities personnel,
b) high level peer reviews of assumptions and methodology by recognized experts and
c) review of technical analysis (calculation files etc.) by Northeast Utilities personnel.

The discussion that follow provides a general description of how these types of independent reviews were performed for each of the external event initiators.

i. <u>Seismic IPEEE</u>

Several different teams were involved in performing the review of assumptions and methodology related to the Seismic Margins Evaluation. Consultants from Stevenson & Associates (electrical and mechanical) and Dr. John Reed (structural) performed the seismic walkdowns for the IPEEE. Their findings and conclusions were peer reviewed, (included walkdowns) performed by Dr. R. P. Kennedy and John Stevenson.

Building response models, in-structure demand assumptions and the interaction analysis between the Turbine and Auxiliary building were performed primarily by Stevenson and Associates with review performed by Northeast Utilities personnel.

ii. Fire IPEEE

NUSCO PRA contracted Yankee Atomic Electric Company (YAEC) to support the fire IPEEE effort. YAEC supported two distinct areas. They are a) reviewing methods and approaches, and (b) performing the technical analysis in selected areas.

Dr. Vesna Dimitrijevic who has performed several fire PRAs provided overall project direction for the fire IPEEE by way of reviewing the NUSCO project plan and methods and approaches. In addition, she and other members of the YAEC team provided technical analysis in many areas such as target-set selection and fire damage analysis. All technical work performed by YAEC was reviewed by the NUSCO PRA personnel to ensure technical knowledge transfer and accuracy of results. All calculation files generated by NUSCO PRA personnel were independently reviewed by other NUSCO PRA personnel.

iii. External Flooding, High Winds/Tornados and Transportation and Nearby Facility Accidents

YAEC was contracted to support the technical analysis of the external event analysis for the above two external initiators. Since YAEC had performed similar type of work for other plants, no separate activity was created to review the methods used. All information that is needed to support the work was provided to YAEC by NUSCO Civil Engineering. The YAEC analysis was documented in calculation files and transmitted to NUSCO. These calculation files were reviewed by NUSCO Civil Engineering or PRA personnel.

6.3 Areas of Review and Major Comments

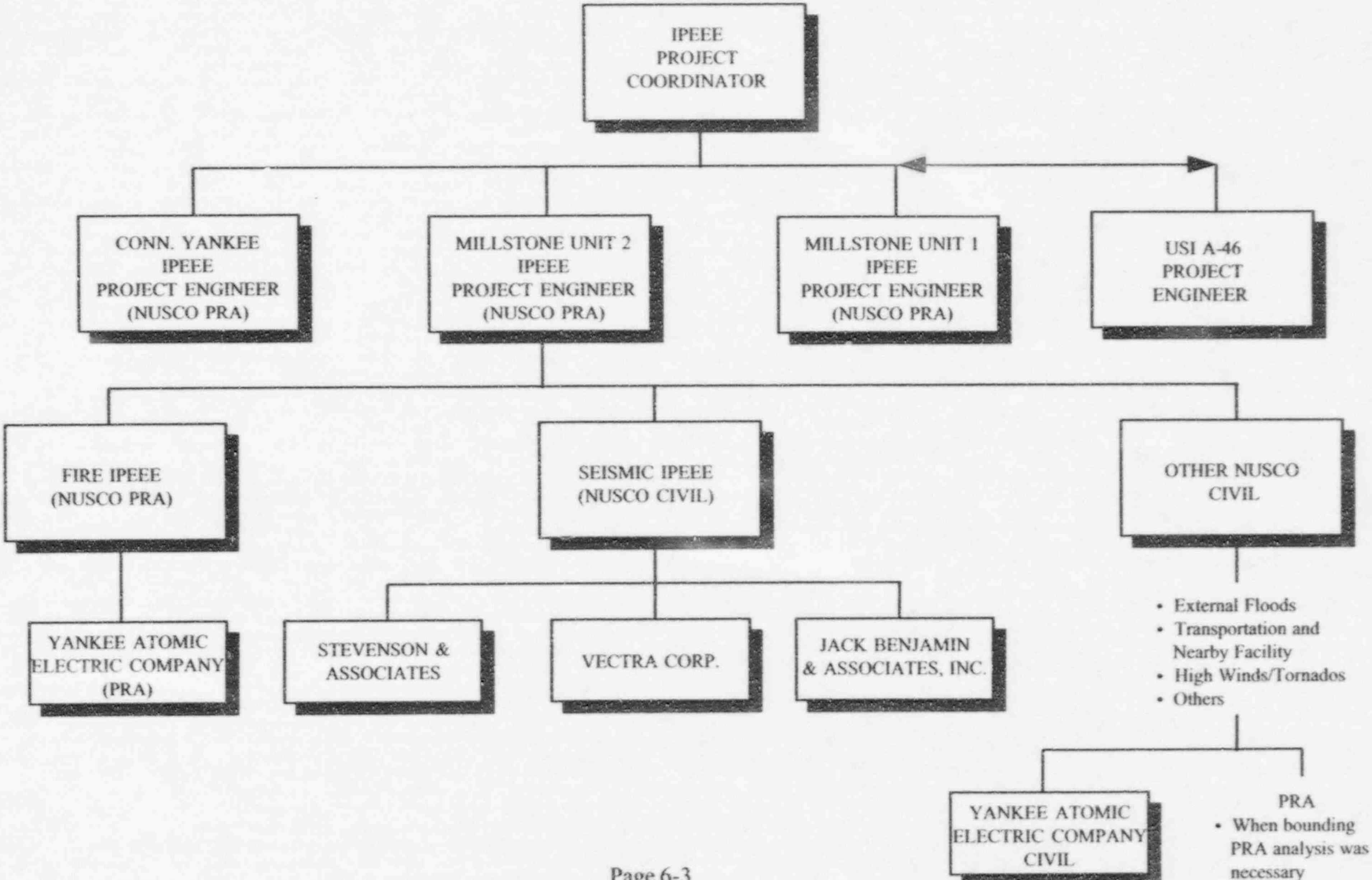
The technical and peer review team was responsible for every facet of the MP2 IPEEE analysis. Because of the diversity of experience, some of the reviewers commented on methods and techniques of the analysis and others commented on the results or accuracy of the model with regard to the real plant.

6.4 Resolution of Comments

Each comment raised by the independent reviews discussed in Section 6.3 was responded to by the project engineer and the MP2 IPEEE team.

MP2 IPEEE
Figure 6.1-1

IPEEE PROGRAM ORGANIZATION



7.0 Plant Improvements

The MP2 IPEEE process revealed several outliers for the beyond design basis external events that were evaluated. Some of these were resolved within the same period of time that the IPEEE took place. Those outliers, which have not been addressed, are tabulated and tracked for further investigation and resolution.

Resolution of some issues may require additional PRA or Engineering evaluation to identify cost-beneficial solutions. As stated in Section 1.4, findings will be prioritized based on their risk significance and the method of resolution, for each finding, will strongly depend upon the potential risk reduction that can be achieved.

Table 7.1-1 provides a listing of all outliers that were recognized. Column 1, of this table, provides a brief description on each outlier. The second column "Proposed Fix" provides a description of the planned action under consideration. The third column "Status" provides the planned schedule for the outlier resolution.

TABLE 7.1-1

OPPORTUNITIES FOR SAFETY ENHANCEMENTS

OUTLIERS	METHOD/S CONSIDERED FOR RESOLUTION	STATUS
SEISMIC		
Air operated valve 2-CHW-11 has a heavy operator that is independently braced.	This component is on the USI A-46 Safe Shutdown Equipment List (SSEL) also. Therefore, it is being tracked under A-46. IPEEE program will support resolution by providing relative risk significance of this issue in comparison to all other USI A-46 issues.	Item to be resolved(1).
The RBCCW Surge Tank does not meet USI A-46 requirements.	This component is on the USI A-46 Safe Shutdown Equipment List (SSEL) also. Therefore, it is being tracked under A-46. IPEEE program will support resolution by providing relative risk significance of this issue in comparison to all other USI A-46 issues.	PDCR #2-95-040 has been prepared and approved to perform a modification on the tank supports. This will resolve the outlier condition.
On Emergency Diesel Generator H7A, one isolation mount housing for a local control panel was found to be cracked.	N/A	Issue resolved. The cracked support was judged not to reduce seismic ruggedness below the SME. However, as good practice, SRT recommended replacement or repair. This work has been completed.
The anchorage of cabinets C25A and C25B could not be determined.	These cabinets are on the USI A-46 SSEL. Therefore, they are being tracked under USI A-46 program for resolution. IPEEE program will support resolution by providing relative risk significance of this issue in comparison to all other USI A-46 issues.	Item to be resolved(1).
File Cabinets in the Control Room present an interaction hazard.	N/A	Issue resolved. Subsequent to the walkdown, a corrective action was issued to correct housekeeping problems.
Gaps between the base on the battery racks DB1 and DB2 and the floor reduce shear capacity of the anchorage.	Eliminate gaps.	Item to be resolved(1).

Note: (1) Findings will be prioritized based on their risk significance and the method of resolution, for each finding, will strongly depend upon the potential risk reduction that can be achieved. The word "resolved" can either mean implementing plant improvements or it can mean determining that further plant improvements are not cost beneficial relative to the corresponding safety improvement.

TABLE 7.1-1 (continued)

120VAC Instr. Panel VR 11 and 21 have a narrow base that results in high anchorage tension.	Evaluate the need to improve anchorage.	Item to be resolved[1]
The enclosure expansion anchorage was found to be limiting for RSST Feeder Breaker's 22S3-2-2 enclosure.	Evaluate the need to improve anchorage.	Item to be resolved[1]
Tank anchorage was found to be limiting for the Chilled Water Surge Tank, T98.	Evaluate the need to improve anchorage.	Item to be resolved[1]
The block wall adjacent to INV-5 is not considered "Safety Related" and was assumed to be unreinforced.	A rocking/collapse calculation has been performed for this wall. Results of this evaluation and the risk significance of INV-5 will be used to decide course of action.	Item to be resolved[1].
FIRE		
Large Quantities of transient combustibles (protective clothing) in open storage racks placed near concentration of cable trays.	i. Reduce Quantity. ii. Store in enclosed fire related lockers. iii. Remove from area.	Item to be resolved[1].
FIRE/SEISMIC INTERACTIONS		
The seismic capacity of Millstone Point Unit 1 (MP1) diesel fire pump fuel tank may not be adequate. MP2 relies on MP1 fire suppression system for fire protection. Fires generated as a result of earthquakes is common. Fire pumps driven using offsite power cannot be depended upon since most earthquakes will result in loss of offsite power.	Perform additional evaluation to ensure seismic adequacy. If determined to be inadequate, perform modification to improve seismic ruggedness.	Item to be resolved[1].
A long run of fire water header system piping along the Turbine Building's north wall appear to have very low seismic capacity.	The pipe run is inadequately attached to its supports. Attach pipe to its supports adequately.	Item to be resolved[1].
The block wall construction of the fire pump house (shared by MP1 and MP2) may not provide adequate seismic ruggedness.	Evaluate seismic ruggedness. If seismic ruggedness is low, enhance structure.	Item to be resolved[1]
HIGH WINDs AND TORNADOs		
The day tank vent pipe, the exhaust gas silencers, and the intake combustion air filters are not protected from tornado missiles. During a Tornado, the Loss of Normal Power (LNP) is expected. The Cross-Tie to MP1 cannot be counted on since the LNP is expected to be for the site. Therefore, diesels will be key to maintaining safety.	Perform probabilistic analysis to determine whether the hazard level is acceptably low.	Safety issue resolved. The probabilistic analysis concluded that frequency of both diesels failing due to a tornado missile is approximately 10^{-7} per year.
The internal systems and components in the Intake structure (eg. Service Water pumps) may be vulnerable to a tornado missile passing through either the doors or the roof hatches.	Perform probabilistic analysis to determine whether the hazard level is acceptably low.	Safety issue resolved. The probabilistic analysis concluded that frequency of both diesels failing due to a tornado is approximately 10^{-7} per year.

Note: (1) Findings will be prioritized based on their risk significance and the method of resolution, for each finding, will strongly depend upon the potential risk reduction that can be achieved. The word "resolved" can either mean implementing plant improvements or it can mean determining that further plant improvements are not cost beneficial relative to the corresponding safety improvement.

TABLE 7.1-1 (continued)

Control Room and Diesel Generator Room Cooling ducts and dampers may be vulnerable to the 10^{-6}/year tornado pressure transient loading.	Perform additional evaluations.	Item to be resolved(1).
OTHER (Hail, Lightening, Turbine Generated Missile, Ice, Snow, Frost, Low Winter Temperature, High Summer Temperature)		
Intakes and vents with insufficient height may pose a problem given a large accumulation of snow and or ice.	Evaluate intakes and vents with insufficient height. This includes the Diesel Generator day tank flame arrester	Item to be resolved(1).
EXTERNAL FLOODING		
Functionality of the backwater valves described in FSAR section 2.5.4.2.2 which prevent flood waters from flowing into buildings via the storm drainage has not established.	Evaluate the backwater valves.	Item to be resolved(1).
AOP 2560 requires that the flood gates be closed if the flood water level exceeds 14ft MSL. The time available to close all flood doors may be insufficient in consideration of the expected rate of rise of flood waters.	Consider change to AOP 2560. Specifically, consider lowering the flood water level at which flood door closing is required.	Item to be resolved(1).
AOP 2560 and Tech Spec 3.7.5 require that installation of the flood protection "can" over one Service Water pump motor should be initiated if the flood water level exceeds 14 ft MSL.	Confirm whether this water level should be used with regards to rising water levels inside the Intake Structure.	Item to be resolved(1).
The FSAR and AOP 2560 note that the Service Water pumps would be tripped if the water level inside the Intake Structure rises to elevation 22 ft MSL. It has not been verified that equipment essential for Service Water pump operation are available at flood levels below 22MSL.	Verify that there is no equipment required for Service Water pump operation which could become inoperable at a lower flood elevation.	Item was resolved during walkdowns. No equipment required for Service Water operation would become inoperable if flooding levels were below 22 ft MSL.
AOP 2560 does not recognize the need to establish a safety line to the Intake Structure during a flood and assumes personnel access to the Intake Structure is required.	Change AOP 2560 to specify, as does MP1 ONP 514A, that a safety line to the Intake Structure should be established during a flood.	Item to be resolved(1).
Information provided in FSAR section 2.5.4 is out dated.	Revise FSAR section 2.5.4 using information provided in Yankee Atomic Calculation #NUC-152.	Item to be resolved.
Underground conduits (accessible from yard man holes and Intake Structure) provides inleakage paths to buildings.	Inleakage into buildings via underground conduits requires further evaluation. The conduits include those accessible from yard manholes and the Intake Structure subject to site flood levels.	Item to be resolved(1).

Note: (1) Findings will be prioritized based on their risk significance and the method of resolution, for each finding, will strongly depend upon the potential risk reduction that can be achieved. The word "resolved" can either mean implementing plant improvements or it can mean determining that further plant improvements are not cost beneficial relative to the corresponding safety improvement.

TABLE 7.1-1 (continued)

Local site ponding due to local intense rainfalls is up to about 1 foot above most door sills for the FSAR (1975 SRP) and 10^{-6} probability rainfalls and up to about 1.6 feet above most door sills for the NWS PMP rainfall. Unlike a hurricane with a long advance warning time, it may not be possible to close all flood doors during a local intense precipitation event since there may be little advance warning.	The effect of these local flood levels, structurally on doors and inleakage into buildings requires further evaluation. A means of reducing inleakage through critical doors may suffice. Another possibility would be to provide for better drainage away from the structures.	A walkdown was performed to review inleakage potential and determine the effect of inleakage on the operability of essential plant equipment. It was determined that given the duration of inleakage and the potential area available for inleakage, local ponding does not pose a significant plant hazard. This determination considered the internal flooding PRA evaluation to understand propagation and the effect of flooding on plant equipment. (As an aside, it was noted, during the walkdown that several of the external flooding stop logs were in need of maintenance).
The FSAR notes that scuppers are provided to prevent excess roof loading due to ponding. There are no scuppers, therefore, maximum ponding, assuming the interior roof drains are clogged as noted in the FSAR, could exceed roof design loads.	Perform further assessments and possible FSAR clarifications.	Item to be resolved(1).
The FSAR implies that site topography precludes local site flooding. Analyses using detailed topographic maps does not corroborate this FSAR statement. It is possible that some alterations to the local topography could reduce local site flooding.	Perform further assessments and possible FSAR clarifications.	Item to be resolved(1).
During the site walkdown, many roof drains were observed to be partially to nearly completely clogged with debris, shells, feathers and bones. Note that during the MP1 SEP, the NARC did not accept any credit for interior roof drains. However,maximum availability of roof drain capacity would be of benefit during occurrence of local intense precipitation. The interior roof drains are designed for a rainfall rate of 3 inches per hour.	Consideration should be given to periodic inspection/cleaning of roof drains.	Item to be resolved(1).
Roof penetrations, such as low vents, low hatches and other penetrations, may not be watertight below the highest potential level of roof ponding.	Perform further evaluation to identify such low vents and hatches and implement appropriate corrective measures.	Item to be resolved(1).

Note: (1) Findings will be prioritized based on their risk significance and the method of resolution, for each finding, will strongly depend upon the potential risk reduction that can be achieved. The word "resolved" can either mean implementing plant improvements or it can mean determining that further plant improvements are not cost beneficial relative to the corresponding safety improvement.

8.0 Summary and Conclusions

This report examines the plant-specific relationship of external events to severe accidents at MP2. The results of the current study indicate a relatively low risk from external events. Several issues relevant to safety were identified as a result of the IPEEE. Some of the issues have already been eliminated by plant modifications or procedure changes. Others are planned and tracked for resolution.

These evaluations have brought to light plant vulnerabilities to severe external events which are typically well beyond design basis. Even though MP2 was found to have low risk attributed to external events such as fires and seismic, the evaluations have provided useful insghts. Since the IPEEE utilized probabilistic methods to evaluate many aspects, it not only identified issues but also helps in understanding the relative risk-significance of the identified issues. These insights will allow plant management to prioritize safety improvements.

Several issues that include Generic Issues (GIs), Unresolved Safety Issues (USIs), a three part unresolved item from NRC Inspection Report 50-336/93-81 (Item # 93-81-09) were addressed and closed out under this IPEEE. They are:

- USI A-45 "Shutdown Decay Heat Requirements."
  IPEEE examined MP2's Seismic and Fire related vulnerabilities of decay heat removal function. No outliers were found.

- Eastern U.S. Seismicity Issue. This issue is closed out under IPEEE. Additional actions were determined to be unnecessary.

- NUREG/CR-5088 "Fire Risk Scoping Study." This issue will be closed out. The Fire/Seismic interaction issues in Table 7.1-1 address all remaining concerns.

- GI-57 "Effect of Fire Protection System Actuations on Safety-related Equipment." Addressing the fire risk outliers, fire/seismic interaction and responding to IN94-12 closes out this issue. Table 7.1-1 identifies all remaining issues to be tracked for resolution.

- "Probable Maximum Precipitation (PMP)" criteria presented in Generic Letter 89-22. Table 7.1-1 identifies all remaining issues to be tracked for resolution.

- Unresolved item # 93-81-09, sloshing effect of fuel in the Diesel Generator day tanks relative to the seismic capacity of these tanks, is discussed in Section 3.2.5.1.

- Unresolved item # 93-81-09, tornado protection of the Diesel Generator day tank vents, is discussed in Section 5.1.5

- Unresolved item # 93-81-09, the effect of ice and snow on the Diesel Generator day tank flame arrestor, is discussed in Section 5.4.6.

In addition to the above, the MP2 Seismic IPEEE was very closely coordinated with the USI-A-

46 "Verification of Seismic Adequacy of Equipment in Operating Plants," which also included the following issues:

- USI A-12 "System Interactions in Nuclear Power Plants."
- USI A-40 "Seismic Design Criteria"